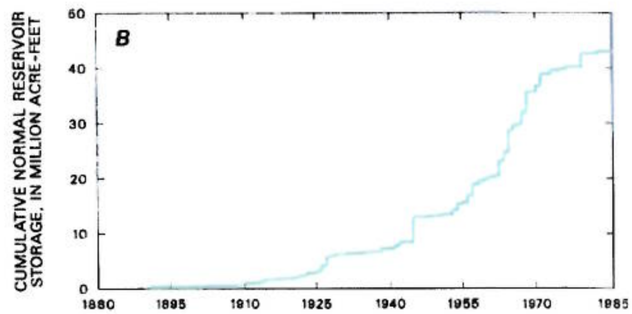
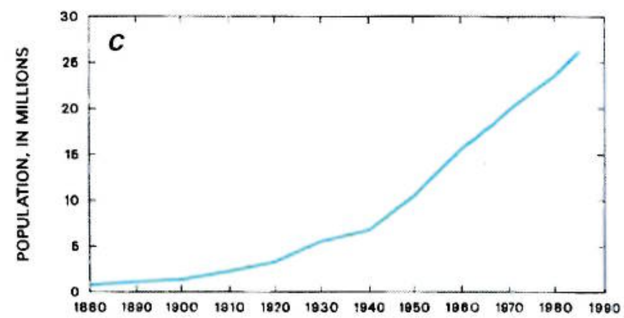
CALIFORNIA
Water Supply and Use

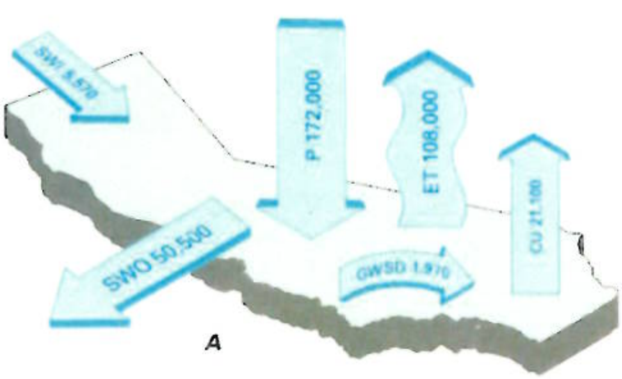
California, which has the largest volume of offstream water use in the Nation, consistently leads all States in surface- and ground-water withdrawals. The State has retained this position for 40 years, primarily because of the large volume of irrigated agriculture (MacKichan, 1951; 1957; MacKichan and Kammerer, 1961; Murray, 1968; Murray and Reeves, 1972; 1977; Solley and others, 1983; 1988). California's water budget (fig. 1A) shows that available water supplies originate from precipitation, ground-water storage depletion, and surface-water inflow from adjacent States. A complex water-management system has developed in response to a geographic and seasonal mismatch between supply and demand (U.S. Geological Survey, 1986, p. 157). Settlement first began near readily available sources of water such as streams, lakes, and springs. During the past 100 years, the population has increased in areas of little rainfall, and water supplies must be pumped from deep aquifers or transported from distant surface-water sources.

Water use may be divided into the broad categories of instream and offstream use. Instream use includes recreation, navigation, pollution abatement, maintenance of fish and wildlife habitat, hydroelectric power generation, and ground-water recharge from stream channels. Offstream use includes domestic, commercial, industrial, mining, thermoelectric power production (including fossil fuel, nuclear, and geothermal), and agricultural (irrigation and livestock) use (Templin, 1986, p. 3). The only instream water use now quantified under the U.S. Geological Survey's water use program is hydropower, which consistently uses the most water of all categories accounted for in California (Templin, 1986, p. 3). In 1985, the volume of instream freshwater used for hydropower was more than twice the volume used for irrigation—the largest category of offstream freshwater use.

In 1985, 37,400 Mgal/d (million gallons per day) of freshwater was withdrawn from streams and aquifers—equivalent to almost 1,420 gal/d (gallons per day) per capita. Of this water, 56.4 percent (21,100 Mgal/d) was consumed, and the balance was returned to surface and ground water. Agriculture accounted for 82.4 percent







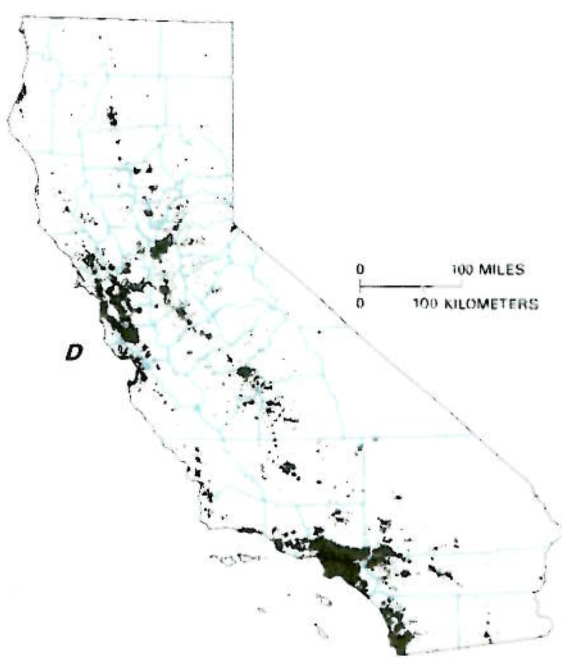


Figure 1. Water supply and population in California. *A*, Water budget, in million gallons per day. *B*, Cumulative normal storage of reservoirs with at least 5,000 acre-feet capacity, 1880 to 1985. *C*, Population trend, 1880 to 1985. *D*, Population distribution, 1985; each dot on the map represents 1,000 people within a census tract. Abbreviations: **CU**, consumptive use; **ET**, evapotranspiration; **GWSD**, ground-water storage depletion; **P**, precipitation; **SWI**, surface-water inflow; **SWO**, surface-water outflow. (Sources: *A*, Ralph G. Allison, California Department of Water Resources, written commun., 1987; California Department of Water Resources, 1983a; Mark Carlos, Imperial Irrigation District, oral commun., 1987; Kahrl, 1979; U.S. Bureau of Reclamation, 1986; U.S. Geological Survey data; White and Garrett, 1986. *B*, U.S. Army Corps of Engineers, 1981. *C*, *D*, Compiled by U.S. Geological Survey from U.S. Bureau of the Census data.)

