

Planning for Climate & Health Impacts in Southeast Minnesota

Emergency Management Considerations for HSEM Region 1

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ABOUT THE REGIONAL PROFILE

EXTREME WEATHER IS A FAMILIAR CONCERN FOR MINNESOTANS

While experience has helped Minnesotans adapt to historical weather patterns, climate change trends are pushing us to adapt even further to weather patterns and extreme events that pose major threats to our health, homes, environment, and livelihood. Over 50 years of storm data on record document that Minnesota has experienced an increase in the number and strength of weather-related natural disasters, particularly those related to rising temperatures and heavy downpours. These events cost our state millions in property loss, damaged infrastructure, disrupted business, medical care and support services, and put residents and responders at risk. Understanding how our weather is changing now and into the future will help planners and decision-makers in emergency management and supporting fields extend our progress in climate adaptation and lead to more resilient communities.

CLIMATE PROJECTION DATA AS A TOOL

Climate projections can help us prepare for the future. These data result from highly sophisticated global climate models and provide a general idea of trends in temperature and precipitation many decades into the future at ever-increasing time and spatial scales. Like every dataset, there are limitations to our understanding and application of the information to real-life decision-making. Yet despite limitations, climate projection data offer a crucial glimpse into our potential futures, and allow us to start considering the best way to allocate our preparedness dollars and management resources to reduce the severe impacts of extreme weather.



Money Creek, Southern Winona County (National Weather Service, 2007)

PUTTING CLIMATE CHANGE INTO CONTEXT

Sometimes, climate change and extreme weather events and the impact on our communities appear distant and abstract. That is why the Minnesota Department of Health's Minnesota Climate & Health Program teamed up with state and local emergency management and preparedness professionals as well as state climatologists to develop a custom climate profile for each of the six Homeland Security and Emergency Management (HSEM) regions across the state. Each regional profile includes a description of climate change trends along with a summary of climate projection data to illustrate these trends. Regional climate data are presented alongside population projection data, as it's important to consider both our climate future and population future as we plan to minimize risk and build resilience against climate impacts.

Additionally, each regional profile provides a local case study, a "focusing event," to illustrate the links between extreme weather and natural disasters and what climate projection data can (and cannot) signify for similar events in the future. Each case study features a recent natural disaster that impacted the HSEM region and provides a comparison between temperature and precipitation measures related to that event alongside historical baseline trends and future projection estimates. Taken together, the six HSEM regional profiles provide an extensive overview of climate change trends for Minnesota and describe the potential impact of these trends for emergency management and preparedness professionals and their partners.

FOR MORE INFORMATION

A long form report, including all six profiles, individual county data, and a more comprehensive description of climate change trends and supporting research will be available at:

[Minnesota Climate & Health Planning Tools & Data](http://www.health.state.mn.us/divs/climatechange/data.html)
(www.health.state.mn.us/divs/climatechange/data.html)

REGION 1 OVERVIEW

REGION 1: Southeast Minnesota

COUNTIES

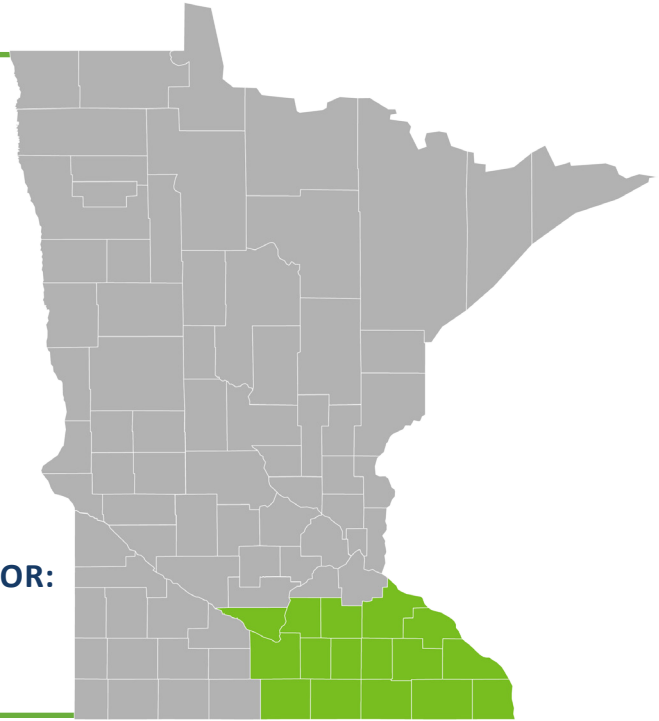
- Blue Earth
- Dodge
- Fairbault
- Fillmore
- Freeborn
- Goodhue
- Houston
- Le Sueur
- Mower
- Nicollet
- Olmsted
- Rice
- Steele
- Wabasha
- Waseca
- Winona

