Climate Change in Minnesota: A Hydrologic Perspective

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Bassett Creek Watershed Management Commission
June 27, 2019
Golden Valley, MN

UNIVERSITY OF MINNESOTA
EXTENSION

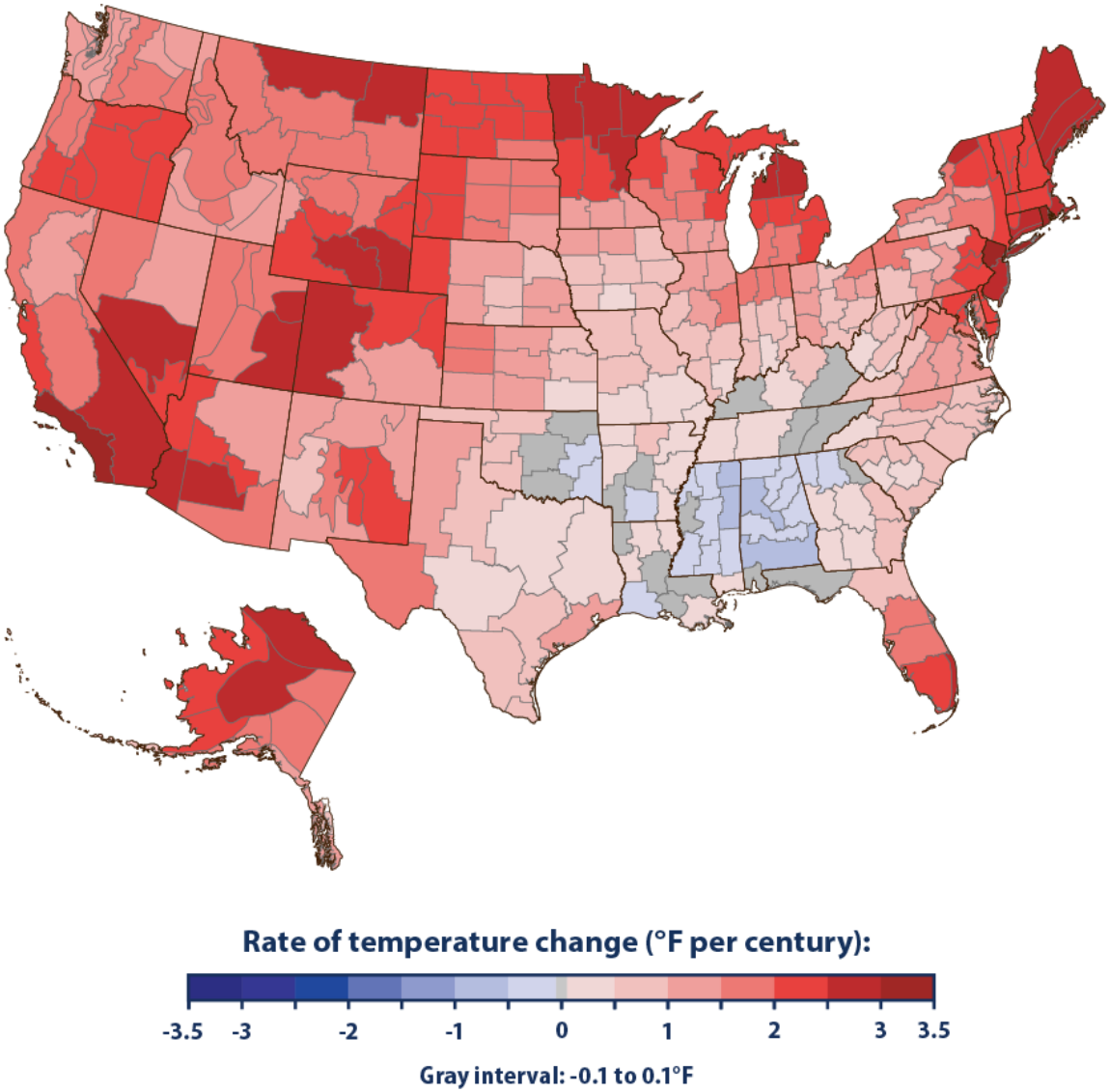
Extreme Weather Events for June 27th in Minnesota

108 degrees F at New London, MN
(Kandiyohi County)
June 27, 1934

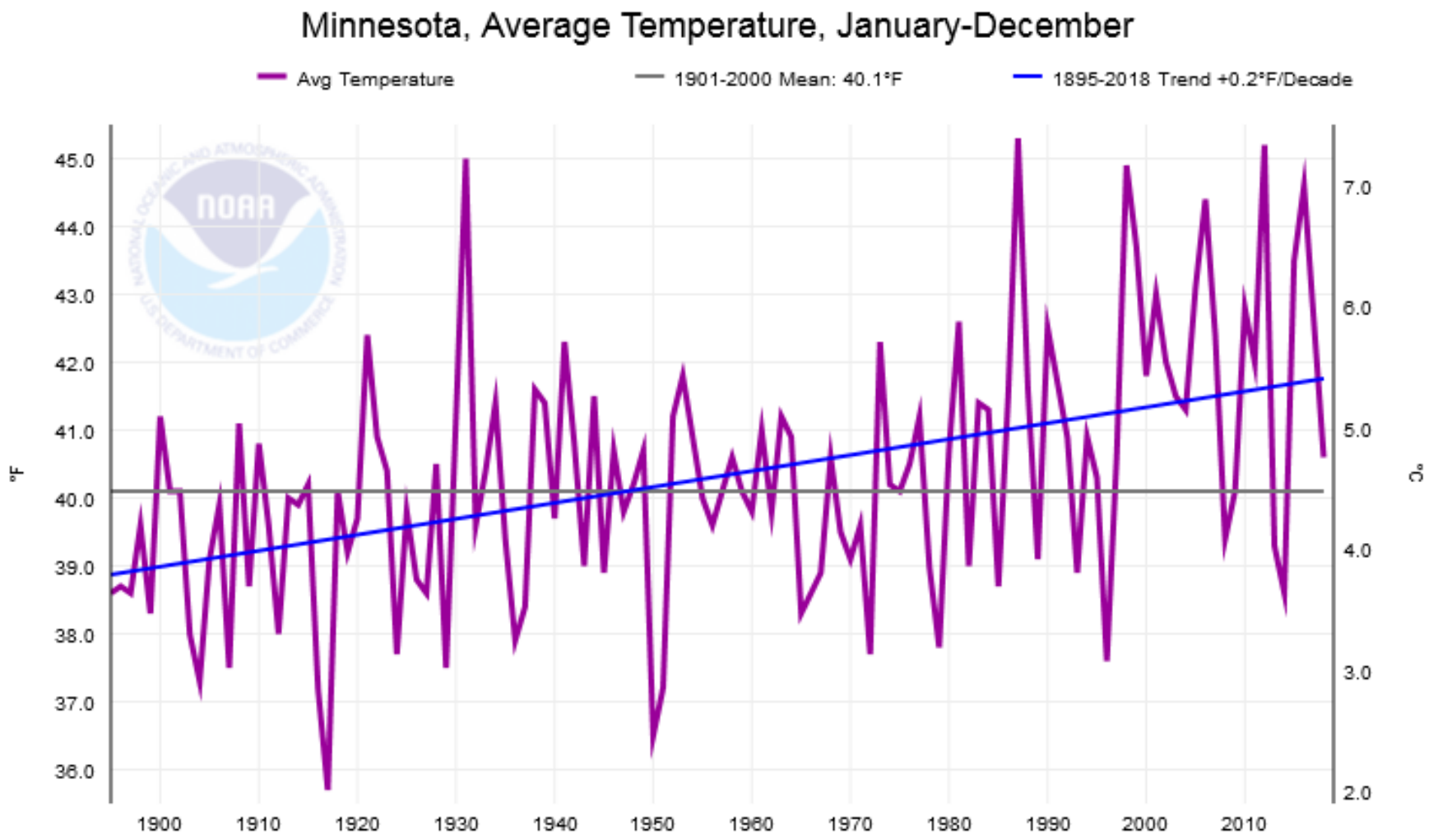
20 degrees F at Baudette, MN
(Lake of the Woods County)
June 27, 1970