(30,800 Mgal/d) of total freshwater withdrawals in 1985; of this amount, 66.2 percent was surface water, and 33.8 percent was ground water. Although consumptive use cannot be quantified precisely using available information, irrigation probably accounted for about 90 percent (19,300 Mgal/d) of the consumptive use of freshwater in 1985.

Californians are concerned about many major water use issues; one of the most notable is the recurrent proposal to increase delivery of water from the north to the south and the resultant effects such action would have on water supplies and quality in northern counties. Hearings are being held now (1987) by the California State Water Resources Control Board to gather information needed to help resolve this issue. A second major issue is the use of irrigation water and return flows on the western side of the San Joaquin and Tulare-Buena Vista Lakes basins. Many investigations of the selenium problems related to the Kesterson National Wildlife Refuge in Merced County are now underway in Merced and Fresno Counties. A third issue is water marketing. Where agricultural water users are finding that the cost effectiveness of sustaining production is questionable, selling water rights is becoming increasingly attractive. The water-marketing concept, like many of the water issues mentioned above, appears to be heading to the courts for resolution.

From 1980 to 1985, the population increased 11.4 percent, from 23.7 million to 26.4 million (California Department of Finance, 1987, p. 5). The population is projected to increase to 31.4 million by the year 2000 (California Department of Finance, 1983); this would mean an average annual increase of more than 330,000 people. Available water supplies are insufficient to meet current needs without substantial ground-water storage depletion (withdrawal in excess of recharge). Delays in developing additional surface-water supplies could result in shortages or increased ground-water storage depletion (California Department of Water Resources, 1983a, p. 2).

HISTORY OF WATER DEVELOPMENT

Water-resources planning and development in California has a long and complex history dating to the 18th century (California Department of Water Resources, 1983a, p. 7). Irrigated agriculture began with crop cultivation by Indians along the Colorado River. Spanish missions expanded irrigation by diverting streams through ditches into their gardens and fields. The irrigation systems established by the missions set an example for incoming settlers who were not accustomed to the long, dry summers.

Until the California Gold Rush in the mid-19th century, little was done to develop water storage and distribution systems. The miners soon discovered, however, that water was the most effective instrument for unlocking the riches they sought. They built reservoirs and widespread networks of ditches and flumes to divert water from streams to sluice the gold-bearing deposits; these were California's first major hydraulic engineering works. By the mid-1860's, more than 4,000 miles of mining canals and ditches were operating (California Department of Water Resources, 1983a, p. 7).

After profits from the gold fields declined, some miners and new settlers turned to farming. Water for irrigation became increasingly important. In the northern and central sections of the State, irrigation practices were simple; many settlers dug ditches to convey water from streams to nearby fields. Water from flowing wells also was plentiful in many valleys and coastal plains during the late 1800's. Because of the drier conditions in southern California, however, settlers recognized the value of storage reservoirs. By the 1880's several important dams had been completed or were under construction.

Until about 1900, water development generally was undertaken by individuals and private companies. As the population and the need for water increased, public endeavor supplemented private initiative. The Wright Irrigation District Act of 1887 authorized the formation of local public irrigation districts, declaring the use of water for irrigation of district lands to be a public use and empowering districts to take over private irrigation enterprises to acquire water. By 1930, more than 100 irrigation districts were in operation. The cities of Los Angeles and San Francisco were among the early leaders in planning and developing projects to import water from other areas.

Local plans for the use of water were conceived and executed without the benefit of a statewide framework for guidance and coordination. The first statewide plan for development of water resources was established in 1920 by Colonel Robert B. Marshall, former chief geographer for the U.S. Geological Survey. Marshall's plan called for a storage reservoir on the northern end of the Sacramento River and a pair of aqueducts, one to convey water down the eastern side of the valley and one down the western side. The plan also provided for conveying water to Los Angeles. Today, the State Water Project (operated by the California Department of Water Resources) and the Central Valley Project (operated by the U.S. Bureau of Reclamation), which somewhat resemble Marshall's original proposals, form the heart of California's water-distribution network.

The history of California's reservoir storage capacity since 1880 (fig. 1*B*) indicates that impoundment of surface-water sources is one of the major approaches used to manage water supplies. Most of the reservoirs in the California part of the Central Lahontan basin supply water to Nevada; storage volumes for these reservoirs, therefore, are not included in figure 1*B*. Population growth and distribution since 1880 (fig. 1*C*) have made water-supply management extremely important. Urban water demands are related to population distribution, which is concentrated in the southern coastal and the San Francisco areas (fig. 1*D*).

WATER USE

In much of California, demand for water exceeds the natural supply. To understand the problems of supply and demand, the sources of natural supply, runoff, inflow, and outflow must first be examined. The water budget (fig. 1*A*) shows an average annual statewide precipitation of 172,000 Mgal/d [193 million acre-ft (acre-feet)], which is equivalent to an average annual rainfall of nearly 24 inches. Distribution of average annual precipitation across the State, however, ranges from about 2 to 100 inches (California Department of Water Resources, 1983a, p. 8). Evapotranspiration and consumptive use accounted for about 72 percent (129,000 Mgal/d) of the total water inflow from all sources and precipitation (about 180,000 Mgal/d). Generally, about 4,100 Mgal/d (4.6 million acre-ft) percolates from stream channels to ground water (California Department of Water Resources, 1983a, p. 89). Average annual surface-water inflow and outflow rates (fig. 1*A*) are about 5,570 Mgal/d (6.24 million acre-ft) and 50,500 Mgal/d (56.6 million acre-ft), respectively. An additional 1,970 Mgal/d is supplied from ground-water storage depletion. Annual average outflow rates, however, have ranged from 13,000 Mgal/d (15 million acre-ft) in 1976–77 to about 120,000 Mgal/d (135 million acre-ft) in 1982–83 (California Department of Water Resources, 1983a, p. 9).

