it a major item in his joint presentation to Congress and meeting with former President Nixon in 1972.

Proposed solutions

The salinity problem has the potential to cause lengthy legal and political battles between the Upper and Lower Basin states. The Lower Basin wants to prevent salinity increases that would result from further upstream development; Upper Basin states are concerned that the salinity issue could prevent future increases in their water use.

The states began to work together and with the federal government in the late 1960s, and in the early 1970s several steps were taken to deal with the problems. In 1972, the U.S. Bureau of Reclamation identified 16 salinity control projects. These would be grouped into three categories: point source projects such as salt springs, diffuse sources that covered extensive areas, and agricultural projects that involved lining of canals and on-farm measures. That year, the seven Basin states adopted a policy to maintain salinity at or below 1972 levels in the lower Colorado River while the states continued to develop their apportioned waters. The federal Clean Water Act of 1972 required the establishment of salinity standards for the Colorado River. In 1973, the seven states formed the Colorado River Basin Salinity Control Forum to establish salinity standards and a Basinwide salinity control plan.

At the same time, negotiations were under way to solve the salinity problem with Mexico. In 1962, salty drainage water and reduced river flows had increased salinity of the water delivered to Mexico from 800 to 1,500 mg/L. After several temporary measures, an agreement was reached in 1972 providing that the average annual salinity of water delivered to Mexico at the northerly international boundary would not be more than 115 ppm (plus or minus 30 ppm) over the average salinity at Imperial Dam.

In 1974, Congress passed the Colorado River Basin Salinity Control Act, Public Law 93-320, to implement both the Mexican and domestic control proposals. The Act authorized a desalting plant at Yuma, Arizona, to reduce the salinity of the Wellton-Mohawk Valley drainage water and other facilities necessary to meet the obligations to Mexico. The domestic salinity problem was addressed by provisions for implementing the salinity policy adopted by the Basin states in 1972, planning studies on 12 salinity control units, and constructing and financing four units by the United States, with the Basin states repaying 25 percent of construction, operation, and maintenance costs.

In 1975, the Forum recommended water quality standards for salinity, including numeric criteria of 723 mg/L below Hoover Dam, 747 mg/L below Parker Dam, and 879 mg/L at Imperial Dam. Their proposal also called for prompt construction of the salinity control units authorized by P.L. 93-320, construction of additional units upon completion of planning reports, implementation of on-farm water management practices to control salinity, limitations on industrial and municipal discharges, use of saline water for industrial purposes, and the inclusion of the salinity components of water quality management plans developed by local governments. The salinity standards were adopted by each of the Basin states and approved by the U.S. Environmental Protection Agency.

Two of the four authorized salinity control units are under construction. The Paradox Valley Unit, a point salt source in Colorado, will be controlled by collection of highly saline brines and their disposal through deep well injection. The Grand Valley Unit, also in Colorado, will reduce salt contribution by reducing the amount of deep percolation of conveyance system seepage and irrigation water into the underlying saline soils. The U.S. Department of Agriculture has implemented a cost-share program of on-farm water management to reduce salinity in Grand Valley and in the Uinta Basin, Utah.

Although progress has been made, the Basin states see the need for expanded salinity control to maintain the numeric criteria. Bills now before Congress would authorize five additional salinity control units to be constructed by the Department of the Interior, give the U.S. Department of Agriculture specific authority for a program of on-farm Colorado River salinity control measures in cooperation with local landowners, and provide for 25 percent of the construction costs to be paid by the Basin states.

In other efforts to control the river's salinity, the Basin states have adopted a policy calling for a no-salt return from industrial discharges and limiting the incremental increase permitted from municipal discharges. The states have also called for the use of saline and/or brackish waters in lieu of high-quality water for industrial purposes.

Conclusion

These combined efforts of the seven Basin states and the federal government represent a significant step toward control of salinity in the Colorado River and reduction of the economic damage it causes. Through timely implementation of all phases of the Basinwide program, the salinity standards can be maintained in the lower river while the states continue to develop their apportioned waters.

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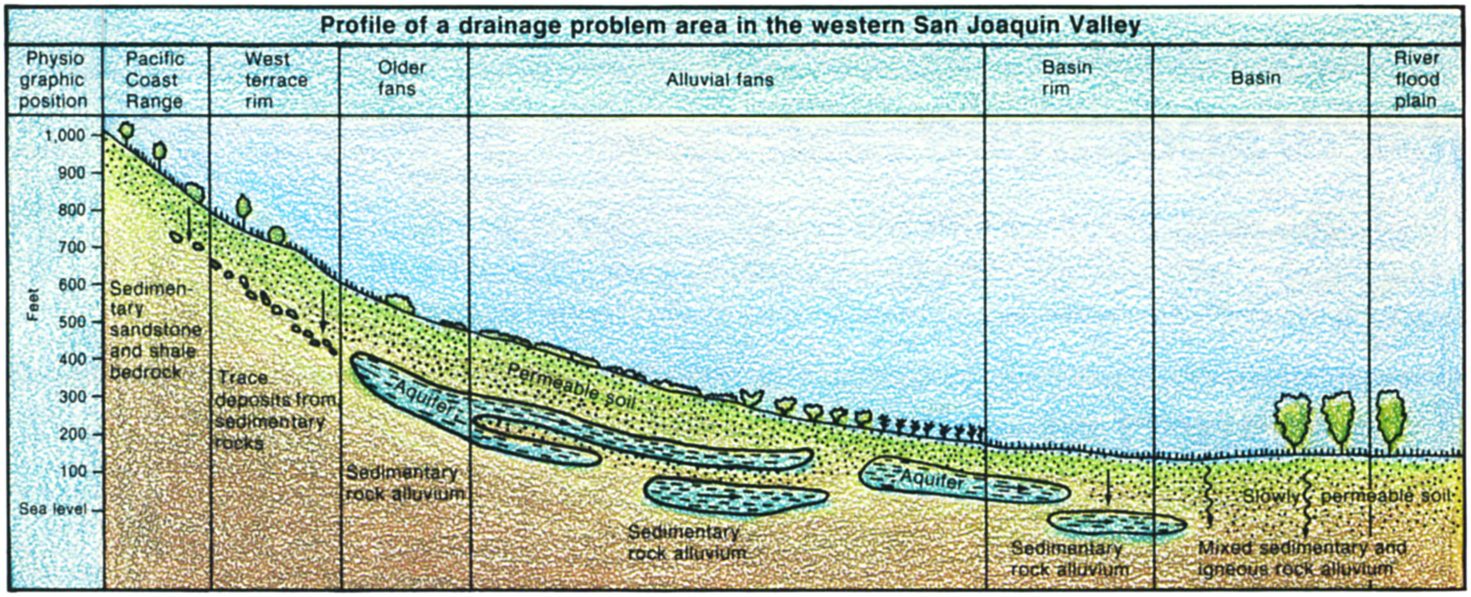
Status of soil salinity in California

