2020

NC3 Nebraska Climate Summary

M. Shulski
University of Nebraska - Lincoln

NC3 Nebraska Climate Summary –

An overview of the 4th National Climate Assessment, Volume II: Impacts, Risks and Adaptation in the United States

NEBRASKA | Northern Great Plains Region

AUTHORS:
Martha Shulski, Nebraska State Climatologist
Tyler Williams, Nebraska Extension Educator

Overview

Nebraska is located in the Northern Great Plains region of the United States and is subject to an extreme, continental climate. Agriculture is a key feature of the Nebraska landscape and economy with 93% of the land devoted to agriculture, adding $21 billion to the state economy in 2017 (Nebraska Department of Agriculture, 2019). According to the U.S. Census Bureau, the July 1, 2018 population of Nebraska was 1.93 million, with nearly 1.1 million living in Lancaster, Douglas, and Sarpy counties (Lincoln and Omaha metros).

Nebraska is subject to warm summers and cold winters. The average annual temperature in Nebraska is around 50°F and has an average high of about 87°F during the month of July and an average low of about 14°F in January (Frankson, Kunkel, Stevens, & Shulski, 2017). A signature feature of the climate is year-to-year variability for both temperature and precipitation. Precipitation varies significantly across the state with a longitudinal gradient. On average, the east receives twice as much precipitation (35 inches annually) as the Nebraska Panhandle (15 inches). The wettest times of year are late spring and early summer. Winter precipitation accounts for only 7% of the annual total (Frankson et al., 2017).

The average annual temperature for Nebraska has increased 1.6°F since 1895. Temperatures have mostly been above the century-long average since 1985. The warmest years have occurred in the 2000s and the Dust Bowl era of the 1930s, and the warmest year on record was 2012. Minimum temperatures have warmed at a rate twice that of maximum temperatures (Shulski, 2018). Going forward, the average annual temperature is expected to rise by 2–5°F by the middle of the century. The projected rate of warming is much higher than what has been experienced over both the long term (since 1895) and short term (since 1985) (Shulski, 2018).

According to the Fourth National Climate Assessment: Volume II, Nebraska experiences on average roughly 15 days with a high temperature greater than 95°F. The occurrence of extreme heat is expected to double in frequency by 2050. Growing season length averages roughly 150 days but can vary significantly from year to year. The length will increase on the order of several weeks by mid-century (Hayhoe, et al., 2018).

Precipitation on a statewide basis has increased by about an inch over the past century. This is largely due to more precipitation during spring; however, the southern portions of Nebraska have experienced a recent declining precipitation trend. This area has dried by roughly an inch in the last 30 years (Hayhoe et al., 2018). Model projections point to a persistence of the general wetting trend but with changes in timing and intensity. Winter and spring totals will be 15–25% wetter than the current climate, while summer will be 5–15% drier and fall will be slightly wetter (5%) by mid-century (Hayhoe et al., 2018). Also of particular concern is the frequency of heavy precipitation events. Currently, daily rainfall greater than one inch is fewer than five days per year; however, by mid-century the prediction is for those events, as well as multi-day precipitation events, to increase by 25% (Hayhoe et al., 2018). This outlines the importance of stormwater management, flood planning and response, and soil health.

Climate and weather directly impact water, agriculture, recreation, energy, and indigenous peoples.

Annual Average Temperature (°F)

Nebraska Climate Trends

These maps show the climate trends over the long term and short term for the state's eight climate divisions on industry-standard date from the National Centers for Environmental Information on the National Oceanic Atmospheric Administration. Long term trends use data collected between 1895 to 2016; short-term trends use data from 1987 to 2016.

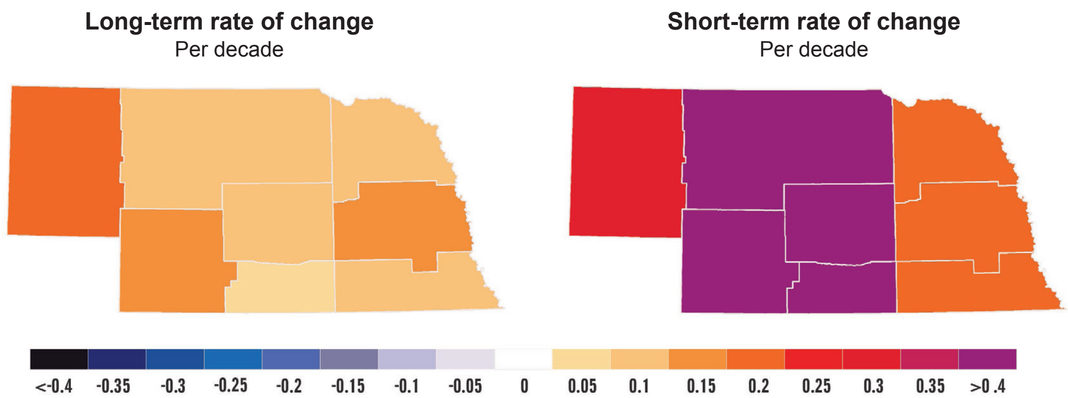


Figure 1. Trends in average annual temperature from 1895-2016 (left) and 1987-2016 (right) for the eight climate divisions in Nebraska. From the Nebraska State Climate Office, 2019.

REFERENCES

Frankson, T., Kunkel, K., Stevens, L., & Shulski, M. (2017). Nebraska state climate summary. *NOAA Technical Report NESDIS 149-NE*. Retrieved from https://statesummaries.ncics.org/chapter/ne/

Hayhoe, K., Wuebbles, D.J., Easterling, D.R., Fahey, D.W., Doherty, S., Kossin, J., . . . Wehner, M. (2018). Our changing climate. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp. 72-144). Washington DC: U.S. Global Change Research Program.

Nebraska Department of Agriculture, U.S. Department of Agriculture National Agricultural Statistics Service, Nebraska Field Office, & Nebraska Bankers Association. (2019, February). *Nebraska agriculture fact card*. Retrieved from http://www.nda.nebraska.gov/facts.pdf

Nebraska State Climate Office. (2019). *Summer Maximum Temperature (F°): Nebraska Climate Trends*. Map in preparation.