Most of the water supply originates in the northern part of the State, but much of the demand is in densely populated and irrigated sections in the southern part. This discrepancy in source of supply and area of demand has resulted in a complex water-transportation network. Major areas of large withdrawals (fig. 2*A*) are related to the water-use categories accounting for the most water use: for example, the dense populations in the urban areas of Los Angeles (Los Angeles County), Sacramento (Sacramento County), San Diego (San Diego County), and San Francisco (San Francisco

County) (fig. 1*D*) use the most public-supplied water, but the rural Central Valley counties (fig. 2*A*) use the most agricultural irrigation water.

The distribution of surface- and ground-water (fig. 2*B,C*) withdrawals by county indicates the availability of surface water in the northern part of the State and the reliance on surface and ground water in the southern part. Large volumes of surface water are imported into southern California from the Colorado and the Owens Rivers and the Sacramento-San Joaquin Delta. Much of the imported and local surface water is used for ground-water recharge; thus, southern California relies heavily on surface and ground water. Of the principal river basins (fig. 3*A*), the Sacramento, the San Joaquin, and the Tulare-Buena Vista Lakes basins are the source of the largest withdrawals. Part of these large withdrawals is transported

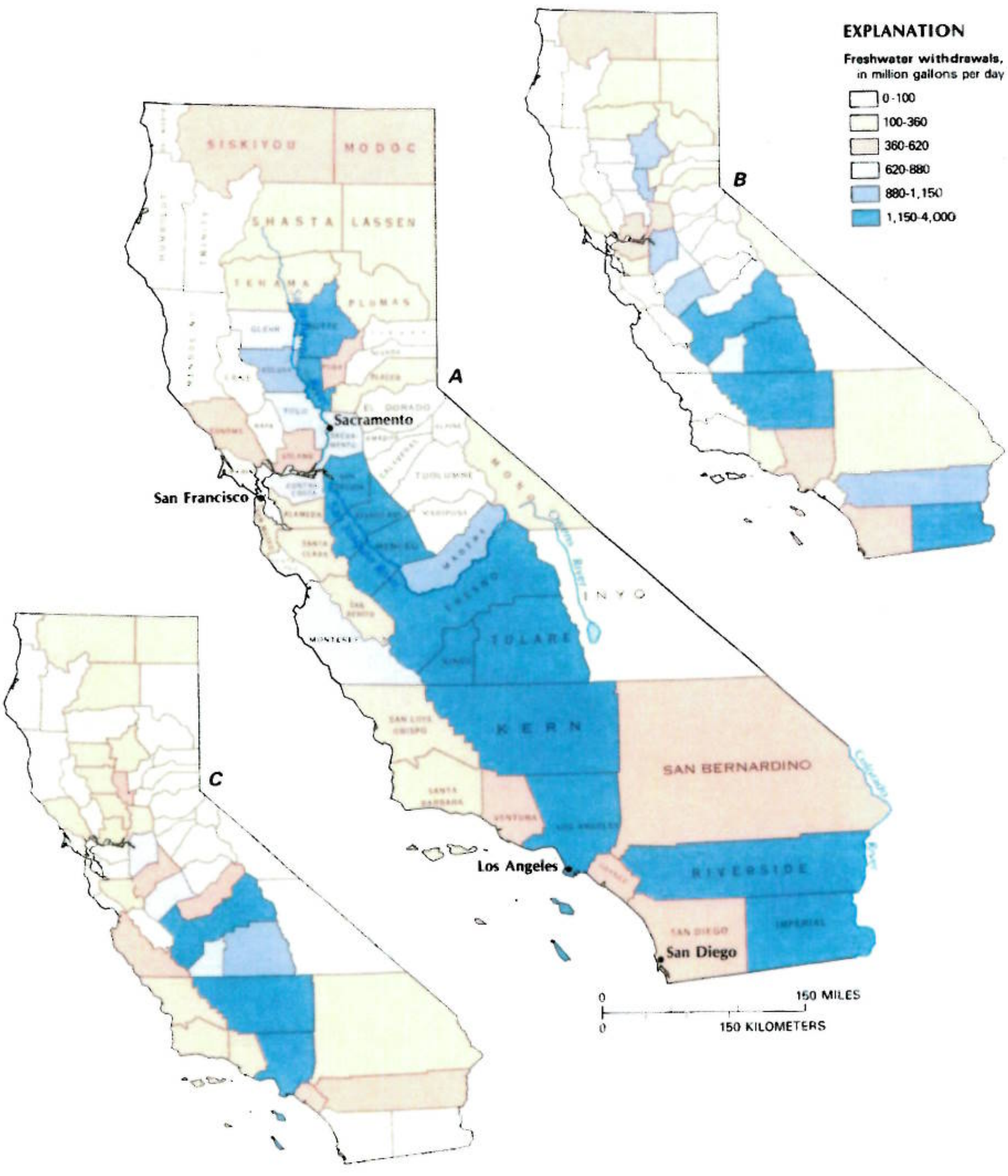


Figure 2. Freshwater withdrawals by county in California, 1985. *A*, Total withdrawals. *B*, Surface-water withdrawals. *C*, Ground-water withdrawals. (Source: Data from U.S. Geological Survey National Water Data Storage and Retrieval System.)

