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Clean Water Scarcity (1950s-present)

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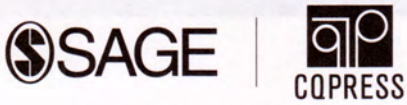

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chapter 21

Clean Water Scarcity (1950s–Present)

Joanna Endter-Wada

IT IS ESSENTIAL TO UNDERSTAND THE EVOLVING water policy challenges of accessing and sharing scarce, clean water in the United States. The nation is headed for difficult times in a complex system that has always been fraught with inherent contradictions and conflicts. The accumulating and combined effects of population growth, economic development strategies, and climate change on water resources reinforces that clean, fresh water is not limitless and foreshadows a reckoning over how it is being used.

Even though planet Earth has abundant water, it is generally conceded that we are experiencing water problems that are leading to a variety of related social and environmental crises. A very small proportion of the total is fresh water (approximately 3 percent), and less than 1 percent is accessible clean water needed to sustain all life. Although water satisfies diverse human aesthetic, cultural, and economic needs, at least 10 percent of the world's population does not have access to safe drinking water, and a much greater percentage experiences health risks from lack of access to clean water for other uses, including sanitation. The U.S. population consumes about 176 gallons of water per capita per day; in many parts of the world per capita consumption is fewer than five gallons per day. These disparities are exacerbated when accounting for water use embedded in food and other consumable products and for variations in water access among different segments of national populations. Although growing and diversifying human uses of water impair the quantity and quality of water available for sustaining the environment, people and nature are bound together in their dependence upon water.

These basic facts give rise to three fundamental dilemmas that underlie U.S. water policy in the late twentieth century and early twenty-first century: (1) how to provide equitable access to the relatively small amount of fresh water for growing and often competing human uses, (2) how to ensure that water of adequate quality is available at places and times needed to support different types of uses, and (3) how to manage water upon which all life depends in ways that balance human and environmental needs.

WATER POLICY LEGACIES

Understanding the legacies of past policies and the changes occurring in government water-related authorities is important for addressing these three fundamental dilemmas. The foundation and course of U.S. water policies were set in the nineteenth century, but rights, institutions, and expectations have been in transition since World War II (1939–1945). Fundamental assumptions and approaches underpinning water policy, law, and management, which had evolved to meet nineteenth-century needs, are being challenged based upon realization that their historical trajectories are not sustainable. Nonetheless, the prevailing legal and scientific framings of water; the political, economic, and institutional power behind existing arrangements to control and utilize water; and the nation's extensive and aging water infrastructure are not easily modified, particularly in today's society that is deeply divided about the role of government and regulation and about balancing public and private interests.

Despite dozens of recommendations from commissions and experts throughout the nation's history, the United States currently does not have a comprehensive or coordinated water policy but, instead, a complex institutional framework for managing water. Governmental jurisdiction over water is shared by the federal government, the states, Indian tribes, and various water commissions operating under interstate compacts and international treaties. Numerous legislative committees, executive agencies, and courts within these governmental entities pursue different mandates and exercise authority over different aspects of water.

The institutional boundaries in this fragmented water policy landscape are legacies of government actions dealing with land and water during rapid European colonization of the North American continent and expansion of its capitalist system. They do not coincide with watershed or ecological boundaries of its natural landscapes. These policy boundaries reflect the fact that governments exercise multiple functions authorized by various water laws and policies in their different realms of authority. These functions include (1) providing citizens with access to water through allocating and frequently arbitrating rights and responsibilities in the use of water, as well as holding water rights for public and Indian lands and for other beneficial uses of water; (2) regulating environmental quality of water and aspects of nature that are highly dependent upon that water; and (3) developing water infrastructure (including scientific information) needed to control and manage the nation's waterways and water supplies. Often, these diverse governmental functions create policy conflicts between and within governments as different agencies fulfill administrative duties and pursue missions that serve varied constituencies and that require them to regulate actions of other government agencies. Such conflicts indicate that the American public is not unified behind the overall goals and objectives of the nation's water policies. Recognizing clean water limits and setting priorities on its use is one of the primary, overarching challenges of the present era.

PROVIDING WATER ACCESS

The foundational legal principal of water law in the United States is that water is a resource owned in common by the public, with individuals granted private rights (generally through permit systems) to use water for purposes and in ways that society has deemed to be beneficial and appropriate. Governments exercise trust responsibilities on behalf of the public, administer water rights, and arbitrate disputes. The need to balance public and private rights and responsibilities is embedded in water law and fuels water controversies. The balancing act that occurs in implementing water law is the key mechanism for providing equitable access to scarce, clean water.

In reality, who gets access to water resources is defined in a confusing welter of laws and policies that differ markedly from state to state and region to region. In the United States, individuals' rights to use water within their jurisdiction are generally governed by state water laws. The federal government apportions water bodies shared by two or more states (through compacts or Supreme Court rulings) and also negotiates treaties with Canada and Mexico regarding

MAP 21.1 **The Great Lakes Basin and Ecosystem**

The Great Lakes Water Basin, which forms a unique ecosystem, includes the Great Lakes themselves and the surrounding land in the United States and Canada. The basin, which forms a unique ecosystem, is managed by the Great Lakes Commission, established in 1955 to "promote the orderly, integrated and comprehensive development, use and conservation of the water resources" of the basin.

SOURCE: U.S. Army Corps of Engineers, Detroit District.

waters the United States shares with its neighbors. The federal government also reserves water rights for public lands it manages or reservations it holds in trust for Native American tribes. People can obtain access in a variety of ways: as members of the public, as individual holders of rights, as shareholders in an irrigation company or other water purveyor company, or as residents (and customers) in the service area of a culinary or potable water provider.

