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Statement for the Record for the
Senate Committee on Environment and Public Works

April 17, 2019

Oversight Hearing on the U.S. Army Corps of Engineers' Management of the 2019 Missouri River Basin Flooding

Introduction

I am honored, Senator Ernst, for the opportunity to submit this statement for the record for your "Oversight Hearing on the U.S. Army Corps of Engineers' Management of the 2019 Missouri River Basin Flooding." This statement will describe how the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and NOAA's National Weather Service (NWS) are working with our partners to improve water prediction and to better inform critical decisions to address those water risks. The statement will describe our forecasts, the conditions across the upper plains and Midwest leading up to the flooding, our decision support to communities before, during and after the floods, and conclude with our prediction for the remainder of the spring.

Introduction

The NWS provides weather, water, and sub-seasonal to seasonal data, forecasts and warnings for the protection of life and property and the enhancement of the national economy. The NWS is focused on striving for a Water and Weather-Ready Nation. To this end, the NWS is continuously working to improve our forecast and warning capabilities as well as providing "impact-based decision support services" (IDSS) to meet the everyday decision needs of core partners at local, state, and federal, and tribal nation levels with regards to water data, forecasts and warnings, the NOAA NWS River Forecast Centers (RFC) and the National Water Center (NWC) monitor the Nation's river systems and provide real-time hydrologic forecasts and guidance for delivery to water resources partners. NWS Weather Forecast Offices (WFO) provide Flood Watches and Warnings to alert people to where hazardous flooding impacts will occur (Figure 1).

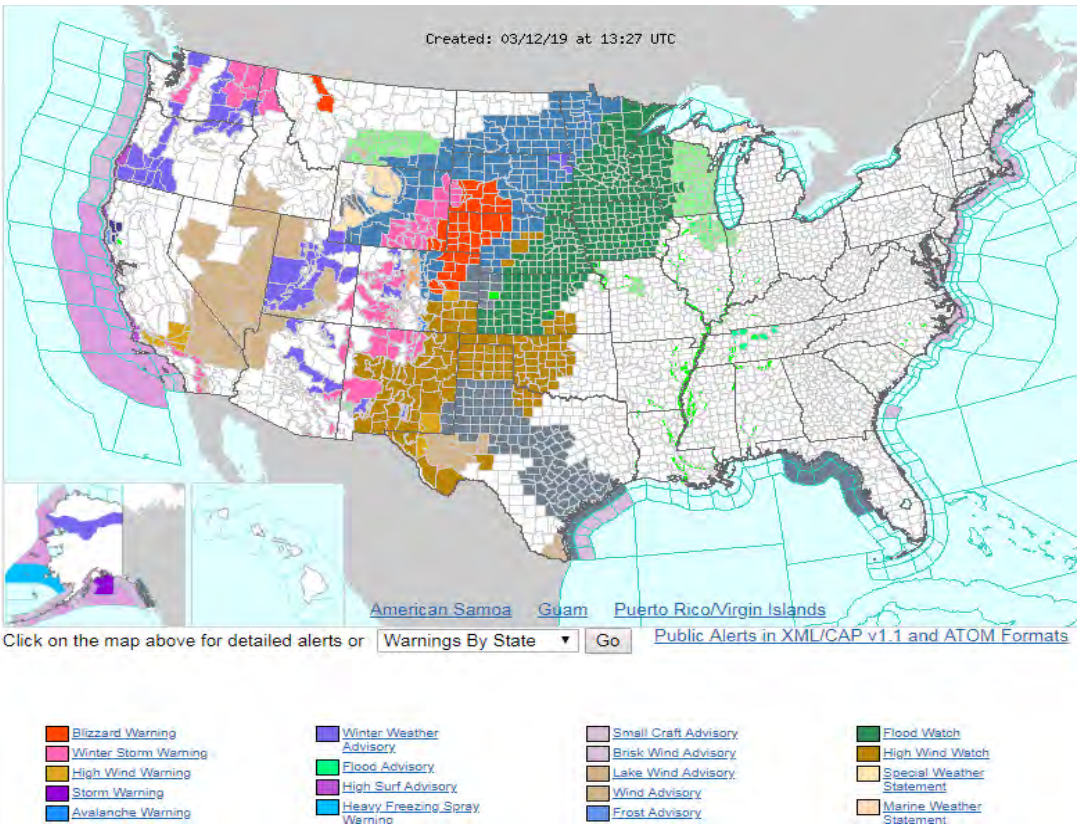

Figure 1 - Weather and Flood Watches and Warnings on March 12, 2019

Overview

The winter of 2018-2019 was the wettest winter on record for many areas across the country, including the central/northern plains, and the upper Midwest (Figure 2). The weather pattern for the last half of winter (February to March 13) in the upper Midwest featured several late season snowfall events along with below normal temperatures. These conditions contributed to a deeper than normal snowpack that lingered into March and a thick layer of frozen ground that prevented any snowmelt from being absorbed by the soils. Additionally, the ground was virtually saturated through the winter, magnifying the run-off into streams and rivers once the snow started melting.

