WATER FACT SHEET

U.S. DEPARTMENT OF THE INTERIOR, U.S. GEOLOGICAL SURVEY

EFFECTS OF MANAGEMENT ALTERNATIVES ON THE SHALLOW, SALINE GROUND WATER IN THE WESTERN SAN JOAQUIN VALLEY, CALIFORNIA

Continued agricultural productivity in the western San Joaquin Valley, California, can be adversely affected by the presence of shallow, highly saline ground water, which can cause accumulation of salts in soils and further degradation of ground-water quality. Evaporation of shallow ground water (within 7 feet of land surface) can cause increases in soil salinity. Chemical constituents, notably selenium, that are toxic to waterfowl are transported in water from subsurface tile-drainage systems in the western San Joaquin Valley. State and Federal investigators have tried to identify management alternatives that will improve upon traditional agricultural drainage systems. As part of this investigation, the U.S. Geological Survey (USGS) has developed computer models of the ground-water system in the western San Joaquin Valley to simulate and assess alternatives for managing the shallow, saline ground water. The 550-square-mile study area that extends from Little Panoche Creek southward to Cantua Creek and from the western boundary of valley deposits to the San Joaquin River and Fresno Slough is shown in figure 1. Preliminary results of the model simulations of ground-water flow are discussed below.

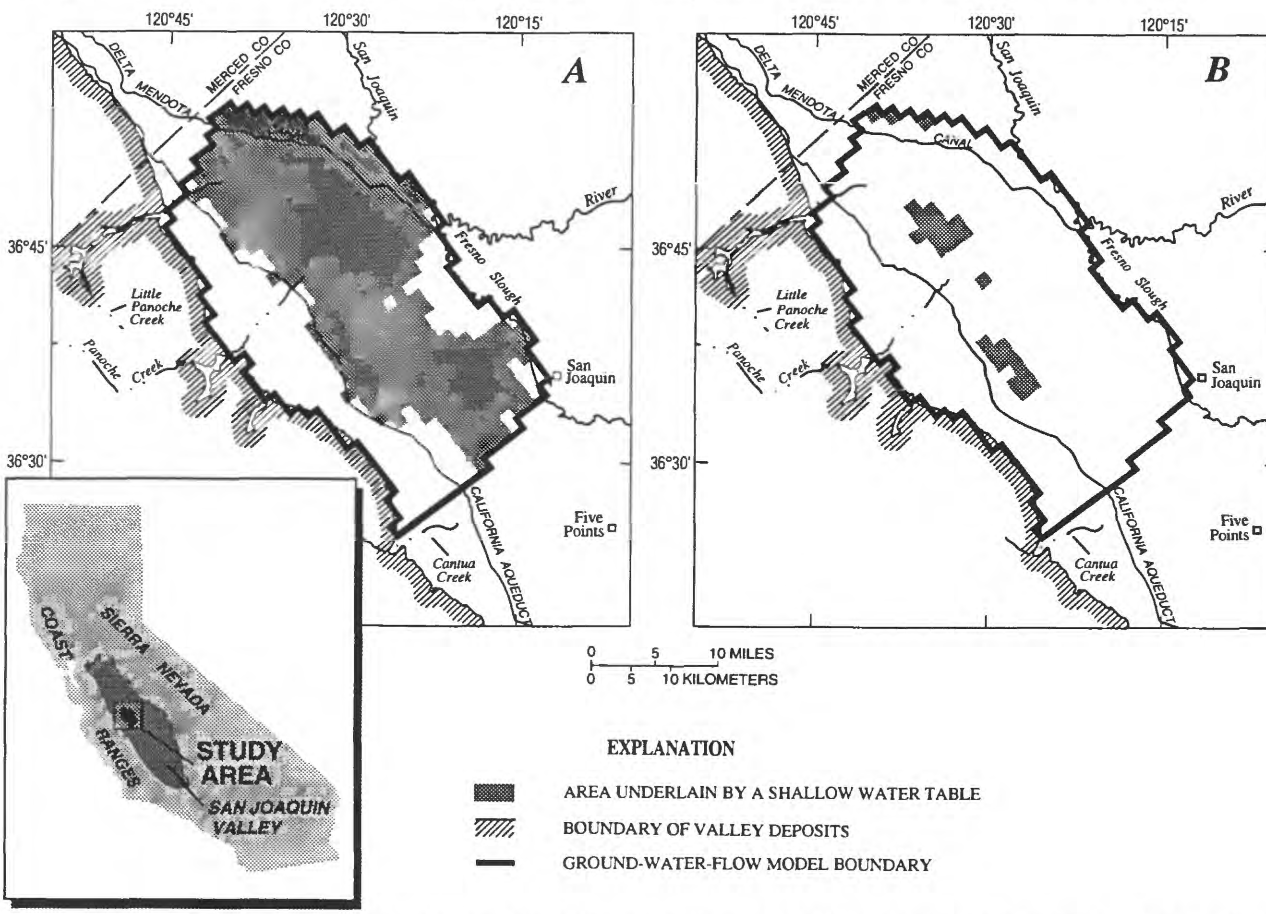

Figure 1. Area underlain by a shallow water table (within 7 feet of land surface) in the year 2040, as determined by ground-water-flow modeling and optimization techniques. *A*, 1980 irrigation and pumping practices. *B*, with improved irrigation efficiency and increased ground-water pumping.

