6A.1 CLIMATE CONTEXT OF 2018-2019 MISSISSIPPI RIVER AND TRIBUTARIES FLOODS

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1.INTRODUCTION

The 2018-2019 flood season produced an astounding series of flood events throughout the Mississippi River system and its tributaries. The expansive area of flooding in the Mississippi River system is not common. The flooding impacted the major river systems from the Ohio, upper Mississippi, Missouri and Arkansas Rivers to the middle and lower Mississippi River, Fig. 1. The National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS) issued accurate spring flood outlooks highlighting the expansive flood risk both in areal extent and coverage.

Fig. 1. Mississippi Drainage System

Summarizing the weather events from this season that drove the flooding in order to put them in the context of past weather events shows interesting comparisons and contrasts. While there were some individual record events, taken individually at a watershed scale, many of the events can't be represented as extremes of the climate record. However, as the events are aggregated over larger areas and longer periods, they do become outliers in the climate record.

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This study examines the climate context of the 2018-2019 weather events across the area of responsibility of five NWS River Forecast Centers (RFCs) at different scales and durations. We also compare the 2018-2019 antecedent conditions and flood events with the historically largest flood events as a gage of the risk for more extreme events, and explore any analogs from some of the more clearly defined climate signals. This information can inform decisions that water resources managers might make in considering the effects of a non-stationary climate on water resource projects.

2.DISCUSSION

Persistent anomaly patterns and blocking were key players in the 2019 floods in the Mississippi drainage system.

The 500 hPa pattern showed a persistent positive anomaly across Alaska into northwest Canada which began in the autumn of 2018, Fig. 2. At the same time, a persistent negative anomaly was anchored from eastern Canada into the north-central United States. This high latitude blocking allowed the strong jet stream from the north-Pacific Ocean to under-cut the blocking and continuously move moderate strength storms across the U.S. into southeast Canada and the Great Lakes.

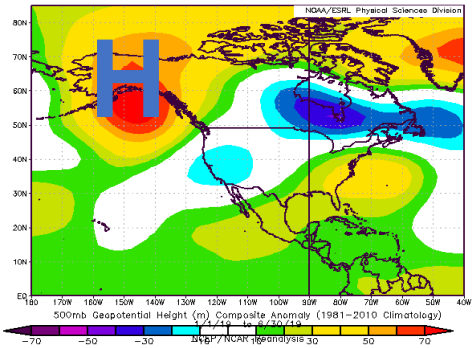


Fig. 2. Jan.-June 2019 500hPA Anomaly. NOAA/ESRL.

With the wet antecedent conditions in place, NOAA issued the spring flood outlook highlighting the risk of a busy flood season across the Mississippi drainage system into the Great Lakes, Fig.3.

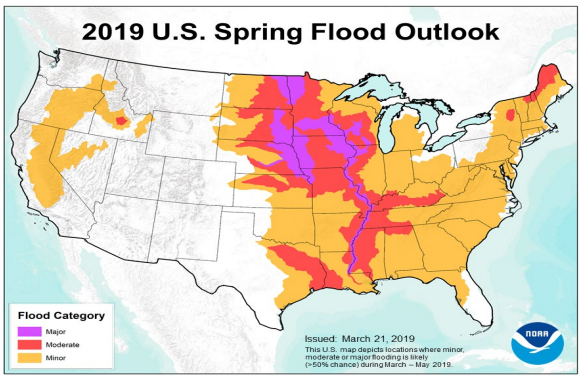


Fig. 3. NOAA Spring Flood Outlook.

The continuous flow of storms from winter through early summer 2019 across the United States resulted in the wettest water year on record (Oct. 2018-Sep. 2019) as reported by the NOAA's National Center for Environmental Information (NCEI), Fig. 4.

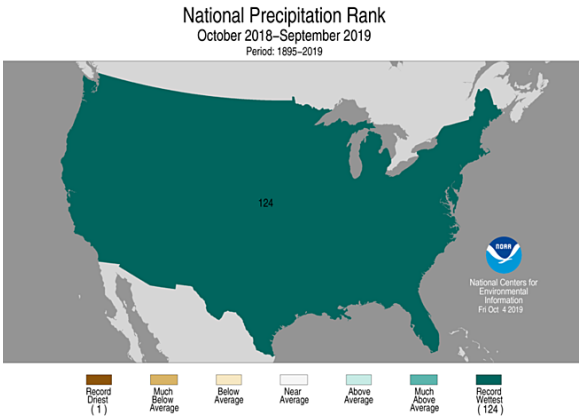


Fig. 4. NCEI Water Year Precipitation Ranked 124 out of 124 years which is Number 1 wettest.

A review of soil moisture and runoff was performed to find years similar to the 2018-2019 water year. Those years included 1926/27, 1972/73, 1982/83 and 1992/93, Fig. 5. The most similar water year was 1972/73 but even that water year fell short of 2018/2019 in terms of areal extent and cumulative volume. A review of each water year was done. The images in Fig. 5 are centered around May which was the height of the 2019 event across the Mississippi drainage system. A review of the cumulative runoff from the United States Geological Society (USGS) showed similar results (last image of Fig. 5).

