89-251

WATER FACT SHEET

U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

GROUND-WATER RESOURCES OF THE CENTRAL VALLEY OF CALIFORNIA

THE AREA

The Central Valley of California, composed of the Sacramento Valley to the north and the San Joaquin Valley and Tulare basin to the south, occupies about 12 percent of the total land area of the State. It is a large alluvium-filled structural basin characterized by approximately 51,800 square kilometers of flatland lying between the Coast Range and Valleys to the west and the Sierra Nevada to the east. The aquifer system of the Central Valley is composed of interlayered gravel, sand, silt, and clay derived from the surrounding mountains. Thickness of sediments comprising the freshwater aquifer averages about 880 meters in the San Joaquin Valley and 460 meters in the Sacramento Valley. The shallow part of the aquifer is under water-table conditions, whereas the deeper part is semiconfined or confined.

The climate of the Central Valley is arid to semiarid, with average annual precipitation ranging from 360 to 510 millimeters in the Sacramento Valley and from 130 to 360 millimeters in the San Joaquin Valley. In general, potential evapotranspiration exceeds precipitation by as much as 0 to 1,020 millimeters in the Central Valley.

Paradoxically, in this semiarid, naturally water-deficient valley, 40 percent of the Nation's fruits, nuts, and other table foods are produced. The agricultural production of the valley is approximately $16 billion (1988) paid to farmers annually, and the State of California reports another $40 billion generated by farm related services and support. This makes California one of the largest agricultural economies in the world.

Large quantities of water are needed for irrigation to support an agricultural economy in the valley. It is estimated that, including delivery losses, an average of 915 millimeters of water per irrigated hectare is used annually. During 1961–77, about 27,200 cubic hectometers of water were used for irrigation, of which about 50 percent was supplied by surface water and the remaining 50 percent by ground water.

Since the last half of the 1800's, ground water in the Central Valley has been developed for irrigation. Early records indicate that estimated pumpage was about 3.0 cubic hectometers in the San Joaquin Valley in 1912 and about 1.5 cubic hectometers in the Sacramento Valley in 1913. The annual pumpage in the Central Valley has increased from about 4.5 cubic hectometers in 1912–13 to about 18,500 cubic hectometers in the drought year 1977; however, the average total pumpage in the mid-1970's was about 14,800 cubic hectometers.

In addition to the agricultural use of ground water, nearly every city in the San Joaquin Valley uses ground water as the principal source for municipal and industrial supplies. Two of the fastest growing cities in California, Fresno and Sacramento, are in the Central Valley.

THE GROUND-WATER PROBLEM

Under natural conditions, the Central Valley has an average annual water deficiency as great as 1,020 millimeters, whereas parts of the bordering Sierra Nevada and Coast Range have an average annual surplus of water. Because of flat, low-lying land with fertile soil, agricultural development and human population tend to be concentrated in the valleys that are deficient in precipitation. Fortunately, ground water is available everywhere in the Central Valley, even where little rain normally falls or little surface water exists.

Water pumped from aquifers may or may not be quickly replenished. In some parts of the Central Valley, the ground water that is withdrawn can be replenished annually during the nonirrigation season by recharge from precipitation and streams; in other areas, replenishment of aquifers occurs only in years of abundant precipitation. In parts of the Central Valley, pumping has caused continuous water-level declines; in parts of the San Joaquin Valley and Tulare basin, water levels have declined nearly 122 meters, depleting stored ground water and lowering water levels to as much as 30 meters below sea level.

