WATER TASK FORCE
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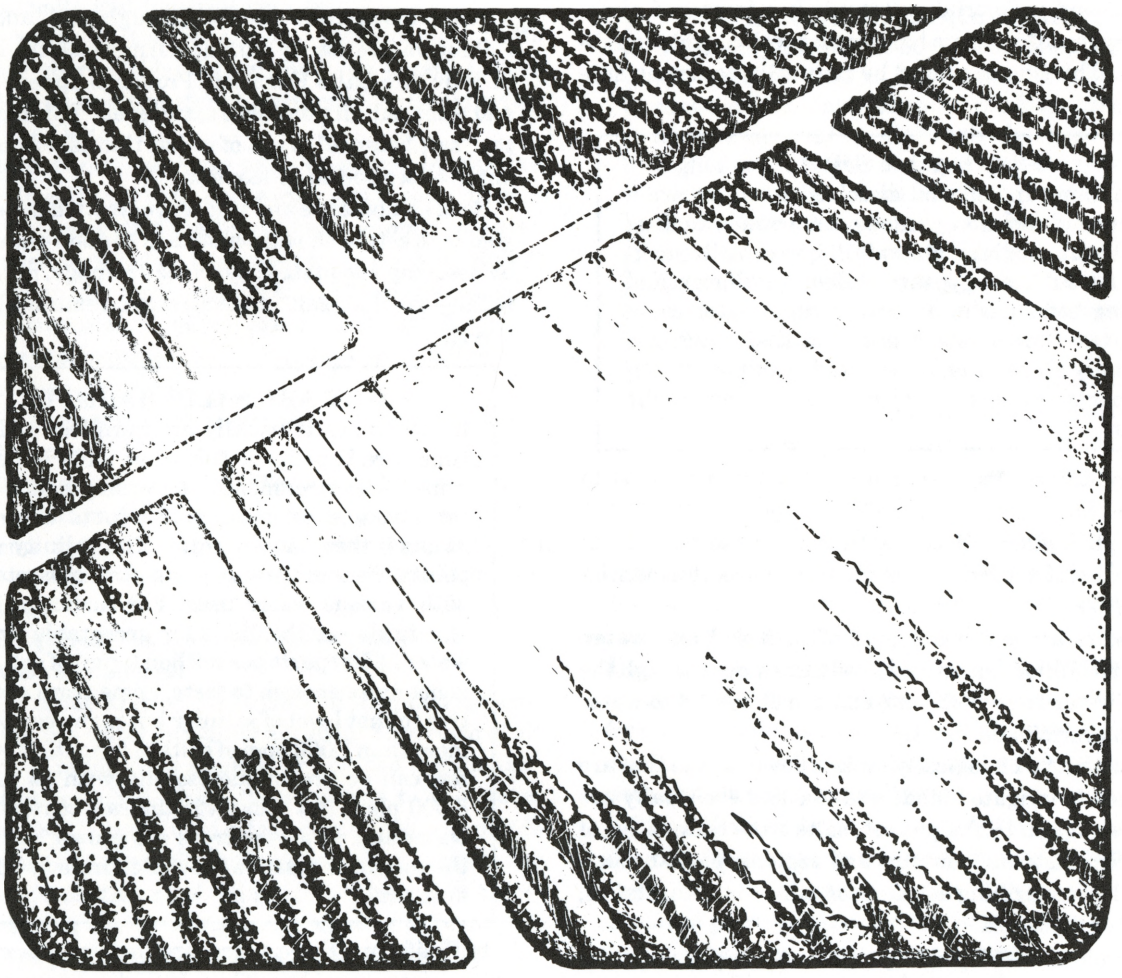
Salts in California's Water Supply



Cooperative Extension **University of California**
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Salts in California's Water Supply

The quality of California's water is a priceless resource. From rainfall and the mountain snowpack comes a year-long flow of high-quality water. Groundwater basins underlying almost half of the state hold additional water, also generally of good quality. But when all this water is put to use, the problems begin.

Fortunately, in recent years disposal of sewage and other municipal and industrial pollutants has improved somewhat. However, California has another serious water quality threat. This one is caused by naturally occurring substances: salts.

What Are Salts?