Several strategies have been proposed to reduce the volume of drainwater and amounts of contaminants in agricultural drainage systems. These strategies include removing land from agricultural use, improving irrigation efficiency to reduce the amount of water reaching the water table, and increasing ground-water pumping to reduce subsurface drainage requirements. The USGS has combined a ground-water-flow model of the study area with mathematical (optimization) techniques to identify the most effective set of pumping strategies that lower the water table to depths greater than 7 feet below land surface. The objectives of this analysis are to minimize the amount of drainflow and the size of the area underlain by a shallow water table, while adhering to the constraints that (1) total pumping remains less than or equal to irrigation requirements and (2) land subsidence is avoided. The use of the combined ground-water-flow model/optimization techniques resulted in pumping strategies that are more effective in lowering the water table than the schemes determined by use of the ground-water-flow model alone.

Preliminary results of simulations using the ground-water-flow model and optimization techniques indicate that improving irrigation efficiency and increasing ground-water pumping would significantly decrease the area in the western San Joaquin Valley where the water table is within 7 feet of the land surface and consequently would reduce the amount of drainflow. If current irrigation management practices continue, about 344 square miles in the study area will be underlain by a shallow water table by the year 2040 (fig. 1*A*). According to simulation results, this area could be reduced to about 26 square miles (fig. 1*B*) if irrigation efficiency were improved and ground-water pumping increased. All simulations indicate that substantial reductions in area in which a shallow water table is within 7 feet of land surface and in the amount of drainflow would result from more efficient irrigation and increased ground-water pumping (figs. 1 and 2).

The applicability of the model simulation results is limited at this time. Management alternatives for controlling the depth to the shallow water table were assessed on a regional scale, the results of which may not be applicable at the scale of an individual water district. A better understanding of the relation between the regional system and on-farm drainage systems, however, is critical because management actions will be implemented at the water district (multi-farm) level. The work completed to date does not consider the limits that ground-water quality places on management alternatives at the water-district level. For example, as water is pumped for irrigation, shallow saline ground water moves downward toward the well screens. How long this movement would take, how it can be minimized, and how much area will be affected are poorly understood and need to be considered in future analyses.

Although the USGS, in cooperation with the California Department of Water Resources and Panoche Water District, has completed a preliminary analysis of ground-water flow and ground-water quality within a single water district, this study was not intended to assess alternatives for managing the shallow water table. Further research on the ground-water-flow system and of the geochemical processes that affect the movement of saline ground water at the scale of an individual water district is needed to develop management strategies for irrigated and drained areas within the San Joaquin Valley and throughout the Western United States.

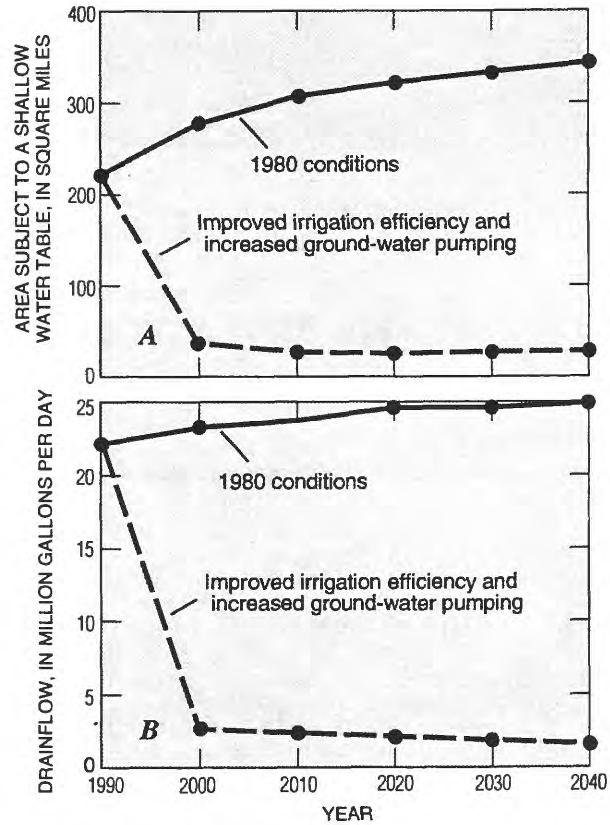

Figure 2. Results of model simulations of ***A***, area underlain by a shallow water table (within 7 feet of land surface) and ***B***, drainflow quantity for 1980 irrigation and pumping practices and for conditions of improved irrigation efficiency and increased ground-water pumping.

SELECTED REFERENCES

Belitz, Kenneth, and Phillips, S.P., 1992, Simulation of water-table response to management alternatives, central part of the western San Joaquin Valley, Calif.: U.S. Geological Survey Water-Resources Investigations Report 91-4193, 41 p.

Belitz, Kenneth, Phillips, S.P., and Gronberg, J.M., 1993, Numerical simulation of ground-water flow in the central part of the western San Joaquin Valley, Calif.: U.S. Geological Survey Water-Supply Paper 2396, 69 p.

Information on technical reports and hydrologic data related to U.S. Geological Survey investigations in the central part of the western San Joaquin Valley, California, can be obtained from:

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Open-File Report 93-665 Paul M. Barlow, Brian J. Wagner, Kenneth Belitz, and John L. Fio

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