Public Rights in Water

Governments exercise what are known as public trust responsibilities over water. Loosely based on Roman ideas that some water rights belong to everybody and rooted in the common law, certain rights in water are protected for the benefit of all the people, such as rights to access and use of the surface of many waterways for navigation, hunting and fishing, and recreation. Some states in the United States declare in their water statues that water is the property of the public subject to private rights to its use that the state has approved; in other states, water is declared a public use subject to state regulation and control. Under the public trust doctrine, states have sovereign interests in navigable waters and the underlying beds to which private rights are subject. These sovereign interests mean that a state is to take the public's interests into account in water planning and allocating water rights. The extent to which states have sought to define and defend these public interests varies greatly, because they are seen to be in conflict with private rights to use water.

Individual Water Rights

Individuals or entities such as municipalities or irrigation companies can claim and hold rights to put the public's water to uses that society has designated as beneficial, with corresponding duties not to impair other people's use of this publicly owned resource. Rules to obtain rights to use water vary by state and by type of water source. Scarcity defines the water allocation system in most states. Eastern states that enjoy generally reliable year-round rainfall based their allocation systems on the European notion of riparianism, in which water rights are connected to ownership of land next to the watercourse, called riparian land, and owners of riparian land have jointly held rights to make reasonable use of adjoining water. The system holds as long as water is returned to the waterbody, and when water is scarce, all riparian landowners share in the shortages. Where water is scarce, the policy is to spread the resource over as much land as possible.

With the notion of prior appropriation, water is allocated separately from the land. The right to use water is tied to a diversion—removing the water from the watercourse and putting it to a "beneficial use." As the "prior" suggests, the first diverter has superior rights in times of scarcity, when water is generally delivered in order of seniority, based on the earliest rights that were established. The "first in time, first in right" notion is modified in some states or based on preferences given to certain beneficial uses (with domestic uses, agriculture, livestock watering, and industry often recognized as being most important).

These basic principles have been adopted in different ways in different states, but twenty-nine states, mostly in the eastern, United States follow some form of riparian system; nine states, mostly in the arid intermountain West, follow a prior appropriation system; and ten states in the Great Plains and on the West Coast, have adopted a hybrid of the two systems. Some states also have systems based on or admixed with ancient systems of law and land tenure. Hawaii reflects a system rooted in ancient land codes; Louisiana contains vestiges of a civil code with French and Spanish origins; and Pueblo water rights of Spanish origin have been integrated into state water laws in some parts of the Southwest. While all of these systems recognize the public nature of water and regulate impairment through responsibilities that users have to each other, the most significant differences have to do with severability of water from land, rules for exercising rights to use water, and distributing risks of water scarcity.

Groundwater

Use of groundwater increased dramatically after the 1930s with development of high-speed centrifugal pumps and government subsidization of rural electrification. Groundwater constitutes a primary source of drinking water and is used extensively in agriculture, providing approximately 40 percent of the supply in each of those use categories. Water law traditionally treated groundwater and surface water separately. Groundwater was initially conceived of as part of the soil, rights were defined by absolute ownership, and "the rule of capture" served interests of economic development. However, as knowledge of groundwater increased, state laws applied to its use variously evolved to incorporate principles applied to surface water such as reasonable use, sharing of shortages, ability to use water on lands other than those overlying an aquifer, and preferences for earlier permit users. State administration of groundwater is complicated by the nature of the harms that individuals' uses can cause for one another and the difficulties in determining liability for impairment. Some of the detrimental effects are lowered water tables, increased pumping costs, land subsidence, and interference with surface water flows. States have worked to establish permit systems for groundwater, designate "critical areas," exercise oversight of well construction, provide some protection for existing uses, and implement conjunctive management of surface water and groundwater.

Federal Reserved Water Rights

Water rights held by governments are generally used for public purposes related to common interests in water, such

as providing recreational opportunities (e.g., water-based sports), promoting environmental justice (e.g., maintaining homelands for American Indian tribes), and protecting the environment (e.g., managing instream flows or habitat for endangered species). Governments hold water rights in trust for Indian tribes and U.S. citizens because the nation has determined that holding some land and resources in public ownership and not fully privatizing those serves important policy objectives. Federal water rights attach to the lands the government has reserved, and this rationale mirrors the riparian assumption that water is part of the land and not just alienable and transferable private property. Allocation of and access to water for cultural, environmental, and national defense purposes under federal reserved rights serve a broader range of societal needs and a more diverse set of constituents than water allocated to private use, reinforcing common interests in public resources.

As clarified over time through court decisions and implementation, the basic elements of the federal reserved rights doctrine vary considerably from state water rights doctrines. These rights are based on the proprietary and sovereign interests of the federal government, and the government holds the title. They do not depend on state law or procedure for their existence even though they may, under certain circumstances (such as some general stream adjudications), be adjudicated in state court proceedings (with the caveat that state courts are to determine those rights according to federal law). Federal reserved rights vest at creation of the reservation; this provision makes most reserved rights for Indian reservations senior throughout many areas of the U.S. West.

The existence of federal reserved water rights along with state water rights has created fundamental dilemmas for water law by giving two different levels of government decision-making authority over allocating and managing the same water. The duality of federal and state water rights has created administrative difficulties related to melding the two water systems and often means that western water has been given away twice, exacerbating the problem of overallocation.

Pressures to Utilize Water and Overallocation

Current dilemmas in providing legal access to fresh water are the legacies of evolution of water law and dual federal-state administration of water rights under the development and expansion of a market economy. Legal principles through which water rights were connected to land ownership primarily for sustenance gave way to conceiving of water as a resource capable of being severed from land and abstracted as a commodity so it could be moved, marketed, and utilized in a variety of resource extraction and industrial activities. Colonization and settlement of the U.S. West initiated a scramble to claim free natural resources from the public domain that were instrumental for the region's development.