Thunderstorm and Flash Flood
6.46” at Zumbrota, MN
(Goodhue County)
June 27, 1998

12 tornadoes in 13 counties
4 deaths, 86 injuries
June 27, 1894



Rate of Temperature Change in the United States, 1901-2015 (via NOAA) shows geographic disparity in the pace of climate change and the response to it. Temperature change is rapid in northern Minnesota

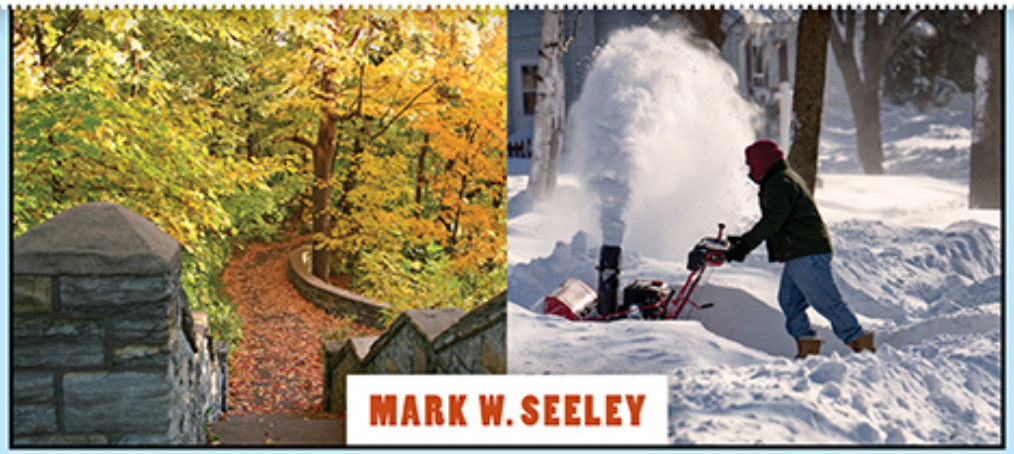


Trend in Mean Annual Temperature for MN

MINNESOTA
WEATHER ALMANAC

SECOND EDITION

Completely Updated for the New Normals



Measurable Attributes of Precipitation

Quantity

Type (liquid,frozen)

