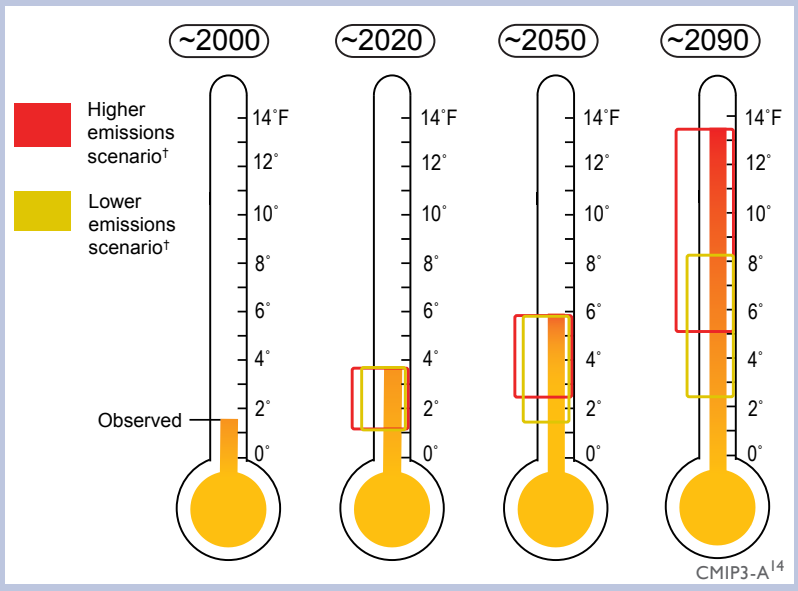
Great Plains

The Great Plains is characterized by strong seasonal climate variations. Over thousands of years, records preserved in tree rings, sediments, and sand deposits provide evidence of recurring periods of extended drought (such as the Dust Bowl of the 1930s) alternating with wetter conditions[1].

Today, semi-arid conditions in the western Great Plains gradually transition to a moister climate in the eastern parts of the region. To the north, winter days in North Dakota average 25°F, while a typical West Texas winter day sees temperatures over 60°F. In West Texas, there are between 70 and 100 days per year over 90°F, whereas North Dakota has only 10 to 20 such days on average.

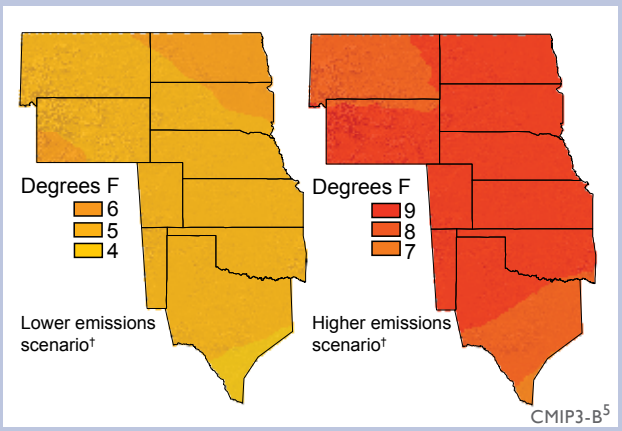
Observed and Projected Temperature Rise



The average temperature in the Great Plains already has increased roughly 1.5°F relative to a 1960s and 1970s baseline. By the end of the century, temperatures are projected to continue to increase by 2.5°F up to more than 13°F compared to the 1960–1979 baseline, depending on future emissions of heat-trapping gases. The brackets on the thermometers represent the likely range of model projections, though lower or higher outcomes are possible.

Significant trends in regional climate are apparent over the last few decades. Average temperatures have increased throughout the region, with the largest changes occurring in winter months and over the northern states. Relatively cold days are becoming less frequent and relatively hot days more frequent[2]. Precipitation also has increased over most of the area[3,4].

Summer Temperature Change by 2080-2099



Temperatures in the Great Plains are projected to increase significantly by the end of this century, with the northern part of the region experiencing the greatest projected increase in temperature.

