

Upper Mississippi River Basin

Climate Change Brief

Precipitation is Increasing

Total annual precipitation has been rising across much of the U.S., and some of the largest changes are in the Upper Mississippi River Basin.

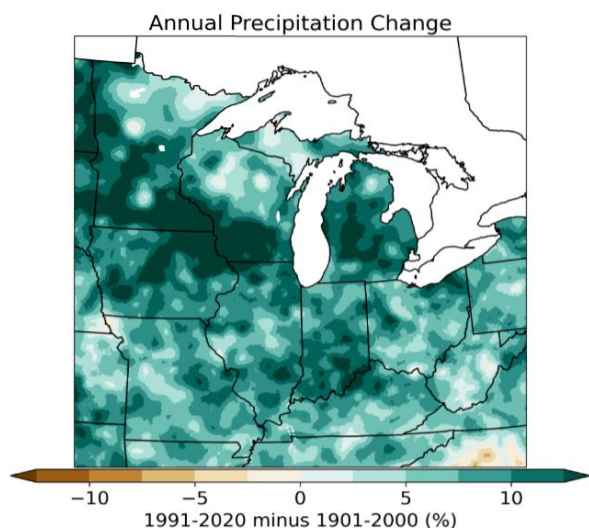


Image: Annual total precipitation changes for 1991-2012 compared to the 1901-1960 average. Source: NOAA NCEI ; adapted from Peterson et al. 2013

In areas, the past 30 years have seen upwards of a 10% increase in total annual precipitation compared to the 20th century average.

Decadal averages of annual precipitation also show a significant increase over the past 30 years.

Between 1991-2020, average annual precipitation increased by +1.34" per decade. This is a big leap from the +0.18" decadal trend from the preceding century (1895-1990).

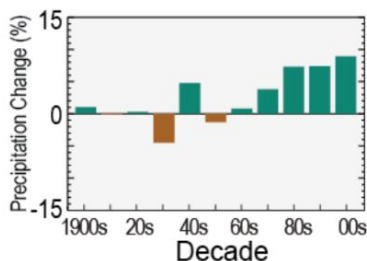
Comparing the periods from 1895-1990 to 1991-2020, the mean and median annual precipitation increased over 3 inches and the maximum precipitation events increased by nearly 5 inches.

Precipitation (in)	1895-1990	1991-2020	Difference
Annual Max	40.4	45.1	+4.7
Annual Mean	32.4	35.9	+3.5
Annual Median	32.3	35.4	+3.1
Annual Min	22.3	27.7	+5.4

Rains are Gaining Intensity

There is also a clear pattern of large precipitation amounts becoming concentrated in high-intensity events. The frequency of heavy precipitation events within the Upper Mississippi River Basin has risen over the past 50 years. In fact, this area saw a 37% increase in the heaviest (1%) events from 1958 to 2012.

NOAA rainfall frequency data shows that the amount of rainfall marking a given storm frequency (1% event, for example) is increasing significantly.

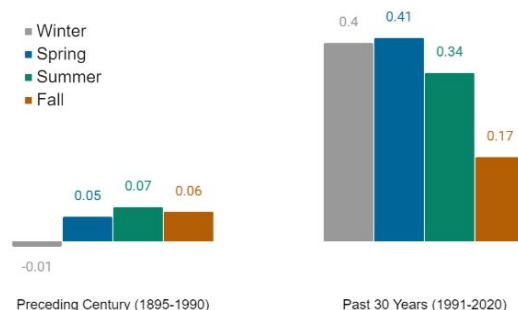


Percent changes in the annual amount of precipitation falling in very heavy events, defined as the heaviest 1% of all daily events from 1901 to 2012 in the Midwest. Figure Source: NOAA NCDC / CICS-NC

Every Season is Wetter

Rising precipitation has been observed across all seasons in the Upper Mississippi River Basin. The biggest increases have been in the winter and spring.