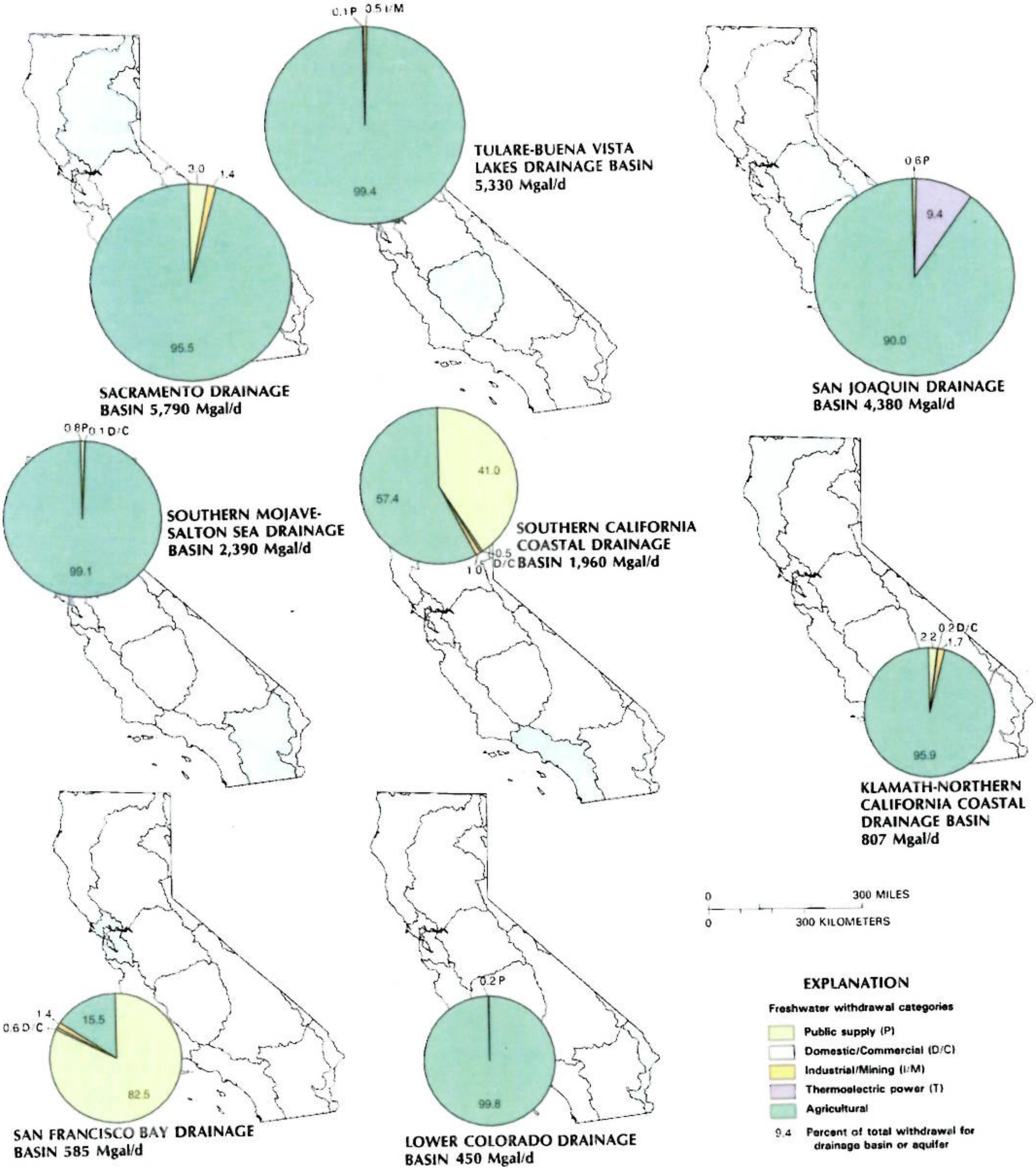


Figure 3. Freshwater withdrawals by category of use and hydrologic unit in California, 1985. *A,* Surface-water withdrawals by principal drainage basin. *B,* Ground-water withdrawals by principal aquifer. Abbreviation: Mgal/d is million gallons per day. (Sources: *A,* Drainage basins from Seaber and others, 1987. *A, B,* Data from U.S. Geological Survey National Water Data Storage and Retrieval System.)