Temperatures are projected to continue to increase over this century, with larger changes expected under scenarios of higher heat-trapping emissions as compared to lower heat-trapping emissions. Summer changes are projected to be larger than those in winter. Precipitation also is projected to change, particularly in winter and spring. Conditions are anticipated to become wetter in the north and drier in the south.

Projected changes in long-term climate and more frequent extreme events such as heat waves, droughts, and heavy rainfall will affect many critical aspects of life in the Great Plains. These include the region's already threatened water resources, essential agricultural and ranching activities, unique natural and protected areas, and the health and prosperity of its inhabitants.

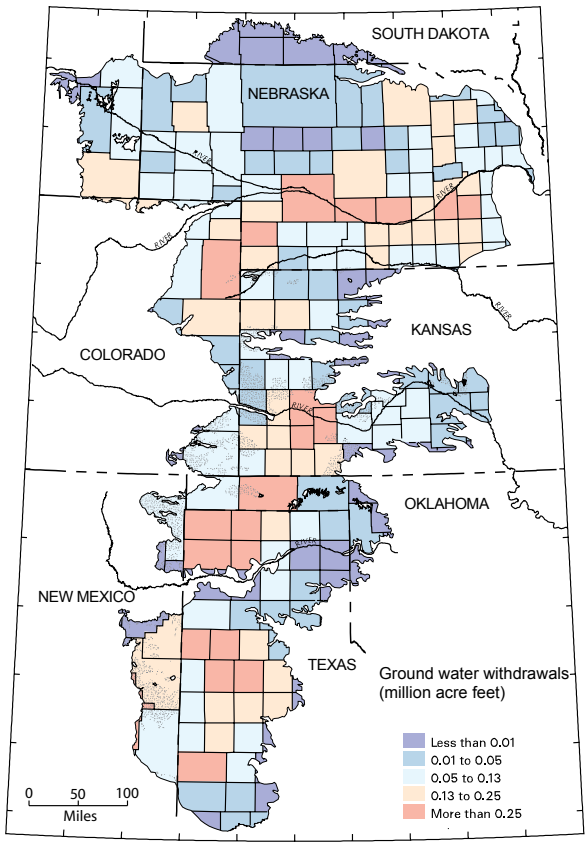
Projected increases in temperature, evaporation, and drought frequency exacerbate concerns regarding the region's declining water resources.

Water is the most important element affecting activities on the Great Plains. Most of the water used in the Great Plains comes from the High Plains aquifer, which stretches from South Dakota to Texas. The aquifer holds both current recharge from precipitation and so-called "ancient" water, water trapped by silt and soil washed down from the Rocky Mountains during the last ice age.

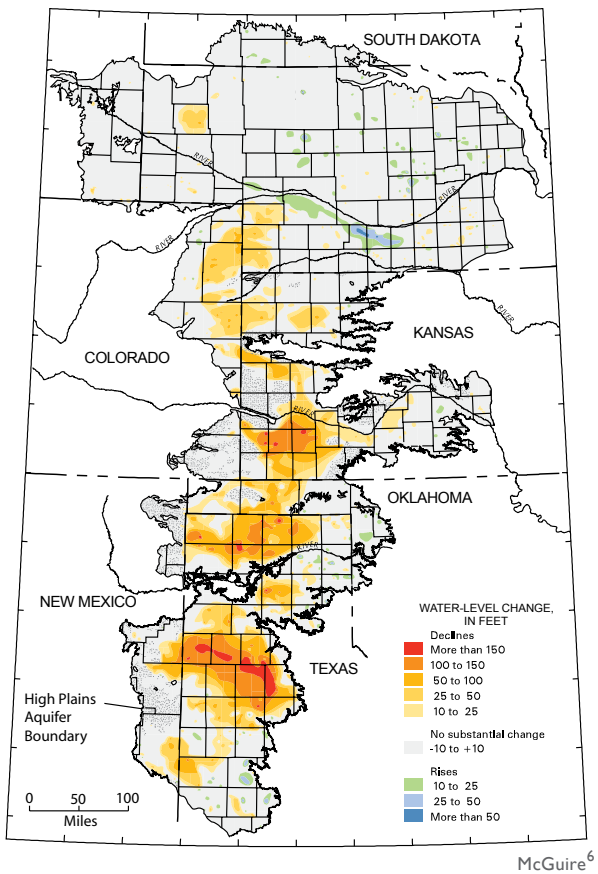
As population increased in the Great Plains and irrigation became widespread, annual withdrawals began to outpace natural recharge[6]. Today, an average of 19 billion gallons of groundwater are pumped from the aquifer each day. This water irrigates 13 million acres of land and provides drinking water to over 80 percent of the region's population[7]. Since 1950, aquifer water levels have dropped an average of 13 feet, equivalent to a 9 percent decrease in aquifer storage. In heavily irrigated parts of Texas, Oklahoma, and Kansas, reductions are much larger, from 100 feet to over 250 feet.

