

Impacts of Future Weather Trends on Public Infrastructure Needs and Design

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Minnesota's Climate is Already Changing

Minnesota's climate is already changing rapidly and will continue to do so into the foreseeable future.

These changes are impacting Minnesota's wildlife, plants, waters, historic resources, infrastructure, and available outdoor recreation activities.

We have a responsibility to adapt to these changes.

We take mitigation steps to reduce our carbon dioxide and other greenhouse gas emissions.

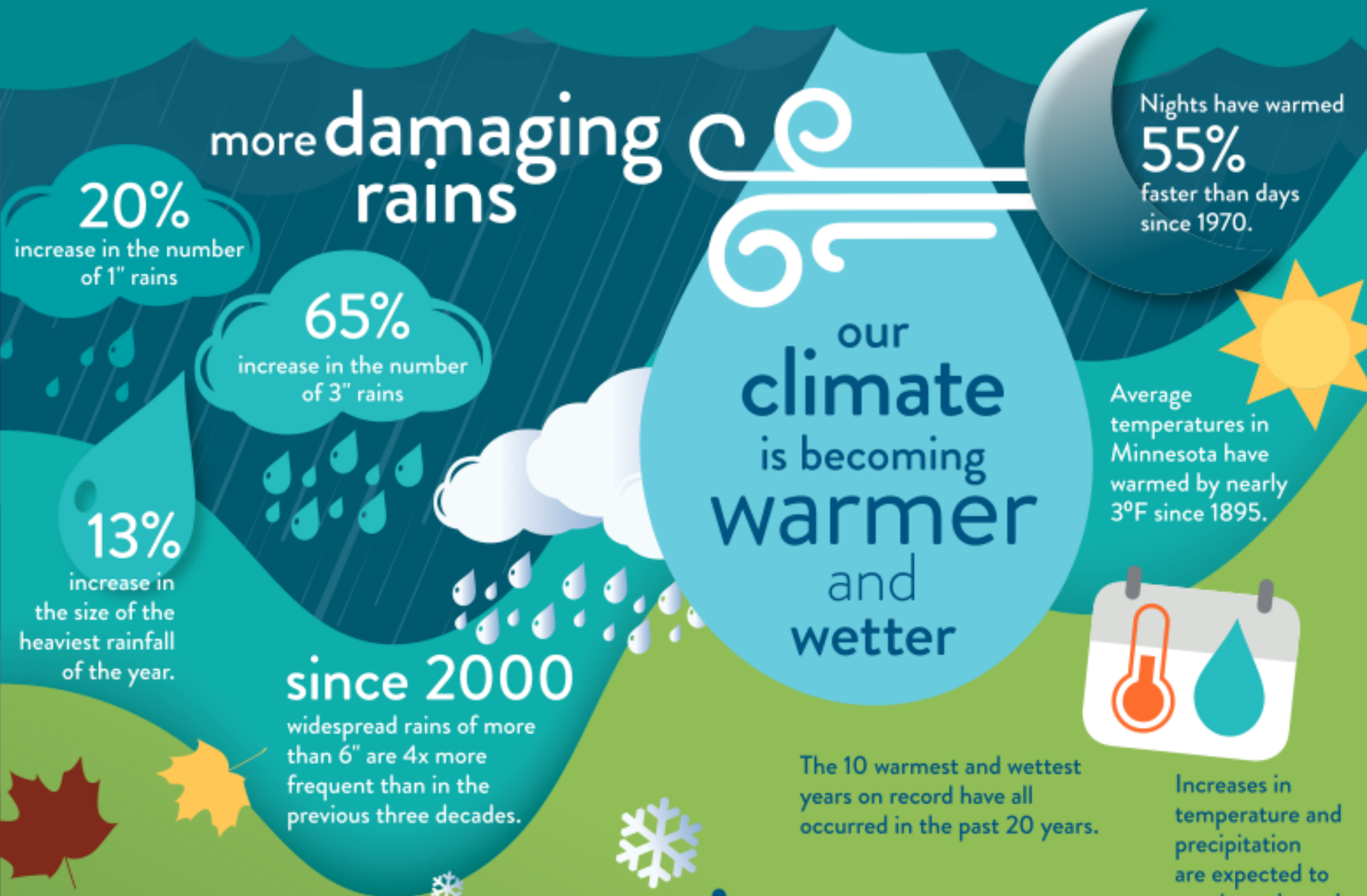
We need your help to adapt to the changing climate and reduce its impact on Minnesota's resources and people.

Action starts with you.

Find out more!
mndnr.gov/climate



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more **damaging rains**

20%
increase in the number of 1" rains

65%
increase in the number of 3" rains

13%
increase in the size of the heaviest rainfall of the year.

since 2000
widespread rains of more than 6" are 4x more frequent than in the previous three decades.

Nights have warmed **55%** faster than days since 1970.

Average temperatures in Minnesota have warmed by nearly 3°F since 1895.

our **climate** is becoming **warmer** and **wetter**

The 10 warmest and wettest years on record have all occurred in the past 20 years.