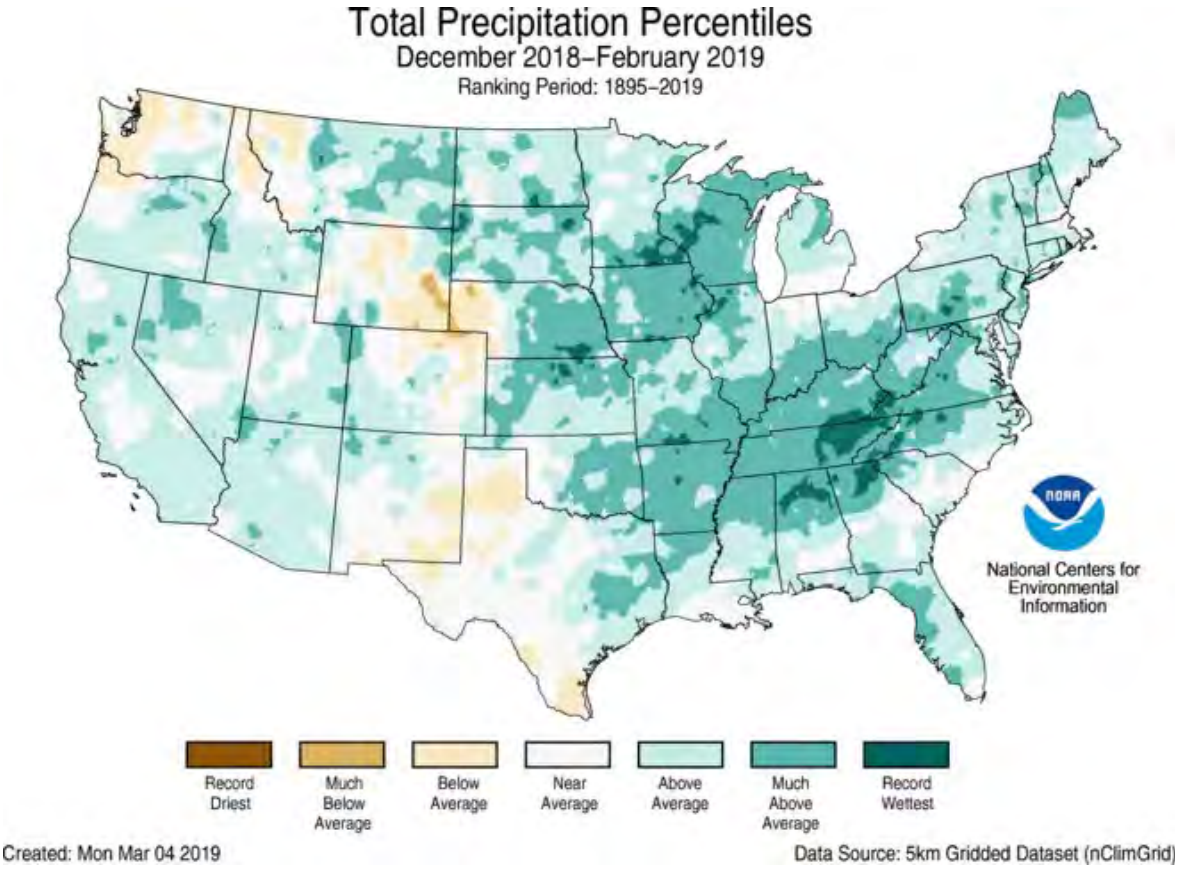

Figure 2 - December 2018-February 2019 is the United States Wettest Winter on Record for Many Areas

Outlooks

The initial regional spring flood outlook for the greater Mississippi River Basin was released on February 21, 2019 and indicated an above average risk for flooding in the eastern half of Missouri River Basin, the Red River of the North, and most of the Mississippi River basin. Local NWS RFCs hosted a webinar for over 200 state and federal partners on February 22 to highlight this information. The regional outlook was updated on March 7 and a second webinar for state and federal partners was held the same day.

The National 2019 Spring Flood Outlook was released on March 21, 2019 and also highlighted the above average risk of flooding (Figure 3). On April 4, NWS local offices hosted another April update to the regional spring flood outlook for the greater Mississippi River Basin for over 250 state and federal partners. The region remains vulnerable for moderate and major flooding into early summer.