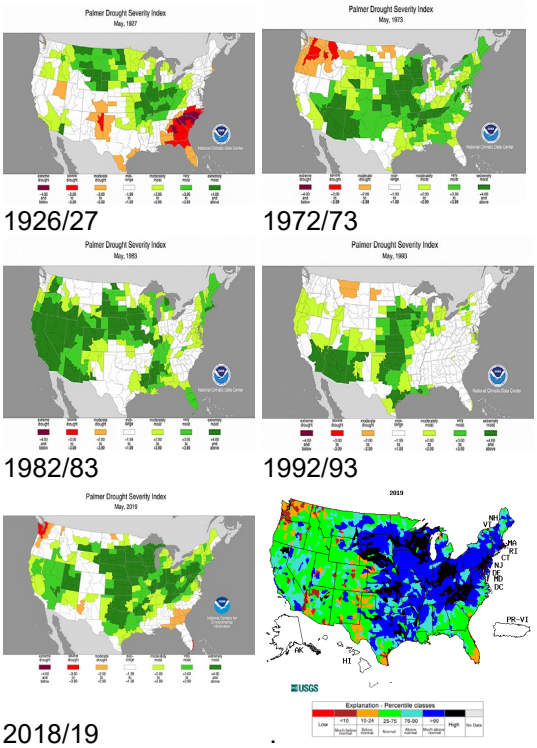
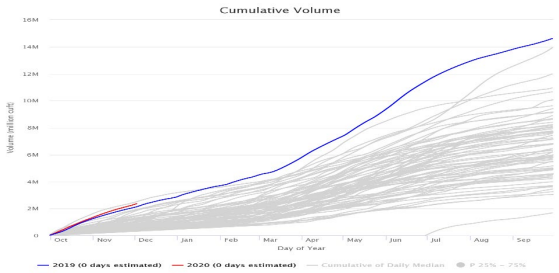
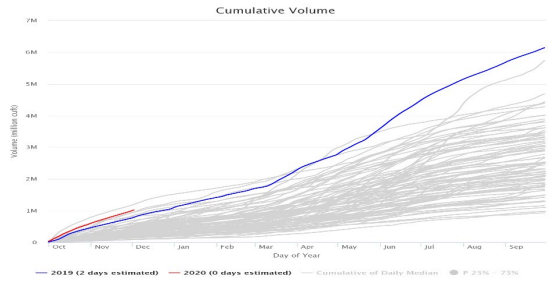


Fig. 5. NCEI Palmer Drought Index centered on May of given year. USGS Cumulative Water Year 2019 Runoff (preliminary).

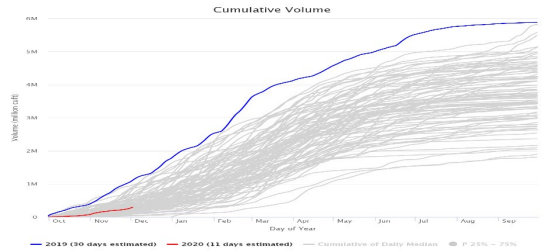
Within the NWS River Forecast Center's (RFCs) covering the Mississippi drainage system and Great Lakes, a significant amount of record floods were observed in the Missouri River Forecast Center's area of coverage. RFCs forecast hundreds of forecast points each day. The Missouri RFC experienced 50 new records at forecast points followed by the upper Mississippi RFC with 11, the Arkansas-Red RFC with 11, the lower Mississippi RFC with 3 and the Ohio RFC with 2. Outside the Missouri region, record floods were not too far outside the normal range. However, USGS cumulative volume of river flows showed for the 2018-2019 water year that record cumulative flows occurred in the Missouri, upper Mississippi, Ohio, Cumberland, Tennessee, Arkansas, lower Mississippi River basins as well at the Great Lakes. Not surprising, the record rainfall across the region resulted in record cumulative volumes of water in the river systems, Fig. 6.



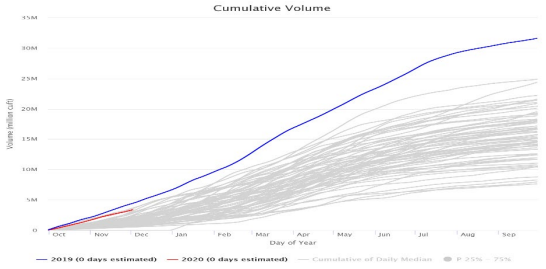
Cumulative Volume Missouri River at Herman since 1929



Cumulative Volume Upper Mississippi River at Chester since 1942



Cumulative Volume Ohio River at Louisville since 1928



Cumulative Volume Mississippi at Memphis since 1933

Fig. 6. Cumulative River Flow Volumes within the Mississippi River system

3.SUMMARY

The record crest and peak events were focused in the Missouri basin during 2019. 2019 did not break the historic levels from years like 1927, 1993 or 1937 outside of the Missouri basin. Peak events are driven by short-term meteorological conditions (even in Missouri in 2019) but 2019 was more of a climatological event, a long duration event over many months.

Except for the Missouri basin, 2019 did not create a significant amount of new record flood levels in the Mississippi River system. A persistent storm track through the Mississippi River system for a large part of 2019 water year yielded persistent high flows. This led to the longest duratrion event with the highest cumulative volume flows throughout most of the Mississippi River system in about 100 years or more and stressed the system including agriculture.

4. REFERENCES

NOAA, 2019: https://www.noaa.gov/media-release/spring-outlook-historic-widespread-flooding-to-continue-through-may