Water was the most critical resource in arid areas, which led to development of prior appropriation, a completely different system of water law than the riparian system adopted in eastern states. Western water laws were designed to provide security for people who productively utilized water and to discourage speculation, but they also contained embedded incentives for overuse. Water had to be continuously diverted and put to beneficial use for rights to vest and remain in effect. Principles of adverse possession or prescription gave legitimacy to claims based on controlling water resources (such as in "possession is nine-tenths of the law"). Also, rights were generally granted in perpetuity. Western states' primary interests in administering water have long been to establish private rights, protect senior users, and optimize consumptive use of the resource for economic development.

Many parts of the United States today are experiencing pressures to claim and develop water in the face of competing uses and conflicting federal-state legal doctrines. Demands for water often exceed existing supplies, and legal rights to use water are often overallocated, resulting in dewatering of streams and overdraft of aquifers. Various strategies have been pursued to address localized situations of water scarcity. Existing water supplies have been stretched through water rights administrative procedures, such as closing river or groundwater basins to new applications, conducting general stream adjudications to validate and reduce existing rights, implementing drought or other shortage restrictions, and conjunctively managing surface and groundwaters. Attempts have also been made to create "new water" supplies through desalination, recycling or reclaiming waste water, rainwater harvesting, and promoting greater water use efficiency through infrastructure upgrades and conservation programs. Many of these alternatives raise takings challenges or property rights controversies. Rules pertaining to water legally classified as "artificial" (wastewater, foreign water, salvage water, developed water) often vary from rules pertaining to "natural" water bodies. Some of the "new water" alternatives are highly energy intensive and entail other economic and environmental trade-offs.

Water Transfer Mechanisms to Reallocate Water

The primary strategy for alleviating shortages and satisfying growing and increasingly diverse water needs, however, is to reallocate existing rights to use water through various types of transfer mechanisms (leases or sales through traditional administrative change applications, market transactions, or water banks). In general, these processes move water rights from agricultural users, whose rights often have the highest legal seniorities under western state water laws, to urban users, who can pay the highest market prices for water. Such transfers often have economic, environmental, and social

effects on third parties who are not involved in the transfer process but lose access to water and the benefits it provides (e.g., other water rights holders, rural communities, the agricultural sector, ethnic communities, the environment, and taxpayers) and raise a variety of equity concerns. Water transfers are often opposed because of potential social and environmental impacts. Because these transfers imply that water does not belong to the watershed, "basin-of-origin protections" have often been used to oppose such transfers. On the other hand, more localized transfers can present opportunities to honor expectations created by the existing water rights systems while adapting water uses to meet changing societal needs through creating new incentive structures. In recent years, western states have changed water laws to exempt more unused water from forfeiture and abandonment (one such western statute was referred to as the "Lazarus Law"), to protect rights to conserved water and to accelerate the transfer process.[1]

Important questions are being debated in the water reallocation process. What priorities will guide reallocation decisions, given the different assumptions and rules embedded in various forms of water law that originally allocated water, particularly regarding public versus private interests? Governments can prioritize categories of socially determined beneficial *uses*. In the implementation of water rights laws, governments generally prioritize *users* on the basis of seniority or prior use. Market mechanisms, in contrast, prioritize access to water through price signals. Therefore, determining priorities for access as water scarcity increases will likely be contentious. Given that water itself is owned by the public and private water rights are usufructuary[2] in nature, what role will governmental agencies and private market actors play in determining how water is reallocated? As complex mechanisms emerge to handle water rights transfers, and amid growing political tensions between the public and private sectors, balancing various rights and interests in water is imperative for providing equitable access to water.

REGULATING WATER QUALITY

From the period of the 1950s to the present, numerous laws have been passed and implemented to deal with environmental problems that influence access to clean water. These laws have prescribed new authorities and functions for government as environmental regulators of water quality. Overallocation of water without attention to connections between water quantity and water quality, development of infrastructure that destroyed the natural functioning of rivers and aquatic ecosystems, and pollution from agricultural and municipal-industrial use of the nation's waters as runoff and waste disposal systems could no longer be ignored.

The urgency of dealing with contamination that affects water resources has been dramatically and repeatedly illustrated by environmental tragedies such as the Cuyahoga River Fire in 1969, toxic contamination at Love Canal in the 1970s, the Three Mile Island nuclear accident in 1979, and the coal ash spill in Kingston, Tennessee, in 2008. The cumulative effects of water contamination have been revealed at ecosystem scales. Pollution from urbanization of the eastern seaboard threatens the Chesapeake Bay. Industrial developments destroy productive fisheries in the Great Lakes. Drainage from agricultural expansion throughout the Mississippi River Basin creates a huge hypoxic wildlife dead zone in the Northern Gulf of Mexico. The combined effects of growing populations and economies cause the vast wetlands of Florida's Everglades and California's great Central Valley to disappear.

Environmental Challenges

Many challenges are involved in providing clean water. The environmental consequences of activities that damage land and air generally also show up in water, yet these areas of the environment are often regulated under different sets of laws. Activities occurring on land, in the air, or with water are

The sun sets over Lake Erie, the shallowest of the Great Lakes and the most prone to pollution. A dead zone within the middle of the lake is being studied by scientists from the National Oceanic and Atmospheric Administration (NOAA). In particular, they have been concentrating on the lake's blue-green algae blooms, trying to determine how to predict when the blooms are spreading or where they might make landfall.

SOURCE: Miklmar/iStockphoto.

administered by many government agencies. Varied types of contaminants affect water, including pesticides, toxic chemicals and substances, and hazardous wastes. These contaminants originate from many sources within different sectors of the economy, such as agriculture, automotive, construction, electric utilities, oil and gas, and transportation. Often, they are dealt with on an emergency basis as releases and spills create immediate threats to public health, even though the long-term consequences of human and environmental exposures to contaminants and toxins can be equally deadly.

