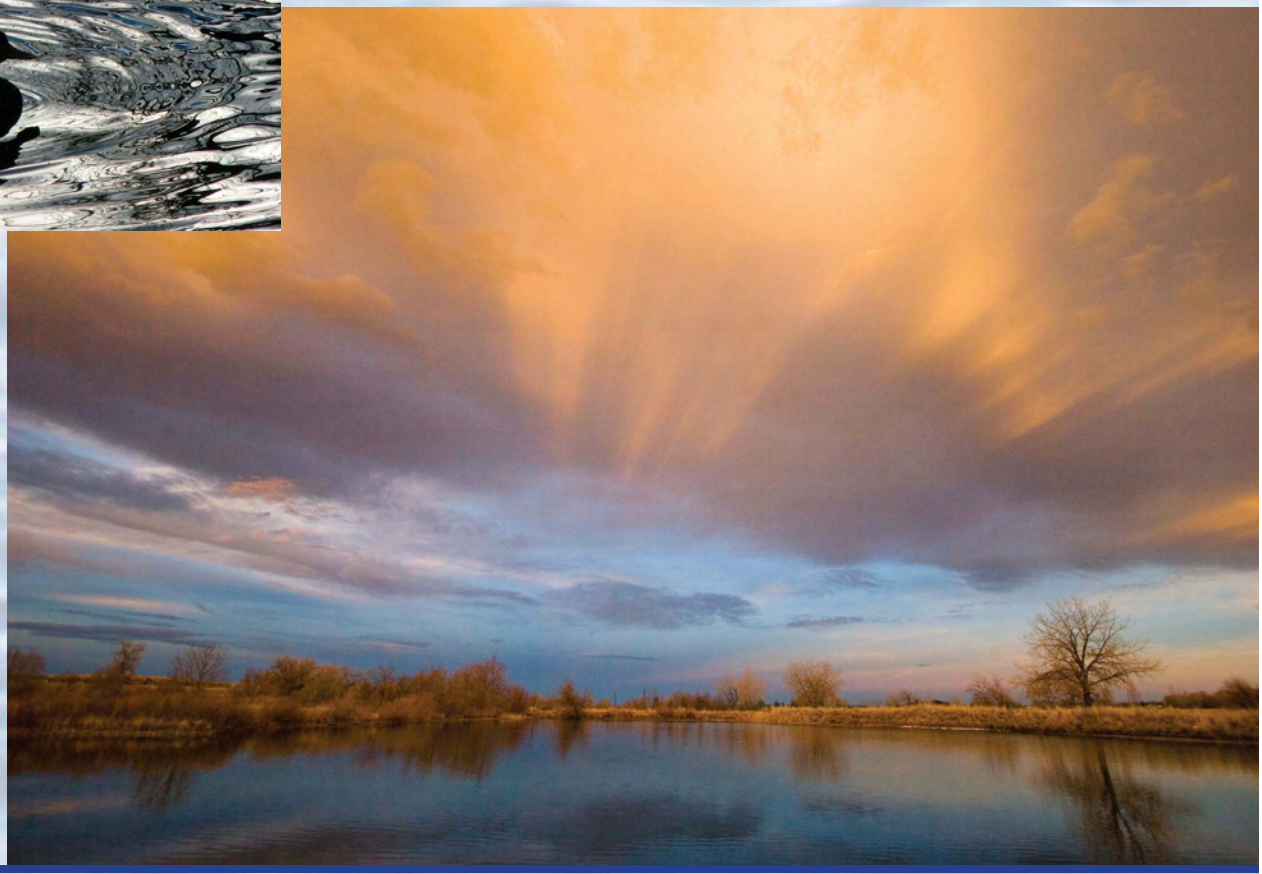
The Effects of Climate Change on Water Resources in the United States

