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.

United States

The U.S. Global Change Research Program, an interagency research program comprised of 13 federal agencies, has released a comprehensive report about climate change in the United States and what it will mean for our future and way of life. The author team is comprised of 28 climate experts from universities and research institutions across the U.S. The report is the first nationwide snapshot of our vulnerability to climate change since 2001 and represents the best available climate science in the United States. The report concludes:

- Global warming is unequivocal and primarily human-induced.
- Widespread climate-related impacts are occurring now and are expected to increase.
- Future climate change and its impacts depend on choices make today.

The report says, “Reducing emissions of carbon dioxide would lessen warming over this century and beyond. Sizable early cuts in emissions would significantly reduce the pace and the overall amount of climate change. Earlier cuts in emissions would have a greater effect in reducing climate change than comparable reductions made later.”

Temperatures have already risen 1.5 degrees Fahrenheit (ºF) globally and have risen by and average 2 (ºF) over the past 50 years in the United States. The report examines three scenarios, a “higher emissions scenario” which heat-trapping emissions continue to rise unabated, a “medium-high emissions scenario”, and a “lower emissions scenario” in which the United States and other countries substantially reduce emissions. By the end of the century, the average U.S. temperature is projected to increase by approximately 7 to 11ºF under the higher emissions scenarios and by approximately 4 to 6.5ºF under the lower emissions scenario.

Public Health and Extreme Weather

Extreme heat waves currently considered rare are projected to occur more frequently in the future under both scenarios. Recent studies show that events that now occur once every 20 years are projected to occur about every other year in much of the country by the end of this century if emissions continue to grow unabated. In addition to occurring more frequently, at the end of this century these very hot days will likely be about 10ºF hotter than they are today.

Flooding from changes in precipitation are projected to become more common if higher emissions prevail. Heavy downpours that are now 1-in-20-year occurrences are projected to occur about every 4 to 15 years and be between 10 and 25 percent heavier by the end of this century.

Atlantic Hurricane rainfall and wind speeds is likely to increase in response to human-caused warming. Analyses suggest that for each 1.8ºF increase in tropical sea surface temperatures, core rainfall rates increase by 6 to 18 percent and the strongest hurricanes surface wind speeds increase by about 1 to 8 percent. For a given storm surge level, more damage is likely under rising seas that add elevation to the ultimate water height reached during a storm. Global sea level is rising from global warming of the ocean and melting of land-based ice.

Ground-level ozone, a dangerous air pollutant, forms more easily when temperatures are higher. Urban areas are especially at risk from increased air pollution. Extreme weather events, including droughts in some parts of the country and flooding in other parts, can also threaten public health. Assuming the same level of pollutant production as today, by the middle of this century, Red Ozone Alert Days (when the air is unhealthy for everyone) in the 50 largest cities in the eastern United States are projected to increase by 68 percent due to warming alone.

Diseases are likely to spread as the world warms. Among the examples the report cites are:

- Food poisoning from bacteria peaks within one to six weeks of the highest reported ambient temperatures.
- In the absence of moderating factors such as pest control programs, climate change influences where mosquitoes, ticks, and rodents that carry West Nile virus, equine encephalitis, Lyme disease, and *Hantavirus* spread.

- Heavy rain and flooding can contaminate certain food crops with feces from nearby livestock or wild animals, increasing the likelihood of food-borne disease associated with fresh produce.

Climate change exacerbates allergies. Climate change has caused an earlier onset of the spring pollen season in the United States. It is reasonable to conclude that allergies caused by pollen have also experienced associated changes in seasonality. Several laboratory studies suggest that increasing carbon dioxide concentrations and temperatures increase ragweed pollen production and prolong the ragweed pollen season. Poison ivy growth and toxicity is also greatly increased by carbon dioxide, with plants growing larger and more allergenic. These increases exceed those of most beneficial plants.

Wet Areas Are Projected to Get Wetter and Dry Areas Drier

Runoff, or water that appears in streams, is expected to increase in the Midwest and Northeast and decrease in the West, especially the Southwest. Northern states east of the Mississippi River experience between a 5 and 20 percent increase in runoff while southwestern areas experience between a 10 and 40 percent decrease by mid-century, based on a medium-high scenario of future emissions. Additionally, under higher emissions, spring snowmelts are projected to arrive more than 20 and in some cases 60 days earlier than usual in many parts of the West and 14 days earlier in Northeast. Early snow melt can lead to drought in subsequent months.

In many places, especially the West, water systems are already taxed. The U.S. Bureau of Reclamation has identified many areas in the West that are already at risk for serious conflict over water. Adapting to gradual changes, such as changes in average amounts of precipitation is less difficult than adapting to changes in extremes. Where extreme events, such as droughts or floods, become more intense or more frequent with climate change, the economic and social costs of these events will increase.