Shulski, M. (2018, December 6). *Nebraska's changing climate – Highlights from the 4th National Climate Assessment*. University of Nebraska–Lincoln Institute of Agriculture and Natural Resources Crop Watch. Retrieved from https://cropwatch.unl.

U.S. Census Bureau. (2018). Annual estimates of the resident population: April 1 to July 1 2018. Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF edu/2018/nebraska-changing-climate

AUTHORS:
Martha Shulski, Nebraska State Climatologist
Tyler Williams, Nebraska Extension Educator

WATER

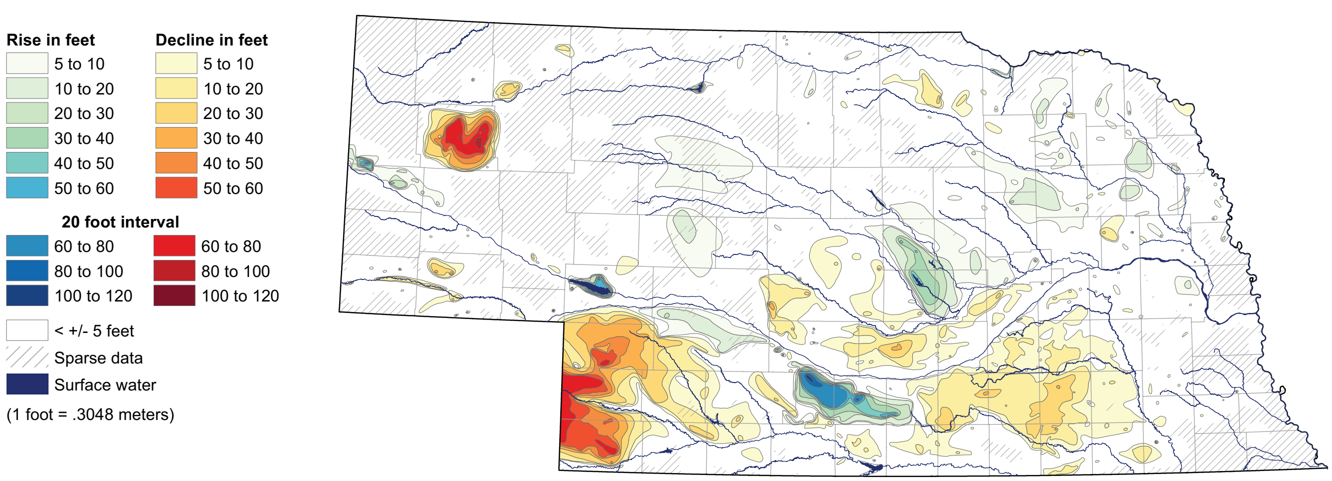
Water is a paramount natural resource for the natural and managed ecosystems and livelihood of Nebraskans. The state is situated above the High Plains Aquifer that runs from Nebraska to Texas. Located in central Nebraska, the Sandhills region (sand dunes stabilized by grass prairie) is a major recharge zone of the aquifer. Groundwater is used extensively and is managed through a local governance system organized by basin, which are called Natural Resource Districts.

Nebraska also has many rivers running primarily from northwest to southeast. The Platte River dissects Nebraska east to west, and its two tributaries, the North and South Platte Rivers, begin in the Rocky Mountains of Wyoming and Colorado, respectively. Snowpack conditions and snowmelt runoff are significant for river flows in the springtime. All of Nebraska lies within the Missouri River Basin.

Nebraska has 8 million acres of irrigated farmland—the most of any state in the United States (Nebraska Department of Agriculture, 2019). Irrigation wells are most densely populated in south central Nebraska with four or more wells per square mile. Changes in groundwater levels over time show the greatest declines (> 50 ft since predevelopment) in southwest Nebraska as well as Box Butte County in the Panhandle. Overall, decline has also occurred for portions of south central Nebraska. In contrast, other portions of the state have seen groundwater levels rise. Changes from 2013-2018 show a general recovery from the 2012 drought (Young et al., 2018).

Average annual precipitation varies significantly across the state, from 15 inches in the Panhandle to 35 inches in the southeast. May and June are the rainy months, and winters are relatively dry. Annually, Nebraska is projected to be slightly wetter; however, climate projections indicate winter and spring are likely to be 20% wetter on average with summers 10% drier. More precipitation will fall as heavy rain events leading to increased erosion potential and the need for enhanced stormwater management and flood planning and response.

Groundwater-Level Changes in Nebraska - Predevelopment to Spring 2018



Sources: U.S. Geological Survey, Nebraska Water Science Center; U.S. Bureau of Reclamation, Kansas-Nebraska Area Office; Nebraska Natural Resources Districts; Central Nebraska Public Power and Irrigation District

Figure 3. Groundwater-level changes from pre-development until Spring 2018. From "Nebraska Statewide Groundwater-Level Monitoring Report," by Young et al., 2018, *Nebraska Water Survey Paper*, 86, p.17.

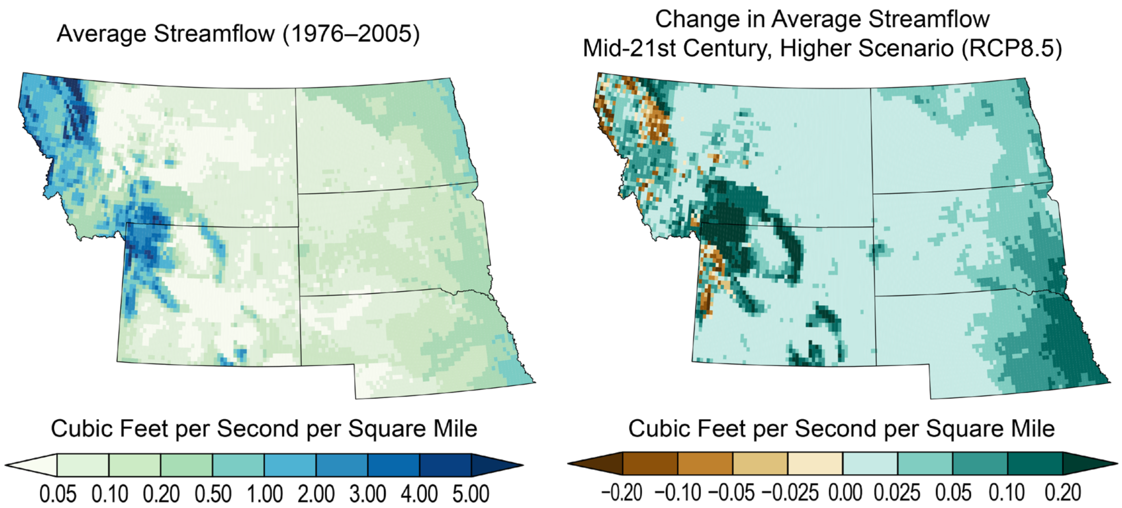


Figure 4. Historical and projected changes in annual streamflow. Adapted from "Northern Great Plains," by Conant et al., 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, p.951. In the public domain.

