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New Findings on Salinity in Streams and Ground Water in the Southwestern United States

In the southwestern U.S., the location and extent of economic and cultural activities are dependent in large part on the availability and quality of water. An important water-quality issue in the southwest is elevated salinity (concentrations of dissolved solids), which can limit the suitability of water for many uses, including agricultural production and drinking water. In response, the USGS National Water-Quality Assessment (NAWQA) Program conducted a regional assessment of salinity in important surface and ground-water supplies in parts of Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming. The recently released USGS report entitled "*Dissolved Solids in Basin-Fill Aquifers and Streams in the Southwestern United States*" (Scientific Investigations Report 2006-5315) is available on the Internet at http://water.usgs.gov/nawqa/studies/mrb/salinity.html. Selected findings are highlighted below.

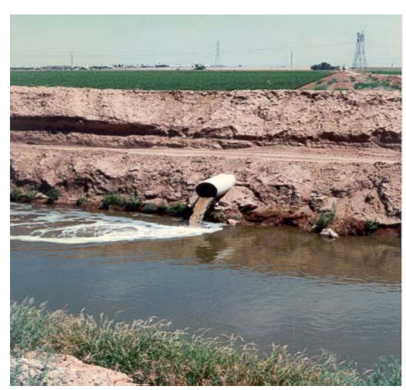
Decreases in salinity in streams are widespread throughout the southwest

Trends in dissolved-solids concentrations in streams were evaluated from 1974 through 2003. The greatest change occurred from 1989 to 2003 when annual concentrations decreased at more than half of the sites throughout the region. The reductions were widespread, as indicated by decreases at nearly all of the sites on the main stem of the Colorado and Green Rivers. Increases were noted at about one-third of the sites, while the remaining sites showed no trends.

Decreases in salinity can be attributed, in part, to natural causes, such as geomorphic changes or episodes of above- or below-normal precipitation. They also may be associated with human-related factors, such as changes in land and water use, reservoir management, trans-basin exports, and implementation of salinity-control projects. Salinity control projects include activities like using low water-use irrigation systems and re-directing saline water away from streams.

Salinity-control projects have been implemented over the last few decades by the Bureau of Reclamation, U.S. Department of Agriculture, and the Bureau of Land Management to control salinity of water delivered to Mexico, per the 1974 Colorado River Basin Salinity Control Act. USGS findings show that dissolved solids decreased from 1989 through 2003 at all sites downstream from salinity-control projects, and that the decreases were greater than decreases upstream from projects. For example, estimated annual loads of dissolved solids in the Gunnison River in the Upper Colorado River Basin decreased by about 162,000 tons per year downstream from the Lower Gunnison salinity-control unit, in contrast to a decrease of only 2,880 tons per year upstream from the unit. This net decrease is about 15 percent of the annual load in the lower Gunnison River.

About three-fourths of water used in the region is from surface water; the remainder is from ground water. About 80 percent of the water is used for irrigation; about 15 percent is used for municipal supplies; and the remaining 5 percent is for domestic, commercial, livestock, and other uses.



USGS findings also show decreases downstream from salinity-control sites in the Lower Colorado River Basin as large as 242,000 tons each year, averaging about 3 to 5 milligrams per liter (mg/L) per year over the last 30 years. The continued, long-term decreases have resulted in salinity levels well below established criteria for dissolved solids at sites in or adjacent to the Lower Colorado River Basin, including below Hoover and Parker Dams and above Imperial Dam.

(*see back*)

Trends were less common in ground water than in surface water. Specifically, no trends in concentrations of dissolved solids were observed in 60 percent of samples collected in the basin-fill aquifers from 1974-2003. Increasing trends were more common than decreasing trends in basin-fill aquifers, but there was no geographic pattern to these trends. Trends were less common with increasing depth below land surface; for example, the likelihood for changes to occur in ground water at depths greater than 1,000 feet below land surface is about 5 percent.

USGS findings document the variability of salinity through the region

Surface-water sites spanned the Colorado River and tributaries including the Green, San Juan, Little Colorado, Virgin, and Gila Rivers, as well as the Bear, Truckee, Carson, and Santa Ana Rivers and Rio Grande. Median concentrations of dissolved solids varied markedly among stream sites, ranging from 22 to 13,800 mg/L, and also varied among different sites on the same stream. Relatively low concentrations were found at sites in the headwaters of the Rio Grande, Colorado, Green, San Juan, Truckee, and Carson Rivers underlain by igneous and metamorphic rocks that are relatively resistant to solution. Higher concentrations (with medians greater than or equal to 500 mg/L) were predominately found in streams in contact with more soluble sedimentary rocks, such as those found on the Colorado Plateau.

Salinity also varies spatially in ground water within the basin-fill aquifers underlying the southwest, including the Rio Grande aquifer system, Basin and Range basin-fill aquifers, and California Coastal Basin aquifers. Dissolved-solids concentrations in ground water ranged from less than 500 mg/L near basin margins where ground water is recharged from nearby mountains to more than 10,000 mg/L in topographically low areas of some basins or in areas adjacent to streams.

Concentrations of dissolved solids in ground water were less than or equal to the U.S. Environmental Protection Agency secondary drinking-water standard for taste and hardness (500 mg/L) in nearly half of the aquifers. At least 70 percent of the region had concentrations less than or equal to 1,000 mg/L. Concentrations greater than 3,000 mg/L were found in topographically low areas with brackish or saline lakes and playas, such as the Great Salt Lake, Mojave Desert, and Death Valley.

Geo-statistical techniques help to assess the role of natural and human sources and factors

The role of natural and human sources of salinity was evaluated on the basis of new USGS geo-statistical modeling techniques and monitoring data. Findings show that geologic units representing natural sources of dissolved solids contribute 44 percent of the total sources of dissolved solids to streams. Land and water-use activities, primarily associated with cultivated and pasture land, contribute the remaining 56 percent. Dissolved solids can vary because of many factors, including rock type, streamflow storage and mixing processes in reservoirs, streambed infiltration, trans-basin diversions, irrigation use, evapotranspiration, and effects of septic tank effluent, municipal wastewater, and saltwater intrusion (in coastal areas). The most significant dissolved-solids accumulation areas in the region include the Salton Sea, Lower Gila-Agua Fria River, Middle Gila River, Lower Bear River, and the Great Salt Lake.

Information supports water management

The USGS report and its many tables, graphs, and maps provide a comprehensive analysis of salinity over time in streams and ground water. It is intended to serve as a standard reference for water managers, policy makers, drinking-water suppliers, and scientists throughout the region to (1) better understand how and why elevated concentrations of dissolved solids occur in streams and ground water and whether salinity issues may get better or worse; (2) assess and predict vulnerability of streams and ground water to elevated salinity in unmonitored areas; (3) evaluate current sites and seek new sites for water supply; and (4) evaluate various strategies for resource-development, water management, and salinity control.

Visit the Internet (http://water.usgs.gov/nawqa/studies/mrb/salinity.html) to access the USGS report, maps, data, and an interactive mapping tool for assessing the spatial distribution and sources of dissolved solids in streams and ground water.

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