

Upper Mississippi River Basin

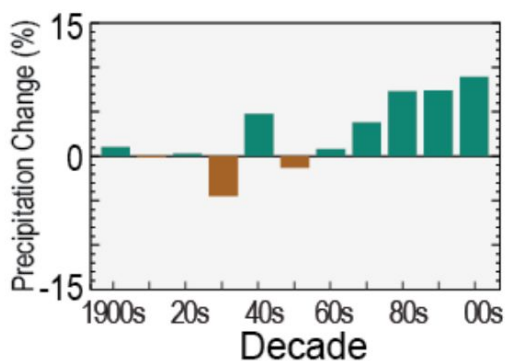
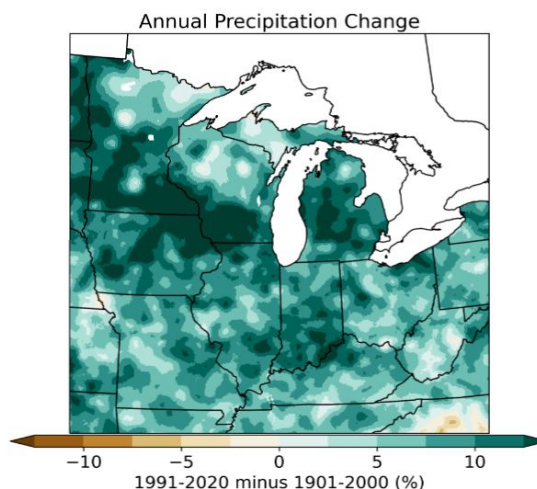
Climate Change Brief

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.

Average annual precipitation has also increased. The past 30 years saw a +1.34" decadal trend. This is a big leap from the +0.18" decadal trend from the preceding century (1895-1990).

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



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

Rains are Gaining Intensity

There is 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.

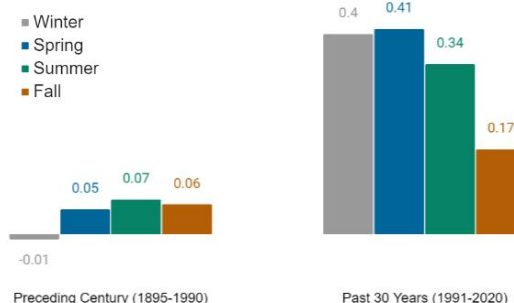
This includes mega-rains, which are defined by their high intensity ($\geq 6''$), large coverage area ($\geq 1,000 \text{ mi}^2$), and often catastrophic impacts.

Every Season is Wetter

Rising precipitation has been observed across all seasons over the last 30 years in the Upper Mississippi River Basin. The biggest increases have been in the winter and spring, with +0.40" and +0.41" decadal trends, respectively.

Note how the rise has accelerated in the past 30 years, when compared to the preceding century.

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



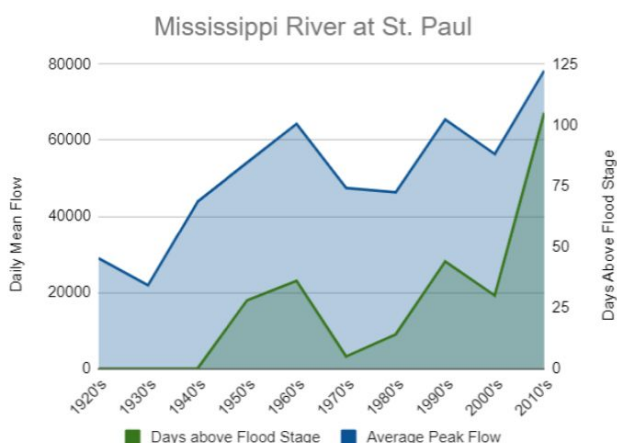
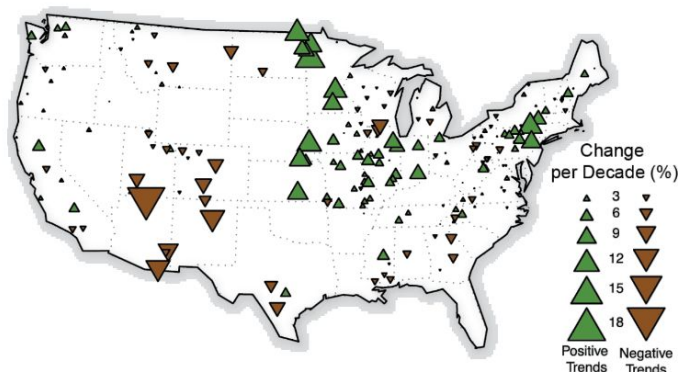
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The River is Responding

How is the Mississippi River handling all of 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.

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



Higher Flows and Longer Floods

In some river reaches, the increasing precipitation has resulted in:

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

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

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.

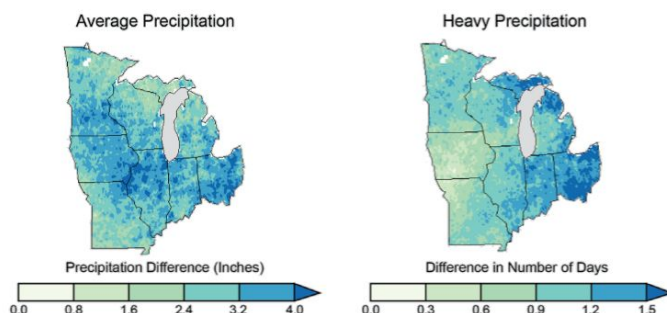


Image: Comparison of 1971-2000 observations with 2041-2070 projections. Left: Increases in total annual average precipitation. Right: Increase in number of days with top 2% precipitation events. Figure source: NOAA NCCDC / CICS-NC