Given the warm summers, evapotranspiration (ET) rates and plant/crop water use can be relatively high. Daily potential ET rates of a third of an inch (2 inches per week) are not uncommon in mid-summer (Irmak & Sharma, 2014) . Climate projections are for summers to become warmer and drier than the current climatology, along with more extreme heat and a longer growing season. This will undoubtedly increase crop water use and potentially strain current water resources—especially in those areas of the state that have seen a decrease in groundwater levels.

Inter-annual variability is high in Nebraska and the Great Plains. Major flooding can precede extreme drought conditions, such as the 2011 flood followed by the 2012 drought. An increase in climate variability is expected in the future. The frequency of flood and drought events will likely be amplified with climate change (Conant et al., 2018).

Reservoirs provide an important water management strategy and are utilized for hydropower, irrigation, and recreational usage in Nebraska. These can provide a good buffer for climate impacts. However, shifts in precipitation patterns, decreased Rocky Mountain snowpack, and increased variability are likely to be greater stressors on water management. Current strategies will need to take these changes into consideration.

REFERENCES

Conant, R.T., Kluck, D., Anderson, M., Badger, A., Boustead, B.M., Derner, J., . . . Small, V. (2018). Northern Great Plains. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp.941-986). Washington, DC: U.S. Government Publishing Office.

Irmak, S. & Sharma, V. (2014). *Monthly, seasonal, and annual spatial and temporal variability of reference (potential) evapotranspiration across Nebraska* (Report No. EC2003). Lincoln, NE: University of Nebraska.

Nebraska Department of Agriculture, U.S. Department of Agriculture National Agricultural Statistics Service, Nebraska Field Office, & Nebraska Bankers Association. (2019, February). *Nebraska agriculture fact card*. Retrieved from http://www.nda.nebraska.gov/facts.pdf

Young, A. R., Burback, M.E., Howard, L.M., Waszgis, M.M., Lackey, S.O., & Joeckel, R. M. (2018). Nebraska statewide groundwater-level monitoring report. *Nebraska Water Survey Paper*, 86: 1–24.

AUTHORS:
Martha Shulski, Nebraska State Climatologist
Tyler Williams, Nebraska Extension Educator

AGRICULTURE

According to the 2017 Ag Census, Nebraska is home to over 46,000 registered farms encompassing nearly 45 million acres, and the success and production of these farms are highly influenced by climate and weather (U.S. Department of Agriculture National Agricultural Statistics Service, 2019). There are over 21 million acres of rangeland and more than 22 million in cropland, with 8.6 million of those acres being irrigated.

The variability in climate from one end of the state to the other, in addition to the erratic seasonal and annual fluctuations in precipitation and temperature, influence the production of agricultural products as well as insect and disease prevalence, soil quality, flooding and erosion, and livestock stress. Key climatic trends and projections influence the success of agricultural systems in the state.

Many characterize the weather and climate of Nebraska as extreme, and the climate model projections are for many of the extremes to increase. Nebraska is projected by mid-century (using the higher emission scenario) to have 30–50 more days above 90°F, 20–30 fewer days below 32°F, and an 8–12% increase in daily, 20-year extreme precipitation (Conant et al, 2018). These extreme conditions challenge animal health and the resiliency of agricultural systems and soils. Extreme heat impacts crop reproduction and livestock heat stress while extreme rainfall creates rill and gully erosion, reducing field productivity and water quality.

By 2100, models project Nebraska to have 20–30 extra days for the “frost-free” season using the lower scenario and 30–40 days using the higher scenario (“Scenarios for the National Climate Assessment,: n.d.). This extended growing season may provide an opportunity for longer maturity crops, extra forage growth, or expand the window for cover crops; however, this may be at the expense of soil moisture. Average minimum temperatures in the winter have increased at a rate of 2–3°F per century since 1895, and average winter temperatures are projected to continue to warm (Hayhoe et al., 2018). Even though this increase in winter temperature is outside of the growing season, this can change the overwintering of pests or even introduce non-native pests. This warming may also influence frost depths in the soil and decrease livestock health with an increase in non-frozen and muddy fields or pens (Mader, 2011).

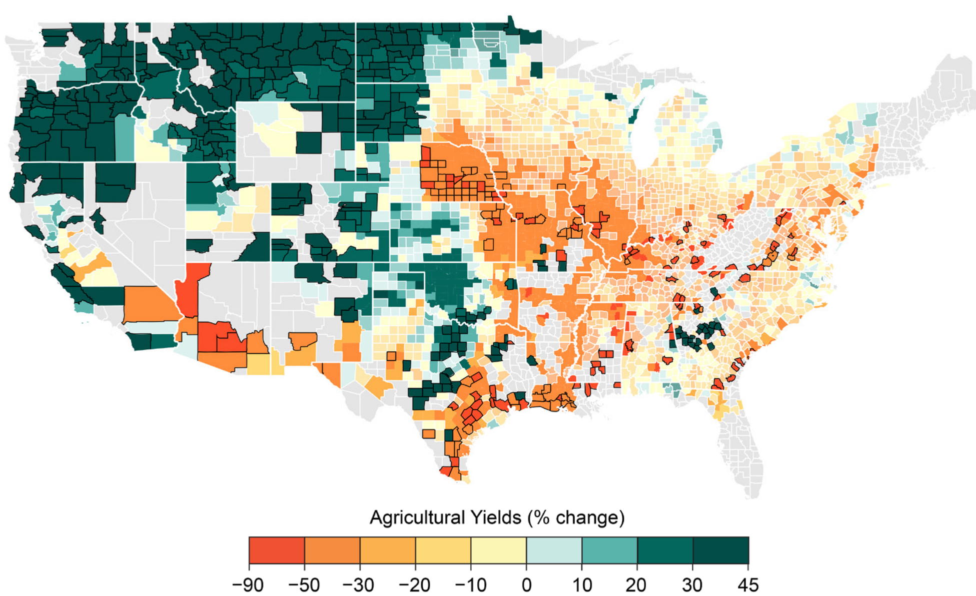


Figure 5. Projected percent change in the yield of corn, wheat, soybeans, and cotton during the period 2080-2099. From “Ecosystems, Ecosystem Services, and Biodiversity,” by Lipton et al., 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, p 285. Source data: Hsiang et al. In the public domain.