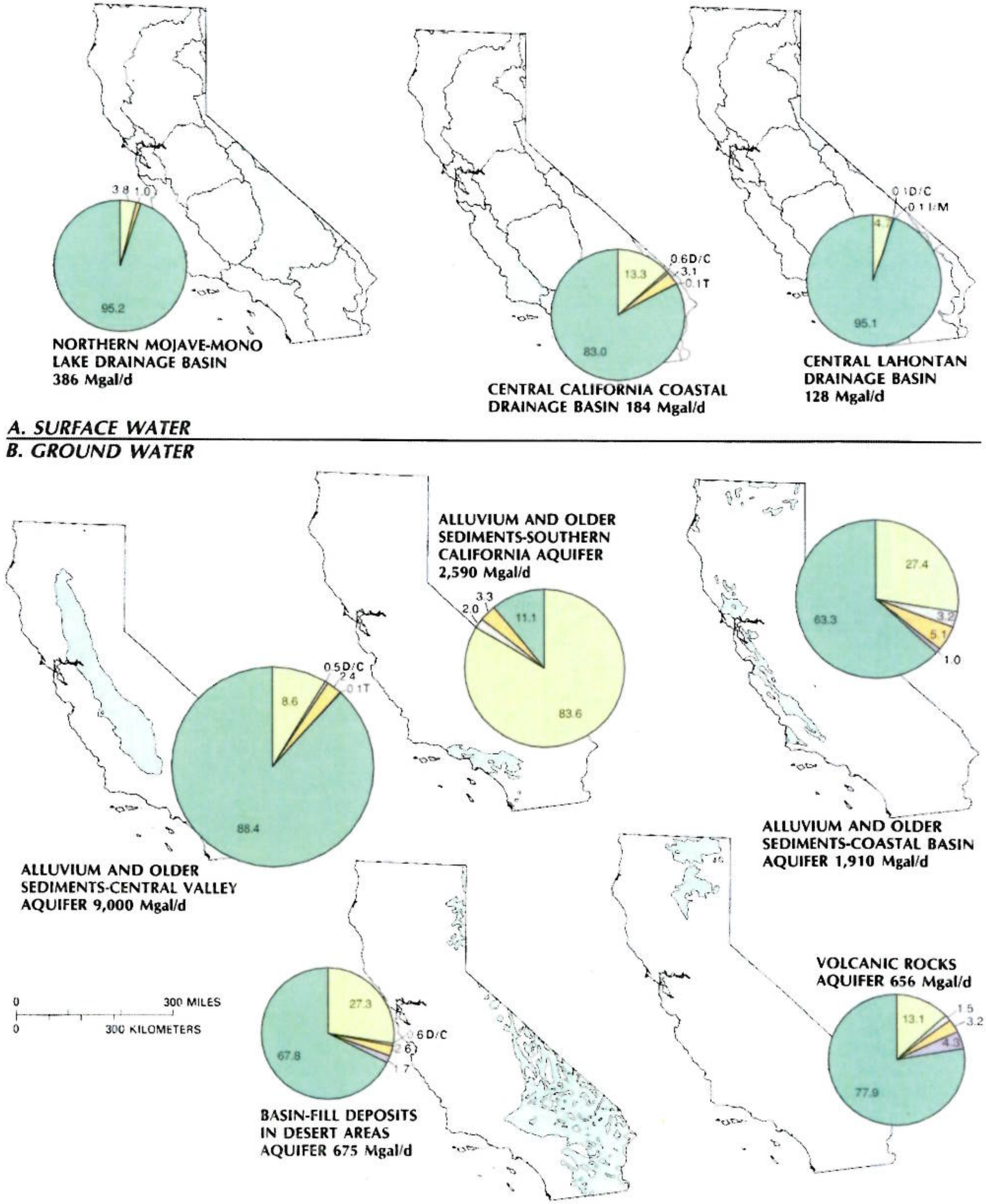


Figure 3. Freshwater withdrawals by category of use and hydrologic unit in California, 1985—Continued.

to the southern Central Valley (including the San Joaquin and Tulare-Buena Vista Lakes Subregions) for irrigation and to southern California for public supply.

Aquifers composed of alluvium and older sediments (mostly of continental origin) and volcanic rock underlie about 40 percent of California (California Department of Water Resources, 1975, p. 7). The alluvial and other sedimentary aquifers can be divided geographically into the Coastal basins, the Central Valley, southern California, and the desert areas (U.S. Geological Survey, 1985, p. 149). These aquifers are principally related in name to the hydrologic units shown in figure 3*A*, except for a few small coastal basin aquifers north and east of Shasta Lake in northern California. The largest volumes of ground-water withdrawals occur in the Central Valley (fig. 3*B*). Ground-water withdrawals also are important in the southern California coastal subregion, where public supply is the largest use of surface- and ground-water (fig. 3*A*,*B*) withdrawals.

The source, use, and disposition of freshwater in California are shown diagrammatically in figure 4. The quantities of water given in this figure and elsewhere in this report may not add to the totals indicated because of independent rounding. The source data indicate that the 22,600 Mgal/d of surface water withdrawn is 60.4 percent of the total freshwater withdrawals in California. Of that total amount, 7.0 percent is withdrawn by public-supply systems, 0.1 percent is self-supplied for domestic and commercial use, 0.7 percent is self-supplied by industrial and mining facilities, 1.8 percent is withdrawn for thermoelectric power generation, and 90.4 percent is withdrawn for agriculture. Other sources, such as saline water and reclaimed sewage wastewater, are not included in figure 4 but are included in this discussion under the appropriate subheadings. The use data indicate that domestic and commercial use accounted for 4,980 Mgal/d, or 13.3 percent of total freshwater withdrawals. Of the domestic and commercial use, 96.1 percent was from public-supply systems, 0.4 percent was self-supplied surface water, and 3.5 percent was self-supplied ground water. The use data indicate that 24.3 percent of the domestic and commercial water was consumed (not readily available for reuse) and 75.7 percent was returned to natural water sources. The use data indicate that, of all water withdrawn, 56.4 percent (21,100 Mgal/d) was consumed and 43.6 percent (16,300 Mgal/d) was returned.

At present, hydropower is the only instream water use studied under the U.S. Geological Survey's water-use program. Instream water use is not included in figure 4. Other instream uses planned for study include aquaculture, recreation, navigation, preservation of fish and wildlife habitat, water-quality improvement, and treaties (Solley and others, 1983, p. 4). The California State Water Resources Control Board (1987, p. 1) is holding hearings on the Sacramento-San Joaquin Delta and San Francisco Bay, which will provide useful information on these types of instream uses.

Hydropower has been an important part of California's history, and its availability has affected the placement of many industries. Electric power companies make every effort to use hydropower because it is a cost-effective way to produce electricity; 24.4 percent of the State's electricity is produced by hydropower. Since 1970,