Projections of increasing temperatures, faster evaporation rates, and more sustained droughts brought on by climate change will only add more stress to overtaxed water sources[4,8–10]. Current water use on the Great Plains is unsustainable, as the High Plains aquifer continues to be tapped at rates greater than it is being recharged.

Groundwater Withdrawals for Irrigation
1950 to 2005



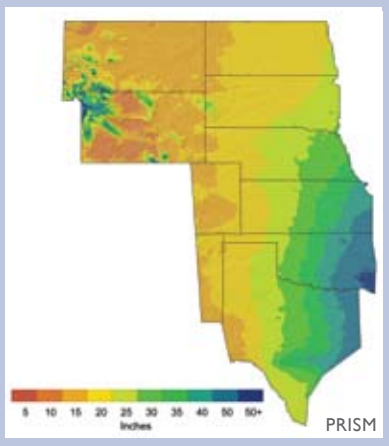
Water Level Changes in the High Plains Aquifer
1950 to 2005



McGuire[6]

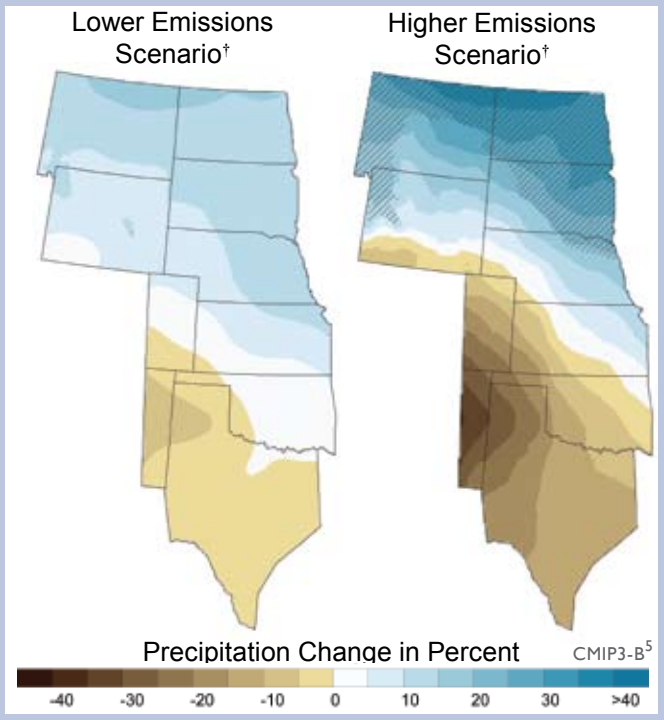
Irrigation is one of the main factors stressing water resources in the Great Plains. In parts of the region, more than 81 trillion gallons of water (pink areas on the irrigation map) were withdrawn for irrigation in Texas, Oklahoma, and Kansas from 1950 to 2005. During the same time period, water levels in parts of the High Plains aquifer in those states decreased by more than 150 feet (red areas on the water level change map).