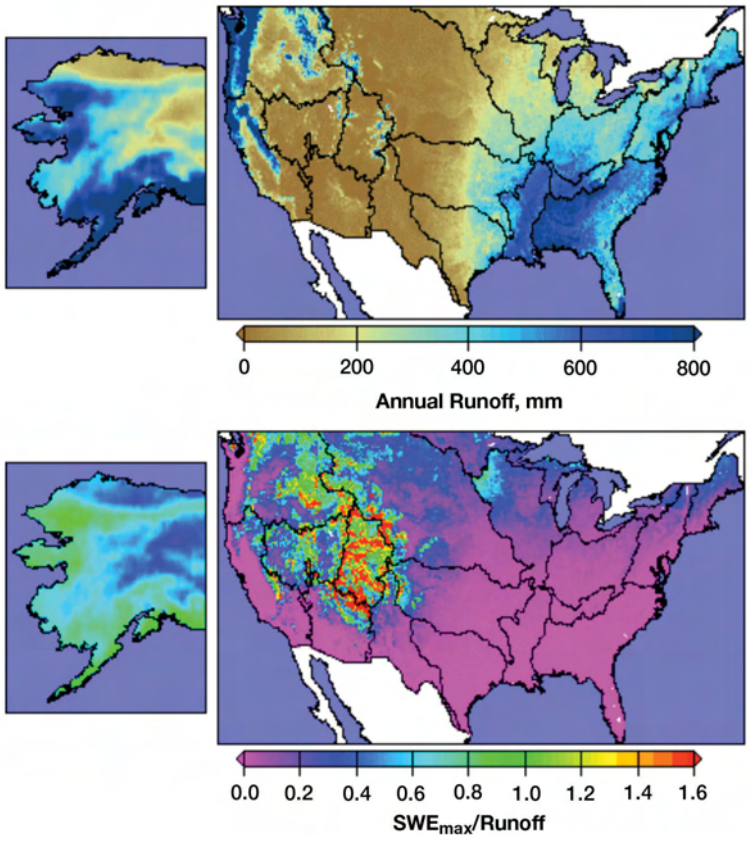
(U.S. Climate Change Science Program Synthesis and Assessment Product 4.3)

Plants, animals, natural and managed ecosystems, and human settlements are susceptible to variations in the storage, fluxes, and quality of water. All of these, in turn, are sensitive to climate change. With robust scientific evidence showing that human-induced climate change is occurring, it is critical to understand how water quantity and quality might be affected.



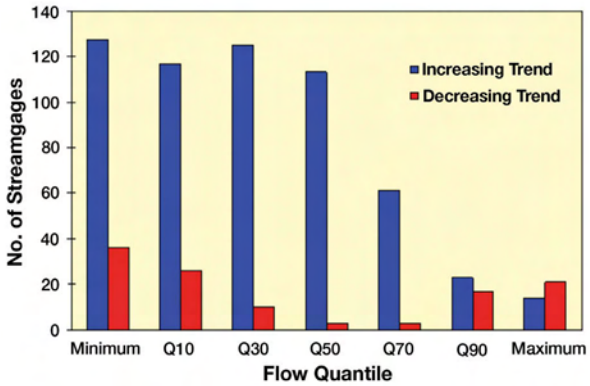
Effects of climate on the nation's water storage capabilities and hydrologic functions will have significant implications for water management and planning as variability in natural processes increases. Although U.S. water management practices are quite advanced, particularly in the West, reliance on past conditions as the foundation for current and future planning and practice will no longer be tenable as climate change and variability increasingly create conditions well outside of historical parameters and erode predictability.

The Synthesis and Assessment Product (SAP) 4.3 provides insights on the implications of climate change on U.S. water resources, with a focus on water quantity and quality. A team of authors – water resources experts – completed an extensive review, analysis and synthesis of the relevant scientific literature related to U.S. water resources. Below, some of the main findings from the SAP 4.3 Water Resources chapter are featured.



Left: The maps show average annual runoff and the ratio of maximum snow accumulation to average annual runoff in the continental U.S. and Alaska (data replotted from Maurer et al. (2002)).

Below: Number of increasing and decreasing trends in continental U.S. streamflow records for a range of flow quartiles. From Lins and Slack (1999).



Water Resources Findings

- Consistent with streamflow and precipitation observations, most of the continental United States experienced reductions in drought severity and duration over the 20th century. However, there is some indication of increased drought severity and duration in the western and southwestern United States (these apparent reverse trends result because increased evaporative demand associated with warmer temperatures more than balances precipitation increases).