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MINNESOTA CLIMATE & POPULATION TRENDS

OUR KNOWLEDGE OF CLIMATE CHANGE IS EXPANDING RAPIDLY

Climate records show that across the Midwest and here in Minnesota we are experiencing an increase in warmer, wetter conditions as well as an increase in extreme weather events and related natural disasters. Experts expect these conditions to continue well into the future. By mid-century, Minnesotans can expect much warmer winters, more severe summer heat waves, a higher frequency of very heavy rain events and a higher frequency of late growing season drought conditions.

Many communities in Minnesota rely on economies rooted in agriculture and outdoor recreation, such as wintertime tourism, including snowmobiling, ice fishing, and skiing. Future climate conditions may stress agricultural economies by delaying planting and fieldwork, increasing disease and pest pressure, and reducing crop yields due to cycles of flooding and dry spells. Rapidly warming winter temperatures will turn snowfall into rain and reduce the depth and timing of lake ice cover, affecting winter recreation.

Extreme rainfall events will increase flood risk, particularly in floodplain areas, disrupting transportation and utility service, and damaging property and infrastructure. In addition, surface runoff may lead to soil erosion, lake pollution, and reduced drinking water quality. Nutrient runoff in particular, along with warmer temperatures, are likely to contribute to a larger occurrence of harmful algal blooms on waters, many valued for recreation. Changing climate conditions are likely to strain the viability of native species, including popular recreational fish, invite encroachment by invasive species, and increase the geographic range and types of ticks and mosquitoes.

Some of these trends are evident in the current climate projection data that are available. However, because these data are often averaged or summarized for large areas over large time periods, they can mask the local peaks in temperature and precipitation that can trigger disasters. Until more finely-scaled climate projection data become available to Minnesota planners and decision-makers, the current data still remain useful for exploring the future ahead and establishing a baseline understanding of what our weather challenges may be moving forward.

REGION 1 CLIMATE PROFILE

Use the following information on temperature, precipitation, and vulnerable populations to help plan for future weather-related incidents.

TEMPERATURE

There has been an increase in winter and summer temperatures. Our average winter lows are rising rapidly, and our coldest days of winter are now warmer than we have ever recorded. In fact, Minnesota winters are warming nearly 13 times faster than our summers. The continued rise in winter temperatures will result in less snow pack, which will increase chances for grassland/wildfires as well as drought. The warmer winter temperatures will also have major consequences for our ecosystems, including native and invasive species, whose growth, migration, and reproduction are tied to climate cues. The increase in Lyme disease across Minnesota is also likely influenced in part by the loss of our historical winters, due to a longer life-cycle period for ticks. Freeze-thaw cycles are likely to increase as well, damaging roads, power lines, and causing hazardous travel conditions. By mid-century our average summer highs will also see a substantial rise, coupled with an increase in more severe, prolonged heat waves that can contribute to drought and wildfires and pose a serious health threat, particularly to children and seniors. Here are temperature trends for HSEM Region 1:



Average Summer Maximum Temperature for HSEM Region 1		
1981-2010	2050-2075	Change
81.4 °F	89.1 °F	+7.7 °F



Average Winter Minimum Temperature for HSEM Region 1		
1981-2010	2050-2075	Change
8.9 °F	18.0 °F	+9.1 °F

PRECIPITATION

There has been an increase in total average as well as heavy precipitation events, with longer periods of intervening dry spells. Our historical rainfall patterns have changed substantially, giving rise to larger, more frequent heavy downpours. Minnesota's high-density rain gauge network has captured a nearly four-fold increase in "mega-rain" events just since the year 2000, compared to the previous three decades. Extreme rainfall events increase the probability of disaster-level flooding. However, there is also an increased probability that by mid-century heavy downpours will be separated in time by longer dry spells, particularly during the late growing season. Over the past century, the Midwest hasn't experienced a significant change in drought duration. However, the average number of days without precipitation is projected to increase in the future, leading Minnesota climate experts to state with moderate-to-high confidence that drought severity, coverage, and duration are likely to increase in the state. Modeling future precipitation amounts and patterns is less straight-forward compared to temperature. Some climate models do a better job than others representing rainfall for the Midwest, and available data sources only provide average estimates on a monthly scale, masking the spikes in extremes that trigger flood and drought disasters. Trend data provided here for HSEM Region 1 are summarized for early summer, when historically Minnesota receives most of its rainfall, and for early fall when rainfall scarcity may threaten crop harvests and local agricultural economies:



Average Early Summer Precipitation for HSEM Region 1		
1981-2010	2050-2075	Change
4.5"	5.1"	+0.6"



Average Early Fall Precipitation for HSEM Region 1		
1981-2010	2050-2075	Change
2.9"	3.0"	+0.1"

VULNERABLE POPULATIONS

There has been an increase in the older adult population. Extreme weather events cause a range of health impacts and disruptions that vary across population groups. The vulnerability of a group is a function of its sensitivity to a hazard, exposure to risks, and capacity for responding or coping with the impacts. Children and older adults are often identified as groups vulnerable to climate change threats, including extreme weather and natural disasters. For example, physiologically these groups have a lower capacity to tolerate extreme heat and are often dependent on others for transportation to cooling centers. These groups are also often critically dependent on others during a disaster, such as needing help to evacuate during a flood or wildfire, or to find alternative housing if displaced. Planning for the specific needs of vulnerable populations strengthens local efforts to reduce the impact of extreme weather-related events. Population trend data provided here for HSEM Region 1 are intended to highlight the changes in two key demographic groups for the region, but planners and managers should also consider future changes in other populations of concern, such as those with low incomes, immigrant groups, indigenous peoples, persons with disabilities, or vulnerable occupational groups (such as outdoor workers):



Childhood Population (0-14) Projection Estimates for HSEM Region 1

2015	2050	Change
123,987	101,405	18.2%



Elder Population (65+) Projection Estimates for HSEM Region 1

2015	2050	Change
108,389	170,325	+57.1%

REGION 1 CASE STUDY

The following case study is intended to illustrate the links between climate and weather and natural disasters. Acting as a “focusing event,” the case study demonstrates how a previous weather-related event (i.e., flood) impacted important economic drivers, environmental resources, and population health. Then, the Climate Projection Data section compares weather data from the case study with baseline and projected weather data to show the possibilities of future disaster events. This case study highlights the relevancy of climate projection data for understanding future climate and weather risks in Minnesota.

EVENT: FLOOD

DATE: 2007

Beginning on August 18th, a series of intense thunderstorms dropped heavy rain on much of southern Minnesota. Over the course of just three days, all or portions of 28 counties received at least four inches of rain, far above historical averages for the entire month. Six-inch totals were common, and some areas in southeastern Minnesota reported record-breaking amounts ranging from eight to 18 inches. The heaviest rainfall occurred in Winona, Fillmore, and Houston counties. An official National Weather Service (NWS) reporting location in Houston County measured 15.10 inches in the 24-hour period ending at 8 am on Sunday, August 19th, setting a new state record.

The combination of rainfall totals and large geographic area affected made this episode one of the most significant “mega-rain” events in Minnesota’s climate history. This historic extreme rainfall event triggered widespread catastrophic flooding in many areas of the Upper Mississippi River Valley and across HSEM Region 1. River and flash flood warnings were issued for nearly two days given the scope of the heavy rain, massive flooding, and infrastructure damage.

REGION 1 CASE STUDY: KEY IMPACTS

It is nearly impossible to capture all the various impacts from a natural disaster. These impacts broadly include costly infrastructure damage, disrupted utility service, prolonged work and school absences, acute physical injury, and persistent strains on mental health, on scales ranging from the community to the household to the individual.

The extensive damage associated with the August 2007 flood is difficult to capture in a single cost estimate. Federal assistance allocated to Dodge, Fillmore, Houston, Olmsted, Steele, Wabasha, and Winona counties to address flood damages exceeded 31 million dollars. The NWS estimated that damage costs for flood impacted areas exceeded 200 million dollars.

The following are just a few examples of the adverse impacts on HSEM Region 1 communities from the August 2007 extreme rainfall event:

PUBLIC SAFETY: Flooding was tied to seven fatalities and numerous injuries, many associated with individuals attempting to drive vehicles through high water. There were reports of at least a dozen boat rescues of individuals from cars and homes.

