Chapter 6 Water

Introduction

Water is vital to a productive and growing economy in the United States, directly and indirectly affecting the production of goods and services in many sectors. Agriculture, energy production and the public supply of water account for more than 90 percent of off-stream water use in the United States.[38] Within the U.S. Department of the Interior (DOI or Interior), the Bureau of Reclamation (Reclamation) and the Bureau of Indian Affairs (BIA) both provide water for a variety of uses in the West. The following provides an overview on Reclamation and BIA's water supply activities and issues associated with the supply and demand for water.

Interior stores and delivers water for irrigation, municipal and industrial (M&I), and other uses. The value of water varies widely according to location, type of use and climatic conditions. Interior's irrigation and M&I water activities are associated with:

- $27 billion in value added;
- $47.4 billion in output; and
- supported an estimated 339,000 jobs.

Interior also delivers water to support in-stream flows, wildlife refuges, and other uses that are difficult to fully value.

Background

Water Withdrawals

The most recent data (Kenny et al., 2009) indicates that about 410 billion gallons per day (Bgal/d) of water was withdrawn for use in the United States during 2005. Figure 6-1 and Figure 6-2 show water use over 1950-2005.[39] About 80 percent of the total (328 Bgal/d) withdrawal was from surface water, and about 82 percent of the surface water withdrawn was freshwater. The remaining 20 percent (82.6 Bgal/d) was withdrawn from groundwater, of which about 96 percent was freshwater. If withdrawals for thermoelectric power in 2005 are excluded, withdrawals were 210 Bgal/d, of which 129 Bgal/d (62 percent) was supplied by surface water and 80.7 Bgal/d (38 percent) was supplied by groundwater.

Thermoelectric power has been the category with the largest water withdrawals since 1965, and for 2005 made up 49 percent of total withdrawals. Irrigation is the second largest category of water use, after thermoelectric. In 1950, irrigation withdrawals of about 89 Bgal/d accounted for about one-half of all water use and 64 percent of use excluding thermoelectric. By the peak year of 1980, irrigation withdrawals totaled 150 Bgal/d and represented 35 percent of total use and 68 percent of the total excluding thermoelectric.

[38] EPA, Value of Water, 2012.

[39] The source of both figures is: Table 14, Trends in estimated water use in the US, 1950-2005. Estimated Use of Water in the United States, Circular 1344, U.S. Department of the Interior, U.S. Geological Survey, 2009.

