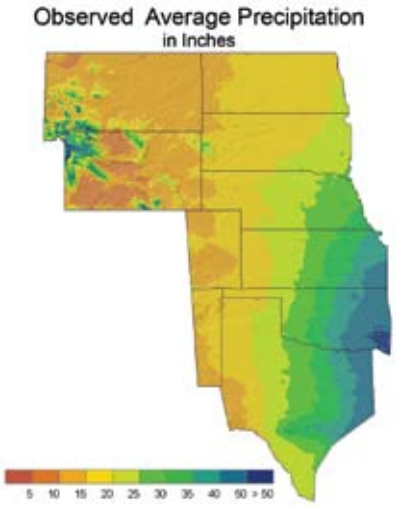
Great Plains

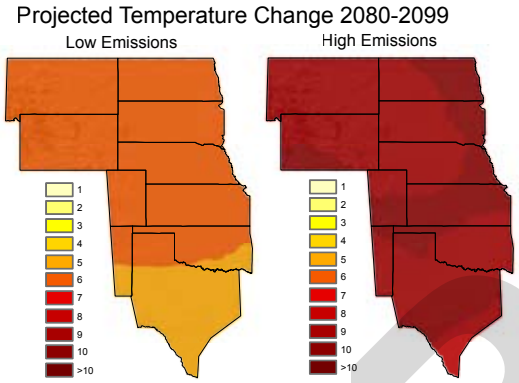


The Great Plains is characterized by strong climate variations. Over thousands of years, records preserved in tree rings, sediments, and sand deposits provide evidence of recurring periods of extended drought (like the Dust Bowl of the 1930s) alternating with wetter conditions[1].

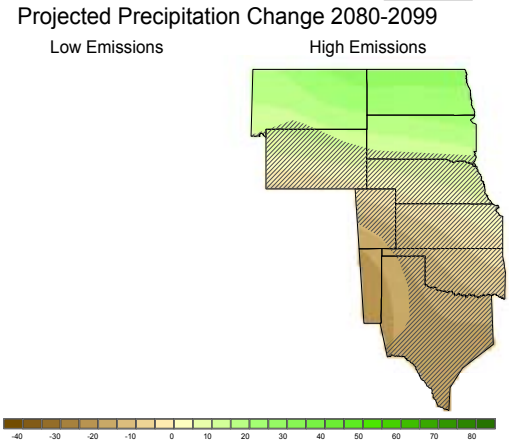
Today, semi-arid conditions in the western Great Plains gradually transition to a moister climate in the east. Temperatures range from very cold in the north, where North Dakota winters average 10°F, to very hot in the south, where West Texas sees more than 100 days per year over 90°F.

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

Over the coming century, temperatures are projected to continue to increase, with the amount of increase depending on future emissions of heat-trapping gases. By the end of the century, much greater changes are expected under higher emissions than lower, and summer changes are projected to be larger than those in winter. Precipitation is also projected to change, particularly in winter and spring. Conditions are anticipated to become wetter in the north, and drier in the south.