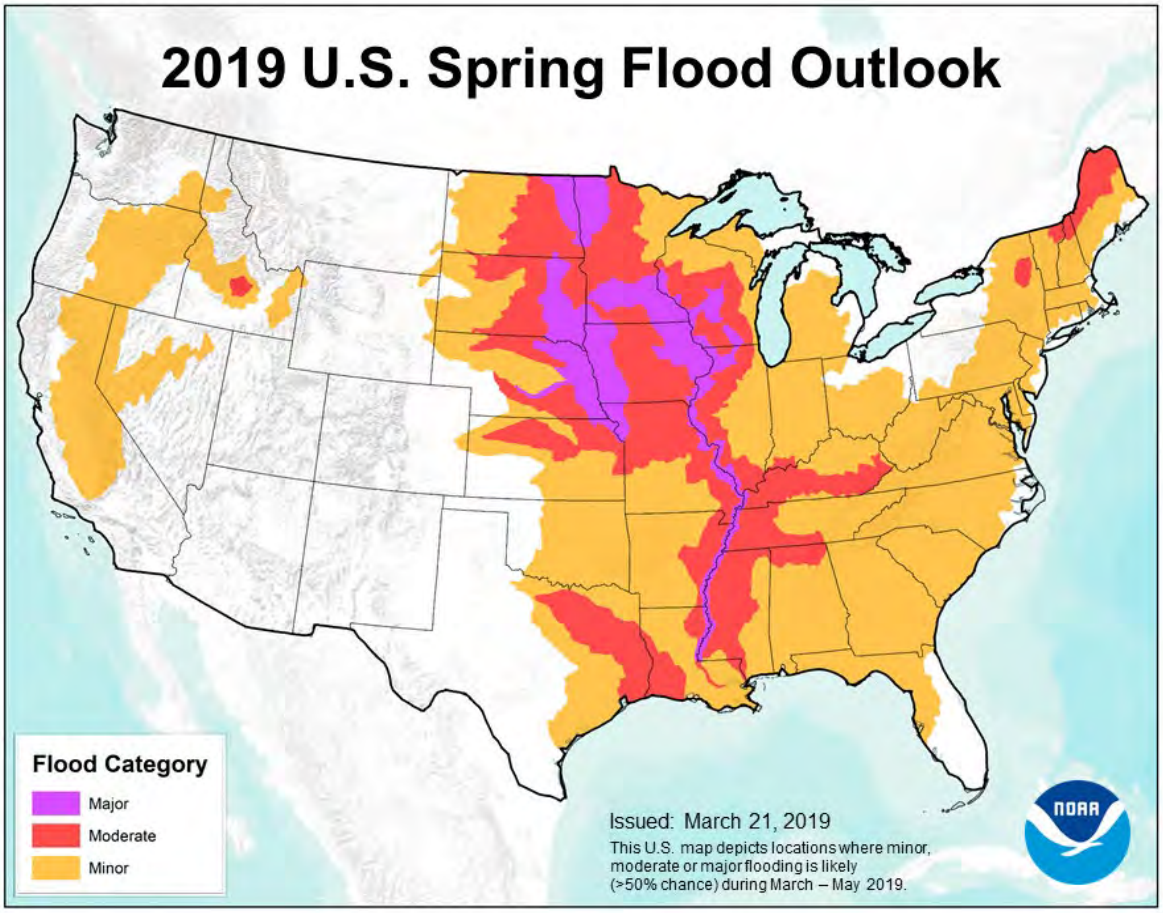

Figure 3 - 2019 National Spring Flood Outlook

Antecedent Conditions

As mentioned above, the weather pattern became very active across the Midwest in late January, February, March, and into April. This active weather pattern ushered in periods of very cold temperatures to the high plains and upper Midwest. These near-record to record cold temperatures in early March prohibited the onset of the typical late winter melt cycle and enabled a deeper than normal snowpack to linger longer than normal (Figure 4).