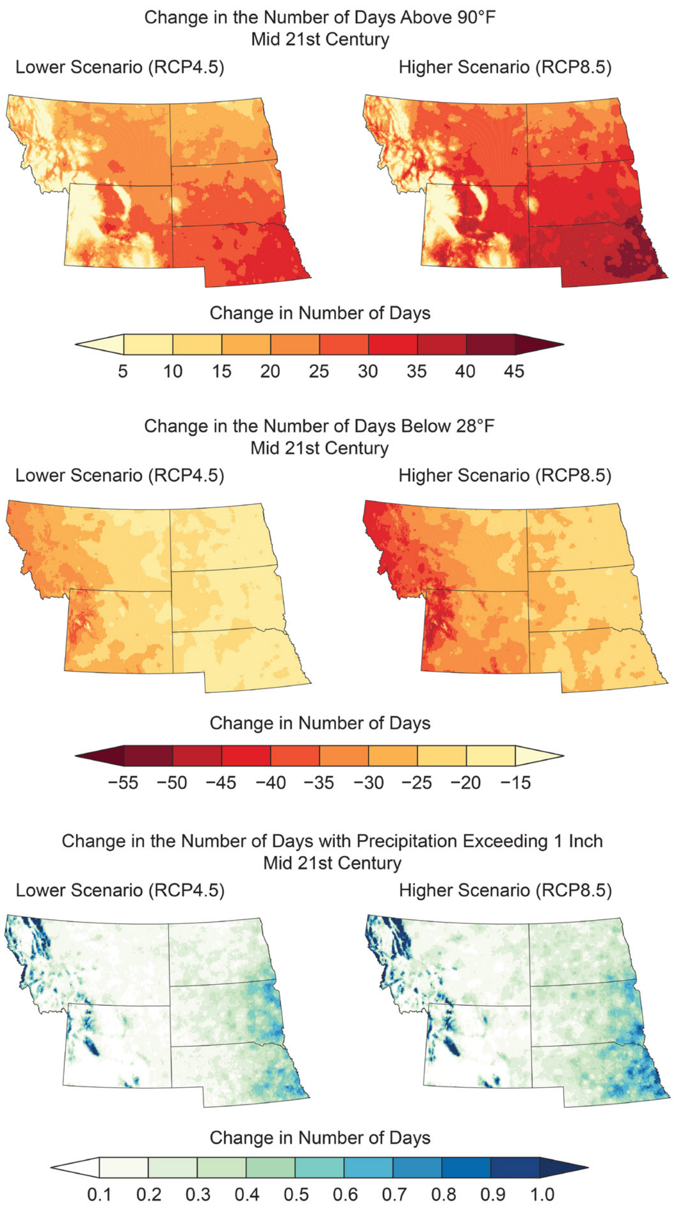


Figure 6. Projected changes for number of days with temperatures above 90°F (top), below 32°F (middle), and precipitation exceeding 1 inch (bottom). Projections for mid-century (2036–2065) compared to 1976–2005 average. From "Northern Great Plains" by Conant et al., 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, p. 950. In the public domain.

Annual precipitation is expected to increase by 5–15% for most of the state through 2100 (Hayhoe et al., 2018). Since 1895, annual precipitation has increased at a rate of 0.15 inches per decade, with the most significant increase during the spring in the eastern half of the state (Frankson et al., 2018). Even though there is an expected increase in annual precipitation, soil moisture and availability are expected to decrease during the growing season due to the warming temperatures and enhanced evaporation. Projections show an increase in average stream flows, adding to the flood risk for low-lying fields, pastures, and livestock systems (Conant et al., 2018).

REFERENCES

Conant, R.T., Kluck, D., Anderson, M., Badger, A., Boustead, B.M., Derner, J., . . . Small, V. (2018). Northern Great Plains. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp.941-986). Washington, DC: U.S. Government Publishing Office.

Frankson, T., Kunkel, K., Stevens, L., & Shulski, M. (2017). Nebraska state climate summary. *NOAA Technical Report NESDIS 149-NE*. Retrieved from https://statesummaries.ncics.org/chapter/ne/

Hayhoe, K., Wuebbles, D.J., Easterling, D.R., Fahey, D.W., Doherty, S., Kossin, J., . . . Wehner, M. (2018). Our changing climate. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp. 72-144). Washington DC: U.S. Global Change Research Program.

Lipton, D., Rubenstein, M.A., Weiskopf, S.R., Carter, S., Peterson, J., Crozier, L., . . . Weltzin, J.F. (2018). Ecosystems, ecosystem services, and biodiversity. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp. 268-321). Washington, DC: U.S. Government Publishing Office.

Mader, T. L. (2011). Mud effects on feedlot cattle. *Nebraska Beef Cattle Reports*, 613: 82–83.

Scenarios for the National Climate Assessment. (n.d.). *Localized constructed analogs data set*. Retrieved from https://scenarios.globalchange.gov/loca-viewer/

U.S. Department of Agriculture National Agricultural Statistics Service. (2019). 2017 *Census of agriculture: United States summary and state data*. Retrieved from https://www.nass.usda.gov/Publications/AgCensus/2017/index.phprecreation & tourism

AUTHORS:
Martha Shulski, Nebraska State Climatologist
Tyler Williams, Nebraska Extension Educator

RECREATION & TOURISM

Ecosystems provide valuable and vital services for the people of Nebraska. Climate is a key driver to the distribution of species, both aquatic and terrestrial. The diverse landscape is home to many miles of rivers and streams, riparian areas, the Sandhills, and grassland prairies. Wetlands offer a key ecosystem service through water filtration to improve quality, enhance protection from floods, recharge groundwater, and provide wildlife habitat. Wetland area in Nebraska has decreased over time, but recent conservation efforts have stabilized the decrease (LaGrange, 2005).