Intensity *(9-15”)*

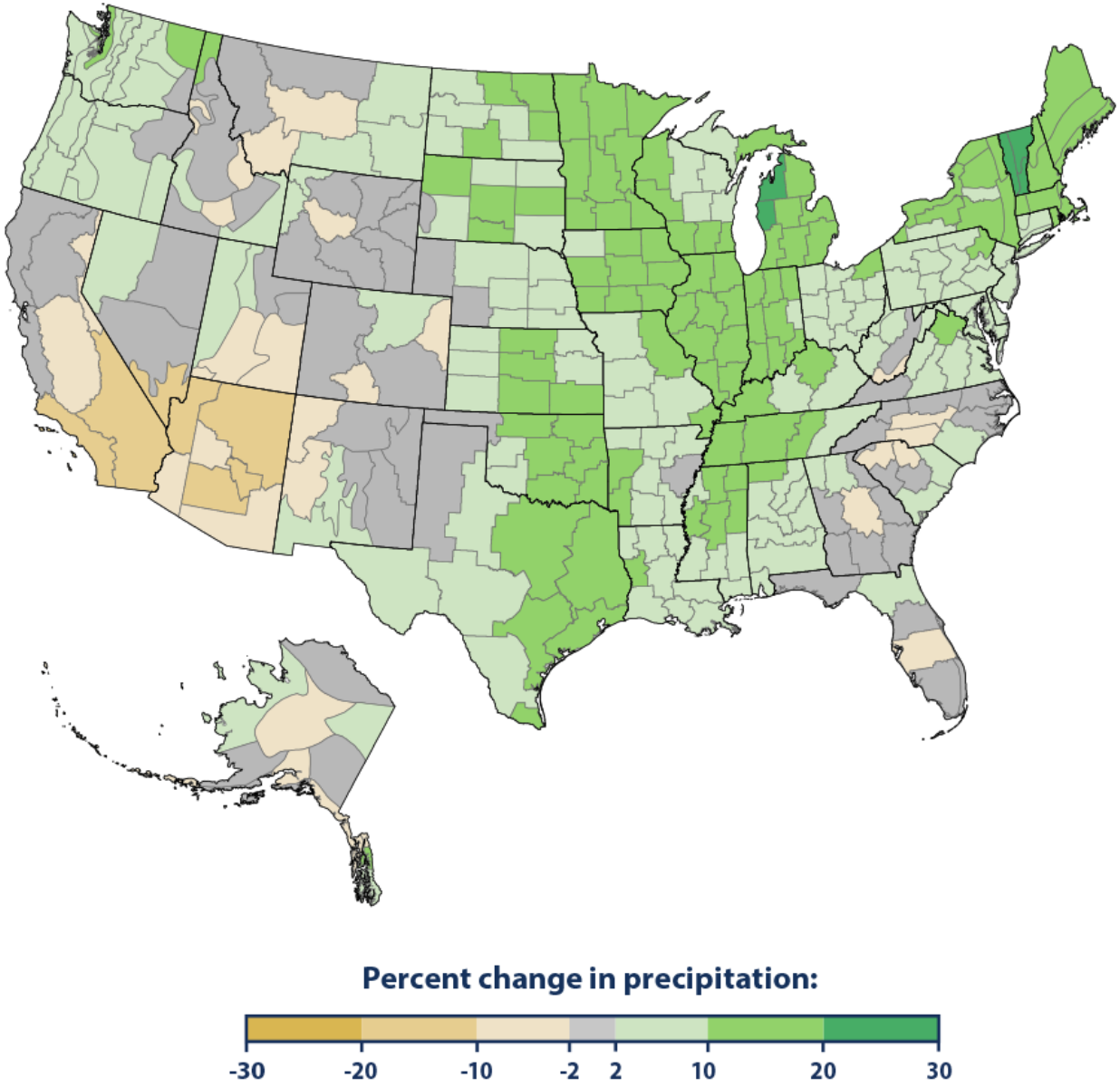
Frequency *(74-145 days)*

Duration *(10 days)*

Seasonality *(shifting)*

Landscape relationship

(interception, absorption, runoff, evaporation)



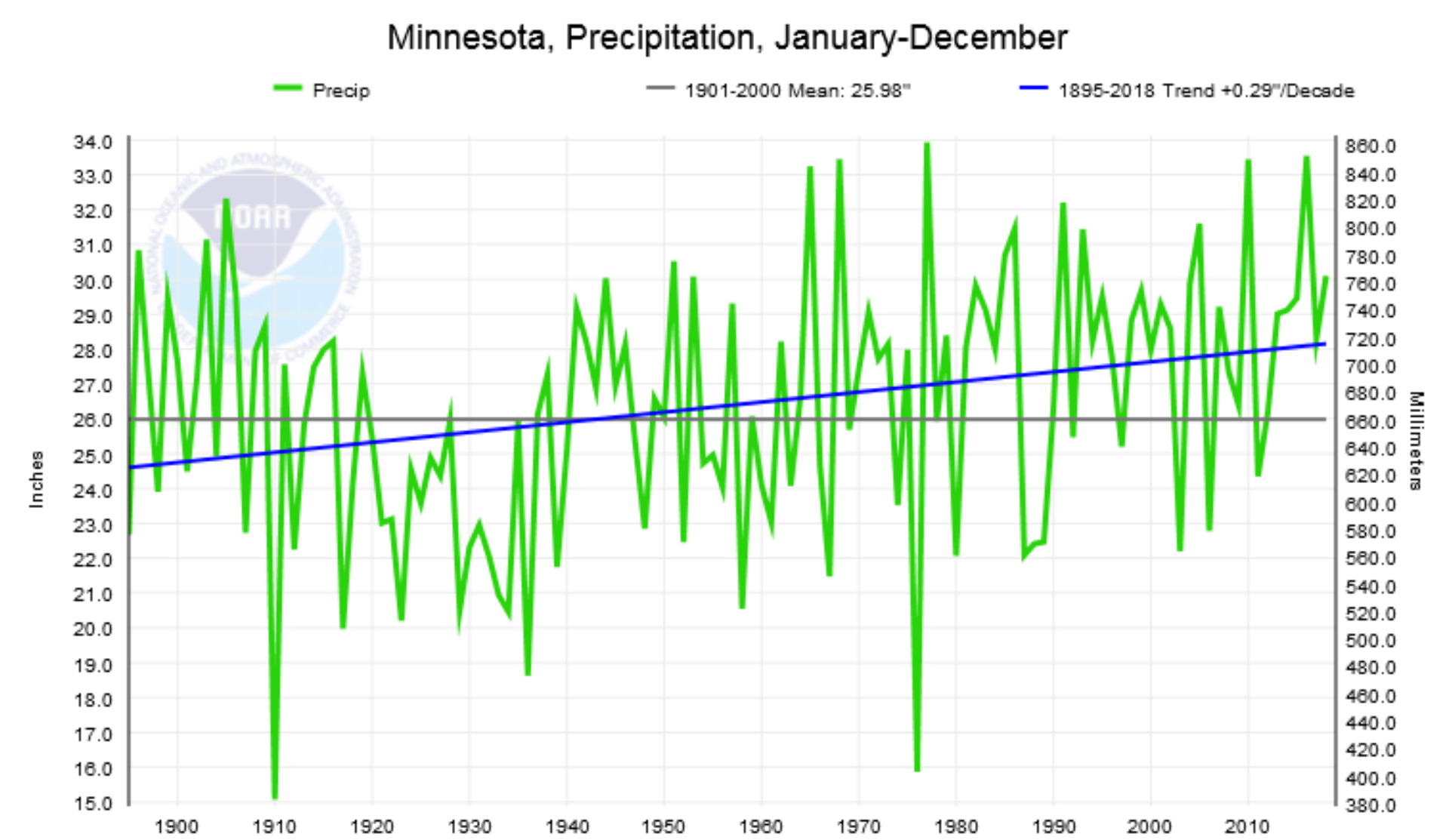
Change in Annual Precipitation in the United States, 1901-2015 (via NOAA) shows geographic disparity. Minnesota is getting wetter.

Ranked Listing of Minnesota's Wettest Years Back to 1895 (124 years)

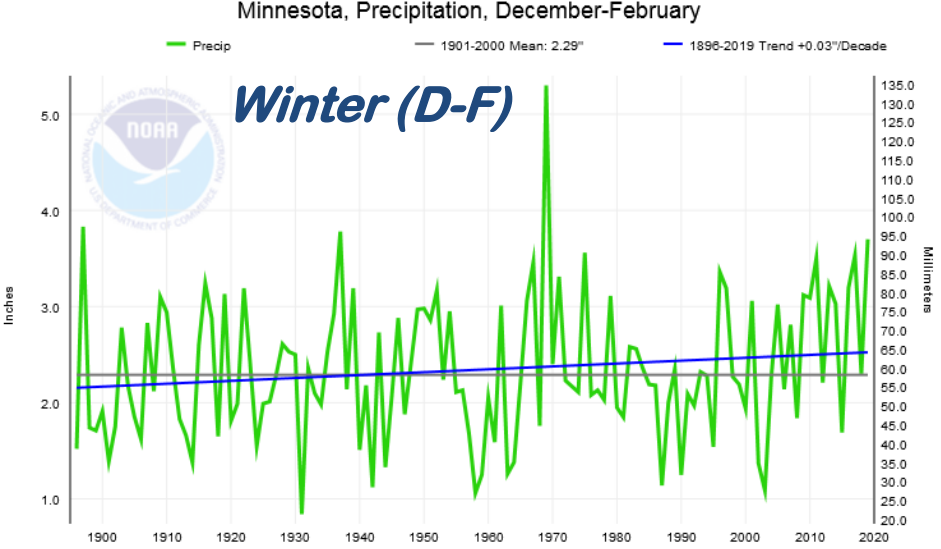
Top Ten Wettest January to December Periods on a Statewide Basis. (inches)