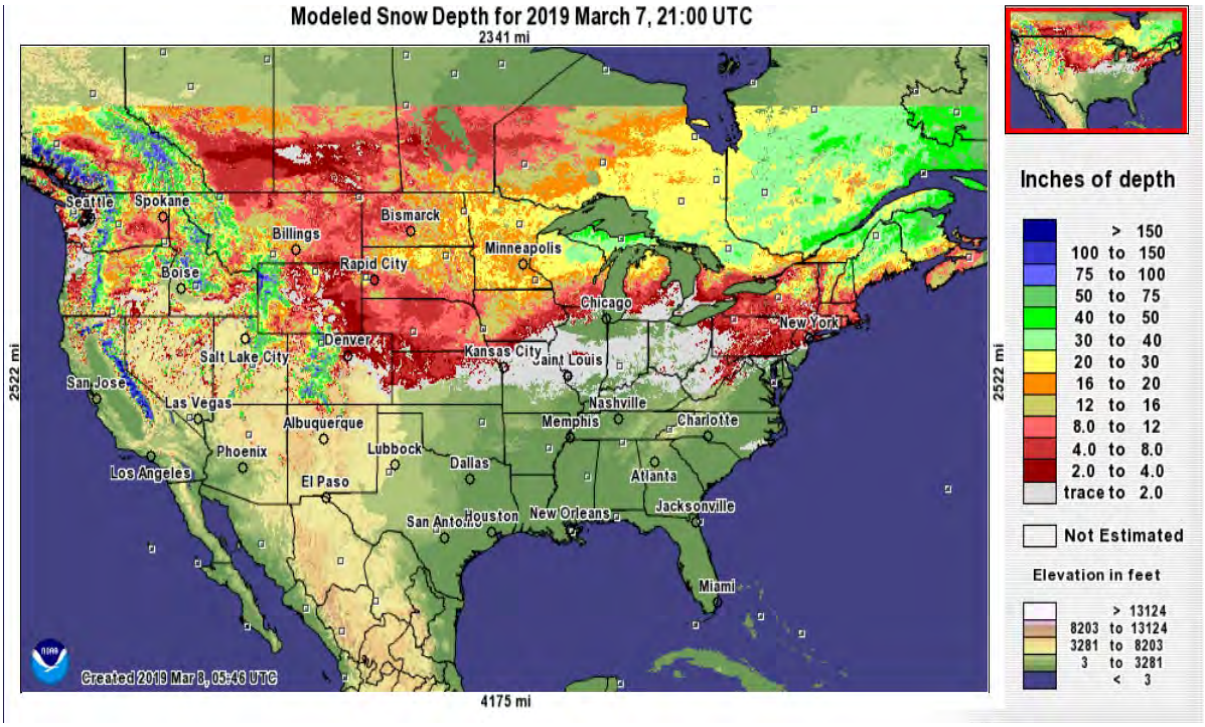

Figure 4 - Snow Depth on March 7, 2019

The much colder than normal temperatures in February and early March led to deep frost depths that approached two feet in some locations across Nebraska and Iowa. This made the ground essentially impervious, absorbing very little if any additional moisture from snowmelt runoff or precipitation.

The final factor that set the stage for the record floods of March 2019 was the pre-existing extremely high amount of moisture in the soil. In fact, much of the plains and upper Midwest were at the 99th percentile of calculated soil moisture levels (Figure 5).

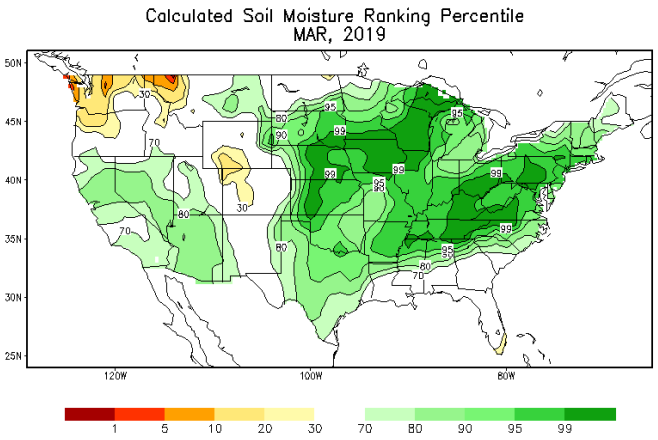

Figure 5 - Soil Moisture March 2019

Flooding Trigger

A very strong storm system developed across Colorado on March 13, moving northeast through the plains on March 14-15. This brought a quick warm up along with widespread rain, on top of existing snowpack, to much of the eastern Platte River basin in Nebraska as well as upstream basins of the Missouri River in South Dakota, as well as most of Iowa (Figure 6).

