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EPA Climate Change And New Mexico

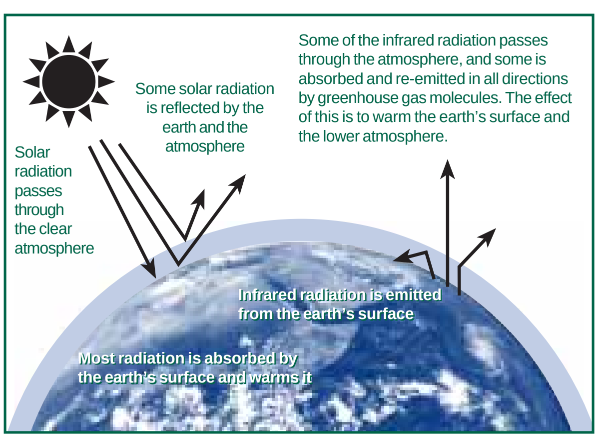
The earth's climate is predicted to change because human activities are altering the chemical composition of the atmosphere through the buildup of greenhouse gases — primarily carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The heat-trapping property of these greenhouse gases is undisputed. Although there is uncertainty about exactly how and when the earth's climate will respond to enhanced concentrations of greenhouse gases, observations indicate that detectable changes are under way. There most likely will be increases in temperature and changes in precipitation, soil moisture, and sea level, which could have adverse effects on many ecological systems, as well as on human health and the economy.

The Climate System

Energy from the sun drives the earth's weather and climate. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F. However, problems arise when the greenhouse effect is ***enhanced*** by human-generated emissions of greenhouse gases.

Global warming would do more than add a few degrees to today's average temperatures. Cold spells still would occur in winter, but heat waves would be more common. Some places would be drier, others wetter. Perhaps more important, more precipitation may come in short, intense bursts (e.g., more than 2 inches of rain in a day), which could lead to more flooding. Sea levels would be higher than they would have been without global warming, although the actual changes may vary from place to place because coastal lands are themselves sinking or rising.

The Greenhouse Effect



Source: U.S. Department of State (1992)

Emissions Of Greenhouse Gases

Since the beginning of the industrial revolution, human activities have been adding measurably to natural background levels of greenhouse gases. The burning of fossil fuels — coal, oil, and natural gas — for energy is the primary source of emissions. Energy burned to run cars and trucks, heat homes and businesses, and power factories is responsible for about 80% of global carbon dioxide emissions, about 25% of U.S. methane emissions, and about 20% of global nitrous oxide emissions. Increased agriculture and deforestation, landfills, and industrial production and mining also contribute a significant share of emissions. In 1994, the United States emitted about one-fifth of total global greenhouse gases.

Concentrations Of Greenhouse Gases

Since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting incoming solar radiation. However, sulfates are short-lived and vary regionally, so they do not offset greenhouse gas warming.

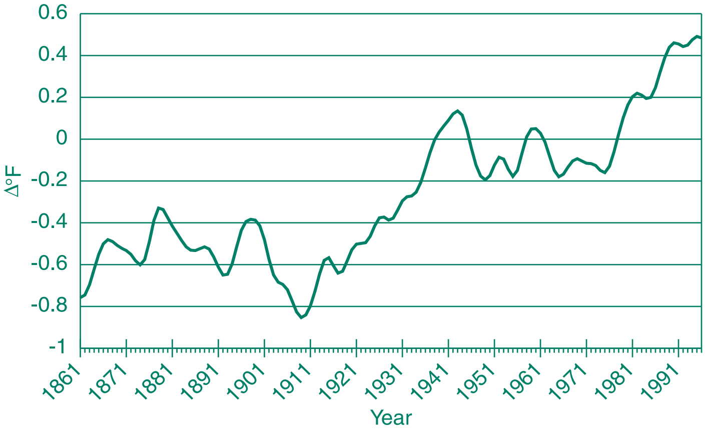
Although many greenhouse gases already are present in the atmosphere, oceans, and vegetation, their concentrations in the future will depend in part on present and future emissions. Estimating future emissions is difficult, because they will depend on demographic, economic, technological, policy, and institutional developments. Several emissions scenarios have been developed based on differing projections of these underlying factors. For example, by 2100, in the absence of emissions control policies, carbon dioxide concentrations are projected to be 30-150% higher than today's levels.