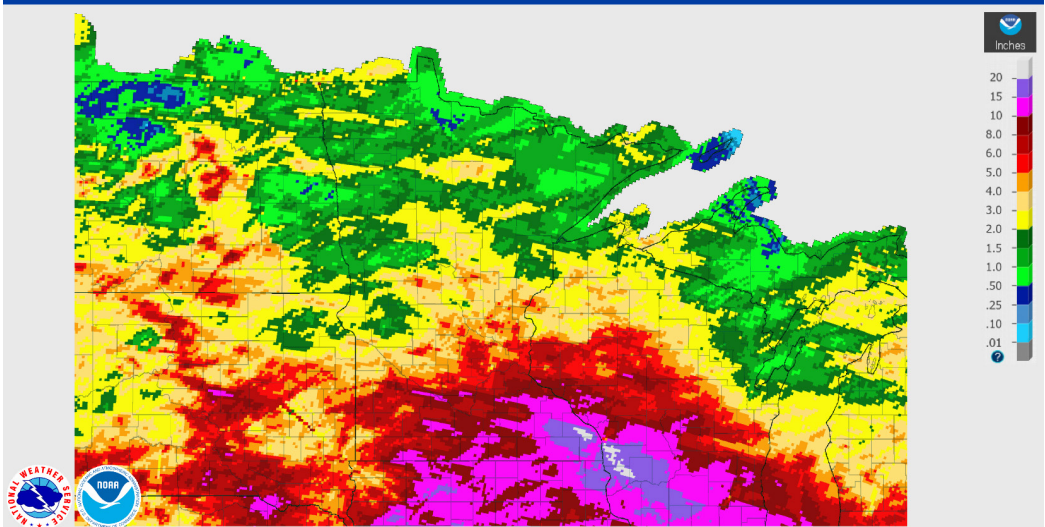
DRINKING WATER QUALITY: Fallen trees and mudslides severely damaged power lines. Many municipal wastewater plants were overwhelmed and forced to bypass untreated sewage. Nearly 50 public water supplies (PWS) were damaged or destroyed. While nearly all community PWS systems were restored within a few days, five non-community PWS were destroyed and 10 experienced significant damage and persistent bacteria problems.

DISPLACEMENT & DISRUPTED COMMUNITY NETWORKS: Evacuations were widespread, ranging from individual residences and businesses to mobile home parks, campgrounds, and nursing homes, which were flooded or collapsing due to mudslides. Extensive sand bagging efforts were required in many areas, and the Red Cross set up evacuation shelters.

INFRASTRUCTURE FAILURES: Many railroad beds, county roads, state highways, bridges, and retaining walls were washed out, buckled, or damaged by mudslides. At least 30 significant petroleum spills occurred requiring response by the Minnesota Pollution Control Agency.

August 01, 2007 Monthly Observed Precipitation

Created on: August 07, 2018 - 20:03 UTC
Valid on: September 01, 2007 12:00 UTC



Monthly Observed Precipitation for August 2007 (National Weather Service, 2007)



“

Over the course of just three days, all or portions of 28 counties received at least four inches of rain, far above historical averages for the entire month.

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*Top: Rushford, MN (Jeff Thompson, 2007)
Bottom left: Kutzky Park (Melissa Egler, 2007)
Bottom right: Homeowner Pumping Water (Sea Stachura, MPR News, 2007)*