Observed Annual Average Precipitation
past 50 years



During the past 50 years, the Great Plains has had more precipitation in the east than in the west, ranging from 10 inches per year in parts of southwestern Wyoming to more than 50 inches per year in southeastern Oklahoma.

Projected Spring Precipitation Change by 2080s and 2090s



Northern areas of the Great Plains are projected to experience a wetter climate by the end of this century, while southern areas are projected to experience a drier climate. The change in precipitation is compared to a 1960-1979 baseline. Hatching indicates areas with higher confidence.

The Dust Bowl: Combined Effects of Land Use and Climate

Over the past century, large-scale conversion of grasslands to crops and ranchland has altered the natural environment of the Great Plains[4]. Irrigated fields have increased evaporation rates, reducing summer temperatures and increasing local precipitation[11,12].

Dust bowl of 1935 in Stratford, Texas.

The Dust Bowl of the 1930s epitomizes what can happen as a result of interactions between climate and human activity. In the 1920s, increasing demand for food encouraged poor agricultural practices. Small-scale producers ploughed under native grasses to plant wheat, removing the protective cover the land required to retain its moisture.

Variations in ocean temperature contributed to a slight increase in air temperatures, just enough to disrupt the winds that typically draw moisture from the south into the Great Plains. As the intensively tilled soils dried up, topsoil from an estimated 100 million acres of the Great Plains blew across the continent.

The Dust Bowl was a result of climate variations combined with poor land practices[13]. However, it effectively demonstrated the potentially devastating effects of combining climate change and human choices made without consideration of resources.

A similar trend is apparent today. Water is being pumped from the Ogallala aquifer faster than it can recharge. In many areas, playa lakes are poorly managed [see page 131]. Existing stresses on water resources in the Great Plains due to unsustainable water usage are likely to be exacerbated by future changes in temperature and precipitation, this time largely due to human-induced climate change.

Agriculture, ranching, and natural lands, already under pressure due to an increasingly limited water supply, also will be stressed by rising temperatures.

Agricultural, range, and croplands cover more than 70 percent of the Great Plains, producing wheat, hay, corn, barley, cattle, and cotton. Agriculture is fundamentally sensitive to climate. Heat and water stress from droughts and heat waves can decrease yields and wither crops[15,16]. The influence of long-term trends in temperature and precipitation can be just as great[16].

As temperatures increase over the coming century, optimal zones for growing particular crops will shift. Pests that were historically unable to survive in the Great Plains' cooler areas are expected to spread northward. Milder winters and earlier springs also will encourage greater numbers and earlier emergence of insects[4]. Rising carbon dioxide levels in the atmosphere can increase crop growth, but also make some types of weeds grow even faster[17].

Projected increases in precipitation are unlikely to be sufficient to offset decreasing soil moisture and water availability in the Great Plains due to rising temperatures and aquifer depletion. In some areas, there is not expected to be enough water for agriculture to sustain even current usage.

With limited water supply comes an increased vulnerability of agriculture to climate change. Further stresses on water supply for agriculture and ranching are likely as the region's cities continue to grow, increasing competition between urban and rural users[18]. The largest impacts are expected in heavily irrigated areas in the southern Great Plains, already plagued by unsustainable water use and greater frequency of extreme heat[4].

Successful adaptation will require diversification of crops and livestock, as well as transitions from irrigated to rain-fed agriculture[19–21]. Producers who can adapt to changing climate conditions are likely to see their businesses survive; some might even thrive. Others, without resources or ability to adapt effectively, will lose out.

Climate change is likely to affect native plant and animal species by altering key habitats such as the wetland ecosystems known as prairie potholes or playa lakes.

