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An overview of the 2019 Missouri flood

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In March 2019, floods occurred in Missouri River downstream area. Towns alongside were overwhelmed. Four deaths have been confirmed so far.[6] Thousands of people lost their home in the accident. The massive spring flooding this year caused a loss of more than 3 billion dollars in damage in the Midwest.[4] Farmer Leo Ettleman said U.S. Army Corps of Engineers (see "the Corps" below) should have made significant changes to its operating manual after the historic 2011 floods, but neither the Corps nor Congress took action.[4] Ettlemen said the kind of flooding the area saw this spring will continue unless changes are made.[4] Until now, the causes of Spencer dam accident and Missouri River floods are under investigation.

Figure 1. An overwhelmed town in Nebraska, retrieved from Great Plains James

Missouri River Event Playback

The trigger - Spencer Dam break

On the Missouri River, the flood event that began on March 13 was triggered by a bombogenesis, or "bomb cyclone" rain event, which brought a significant amount of precipitation and warmer temperatures to a large area in central and western Nebraska, South Dakota, and western Iowa, and a portion of northern Missouri and Kansas. The combination of rainfall and warmer temperatures quickly melted the plains snowpack, and thawed its frozen soils, resulting in rapid runoff and ice jams.

Highway 281 bridge between the small northeast Nebraska town of O'Neil and Spencer, swept away when the 92-year-old Spencer Dam, just upstream of it, was breached and destroyed on March 14.[6] Part of the Highway 281 bridge remains on the Spencer side, but the entire bank on the O'Neil side of the bridge has been cut away by chunks of ice and high water.[6] Destroyed Spencer Dam was the last protection of floods before Niobrara River feeds into Missouri River. Unfortunately, much of the water that flows down the Niobrara River into the Missouri ends up at the Gavins Point Dam on the Nebraska-South Dakota border.[6]

Figure 2. Spencer Dam break, retrieved from Getty Images

Figure 3. Spencer Dam after its failure, retrieved from Nebraska State Peter Rickett Governor Office

Emergency action - Flood discharge at Gavins Point Dam

On the morning of March 14, all eyes were on Gavins Point Dam, which sits where the Missouri River divides Nebraska from South Dakota, right below where the Niobrara feeds into it. Even after the upstream Fort Randall Dam cut its water release down to 0 cfs (cubic feet per second) that morning, the storage space behind the dam was running perilously low. A day earlier, Gavins Point had already increased its water release from 17,000 cfs to 27,000 cfs.[9] The Lewis and Clark Lake it creates us the only place to deposit water near Gavins Point. The lake rose 1.6-feet higher than it ever had before.[6] The dam was constructed primarily as a reregulation dam for releases from Fort Randall Dam.[10] To provide a sense of scale, at its peak, the Corps estimates that the Niobrara River and its tributaries were sending more than 180,000 cfs of water into the Gavins Point reservoir - while the typical daily inflow during March is only 4,000 cfs.[8]

The Corps could only open the spillway bays to avoid Gavins Point Dam breaking. Gavins Point has 14 spillway bays, all of which were closed with radial arm tainter gates. To increase the flow-through, operators at the dam opened 12 of the bays, as the remaining two couldn't be fully opened due to ice buildup.[9]

Figure 4. Gavins Point Dam and its 14 spillway bays, retrieved from U.S. Army Corps of Engineers