The Environmental Protection Agency (EPA), established in 1970, coordinates and implements the broad range of environmental legislation passed during this era and promulgates regulations that contain the technical and operational details necessary to implement those laws. It regulates activities that pose pollution and contamination threats to water, land, and air and that broadly affect human and environmental health. The EPA addresses crosscutting issues such as asbestos, lead, and mercury that are not covered by any specific law but that require actions under various laws the EPA is responsible for implementing and/or require coordination with other agencies that share regulatory responsibility for environmental consequences in areas such as human health and occupational safety. In terms of water, the EPA is working to change the overall regulatory emphasis from "end of pipe" treatment of waste after it is produced to preventive actions that move upstream in watersheds and in manufacturing processes to prevent generation of wastes.

Through a variety of legal authorities and policy tools provided by U.S. environmental laws, the EPA is directed to identify environmental risks, determine liability and assign penalties for environmental law violations, and inventory and monitor the health of the nation's human and natural environment. Most of the nation's most prominent environmental laws are implemented by the EPA, many of which work to protect water quality indirectly. The two primary laws under which the EPA protects water directly are the Clean Water Act (CWA) of 1972 (which amended the Federal Water Pollution Control Act) and the Safe Drinking Water Act (SDWA) of 1974.

The Clean Water Act

The Clean Water Act (CWA) applies to surface waters and aims to eliminate the discharge of pollutants into waterways to make them fishable and swimmable and to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." It contains technology forcing, permitting, and funding provisions to help achieve these goals. Implementation responsibilities are shared by federal, state, and tribal governments. Under Section 402 of the CWA, permits are issued for direct discharges of pollutants into water bodies through the National Pollutant Discharge Elimination System (NPDES). Designated beneficial uses are determined for each water body, and water bodies are considered impaired if water is not of sufficient quality to support their designated uses, in which case Total Maximum Daily Load (TMDLs) programs are to be implemented. Control over point sources of pollution, primarily consisting of discharge pipes, has been easier to exercise under the CWA than control over nonpoint sources of pollution, which generally consist of runoff from agricultural, wild, and urban lands that have been disturbed, are poorly managed, or have lost natural features capable of mitigating the effects of runoff, such as wetlands and riparian buffers. The CWA has been deemed a success for improving water quality in the nation's surface waters but also has been evaluated as having fallen short of fully meeting its goals and potential. Implementation and funding challenges remain to adequately assess and monitor all waters, regulate new chemical substances such as pharmaceuticals and personal care products, understand consequences from interactions of different types of contaminants, and move beyond chemical criteria to more comprehensive definitions and monitoring of biological health.

The most controversial aspect of the CWA in recent years has been implementation of Section 404, which requires permits from the Army Corps of Engineers for discharge of dredged or fill material into navigable waters of the United States, including wetlands. A series of legal challenges have narrowed the definition of "the waters of the United States" and required that wetlands or non-navigable, nonpermanent tributaries have a "significant nexus" with traditional navigable water, thereby limiting federal jurisdictional authority over water and reducing wetland protection. Definitional battles, permitting loopholes, and decisions such as issuance of nationwide permit NWP 21 that enabled mountaintop removal mining have limited the overall outcome of providing and protecting clean water under CWA.

The Safe Drinking Water Act (SDWA)

The SDWA is structured similarly to the CWA. EPA sets national, health-based standards for public drinking water for twenty-five or more people and provides technical assistance and financial support to municipalities and other water providers charged with implementing these standards. As part of its goal to protect surface and underground sources of water used for public drinking water supplies, the SDWA contains provisions concerning various types of underground injection activities. These provisions enabled the EPA to regulate hydraulic fracturing until the U.S. Congress, in a controversial move, amended the SDWA (and other environmental laws, including the CWA) as part of the 2005 Energy Policy Act. The SDWA amendments added two exclusions to the definition of underground

GLOBAL CONNECTIONS

Perspectives on Access to Clean Water

The figures are shocking. In 2013, more than one billion people lack access to improved water supplies, and close to three billion people lack access to adequate sanitation facilities, while millions of people, most of them children, die every year from preventable diseases associated with inadequate water for drinking, hygiene, and sanitation. *The inequities are glaring.* Nearly every indicator related to human access to clean fresh water reveals large disparities between countries and even within countries, with the wealthy currently enjoying a level of water security that is only defined as a goal to be achieved decades from now in most parts of the world. *The burdens are humbling.* People in many parts of the world, especially women, spend hours every day just fetching water, leaving them with less time for education, employment, social life, leisure, and other activities.

Clean water scarcity has gained increased attention in the international arena. Water is recognized as essential for human health, for all socioeconomic development, and for maintaining healthy ecosystems. Goals for water access and security were set in Agenda 21, the Millennium Development Goals, Rio+20, and the Post-2015 Development Agenda. Efforts to stimulate action have been pursued, such as the United Nations' programs of International Decade for Action "WATER FOR LIFE," 2005–201, International Year of Water Cooperation (2013), and the annual World Water Day (its twentieth anniversary was in 2013). In July 2010, the UN General Assembly, through Resolution A/RES/64/292, declared safe and clean drinking water and sanitation a human right essential to the full enjoyment of life and all other human rights. Through numerous global efforts, water has been identified as a strategic issue and policy priority requiring joint action and broad cooperation on the part of governments, water service providers, and the nonprofit sector.