Salts found in soil and dissolved in water are a mixture of commonly known compounds such as table salt (sodium chloride), epsom salt (magnesium sulfate), gypsum (calcium sulfate), and baking soda (sodium bicarbonate). Salts move with the flow of water and find their way into virtually all parts of natural and man-made environments. Most salts eventually end up in the ocean.

Salinity differs from other water quality problems in several ways.

- Although higher salt concentrations cause most problems, all water carries enough salt to create potential difficulties.
- Most salts are a natural part of both soil and water. About 20 million tons of dissolved salts move through the state's waterways each year and are delivered to water users on farms and in cities.
- Salts cannot be biologically broken down. Those that are imported to irrigated lands and to cities eventually are exported again. In the process, salts cross boundaries of irrigation districts, counties and regions; pass through the soil to underlying aquifers; or collect in saline lakes, ponds, or estuaries.
- Salt problems develop slowly and insidiously. It may take 5 years or 50 for salts to reach the level where crops begin to die and the land becomes unproductive. But when and if that finally happens, there are no quick or easy solutions.

In one important way, however, salinity is similar to other water pollution problems—*we know how to solve it.* The hindrances are (1) conflicts among different interest groups, (2) cost, and (3) possible environmental side effects.

Salt buildup

Salts move continually through soil and water in California, ordinarily with no harmful effects, as described in Why Are Salts Harmful? Problems appear only where and when salinity builds to toxic levels. This happens when the "salt balance" is out of order; that is, when more salts enter a location than leave it.

Both salt balance and salt concentration are crucial. The goal is to establish salt balance in the soil-water system—by assuring adequate subsurface drainage, natural or artificial— so that salt concentration remains below toxic levels.

WHY ARE SALTS HARMFUL?

In nature, salts usually are harmless and sometimes are beneficial. But when salts build up in sensitive environments—for example, in freshwater streams or around the roots of growing plants— they can do harm. The salinity danger point differs in various parts of an ecosystem and with various water uses. For instance, federal standards set the limit for acceptable drinking water at 500 parts per million (ppm) of salt, which is not quite enough to taste. Some crops are sensitive to that level of salinity but many can tolerate more than 1,000 ppm of salts in irrigation water. A few can be grown successfully with as much as 5,000 ppm. But whatever the salt content of the water and whatever crops are grown, salinity in the root zone must be prevented from building up over time.

In California, there are several regions where salt buildup is a serious problem. These include certain groundwater basins and low-lying farmlands, such as:

- Groundwater aquifers in parts of Southern California, particularly Orange County

- Farmland in the Imperial Valley, where the situation is stable at present but is threatened by salinity of the Colorado River and rising water in the Salton Sea
- Farmland in the southern San Joaquin Valley

More than 400,000 acres are salt-affected, and over a million are threatened in the southern San Joaquin Valley by rising water tables that lead to salt damage. Not only is this particular drainage and salt problem spreading, but no agreed-upon answer is at hand. It is estimated that 2.6 million more tons of salt are accumulating in the valley each year.

Source and process

To understand the problem it is necessary to know the origins of salts in California's water. Major sources are:

- The Colorado River, which often has a salt content of about 900 ppm (about 1.2 tons per acre-foot of water, or one-tenth of an once per gallon), where it is diverted to the Coachella and Imperial valleys.
- Saline water in the Sacramento-San Joaquin Delta (primary source: tidal inflow from the ocean) that is picked up during transfer of Northern California water across the Delta.
- Mountain runoff carrying salts dissolved by rainfall from rock and minerals. Large amounts of salts, in generally low concentrations but in huge volumes of water, are carried by streams from the Sierra Nevada. Runoff with higher salt concentration but in lower flows comes from marine sedimentary rocks in the Coast Range.
- Groundwater aquifers, some having much higher salt content than normal.
- Saline native soils and saline strata underlying some irrigated areas.
- Certain man-made sources. These include urban water users (salt from food residues, water softeners, and so on); some industrial users (food processors, chemical plants, and so on); and farming operations (manure, fertilizers).

The next question is: How do salts become concentrated enough to cause damage?

Most salt concentration takes place in irrigated agriculture as crops use water. In California about 85 percent of all water that is taken from streams or pumped from underground goes to farms. Some later returns to the water supply, but most is transpired into the air by growing plants or evaporates from wet soil. During this process, salts in the water remain in the soil. Each irrigation brings in a new load of salt, and in this way, a ton or more of salts may be applied each year to an acre of California farmland.