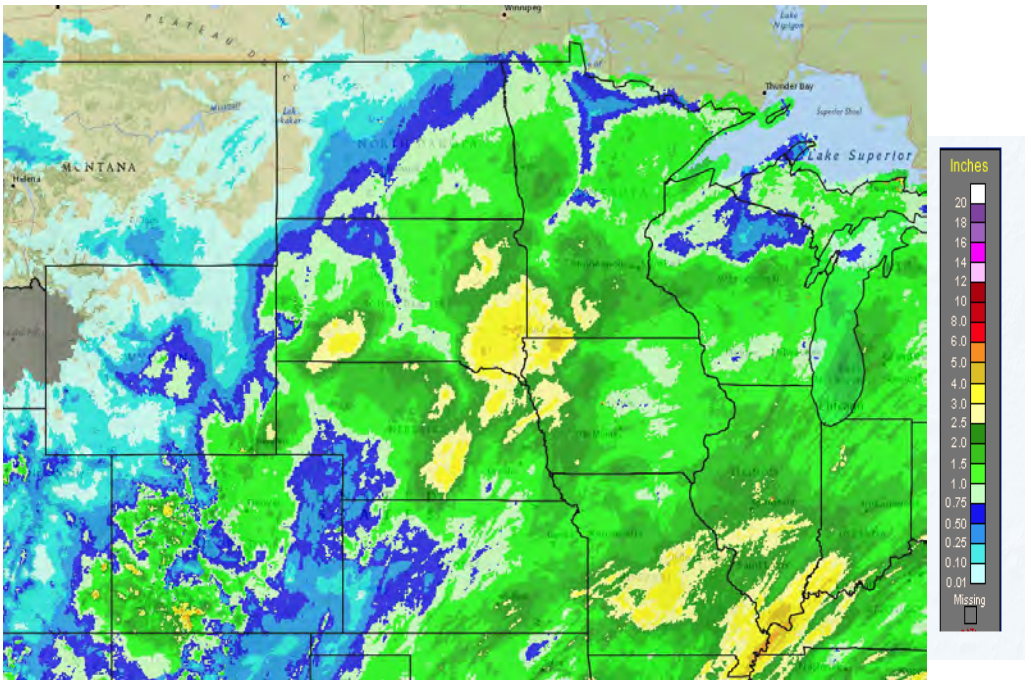

Figure 6 - Observed Precipitation March 8-15, 2019

This storm system was well forecast. The NWS numerical weather prediction (NWP) models that support operational weather forecasts indicated nearly a week in advance that a large, late season winter storm would affect vast portions of the Midwest. The NWS forecasts and warnings were issued across the region, with the regional and national press focused on the potential impact of this strong storm. The accuracy of this forecast was enhanced by space-based data from international satellites and from NOAA-20, NOAA's most advanced polar-orbiting satellite that contributes global atmospheric water and pressure data that is used in NWS NWP models. Data from these satellites were integral input to NWP models which indicated the potential for heavy rainfall and precipitation across the Midwest up to a week in advance of the storm.

As the storm hit, within two days virtually all of the snowpack that existed across Nebraska and Iowa had melted. Figure 7 illustrates the amount and spatial distribution of Snow Water Equivalent before melting occurred, and Figure 8 the Snow Water Equivalent after melting.

