



Climate Change Southwest Impacts & Adaptation



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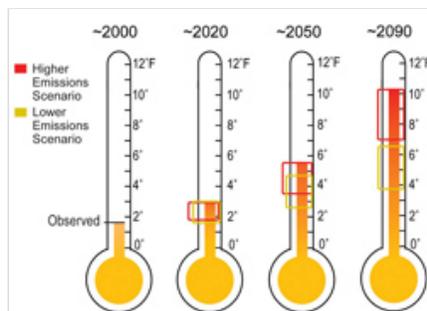
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each state in this region exceeded the national average growth rate between 2000 and 2010. Several states, such as Nevada (35.1%), Arizona (24.6%), and Utah (23.8%) experienced population growth rates more than double the national average of 9.7%.^[1]

There is a wide range of elevation and climate types across the region. Elevation ranges from valleys that are below sea level to mountains that have some of the highest peaks in the continental United States. The region is generally drier than other regions of the United States. It includes deserts in the southern portion, such as the Mojave Desert. Areas of northern California, the Rocky Mountains, and Sierra Nevada tend to get more precipitation and snow. Additionally, the Central Valley in California is one of the most productive agricultural regions in the country.

The climate of the Southwest is changing. Over the last century, the average annual temperature has increased about 1.5°F. Average annual temperature is projected to rise an additional 2.5-8°F by the end of the century.^[2] Warming in the Southwest is projected to be greatest in the summer.^[3]

Warming has already contributed to decreases in spring snowpack and Colorado River flows, which are an important source of water for the region.^[2] Future warming is projected to produce



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more severe droughts in the region, with further reductions in water supplies. Future water scarcity will be compounded by the region's rapid population growth, which is the highest in the nation.^[2]

Impacts on Water Resources

A reliable water supply is crucial for the people, agriculture, energy, and ecosystems of the Southwest. The region's water supplies are already constrained under current climate conditions. Water allocations in the region,

The Southwest is bordered by the Pacific Ocean to the west, the Rocky Mountains to the east, and Mexico to the south. The region includes the cities of Albuquerque, Phoenix, Las Vegas, Salt Lake City, Denver, San Diego, Los Angeles, Sacramento, and San Francisco, among others. The region is home to approximately 50 million residents and is growing quickly.^[4] The population growth in

Key Points

- Increasing temperatures and more frequent and severe droughts will likely worsen existing competition for water resources.
- Drought, wildfire, changes in species' geographic ranges, invasive species, and pests will likely threaten native Southwest forests and ecosystems.
- Climate change may make it difficult for the Southwest's growing cities to attain air quality standards and meet energy and water demands.
- Climate change poses threats to the region's native peoples, infrastructure, agriculture, and recreational activities.

Related Links

EPA:

- [Climate Change and Water: Southwest](#)
- [Climate Change and Water: Montane Region](#)
- [EPA Region 6 \(including the Southwest states of NM and TX\)](#)
- [EPA Region 8 \(including the Southwest states of CO and UT\)](#)

Observed and projected temperature change in the Southwest, compared to a 1960-1979 baseline period. The brackets represent the likely range of model projections.
Source: [USGCRP \(2009\)](#)

some of which were agreed upon almost a century ago, have become difficult to meet. Meanwhile, groundwater pumping is already lowering water tables. Future climate change is projected to worsen these conditions. ^[2]

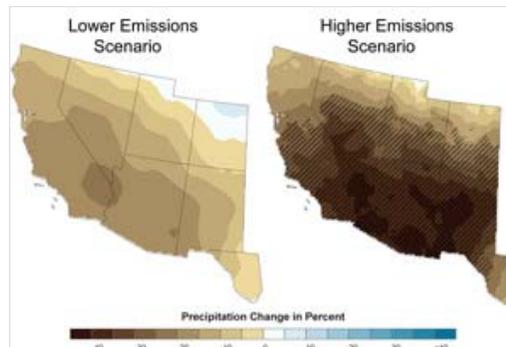
- [EPA Region 9 \(including the Southwest states of AZ, CA, and NV\)](#)

Other:

- [IPCC Working Group II : North America](#) [EXIT Disclaimer](#)
- [USGCRP. Global Climate Change Impacts in the United States: Southwest](#)
- [Climate Assessment for the Southwest: University of Arizona](#) [EXIT Disclaimer](#)
- [U.S. Fish and Wildlife Service: Climate Change in the Pacific Southwest](#)
- [ITEP. Tribes & Climate Change](#) [EXIT Disclaimer](#)

Increasing temperatures are projected to further reduce snowpack, which will lead to reduced streamflows, especially in the spring.

- Springtime precipitation is likely to decrease significantly, making it more difficult to meet water demands during the summer, ^[2] when conditions are typically the driest.
- Climate change will likely stress groundwater-based systems and result in decreased groundwater recharge. ^[2]
- While severe droughts are already part of the Southwest climate, human-induced climate change will likely result in more frequent and more severe droughts with associated increases in wildfires. ^[2]
- Projected temperature increases, river-flow reductions, dwindling reservoirs, and rapid population growth will increase the competition for water resources across sectors, states, tribes, and even between the United States and Mexico. This could potentially lead to conflicts.