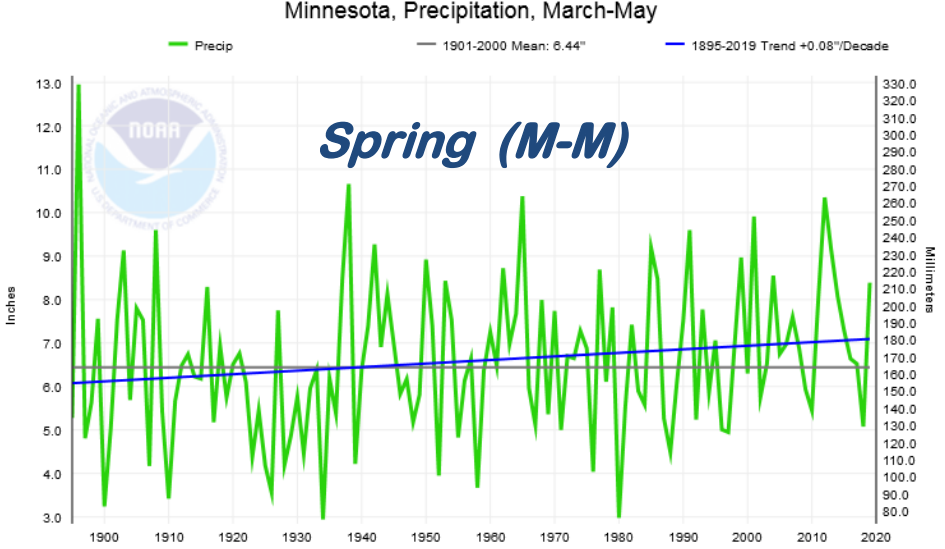
Rank	Year	Total	Normal	Dep.	%Norm
1	1977	33.93	27.92	6.01	122
2	2016	33.54	27.92	5.62	120
3	1968	33.45	27.92	5.53	120
4	2010	33.44	27.92	5.52	120
5	1965	33.24	27.92	5.32	119
6	1905	32.32	27.92	4.40	116
7	1991	32.20	27.92	4.28	115
8	2005	31.60	27.92	3.68	113
9	1986	31.45	27.92	3.52	113
10	1993	31.44	27.92	3.52	113