- There is a trend toward reduced mountain snowpack and earlier spring snowmelt runoff peaks across much of the western United States. This trend is very likely attributable at least in part to long-term warming, although some part may have been played by decadal-scale variability, including a shift in the phase of the Pacific Decadal Oscillation in the late 1970s. Where earlier snowmelt peaks and reduced summer and fall low flows have already been detected, continuing shifts in this direction are very likely and may have substantial impacts on the performance of reservoir systems.

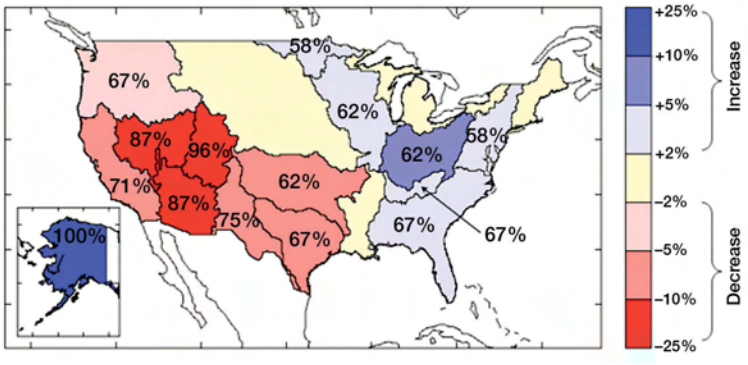
- Water quality is sensitive to both increased water temperatures and changes in precipitation. However, most water quality changes observed so far across the continental United States are likely attributable to causes other than climate change.

- Stream temperatures are likely to increase as the climate warms, and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods, when they are of greatest concern. Stream temperature increases have already begun to be detected across some of the United States, although a comprehensive analysis similar to the one done for streamflow trends has yet to be conducted.

- A suite of climate simulations conducted for the Intergovernmental Panel on Climate Change's Fourth Assessment Report shows that the United States may experience increased runoff in eastern regions, gradually transitioning to little change in the Missouri and lower Mississippi river basins, to substantial decreases in annual runoff in the Interior West (Colorado and the Great Basin).

Water Resources Findings

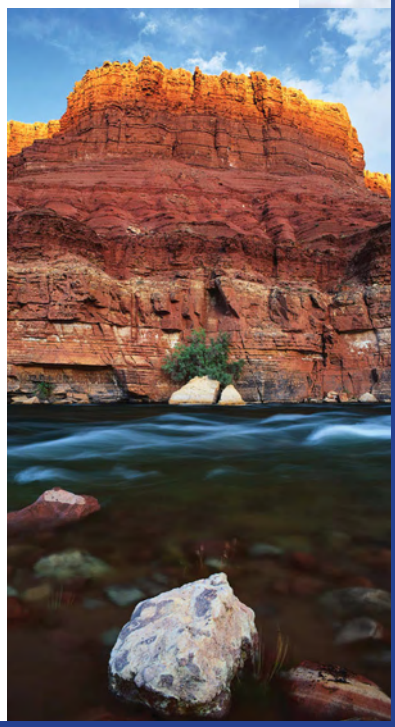
- Trends toward increased water use efficiency are likely to continue in the coming decades. Pressures for reallocation of water will be greatest in areas of highest population growth, such as the Southwest. Declining per capita (and, for some cases, total) water consumption will help mitigate the impacts of climate change on water resources.



Median changes in runoff interpolated to USGS water resources regions from Milly et al. (2005) from 24 pairs of general circulation model simulations for 2041-2060 relative to 1901-1970. Percentages are fraction of 24 runs for which differences had same sign as the 24-run median. Results replotted from Milly et al. (2005) by Dr. P.C.D. Milly, USGS.

Findings Related to Current Observing Systems

- Essentially no aspect of the current hydrologic observing system was designed specifically to detect climate change or its effects on water resources. Many of the existing systems are technologically obsolete, are designed to achieve specific, often incompatible management accounting goals, and/or have significant data collection gaps in their operational and maintenance structures. As a result, many of the data are fragmented, poorly integrated, and unable to meet the predictive challenges of a rapidly changing climate.



US Climate Change Science Program
www.climatescience.gov