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Spring precipitation change for 2080-2099 compared to 1961-1979 under two emissions scenarios. High confidence in the projected changes is indicated by hatched areas.

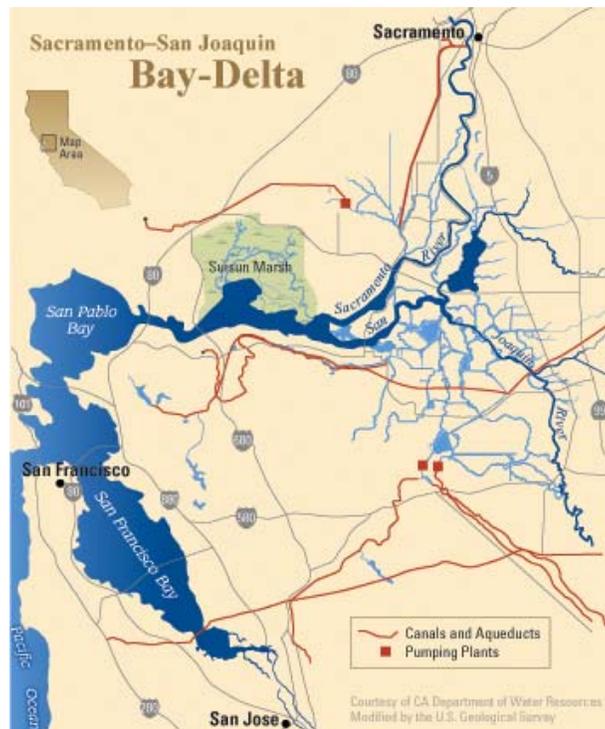
Source: [USGCRP \(2009\)](#)

For more information on climate change impacts on water, please visit the [Water Resources](#) page.

Flood Risk in the Sacramento-San Joaquin River Delta

Flooding threatens humans and infrastructure in low-lying areas such as the Sacramento-San Joaquin River Delta system. This region, which extends from San Francisco almost to Sacramento, is entirely below sea level. Climate changes are projected to more than double the risk of Delta flooding events by the middle of the century and cause an eight-fold increase by the end of the century. ^[2]

Warmer temperatures will impact the amount of snowpack and timing of snowmelt in the mountains of California, which provide the freshwater resources that flow into the Sacramento-San Joaquin Delta. Climate change is projected to increase flood risk, as more rapid and earlier snowmelt in the spring increases runoff. More frequent flooding in the region is likely to create [water](#) quality and supply issues.



Map of the Sacramento-San Joaquin River Delta

Source: [USGS \(2010\)](#)

Impacts on Recreation

Increasing temperatures and decreasing snow cover will affect economically important winter activities in the Southwest such as skiing, snowshoeing, and snowmobiling. Climate change is projected to result in later seasonal snow, less snow coverage, earlier wet snow avalanches, and generally shorter snow seasons.^[2] Ski seasons are projected to be 3-6 weeks shorter by the 2050s and 7-15 weeks shorter by the 2080s in the Sierra Nevada of California.^[3]

For more information on climate change impacts on infrastructure and economy, please visit the [Society](#) page.

Impacts on Forests and Other Ecosystems

Projected increases in drought, wildfire, invasive species, and pests, as well as changes in the geographic ranges of species, will likely threaten native forests and other ecosystems in the Southwest.^[4]

- More severe drought may threaten forest populations in the region (see text box for more information about piñon pine trees).

Piñon Pine Die-off ^[4]

Photos taken from the same vantage point near Los Alamos, New Mexico, in 2002 (left) and in 2004 (right).
Source: [USGS \(2004\)](#)

In 2000-2003, the combination of severe drought and unusually high temperatures led to significant die-off of piñon pines in the Four Corners region of the Southwest. Piñon pines are very drought tolerant and have survived dry periods in the past. However, in 2000-2003, high temperatures made drought conditions worse, making the piñons more susceptible to pine bark beetle attacks. In some areas, more than 90% of the piñons died. This resulted in a major change in the structure and function of the ecosystem over a large area. The piñon die-off is an example of how climate change can interact with other non-climate stresses to push a species past a threshold beyond which it cannot survive.



