Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

backgrounder

All information in this summary is entirely based on "Global Climate Change Impacts in the United States" (USGCRP, 2009). To enhance clarity, slight modifications were made that maintain the intended meaning of the report.

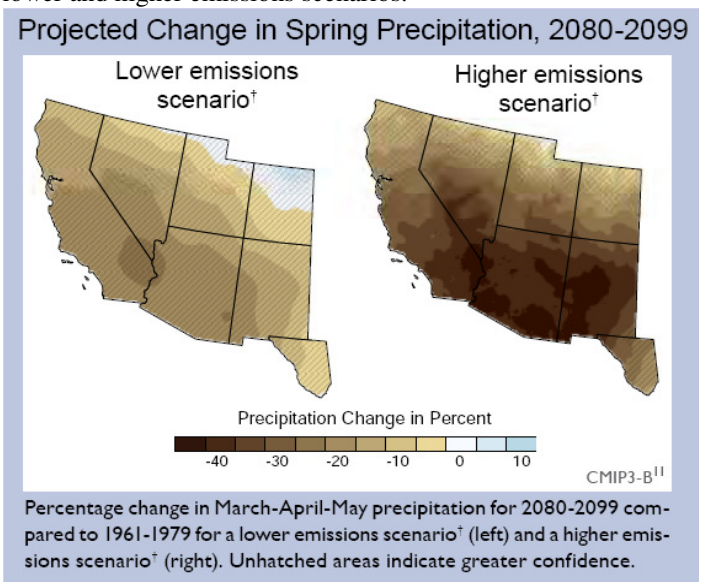
Southwest

Arizona, California, Colorado, Nevada, New Mexico, West Texas, Utah

Under a lower-emissions scenario the Southwest as a whole is projected to warm between approximately 4 and 6 degrees Fahrenheit (ºF) by the end of the century. Under a higher-emissions scenario, it is projected to warm between approximately 7 and 10 ºF. Recent warming is among the most rapid in the nation, significantly more than the global average in some areas.

WATER

The Southwest section of the report contains a detailed graphic underscoring the difference in spring precipitation under lower and higher emissions scenarios:



Percentage change in March-April-May precipitation for 2080-2099 compared to 1961-1979 for a lower emissions scenario† (left) and a higher emissions scenario† (right). Unhatched areas indicate greater confidence.

The report singles out the Southwest as being vulnerable to drought. It says, "The combined effects of natural climate variability and human-induced climate change could turn out to be a devastating "one-two punch" for the region." Among its findings:

- The arid region of the Southwest is projected to become drier in this century. There is emerging evidence that these changes are already underway. Deserts in the United States also are projected to expand to the north, east, and upward in elevation in response to projected warming and associated changes in climate. Increased drying in the region contributes to a variety of changes that exacerbate a cycle of desertification.
- Water supplies in some areas of the Southwest are already becoming limited, and this trend towards scarcity is likely to be a harbinger of future water shortages. Groundwater pumping is lowering water tables, while rising temperatures reduce river flows in vital rivers including the Colorado. Limitations imposed on water supply by projected temperature increases are likely to be made worse by substantial reductions in rain and snowfall in the spring months. Assuming current reservoir infrastructure levels, this threatens to reduce meeting reservoir volumes needed to meet summer demand.
- The magnitude of temperature increases projected for the Southwest, particularly when combined with urban heat island effects for major cities such as Phoenix, Albuquerque, Las Vegas, and many California cities, represent

significant stresses to health, electricity, and water supply in a region that already experiences very high summer temperatures.

- There is a high likelihood that water shortages could limit power plant electricity production in many regions, projecting future water constraints on electricity production in thermal power plants for Arizona, Utah, Texas, Louisiana, Georgia, Alabama, Florida, California, Oregon, and Washington State by 2025.
- The number of dry days between precipitation events is projected to increase, especially in more arid areas. In southern US, significant reductions in precipitation are expected in winter and spring as the subtropical dry belt expands. This is particularly pronounced in the Southwest, where it will likely have serious ramifications for water resources
- Droughts cause soil moisture reductions that can reduce expected runoff until soil moisture is replenished. Conversely, water-saturated soils can generate floods with only moderate additional precipitation. All models project substantial declines in runoff in the interior West, especially the Southwest. Projections for runoff in California and other parts of the West also show reductions, although less than in the interior West. In short, wet areas are projected to get wetter and dry areas drier.
- Observations indicate a transition to more rain and less snow in the West over the last 50 years. Runoff in snowmelt-dominated areas is occurring up to 20 days earlier in the West. Future projections for most snowmelt-dominated basins in the West consistently indicate earlier spring runoff, in some cases up to 60 days earlier. Earlier runoff produces decreased late-summer streamflows which stress human and environmental systems through less water availability and higher water temperatures.
- When it does rain, the rain tends to come in heavy downpours, and since there is less vegetation to protect the soil, water erosion increases. Higher air temperatures and decreased soil moisture reduce soil stability, further exacerbating erosion.