Recreational activities are primarily hunting, fishing, boating, and wildlife viewing. Tourism is the state's third largest industry (Nebraska Tourism Commission, 2018). One of the primary tourist activities in the state is experiencing the Sandhill crane migration during the spring as millions of migratory birds zero in on the central Platte. Much of the landscape in Nebraska is under private ownership and largely used for agricultural production (Nebraska Department of Agriculture, 2019), therefore management of these landscapes is not controlled or systematic. As such, one defining characteristic of Nebraska and the Great Plains in general is habitat fragmentation. Changes to the agricultural landscape will impact the natural ecosystems imbedded around and within those agricultural landscapes.

Climate change influences recreation through several mechanisms: direct impacts to ecosystems and populations, changes in environmental conditions that directly affect recreationists, and effects of adaptation policies on habitat quality or recreational enjoyment. Climate stressors to ecosystems include a warmer climate regime, more extreme heat, shifting seasonality and timing of events (such as earlier last frost and overwinter emergence), increased variability, and more extreme rain events. The rate of climate change going forward is expected to be higher than historical rates of change (Conant et al., 2018). It is thought that all ecosystems will be impacted by climate change. Water quantity and quality will be altered with aquatic ecosystems likely to be the most impacted, such as wetlands, lakes, rivers, and streams (Bathke, Oglesby, Rowe, & Wilhite, 2014).

Species shifts have been documented as the climate has warmed overall, and this is expected to accelerate. This will include the influx of undesirable and previously unmanaged invasive species and pests. Furthermore, there are complex interactions to various components of ecosystems that complicate adaptive management approaches.

Scenario planning is an important tool that agencies and organizations are utilizing to prepare for and adapt to climate-driven challenges.

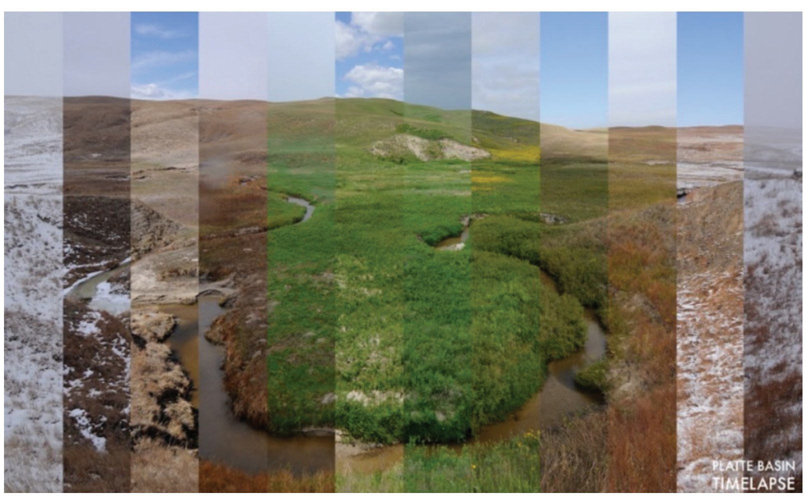


Figure 7. The Platte Basin Timelapse Project provides a multimedia story of water in Nebraska with a series of cameras along the Platte River. From "Northern Great Plains" by Conant et al., 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, p. 948. Photo credit: Mariah Lundgren, University of Nebraska Platte Basin Timelapse Project.

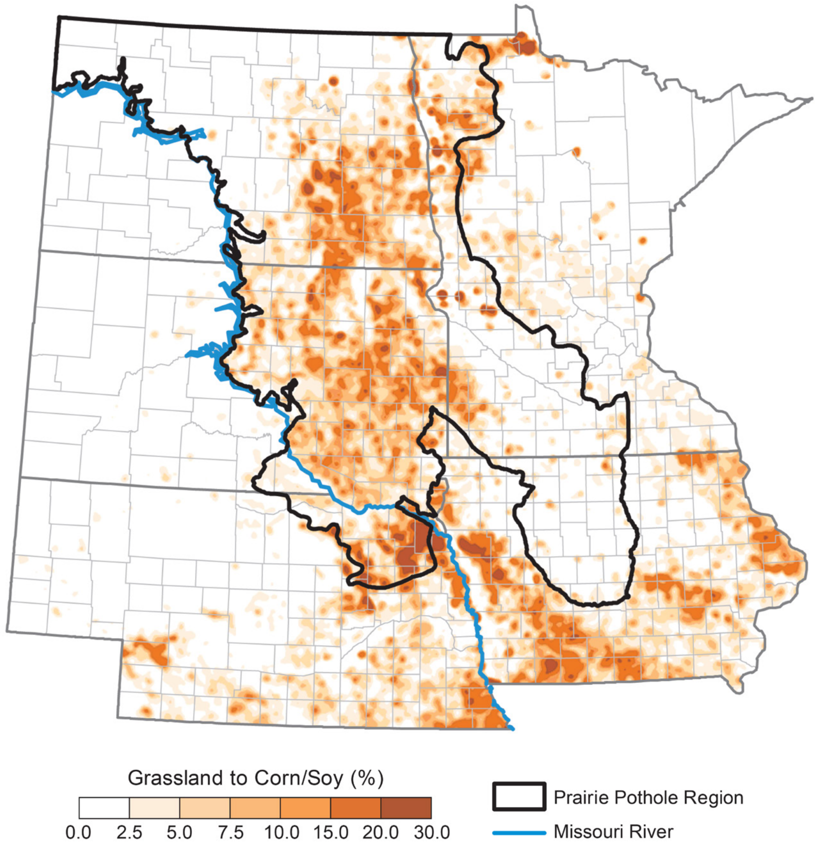


Figure 8. Grassland loss to corn and soy between 2006 and 2011, expressed as a percentage of 2006 grassland acres. From "Northern Great Plains" by Conant et al., 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, p. 961. Source data: Wright and Wimberly, 2013. In the public domain.