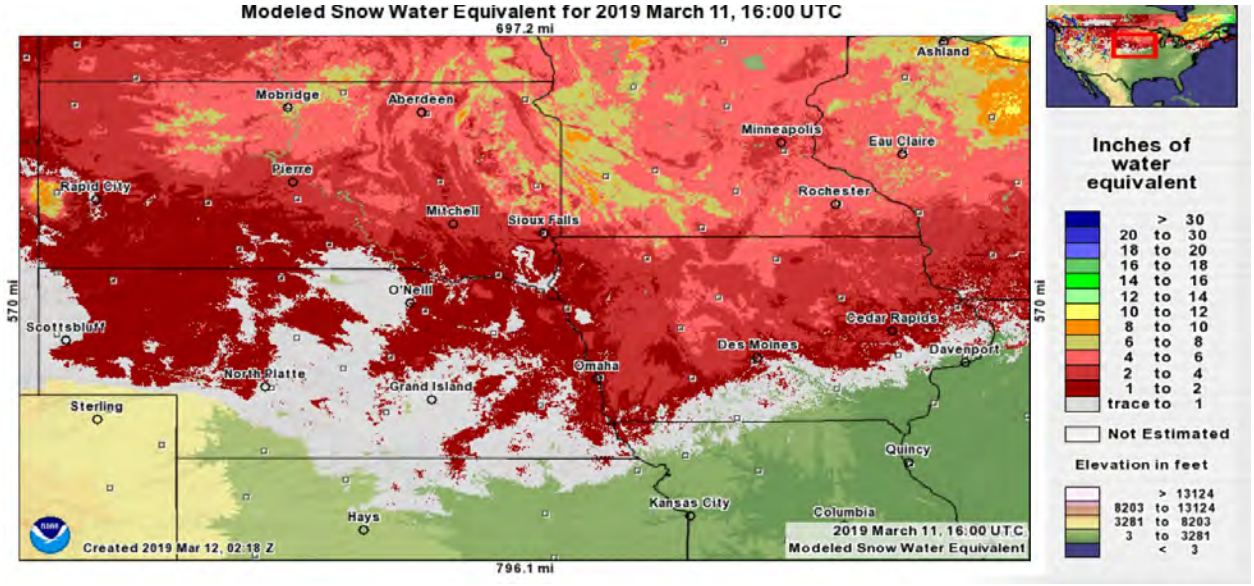

Figure 7 - Snow Water Equivalent BEFORE melting

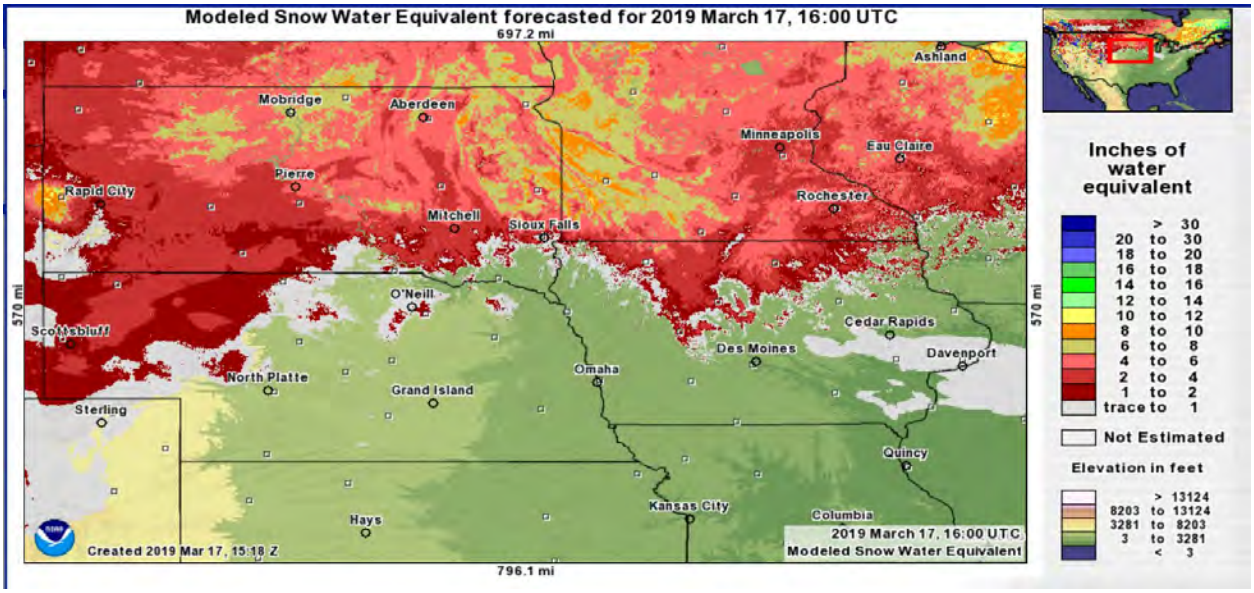

Figure 8 - Snow Water Equivalent AFTER melting

All of the water stored in the snowpack melted and added to the runoff generated by the widespread one to three inches of rain that fell across the area March 12-15. This runoff could not be absorbed by the frozen ground and quickly found its way into tributaries of the Missouri River system, sending local creeks and rivers to record levels in a matter of hours. Readings from U.S. Geological Survey (USGS) river gages across the region were transmitted via NOAA GOES-East Data Collection System to river forecasting centers and the National Water Center. These readings were used to monitor evolving conditions, for initial hydrologic forecast models, and were relied upon by weather forecasters and emergency managers to inform decisions about evacuations, road closures, and other measures to safeguard critical infrastructure. Rivers were

so swollen with water from the combined rainfall and melted snow-cover that it caused many levees to be overtopped or breached. In many locations in central and eastern Nebraska, river ice accumulation was dislodged, resulting in ice jams and record flooding with disastrous results. High river flows, aggravated by dislodged river ice, resulted in the destruction of a bridge on Highway12, and later, the failure of Spencer Dam, both on the Niobrara River. Large, thick chunks of ice were dislodged and piled up on Highway 14, which follows along the Niobrara River. Water and ice chunks from the Niobrara River destroyed a railroad bridge west of Columbus. Water and ice from the Elkhorn River damaged many bridges and destroyed a main east-west bridge on Highway 92 out of Omaha.

Breaches of levees occurred on the Platte, Elkhorn and Missouri Rivers due to the large volume of water, which prompted evacuations of many residents. Farther south, water on the Blue River and Turkey Creek flooded roadways as well.

River and Reservoir Inflow Forecasts

Initial forecasts for the Missouri River were issued Saturday, March 9, projecting the river from Nebraska City, Nebraska, downstream to St. Joseph, Missouri, to exceed the flood stage. The first forecasts indicating flooding along the Big and Little Sioux Rivers, Elkhorn River, and the Platte River were issued Monday, March 1. Reservoir inflow forecasts were provided to the US Army Corps of Engineers (USACE) twice-per-day for Gavins Point Dam beginning Tuesday, March 12. Inflow forecasts for Oahe, Big Bend, and Ft. Randall Dams began on Tuesday, March 19.

Records Broken

In March and April 2019, over 50 river forecast locations in the Missouri and Mississippi River basins had recorded new record flood levels (Figure 9). Below are examples of river level observations and forecasts at a few sites along the Missouri River depicting record high flood levels (Figure 10) and images from the NOAA Geostationary Operational Environmental Satellite (GOES East) of the rivers before and during the floods (Figure 11).