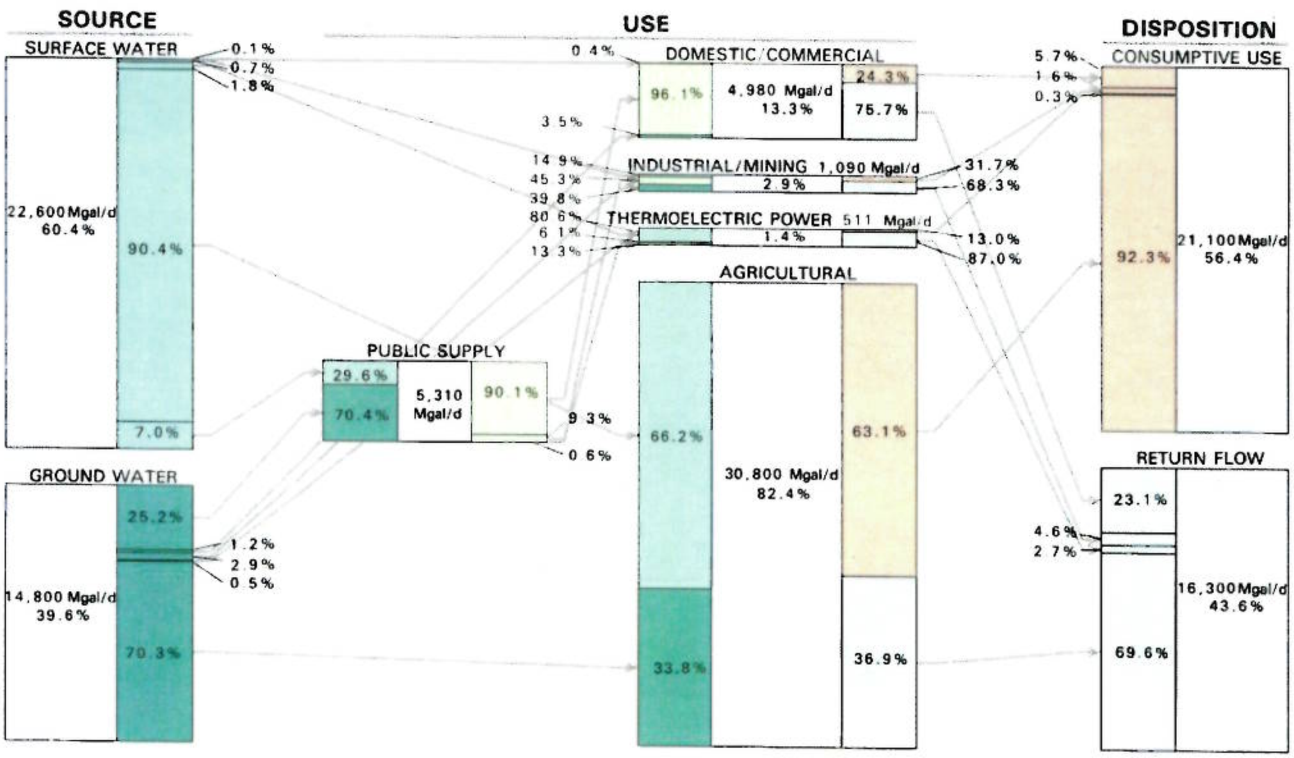


Figure 4. Source, use, and disposition of an estimated 37,400 Mgal/d (million gallons per day) of freshwater in California, 1985. Conveyance losses in public-supply distribution systems and some public water uses, such as fire fighting, are included in the total shown for domestic and commercial use; losses in irrigation distribution systems are included in the total shown for agricultural return flow. All numbers have been rounded and values may not add to totals. Percentages are rounded to the nearest one tenth of 1 percent (0.1%) between 0.1 and 99.9 percent. (Source: Data from U.S. Geological Survey National Water Data Storage and Retrieval System.)

annual water use for hydropower has been stable at between 81,000 and 84,000 Mgal/d (Murray and Reeves, 1972; 1977; Solley and others, 1983). In 1985, about 83,800 Mgal/d was used to generate about 32,000 GWh (gigawatthours) of electricity. The consumptive use of water in this process, mostly from evaporation, has not been calculated separately, but it is included in the total evapotranspiration shown in figure 14. In 1985, about 10.6 percent of the Nation's hydropower was generated in California, but California accounted for only 2.7 percent of water used by the Nation for hydropower generation. The main reason for this small water use by hydropower plants in California relative to the quantity of power generated is that large changes in elevation are available at most hydropower sites in the State, so that a given quantity of water can produce more power. Thus, the ratio of power produced to water used is large in comparison to other States.

Saline water is used extensively (11,700 Mgal/d) for cooling of fossil-fueled and nuclear powerplants along the coast. Reclaimed sewage wastewater is used primarily for irrigation of certain crops (California Department of Water Resources 1983a, p. 80) and accounted for about 196 Mgal/d during 1980 and 233 Mgal/d during 1985 (R.G. Allison, California Department of Water Resources, written commun., 1987). In 1985, there were 892 public and 745 other wastewater-treatment plants in operation, which had a reported total discharge of 2,770 Mgal/d.

PUBLIC SUPPLY

Public-supply systems withdraw, treat, and distribute water to users (fig. 4). In 1985, California ranked first in the Nation in freshwater withdrawals for public-water supply, accounting for 5,310 Mgal/d (14.5 percent of the national total). California also has the largest population served by public suppliers, 24.3 million (12.2 percent of the national total). Although many water-supply systems also deliver to irrigation-water users, those deliveries are included in the irrigation category rather than the public-supply category.

Of the 5,310 Mgal/d withdrawn for public supply, about 29.6 percent (1,570 Mgal/d) came from surface-water sources, and 70.4 percent (3,730 Mgal/d) came from ground-water sources (fig. 4). The source used depends on the local availability of surface water. Public-supply deliveries during 1985 were used in the following statewide proportions: domestic and commercial, 90.1 percent; industrial and mining, 9.3 percent; and thermoelectric power, 0.6 percent (fig. 4). Statewide distribution of areas receiving public-supply water is closely related to the distribution of population centers.

In 1985, the Southern California Coastal basin accounted for 56.2 percent of the State's population served by public suppliers, compared to 25.0 percent in the remaining coastal basins; 15.8 percent in the Central Valley, including the Sacramento, the San Joaquin, and the Tulare–Buena Vista Lakes basins; and 3.0 percent in the desert areas. The Southern California Coastal basin used about 55.9 percent of the 1985 total withdrawals for public-water supply, whereas the remaining coastal subregions used about 20.0 percent, the Central Valley used about 19.8 percent, and the desert areas used about 4.3 percent. Of the population receiving public supplies in the Southern California Coastal basin during 1985, 71.8 percent was supplied from ground-water sources. By comparison, ground water supplied 47.4 percent of the population in the remaining coastal basins, 79.5 percent in the Central Valley, and 78.2 percent in the desert areas.

DOMESTIC AND COMMERCIAL

Domestic and commercial water users rely on self- and public-supply systems. Public supply delivered 96.1 percent of all domestic and commercial water used in California during 1985. The total for domestic and commercial use in 1985 was 4,980 Mgal/d (fig. 4). According to the most recent survey available (U.S. Bureau of the Census, 1983, p. 6–421 to 6–425), 89.1 percent of California's self-supplied domestic water comes from wells and springs. Domestic and commercial consumptive use during 1985 was about 1,210 Mgal/d (fig. 4). These figures are based on consumptive use coefficients from the California Department of Water Resources (1983b, p. 9). Domestic water provided by public suppliers was used at the rate of 133 gal/d per capita. Self-supplied domestic water, however, was used at an estimated rate of 75 gal/d per capita (California State Water Resources Control Board, 1977, p. 22).