Current Climatic Changes

Global mean surface temperatures have increased 0.6-1.2°F between 1890 and 1996. The 9 warmest years in this century all have occurred in the last 14 years. Of these, 1995 was the warmest year on record, suggesting the atmosphere has rebounded from the temporary cooling caused by the eruption of Mt. Pinatubo in the Philippines.

Several pieces of additional evidence consistent with warming, such as a decrease in Northern Hemisphere snow cover, a decrease in Arctic Sea ice, and continued melting of alpine glaciers, have been corroborated. Globally, sea levels have risen

Global Temperature Changes (1861–1996)



Source: IPCC (1995), updated

4-10 inches over the past century, and precipitation over land has increased slightly. The frequency of extreme rainfall events also has increased throughout much of the United States.

A new international scientific assessment by the Intergovernmental Panel on Climate Change recently concluded that ***"the balance of evidence suggests a discernible human influence on global climate."***

Future Climatic Changes

For a given concentration of greenhouse gases, the resulting increase in the atmosphere's heat-trapping ability can be predicted with precision, but the resulting impact on climate is more uncertain. The climate system is complex and dynamic, with constant interaction between the atmosphere, land, ice, and oceans. Further, humans have never experienced such a rapid rise in greenhouse gases. In effect, a large and uncontrolled planet-wide experiment is being conducted.

General circulation models are complex computer simulations that describe the circulation of air and ocean currents and how energy is transported within the climate system. While uncertainties remain, these models are a powerful tool for studying climate. As a result of continuous model improvements over the last few decades, scientists are reasonably confident about the link between global greenhouse gas concentrations and temperature and about the ability of models to characterize future climate at continental scales.

Recent model calculations suggest that the global surface temperature could increase an average of 1.6-6.3°F by 2100, with significant regional variation. These temperature changes would be far greater than recent natural fluctuations, and they would occur significantly faster than any known changes in the last 10,000 years. The United States is projected to warm more than the global average, especially as fewer sulfate aerosols are produced.

The models suggest that the rate of evaporation will increase as the climate warms, which will increase average global precipitation. They also suggest increased frequency of intense rainfall as well as a marked decrease in soil moisture over some mid-continental regions during the summer. Sea level is projected to increase by 6-38 inches by 2100.

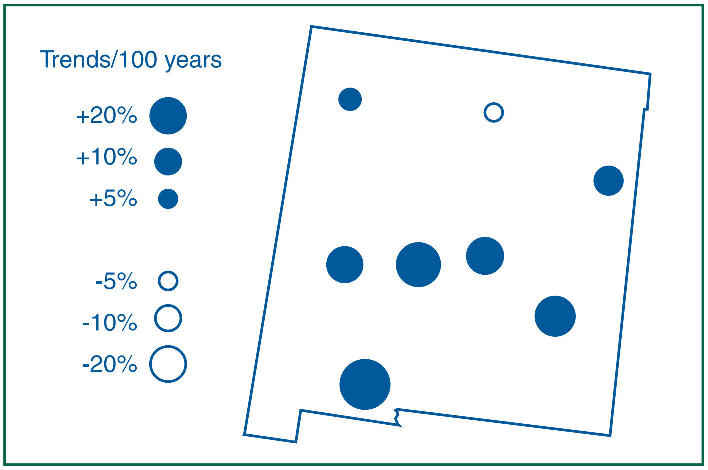
Calculations of regional climate change are much less reliable than global ones, and it is unclear whether regional climate will become more variable. The frequency and intensity of some extreme weather of critical importance to ecological systems (droughts, floods, frosts, cloudiness, the frequency of hot or cold spells, and the intensity of associated fire and pest outbreaks) could increase.

Local Climate Changes

Over the last century, the average temperature near Albuquerque, New Mexico, has decreased 0.8°F, and precipitation has increased by up to 20% in many parts of the state. These past trends may or may not continue into the future.