Ten percent of the Great Plains is protected lands, home to unique ecosystems and wildlife. The region is a haven for hunters and anglers, with its ample supplies of wild game such as moose, elk, and deer; birds such as goose, quail, and duck; and fish such as walleye and bass.

Climate-driven changes are likely to combine with human stresses to further increase the vulnerability of natural ecosystems to pests, invasive species, and loss of native species. Changes in temperature and precipitation affect the composition and diversity of native animals and plants through altering their breeding patterns, water and food supply, and habitat availability[4]. In a changing climate, populations of some pests such as red fire ants and rodents, better adapted to a warmer climate, are projected to increase[22,23]. Grassland and plains birds, already besieged by habitat fragmentation, could experience significant shifts and reductions in their range[24].

Urban sprawl, agriculture, and ranching practices already threaten the Great Plains' distinctive wetlands. Many of these are home to endangered and iconic species. In particular, prairie wetland ecosystems provide crucial habitat for migratory waterfowl and shorebirds.

Mallard ducks are one of the many species that inhabit the playa lakes, also known as prairie potholes.

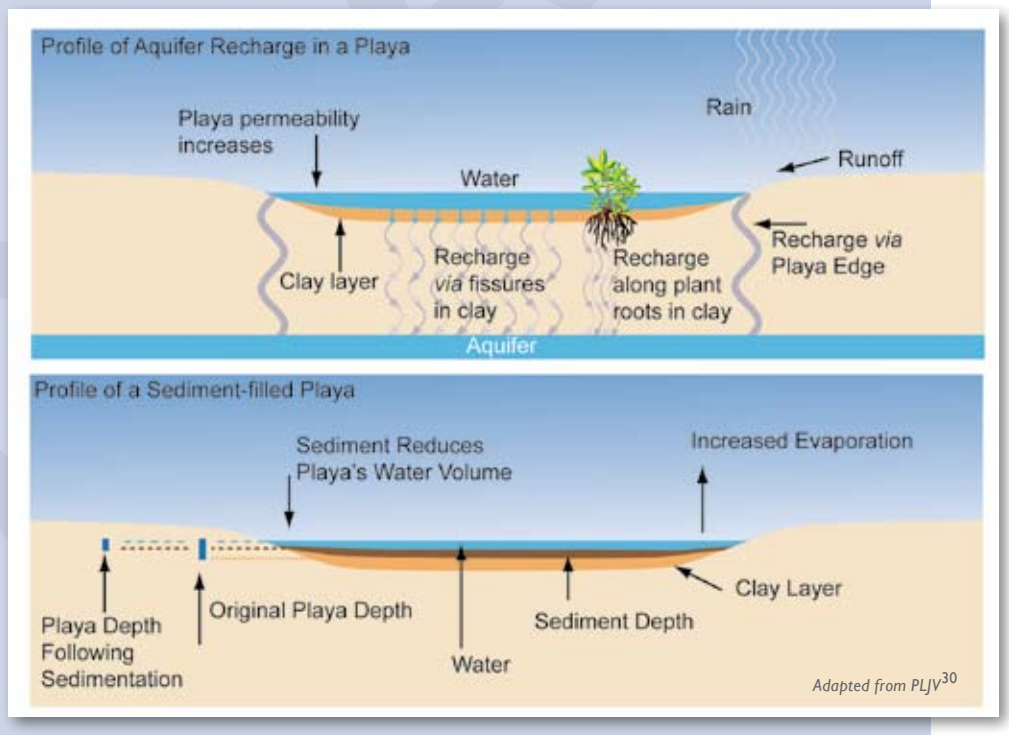
Playa Lakes and Prairie Potholes

Shallow ephemeral lakes dot the Great Plains, anomalies of water in the arid landscape. In the north they are known as prairie potholes; in the south, playa lakes. Playa lakes create unique microclimates that support diverse wildlife and plant communities. A playa can lie with little or no water for long periods, or have several wet/dry cycles each year. When it rains, what appeared to be only a few clumps of short, dry grasses just a few days earlier suddenly teems with frogs, toads, clam shrimp, and aquatic plants.

