25 Southwest

Low water levels in Lake Mead

Key Message 1

Water Resources

Water for people and nature in the Southwest has declined during droughts, due in part to human-caused climate change. Intensifying droughts and occasional large floods, combined with critical water demands from a growing population, deteriorating infrastructure, and groundwater depletion, suggest the need for flexible water management techniques that address changing risks over time, balancing declining supplies with greater demands.

Key Message 2

Ecosystems and Ecosystem Services

The integrity of Southwest forests and other ecosystems and their ability to provide natural habitat, clean water, and economic livelihoods have declined as a result of recent droughts and wildfire due in part to human-caused climate change. Greenhouse gas emissions reductions, fire management, and other actions can help reduce future vulnerabilities of ecosystems and human well-being.

Key Message 3

The Coast

Many coastal resources in the Southwest have been affected by sea level rise, ocean warming, and reduced ocean oxygen—all impacts of human-caused climate change—and ocean acidification resulting from human emissions of carbon dioxide. Homes and other coastal infrastructure, marine flora and fauna, and people who depend on coastal resources face increased risks under continued climate change.

Key Message 4

Indigenous Peoples

Traditional foods, natural resource-based livelihoods, cultural resources, and spiritual well-being of Indigenous peoples in the Southwest are increasingly affected by drought, wildfire, and changing ocean conditions. Because future changes would further disrupt the ecosystems on which Indigenous peoples depend, tribes are implementing adaptation measures and emissions reduction actions.

Key Message 5

Energy

The ability of hydropower and fossil fuel electricity generation to meet growing energy use in the Southwest is decreasing as a result of drought and rising temperatures. Many renewable energy sources offer increased electricity reliability, lower water intensity of energy generation, reduced greenhouse gas emissions, and new economic opportunities.

Key Message 6

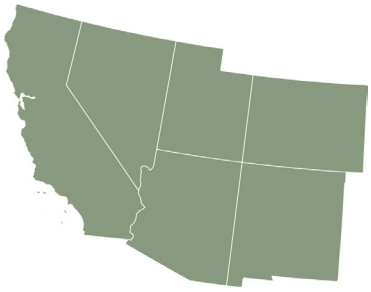
Food

Food production in the Southwest is vulnerable to water shortages. Increased drought, heat waves, and reduction of winter chill hours can harm crops and livestock; exacerbate competition for water among agriculture, energy generation, and municipal uses; and increase future food insecurity.

Key Message 7

Human Health

Heat-associated deaths and illnesses, vulnerabilities to chronic disease, and other health risks to people in the Southwest result from increases in extreme heat, poor air quality, and conditions that foster pathogen growth and spread. Improving public health systems, community infrastructure, and personal health can reduce serious health risks under future climate change.



The Southwest region encompasses diverse ecosystems, cultures, and economies, reflecting a broad range of climate conditions, including the hottest and driest climate in the United States. Water for people and nature in the Southwest region has declined during droughts, due in part to human-caused climate change. Higher temperatures intensified the recent severe drought in California and are amplifying drought in the Colorado River Basin. Since 2000, Lake Mead on the Colorado River has fallen 130 feet (40 m) and lost 60% of its volume, a result of the ongoing Colorado River Basin drought and continued water withdrawals by cities and agriculture.

The reduction of water volume in both Lake Powell and Lake Mead increases the risk of water shortages across much of the Southwest. Local water utilities, the governments of seven U.S. states, and the federal governments of the United States and Mexico have voluntarily developed and implemented solutions to minimize the possibility of water shortages for cities, farms, and ecosystems. In response to the recent California drought, the state implemented a water conservation plan in 2014 that set allocations for water utilities and major users and banned wasteful practices. As a result, the people of the state reduced water use 25% from 2014 to 2017.

Exposure to hotter temperatures and heat waves already leads to heat-associated deaths in Arizona and California. Mortality risk during a heat wave is amplified on days with high levels of ground-level ozone or particulate air pollution. Given the proportion of the U.S. population in the Southwest region, a disproportionate number of West Nile virus, plague, hantavirus pulmonary syndrome, and Valley fever cases occur in the region.

Analyses estimated that the area burned by wildfire across the western United States from 1984 to 2015 was twice what would have burned had climate change not occurred. Wildfires around Los Angeles from 1990 to 2009 caused $3.1 billion in damages (unadjusted for inflation). Tree death in mid-elevation conifer forests doubled from 1955 to 2007 due, in part, to climate change. Allowing naturally ignited fires to burn in wilderness areas and preemptively setting low-severity prescribed burns in areas of unnatural fuel accumulations can reduce the risk of high-severity fires under climate change. Reducing greenhouse gas emissions globally can also reduce ecological vulnerabilities.