Over the next century, climate in New Mexico could experience additional changes. For example, based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model (HadCM2), a model that accounts for both greenhouse gases and aerosols, by 2100 temperatures in New Mexico could increase by 3°F in spring (with a range of 1-5°F), 4°F in fall (with a range of 2-7°F), and 5°F in winter and summer (with a range of 2-9°F). Precipitation is estimated to decrease slightly (with a range of 0 to -10%) in summer, to increase slightly in fall (with a range of 0-10%), to increase by 15% in spring (with a range of 5-25%), and to increase by 30% in winter (with a range of 15-60%). Other climate models may show different results, especially regarding estimated changes in precipitation. The impacts described in the sections that follow take into account estimates from different models. The amount of precipitation on extreme wet or snowy days in winter is likely to increase. The frequency of extreme hot days in summer would increase because of the general warming trend. It is not clear how the severity of storms might be affected, although an increase in the frequency and intensity of winter storms is possible. There also could be an increase in the frequency of summer thunderstorms associated with monsoonal moisture flow from the Gulf of Mexico.

Precipitation Trends From 1900 To Present



Source: Karl et al. (1996)

Human Health

Higher temperatures and increased frequency of heat waves may increase the number of heat-related deaths and the incidence of heat-related illnesses. The elderly, particularly those living alone, are at greatest risk. These effects have been studied only for populations living in urban areas; however, even those in rural areas may be susceptible.

Upper and lower respiratory allergies are influenced by humidity. A 2°F warming and wetter conditions could increase respiratory allergies.

Infected individuals can bring malaria to places where it does not occur naturally. Also, mosquitoes in New Mexico can carry malaria. If conditions become warmer and wetter, mosquito populations could increase, thus increasing the risk of transmission if this and other diseases are introduced into the area. Increased runoff from heavy rainfall could increase water-borne diseases such as giardia, cryptosporidia, and viral and bacterial gastroenteritides. Developed countries such as the United States should be able to minimize the impacts of these diseases through existing disease prevention and control methods.

Rodent-borne diseases are prevalent in New Mexico, and upsurges of rodent populations have been associated with extreme events and in particular the El Niño Southern Oscillation phenomenon. In 1993, hantavirus pulmonary syndrome emerged in New Mexico, and the deer mice that are the primary reservoir for hantaviruses are prevalent in New Mexico. Long droughts punctuated by heavy rains can decrease the predators (owls, snakes, and coyotes) of rodents, and the heavy rains can provide the rodents with added food supplies (grasshoppers and piñon nuts).

Water Resources

Groundwater is the principal source of water for public, industrial, and agricultural uses in New Mexico. Irrigation, the largest user of water, relies on groundwater and surface water supplies. Except in mountainous areas, many streams run dry at some time of the year. Reservoirs on the larger perennial rivers, including the Rio Grande, Pecos, and San Juan rivers, provide storage to reduce the variation in streamflow and the severity of floods.

Much of streamflow in New Mexico results from spring and summer rainfall and snowmelt in the mountains. In nonmountainous regions, runoff results from short, intense rainstorms. A warmer climate could mean less winter snowfall, more winter rain, and a faster, earlier spring snowmelt. This could result in higher winter and spring flows and the inability to store flood waters for use later in the summer. Additionally, without large increases in rainfall, higher temperatures and increased evaporation could lower lake levels and streamflows in the summer. Less water would be available to distribute to the central and southern parts of the state, where adequate supplies for irrigation and municipal uses is a concern. In the densely populated middle Rio Grande Valley, which includes Albuquerque, the availability of adequate water to meet the needs of its growing population is a major issue. During years of meager snowfall, many areas must supplement surface water supplies with groundwater; however, less spring and summer recharge could lower groundwater levels. This could amplify problems in the eastern and southeastern parts of the state, where groundwater levels are declining because of large irrigation withdrawals, as well as in west-central New Mexico, where groundwater development has increased to support municipal, domestic, industrial, and agricultural uses. Lower flows and higher temperatures could also impair water quality by concentrating pollutants and reducing the capacity of streams to assimilate wastes. The limited surface waters of New Mexico are almost completely allocated through legal compacts and water-rights agreements. Tribal water rights are also an important issue. Changes in water availability could complicate the complex water rights and allocation issues in New Mexico.

