Water scarcity could become one of the most pressing natural resource issues of the twenty-first century. Earth’s population has nearly tripled since 1950, and projections indicate that it could quadruple by 2050. Rising demands for food and energy brought about by population increases and economic growth have seriously taxed this valuable resource worldwide, and ecosystems are further stressed by climate change and pollution (Eckstein 2009). Despite the contributions of science to understanding water scarcity and hydrological cycles, water availability in the United States is still ultimately mediated through existing infrastructure and traditional sociopolitical institutions that govern water use.

Scientific Background

Although water covers 70 percent of Earth, only 2.5 percent is fresh. Freshwater comes from rain, underground sources, ice, rivers, and lakes; the rest is saltwater and is thus unusable in its natural state for most applications. Water scarcity exists when freshwater is insufficient to meet demands. Scientific inquiry into water scarcity examines demand and supply in addition to issues related to climate change, desertification, growing populations, biodiversity, disparate water distribution, and distribution management and hazards (such as wildfires). Water supplies depend on precipitation patterns, climate, and water sources (precipitation, desalination, or surface and groundwater supplies).

Freshwater availability is crucial to maintaining environmental and social systems. Groundwater is the source of nearly 40 percent of the freshwater used in the United States, and most rural areas depend on it for drinking and other domestic purposes. Losing groundwater faster than it can be replaced causes wells and natural springs to dry up, and surface water, such as wetlands and rivers, to disappear (Environment News Service 2010).

Competing Human Issues

Population growth is the most important trend affecting the demand for water, but that alone does not completely explain the water scarcity problem. Over the past century, water consumption has increased twice as fast as population growth. As populations grow and urbanization expands, desire for agricultural and industrial products increases. Current studies indicate that in some U.S. locations the freshwater supply is reaching its limits while usage escalates.

Water scarcity is subject to considerable regional variation based on local demand. Differences in availability can be due to precipitation levels, rainfall seasonality, storage capacity, and/or the degree to which river flows and groundwater are replenished. Significant groundwater depletion has already occurred in many areas of the country; in some cases it has permanently reduced aquifer storage capacity or allowed saltwater to intrude into freshwater sources.

In the past, most water scarcity studies were limited to assessing human water needs for domestic, industrial, and agricultural uses. Studies identified areas of current and future water scarcity and areas of potential water-related conflicts (“water wars”) and helped establish priorities for financing water projects. These studies did not, however, consider the requirements of freshwater ecosystems that,
for example, support fisheries and provide flood protection and wildlife habitat. Consequently, a
growing scientific constituency has begun studying water allocation for ecosystem services and
integrity, such as the benefits of leaving water in streams for environmental, recreational, and water-
quality purposes. Their findings have intensified the debate about freshwater allocation (Wolf 2007). A
growing number of scientists now argue for allocating water to maintain ecosystems in the same way it
is earmarked for agriculture, power generation, domestic use, and industry.

**Climate Change Concerns**

Climate change is further altering freshwater supplies. Receding glaciers, diminished stream and river
flow, and shrinking lakes have reduced previously available sources. Aquifers are overdrawn and are not
recharging quickly enough to meet demand.

Water scarcity and drought cause social and economic problems that will only get worse due to climate
change. In 2012, the United States experienced the most severe drought in at least twenty-five years.
Drought affected 80 percent of agricultural land in the country, causing poor agricultural conditions,
significant wind and insect damage to crops, hay shortages, forced sales of livestock, agricultural
production losses, reduced supplies of irrigation water, price increases, more intense wildfires, and
enforced water usage restrictions (U.S. Department of Agriculture [USDA] 2013). Experts expect that
climate change will affect water supply conditions in all regions of the United States, through either
increased demand associated with higher temperatures or changes in supply because of new

**Politics and Policy**

Water policy serves multiple objectives and competing interests, and therefore water scarcity issues
are becoming more politicized worldwide. In the United States, controversies exist over the definition
of scarcity and whether scarcity is a policy-induced consequence of mismanaging water resources.
Debates also center on issues related to scarcity management, such as modifying existing policy,
making investments to improve technological efficiencies, implementing alternative water management
regimes, scaling solutions from local to international, and what role the public sector and market-based
solutions should play in management scenarios.

Water scarcity in U.S. policy historically has involved powerful and competing industry lobbyists, public
and private entities, state and federal agencies, and complex state and federal legislation. In California’s
Central Valley, for instance, farmers were paying only about one-tenth of what it cost the government
to supply water to the region, whereas now they are on limited contracts that require repayment costs.
Private companies have sought similar price inequities but are often met with resistance as citizens
speak up in protest. Although these types of controversies can start water wars, they also can foster
cooperation when citizens work together to return water systems to local, democratic, and public
control.

**The Role of the Federal Government**

The federal government has authority to manage water resources, but it recognizes state authorities,
which can result in ineffective and inequitable enforcement of key water laws. Additionally,
responsibilities for water policy implementation are spread among diverse federal agencies, creating
confusion about which agency has authority in a given case.