* 2018 ranked 15th

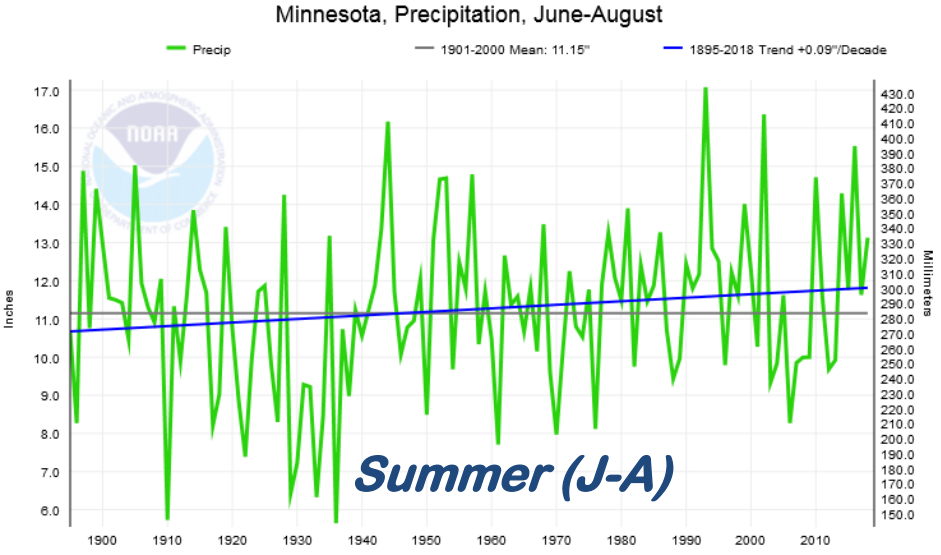


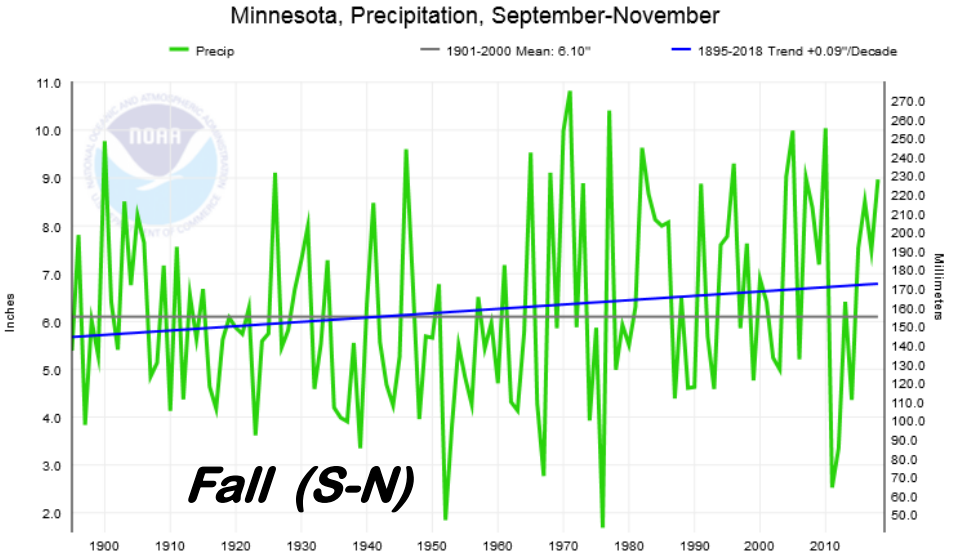
Trend in annual precipitation for MN



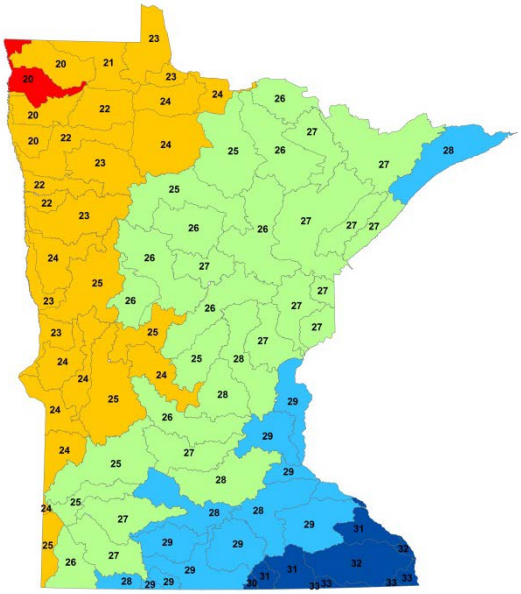


Seasonal Statewide Precipitation Trends in MN

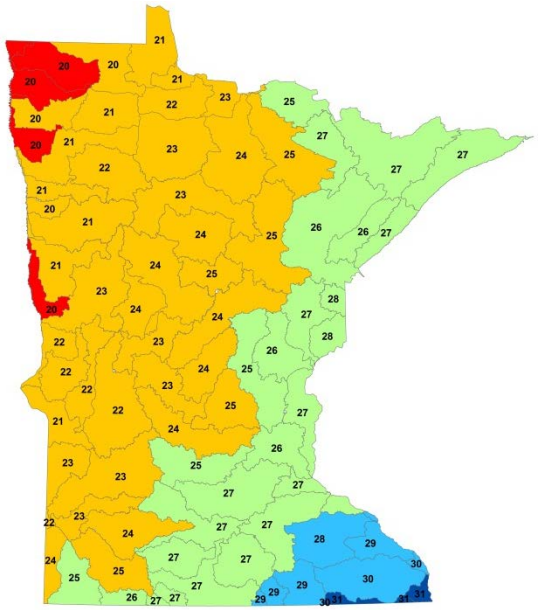




Average Annual PPT 1891-1920, in



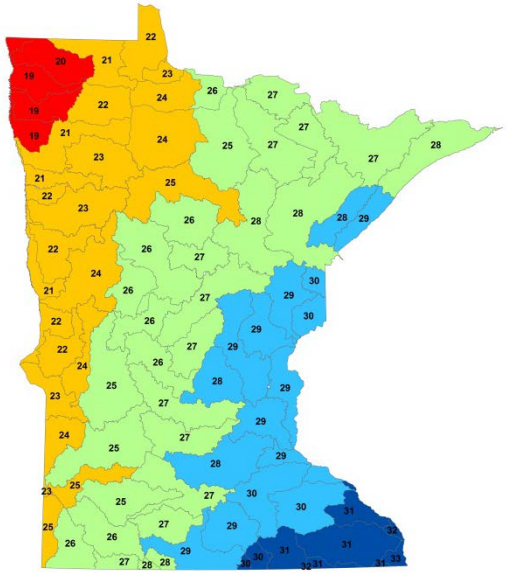
Average Annual PPT 1921-1950, in



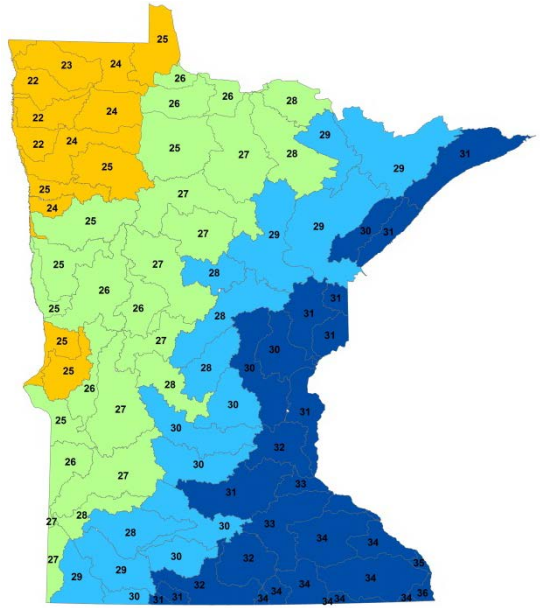
Avg. Annual PPT, in

- < 20
- 21 - 25
- 26 - 28
- 29 - 30
- > 30

Average Annual PPT 1951-1980, in



Average Annual PPT 1981-2010, in



Source: MN-SCO

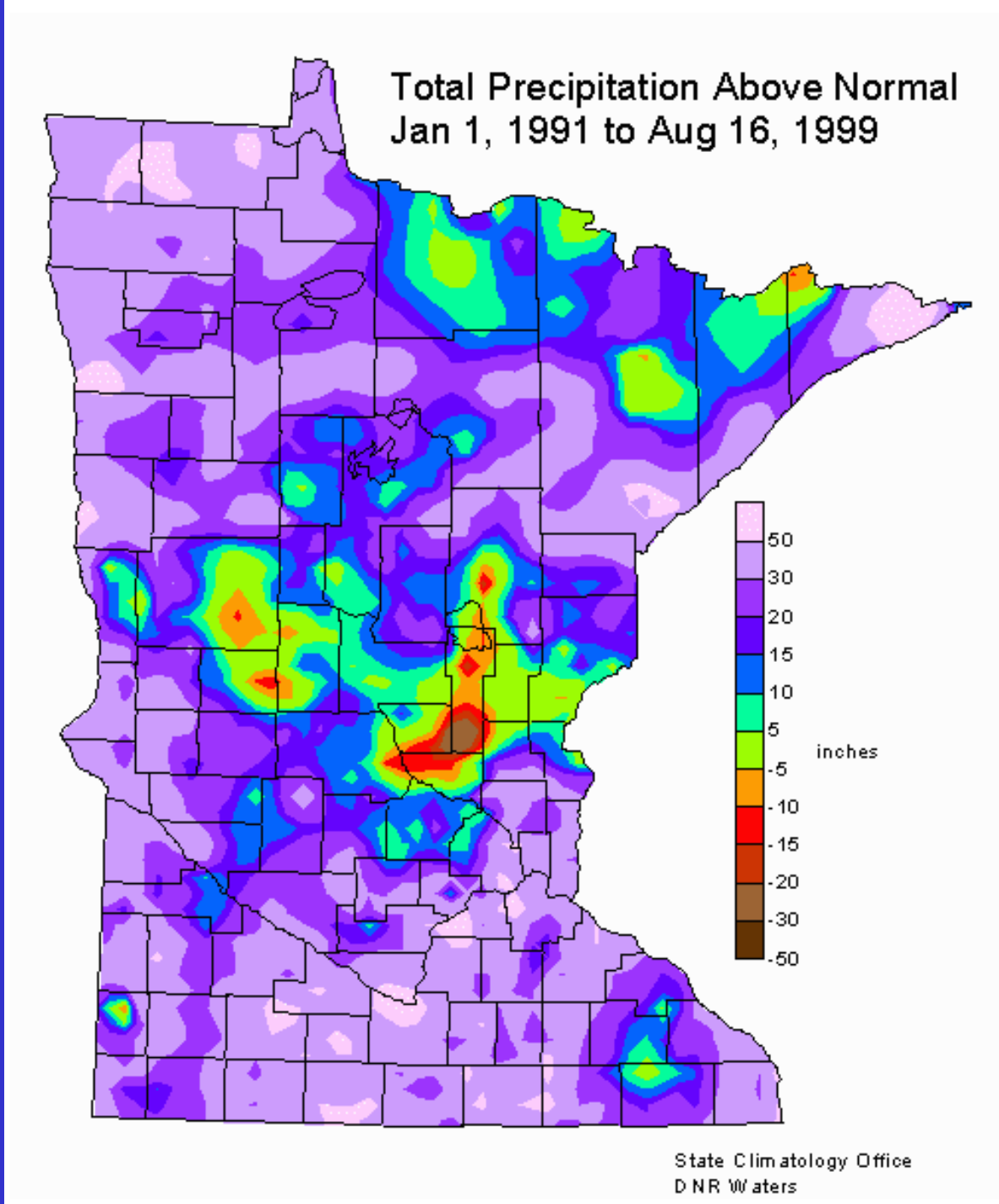
Change in Annual Precipitation "Normals" at Faribault, MN