Salt concentration also takes place in cities. Acre for acre, through landscape and human use of water, urban areas concentrate salts at about the same rate as farms. In addition, certain coastal cities divert low-salt Sierra Nevada runoff through aqueducts. In some cases, this results in loss of streamflow that otherwise would help to dilute salts and carry them to the ocean

The farmer's dilemma

Farmers avoid salt buildup in their soil by leaching—applying extra irrigation water to carry much of the salt below the root zone, as described in Leaching Requirement. But by applying additional water, the farmer may aggravate another problem: drainage. If subsurface water rises up to waterlog the root zone within 3 or 4 feet of the soil surface, an artificial drainage system—ditches or underground tile drains, or both—may be required. Although the problem may be reduced by using only the minimum amount of water for leaching, adequate subsurface drainage is always a necessity on irrigated farms. Either natural drainage must be sufficient or artificial drains must be installed.

LEACHING REQUIREMENT

Commonly about 10 to 20 percent of applied irrigation water is used to leach salts. This amount is considered essential for most combinations of crop and water quality, although the need may be higher or lower. For example, salt-sensitive crops (citrus, avocados, beans) irrigated with Colorado River water (900 ppm) have a leaching requirement of about 30 percent. Tolerant crops (cotton, barley, wheat, alfalfa) using the same water have a leaching requirement of 2 to 10 percent. Less saline water means correspondingly lower leaching requirements.

Drainage complications are most likely where "perched" water tables build up on top of a subsurface layer of impervious soil. This shallow groundwater, fed by irrigation and by drainage from upslope lands, is often very salty.

In low-lying areas, when a perched water table develops very near the surface, there may be no place to dispose of drainage. In that case, the farmer is in trouble as the water table keeps rising. First, trees and other deep-rooted plants die. Within a few years, grains and other crops that require a foot or two of root zone are forced out. Grasses may survive for a while, but finally, in low rainfall areas such as the San Joaquin and Coachella valleys, the soil surface crusts over with salt and nothing will grow.

What if there is no perched water table, if salts and drainage water can move freely below the root zone? The farmer in such a location does not have either a salt or a drainage problem—but salts and water percolating down from his land may contribute to problems of his neighbors downslope. They also may degrade the deep water table on which the whole area depends. Almost always, salinity and drainage problems are area wide, caused collectively by many water users.

Master drains and salt sinks

To solve such area-wide drainage problems, farm-size drainage systems are essential but are not enough. Two other elements are required: a place to put unusable drainage water (a "salt sink") and a way to move it there (a "master drain").

In California, one important salt sink is the Salton Sea, which receives drainage water from the Imperial and Coachella valleys through the state's only completed master drains. There are other, unused natural salt sinks—several desert dry lakes and two ancient lake bottom areas in the San Joaquin Valley, now drained and farmed (Tulare and Buena Vista lakes).

But the natural salt sink for most of California is the Pacific Ocean, which already contains about 35,000 ppm salts. Rivers leading to the ocean have historically been used as salt drains, even though they have become more polluted in the process. That is particularly true of the San Joaquin River.

This points again to the most pressing salinity problem in California today. Over a million irrigated acres along the low-lying center and west side of the southern San Joaquin Valley— in Fresno, Kings, and Kern counties— are threatened by rising water tables and high salinity. (Total irrigated acreage in the valley: 4.5 million.) The San Joaquin River generally has low flows and fairly high salinity in the summer, and already often carries more than the legally allowable salt load. The river cannot be used to remove any more saline drainage, except possibly during winter.

One solution would be to build a master drain to export salty, unusable water out of the valley. That proposal, detailed in a joint study by federal and state agencies, is still under study. Meanwhile, a large drainage canal built by the U.S. Bureau of Reclamation extends part way down the San Joaquin Valley but ends in an evaporation reservoir where much of the salt is allowed to accumulate. However, the reservoir has limited capacity and there are serious concerns about environmental effects.

What are the chances of completing a San Joaquin drain—and when? So far, there is lack of agreement on the degree of need, on funding, on the drain route, and on the final disposal area. In any case, the solution must involve many different interest groups. For Californians concerned about their state's resources, addressing this issue is an important public policy task.

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