Historically, the Bureau of Reclamation and the Corps of Engineers have played the largest role in water
management through constructing, operating, and maintaining large facilities to store and manage untreated water. Currently, however, more than thirty federal agencies and programs within the Departments of Interior, Agriculture, and Commerce have some type of water-related mission. These agencies build, operate, and maintain large storage and distribution facilities, too, but also collect and share water availability and use data, administer clean water and environmental protection laws, assist in developing and implementing water-management agreements and treaties, and act as trustees for federal and tribal water rights.

In the 1970s, the U.S. Congress recognized a need for a more comprehensive water planning and management approach and passed the National Water Commission Act. This act called for the creation of a National Water Commission, which produced a 600-page report concluding, among other things, that collaboration among agencies must be improved, more research and data must be collected, and more attention must be paid to infrastructure projects (National Water Commission 1973).

Today, additional federal agencies administer clean water and environmental protection laws that affect water resource management. The Environmental Protection Agency administers the Clean Water Act—the nation's principal federal law regulating surface-water quality. The Fish and Wildlife Service and National Marine Fisheries Service are responsible for administering the Endangered Species Act, which requires federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed plant or animal species or to adversely modify or destroy designated critical habitat, including water.

Although agencies can make recommendations to address water scarcity issues, funding requests are ultimately requested from the executive branch. The legislative branch is charged with actually appropriating requested funds, but the executive and legislatives branches are not always in agreement regarding vision or priorities. Political gridlock also slows the rate at which advances in scientific and technical understanding of water scarcity issues are brought into the decision-making process.

**The Role of State Governments**

Many water problems must be resolved at the local and state levels. However, federal statutes restrict state water regulation, and control over water management is lodged in myriad districts with varied incentives and limited capabilities to develop sustainable and enforceable long-term water management programs. State laws governing water allocation fall under the *riparian doctrine* (grounded in English common law) and *prior appropriation doctrine* (based on the 1876 Colorado Constitution).

Under the riparian doctrine, water rights are linked to land ownership—owners of land bordering a waterway have a right to use the water that flows past the land for any reasonable purpose. All landowners have an equal right to use the water, and no one gains a greater right through prior use. In contrast, the prior appropriation doctrine does not link water rights with land ownership. Water rights instead are linked to priority and beneficial water use—parties who obtain water rights first generally have seniority for the use of water over those who obtain rights later, and rights holders must put the water to beneficial use or abandon their right to use the water.

When a water shortage occurs, under the riparian doctrine all water users share the shortage in proportion to their rights, but under the prior appropriation doctrine, shortages fall on those who last obtained a legal right to use the water. Inconsistent national interpretation of the doctrines leaves policy decisions with the states; most Western states have adopted the prior appropriation doctrine,
and Eastern states use the riparian doctrine (Schutz 2012).

States enter into interstate compacts to address water allocation, quality, and other issues on rivers and lakes that cross state borders. The resulting decentralization of scientific and regulatory authority contributes to a lack of comprehensive water scarcity policy.

**Policy Directions**

Clearly, water scarcity is a complex policy domain. The United States has not generally focused on comprehensive and integrated policies. Human and ecological water needs have been managed separately, and management has been fragmented and isolated in separate agency arenas. Historically, planning and constructing large water storage systems, such as dams and distribution networks, were the province of water engineers and hydrologists, and financing expensive water infrastructure was regarded as a government responsibility. In recent decades, however, emphasis has shifted toward attempting to induce cooperative behavior by involving diverse stakeholder groups. Stakeholder networks and stakeholder expertise have become crucial for achieving politically feasible outcomes in water management and sustainability solutions (Sabatier et al. 2005).

A shifting water-usage paradigm that acknowledges water as a limited resource is evident in voluntary efforts to address water scarcity. For example, individuals and businesses are making efforts that include recycling and conserving water by using appliances such as low-volume shower heads and more efficient washing machines and toilets, and by using native plants and lawn substitutes in landscaping. Growing public recognition that water is finite has led to policies that encourage conservation across the United States. New requirements for water-efficient fixtures, more efficient irrigation methods, and water marketing policies that allow users to bid on water rights have discouraged wasteful water use (Head 2010).

As the scientific evidence of environmental degradation of waterways becomes more compelling, corresponding shifts in far-reaching U.S. policy are beginning to occur. As one example, for nearly a century dams have been constructed to store water and generate electricity, but due to negative effects on aquatic habitats, sediment accumulation, and other ecological consequences, the Army Corps of Engineers announced in 1998 that it would no longer build large dams and water diversion projects. In the Pacific Northwest, several dams are in various stages of removal to allow for the return of upstream salmon spawning.

**Conclusion**

As a result of climate change, projected population growth, and rising demand for food and energy, the world's water supply faces some extraordinary challenges in the near term. Scientists and policy makers are looking at ways to enhance water supplies and re-think approaches to managing demand.

The United States has seen important strides in water management, wastewater treatment, pollution reduction, conservation, and efficiency measures since the 1970s, but much room for improvement remains. A fragmented history of addressing water policy has resulted in a patchwork of old laws, competing economic interests, and aging technological infrastructure. Addressing the problem of water scarcity will take time and effort and an examination of complex social, technological, and ecological priorities.

**Bibliography and Further Reading**


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