PERIOD	AMOUNT (IN.)
1921-1950	24.80″
1931-1960	27.06″
1941-1970	29.49″
1951-1980	30.30″
1961-1990	31.00″
1971-2000	31.67″
1981-2010	32.63″

31 percent increase since 1921-1950 period

Extremes: 10.81″ in 1910, 42.20″ in 1951

1990s wettest decade of the 20th Century in Minnesota



Radiosonde history of PW at MSP since 1948

(Most record high values have occurred since 1990)

Change in Frequency of Extreme Climate Attributes

Only one occurrence of TRW>10” before 1972, 18 such episodes since (16.27” at Hokah in August 2007)

No measurement of 80°F dew points in history until 1983, scores of measurements since, including 88°F at Moorhead on July 19, 2011

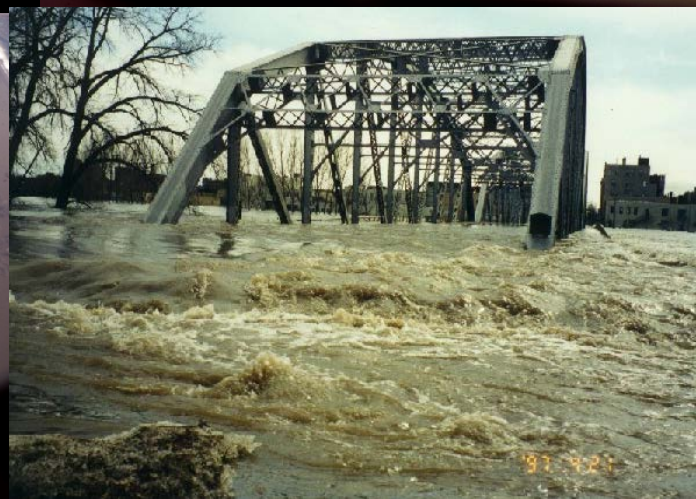
No measurement of 52 inches of annual precipitation in Minnesota history until 1991, ten such measurements since then, including 60.21” at Harmony in 2018