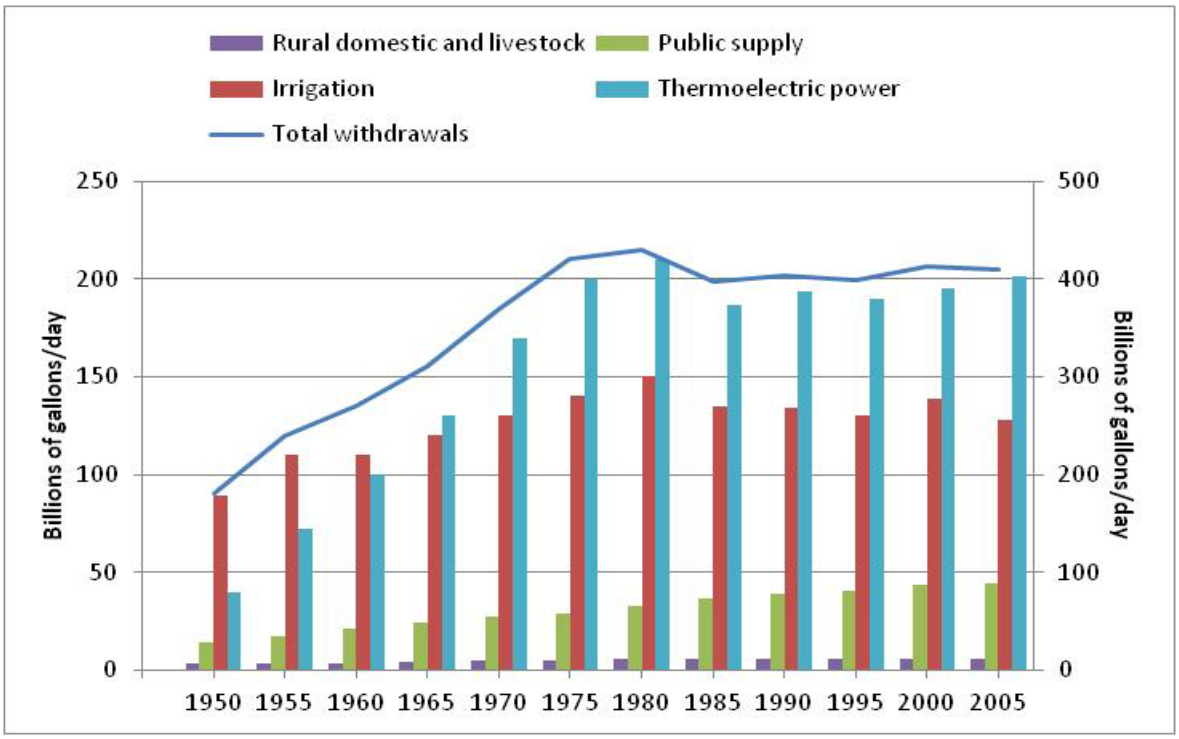

Figure 6-1. Water Withdrawals, 1950-2005

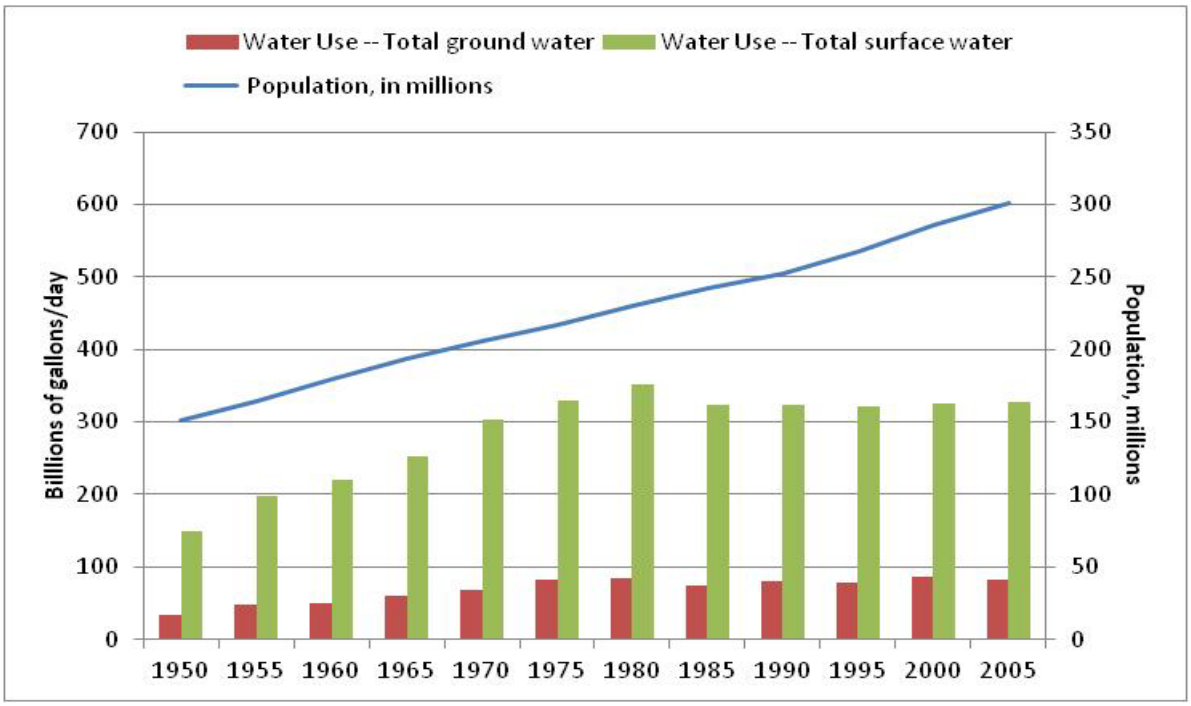

Figure 6-2. Population, Surface and Groundwater Use

Source for both figures: Table 14, Trends in estimated water use in the U.S., 1950-2005. Estimated Use of Water in the United States, Circular 1344, U.S. Department of the Interior, U.S. Geological Survey, 2009.

Agricultural activities, which include crop irrigation, livestock watering, and aquaculture, withdraw approximately 140 billion gallons of water per day, and consume the largest quantity of water of any sector in the U.S. economy (USGS, 2009). Access to water is vital to agricultural productivity, particularly in the arid and semi-arid regions of the Great Plains and the West, where irrigation projects bolster the international competitiveness of U.S. farms.[40]

Irrigated agriculture makes a significant contribution to the value of U.S. agricultural production. In 2012, the cash receipts from crops and livestock was estimated to be about $385.5 billion.[41] Based on 2007 Census of Agriculture data, irrigated farms accounted for $118.5 billion in sales, or roughly 40 percent of the value of U.S. agricultural production.[42] Applying this proportion to the value of production in 2012, irrigated agriculture is estimated to account for approximately $154.2 billion in sales.

Water Allocation and Transfers

Water is generally allocated via administrative mechanisms, often at the state level, rather than by markets. In the Western United States the prior appropriation doctrine allocates water first to the earliest users, which are frequently agricultural. Market mechanisms may allow transfer of such valuable rights to higher value municipal and industrial uses. The price paid for water delivery does not always fully reflect the opportunity costs associated with using the resource.

