CLIMATE IMPACTS – GREAT PLAINS

From the Adaptation Workbook: www.adaptationworkbook.org/explore-impacts

This region was defined in the National Climate Assessment (2014) and includes the states of Kansas, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming. For more details, see: National Climate Assessment (2018) - Northern Great Plains and National Climate Assessment (2018) - Southern Great Plains.

Summary of Climate Impacts (details and citations on subsequent pages):

Temperatures in the Great Plains are projected to increase by 3.5 to 9.5 degrees Fahrenheit by 2085.

By the middle of the century, the Great Plains region is expected to experience between 10 and 30 more days per year with a maximum temperature exceeding the current hottest 2% of days.

The Great Plains region is expected to experience between 0 and 25 fewer days per year with a minimum temperature below 10 degrees Fahrenheit by the middle of the century.

Climate conditions may slightly increase wildfire risks in in the Great Plains by the end of the century.

By the end of the century, average annual precipitation is projected to increase slightly in northern Great Plains, but may decrease in the southern Great Plains.

The number of days per year with more than 1 inch of precipitation will increase across the Great Plains by the middle of the century.

A majority of climate models suggest that precipitation in the Great Plains will increase in the winter, spring, and fall by the end of the century, but most models project that summer precipitation may decrease.

The freeze-free season is expected to increase by 15 to 30 days in the Great Plains by the middle of the century.

Longer growing seasons, warmer temperatures, and greater water demand for agriculture may reduce available water for natural ecosystems.

Climate change will amplify many existing stressors to forests in the Great Plains, such as invasive species, insect pests and pathogens, and disturbance regimes.

Low-diversity systems are at greater risk from climate change.

Systems that are more tolerant of disturbance have less risk of declining on the landscape

Species in fragmented landscapes will have less opportunity to migrate in response to climate change.

Systems that are limited to particular environments will have less opportunity to migrate in response to climate change.

Temperatures in the Great Plains are projected to increase by 3.5 to 9.5 degrees Fahrenheit by 2085.

All climate models agree that temperatures are projected to increase over the 21st century across the Great Plains, with almost uniform temperature increases across the entire region. The greatest warming is expected in the northern Plains, especially the Dakotas. In winter, the greatest warming is expected in northern states. Springtime warming is generally smaller than winter warming, with the largest increases occuring in southwest Texas. Summer shows a large amount of warming, with a localized maximum in southwest Kansas.

K. Kunkel, L. Stevens, and others. 2014. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Climate of the U.S. Great Plains. U.S. Global Change Research Program.

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For an average of seven days per year, maximum temperatures reach more than 100 degrees F in the Southern Plains and about 95 degrees F in the Northern Plains. By the middle of the century, Central Texas north to the Dakotas may experience an increase of 10-20 more hot days per year. East Texas, Wyoming, and western Montana are projected to have 22-30 more hot days by the middle of the century, according to a range of climate scenarios. Similar increases are expected in the number of nights with minimum temperatures higher than 80 degrees F in the south and 60 degrees F in the north.

M. Shafer, D. Ojima, and others. 2014. National Climate Assessment – Great Plains. U.S. Global Change Research Program.

The Great Plains region is expected to experience between 0 and 25 fewer days per year with a minimum temperature below 10 degrees Fahrenheit by the middle of the century.

The largest decreases are expected in the northern half of the region. The smallest decrease in cold days is expected in Oklahoma and Texas, where these kinds of cold days rarely occur. Similarly, the region is expected to have up to 32 fewer days with a minimum temperature below 32 degrees by the middle of the century, particularly in western Montana, Wyoming, and the western edges of Nebraska, Kansas, Oklahoma, and Texas.

K. Kunkel, L. Stevens, and others. 2014. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Climate of the U.S. Great Plains. U.S. Global Change Research Program.

Climate conditions may slightly increase wildfire risks in in the Great Plains by the end of the century.

