TECHNICAL BULLETIN *Prepared by the Davey Institute*

Climate Change Projections for the Southwest United States

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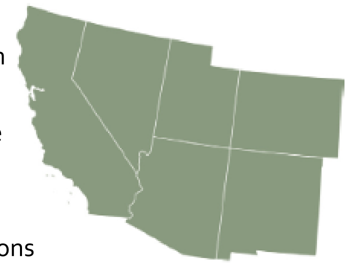
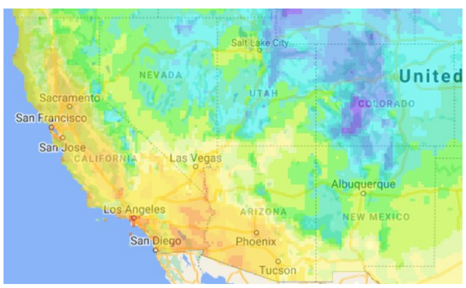


Image from Fourth National Climate Assessment

The Davey Climate Change Fact Sheet Series projects the future impacts of climate change in our industry over the next 30-70 years, with emphasis on changes in temperature, precipitation, storm intensity, tree health, pest pressure, wildfire, and worker stress. Temperatures across the U.S. are expected to increase between 3-11°F by the end of this century, with future patterns of greenhouse gas emissions providing the largest source of uncertainty. The Intergovernmental Panel on Climate Change (IPCC) predicts future climates based on modeling for different emissions scenarios, called "Representative Concentration Pathways (RCP)." This fact sheet focuses on changes expected to occur in the Southwest U.S. based on a lower (RCP4.5) and high (RCP8.5) emissions scenario. Currently, global patterns of fossil fuel consumption correspond most closely with the high emission scenario, while the lower emission scenario will require significant mitigation measures yet to be implemented.



Current winter hardiness zones

Winter hardiness zones projected for end of century under the lower emission scenario

The climate is warming. The Southwest has warmed over the last century, with southern California and western Colorado experiencing the greatest increases in annual average temperatures, having warmed about 3°F, while Arizona and Utah have increased by 2°F. By the end of the century, under the higher emission scenario, annual average temperatures are projected to increase by 8.6°F across the Southwest with most of California experiencing 20-40 additional days with maximum temperatures of at least 90°F.

Meanwhile Arizona and New Mexico are predicted to experience 40-60 additional extreme heat days by end of century. Plant hardiness zones are transitioning as the climate warms. By mid-century, mean minimum temperature will have increased by 2°F (low scenario) and 6.5° (high scenario), on average throughout the region; end-of-century projections are increases of 4°F and 8.3°F, respectively.

Variable precipitation with more megadroughts Although natural climate variability is the primary cause of major droughts in the Southwest, recent droughts have been intensified by increasing temperatures, particularly in California and the upper Colorado River Basin. Hotter temperatures, which result in drying earlier in the season and greater evapotranspiration, are projected to increase probabilities of these megadroughts, which can persist a decade or longer.

In recent decades, less summer precipitation and more evaporation resulting from higher temperatures have decreased river flows throughout the region including the Colorado River, where drought has reduced the volume of water in Lakes Mead and Powell by over half. Average total summer precipitation is projected to remain highly variable, with the proportion of precipitation falling as heavy downpours increasing. Higher temperatures have decreased seasonal snowpack over the past 50 years. This trend is predicted to intensify, as more precipitation in the mountains is projected to fall as rain and less as snow, leading to more winter runoff and less water stored in the snowpack.

Ground water is also being depleted faster than it can be recharged. As these trends amplify, competition for water among competing interests will intensify, including agriculture, municipalities, and conservation of aquatic ecosystems. Restrictions on watering constrain the ability to relieve stress experienced by trees during drought, which results in their increased susceptibility to secondary pests such as wood-borers, vascular wilt and canker pathogens.

Changing forests: insect outbreaks and wildfire

Tree mortality in the Southwest has doubled over the last 50 years due to drought, wildfire, and insect outbreaks. Drought-induced bark beetle outbreaks covering several hundred thousand acres in Arizona and New Mexico have eliminated large tracts of piñon pine from pine-juniper forests. At higher-altitude montane forests, warmer temperatures have increased the overwintering survival of mountain pine beetle, contributing to expansive outbreaks and widespread mortality of lodgepole pine, especially in Colorado and parts of Utah.

Warming and drying of the climate, along with decades of fire suppression that increased fuel loads, have increased wildfire frequency, duration, and season length, resulting in a doubling of the area of forest that has burned on average each year throughout the western U.S. since 1984 . Wildfire has increased to an even greater degree in California, increasing fivefold on an annual basis since the early 1970s, and has transformed California ecosystems and Southwest forests from net carbon sinks to net carbon emitters. Increased wildfire has been strongly linked to dryer fuels, increased spring and summer temperatures, and earlier spring snowmelt. This trend is projected to intensify in coming decades as the climate continues to become warmer and drier. Efforts to conserve forests can help mitigate climate change via carbon sequestration. Old-growth coastal redwood ecosystems of northern California store especially large quantities of carbon.

Worker safety: increased exposure to extreme heat

As the climate warms, people that work and recreate outside will experience greater risk of heat stress. For example, the extreme heat wave that impacted California for more than two weeks in 2006 resulted in 16,000 emergency room visits and 600 additional deaths. Under the lower and higher emissions scenarios, the Southwest would experience 425 and 850 additional premature deaths each year, respectively, by the middle of the century. By the end of the century, premature deaths are projected to double from 2050 levels under both scenarios.

In addition to extreme heat, concern for human health is exacerbated when conditions are compounded by ground-level ozone air pollution and particulate air pollution (such as from wildfires and dry and dusty conditions), especially for those suffering from conditions such as dehydration, cardiovascular, and respiratory stress. High temperatures amplify the concentration of ground-level ozone; the frequency of high ozone days is projected to increase, especially in urban areas. Ozone also stresses trees, decreasing their growth and resistance to insects and disease.

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