The Western States Water Council (WSWC) recently conducted a survey of its member states on the subject of water transfers. Of the 17 states the WSWC surveyed, three-quarters indicated that transfers are important for water allocation and will likely be used to meet future water demand. Data available for the Western states show that all states have experienced water transfers, but some more than others. Colorado has a large number of smaller-volume transactions. California has the largest volume traded.[43] In particular, active markets are found in Northern Nevada, California, the service area associated with the Bureau of Reclamation's Colorado-Big Thompson project, and the Lower Rio Grande Valley. There are both demand and supply side drivers of water transfers. These can include:

- Demand side: urban growth; energy development; drought and scarcity as well as market trends in the agricultural sector; preservation and enhancement of fish and wildlife habitat.
- Supply side: farmers seeking to “diversify their portfolios,” effectively using water as another crop; and urban areas that may have accumulated water rights to meet projected growth can lease out that water in interim years with low demand or wet conditions.

Water banks exist in almost all western states. While there are significant differences in the way banks operate, the common goal is moving water to where it is needed most. Water banking is emerging as an

[40] EPA Value of Water, Public Review Draft 9/12.
[41] Income statement for farm sector, 2008-2012F, Economic Research Service, USDA. http://www.ers.usda.gov/datafiles/Farm_Income/US_Farm_Income_and_Wealth_Statistics_includes_the_US_Farm Income_Forecast_2012/Nf_t2-rto.pdf.
[42] Schaible, Glenn, Aillery, Marcel. 2012. Water Conservation in Irrigated Agriculture: Trends and Challenges in the Face of Emerging Demands. USDA Economic Research Service Economic Information Bulletin Number 99.
[43] The Western Governors’ Association. December 2012. *Water Transfers in the West Projects, Trends, and Leading Practices in Voluntary Water Trading*.

important management tool to meet growing and changing water demands throughout the United States. Like other forms of temporary water transfers, water banks can help make water supplies available to meet critical needs, especially during dry years.[44]