Addressing clean water scarcity in the international arena, as in the United States, involves clarifying and utilizing legal rights, investing in infrastructure, promoting common or public interests in water, and implementing environmental safeguards to protect water quality. As American Indians have learned, having moral obligations and legal principles or rights on your side ("paper rights") is not the same thing as having physical and economic access to water ("wet water"). The current challenges of making water accessible in sufficient quantities and acceptable qualities to meet even basic human needs are much greater when people struggle with legacies of colonialism, confront disadvantages in processes of globalization, and suffer from the poverty that often results from their political-economic position in these historical trajectories.

People in disadvantaged positions in underdeveloped nations, as well as highly developed countries, are currently at the forefront of significant battles over privatization of public water services and the contamination of surface and groundwater supplies that would exacerbate problems of clean water scarcity. Their battles are everyone's battles in the globally interconnected and interdependent world of water. Shocking figures, glaring inequities, and humbling burdens require greater international water policy and environmental justice efforts in order to make the water security some people enjoy today a reality in the lives of many people for whom it remains a current dream but a distant reality.

SOURCES: World Health Organization, http://www.who.int/water_sanitation_health/en/. United Nations, http://www.unwater.org/. World Water Council, http://www.worldwatercouncil.org/. UNICEF, http://www.unicef.org/wash/index_3951.html.

injection that effectively exempt hydraulic fracturing from complying with the SDWA (these exclusions have been dubbed the "Halliburton Loophole").

Today, citizens in some regions of the nation enjoy some of the safest drinking water in the world. However, there are inequities of access within the United States. People in wealthy communities generally enjoy safer drinking water than people in poorer ones. Their communities are usually located in more pristine and less contaminated environments, such as exurban communities in the vicinity of National Forests or National Parks in the West, where water sources may be protected. Wealthy communities often have the political and economic resources to secure legal rights to good water and to litigate when it is contaminated. They are more likely to secure water projects to transport higher-quality water from distance sources and/or to treat lower-quality local sources. In January 2014, for example, hundreds of thousands of people in West Virginia were unable to use tap water for nearly a week due to a chemical leak that tainted their supply. In complimenting these people for how well they were handling such an inconvenience, one news commentator noted that if that had occurred in a major East Coast city, people would be acting as if it was Armageddon.

As Erin Brockovich taught us in California, and in the 2000 movie, safe drinking water must be safeguarded. Contemporary concerns over drinking water safety indicate that continued access to clean drinking water cannot be taken for granted and that new forms of risk are associated with drinking water protection in highly industrialized nations. The proliferation of thousands of new chemicals for which no standards have been set and no monitoring occurs, as well as the proliferation of pockets of cancer rates and deformities in humans and animals, raises alarms.[3] Many municipal water systems that are aging and in need of replacement or upgrade must also prepare to handle new contaminants that may require different detection and treatment options. Residential expansion into exurban areas dependent on water from wells and septic systems needs better monitoring to protect small community systems. Perhaps the biggest threat to safe drinking water in many parts of the country is the rapid and extensive growth of natural gas and coal bed methane extraction that utilizes

hydraulic fracturing as well as other water-intensive energy industries. These activities are known to cause contamination risks to surface and groundwater supplies resulting from underground injection of chemicals and wastewater and from spills, discharges, and wastewater disposal into water sources and treatment facilities.

The challenges of providing clean, safe water are many, but the history of problems with water quality that laws are designed to address is long. Confronting these challenges will require greater efforts to work across legal and jurisdictional boundaries to better integrate management of surface and groundwater, water quantity and quality, and land and water use.

MANAGING WATER FOR HUMANS AND THE ENVIRONMENT

The federal and state governments take the lead in managing the nation's water resources, but other governments and entities are also involved, such as tribal governments and river commissions. Planning and constructing public infrastructure needed to develop and utilize the waterways and water resources of the nation have long been significant government functions. While the federal government has largely deferred to state administration regarding water allocation, it has assumed the lead in planning and constructing large-scale water infrastructure. Using its powers to operate on river basin and large landscape scales, it has fundamentally altered rivers, lakes, and shorelines of the United States to meet human needs.

Water structures are developed to serve many different purposes, including navigation, flood control, hydroelectric power generation, water delivery, and recreation. Public infrastructure has helped make water easily accessible, convenient, and inexpensive, even in arid and drought-prone parts of the nation and has supported growth of water-intensive lifestyles and consumption patterns.

Responsible Departments and Agencies

Administrative responsibility for carrying out work related to water infrastructure is widely distributed among federal agencies in the Departments of Agriculture, Commerce, Defense, Energy, and Interior, with a few independent agencies added for good measure. Key federal agencies with water-related science and engineering missions include the U.S. Geological Survey (USGS), the Army Corps of Engineers (ACE), the Bureau of Reclamation (BOR), the National Oceanic and Atmospheric Administration (NOAA), the Tennessee Valley Authority (TVA), the Bonneville Power Administration (BPA), the Federal Energy Regulatory Commission (FERC), and the Environmental Protection Agency (EPA). Many of these agencies long enjoyed focused missions but expansive authorities, venerable reputations, secure funding sources, and powerful constituencies (particularly the USGS, ACE, and BOR) that put them at the center of water science and infrastructure construction throughout the nation.

Water Projects

The history of water infrastructure in this country is a storied one, creating economies and cultures around public works—for example, engineering feats such as the Illinois Waterway, Saint Lawrence Seaway, Hoover Dam, All-American Canal, Central Valley Project, California Aqueduct, Grand Coulee Dam, Columbia Basin Project, Colorado-Big Thompson Project, and Glen Canyon Dam. Hundreds of interconnected projects altered waterways and hydrologic systems on regional scales, providing jobs and promoting economic development in the process. Harbors, dams, locks, and canals constructed in the eastern United States supported war and independence efforts, created river transportation networks to facilitate exploration and settlement, and powered the mills of growing industrial cities. Dikes, channels, drainage structures, levees, and dams aided navigation and flood control in the Great Lakes region and along the Mississippi River that promoted the development of agriculture, mining, and manufacturing in midwestern and southern regions of the nation. Dams, hydroelectric facilities, diversions, storage structures, and pipelines enabled establishment of agricultural empires, natural resource-dependent economies, and large metropolitan areas in arid, drought-prone western regions of country.