REFERENCES

Bathke, D.J., Oglesby, R.J.,Rowe, C., & Wilhite, D.A. (2014). Understanding and assessing climate change: implications for Nebraska. *Papers in the Earth and Atmospheric Sciences*. Retrieved from https://digitalcommons.unl.edu/geosciencefacpub/439/

Conant, R.T., Kluck, D., Anderson, M., Badger, A., Boustead, B.M., Derner, J., . . . Small, V. (2018). Northern Great Plains. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp.941-986). Washington, DC: U.S. Government Publishing Office.

LaGrange, T. (2005). *Guide to Nebraska's wetlands and their conservation needs* (2nd ed.). Lincoln, NE: Nebraska Game and Parks Commission.

Nebraska Department of Agriculture, U.S. Department of Agriculture National Agricultural Statistics Service, Nebraska Field Office, & Nebraska Bankers Association. (2019, February). *Nebraska agriculture fact card*. Retrieved from http://www.nda.nebraska.gov/facts.pdf

Nebraksa Tourism Commission. (2018). *Nebraska tourism commission 2018 annual report* [PDF file]. Retrieved from https://visitnebraska.com/sites/default/files/2019-04/2018_Annual_Report_For_Web-2.pdf

AUTHORS:
Martha Shulski, Nebraska State Climatologist
Tyler Williams, Nebraska Extension Educator

ENERGY

Energy development is abundant and expanding in the Northern Great Plains region. It represents a significant source of greenhouse gasses that contribute to climate change. Furthermore, the extraction and distribution of infrastructure related to energy is vulnerable to climate change and future extreme weather events.

In Nebraska, the types of energy produced do not always align with the types of energy consumed (U.S. Energy Information Adminstration, 2019). Production from the state is generated primarily from biofuels in the form of corn ethanol, followed by nuclear, other renewable energy (wind and hydropower), and oil. According to the U.S. Energy Information Administration, Nebraska produces 13% of the nation's fuel ethanol, ranking second in the nation (2019). Nebraska has one of only six operating uranium mines in the country. The ore is made into fuel for nuclear reactors. Energy consumption is from a wider variety of sources, with the top five sources being coal (63%), nuclear (15%), wind (14%), hydropower (4%) and natural gas (3%). The sectors utilizing energy are from industry (44.8%), which includes agricultural usage, transportation (23.1%), residential (16.7%), and commercial (15.4%). Infrastructure for transport of energy within and across Nebraska is through rail systems and underground pipelines (U.S. Energy Information Administration, 2019).

Figure 9. Missouri River flooding in June of 2011 reached the Omaha Public Power District's Fort Calhoun Station, a nuclear power plant north of Omaha. From "Northern Great Plains" by Conant et al., 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, p. 963. Photo credit: Harry Weddington, U.S. Army Corps of Engineers.

Some key threats to energy production in Nebraska include high summer temperatures and more damaging hail events that could potentially lower crop yields used for biofuels. Climate change in the region will manifest through an overall warming of the climate with more extreme heat events and higher overnight lows. Projections of precipitation indicate that compared to our current climate, we will experience wetter winter and spring seasons, drier summer conditions, more extreme precipitation events that lead to floods, and a higher frequency of drought (Hayhoe et al. 2018). Thermoelectric power generation is expected to be impacted by lower and more variable streamflows, or inflows, to existing reservoirs. Rivers influenced by Rocky Mountain snowmelt runoff are expected to have altered streamflows in the future due to less snow water equivalence and an earlier melt pulse. Furthermore, there is expected to be even greater variability in precipitation from what Nebraska currently experiences. Given the climate projections, the expectation is for a greater energy demand, particularly during summer, to meet future needs (Bathke et al. 2014, Conant et al. 2018).

The intensity and frequency of increased flooding potential highlight the risk of physical damage to energy infrastructure. A recent example which reveals vulnerability to extreme events is the 2011 flood. Portions of the Missouri River basin received near-record snow and record rainfall in the late spring and early summer. The Fort Calhoun station nuclear power plant, operated by Omaha Public Power District and located on the Missouri River, was in danger when the protective berm failed and floodwaters compromised operations. Reactor cooling was shut down and luckily the spent fuels were unaffected. Other risks to energy infrastructure in a changing climate are disruption or damage to railroads and pipelines from increased heavy precipitation events leading to flooding and erosion, and soil stability issues during drought and low soil moisture availability. The risks are thought to negatively impact individuals, communities, and the economy. New approaches to increase preparedness and mitigation efforts will help to reduce risk.