CLIMATE PROJECTION DATA

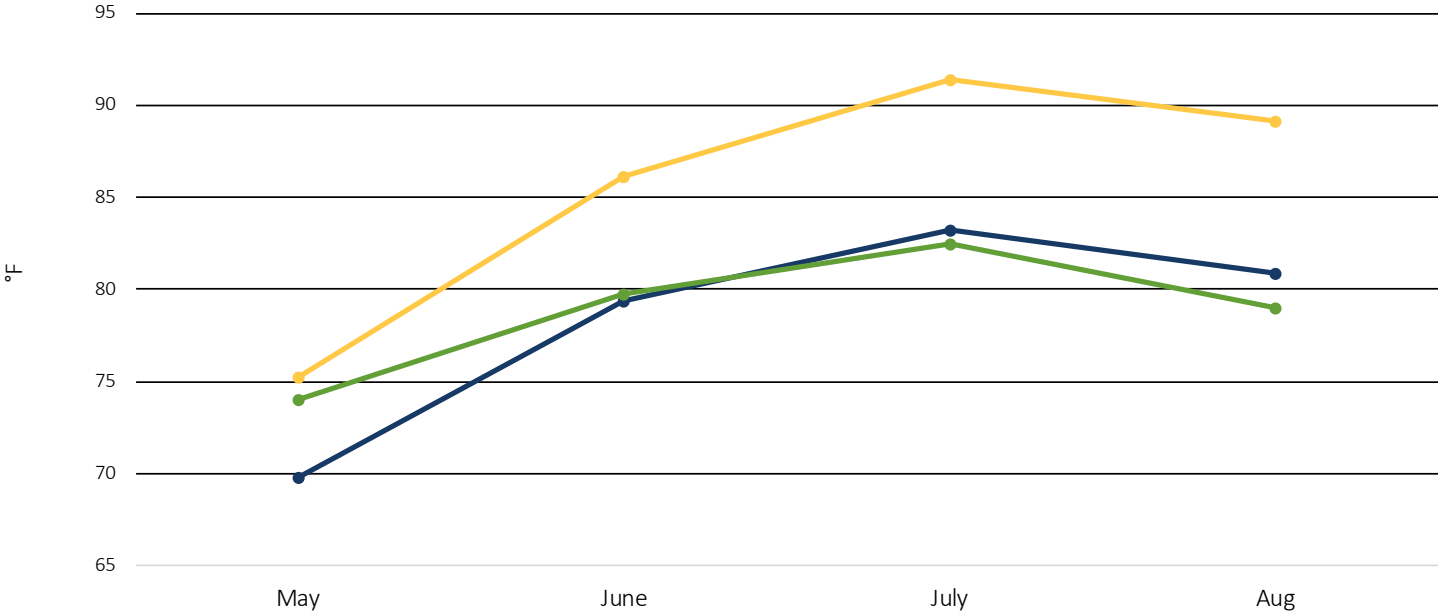
Following are visual representations of climate projection data for Region 1. Data for all counties included in Region 1 were averaged to derive regional estimates. (Data for individual counties are available in the long-form report.) The graphs below compare future temperature and precipitation projection data (in yellow) with a historical climate baseline (in blue) and climate measures from the regional case study event (in green). Because preceding conditions can influence a disaster event, data for months May, June, and July are also provided.

LEGEND

- **Historical:** 1981- 2010
- **Case Study:** 2007 flood
- **Projected:** 2050- 2074