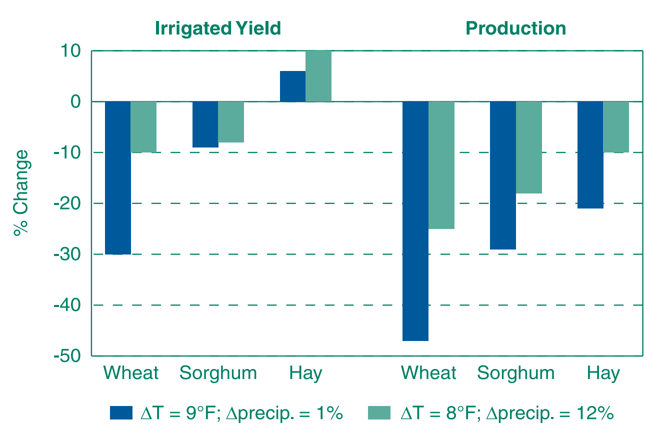
More rain could ease water competition, but it also could increase flooding. Earlier, more rapid snowmelts could contribute to winter and spring flooding, and more intense summer storms could increase the likelihood of flash floods. Increased rains also could increase erosion and pollution from runoff from mining areas, and exacerbate levels of pesticides and fertilizers from runoff from agricultural lands. Stream sedimentation is a major water quality problem in New Mexico, as is contaminated runoff from grazing lands, mining areas, urban areas, and irrigated fields.

Agriculture

The mix of crop and livestock production in a state is influenced by climatic conditions and water availability. As climate warms, production patterns could shift northward. Increases in climate variability could make adaptation by farmers more difficult. Warmer climates and less soil moisture due to increased evaporation may increase the need for irrigation. However, these same conditions could decrease water supplies, which also may be needed by natural ecosystems, urban populations, industry, and other users.

Understandably, most studies have not fully accounted for changes in climate variability, water availability, crop pests, changes in air pollution such as ozone, and adaptation by farmers

Changes In Agricultural Yield And Production



Sources: Mendelsohn and Neumann (in press); McCarl (personal communication) to changing climate. Including these factors could change modeling results substantially. Analyses that assume changes in average climate and effective adaptation by farmers suggest that aggregate U.S. food production would not be harmed, although there may be significant regional changes.

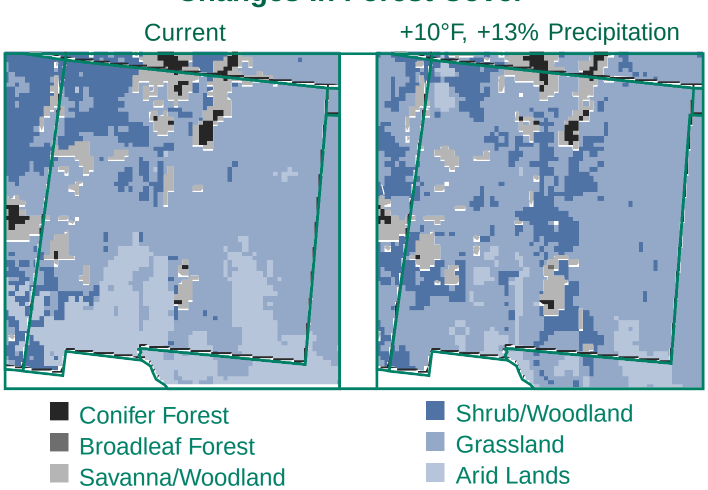
In New Mexico, production agriculture is a $1.6 billion annual industry, two-thirds of which comes from livestock, mainly cattle. More than one-half of the farmed acres are irrigated. The major crops in the state are sorghum, wheat, and hay. Climate change could reduce wheat yields by 10-30% and sorghum yields by 7-9% as temperatures rise beyond the tolerance levels of the crop. Hay and pasture yields could fall by 4% or rise by 9%, depending on how climate changes and the extent of irrigation. Farmed acres could fall by 20-25% as a result of climate change. Livestock production may not be affected, unless summer temperatures rise significantly and conditions become significantly drier. Under these conditions, livestock tend to gain less weight and pasture yields decline, limiting forage.