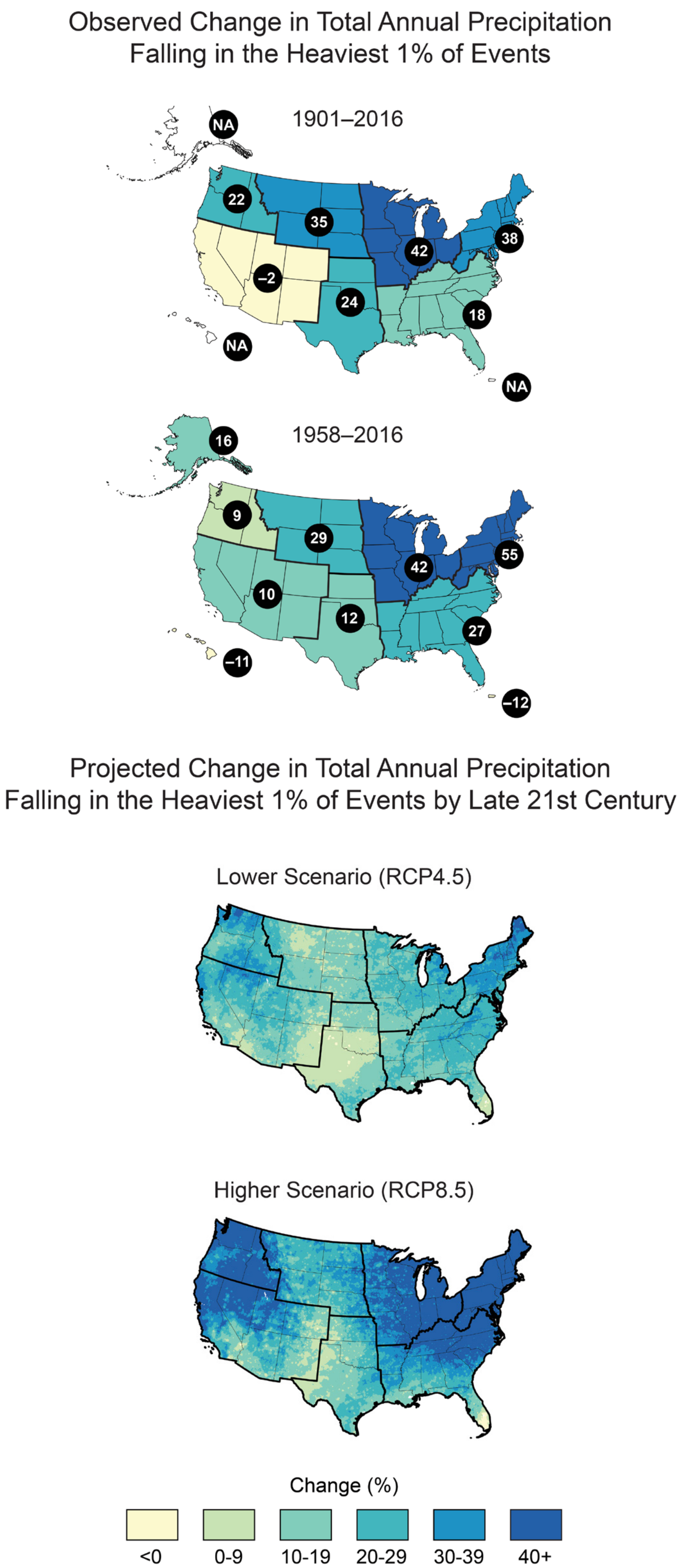


Figure 10. Observed and predicted perciptation falling in the the heaviest 1% of weather events. From "Our Changing Climate" by Hayhoe et al., 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, p. 90. In the public domain.

REFERENCES

Bathke, D.J., Oglesby, R.J.,Rowe, C., & Wilhite, D.A. (2014). Understanding and assessing climate change: implications for Nebraska. *Papers in the Earth and Atmospheric Sciences*. Retrieved from https://digitalcommons.unl.edu/geosciencefacpub/439/

Conant, R.T., Kluck, D., Anderson, M., Badger, A., Boustead, B.M., Derner, J., . . . Small, V. (2018). Northern Great Plains. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp.941-986). Washington, DC: U.S. Government Publishing Office.

Hayhoe, K., Wuebbles, D.J., Easterling, D.R., Fahey, D.W., Doherty, S., Kossin, J., . . . Wehner, M. (2018). Our changing climate. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp. 72-144). Washington DC: U.S. Global Change Research Program.

U.S. Energy Information Administration. (2019, March 21). *Nebraska state profile and energy estimates*. Retrieved from https://www.eia.gov/state/?sid=NE

AUTHORS:
Martha Shulski, Nebraska State Climatologist
Tyler Williams, Nebraska Extension Educator

INDIGENOUS PEOPLES

Indigenous peoples are subject to a unique set of circumstances with regard to climate change impacts. Overall, indigenous people have a deep connection to the natural world through centuries of cultural and spiritual practices. Often termed traditional ecological knowledge, communities are intimately linked to the landscape and all the components contained therein. Tribes have exhibited tremendous resilience to historical changes in climate; however, the arrival of forced assimilation and migration present social, cultural and economic stressors to traditional ways of life. Subsistence lifestyles that link the health and well-being of people to the land are increasingly compromised. As such, tribal nations are disproportionately impacted by the challenges of a rapidly changing climate.

There are 27 federally recognized tribes within the Northern Great Plains region of the United States. In Nebraska, sovereign tribal nations with land consist of the Santee Sioux, Winnebago, Omaha, Sac and Fox, and Iowa. These reservations are found in the northeast and extreme southeast portions of the state. The Ponca do not have land within the state of Nebraska but reside within the state boundaries. In addition, there are two tribal colleges: Little Priest in Winnebago and Nebraska Indian Community College with three campuses in Macy, Santee, and South Sioux City.

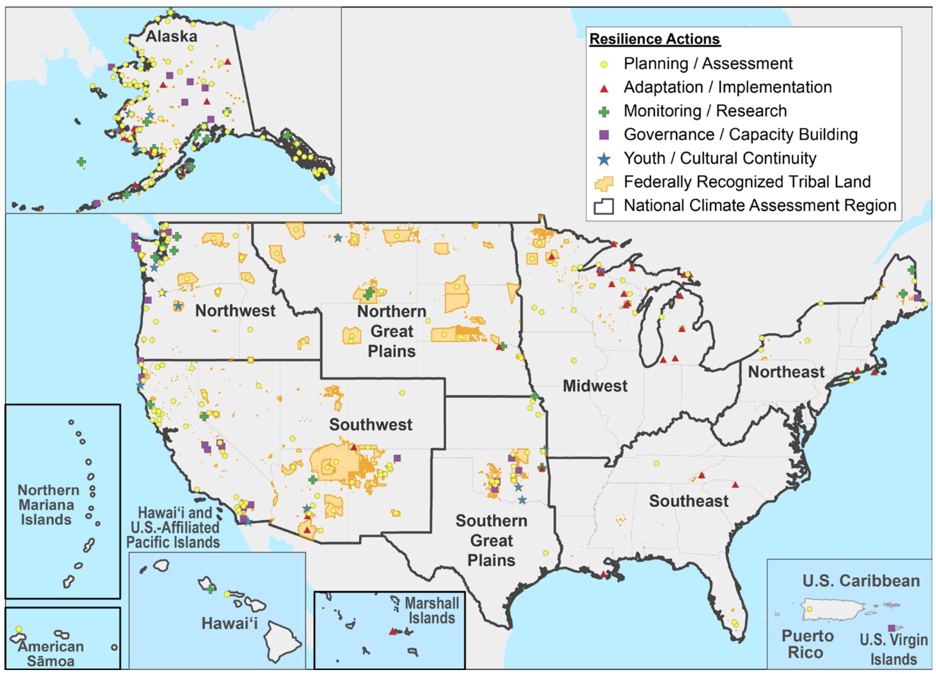


Figure 11. Map of federal recognized tribal land and resilience to climate change actions taken by indiegenous peoples. From "Tribes and Indigenous Peoples" by Jantarasami et al., 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, p. 575. In the public domain.