Maximum Temperature

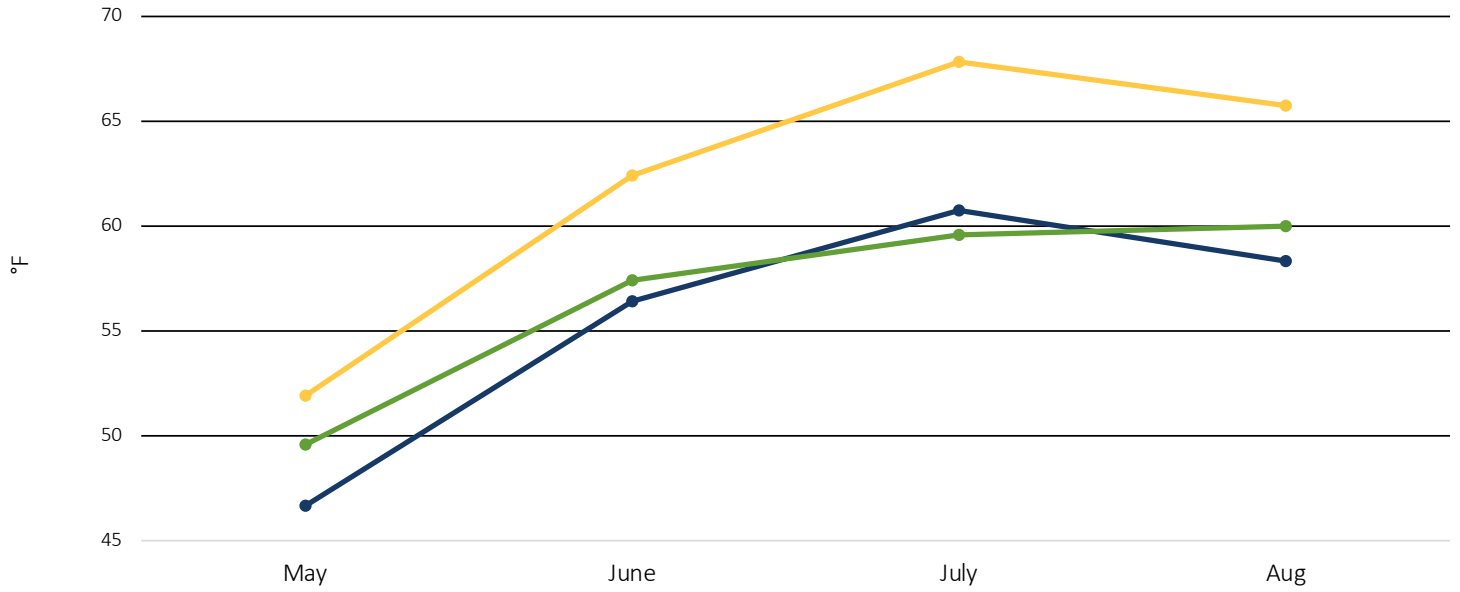
Trend comparison to 2007 flood data



	May	June	July	August
Historical: 1981- 2010	69.9	79.4	83.3	80.9
Case Study: 2007 flood	74.0	79.8	82.5	79.0
Projected: 2050- 2074	75.3	86.1	91.4	89.1

Minimum Temperature

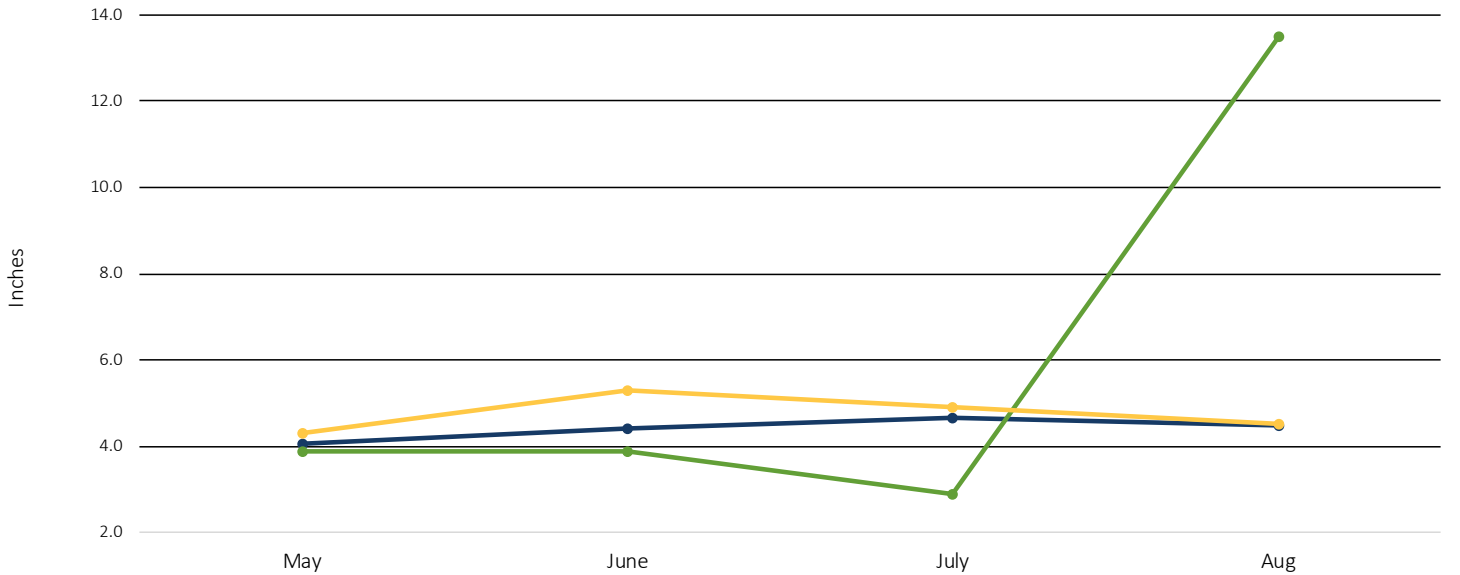
Trend comparison to 2007 flood data



	May	June	July	August
Historical: 1981- 2010	46.7	56.4	60.7	58.3
Case Study: 2007 flood	49.6	57.4	59.6	60.0
Projected: 2050- 2074	51.9	62.4	67.8	65.7