The report singles out the Colorado River system for its particular vulnerability to climate change:

- Reservoirs in the system, including the giant lakes Mead and Powell, were nearly full in 1999, with almost four times the annual flow of the river stored. By 2007, the system had lost approximately half of that storage after enduring the worst drought in 100 years of record keeping. Runoff was reduced due to low winter precipitation, and warm, dry, and windy springs that substantially reduced snowpack.
- Numerous studies over the last 30 years have indicated that the river is likely to experience reductions in runoff due to climate change. In addition, diversions from the river to meet the needs of cities and agriculture are approaching its average flow. Under current conditions, even without climate change, large year-to-year fluctuations in reservoir storage are possible.
- If reductions in flow projected to accompany global climate change occur, water managers will be challenged to satisfy all existing demands, let alone the increasing demands of a rapidly growing population.
- Water is also an important source of hydroelectric power, and water is required for the large population growth in the region

Paradoxically, a warmer atmosphere and an intensified water cycle are likely to mean not only a greater likelihood of drought for the Southwest but also an increased risk of flooding. Winter precipitation in Arizona, for example, is already becoming more variable, with a trend towards both more frequent extremely dry and extremely wet winters. Some water systems rely on smaller reservoirs being filled up each year. More frequent dry winters suggest an increased risk of these systems running short of water. However, a greater potential for flooding also means reservoirs often cannot be filled to capacity as safely in years where that is possible. Flooding also causes reservoirs to fill with sediment at a faster rate, thus reducing their water-storage capacities. Moreover, increased flood risk in the Southwest is likely to result from a combination of decreased snow cover on the lower slopes of high mountains, and an increased fraction of winter precipitation falling as rain and on top of snow increasing chances for rapid runoff and flooding.

Native cultures in the Southwest are particularly vulnerable to impacts of climate change on water quality and availability. The Southwest is home to dozens of Native communities whose status as sovereign nations means they hold treaty rights to the water that runs through their land. However, the amount of water available to each nation is negotiable. While several nations have legally settled their water rights, many other tribal negotiations are either currently underway or

pending. The Navajo Nation, the largest Native American reservation in the United States, is now negotiating its claim to the New Mexico portion of the San Juan River with the federal government. Competing demands from treaty rights, rapid development, and changes in agriculture in the region, exacerbated by years of drought and climate change, have the potential to spark significant conflict over an already overallocated and dwindling resource.

HEALTH

A study of climate change impacts in California projects that, by the 2090s, annual heat-related deaths in Los Angeles risk increasing from the 1990s baseline of about 165 deaths; by two to three times under a lower emissions scenario; and by five to seven times under a high emissions scenario.

Californians currently experience the worst air quality in the nation. More than 90 percent of the population lives in areas that violate air quality standards for ground-level ozone or small particles. These pollutants cause an estimated 8,800 deaths and over a billion dollars in health care costs every year in California. Higher temperatures are projected to increase the frequency, intensity, and duration of conditions conducive to air pollution formation, potentially increasing the number of days conducive to air pollution by 75 to 85 percent in Los Angeles and the San Joaquin Valley, towards the end of this century, under a higher emissions scenario, and by 25 to 35 percent under a lower emissions scenario. Air quality could be further compromised by wildfires, which are already increasing as a result of warming.

Wildfires in the United States are already increasing due to warming. In the West, there has been a nearly fourfold increase in large wildfires in recent decades, with greater fire frequency, longer fire durations, and longer wildfire seasons. This increase is strongly associated with increased spring and summer temperatures and earlier spring snowmelt, which have caused drying of soils and vegetation. In addition to direct injuries and deaths due to burns, wildfires can cause eye and respiratory illnesses due to fire-related air pollution.