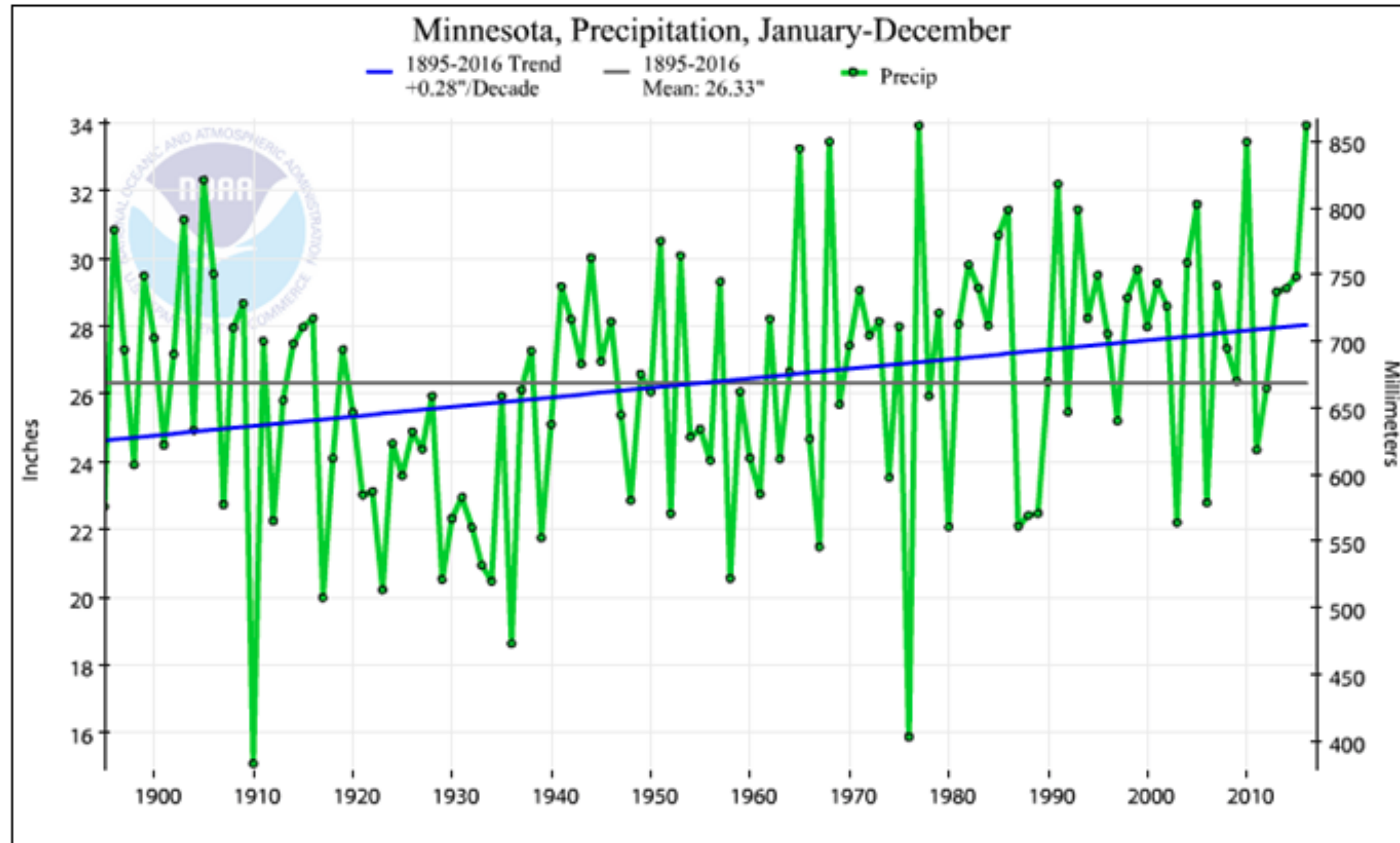
Increases in temperature and precipitation are expected to continue through the century.

The length of the frost-free season is increasing over time and is expected to continue to increase through the century.

winter is warming much faster than summer with fewer days and nights of extreme cold.

Potential Future Weather Changes

Precipitation has been increasing in Minnesota over the last century, as shown in the Figure below, which illustrates historic annual precipitation, from 1865-2016.