Playa lakes

The playas provide a perfect home for migrating birds to feed, mate, and raise their young. Millions of shorebirds and waterfowl, including Canada geese, mallard ducks, and Sandhill cranes, depend on the playas for their breeding grounds. From the prairie potholes of North Dakota to the playa lakes of West Texas, the abundance and diversity of native bird species directly depends on these lakes[25,26].

Despite their small size, playa lakes and prairie potholes also play a critical role in supplying water to the Great Plains. The contribution of the playa lakes to this sensitively balanced ecosystem needs to be monitored and maintained in order to avoid unforeseen impacts on our natural resources. Before cultivation, water from these lakes was the primary source of the recharge to the High Plains aquifer[27]. But many playas are disappearing and others are threatened by growing urban populations, extensive agriculture, and other filling and tilling practices[28]. In recent years, agricultural demands have drawn down the playas to irrigate crops. Agricultural waste and fertilizer residues drain into playas, decreasing the quality of the water, or clogging them so the water cannot trickle down to refill the aquifer. Climate change is expected to add to these stresses, with increasing temperatures and changing rainfall patterns altering rates of evaporation, recharge, and runoff to the playa lake systems[29].



Ongoing shifts in population from rural to urban centers are expected to increase the vulnerability of Great Plains inhabitants to climate change.

Inhabitants of the Great Plains include a rising number of urban dwellers, a long tradition of rural communities, and extensive Native American populations. Although farming and ranching remain primary uses of the land—taking up much of the region's geographical area—growing cities provide housing and jobs for more than two-thirds of the population. For everyone on the Great Plains, though, a changing climate and a limited water supply are likely to challenge their ability to thrive, leading to conflicting interests in the allocation of increasingly scarce water resources[18,31].

Native American communities

The Great Plains region is home to 65 Native American tribes. Native populations on rural tribal lands have limited capacities to respond to climate change[31]. Many reservations already face severe problems with both water quantity and quality—problems likely to be exacerbated by climate change and other human-induced stresses.

Rural communities

As young adults migrate out of these communities, they are increasingly populated by a vulnerable demographic of very old and very young, placing them more at risk for health issues than urban communities. Combined effects of changing demographics and climate are likely to make it more difficult to supply adequate and efficient public health services and educational opportunities to rural areas. Climate-driven shifts in optimal crop types and increased risk of drought, pests, and extreme events will add more economic stress and tension to traditional communities[15,18].

Urban populations

Although the Great Plains is not yet known for its large cities, many mid-sized towns throughout the region are growing rapidly. One in four of the most rapidly growing cities in the nation is located in the Great Plains[32] (see *Society* sector). Most of these growing centers can be found in the southern parts of the region, where water resources are already seriously constrained. Urban populations, particularly the young, elderly, and economically disadvantaged, also might be disproportionately affected by heat[33].

New opportunities

There is growing recognition that the enormous wind power potential of the Great Plains could provide new avenues for future employment and land use. Texas already produces the most wind power of any state. Wind energy production also is prominent in Oklahoma. North and South Dakota have rich wind potential[34].

Adaptation: Options for Agriculture

As climate change creates new environmental conditions, effective adaptation strategies become increasingly essential to ecological and socioeconomic survival. A great deal of the Great Plains' adaptation potential might be realized through agriculture. For example, plant species that mature earlier and are more resistant to disease and pests are more likely to thrive under warmer conditions. Other emerging adaptation strategies include dynamic cropping systems and increased crop diversity. In particular, mixed cropping-livestock systems maximize available resources while minimizing the need for external inputs such as irrigation that draws down precious water supplies[21]. In many parts of the region, diverse cropping systems and improved water use efficiency will be key to sustaining crop and rangeland systems[35]. Reduced water supplies might cause some farmers to alter the intensive cropping systems currently in use[36,37].