TECHNICAL BULLETIN *Prepared by the Davey Institute*

DAVEY

Climate Change Projections for the Midwest United States

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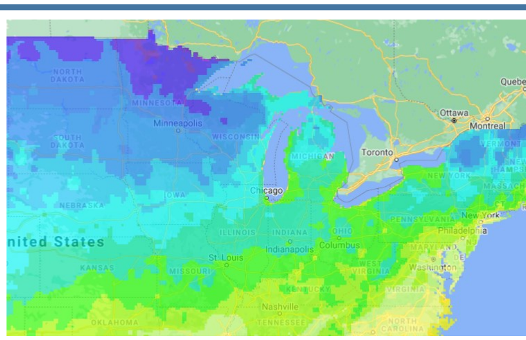
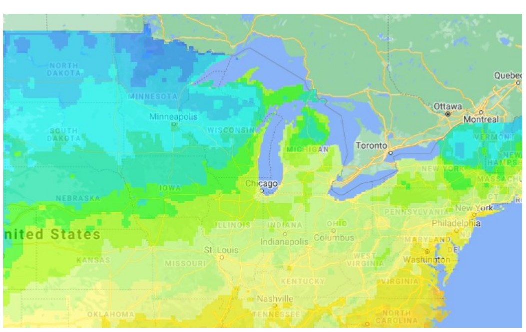
Image from Fourth National Climate Assessment

The Davey Climate Change Fact Sheet Series projects the future impacts of climate change in our industry over the next 30-70 years, with emphasis on changes in temperature, precipitation, storm intensity, tree health, pest pressure, wildfire, and worker stress. Temperatures across the U.S. are expected to increase between 3-11°F by the end of this century, with future patterns of greenhouse gas emissions providing the largest source of uncertainty. The Intergovernmental Panel on Climate Change (IPCC) predicts future climates based on modeling for different emissions scenarios, called "Representative Concentration Pathways (RCP)." This fact sheet focuses on changes expected to occur in the Midwest U.S. based on lower (RCP4.5) and higher (RCP8.5) emissions scenarios. Currently, global patterns of fossil fuel consumption correspond most closely with the high emission scenario, while the lower emission scenario will require significant mitigation measures yet to be implemented.

The climate is warming. The climate has warmed over the last century throughout the Midwest, with the southern stretch of the region along the Ohio River having warmed about 1°F (annual average), Wisconsin and Michigan about 2°F, and northern Minnesota warming more than 3°F, making it one of the fastest warming areas of the continental U.S. By the end of the century, southern Minnesota and Ohio are predicted to experience 5-15 more days per year with temperatures that exceed 95°F, and Illinois 15-20 more days. At the same time, Michigan's climate is predicted to resemble the current climates of Missouri and Oklahoma under the lower and high emissions scenarios, respectively, and Illinois the current climate of Texas.



Current winter hardiness zones



Winter hardiness zones projected for end of century under the lower emission scenario