Different modeling approaches generally conclude that future climate conditions will increase the risk of wildfire across the Great Plains. Annual fire probability, calculated solely with climate data and physical principles, is projected to increase by 20% to 1200% across the region by the end of the century, with the largest increases occuring in Wyoming and western Montana. Fire probability may decrease in Texas, however. The incidence of atmospheric conditions that contribute to large and erratic fire behavior, measured by the Haines Index, is also projected to occur more frequently (2 to 11 percent increase) by the end of the century, again with the largest increases the northern Plains and Wyoming in particular. The limitation for these sorts of projections is that they do not account for changes in land use, fire suppression rates, or vegetation changes.

Y. Tang, S. Zhong, and others. 2015. The Potential Impact of Regional Climate Change on Fire Weather in the United States. Annals of the Association of American Geographers.

R. Guyette, F. Thompson, and others. 2014. Future Fire Probability Modeling with Climate Change Data and Physical Chemistry. Forest Science.

By the end of the century, average annual precipitation is projected to increase slightly in northern Great Plains, but may decrease in the southern Great Plains.

There is uncertainty between different climate scenarios for future precipitiation projections in the Great Plains. Generally, there is a south-to-north gradient in annual precipitation projections, with increases projected north of the Nebraska-North Dakota border and decreases projected from Kansas to Texas.

K. Kunkel, L. Stevens, and others. 2014. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Climate of the U.S. Great Plains. U.S. Global Change Research Program.

The number of days per year with more than 1 inch of precipitation will increase across the Great Plains by the middle of the century.

Most of the region is projected to experience 0 to 30% more days each year with more than an inch of precipitation by the middle of the century. The largest increases (up to 45% increases) in extreme precipitation are expected in North Dakota and Montana. Days with more than 2 inches, 3 inches, and 4 inches of precipitation are also expected to occur more regularly by the middle of the century.

K. Kunkel, L. Stevens, and others. 2014. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Climate of the U.S. Great Plains. U.S. Global Change Research Program.

A majority of climate models suggest that precipitation in the Great Plains will increase in the winter, spring, and fall by the end of the century, but most models project that summer precipitation may decrease.

Simulated changes in summer precipitation by the end of the century range from a 37-percent decrease to a 12-percent increase, with a mean around an 10-percent decrease. The strongest agreement for drier summers occurs in Oklahoma and west Texas. The means of several climate models indicate that winter and spring precipitation may increase around 3 percent by the end of the century, with larger increases expected in the Dakotas. Under mild climate scenarios, changes are generally smaller than in more extreme climate scenarios.

K. Kunkel, L. Stevens, and others. 2014. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Climate of the U.S. Great Plains. U.S. Global Change Research Program.

The freeze-free season is expected to increase by 15 to 30 days in the Great Plains by the middle of the century.

The freeze-free season is defined as the period of time between the last spring frost (daily minimum temperature below 32 degrees F) and the first fall frost. The length of the annual freeze-free season has been increasing since the 1980s, and all climate models agree that it will continue to increase in the future. The largest increases are projected for the high country of Wyoming and Montana.

K. Kunkel, L. Stevens, and others. 2014. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment - Climate of the U.S. Great Plains. U.S. Global Change Research Program.

Longer growing seasons, warmer temperatures, and greater water demand for agriculture may reduce available water for natural ecosystems.

Water is central to the productivity of the Great Plains. Projected increases in winter and spring precipitation in the Northern Plains may benefit productivity by increasing water availability through soil moisture reserves during the early growing season. The Northern Plains will remain vulnerable to periodic drought because much of the projected increase in precipitation is expected to occur in the cooler months while increasing temperatures will result in additional evapotranspiration. In the Central and Southern Plains, projected declines in precipitation in the south and greater evaporation everywhere due to higher temperatures will increase irrigation demand and exacerbate current stresses on natural ecosystems. Adding to climate change related stresses, growing water demands from large urban areas are also placing stresses on limited water supplies.

M. Shafer, D. Ojima, and others. 2014. National Climate Assessment – Great Plains. U.S. Global Change Research Program.

Climate change will amplify many existing stressors to forests in the Great Plains, such as invasive species, insect pests and pathogens, and disturbance regimes.

Forest ecosystems throughout the Great Plains are exposed to a range of natural, introduced, and anthropogenic stressors. High-elevation forests and semiarid riparian forests are faced with their own distinct kinds of stressors. Invasive plants, forest pests, diseases, droughts, and floods are expected to become more damaging under climate change, and these factors may interact in unpredictable ways.