The "Tribes and Indigenous Peoples" chapter of the National Climate Assessment highlights three key messages: (1) climate change threatens the livelihoods and economies of indigenous peoples who face institutional barriers to resource management; (2) indigenous health, based on interconnected social and ecological systems, will be uniquely challenged by climate impacts that threaten the foundation of cultural heritages, identities, and physical and mental health; and (3) climate impacts that are proactively addressed are subject to institutional barriers that limit adaptive capacities.

Specific to the Northern Great Plains, "indigenous peoples… are at a high risk from a variety of climate change impacts, especially those resulting from hydrologic changes, including changes in snowpack, seasonality and timing of precipitation events, and extreme flooding and droughts as well as melting glaciers and reduction in streamflows," (Conant et al, 2018, p. 976). These changes are already resulting in harmful impacts to tribal economies, livelihoods, and sacred waters and plants used for ceremonies, medicine, and subsistence. At the same time, many tribes have been proactive in adaptation and strategic climate change planning (Conant et al., 2018).

Water is lifeblood, and it has cultural and religious significance for tribal communities that goes beyond consumptive uses. The expected increase in climate extremes, such as floods and droughts, will further challenge water management on tribal lands. Tribal governments are increasingly engaged in and leading efforts both in preparation for and response to climate change impacts. This is oftentimes, but not always, performed

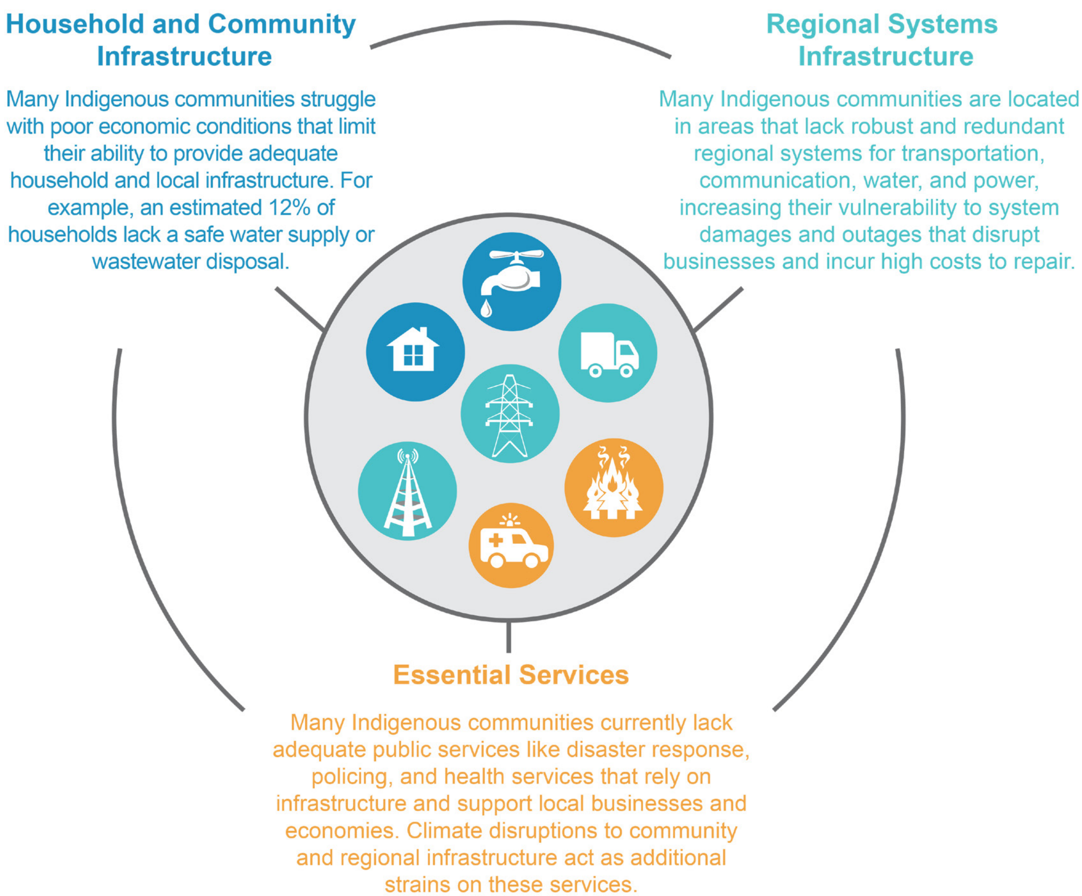


Figure 12. Many indigenous peoples already encounter infrastructure challenges making them especially vulnerable to changes in climate. From "Tribes and Indigenous Peoples" by Jantarasami et al., 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II*, p. 580. In the public domain.

through the tribe's Environmental Protection Agency. In Nebraska, efforts related to mitigation and adaptation have focused on such topics as renewable energy, wetland restoration, adaptation strategies, and climate change vulnerability assessment. Indigenous communities face multiple barriers to adaptation planning: inadequate funding, limited personnel with technical expertise, identifying and synthesizing relevant climate data, competing tribal priorities, frequent employee turnover, tribal leadership support, and/or community support. To help reduce some of these barriers, more training is needed to enhance local capacity, such as the training available through the Institute for Tribal Environmental Professionals (ITEP).

REFERENCES

Conant, R.T., Kluck, D., Anderson, M., Badger, A., Boustead, B.M., Derner, J., . . . Small, V. (2018). Northern Great Plains. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp.941-986). Washington, DC: U.S. Government Publishing Office.

Jantarasami, L.C., Novak, R., Delgado, R., Marino, E., McNeeley, S., Narducci,C., . . . Powys Whyte, K. (2018). Tribes & indigenous peoples. In D.R. Reidmiller, C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, & B.C. Stewart (Eds.), *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* (pp. 572-603). Washington, DC: U.S. Government Publishing Office.