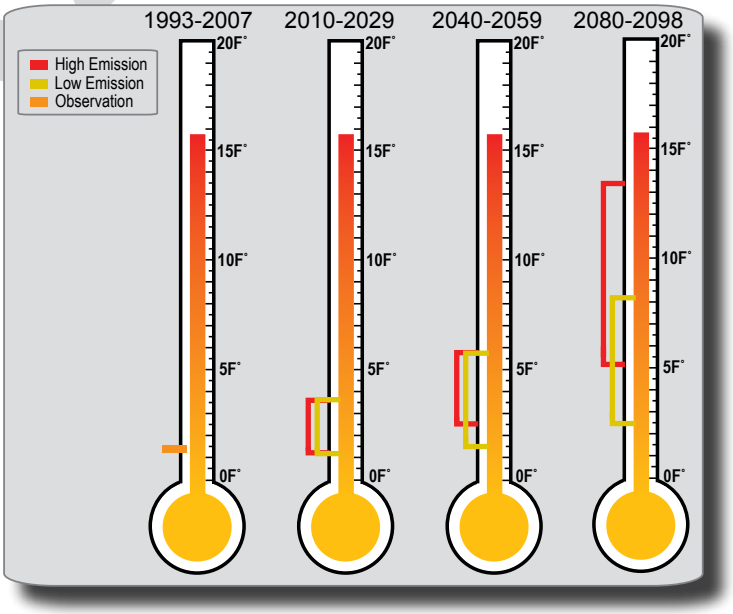


Projected change in summer temperature (°F)



Projected percentage change in spring precipitation. Hatched areas are less certain.

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.



The Dust Bowl: combined affects of human activities and climate

Over the past century, large-scale conversion of grasslands to crop and ranch land has altered the natural environment of the Great Plains. Irrigated fields have increased evaporation rates, reducing summer temperatures and increasing local precipitation[4,5].

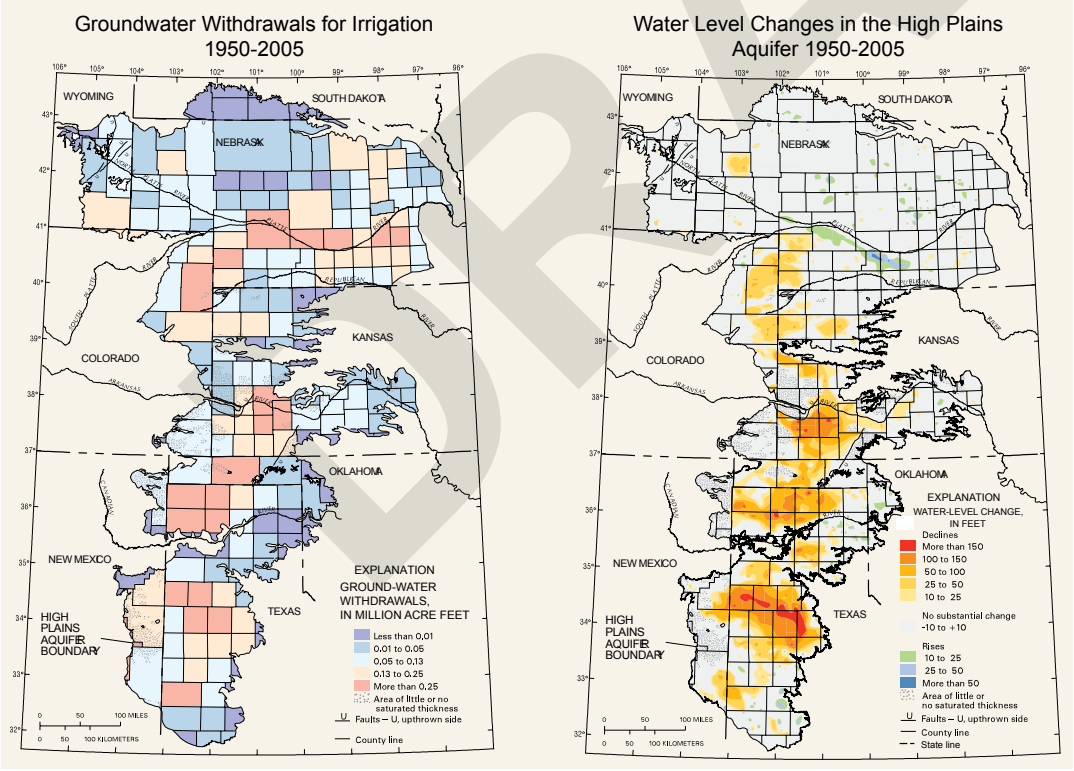
The dustbowl of the 1930s is an extreme example of what can happen as a result of interactions between climate and human activity. In the 1920s, increasing demand for food encouraged poor agricultural practices. Small-scale producers ploughed under native grasses to plant wheat, removing the protective cover the land required to retain its moisture. Natural variations in the ocean then caused temperatures to increase slightly, just enough to disrupt the winds that typically draw moisture north from Mexico 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 dustbowl resulted from natural climate changes, combined with poor land practices[6]. 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 in regional water use.