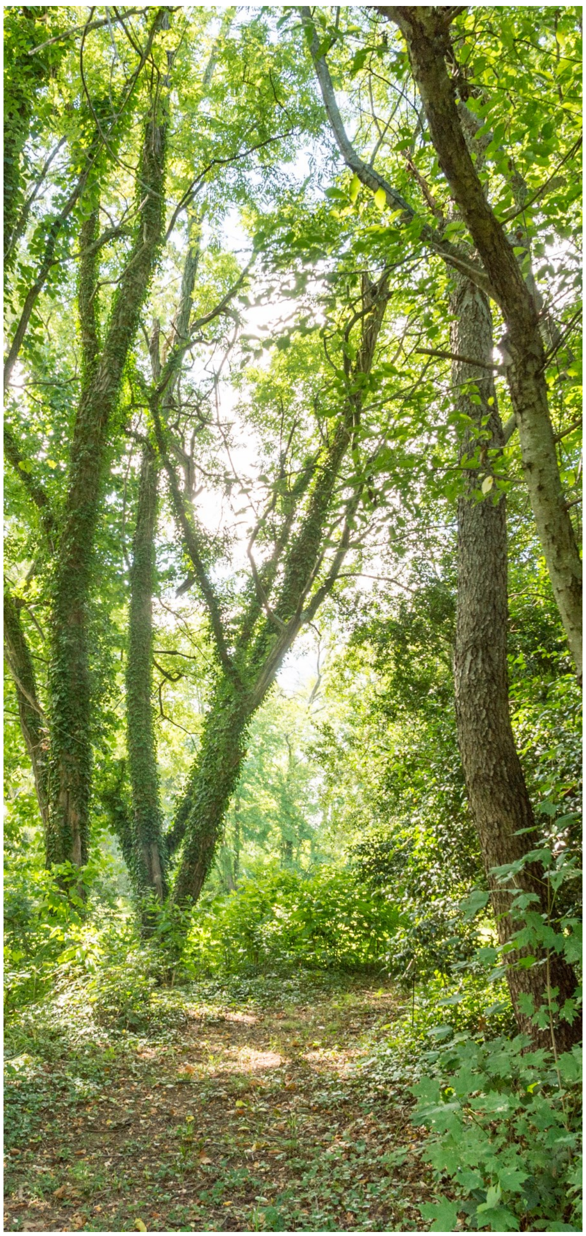
Winter hardiness zones are changing

Winters are also warming throughout the Midwest, which is leading to changes in USDA plant hardiness zones that will have important implications for tree planting for future environments. For example, over the last 30 years Columbus, OH has warmed from zone 5 (minimum winter temperatures between -20 and -10°F) to zone 6 (-10 to 0°F) and is predicted to transition to zone 7 (0 to 10°F) by the second half of the century.

By the end of the century, Minneapolis and Chicago are predicted to transition from their current zone 4 (-30 to -20°F) and zone 6, respectively, to zones 6 and 7 under the lower emission scenario and zones 7 and 8 under the higher emission scenario.

Increased precipitation and extreme rainfall events will occur

Total precipitation has increased over most of the Midwest, as have extreme precipitation events and flooding. Over the last 50 years, average annual precipitation has increased 5-10 percent over most of the Midwest, and rainfall during the four wettest days of the year has increased about 35 percent. Spring rainfall, total average precipitation, extreme rainfall events, and frequency of flooding are predicted to continue to increase throughout much of the Midwest over the rest of the century.



Forest composition is changing. As in other regions, there will be winners and losers among tree species as the climate warms. A longer growing season and increased degree-day accumulation is contributing to increased growth of some tree species. In the North Woods of the Upper Great Lakes region, the distribution of northern hardwood and boreal tree species such as paper birch, quaking aspen, balsam fir, and black spruce trees, are predicted to decline as species with more heat and drought tolerance such as oak, hickory, and pines become more competitive.

Increasing temperatures and more frequent summer drought are predicted to accelerate the northward migration of some tree species in the Upper Great Lakes through effects on their interactions with key insects. For example, paper birch is predicted to experience increased stress from summer drought and high temperatures. This, in turn, is predicted to increase the frequency of bronze birch borer outbreaks and associated widespread birch decline and mortality, especially at the southern edge of the distribution in Minnesota, Wisconsin, and Michigan.

Similarly, black ash is a dominant forest species across large expanses of forest in northern Minnesota. As warming temperatures increase the overwintering survival of the invasive emerald ash borer in the northern reaches of its current distribution, black ash is increasingly threatened with extinction and is predicted to be replaced by more southern species such as red and silver maple. In Missouri, the abundance of pines is predicted to increase as hickory declines.

Tree stress is increasing

Temperatures greater than 86° can negatively affect plant photosynthesis, and, subsequently, plant growth and health. By mid-century, days above this threshold are expected to increase across the region by an average of 38 and 63 days from the baseline period 1980-2009 under low and high scenarios.

Increased precipitation and humidity in spring is projected to increase the incidence of plant diseases, while intermittent summer droughts are predicted to be more frequent and severe as periods without rain become longer, very hot days more frequent, and soil becomes drier as evaporation increases.

The warming climate is also causing insect pests to increase their reproductive rate, number of generations per year, and the northward migration of pest species into the region. For example, as warmer temperatures decrease overwintering mortality of the invasive redbay ambrosia beetle, the vector of laurel wilt disease, it is predicted to spread north to midwestern states by 2050 where it will threaten populations of sassafras trees and related species.

Human health and worker safety: extreme heat and insect-vectored diseases

As the climate warms, people that work and recreate outside will experience greater risk of heat stress, as well as exposure to ground-level ozone and arthropod-vectored diseases. The increase in extreme heat days (>95°F) projected throughout the region under both the lower and higher emission scenarios will impact worker health and safety.

In the absence of adaptation measures, the Midwest region is projected to incur 2,000 additional premature deaths per year (relative to 1989-2000) under the high emission scenario, which is the greatest projected increase for any region of the U.S.

High temperatures also result in production of ozone, a pollutant that damages the lungs. Increased ozone concentrations across the Midwest are projected to result in an additional 200–550 premature deaths per year across the Midwest by 2050, primarily in urban areas. Ozone also stresses trees, decreasing their growth and resistance to insects and disease.

The incidence of Lyme disease has increased in recent decades throughout the Midwest, and this trend is expected to continue as the distribution of ticks that vector this disease expands and the ticks become active earlier in the season in response to a warming climate. The incidence of diseases spread by mosquitos such as West Nile virus are also predicted to increase as the mosquitos that vector them expand their range.

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