Demand and Supply Issues

Population and economic growth, changing social values with respect to water quality and the environment, and Native American water right claims have been and will continue to be forces driving demand for water resources within the United States. Continued and increased energy developments with the associated water requirements for hydraulic fracturing, processing, or refining, is likely to increase water demand in affected areas. In addition, energy production and biofuel development may also increase demand for water resources in some regions. Over time, climate change impacts are expected to alter both water supplies and water demands across and within regions. Warming temperatures, changing precipitation patterns, and reduced snowpack are expected to significantly reduce late spring/summer streamflows (flows that historically were available for reservoir storage to meet peak irrigation water demands) and groundwater recharge across much of the West. In addition, higher temperatures are expected to increase crop-water demands via reduced crop ET efficiency.[45]

Temperature and precipitation conditions over Western U.S. regional drainages are projected to change as the effects of global climate change are realized. Climate models suggest that over any of the regional drainages temperatures are projected to increase during the 21st century. Some climate models suggest increases in precipitation while others suggest decreases. Much of the Western United States experienced warming during the 20th century (roughly 2 degrees Fahrenheit) and is projected to experience further warming during the 21st century with central estimates varying from roughly 5–7 °F, depending on location. As related to precipitation, historical trends in annual conditions are less apparent. These historical and projected climate changes have implications for hydrology (e.g., potentially more rain and less snow in some basins).[46]

Outputs

Reclamation maintains 476 dams and 348 reservoirs with the capacity to store 245 million acre-feet of water, and manages water for agricultural, municipal, and industrial use, and provides flood control and recreation for millions of people. Reclamation manages water for agricultural, municipal, and industrial use, and provides flood control and recreation for millions of people. More than 42 million acres, or roughly 75 percent, of the more than 56 million acres of irrigated land in the U.S. are located in the 17 western Reclamation states. Moreover, Reclamation facilities deliver water to approximately one-fourth of the irrigated land in the west, (or about ten million acres) and provide approximately 10 trillion gallons to over 31 million people for municipal and industrial uses and other non-agricultural uses.[47]

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[44] Analysis of Water Banks in the Western States, Washington Department of Ecology (2004), available at, http://www.ecy.wa.gov/pubs/0411011.pdf.

[45] Schaible, Glenn, Aillery, Marcel. 2012. Water Conservation in Irrigated Agriculture: Trends and Challenges in the Face of Emerging Demands. USDA Economic Research Service Economic Information Bulletin Number 99.

[46] Reclamation, SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water, Report to Congress, 2011.

[47] See: http://www.usbr.gov/facts.html.

Reclamation facilities also reduce flood damages in communities where they are located and thereby create an economic benefit by sparing these communities the cost of rebuilding or replacing property damaged or destroyed by flood events. The value of avoided flood damages for each region is about $1.2 million per year. [48]

Western rivers provide Native Americans with water for irrigation, domestic, municipal, rural, and industrial water projects. Water also provides important fish and wildlife habitat, and supports cultural, historic, and religious uses for tribes. BIA manages 17 irrigation projects on Indian reservations in the western United States which serve approximately 25,000 users. These projects, which were generally constructed in the late 1800s and early 1900s, include water storage facilities and delivery structures for agricultural purposes. Total irrigated acres are approximately 750,000. More recently, the Bureau of Reclamation has also designed and constructed a number of rural water projects to serve Native Americans. However, BIA's water management roles go beyond providing water facilities and storage and include trust management responsibilities which are also important to local economies.

Reclamation delivered an estimated 28.4 million acre-feet of water in FY 2012. Data are not readily available to comprehensively allocate those deliveries among different purposes or across Reclamation projects. However, as a point of comparison, Reclamation delivered an estimated total of 28.5 million acre-feet in 1992, with 23.8 million acre-feet for irrigation (83.5%), 2.8 million acre-feet for M&I use (9.8%), and 1.9 million acre-feet for other nonagricultural uses (6.7%).[49] Municipal and industrial uses typically include uses customarily found in the operation of municipal and community water systems and for uses in industrial processes. Industrial processes can include thermal power generation and mining operations. Municipal uses include household, commercial and public supplies.