INDUSTRIAL AND MINING

Freshwater use for industry and mining during 1985 was 1,090 Mgal/d (fig. 4) accounting for only 2.9 percent of California's total offstream freshwater use. Public supply delivered 45.3 percent (494 Mgal/d) of all industrial and mining water used during 1985, while self-supplied users provided the remaining 54.7 percent. For self-supplied users, surface water was the source of 162 Mgal/d and ground-water sources provided 434 Mgal/d. Industrial and mining consumptive use during 1985 was about 346 Mgal/d, which is 31.7 percent of this category's total water use and 1.6 percent of the total consumptive use of all categories in figure 4. Saline water was also used by industrial and mining users during 1985 at rates of 262 Mgal/d and 301 Mgal/d, respectively. Reclaimed sewage wastewater provided an additional 2.9 Mgal/d to industrial users.

The largest water-use industries are the food and kindred products and the petroleum-related industries. Almost all industry groups in food and kindred products consume large quantities of water, and the petroleum-related industries have a reported consumptive use of about 54 percent of the total withdrawals (California Department of Water Resources, 1982, p. 13, 29–30, 51–52). Oil extraction is the largest known water use related to mining. Water is extracted along with the oil and is reinjected to enhance oil recovery.

Total industrial and mining use of freshwater, saline water, and reclaimed sewage has increased from 1,170 Mgal/d in 1975 to 1,656 Mgal/d in 1985 (Murray and Reeves, 1977, p. 26; Solley and others, 1988, p. 23, 37). The volume of water used in oil extraction probably accounts for the overall increase in water use in the industrial and mining category.

THERMOELECTRIC POWER

Between 1980 and 1985, the use of fresh ground water for cooling in thermoelectric power generation apparently has decreased sharply; however, the use of saline surface water has increased. Withdrawal of fresh ground water decreased from 886 Mgal/d in 1980 to 68 Mgal/d in 1985. Withdrawal of fresh surface water also declined from 1,084 Mgal/d in 1980 to 412 Mgal/d in 1985. Withdrawal of saline surface water, however, increased from 9,189 Mgal/d in 1980 to more than 11,700 Mgal/d in 1985. The apparent decrease in use of freshwater may have resulted from the conversion of powerplants to accommodate saline surface water or from improved information gathering for 1985.

Of California's many thermoelectric powerplants, most are fossil fuel, some are geothermal, and three are nuclear. During 1985, 24.6 percent (12,200 Mgal/d) of offstream water use was for cooling thermoelectric powerplants, which produced 98,900 GWh of electricity. Thermoelectric powerplant consumptive use of cooling water was less than 0.6 percent, primarily because of the once-through closed cooling systems in many fossil-fueled and nuclear powerplants. Most of these systems are along the coast and withdraw large volumes of saline surface water—more than 11,700 Mgal/d in 1985.

During 1985, fossil-fueled powerplants withdrew 8,400 Mgal/d of saline surface water, 412 Mgal/d of fresh surface water, and 8.7 Mgal/d of fresh ground water and received 17 Mgal/d of public-supply water. Fossil-fueled powerplants' consumptive use was 19.1 Mgal/d of freshwater and 5.75 Mgal/d of saline water (primarily through their evaporative cooling towers) while producing 66,900 GWh of electricity during 1985. Nuclear powerplants withdrew about 3,340 Mgal/d of saline surface water and 0.2 Mgal/d of freshwater and received 14.0 Mgal/d of public-supplied water. Nuclear powerplants' consumptive use was 5.6 Mgal/d of freshwater and no saline water. These plants produced 19,700 GWh of electricity. Geothermal powerplants used 59.5 Mgal/d of ground water; consumptive water use was 42.0 Mgal/d. They produced 12,300 GWh of electricity.

AGRICULTURAL

Agricultural water use can be divided into two categories—irrigation and nonirrigation including livestock. Irrigation is by far the largest offstream water use in California. During 1985, about 30,800 Mgal/d of freshwater was used for agriculture; irrigation accounted for 99.4 percent (30,600 Mgal/d) of that total and agricultural nonirrigation only 0.6 percent (200 Mgal/d). Water used for irrigation in California accounted for 22.3 percent of the Nation's total irrigation water use. Trends in irrigation-water use show increases of 6 percent between 1970 and 1975, of 12 percent between 1975 and 1980, and a return to about the 1970 level in 1985. Trends in the use of fresh ground water for irrigation indicate a decline from 89 percent of the total use of fresh ground water in 1970 and 1975 to 86 percent in 1980 and 70 percent in 1985 (Murray and Reeves, 1972, p. 22; 1977, p. 24, 30; Solley and others, 1983, p. 40; Solley and others, 1988, p. 67). These trends indicate a shift from the use of ground water to a greater reliance on surface water.

Most of the withdrawals for irrigation are in the Central Valley. In 1985, the Valley used 75.3 percent (23,100 Mgal/d) of the irrigation water use. Similarly, it accounted for 72.5 percent (14,700 Mgal/d) of all surface water and 81.0 percent (8,410 Mgal/d) of all ground water used for irrigation in 1985. The volume of fresh ground water used for irrigation (8,410 Mgal/d) in the Central Valley accounted for 18.3 percent of the Nation's fresh ground water used for irrigation and 11.5 percent of the Nation's total fresh ground water used during 1985.

California accounted for 16.7 percent (9.6 million acres) of the Nation's irrigated land during 1985. This acreage reflected a decrease from 9.7 million acres in 1980 (Solley and others, 1983, p. 18); even so, the acreage was larger than in 1975 (9.0 million acres) (Murray and Reeves, 1977, p. 24) and in 1970 (8.7 million acres) (Murray and Reeves, 1972, p. 22). Federal agricultural subsidy programs, such as Payment In Kind and the Set Aside Programs, contribute to the fluctuation of irrigated acreage from year to year: for example, about 500,000 acres were part of by the Set Aside Program during 1985 (Glenn Sawyer, California Department of Water Resources, oral commun., 1987).

During 1985, total water use for agriculture was 66.2 percent surface water and 33.8 percent ground water (fig. 4), but, for nonirrigation agricultural use, it was 79.6 percent surface water (159 Mgal/d) and 20.4 percent ground water. Nonirrigation agricultural use for livestock was about 200 Mgal/d in 1985 compared to 87 Mgal/d in 1980 (Solley and others, 1983, p. 14), 100 Mgal/d in 1975 (Murray and Reeves, 1977, p. 22), and 91 Mgal/d in 1970 (Murray and Reeves, 1972, p. 20). Livestock production has been stable since 1980 (Daniel Halverson, California Crop and Livestock Reporting Service, oral commun., 1987). The increase in this water-use category probably is due to different methods of estimating or classifying livestock in the 1985 report.