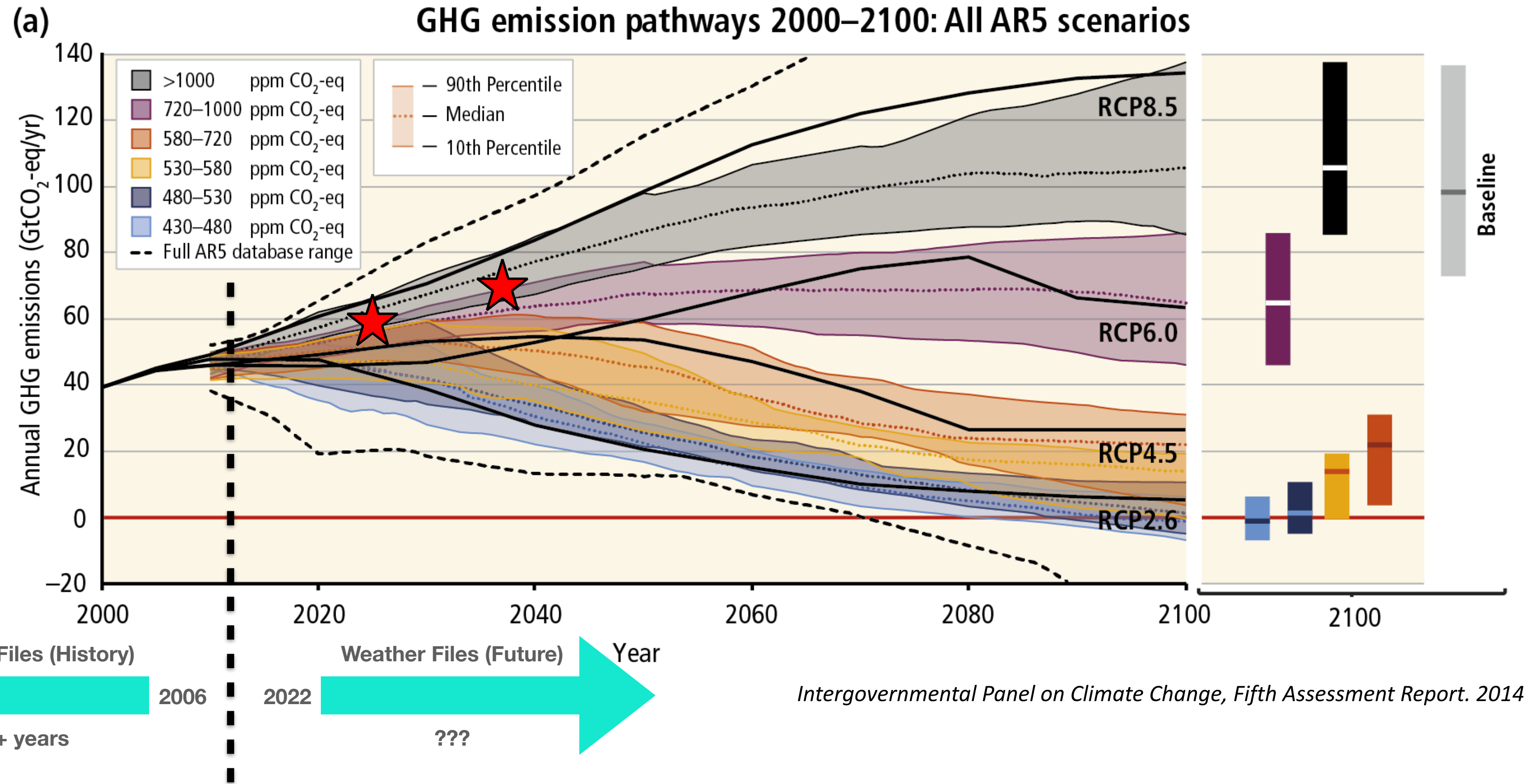


Between 1958 and 2012, the Midwest has already experienced a 37% increase in larger rain events of 2.5 inches or greater.

Potential Future Weather Changes



Potential Future Weather Changes



Potential Future Weather Changes

Strategy	Hours: Actual and Percentage					
	Now		2030		2040	
Comfort	942	11%	885	10%	936	11%
Sun Shading of Windows	586	7%	778	9%	817	9%
High Thermal Mass	154	2%	217	2%	240	3%
High Thermal Mass Night Flushed	154	2%	228	3%	256	3%
Direct Evaporative Cooling	109	1%	179	2%	198	2%
Two-Stage Evaporative Cooling	111	1%	192	2%	216	2%
Natural Ventilation Cooling	104	1%	162	2%	170	2%
Fan-Forced Ventilation Cooling	72	1%	104	1%	106	1%
Internal Heat Gain	1589	18%	1353	15%	1361	16%
Passive Solar Direct Gain Low Mass	899	10%	826	9%	796	9%
Passive Solar Direct Gain High Mass	624	7%	559	6%	539	6%
Wind Protection of Outdoor Spaces	259	3%	254	3%	249	3%
Humidification Only	0	0%	0	0%	0	0%
Dehumidification Only	491	6%	659	8%	692	8%
Cooling, add dehumidification if needed	305	3%	549	6%	604	7%
Heating, add humidification if needed	4791	55%	4545	52%	4436	51%

Predicted Effectiveness of Comfort Strategies for Minneapolis / Saint Paul – Climate Consultant, UCLA Energy Design Tools Group



Needed Research

- Apply new and emerging downscaled climate data to Minnesota
- Model the impact of changing climate on energy efficiency and design
- Understand the impact of changing climate on site and water design to increase resilience
- Assess additional risks and impacts and develop the role infrastructure can play to reduce those impacts





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