Forests

Trees and forests are adapted to specific climate conditions, and as climate warms, forests will change. These changes could include changes in species composition, geographic range, and health and productivity. If conditions also become drier, the current range and density of forests could be reduced and replaced by grasslands and pasture. Even a warmer and wetter climate could lead to changes; trees that are better adapted to these conditions, such as fir and spruce, would thrive. Under these conditions, forests could become more dense. These changes could occur during the lifetimes of today's children, particularly if the change is accelerated by other stresses such as fire, pests, and diseases. Some of these stresses would themselves be worsened by a warmer and drier climate.

With changes in climate, the extent of forested areas in New Mexico could change little or decline by as much as 15-30%. The uncertainties depend on many factors, including whether soils become drier and, if so, how much drier. Hotter, drier weather could increase the frequency and intensity of wildfires,

Changes In Forest Cover



Sources: VEMAP Participants (1995); Neilson (1995)

threatening both property and forests. Drier conditions would reduce the range and health of ponderosa and piñon-juniper forests, and increase their susceptibility to fire. Grassland, rangeland, and even desert could expand into previously forested areas in the northern part of the state and those found at higher elevations. Milder winters could increase the likelihood of insect outbreaks and of subsequent wildfires in the dead fuel left after such an outbreak. These changes would significantly affect the character of New Mexico forests and the activities that depend on them. However, increased rainfall could reduce the severity of these effects.

Ecosystems

A wide variety of ecosystems are found in New Mexico, including the Chihuahuan Desert, Great Plains grassland, Great Basin shrub-steppe, piñon-juniper woodland, bosque riparian forests and wetlands, ponderosa pine forests, mixed-conifer montane forests, and subalpine forests and meadows. Narrow strips of riparian vegetation throughout the state are extremely important to wildlife, especially the endangered cactus ferruginous pygmy owl, southwestern willow flycatcher, masked bobwhite quail, Mexican spotted owl, and southern nesting bald eagle. Bitter Lake, in the southeastern part of the state, is an oasis at the edge of the desert, providing habitat for snow geese, sandhill cranes, endangered interior least terns, and thousands of other birds. Mountaintop habitats in the Chihuahuan Desert are isolated from one another and have remarkably different species because their biotic communities have evolved in distinct ways over time. For example, more than 2,000 plant species thrive in this area at the intersection of Arizona, New Mexico, and Mexico, nearly 10% of all the species found in the United States.

The destruction of riparian areas, primarily through overwhelming pressures for water resources and overgrazing, is the single most important factor threatening and endangering many species of fish and wildlife in New Mexico. For example, the Gila River is the only U.S. river basin with all 47 of its freshwater fish species extinct, listed as threatened or endangered, or recommended as candidates of such listings. Climate change could exacerbate these existing threats. The narrow riparian habitat bands would be greatly influenced by decreased water availability. This could ultimately alter avian species number and community composition, with the loss of many species that rely on riparian vegetation for nesting and food resources, such as the endangered southwestern willow flycatcher and Mexican spotted owl. Warmer water temperatures could adversely affect habitat conditions for already endangered fish, and favor the spread of exotic species that are imperiling the survival of New Mexico's native fish species. In desert areas, many plants and animals already live near their tolerance limits and may be unable to survive under hotter conditions. Mountaintop island habitats are equally vulnerable to changing conditions. Whereas other ecosystems may have room to migrate in response to warming temperatures, those in mountain areas could have little room to move upslope.

For further information about the potential impacts of climate change, contact the Climate and Policy Assessment Division (2174), U.S. EPA, 401 M Street SW, Washington, DC 20460, or visit http://www.epa.gov/globalwarming/impacts.