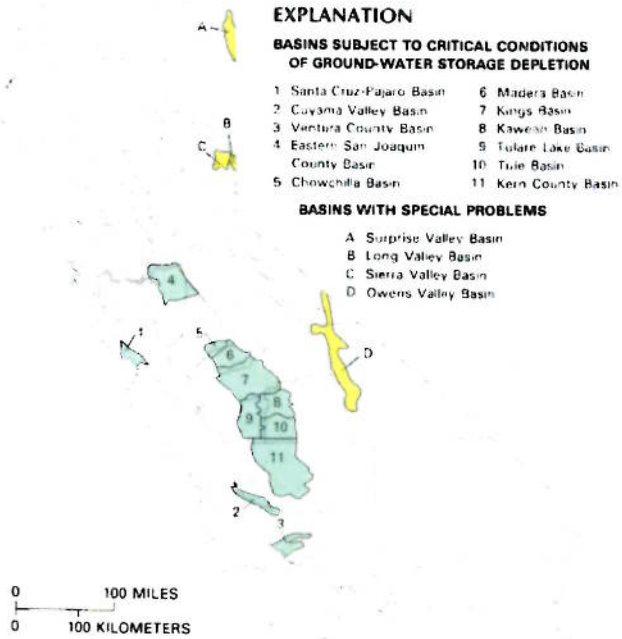


Figure 5. Basins subject to critical conditions of ground-water storage depletion and basins with special withdrawal, storage, or water-quality problems of local concern. (Source: Modified from California Department of Water Resources, 1980, p. 4.)

WATER MANAGEMENT

California has a wide range of water-rights laws. In some instances, water users have riparian rights, and reporting surface-water withdrawals is not required; in other instances, rights for surface and ground water have been set by a court of law, and withdrawal reports are required. Ground-water withdrawals are regulated only where (1) basins have been adjudicated, (2) the State Legislature has granted a local water district the power to tax pumpage, or (3) the water agencies in an area have agreed to self-regulation apart from any State regulation.

Many water agencies are responsible for surface-water management (U.S. Geological Survey, 1986, p. 165), and the number of agencies still is increasing because of continually expanding urban areas. The need for ground-water management also is increasing in response to demands. Areas subject to critical conditions of ground-water storage depletion (withdrawals in excess of recharge) and basins that have special withdrawal, storage, or water-quality problems of local concern (fig. 5) are requiring increased attention by water managers in the State (California Department of Water Resources, 1980, p. 4). The need for water-use information, therefore, has also increased. Legal resolutions typify the California water-management practices of the past and probably will continue unless an enforced statewide mandate for water management develops.

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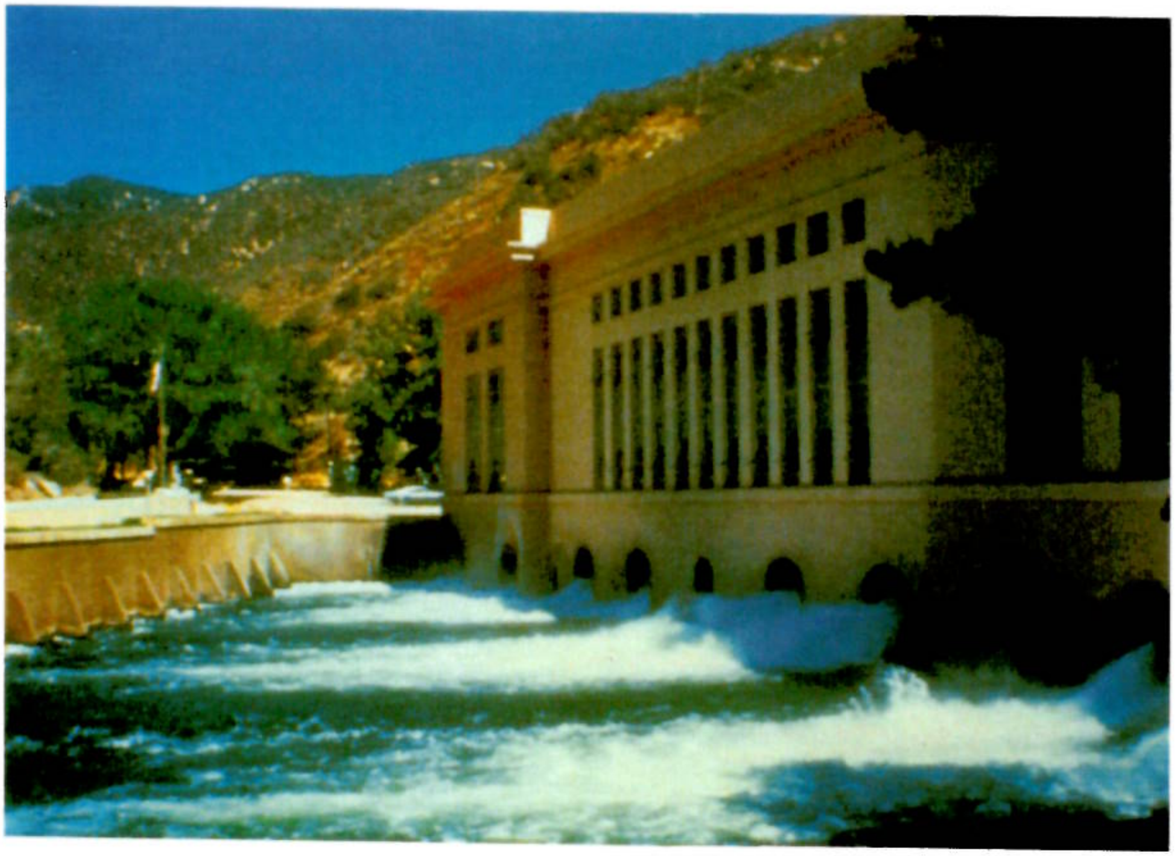

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