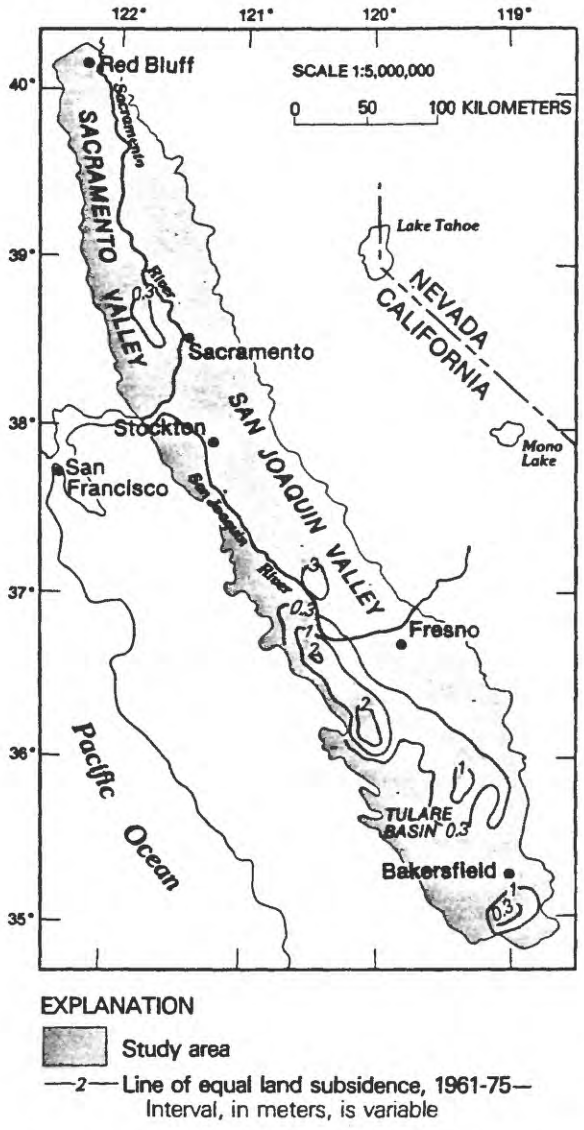
CHANGES IN THE AQUIFER SYSTEM

One of the earliest and most obvious results of extensive ground-water pumping was widespread land subsidence in the San Joaquin Valley. Subsidence began in the mid-1920's as ground water was pumped for irrigation. More than 12,950 square kilometers of land surface in the Central Valley has subsided more than 0.3 meter. At one place in the San Joaquin Valley, the maximum subsidence exceeded 9 meters by 1970. The figure on the reverse side illustrates the areas of land subsidence during 1961–75.

The rate of subsidence in the areas most severely affected by pumping in the San Joaquin Valley has been decreasing since delivery of surface water began in 1968. However, the rate of subsidence may increase if pumping reduces water levels below the previous maximum lows. For example, during the 1976–77 drought, water levels declined a maximum of nearly 61 meters in 8 months. This resulted in the recurrence of subsidence (as much as 150 millimeters in 1977), which had nearly stopped after 1972.

Recent studies have documented as much as 1.2 meters of land subsidence since 1954 in the Sacramento Valley about 40 kilometers north of the city of Sacramento. A result of subsidence caused by ground-water withdrawal has been the loss of about 79,000 cubic hectometers of aquifer storage capacity.

Most of the space occupied by water in noncompacted fine-grained artesian aquifer materials is lost during compaction. Therefore, when water levels recover following pumping, less



Areas of land subsidence in the Central Valley of California observed during 1961–75 (modified from Williamson and Prudic, 1984).

water is stored in a given volume of the aquifer than before compaction occurred. As compaction stops, water can be withdrawn from or returned to artesian storage only.

Subsidence has also caused damage to structures such as aqueducts, roads, bridges, buildings, and well casings. In low areas, subsidence also increases the potential for flooding and seawater encroachment, which may become a problem in the Sacramento Valley where subsidence is only just beginning.

Other changes to the aquifer system are:

- Prior to development, the aquifers were recharged by precipitation and stream seepage in upland areas. The aquifers discharged to streams and lakes in topographic depressions, and by evapotranspiration in the central part of the Valley. The total regional circulation through the ground-water flow system was estimated to be about 79,000 cubic hectometers per year.
- Since development, about 78,900 cubic hectometers of water have been removed from aquifer storage; 49,300 cubic hectometers of water have been removed because of the lowering of the water table; 20,960 cubic hectometers have been removed during compaction of fine-grained sediments and accompanying land subsidence; and 8,640 cubic hectometers have been removed from the elastic storage of the confined aquifer.
- Historical records indicate that during 1961–77, ground-water withdrawals were about 14,800 cubic hectometers, of which 94 percent was for irrigation (13,910 cubic hectometers) and 3 percent was for municipal water supplies (432 cubic hectometers). Computer simulation of the ground-water-flow system indicated that ground-water recharge during this period was about 12,510 cubic hectometers, of which 81 percent was from irrigation return flow, 14 percent was from precipitation, and 5 percent was from streams and lakes. The difference between annual ground-water discharge and recharge indicates a net loss of 990 cubic hectometers from aquifer storage; about half is from aquifer storage and half from elastic storage and compaction of sediments.
- The vertical movement of water through the Corcoran Clay (San Joaquin Valley) that separates the unconfined and confined aquifers is directly related to the density of wells that penetrate the clay and are open to both aquifers. Field measurement and computer simulation both show that the current (1989) vertical movement is about 10 times greater than under natural conditions.

GROUND-WATER QUALITY

Except at a few localities, the quality of ground water is good (dissolved solids concentrations range from 200 to 1,200 milligrams per liter (mg/L)) for most purposes in the Sacramento Valley. In the western part of the San Joaquin Valley, a shallow water body is not extensively used because of poor water quality (dissolved solids concentrations range from 1,000 to 5,000 mg/L; chloride and sulfate concentrations average about 400 and 440 mg/L, respectively). Prior to the importation of surface water, water for irrigation was pumped from a confined aquifer below the water-table aquifer. During predevelopment conditions, water levels in the confined aquifer were above those in the shallow aquifer; however, irrigation pumping has lowered water levels in the confined aquifer to below those in the water-table aquifer. As a result, poor quality water in the shallow aquifer can flow to and contaminate the lower confined aquifer. In addition, pesticides and fertilizers have been applied to the land; these substances and minerals in soils, such as selenium and boron, could be leached by irrigation water. Dibromochloropropane (DBCP), a suspected carcinogen and widely used nematocide, has been detected in ground water in every county in the San Joaquin Valley and Tulare basin, and has been detected in public water supplies of the city of Fresno.

The future economy of the Central Valley depends on wise use of ground water in conjunction with imported surface water. Scientific information, such as the foregoing, is currently being used by various State and local agencies to formulate water conservation and water pollution abatement plans. In fiscal year 1989, the USGS has entered into interagency agreements with 25 Federal, State, and local agencies to conduct ground-water investigations. Information from many of these investigations will help water management officials in the Central Valley formulate plans for protection of the aquifer system.

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