Total Precipitation

Trend comparison to 2007 flood data



	May	June	July	August
Historical: 1981- 2010	4.1	4.4	4.7	4.5
Case Study: 2007 flood	3.9	3.9	2.9	13.5
Projected: 2050- 2074	4.3	5.3	4.9	4.5

SUMMARY

CLIMATE DATA EXPERTS expect that future climate conditions across the Midwest will continue to change and affect our environment, economy, and public health. Although it is difficult to attribute any single weather event to the influence of climate change, the mega-rain event that occurred in August 2007 represents the type of extreme rainfall event climate experts expect to see more of in the near future. Minnesota has experienced a four-fold increase in mega-rain events since the year 2000. These are events in which six inches of rain covers more than 1,000 square miles and the core of the event exceeds eight inches. Events of this scale and magnitude represent a substantial flood risk as demonstrated by the August 2007 rainfall. According to the NWS, 30 flash flood warnings and 31 river flood warnings were issued related to this event.

Why is climate change causing more extreme precipitation? Put simply, warming of the earth increases evaporation and warmer air can hold more water vapor. For each degree of warming, the air's capacity for water vapor goes up by about 7 percent, and an atmosphere with more moisture can produce more intense precipitation events. In addition, prolonged high heat days speed soil evaporation and coupled with extended periods of low rainfall can lead to hard soils that are less absorptive. When heavy rain events occur, these hard, dry soils can cause excessive runoff that overwhelm sewers and lead to severe flooding.

A comparison of precipitation data for the August 2007 event with past and future trends underscores how abnormal this event was historically, but provides little insight into how the probability of this event may increase in the future, particularly since average overall rainfall for August is not projected to change. However, monthly precipitation averages for May, June, and July are projected to increase. Even slight increases in average values could mean dramatic increases in extremes. It is difficult to project exactly how extreme these potential changes may become in the next few decades. Given expert consensus that extreme rainfall events will increase in the Midwest, recent historical data from Minnesota substantiating that trend, and the catastrophic potential of flood disasters support decision-making aimed at increasing community resilience to flooding. Resiliency strategies vary widely according to method of implementation and cost. Yet, many, like conservation practices, are proving highly effective at reducing flood risk. For example, the August 2007 flooding prompted an inventory of approximately 1,600 water and sediment control basins in Winona County, which not only held up well during the event, but contributed substantially to reducing peak stream and river flows and associated erosion (Kean, 2011).

Climate data is a critical tool in planning for resilient communities into the future.

CLIMATE DATA IS A CRITICAL TOOL in planning for resilient communities into the future. Assessing threats from climate change and planning effective mitigation and response strategies is a key element for emergency managers and other planners to reduce future risk. It's crucial to understand the potential impacts of climate change and the associated priorities and vulnerabilities of communities, including population, the environment, critical infrastructure, and more. However, vulnerability is a nuanced concept and most effective as an indicator of risk when planners seek to understand and address vulnerability as close to the individual level as possible and in association with a specific hazard.

Population projections for HSEM Region 1 show a slight decrease in children but a substantial increase in elders. As older populations tend to have a greater need for health care services, disrupted access due to flooded roads or power outages is a major concern. Furthermore, evacuation and displacement from residences and support networks have greater adverse impacts on older individuals, making this a difficult response strategy to rising floodwaters and associated mudslides. Considering the impacts of climate change to vulnerable populations is just one example of how to prioritize mitigation and response planning.

CLIMATE PROJECTION DATA continues to improve and should be considered as a priority to advance for Minnesota. The precipitation projection data used for this profile were only available as monthly averages, and thus obscure the probability of daily, even hourly extremes that are the true drivers of flood risk. Minnesota would benefit from a statewide high-quality climate projection dataset that is derived using the climate and environment features unique to our state, similar to datasets developed for other states. Meanwhile, data from national resources, like the U.S. Geological Survey (USGS) and National Oceanic and Atmospheric Administration (NOAA), can still provide a powerful input to regional scenario-planning efforts by allowing planners, managers, and analysts a means of "unpacking" general climate change predictions for the Midwest by looking at potential monthly fluctuations in coarse precipitation and temperature measures for Minnesota and its counties.