Projections of increasing temperature, evaporation, and drought frequency exacerbate concerns regarding the availability of water in a region dependent on a declining groundwater source.

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 (Figure 4). The aquifer holds so-called "ancient" water, water trapped by silt and soil washed down from the Rocky Mountains during the last ice age.

Initially, water from the aquifer was seen as a last resort, to be used only when the rains failed. As irrigation became a way of life in the Great Plains, however, annual withdrawals soon began to outpace natural recharge[7].

Today, an average of 19 billion gallons of ground water 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[8]. Since 1950, aquifer water levels have dropped an average of 13 feet. In heavily irrigated parts of Texas, Oklahoma, and Kansas, reductions are much larger, from 100 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. 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.

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

The Great Plains is the agricultural heartland of the nation. Range and croplands cover more than 70 percent of the region, producing wheat, hay, corn, barley, cattle, and cotton. Agriculture is fundamentally sensitive to climate. Heat and water stress from droughts, floods, and heat waves can decrease yields and wither crops[9]. The influence of long-term trends in temperature and precipitation can be just as great[10].

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. Rising carbon dioxide levels in the atmosphere can increase crop growth, but also make some types of weeds grow even faster[11].

Projected increases in precipitation are unlikely to be sufficient to offset decreasing 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 current usage.

Adaptation Strategies

Successful adaptation will require diversification of crops and livestock, as well as transitions from irrigated to rain-fed agriculture[13,14]. Producers who can adapt to changing climate conditions will likely survive; some may even thrive. Others, without resources or ability to adapt, will lose out.

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[12]. 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.

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 fishermen, with its ample supplies of moose, elk, and deer, goose, quail, and duck, and 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. In a changing climate, populations of some pests that are better adapted to a warmer climate, such as red fire ants and rodents, are projected to increase[15,16]. Grassland and plains birds, already besieged by habitat fragmentation, could experience significant shifts and reductions in their range[17].

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

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 Native American populations and a rising number of urban dwellers. Though rural populations are declining, there is a long tradition of rural communities. 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[12].

Native American communities: The Great Plains is home to 65 Native American tribes. 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: These communities, increasingly populated by a vulnerable demographic of very old and very young, tend to be 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[9,12].

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. Most of these growing centers can be found in the south, where water resources are already challenged. Urban populations, particularly the young, elderly, and economically disadvantaged, may also be disproportionately affected by heat[24].

A number of cities in the Great Plains have identified ways they expect climate change to affect them. Some have designed and begun implementing ways to reduce their community's emissions of heat-trapping gases. For example, Austin, Texas has launched an aggressive campaign to become "carbon neutral" by 2020 through powering all city facilities and vehicles with renewable and alternative energy sources, requiring new housing to use no net energy that emits heat-trapping gases, and initiating community programs to help residents reduce emissions.

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 and toads, clam shrimp, and aquatic plants.

The playas provide a perfect home for migrating birds to feed, mate, and rest. Millions of shorebirds and waterfowl depend on the playas for their breeding grounds, including Canada geese, mallard ducks, and Sandhill cranes. 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[18,19].

Despite their small size, playa lakes and prairie potholes also play a critical role in supplying water to the Great Plains. Before cultivation, water from these lakes was the primary source of the recharge to the High Plains aquifer[20]. But many playas are disappearing and others are threatened by growing urban populations, extensive agriculture, and other filling and tilling practices[21]. 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 stressors, with increasing temperatures and changing rainfall patterns altering rates of evaporation, recharge, and runoff to the playa lake systems[22].