Value Added, Economic Contributions and Economic Values

For FY 2012, the estimated value added, economic contributions, and employment associated with Reclamation's and BIA's water supply activities are summarized in Table 6-1.

Table 6-1. Water Deliveries – Economic Contributions and Value Added

Activity	Estimated Value Added	Estimated Economic Contribution ($ billions)	Estimated Employment Supported (number)
Irrigation – Reclamation	22.6	42	305,256
Irrigation – BIA	0.5	1.1	9,758
M&I - Reclamation	3.7	4.3	24,000
Total	26.8	47.4	339,014

It is difficult to determine the economic value of water because the values depend upon multiple dimensions (the volume supplied; where and when it is supplied; the reliability of supply; and water quality considerations) and because in most instances market values are not available. For water

[48] See: http://www.usbr.gov/facts.html.

[49] 1992 Summary Statistics, Water, Land, and Related Data. U.S. Department of the Interior, Bureau of Reclamation. Nonagricultural uses include irrigation of urban and suburban areas; water for stock, fish, and wildlife; and construction uses under temporary contracts.

supplied by Reclamation and BIA facilities, a number of additional factors (e.g., varying irrigation technology; considerations related to water rights and water use law; subsidization of public water supply projects; competition from other users; climate change; commodity prices; and the structure and nature of global food demand) make valuation challenging.

Economists have developed a variety of approaches to estimate the value of a unit of water used in the agricultural sector. These values vary widely due to the estimation methods and the specific aspects of water value that each method captures. The methods include acquisition cost; the factor input method (this method incorporates the relationship between crop yield and water input and yield increases can be valued by commodity prices to provide an estimate of the value of water as an input to production); examining data from water transfers; and the hedonic price approach. EPA (2012) presented the following average values:

- Public supply and domestic self-supply: up to $4,500 per acre foot;[50]
- Agriculture: $12 to $4,500 per acre foot;
- Manufacturing: $14 to $1,600 per acre foot;
- Thermoelectric cooling: $12 to $87 per acre foot;
- Hydropower: $1 to $157 per acre foot; and
- Mining and energy resource extraction: $40 to $500 per acre foot.

These value estimates are "average" values, not "marginal" values.[51] These values reflect values arising from the *use* of water. Water also has value when left instream to support ecosystem functions, such as dilution of wastes, channel maintenance, and enhancement of fish and wildlife habitat. There may also be some nonuse value attributable to the knowledge that the river has sufficient flow; this value could reflect, among other things, concerns for the ecological integrity of the aquatic environment. These values have been estimated by a number of studies[52]

Preserving or restoring damaged ecosystems in arid regions often involves water acquisitions to provide instream flows for wetlands and to maintain and enhance endangered species habitat. For example, under the Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990 (P.L. 101-618) Congress directed the Secretary of the Interior to acquire by purchase or other means, enough water to sustain 25,000 acres of primary wetland habitat in the Stillwater National Wildlife Refuge, Stillwater Wildlife Management Area, Carson Lake and Fallon Paiute-Shoshone Reservation wetlands, all within Churchill County, Nevada. In order to meet the 25,000 acre objective, the FWS has determined that an annual average of 125,000 acre-feet of water will be needed. Of this total, FWS expects to purchase up to 75,000 acre-feet, with the balance provided from irrigation project drainwater, reservoir spills, and

[50] $4,500 would represent an extreme upper bound that would only be observed infrequently and in special circumstances (say where irrigated land is located on the fringe of a growing metropolitan area).