LIVLIHOOD AND INFRASTRUCTURE COSTS

Communities that have developed near areas of agricultural production, such as the wine-producing regions of California, depend on the continued productivity of those regions, which would likely be compromised by increased temperature or severe weather. Specialty crops in California such as apricots, almonds, artichokes, figs, kiwis, olives, and walnuts require a minimum number of hours at a chilling temperature threshold in the winter to become dormant and set fruit for the following year. Accumulated winter chilling hours have already decreased across central California and its coastal valleys. This trend is projected to continue to the point where chilling thresholds for many key crops could no longer be met. A steady reduction in winter chilling could have serious economic impacts on fruit and nut production in the region. California's losses due to future climate change are estimated between zero and 40 percent for wine and table grapes, almonds, oranges, walnuts, and avocadoes, varying significantly by location and emissions scenarios.

Decreases from 40 to almost 90 percent are likely in end-of-season snowpack under a higher emissions scenario in counties with major ski resorts from New Mexico to California. In addition to shorter seasons, earlier wet snow avalanches—more than six weeks earlier by the end of this century under a higher emissions scenario—could force ski areas to shut down affected runs before the season would otherwise end. Resorts require a certain number of ski days just to break even; cutting the season short by even a few weeks, particularly if those occur during the lucrative holiday season, could easily render a resort unprofitable that does not diversify into warmer season activities.

The Southwest is home to two of the world's 34 designated "biodiversity hotspots." Ecotourism has become the economic driver in many parts of this region, but logging, land clearing for agriculture, urban development, and now climate change threaten the region's viability. They hold unusually large numbers of plant and animal species that are endemic (found nowhere else), and they have already lost over 70 percent of their native vegetation. One of these biodiversity hotspots is the Madrean Pine-Oak Woodlands. Once covering 178 square miles, only isolated patches remain in the United States, mainly on mountaintops in southern Arizona, New Mexico, and West Texas. The greatest diversity of pine species in the world grows in this area: 44 of the 110 varieties, 35 as well as more than 150 species of oak. Some 5,300 to 6,700 flowering plant species inhabit the ecosystem, and over 500 bird species, 23 of which are endemic. More hummingbirds are found here than anywhere else in the United States. There are 384 species of reptiles, 37 of which are endemic, and 328 species of mammals, six of which are endemic. There are 84 fish species, 18 of which are endemic. Some

200 species of butterfly thrive here, of which 45 are endemic, including the Monarch that migrates 2,500 miles north to Canada each year.

Rising temperatures increase higher take-off speeds and longer runways at airports because more lift is needed when temperatures are higher. Extreme heat affects aircraft lift; because hotter air is less dense, it reduces the lift produced by the wing and the thrust produced by the engine—problems exacerbated at high altitudes and high temperatures. Recent hot summers have seen flights cancelled due to heat, especially in high altitude locations. Economic losses are expected at affected airports. A recent illustrative analysis projects a 17 percent reduction in freight carrying capacity for a single Boeing 747 at the Denver airport by 2030 and a 9 percent reduction at the Phoenix airport due to increased temperature and water vapor

MOUNTAIN ECOSYSTEMS

In the Rocky Mountains reduced snow cover leaves young plants unprotected from spring frosts, with some plant species already beginning to suffer as a result. In California, two-thirds of the more than 5,500 native plant species are projected to experience range reductions up to 80 percent before the end of this century under projected warming.

Wherever droughts increase, forest productivity decreases and tree death will likely increase. Under higher emissions scenarios, high elevation forests in California, for example, are projected to decline by 60 to 90 percent before the end of the century.

Fewer wildflowers are projected to grace the slopes of the Rocky Mountains as global warming causes earlier spring snowmelt. Larkspur, aspen fleabane, and aspen sunflower grow at an altitude of about 9,500 feet where the winter snows are deep. Once the snow melts, the flowers form buds and prepare to bloom. But warmer springs mean that the snow melts earlier, leaving the buds exposed to frost. The percentage of buds that were frosted has doubled over the past decade. Frost does not kill the plants, but it does make them unable to seed and reproduce, meaning there will be no next generation where that occurs.