Currently, western states have some of the fastest growing cities and economies in the nation. Because of the past success of its water infrastructure in delivering reliable water supplies to meet growing needs, people have come to expect water will continue to be available, resulting in even greater water dependencies and vulnerabilities to future water scarcity. To meet these growing demands, western cities and states are pursuing aggressive strategies to acquire additional supplies and to manage demand through greater efficiency and conservation. For instance, Las Vegas, for many years the fastest-growing city in the nation, has sought with great determination to renegotiate the Colorado River Compact, secure water from distant rural groundwater basins, and pioneer and promote innovative water conservation programs.

Government infrastructure projects often created great fortunes for some segments of the population and displaced or negatively impacted other segments of the population, earning them the moniker "pork-barrel projects" when they distributed benefits to economically powerful and politically connected interests. For example, the great agricultural fortunes made in California and Florida were created through government-supported infrastructure that transformed the Central Valley and the Everglades, turning them into vast expanses of productive farmland.

The primary losers in these transformations were rural communities and natural ecosystems.

Support and funding for new water projects have dried up, and few massive make-work projects have been undertaken in recent decades, even though many project dreams are still alive and authorized projects and design blueprints remain on file awaiting changes in political-economic or climatic circumstances.[4] Criticisms from several directions converged to bring the era of large water infrastructure projects to an end by the 1990s. Environmentalists mounted opposition based on a long list of negative impacts water projects had on the environment: disrupting the natural flow of rivers, destroying wetlands, blocking annual fish migrations, threatening species extinctions through habitat alterations, exacerbating problems related to invasive species, compromising the scenic and cultural heritage of natural landscapes, and interrupting a variety of ecosystem services provided by undisturbed natural waterways and bodies of water. Fiscal conservatives opposed continued funding of large water infrastructure projects based upon their list of concerns: mounting budget deficits, evidence of waste of taxpayer money on pork-barrel projects, revelations of faulty economic analyses used to justify new projects, and frustrations with trying to rein in the spending of agencies with powerful constituencies. Ironically, President Reagan was more effective at halting many of the big dam projects that President Carter had identified on his federal water project "hit list."

Another factor in altering the previous approach to managing water resources primarily through constructing large infrastructure projects was that society recognized that engineering "solutions" were neither cost-effective nor technically effective. Environmentalists and fiscal conservatives, as well as members of the public at large, were less in awe of agencies' traditional scientific, technical, and engineering expertise. They became concerned about the lack of independent oversight of agency decision making and were not easily convinced to trust agency recommendations about the public value of proposed water projects, given the private gain so many projects had facilitated and the trade-offs continued funding implied with public policy priorities in other realms. Additionally, ecological and social sciences, traditionally underrepresented in water agencies, were demonstrating the effectiveness of alternative approaches to water management more in tune with the needs of natural ecosystems (e.g., wetland restoration for flood control, human behavioral change for producing "new" water supplies through conservation and greater efficiency).

Ongoing Debates

New construction, however, is not the only issue. Much of the debate continues over the nation's existing water infrastructure, which is aging or in disrepair, and some of it, such as the effort to "contain" the Mississippi, is now recognized as ill-conceived and unwise. In several recent "report cards," the American Society of Civil Engineers has given the water infrastructure of the United States a "D." Estimated replacement and maintenance costs are staggering. Upgrading the nation's infrastructure requires investment strategies. The reluctance of public officials to address investment needs under current government budgetary constraints means that not only does water infrastructure continue to fall into disrepair, but many public water systems and services become targets of privatization efforts, not always with satisfactory results. While upgrading water infrastructure carries a heavy price, it also presents opportunities to create new types of infrastructure to meet current economic, environmental, and equity concerns.

However, transitions in water infrastructure involve several challenges. Because the existing infrastructure often constitutes large, integrated water systems at river or watershed scales built over many decades, long-term visions for new systems are needed with accompanying plans for how replacing certain parts can help move the larger systems in new directions. In addition, better preparation is needed for the increasing frequency of emergency events that force infrastructure replacement, such as hurricanes and storms, so that constructing new infrastructure does not occur under crisis conditions that allow little time for adequate planning or public input.

Another challenge is that while existing infrastructure has often had negative environmental consequences, it can also create paradoxical dependencies between natural and human-engineered systems. At times, wildlife or water managers have adapted to this infrastructure in ways that end up serving environmental purposes in unintended ways. Agriculturally dependent wetlands and "riparian" habitat connected to unlined canal systems throughout settled valleys of the Intermountain West provide examples where sometimes replacing old infrastructure and promoting greater efficiency through piping conveyance systems could eliminate wildlife habitat dependent on inefficient seepage from the old system. These types of situations can also have negative impacts on other human populations, as was illustrated in the high-profile dispute between the U.S. and Mexico over the U.S. plan to line the All-American Canal in order to conserve water lost in transport from the Colorado River to Los Angeles. Water from the unlined canal seeped into the groundwater and flowed across the border for many years, supplying water for cities and agriculture in the Mexicali Valley and sustaining wetlands in Andrade Mesa in Mexico.