[51] There are wide variation in values, depending upon the crop in question, the region of the country, and other factors. Some studies have found irrigation water values of zero, while upper-bound values approached $1,000 per acre foot for some crops. Data on water transfers (Brewer 2007) yields a wide range of values, depending on the specific conditions of the transfer, with the average price associated with a temporary agricultural lease of approximately $30 per acre-foot. Source: EPA, Office of Water, December 2012.

[52] Some examples include the economic analysis conducted for the Secretarial Determination to remove four dams on the Klamath River; and NPS's assessment of the effects of the re-regulation of Glen Canyon dam on resources of the Grand Canyon.

other sources (U.S. DOI, 1996). Figure 6-3 shows annual water acquisitions and costs per acre-foot to help support the wetlands in Stillwater National Wildlife Refuge and the Lahontan Valley. As of the end of 2012, FWS had acquired about 39,000 acre-feet of water. The cost of acquiring water has risen in nominal terms from around $500 per acre-foot in the 1990s to over $1,300 per acre-foot in recent years. The increase in prices reflects demand for development, both for residential and dairy, and the recognition that water rights have considerable future value.

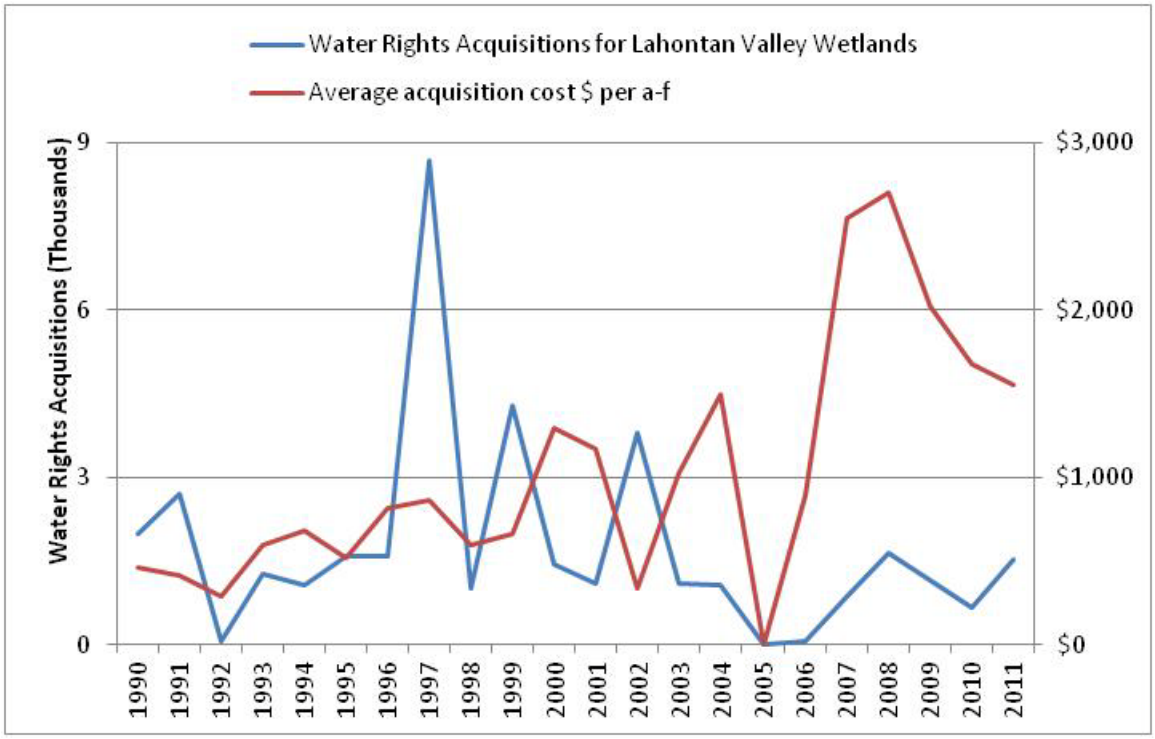

Figure 6-3. Lahontan Valley Water Rights Acquisitions

Source: FWS data.

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