NEXT STEPS: MINIMIZE RISK & BUILD RESILIENCE

Prepare today for tomorrow's climate hazards. Emergency managers, planners, elected officials, and the public play a critical role in creating safe and healthy communities, especially in the face of extreme weather events. There are steps you can take to minimize local risk and build more resilient communities:



BRING EVERYONE TO THE TABLE: Build an inclusive yet nimble team to collectively identify climate hazards and potential impacts. Be sure to include members of the community; local department professionals responsible for built, natural, and health resources; planning commissioners; faith-based and cultural organizations; research centers; and commercial organizations. Including diverse perspectives throughout your process will help support more equitable planning efforts that best leverage cross-functional resources.



INCORPORATE CLIMATE INTO PLANNING: Incorporate climate projection data into planning efforts, such as exercise scenarios and long-range planning, to comprehensively identify future climate hazards and potential cascading effects. Explore how these interact with non-climate hazards in the community, such as aging infrastructure, to understand potential exposure to multiple threats and prioritize actions that build the community's capacity to respond.



CHAMPION CLIMATE & HEALTH: Be a champion for climate and health data. Seek opportunities to learn about these data and incorporate it in your work on an iterative basis. Support its application in professional networks and articulate the need to fund dynamically downscaled climate projection datasets for Minnesota. Climate data is a critical multi-discipline tool in proactively planning for resilient communities.

RESOURCES & REFERENCES

TOOLS & DATA

- [Advanced Hydrologic Prediction Service](https://water.weather.gov/precip/), National Weather Service
Data source for historical, current, and short-term future precipitation and river forecasts for all U.S. states.
<https://water.weather.gov/precip/>
- [Climate at a Glance: National Climatic Data Center](http://www.ncdc.noaa.gov/cag/), National Oceanic and Atmospheric Administration
Source for all historical and much of the case study data presented in this profile.
www.ncdc.noaa.gov/cag/
- [Minnesota Climate and Health Profile Report \(PDF\)](http://www.health.state.mn.us/divs/climatechange/docs/mnprofile2015.pdf), Minnesota Department of Health
Profiles historic climate trends, future projections, and likely climate change impacts on the health of Minnesotans.
<http://www.health.state.mn.us/divs/climatechange/docs/mnprofile2015.pdf>
- [Minnesota Climate Change Vulnerability Assessment \(PDF\)](http://www.health.state.mn.us/divs/climatechange/docs/mnclimvulnreport.pdf), Minnesota Department of Health
Assesses five climate hazards and the populations that are most vulnerable to the hazards in Minnesota.
<http://www.health.state.mn.us/divs/climatechange/docs/mnclimvulnreport.pdf>
- [Minnesota Population Projection Data](https://mn.gov/admin/demography/data-by-topic/population-data/our-projections/), Minnesota State Demographic Center
Source for all population projection data presented in this profile.
<https://mn.gov/admin/demography/data-by-topic/population-data/our-projections/>
- [National Climate Change Viewer](http://www2.usgs.gov/climate_landuse/clu_rd/nccv/viewer.asp), United States Geological Survey
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RESOURCES & REFERENCES

KNOWLEDGE & CAPACITY

- [Climate Change and Minnesota](#), Minnesota Department of Natural Resources
Source of information on climate change trends and impacts for Minnesota, with an emphasis on natural resources.
https://www.dnr.state.mn.us/climate/climate_change_info/index.html
- [Five Steps Toward Enhancing Climate Resilience](#), Emily Wasley, DomesticPreparedness.com
Practical action steps to help emergency managers build a path to enhance their climate resilience.
<https://www.domesticpreparedness.com/resilience/five-steps-toward-enhancing-climate-resilience/>
- [Flooding in Minnesota](#), Minnesota Department of Natural Resources
Comprehensive catalog of drought information.
<https://www.dnr.state.mn.us/climate/floods/index.html>
- [U.S. Climate Resilience Toolkit](#), United States Global Change Research Program
Information and tools to help communities adapt to climate change, featuring real-world case studies.
<https://toolkit.climate.gov/>

REFERENCES

- Kean, 2011. [Brief Analysis of Flooding in Minnesota \(PDF\)](#). Minnesota Board of Water & Soil Resources
http://www.bwsr.state.mn.us/publications/flooding_analysis-2011.pdf



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Front cover photo: Washout (Sea Stachura for MPR, 2007)

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