J. Vose, D. Peterson, and others. 2012. Effects of Climate Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the U.S. Forest Sector.. USDA Forest Service Pacific Northwest Research Station.

Low-diversity systems are at greater risk from climate change.

Studies have consistently shown that diverse systems have exhibited greater resilience to extreme environmental conditions and greater potential to recover from disturbance than less diverse communities. This relationship makes less diverse communities inherently more susceptible to future changes and stressors. The diversity of potential responses of a system to environmental change (response diversity), is a critical component of ecosystem resilience. Response diversity is generally reduced in less diverse ecological systems. Genetic diversity within species is also critical for the ability of populations to adapt to climate change, because species with high genetic variation have better odds of producing individuals that can withstand extreme events and adapt to changes over time.

T. Elmqvist , C. Folke, and others. 2003. Response diversity, ecosystem change, and resilience. Frontiers in Ecology and the Environment.

A. Hoffman and C. Sgrò. 2011. Climate change and evolutionary adaptation. Nature.

Systems that are more tolerant of disturbance have less risk of declining on the landscape

Disturbances such as wildfire, flooding, and pest outbreaks are expected to increase in the future. Forests that are adapted to gap-phase disturbances, with stand-replacing events occurring over hundreds or thousands of years, may be less tolerant of more frequent widespread disturbances. Mesic hardwood forests can create conditions that could buffer against fire and drought to some extent, but these systems are not expected to do well if soil moisture declines significantly. Forest systems that are more tolerant of drought, flooding, or fire are expected to be better able to withstand climate-driven disturbances. This principle holds true only to a given point, because it is also possible for disturbance-adapted systems to experience too much disruption. For example, dry pine forests and woodlands might benefit from drier conditions with more frequent fire, but these systems might also convert to savannas or open grasslands if fire becomes too frequent or drought becomes too severe.

G. Nowacki and M. Abrams. 2008. The Demise of Fire and "Mesophication" of Forests in the Eastern United States. BioScience.
E. Gustafson and B. Sturtevant. 2013. Modeling Forest Mortality Caused by Drought Stress: Implications for Climate Change. Ecosystems.

Species in fragmented landscapes will have less opportunity to migrate in response to climate change.

Habitat fragmentation can hinder the ability of tree species to migrate to more suitable habitat on the landscape, especially if the surrounding area is nonforested. Modeling results indicate that mean centers of suitable habitat for tree species will migrate between 60 and 350 miles by the year 2100 under a high emissions scenario and between 30 and 250 miles under milder climate change scenarios. Based on data gathered for seedling distributions, it has been estimated that many northern tree species could possibly migrate northward at a rate of 60 miles per century. Fragmentation makes this disparity even more challenging, because the landscape is essentially less permeable to migration.

L. Iverson, M. Schwartz, and others. 2004. How fast and far might tree species migrate in the eastern United States due to climate change? Global Ecology and Biogeography.
C. Woodall, C. Oswalt, and others. 2009. An indicator of tree migration in forests of the eastern United States. Forest Ecology and Management.

Systems that are limited to particular environments will have less opportunity to migrate in response to climate change.

Some species and forest types are confined to particular habitats on the landscape, whether through requirements for hydrologic regimes, soil types, or other reasons. Similar to species occurring in fragmented landscapes, isolated species and systems face additional barriers to migration. Widespread species may also have particular habitat requirements. For example, sugar maple is often limited to soils that are rich in nutrients like calcium, so this species may actually have less available suitable habitat than might be projected solely from temperature and precipitation patterns. Riparian forests are not expected to be able to migrate to upland areas because many species depend on seasonal flood dynamics for regeneration and a competitive advantage. Similarly, lowland conifer swamps contain a unique mix of species that are adapted to low pH values, peat soils, and particular water table regimes. These species face additional challenges in migration compared to more-widespread species with broad ecological tolerances.

A. Jump and J. Peñuelas. 2005. Running to stand still: adaptation and the response of plants to rapid climate change. Ecology Letters.