Every season is wetter over past 30 years (average change in inches per decade)



Note how the trend of increasing precipitation has significantly accelerated over the past 30 years.

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One Cause of Increasing Precipitation

One of the implications of a warming Earth is that the atmosphere can hold more water vapor. In fact, the maximum amount of water vapor increases almost exponentially with warming air temperatures. Greater amounts of rainfall can occur as weather systems precipitate the increased amount of moisture in the atmosphere.

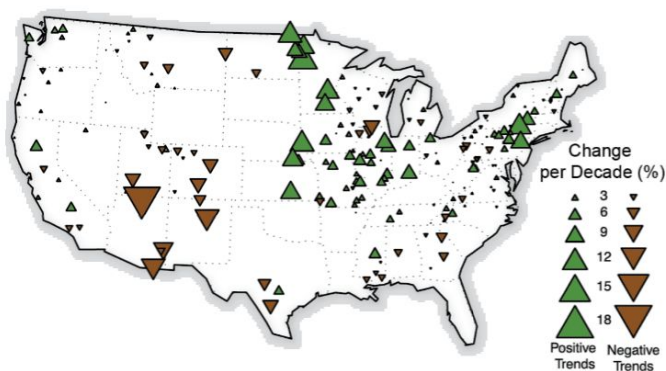
The River is Responding

How is the Mississippi River handling this extra water? Annual flood magnitudes are increasing across most of the Upper Mississippi River Basin, with decadal rises as high as +15%. This region is seeing the most significant increasing trends of any area in the U.S.

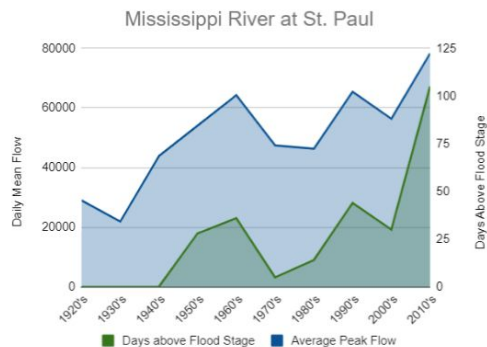
Consequences of increased precipitation include:

- Increased days above flood stage
- Higher average peak flow in rivers

At several sites, the Mississippi River was above flood stage approximately 5-10x longer in the past decade than on average over the preceding 80 years.



Trend magnitude and direction of annual flood magnitude, 1920-2008. Figure source: Peterson et al. 2013



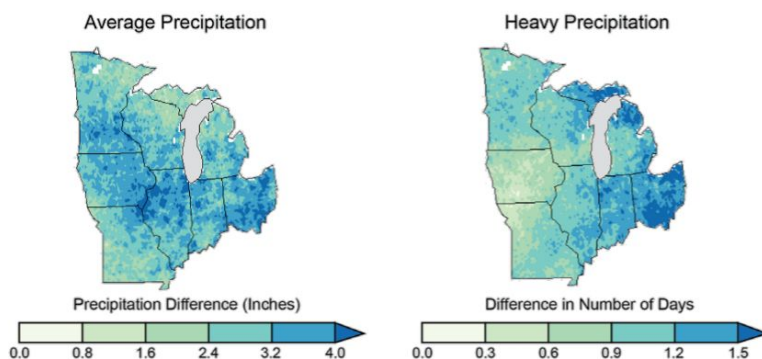
Note the dramatic change in the length of time the river spent above flood stage in the past decade (2010's).

Climate Projections

Projections for the rest of the century show that many of the observed upward trends will continue.

- Increase in average precipitation
- More intense precipitation events
- Winter and spring will see the largest increases in precipitation

Consequently, rivers and streams within the Upper Mississippi River Basin may continue to experience higher flows and longer floods.



Comparison of 1971-2000 observations with 2041-2070 projections. Left: Increases in total annual average precipitation. Right: Increase in number of days with top 2% precipitation events. Figure source: NOAA NCEP / CICS-NC.