Dam Removal

Large dam projects that were once symbolic of economic progress and a source of national pride have become the

ENVIRONMENTAL DEBATES

Wetland Farming in the Bear River Basin

Development of extensive water infrastructure throughout the United States has destroyed or fundamentally altered many wetlands. Much of this infrastructure was developed specifically to support agricultural development. For decades, wetlands were drained under government policies and programs that favored agriculture and other land uses. Today, however, wetlands are understood to be important providers of ecosystem services that benefit people. These benefits include erosion and storm protection, flood control, soil and nutrient retention, water filtration, groundwater recharge, wildlife habitat, and recreational hunting and fishing opportunities. How can the benefits wetlands provide be secured in places where they were formerly destroyed or impaired? Given the often extensive development of water infrastructure, is it possible to restore wetlands to historical conditions, or are alternative strategies required moving forward?

Management strategies for wetlands contained in federal wildlife refuges in the Bear River Basin of Idaho, Utah, and Wyoming provide a somewhat paradoxical example of the relationship between agriculture and wetlands. The Bear River flows for five hundred miles through the three states before flowing into the Great Salt Lake. The river has been engineered and manipulated through the construction of multiple dams and diversion structures to serve agriculture and hydropower production interests. Three wetland complexes of the National Wildlife Refuge System are located in this river basin. Each of these three wetland refuges is defined by its relationship to agricultural water structures: Cokeville-Meadows National Wildlife Refuge in Wyoming is an irrigation-dependent wetland, Bear Lake National Wildlife Refuge in Idaho is a reservoir-adjacent wetland, and the Bear River Migratory Bird Refuge in Utah is a diked-delta wetland. Wetlands in the Wyoming and Idaho refuges were actually created by water management activities for agricultural irrigation in places they formerly did not exist or where they were previously much smaller geographically. The Utah refuge encompasses wetlands at the delta of the Bear River in the Great Salt Lake that were greatly impaired by upstream water development for agriculture. Managers of this refuge have been particularly adept at adapting to their social-ecological context and seeking opportunities to build alliances with nearby duck clubs and agricultural producers to manage and enhance formerly degraded wetland habitat.

Managers of all of these refuges pursue water management strategies adapted to the present legal and built infrastructure of the river. They have obtained state water rights, bought shares in local irrigation companies, acquired or built canals and dikes to manage water on their land, and engaged in practices that can best be characterized as "wetland farming." In recent years, the U.S. Fish and Wildlife Service supported construction of a dam on the lower Bear River with the intention of securing storage rights for late season irrigation (the dam has not yet been constructed) at the Bear River Migratory Bird Refuge. This case illustrates how paradoxical dependencies and adaptations may serve environmental purposes in unintended ways. Similar agriculturally dependent wetlands and riparian habitats connected to unlined canal systems exist throughout settled valleys of the Intermountain West.

SOURCES: Rebekah Downard and Joanna Endter-Wada, "Keeping Wetlands Wet in the Western United States: Adaptations to Drought in Agricultural-Dominated Human-Natural Systems," *Journal of Environmental Management* 131 (December 15, 2013): 394–406. Lisa W. Welsh, Joanna Endter-Wada, Rebekah Downard, and Karen M. Kettenring, "Developing Adaptive Capacity to Droughts: The Rationality of Locality" *Ecology and Society* 18, no. 2 (2013): 7, http://dx.doi.org/10.5751/ES-05484-180207. Joanna Endter-Wada, Lisa W. Welsh, Rebekah Downard, and Karen Kettenring, *Paradoxes in Adapting to Droughts,* Case Study Video, First Emerging Issues Conference, Ecological Society of America (2009), YouTube: Part 1 at http://www.youtube.com/watch?v=MsRcSHJdodo and Part 2 at http://www.youtube.com/watch?v=0KtNR3FtXOc.

focus of conflicts pitting ecological approaches to controlling flooding against traditional engineering/pork-barrel programs. Hundreds of dams in the United States have been removed, most often those that had filled with sediment, became too expensive to maintain or repair, or outlived their original purpose. Most of the removals have been relatively small and have become bargaining chips in hydropower relicensing or river restoration projects.

Large mainstem dams that are part of highly developed river systems serving hydropower, irrigation, and municipal interests have not been removed. In some instances, operational modifications, such as fish bypass on Columbia River dams or experimental floods at Glen Canyon Dam, have been utilized to further environmental objectives. Debates over dam construction, removal, and operation will likely remain heated as the nation faces threats of climatic change, because hydroelectric power and water storage are tied to some of the potential climate change mitigation and adaptation strategies.

The nation's preeminent dam builders, the Army Corps of Engineers and the Bureau of Reclamation, have been trying to redefine their missions and relevance for at least two decades. Political divisiveness between those constituencies still counting on long-authorized water projects being funded and ones intent on dismantling water infrastructure harmful to the environment has left these agencies somewhat ambivalent about future directions. Nonetheless, these agencies contain much scientific and technological expertise relevant to managing water and are trying to reform their engineering cultures and "green" their staffs. Congress expanded their missions and tasks to include development of water information technologies and involvement in various environmental and restoration initiatives. Somewhat ironically, the Army Corps of Engineers now oversees Section 404 permits under the Clean Water Act and has responsibilities to protect and restore riparian and wetland habitats that many of its previous activities once destroyed. Both agencies increasingly perform emergency

and disaster response functions to deal with droughts, floods, and storms that are now understood to have natural as well as human-induced causes, with existing infrastructure sometimes exacerbating their effects.

The United States has dealt with water scarcity by developing extensive water infrastructure. This infrastructure has eliminated natural barriers to navigating natural rivers, development in flood plains, populating arid regions, irrigating marginal lands, developing water-intensive forms of energy, and transforming the real estate of coastal regions. This approach has created reliable access to and growing demand for highly subsidized supplies of clean fresh water. The nation's water infrastructure has made it convenient and economical for agribusiness corporations, urban and exurban residents, and varied industries to waste and contaminate water. Having subsidized its original development, the public is now responsible for mitigating the consequences and ensuring against the risks that are part of this water infrastructure's legacy.