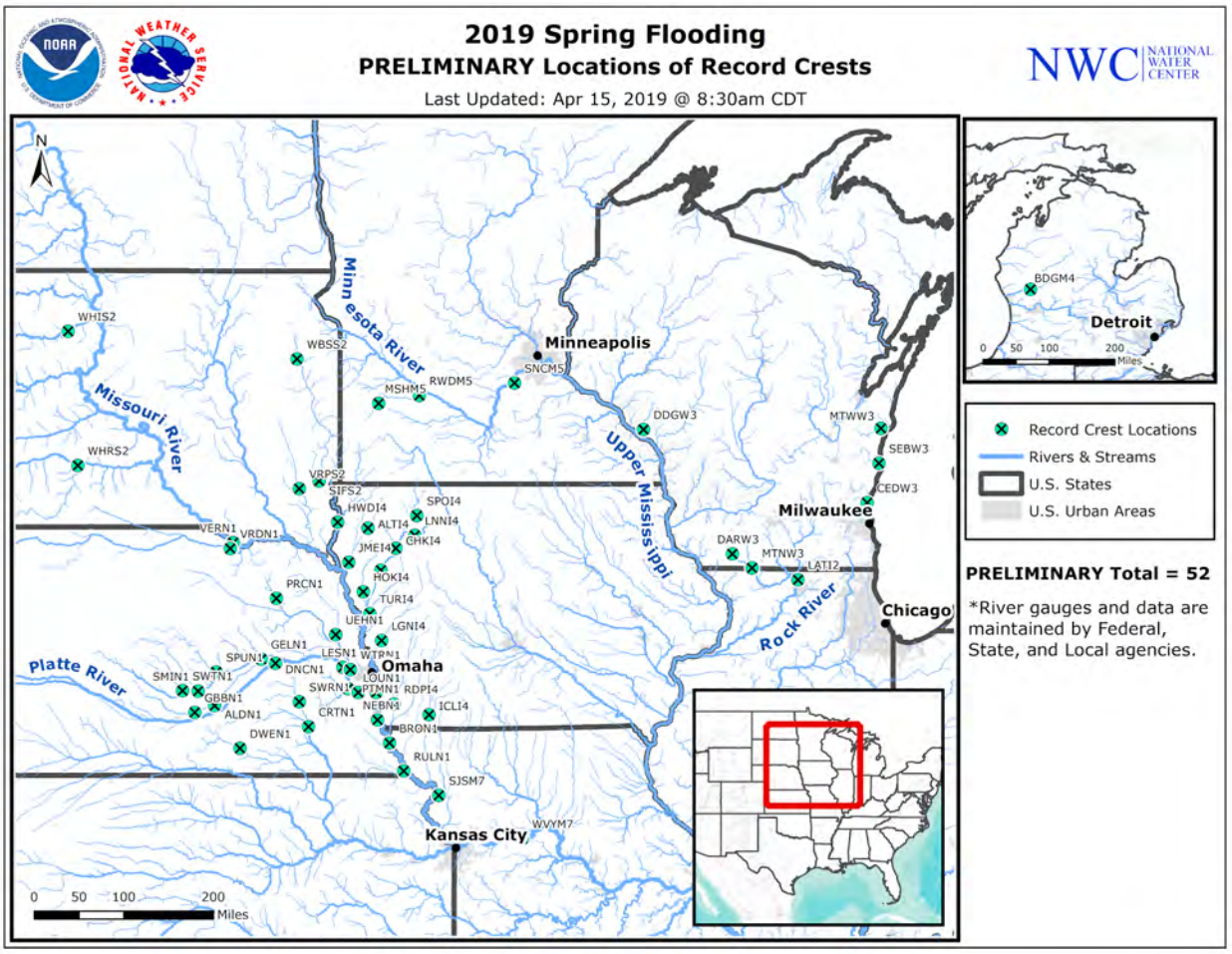

Figure 9 - Record Floods - Preliminary Count of Locations with 2019 Floods of Record

NWS Partner Coordination and Decision Support

Beginning in February, 24 local NWS WFOs began providing forecast support to partners and local emergency management (EM) officials throughout the upper Midwest and high plains to ensure they received the best, up to date information and forecasts as possible. This life-saving decision support for the EMs allowed them to take proactive actions to help mitigate the situation and deploy assets to prepare, respond, and recover. As the early March storm approached, these forecast offices continued their coordination throughout the affected areas before, during and after the historic March flooding. By the second week of March, it became clear the ice jam potential would be exacerbated by heavy rain falling on an existing snow pack with frozen ground, especially in southeast South Dakota, northwest Iowa and eastern Nebraska. WFOs held daily briefings with core partners and EMs to better inform them of the potentially historic flooding that was going to occur. This critical exchange of information occurred at all government levels - federal, state, local and tribal, including USGS, USACE and FEMA.