Virgil L. Backlund **Ronald R. Hoppes**

Saline and sodic soils occur naturally in arid and semiarid regions, and as water development brings more land into irrigation, the salinity problem expands. The condition is aggravated by poor soil drainage, improper irrigation methods, poor water quality, insufficient water supply for adequate leaching, and insufficient disposal sites for water that leaches salts from the soil. Problems caused by soil salinity are compounded when a high water table impedes root development and concentrates salts in the already limited root zone.

Irrigation water applied to higher elevation agricultural lands drains into the problem areas, bringing salts and contributing to the high water table problem (see drawing). Difficulties increase when surface irrigation water is of poor quality, containing more than 300 to 800 mg/L in total dissolved salts. Groundwater supplies also are deteriorating in quality, because the groundwater overdraft occurring in these areas decreases the amount of water and therefore increases the salt concentration.

Recent surveys by the U.S. Department of Agriculture Soil Conservation Service indicate that salinity affects 4.18 million acres of the 55.6 million



Source: USDA, Soil Conservation Service

Irrigation water applied to soils at higher elevations can have an impact on soils at lower elevations. The excess water drains to the more slowly permeable soils in the basin, contributing to salinity and high water tables.

acres of nonfederal land in California (table 1). More startling, however, is that 2.9 million of the 10.1 million acres irrigated in California are affected (table 2). These acreages are based on soils that now have an electrical conductivity of 4 decisiemens per meter (dS/m) (about 2,500 mg/L salt) or more.

Five of the nation's top ten agricultural counties are in the San Joaquin Valley and have salinity and drainage problems. Crop yields decrease as soil salinity levels increase. For example, field beans yield only 40 percent of their potential even at a low soil salinity level of 4 dS/m. Cotton, dates, and sugarbeets are not affected at the low level; barley is very sensitive at this low level only during germination. Many growers have a production loss of 20 percent without being aware of drainage and salinity problems, recognizing the situation only as problems become more severe.

Projections made by the Soil Conservation Service River Basin Planning Staff in 1977 (unpublished data) indicate that acreage with salinity problems in the San Joaquin Valley (both federal and nonfederal land) will increase to 3.6 million acres by the year 2000 if corrective actions are not taken. Installing drainage systems can reduce production losses caused by high water table and salinity problems, but insufficient disposal sites for the saline drainage water (especially in the San Joaquin Valley), high installation costs, and agricultural economic conditions have kept landowners from carrying out needed measures.

Disposal of saline drainage water thus represents the biggest challenge in solving California's salinity problems. Both on-farm evaporation basins and district or regional facilities would require areas equal to about 20 percent of the irrigated lands to be drained. (This estimate assumes that each acre with a high-water-table problem will discharge 1 acre-foot of effluent each year and that evaporation from evaporation basins will average 5 feet per acre per year. Each acre with a high water table will therefore require 0.2 acre for evaporation.)

Additional methods of disposing of saline water are being explored by researchers at the University of California and other institutions. They include a master drain to provide the necessary outlets for the water and the use of saline wastewater for cooling electrical energy plants.

TABLE 1. Extent of salinity and associated problems by land use in California

Primary land use	Nonfederal land acreage	Salinity/ sodicity soils*	High water table	Water quality
	acres (millions)			
Irrigated cropland	10.1	2.9	2.7	3.4
Dry cropland	1.8	0.0	0.1	0.1
Grazed land	19.6	0.8	0.4	0.4
Timberland	8.9	0.0	0.0	0.1
Wildlife land	1.2	0.2	0.1	0.2
Urban	5.0	0.1	0.1	0.5
Other	9.0	0.2	0.1	0.3
Total	55.6	4.2	3.5	5.0

Source: County Resources Inventory 1982, U.S. Department of Agriculture Soil Conservation Service, Davis, California.

*Areas having an electrical conductivity of 4 dS/m (abut 2,500 mg/L) or greater and/or exchangeable sodium percentage (ESP) values greater than 15 percent. Water table at a depth of 5 feet or less or at a depth that affects the growth of commonly grown crops. Includes parameters such as salinity or boron toxicity.

TABLE 2. Salinity and drainage problems by major irrigated areas (approximate area)

Location	Irrigated area	Salinity/ sodicity	High water table	Water quality
	acres (millions)			
San Joaquin Valley	5.6	2.2	1.5	2.3
Sacramento Valley	2.1	0.2	0.4	0.3
Imperial Valley	0.5	0.2	0.5	0.5
Other areas	1.9	0.3	0.3	0.3
Total	10.1	2.9	2.7	3.4

Source: See table 1 source note.

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