CHALLENGES AND FUTURE DIRECTIONS

Today, we live with the legacies and consequences of past water policy approaches as we try to chart a different course for dealing with clean water scarcity. In many ways, our existing water policies achieved what they were designed to do. Rights to use water were distributed, arid regions were settled, and thriving economies were created. The government assumed drought and flood risks and subsidized infrastructure. Water was made available for the increasingly diverse uses of modern society so that Americans today are able to consume, on average, 176 gallons of water per day, supporting water-consumptive lifestyles. However, these policies also had significant unintended consequences: the accelerated rate at which water is being depleted and contaminated, growing inequities in water access, and the destruction of many natural ecosystems.

Substantial water policy reforms are needed to address these consequences. However, reform attempts have encountered opposition because of the economic dependencies, private property interests, and social expectations that previous water policies created. At present, many cities and states continue to pursue the existing water policy path. They seek to acquire new water supplies through constructing infrastructure projects, reducing demand through greater efficiency, and competing for government subsidies to aid in their efforts. Most of the water they secure, however, is being used to accommodate new population growth and economic development. To secure new water supplies, cities and states try to find and claim untapped sources or engage in water negotiations, trades, and transfers. While their strategy buys time in the short run, it increases their populations' dependencies on scarce supplies and peoples' expectations that convenient and inexpensive clean water will continue to be provided. In fact, many public officials are subject to criticism if they increase the price of water or restrict access to it in any way.

One of the most significant legacies and consequences of the general path that our previous water polices took us down is the fragmented political and institutional landscape for dealing with water, as well as the separation of water policy and management from that of other natural resources. In a highly interconnected world, it is no surprise that most of the approaches being advocated in this current period of transition are founded on various concepts of boundary spanning and integration. These approaches include conjunctive management of interconnected bodies of water, Watershed Management, Integrated Water Resource Management (IWRM), Ecosystem Management, and "Wet Growth." Recognizing that the old path of U.S. water policies that depended on highly engineered infrastructure is becoming increasingly less viable, one of the new directions has been described as the "Soft Path Approach to Water Management."[5] Interestingly, most of the successful case studies and out-of-the-box solutions dealing with clean water scarcity are highly localized, because integration is more easily achieved through reuniting water with the needs it must serve and the way people have come to know it in specific contexts.

As we consider and debate future water policy reforms, several key issues need to be addressed if we are concerned about accessing and sharing scarce clean water. The first issue is to acknowledge that clean water is scarce and to confront what that means in terms of how best to use it now and in the future. This entails finding ways to productively deliberate societal priorities and the trade-offs and decisions that growing water scarcity will make us collectively confront. These societal deliberations should include a more forthright discussion of the concept of "beneficial use of water." Which uses does society consider to be most beneficial in different landscapes? How can we enable those considerations to guide the allocation and reallocation of water? In managing water, we have spent much time focusing on how much water is available in order to secure and allocate it and not enough time on what is appropriate to do with what we have.

A second issue is to recognize the conditional nature of our access to water, given uncertainties in its availability and other people's claims upon it. Water laws specify long-term water rights (in perpetuity) and establish expectations to use of a resource that is highly unpredictable and variable. However, private rights to water are qualified by other people's rights and by rights held by the public. Therefore, we need an honest accounting of rights to and uses of water in order to deal with the overappropriation of water, because promising rights to access more water than is available poses

great uncertainties in terms of managing future use. Fully recognizing the conditional nature of access to water implies substantial adjustment in current expectations and behaviors.

A third issue is to understand what it means to share such a scarce and vital resource. One element of sharing involves protecting water as a public resource and giving greater meaning to government's trust responsibilities as we work to balance the public and private rights in water. Another element involves keeping water clean and not wasting it out of respect for those with whom it is shared. Recognizing other humans' and nature's needs for water is the foundation of sharing. The need to share scarce clean water challenges us to deal with the science and policy uncertainties that stand between meeting both human and environmental needs for clean water. Many U.S. water policy challenges lie ahead as we seek to integrate these multiple needs into future water decision-making processes and U.S. environmental policy.

***See also* Chapter 19: The Environmental Protection Agency and Its Precursors: History, Responsibilities, and Policies (1970–Present); Chapter 20: The Modern Environmental Movement (1950s–Present); Chapter 22: Environmental Health Issues (1950s–Present); Chapter 23: Food Systems and the Environment (1950s–Present); Chapter 24: The Oceans and Fisheries (1950s–Present); Chapter 25: Global Warming and Climate Change Policy (1960s–Present); Chapter 26: Diplomacy and Environmental Policy: Endangered Species and Others at Risk (1950s–Present).**

NOTES

1. See Adam Schempp, *Western Water in the 21st Century: Policies and Programs That Stretch Supplies in a Prior Appropriation World* (Washington, DC: Environmental Law Institute, June 2009).
2. A usufructuary right refers to the right of one individual to use and enjoy the property of another, provided its substance is neither impaired nor altered. In a water law context where water is declared to be the property of the public, it means that individuals who hold water rights have the right to use the public's water, subject to oversight of the state.
3. See Sandra Steingraber, *Living Downstream: An Ecologist's Personal Investigation of Cancer and the Environment,* 2nd ed. (Cambridge, MA: Da Capo Press, 2010).
4. See Denise Fort and Barry Nelson, *Pipe Dreams: Water Supply Projects in the West* (New York: Natural Resources Defense Council, June 2012).
5. See Juliet Christian-Smith and Peter Gleick, *A Twenty-first Century U.S. Water Policy* (New York: Oxford University Press, 2012).

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