At the Golden Gate Bridge in San Francisco, sea level rose 9 inches (22 cm) between 1854 and 2016. Climate change caused most of this rise by melting of land ice and thermal expansion of ocean water. Local governments on the California coast are using projections of sea level rise to develop plans to reduce future risks. Ocean water acidity off the coast of California increased 25% to 40% (decreases of 0.10 to 0.15 pH units) from the preindustrial era (circa 1750) to 2014 due to increasing concentrations of atmospheric carbon dioxide from human activities. The marine heat wave along the Pacific Coast from 2014 to 2016 occurred due to a combination of natural factors and climate change. The event led to the mass stranding of sick and starving birds and sea lions, and shifts of red crabs and tuna into the region. The ecosystem disruptions contributed to closures of commercially important fisheries.

Agricultural irrigation accounts for approximately three-quarters of water use in the Southwest region, which grows half of the fruits, vegetables, and nuts and most of the wine grapes, strawberries, and lettuce for the

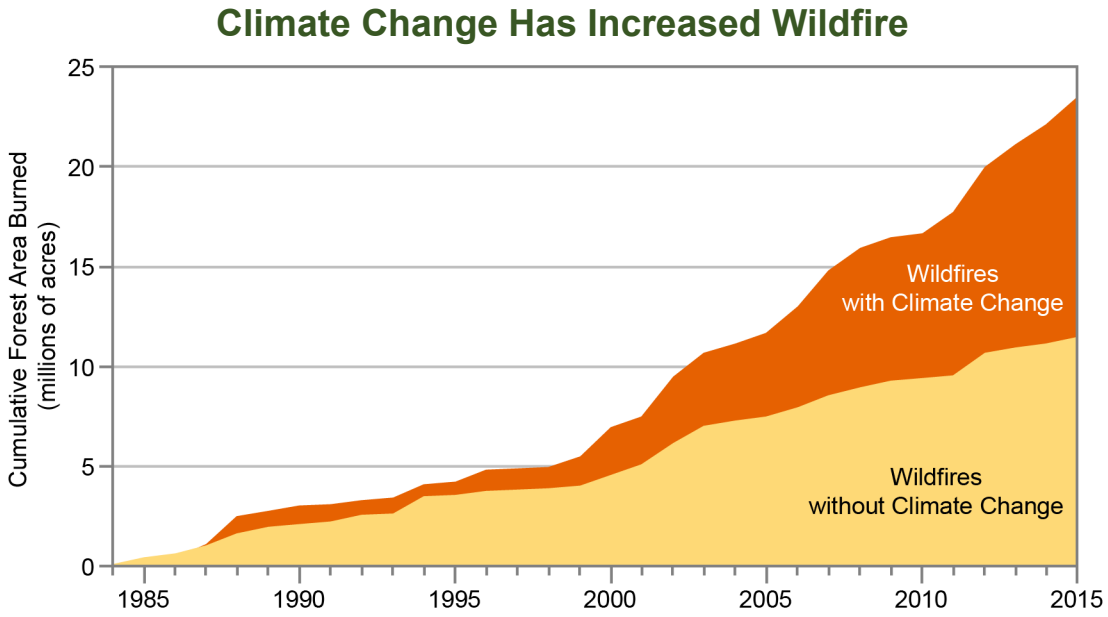
United States. Increasing heat stress during specific phases of the plant life cycle can increase crop failures.

Drought and increasing heat intensify the arid conditions of reservations where the United States restricted some tribal nations in the Southwest region to the driest portions of their traditional homelands. In response to climate change, Indigenous peoples in the region are developing new adaptation and mitigation actions.

The severe drought in California, intensified by climate change, reduced hydroelectric generation two-thirds from 2011 to 2015.