Climate Change is Projected to Increase Energy Demand While Threatening Energy Production

Warming will be accompanied by decreases in demand for heating energy and increases in demand for cooling energy, resulting **in overall significant increases in electricity use and peak demand in most regions**. Studies find that demand for cooling energy increases from 5 to 20 percent per 1.8ºF of warming, and the demand for heating energy drops by 3 to 15 percent per 1.8ºF of warming.

Water shortages are highly likely to limit power plant electricity production in many regions Warmer water reduces the efficiency of thermal power plant cooling technologies. Large coal and nuclear plants have been limited in their operations by reduced river levels caused by higher temperatures and thermal limits on water discharge. The efficiency of thermal power plants, fossil or nuclear, is sensitive to ambient air and water temperatures; higher temperatures reduce power outputs by affecting the efficiency of cooling. Although this effect is not large in percentage terms, even a relatively small change at the source is amplified by the typical transmission losses en route to the end use location.

Observed and projected increases in a variety of extreme events, including hurricanes and flooding, will likely have significant impacts on the energy sector.

Climate Change Threatens Transportation Infrastructure

Sea-level rise could potentially affect commercial transportation activity valued in the hundreds of billions of dollars annually through inundation of area roads, railroads, airports, seaports, and pipelines. More intense storms, especially when coupled with sea-level rise, leads to more far-reaching and damaging storm surge. An estimated 60,000 miles of coastal highway are already exposed to periodic flooding from coastal storms and high waves. More intense rainstorms can lead to rivers flooding, which can “wash out” or degrade nearby railbeds and roadbeds.

Longer periods of extreme heat in summer might damage roads in several ways, including softening of asphalt that leads to rutting from heavy traffic that occurs with temperature sustained over 90ºF. Extreme heat can cause deformities in rail tracks, at minimum resulting in speed restrictions and, at worst, causing derailments. Air temperatures above 100ºF can lead to equipment failure. Extreme heat also causes thermal expansion of bridge joints, adversely affecting bridge operations and increasing maintenance costs.

Air travel faces challenges from: coastal flooding, higher take-off speeds and longer runways needed because more lift is needed when temperatures are higher. Recent hot summers have seen flights cancelled due to heat, especially in high altitude locations. One 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

Climate Change Threatens Agriculture and Livestock Production

The negative consequences of climate change on agriculture largely outweigh benefits.

Threats to crops

- Analysis of crop responses suggests that even moderate increases in temperature will likely decrease yields of corn, wheat, sorghum, bean, rice, cotton, and peanut crops.
- Crops will be more frequently exposed to temperature thresholds at which pollination and grain-set (becoming a seed) processes begin to fail and quality of vegetable crops decreases.
- For many high-value crops, just hours or days of moderate heat stress at critical growth stages can reduce grower profits by negatively affecting visual or flavor quality.
- Higher temperatures mean a longer growing season for crops that do well in the heat, such as melon, okra, and sweet potato, but a shorter growing season for crops more suited to cooler conditions, such as potato, lettuce, broccoli, and spinach.
- Grain, soybean, and canola crops have relatively low optimal temperatures, and thus will likely have reduced yields and increasingly experience failure as warming proceeds.
- Common snap beans show substantial yield reduction when nighttime temperatures exceed 80ºF.
- Fruits, vegetables, and grains can suffer even under well-watered conditions if temperatures exceed the maximum level for pollen viability in a particular plant; if temperatures exceed the threshold for that plant, it won't produce seed and so it won't reproduce.
- Fruits that require long winter chilling periods will likely experience declines in many current locations ideal for growing this crop. Many varieties of fruits such as popular varieties of apples and berries require between 400 and 1,800 cumulative hours below 45ºF each winter to produce abundant yields the following summer and fall.
- Mild winters and warm, early springs induce premature plant development and blooming, resulting in exposure of vulnerable young plants to subsequent late-season frosts.
- Field flooding during the growing season causes crop losses due to low oxygen levels in the soil, increased susceptibility to root diseases, and increased soil compaction due to the use of heavy farm equipment on wet soils.
- Storms with heavy rainfall often are accompanied by wind gusts, and both strong winds and rain can flatten crops, causing significant damage. Vegetable and fruit crops are sensitive to even short-term, minor stresses, and as such are particularly vulnerable to weather extremes.
- Drought frequency and severity are projected to increase in the future over much of the United States, particularly under higher emissions scenarios. Increased drought will more likely occur at a time when crop water requirements also are increasing due to rising temperatures.
- Weeds benefit more than cash crops from higher temperatures and carbon dioxide levels.
- Many insect pests and crop diseases thrive due to warming, increasing losses and pest management costs. Crop diseases in general are likely to increase as earlier springs and warmer winters allow proliferation and higher survival rates of disease pathogens and parasites.