Specifically, the NWS coordinated closely with the USACE on the flooding, local impacts, river water volume, river levels, dam inflow and outflow, and impacts to levies. The coordination was frequent, effective, and the actions of the USACE likely prevented worse damage and impact. Details of some of the exchanges follow.

The NWS called USACE Missouri Basin Water Management (MBWM) at 10:25 AM Tuesday, March 12, notifying USACE MBWM that NWS river forecast models indicated a large inflow volume likely to impact Gavins Point Dam. This communication initiated the continuous, multiple-times-per-day, telephone, live internet "chat," and email communication that would be ongoing between the NWS and USACE MBWM over the next three weeks. NWS-USACE MBWM coordination focused on USACE MBWM release schedules from the six mainstem system dams, and the NWS reservoir inflow forecasts being provided to USACE MBWM.

During the period March 15-27, NWS presented weather and river outlooks on the daily USACE MBWM-hosted Congressional Delegation (CODEL) call. The audience included congressional staff, state and local officials, and the press.

On Friday, March 15, the NWS reached out to USACE Omaha District (NWO) and USACE Kansas City District (NWK) for levee unit conditions. This initial contact led to daily updates by phone as well as the USACE providing the NWS with updated levee unit status. In a few cases, the NWS notified USACE when gage observations potentially indicated a new levee breach had not yet been reported to the USACE. USACE NWK deployed a hydraulic engineer to the NWS for a period of four days to assist in executing the NWS hydraulic river model in support of NWS understanding of river-levee interactions.

On Tuesday, March 19, the NWS requested USGS to extend stage-discharge relationships for several river locations which the NWS expected to exceed the current relationship. A stage-discharge, or rating table, is a relationship between stage (measured in feet) and discharge or volumetric flow (reported in cubic feet per second) at a cross section of a river. Throughout the latter half of March, the NWS and USGS coordinated on timing and location of USGS field measurements, stage-discharge relationship revisions, and the potential impacts on USGS information due to changing levee conditions.

During the period between March 14 and March 24, the NWS provided daily river outlook briefings to the Kansas Department of Emergency Management, focused primarily on the Elwood, Kansas (St. Joseph reach) levee unit. These briefings continue on an as needed basis.

Beginning on March 15, the NWS began providing river stage outlooks during semi-weekly navigation industry calls. The US Coast Guard also took part in these calls. These calls continue on an as needed basis.

River Outlook April Through Mid-Summer, 2019

The Missouri River basin mountain snowpack (eastern slopes of the Northern Rockies) is near average and April 15 marks the usual snow water equivalent peak accumulation date in the mountains. Mountain snowmelt runoff usually peaks in the early-to-mid June time period, and NWS projections call for no additional significant flooding resulting from the expected mountain snowmelt runoff. However, a large-scale precipitation event late during the spring/early summer may exacerbate flooding potential.

The April 10-12 storm system dropped one to more than two feet of snow with 1-3 inches of snow water equivalent over South Dakota. Snowmelt began in earnest on April 15 and has now completely melted. As of mid-April, the James River remained in major flood category in South Dakota. The James should crest at its mouth in early May. The Big Sioux River is currently experiencing minor-to-moderate flooding, and will remain fairly steady at its mouth until late April, when a general falling trend should begin. The contribution by both the James River and the Big Sioux River over the next few weeks is not expected to have any additional significant impacts on the Missouri River.

The eastern portion of the Missouri River basin remains very wet, and many streams continue to run high. With long-range seasonal projections indicating the likelihood of above-average precipitation, the eastern portion of the basin remains vulnerable to episodic rounds of localized flooding through the remainder of the spring and into early summer. Moderate-level flooding is likely to occur off-and-on during the course of the next three months in eastern Nebraska, eastern Kansas, southeast South Dakota, western Iowa, and across the state of Missouri. This expectation of moderate level flooding includes the mainstem Missouri River from Nebraska City, Nebraska, to the confluence with the Mississippi River at St. Louis, MO.

Summary

Forecasting and responding to this event involved participation of several federal agencies and all levels of government—federal, state local and tribal. NWS climate and weather predictions largely predicted the winter antecedent conditions that were prime for springtime flooding. NWS staff throughout the Midwest were in constant communication with state and local emergency managers as March and April strong storm systems and rain that fell on top of the deep snowpack triggered widespread flooding. The region will continue to experience the impact from flooding of the Missouri and Mississippi River basins into May and beyond. NWS offices provided numerous outlooks and briefings for the impacted area and had extensive coordination with USACE helping them monitor and adjust dam releases and river flows ahead of and during the record Spring Floods of 2019.