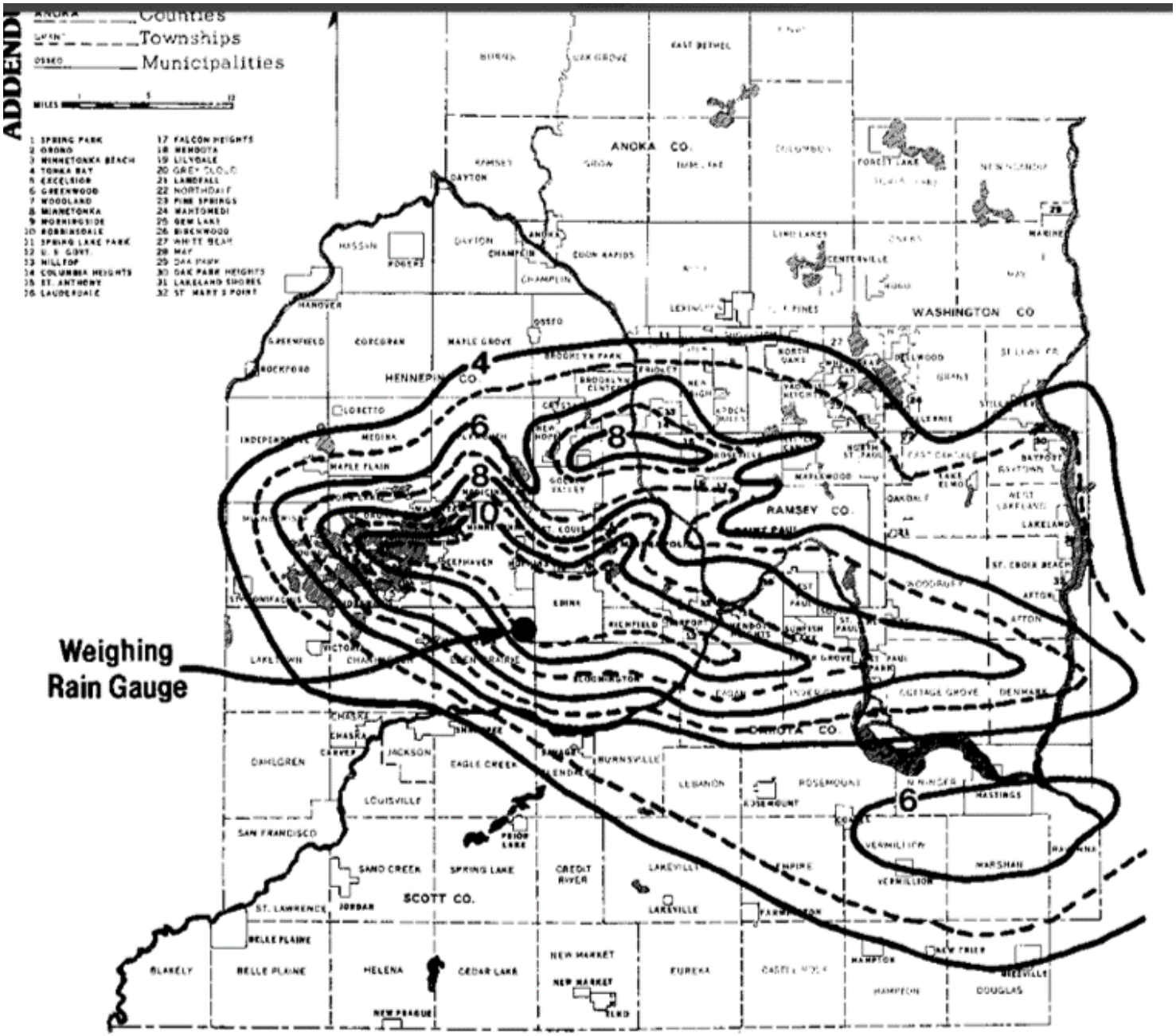
Historic Crests at Fargo, ND

Historic Crests

(1) 40.84 ft on 03/28/2009
(2) 39.72 ft on 04/18/1997
(3) 39.10 ft on 04/07/1897
(4) 38.81 ft on 04/09/2011
(5) 37.34 ft on 04/15/1969
(6) 37.13 ft on 04/05/2006
(7) 36.99 ft on 03/21/2010
(8) 36.69 ft on 04/14/2001
(9) 35.39 ft on 04/09/1989
(10) 34.93 ft on 04/19/1979

Images of the April 22, 1997 Red River Valley Flood

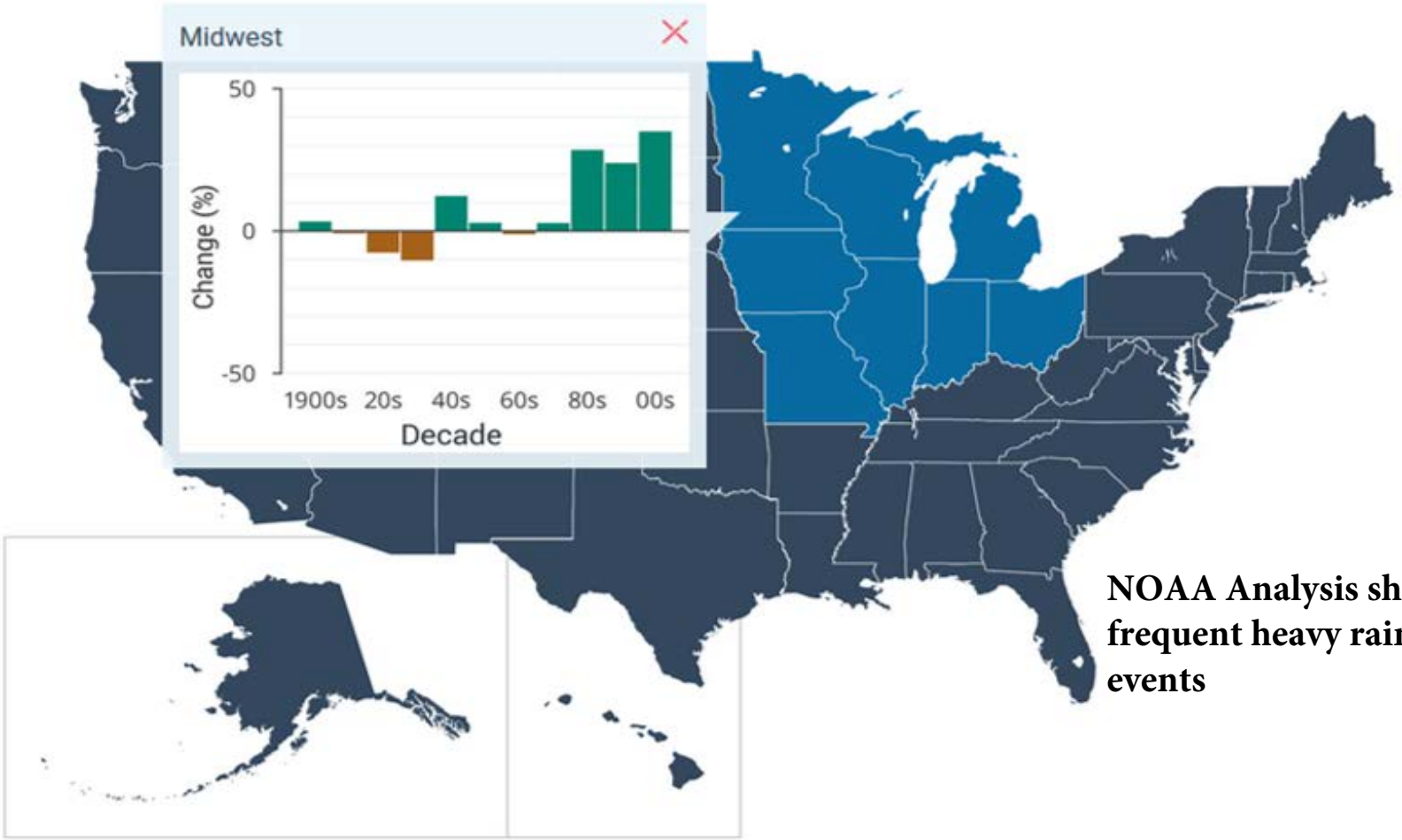




WESTERN AND SOUTH CENTRAL TWIN CITIES FLASH FLOOD - JULY 23-24, 1987

Worst flash flood in Twin Cities history Delivered 10 inches of rain in 6 hours

July 23-24, 1987 in the Twin Cities
10” in 6 hours, and 17.90” for the month



NOAA Analysis shows more frequent heavy rainfall events

Figure 2.17: Percent changes in the annual amount of precipitation falling in very heavy events, defined as the heaviest 1% of all daily events from 1901 to 2012 for each region. The far right bar is for 2001-2012. In recent decades there have been increases nationally, with the largest increases in the Northeast, Great Plains, Midwest, and Southeast. Changes are compared to the 1901-1960 average for all regions except Alaska and Hawai'i, which are relative to the 1951-1980 average. (Figure source: NOAA

