IMPACT

Water: Impacts, Risks, and Adaptation

"Water is a 'super sector' that has direct and indirect connections to perhaps all natural and human systems."

With projected reductions in streamflow, the Central Arizona Project, a 336-mile aqueduct that diverts water from the Colorado River to central and southern Arizona, will be first in line for potential Colorado River shortages.

Key Messages

1

The water cycle is a primary mechanism by which the earth redistributes heat. Climate change has already altered the water cycle and additional changes are expected. A large portion of the Southwest is expected to experience reductions in streamflow during the twenty-first century.

2

Twentieth-century water management was based in part on the principle that the future would look like the past. Lack of a suitable replacement for this principle, known as *stationarity*, is inhibiting the process of adaptation and the search for solutions.

3

Considerable resources are now being allocated by larger water sectors to understand how to adapt to a changing water cycle. A full range of solutions involving both supply and demand are being examined. Most smaller utilities have not begun the process of adapting. To date, adaptation progress has been modest.

The tenth chapter of the *Assessment of Climate Change in the Southwest United States* focuses on societal vulnerabilities to impacts from changes in sources, timing, quantity, and quality of the Southwest's water supply. It addresses both vulnerabilities related to environmental factors (such as wildfire risk and increased stream temperatures) and issues related to water management (such as water and energy demand and reservoir operation). "Water: Impacts, Risks, and Adaptation" also describes water management strategies for the coming century, including federal, regional, state, and municipal adaptation initiatives.

For more information about *Assessment of Climate Change in the Southwest United States*, see: www.swcarr.arizona.edu, www.cakex.org, www.islandpress.org/NCAreports.
This fact sheet developed by Institute of the Environment, University of Arizona.

Impacts, Risks, and Vulnerabilities

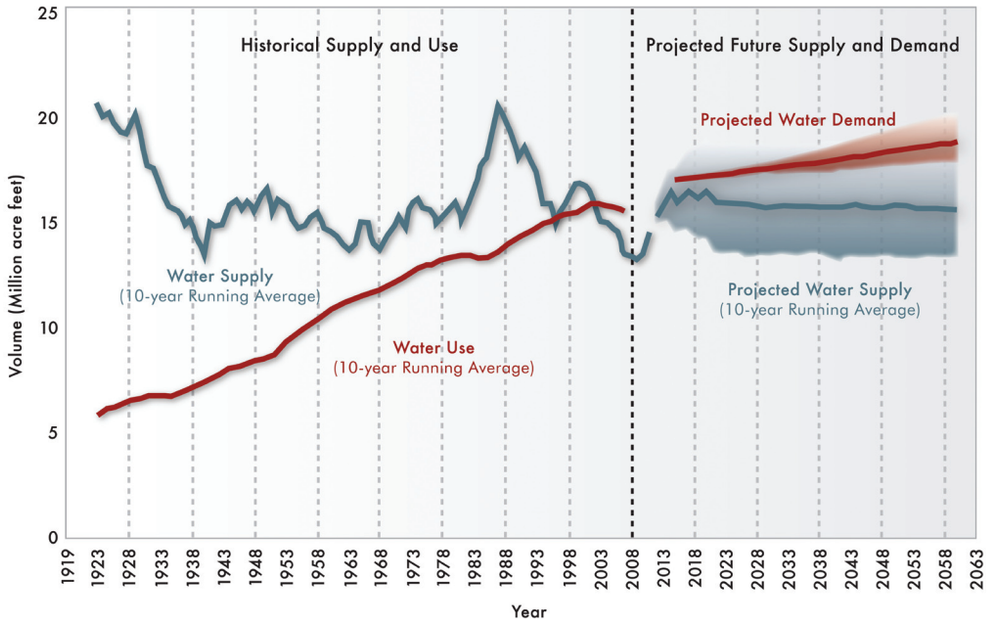
Water demands for agriculture and urban outdoor watering will increase with elevated temperatures. Higher temperatures will raise evapotranspiration by plants, lower soil moisture, lengthen growing seasons, and thus increase water demand. Changes in snowpack, the timing of streamflow runoff, and other hydrologic changes may affect reservoir operations such as flood control and storage. Increased water temperatures and changes in patterns of precipitation could affect water quality. For example, changes in the timing and rate of streamflow may affect sediment load and levels of pollutants, potentially affecting human health. Stream temperatures are expected to increase, which could have direct and indirect effects on aquatic ecosystems, including the spread of in-stream, non-native species and aquatic diseases to higher elevations, and the potential for non-native plant species to invade riparian areas.

Adaptation Initiatives

The federal government has twenty or more agencies with an interest in water management. Historically, coordination of these agencies has been limited, but the last five years has seen the birth of many interagency adaptation activities related to water.

Most southwestern states have begun to categorize the impacts of climate change on water supplies. Colorado, New Mexico, Utah, and California have produced documents describing climate impacts on water resources and in some cases, societal vulnerabilities to water resources under a changing climate. Major municipal utilities in the Southwest now have personnel dedicated to studying the impacts of climate change on their systems.

Despite all of this adaptation-focused information-gathering activity in the Southwest, few if any water-related decisions have been made due to these actions. This is in part due to the wide range of projections for both temperature increases and precipitation changes from climate models. Decision makers everywhere are struggling to obtain actionable science, defined as "data, analysis, forecasts that are sufficiently predictive, accepted and understandable to support decision making."



Colorado River long-term supply-demand imbalance in the twenty-first century.

Colorado River

Sensitivity studies attempt to quantify future changes in runoff without relying on climate-model projections; instead they use a hydrology model driven by temperature and precipitation. When temperature is varied and precipitation is held constant, for every 1°F increase in temperature, sensitivity studies show there is a decrease in Colorado River streamflow at Lees Ferry of 2.8 to 5.5 percent. Similarly, holding temperature constant, each 1 percent change in precipitation (either an increase or decrease) converts into a 1 to 2 percent change in runoff. Climate-model projections also suggest decreases in Colorado River streamflow during the next century.

Supply and Demand Strategies and Solutions

Water strategies and solutions to meet the needs of southwestern population growth range from increasing supplies to decreasing demands. Examples of these strategies include new dams (in California and Colorado), desalination (San Diego), basin imports via pipeline (in St. George, Utah, and the Front Range of Colorado), municipal conservation, permanent transfers from agriculture (Colorado Springs), water markets, land fallowing (Los Angeles), canal lining (San Diego), retirement of grass lawns through financial incentives (Las Vegas), groundwater banking (Arizona), water re-use (Orange County, California, and Aurora, Colorado), new water rate structures, consumer education, indoor fixture rebates (Denver), new landscape and xeriscape design, water-loss management from leaky mains, and aquifer storage and recovery (Arizona). Per-capita demand in recent years has been reduced in many southwestern cities through active demand management programs.

Projected changes in median streamflow at various gauge locations.

Gauge Location	2020s Median Flow	2050s Median Flow	2070s Median Flow
Colorado River above Imperial Dam	-2%	-7%	-8%
Colorado River at Lees Ferry	-3%	-9%	-7%
Rio Grande at Elephant Butte Dam	-4%	-13%	-16%
Sacramento River at Freeport	3%	3%	-4%
Sacramento-San Joaquin Rivers at Delta	3%	1%	-4%
San Joaquin River at Friant Dam	1%	-9%	-11%

Information from: Udall, B. 2013. "Water: Impacts, Risks, and Adaptation." In *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, 197–217. A report by the Southwest Climate Alliance. Washington, DC: Island Press.