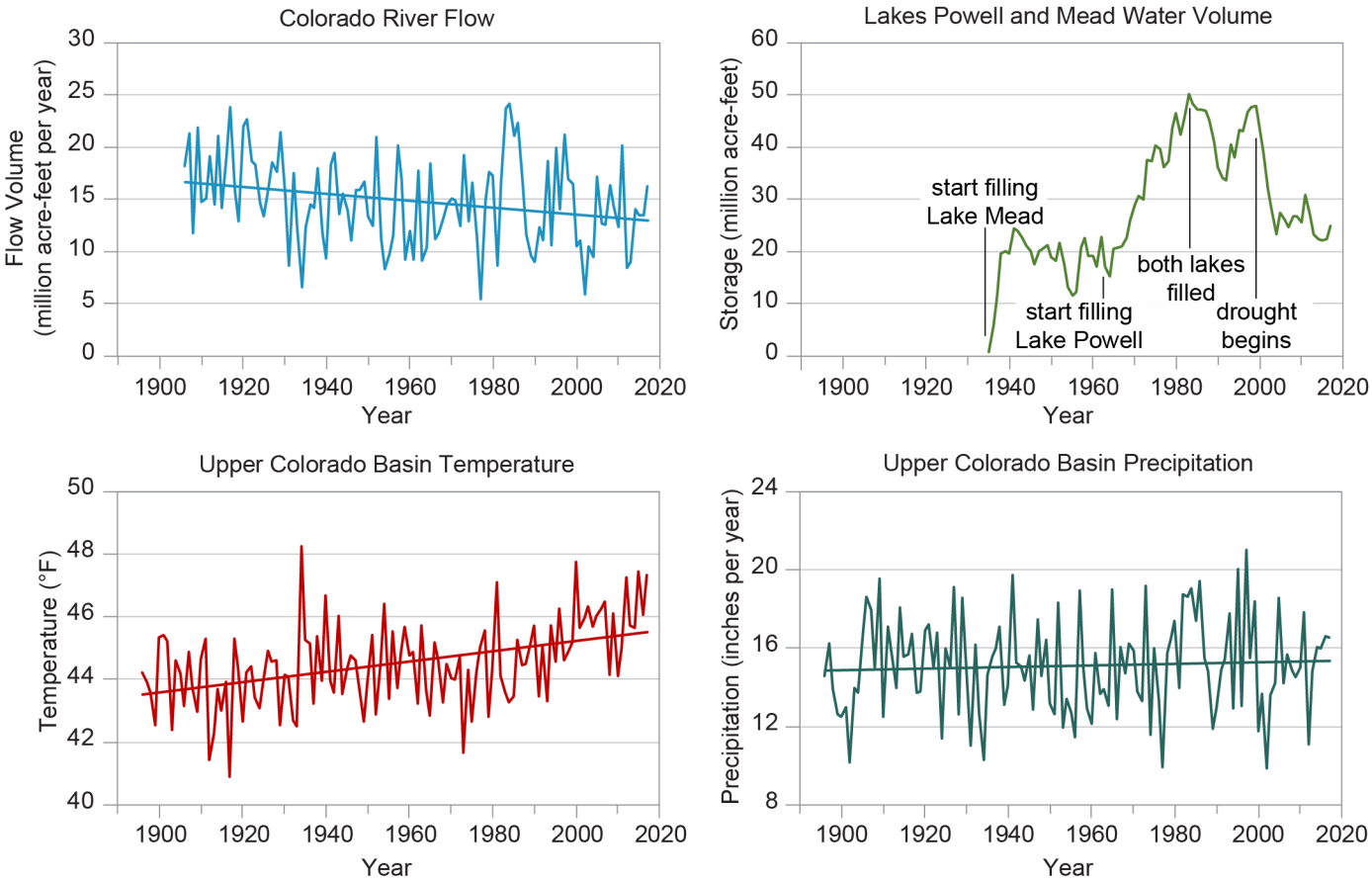
The efficiency of all water-cooled electric power plants that burn fuel depends on the temperature of the external cooling water, so climate change could reduce energy efficiency up to 15% across the Southwest by 2050. Solar, wind, and other renewable energy sources, except biofuels, emit less carbon and require less water than fossil fuel energy. Economic conditions and technological innovations have lowered renewable energy costs and increased renewable energy generation in the Southwest.

For full chapter, including references and Traceable Accounts, see https://nca2018.globalchange.gov/chapter/southwest.



The cumulative forest area burned by wildfires has greatly increased between 1984 and 2015, with analyses estimating that the area burned by wildfire across the western United States over that period was twice what would have burned had climate change not occurred. *From Figure 25.4 (Source: adapted from Abatzoglou and Williams 2016).*

Severe Drought Reduces Water Supplies in the Southwest



Since 2000, drought that was intensified by long-term trends of higher temperatures due to climate change has reduced the flow in the Colorado River (top left), which in turn has reduced the combined contents of Lakes Powell and Mead to the lowest level since both lakes were first filled (top right). In the Upper Colorado River Basin that feeds the reservoirs, temperatures have increased (bottom left), which increases plant water use and evaporation, reducing lake inflows and contents. Although annual precipitation (bottom right) has been variable without a long-term trend, there has been a recent decline in precipitation that exacerbates the drought. Combined with increased Lower Basin water consumption that began in the 1990s, these trends explain the recently reduced reservoir contents. Straight lines indicate trends for temperature, precipitation, and river flow. The trends for temperature and river flow are statistically significant. *From Figure 25.3 (Sources: Colorado State University and CICS-NC. Temperature and precipitation data from: PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu, accessed 20 Jun 2018).*