- Increasing temperatures and related reductions in spring snowpack and soil moisture are projected to increase the area burned by wildfire. Climate change could also cause subtle shifts in the way fires spread, which could result in "runaway fires" that rekindle after appearing under control. This risk may be compounded by urban development, which could worsen wildfire risk to population centers as they encroach on forested areas. ^[2]
- Climate change is projected to cause shifts in ecosystem distribution as species move northward and to higher elevations. These shifts include reductions in existing high-elevation ecosystems such as alpine forests and tundra, as well as expansions of grasslands. In California, over 3,000 native plant species are expected to face reductions in the geographic range within which they can survive. Other stressors which, when compounded by climate change, will hinder species' ability to migrate or adapt to new conditions include: the expansion of human development, air and water pollution, invasive species, streamflow reductions, and the region's mountainous terrain. ^[2]
- Changes in species' geographic ranges, climate change, and invasive species will likely threaten iconic landscapes, such as that of the Saguaro cactus in the Sonoran Desert. ^[2] By shifting native shrubs and cacti northward, an invasive species of grass from Africa may turn fire-proof desert areas into fire-prone grassland. The non-native grass is also able to spread quickly after fires, pushing out native species such as the saguaro cactus. ^[4]
- Climate change will add to the pressures already threatening the Southwest's two designated "biodiversity hotspots" ^[EXIT Disclaimer] — the California Floristic Province and the Madrean Pine-Oak Woodlands. ^[2]

For more information on climate change impacts on forests, please visit the [Forests](#) page.

To learn more about climate change impacts on ecosystems, please visit the [Ecosystems](#) page.

Impacts on Human Health

Warming temperatures will likely make it more difficult for the Southwest's rapidly growing cities to meet air quality standards. For example, more than 90% of California's population lives in areas that violate state air quality standards for ground-level ozone or small particles, with air pollutants causing an estimated 8,800 deaths and over \$1 billion in health care costs every year. ^[2] Warmer temperatures are expected to



Climate change may shift the geographic range of species, like the Saguaro cactus.
Source: [USGS \(1958\)](#)

increase the frequency, intensity, and duration of conditions that are conducive to air pollution formation, further exacerbating air quality issues in the Southwest. These conditions threaten the health and well-being of people who suffer from respiratory ailments, such as asthma and chronic obstructive pulmonary disease. ^[2]

For more information on climate change impacts on human health, please visit the [Health](#) page.

Impacts on Native Americans

The Southwest is home to many Native American communities. With changing climate conditions, including increased temperatures and severe droughts, Native Americans living on reservations could suffer from limited access to water resources. Since reservation lands were established and set aside in historic agreements, Native Americans living on reservations may be unable to relocate. They may have limited recourse if reservation water supplies become scarce or contaminated. ^[2]

For more information on climate change impacts on infrastructure and economy, please visit the [Society](#) page.

Impacts on Energy

Increasing temperatures are expected to threaten the reliability of electricity and water supplies in the Southwest's cities. Increased air conditioning demand during more intense and longer-lasting heat waves, limitations in the capacity of hydroelectric power systems, and increasing severity of droughts would impact the supply and distribution of electricity. These impacts are expected to be compounded by the region's rapid population growth. ^[2]

For more information on climate change impacts on energy, please visit the [Energy](#) page.

Impacts on Agriculture

Though climate change can benefit some crops through less freezing and increased productivity, warming beyond modest increases will likely harm the region's agriculture. California grows several temperature-sensitive specialty crops, such as apricots, almonds, artichokes, figs, kiwis, olives, walnuts, and wine grapes. Increased temperatures may make the regions that currently grow these crops unviable. ^[2] The Central Valley in California produces a significant portion of the nation's food. Crop failure in this region could impact the food supply and the price of food.

For more information on climate change impacts on agriculture and food supply, please visit the [Agriculture and Food Supply](#) page.

The Rocky Mountains

The Rocky Mountains stretch from New Mexico to Canada. Mountain ecosystems, particularly the Northern Rockies, are sensitive to climate change. The high elevations of the Rockies have experienced temperature increases three times the global average. The Rocky Mountains provide habitats for unique plants and animals, including endangered species like the grizzly bear and bull trout. ^[2] In addition, runoff from the Rocky Mountains fills some of the nation's large rivers, such as the Colorado River. These rivers supply water for a large portion of the Southwest. Future runoff for the Colorado River basin and many of the other rivers in the Southwest is projected to decline with future warming. ^[2]

The Rocky Mountains provide critical habitat for rare animals like this grizzly bear and cubs in Yellowstone National Park.
Source: [USGS \(2010\)](#)

Warmer temperatures in the Rocky Mountains are resulting in a variety of impacts. For instance, early snow melts encourage premature plant development. When the buds are exposed to frost they do not seed properly. As a result, warmer conditions lead to fewer wildflowers during the spring. ^[2]

To learn about the impact of mountain pine beetles on forests in Colorado, visit the [Forest Impacts](#) page.

The [Ecosystem Impacts](#) page features information about how climate change impacts the American Pika in the Rocky Mountains.



cts-adaptation/southwest.html

To learn more about what the Southwest is doing to adapt to climate change impacts, please visit the [adaptation section](#) of the Southwest Impacts and Adaptation page.

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[1] [U.S. Census Bureau \(2010\). *State & County Quick Facts*.](#)

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[3] [Field, C.B., L.D. Mortsch, M. Brklacich, D.L. Forbes, P. Kovacs, J.A. Patz, S.W. Running and M.J. Scott \(2007\). North America. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability*.](#) [EXIT Disclaimer](#) Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.). Cambridge University Press, Cambridge, United Kingdom.

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