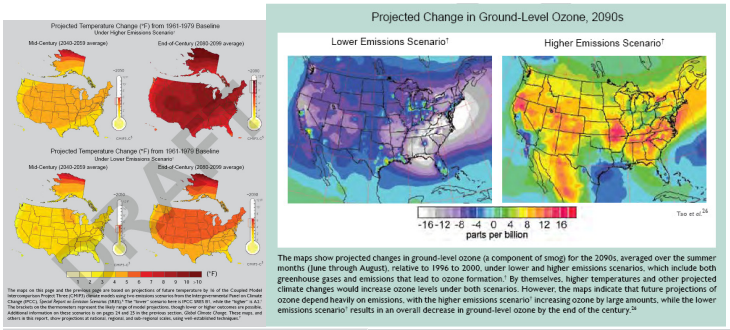
Threats to Cattle and livestock production:

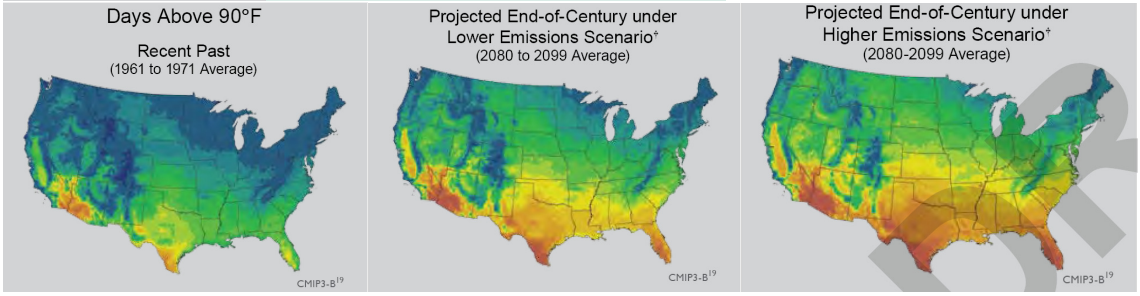
- In grassland where cattle feed, increases in carbon dioxide are generally reducing the quality of forage, so that more acreage is needed to provide animals with the same nutritional value, resulting in an overall decline in livestock productivity.
- Like human beings, cows, pigs, and poultry are warm-blooded animals that are sensitive to heat. The more the U.S. climate warms, the more livestock production will likely fall. For example, an analysis of warming in the range of 9 to 11ºF projected a 10 percent decline in livestock yields in cow/calf and dairy operations in Appalachia, the Southeast (including the Mississippi Delta), and southern Plains regions, while a warming of 2.7ºF caused less than a 1 percent decline.

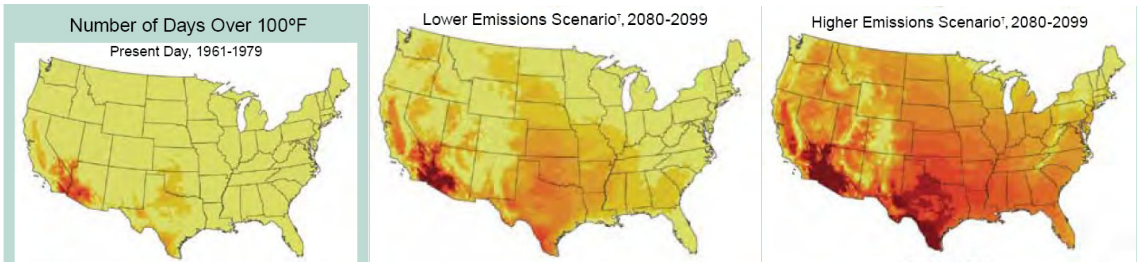
- Heat stress causes cow milk production declines, the number of days it takes for cows to reach their target weight grows longer in meat operations, conception rate in cattle falls, and swine growth rates decline due to increased heat.

Important Maps to Draw Data From

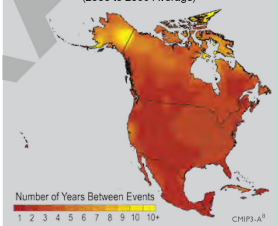
High resolution maps documenting climate change consequences will be available on the Web when the report is released. It will be easy to draw state-specific projections from these maps. They include, in order, a map of projected temperature increases for lower and higher emissions scenarios for mid and late century, a map of ground-level ozone pollution under higher and lower scenarios, a map of days above 90 degrees for lower and higher emissions scenarios, days above 100 degrees for lower and higher emissions scenarios, projected frequency of extreme heat under a higher emissions scenario, maps depicting changes in precipitation under a higher emissions scenario and a map on projected forest habitat changes under a mid emissions scenario.