Observations – Minnesota Trends

Minnesota Mega-rain Events

August 6, 1866, Southern Minnesota
July 17-19 1867, Central Minnesota
July 20-22, 1909, Northern Minnesota
September 9-10, 1947 Iron Range
July 21-22, 1972, Grand Daddy Flash Flood
June 28-29, 1975, Northwest Minnesota
July 23-24, 1987, Twin Cities Superstorm
June 9-10, 2002, Northern Minnesota
September 14-15, 2004 Southern Minnesota
August 18-20, 2007, Southern Minnesota
September 22-23, 2010 Southern Minnesota
June 19-20, 2012, Northeast Minnesota
July 11-12, 2016 central and east-central Minnesota
August 10-11, 2016 west-central and southeastern Minnesota

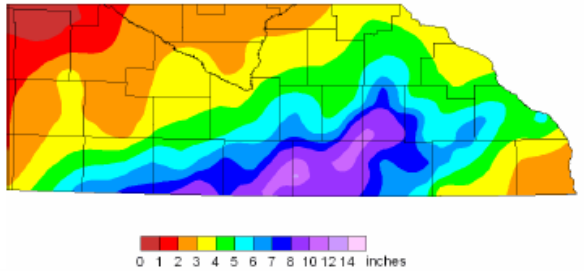
Defined as 6" or greater rains cover at least 1000 square miles and a peak amount of 8" or greater. Seven events from statehood (1858) to 2001, seven more since 2002.

Shift in Precipitation Recurrence Intervals

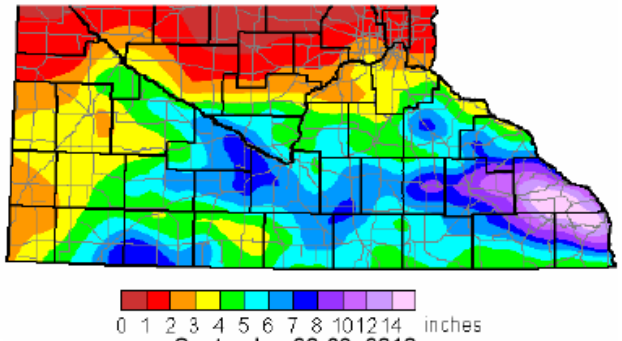
Mega Rains since 2002 show even northern Minnesota is vulnerable .

'1000-yr (approx.) events' in Southern Minnesota in the last decade.

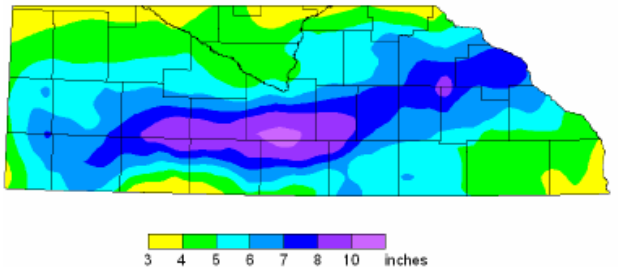
September 14-15, 2004



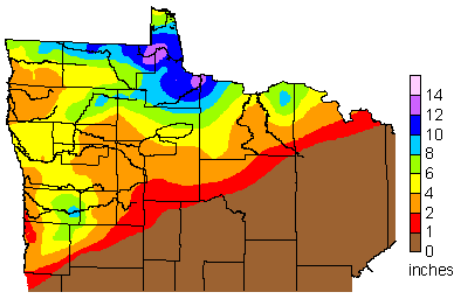
August 18 through August 20 (8:00 AM CDT), 2007



September 22-23, 2010

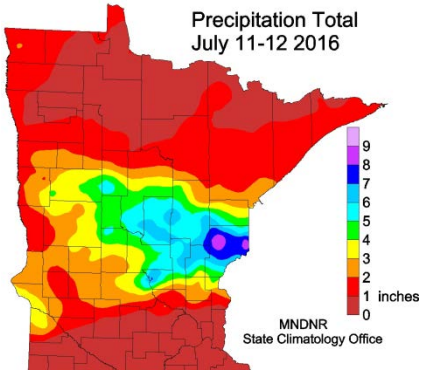


Rainfall Totals - June 9 and 10, 2002



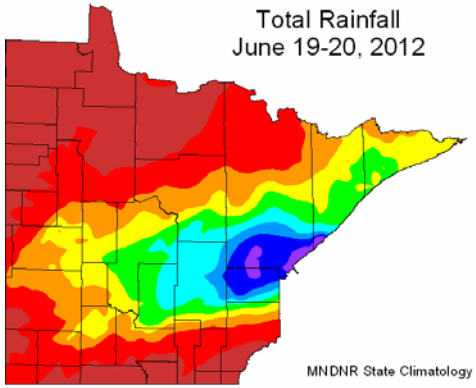
State Climatology Office - DNR Waters

Precipitation Total
July 11-12 2016



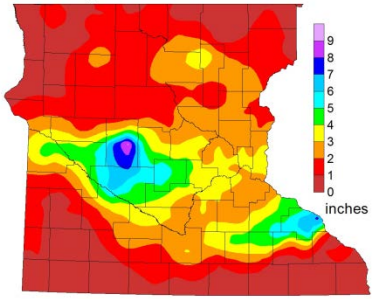
MNDNR
State Climatology Office

Total Rainfall
June 19-20, 2012



MNDNR State Climatology Office

Precipitation Total
August 10-11 2016



DNR State Climatology Office, Aug 11, 2016

'by-eye' estimate of the total area covered by 10" of rain over the 7 years of 2004-2010 appears to be near 1400 sq. mi. or about 200 sq. mi per year. Given that the area of the southern 3 layers of counties looks to be approximately 0000 sq. mi. the areal fraction of the southern three counties covered by 10" per year appears to be approximately /100; i.e. at the rate of coverage for the last 7 years an area equal to the whole southern three county area could be covered in about 100 years.

Damage at Whitewater State Park, Aug, 2007

Measures of Climate Change

- Central measures of temperature and precipitation are steeply upward in Minnesota relative to other states
- Though temperature trends are upward in all seasons, they are rising most rapidly in winter.
- Minimum temperatures are increasing at roughly twice the pace of maximum temperatures
- Combined with a greater frequency of high dew points, Heat Advisories and Heat Warnings are becoming more common
- A higher frequency of intense rainfall events is observed
- A higher frequency of large hail (3/4”) is observed
- More rainfall events in winter are being reported
- Changes of atmospheric mixing depth are observed
- Wide and rapid variation in the hydrologic cycle

For those who doubt or wish to dismiss the evidence that climate is changing ….the data from our own Minnesota landscape indicate it is happening and already producing consequences. It is clearly poor judgment to ignore this!

www.cloudappreciationsociety.org