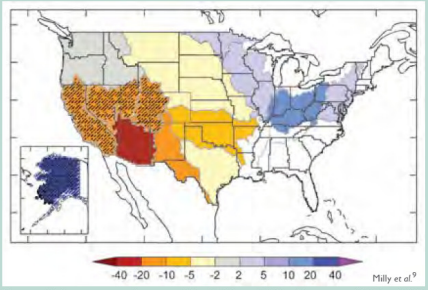


Projected Frequency of Extreme Heat
(2080 to 2099 Average)



Simulations for 2080 to 2099 indicate how currently rare extremes (a 1-in-20-year event) are projected to become more common-place. A day so hot that it is currently experienced once every 20 years would occur every other year or more frequently by the end of the century under the higher emissions scenario.[1]

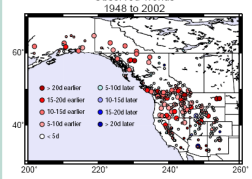
Projected Changes in Annual Runoff



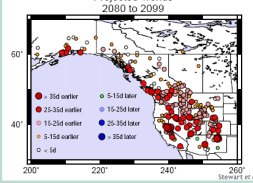
Projected changes in median runoff for 2041 to 2060, relative to a 1901 to 1970 baseline, are mapped by water-resource region. Colors indicate percentage changes in runoff. Hatched areas indicate greater confidence due to strong agreement among model projections. U.S. white areas indicate divergence among model projections. Results are based on emissions in between the lower and higher emissions scenarios.[1]

Trends in Peak Streamflow Timing

Observed Trends
1948 to 2002

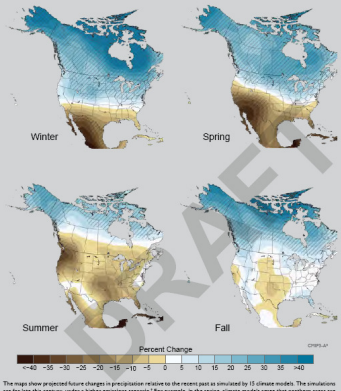


Projected Trends
2080 to 2099



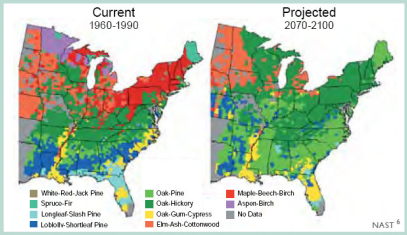
Top map shows changes in runoff timing in snowmelt-driven streams during 1948-2002 with red circles indicating earlier runoff, and blue circles indicating later runoff. Bottom map shows projected changes in snowmelt-driven streams by 2080-2099, compared to 1951-1980, under a higher emissions scenario.[1]

Projected Change in North American Precipitation
by 2080-2099



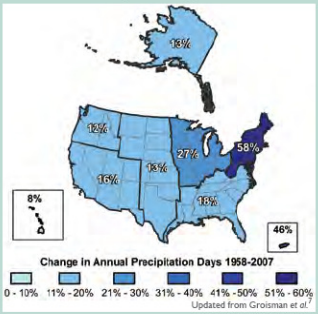
The maps show projected future changes in precipitation relative to the recent past as simulated by 15 climate models. The simulations are for late this century, under a higher emissions scenario.[1] For example, in the spring, climate models agree that northern areas are likely to get wetter, and southern areas drier. There is less confidence in exactly where the transition between wetter and drier areas will occur. Areas where climate models show some divergence are hatched in the maps, suggesting less confidence in the projections in those areas. In the hatched areas, the projected changes are small relative to the wide range of model outcomes.

Projected Shifts in Forest Types



The maps show current and projected forest types. Major changes are projected for many regions. For example, in the Northeast, under a mid-range warming scenario, the currently dominant maple-beech-birch forest type is projected to be completely displaced by other forest types in a warmer future.[2]

Increases in Very Heavy Precipitation Days
(1958-2007)



The map shows the percentage increases in the average number of days with very heavy precipitation (defined as the heaviest 1 percent of all events) from 1958 to 2007 for each region, compared to a baseline period of 1961-1990. The clearest trends toward more very heavy precipitation days are evident at the national scale, and in the Northeast and Midwest.