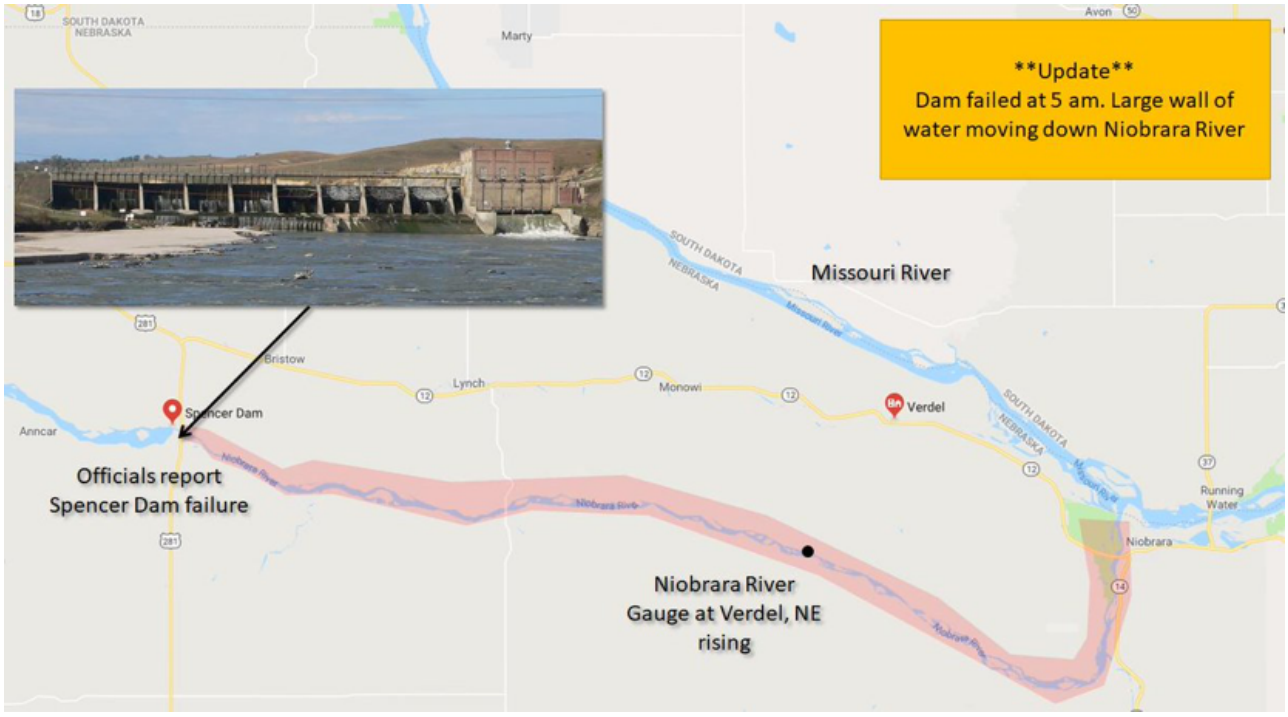

Figure 5. Location of Spencer Dam on Missouri River on map, retrieved from NBS MBRFC

A world of waters - Heavy losses alongside Missouri River downstream area

During March 2019 floods, several of the tributary rivers that join the Missouri River below Gavins Point Dam, including the James (in South Dakota), Vermillion, Bog Sopix, Floyd, Elkhom, Papillion and Platte Rivers, contributed significantly to downstream Missouri River stages.[8]

Figure 6.Missouri River on map, retrieved from Missouri River, Wikipedia

Gage data show that many of the levees, in portions of Iowa, Nebraska, Missouri, and Kansas, overtopped before any of the increased releases from Gavins Points Dam reached these levees. These Levees were overwhelmed by the record inflows, caused solely from runoff from these tributaries, which flow into the Missouri River below Gavins Point Dam.8 Except for the Dam, all wastewater and freshwater treatment plants alongside southern river bank in Nebraska were immediately shut down.

Missouri River Flood Event Analysis

At present, reasons of Spencer Dam break and floods in Missouri River are not clear yet. According to correlated reports and materials, possible causes could be:

Aging Dam System

Built in the late 1920s and owned by the Nebraska Public Power District (see "NPPD" below), Spencer Dam generates electricity when the utility needed it.[3] It was a 3,700-ft-long hydroelectric dam that consisted of a 400-ft-long gated spillway section and powerhouse, and a 3,300-ft-long earthen dam embankment.[6] Without any spillways, it was constructed with five "stop-log" gates on the dam.[1]

The workers, NPPD said, had opened some of the five "stop-log" gates on the dam, per emergency procedure when water levels are high,[1] but some were frozen shut by the ice and cold water.[6] NPPD official have said their workers abandoned the dam after unsuccessfully trying to open more floodgates and noticing that water was beginning to overtop the earthen portion of the structure.[2] The collapse of the 29-ft-high dam unleashed a wall of water 11 to 15 feet in height, washing away a home, several trailers and a unique straw-bale saloon/bite ship just below it.[2] The Nebraska Dept. of Nature Resource (see "NDNR" below) is in charge of inspecting the state's 2,924 dams.[6] "Like most of the nation's infrastructure, our dams are aging," Tim Gokie, chief engineer of the state's dam safety program, says "Many of the dams were designed with a 50-year design life. We have 1,200 dams in our inventory that are more than 50 years old."[6] With age it comes problems with any infrastructure - steel corrodes, concrete deteriorates over time.[2] Repairs and upgrades to dams are expensive. It can be a real struggle for both public and private dam owners to find funding to make upgrades.[6]

Records obtained by The World-Herald indicated that the dam was last inspected in April 2018 and rated in "fair"condition.[1] But the report from NDNR carried an ominous warning about the concrete and earthen structure: "deficiencies exist which could lead to dam failure during rare, extreme storm events."[1] The deficiencies noted by the NDNR, which included "seepage" downstream of the dam and "spaling, cracking and scaling" of concrete in the spillway area were not effecting the "integrity" of the structure, Spencer told The World-Herald.[1] Officials with NPPD said that while four deficiencies were noted in the 2018 inspection, most were minor and all had been addressed.[1] It is doubtful that embankment seepage played any role in the failure.[6] Indeed, much of dam and levee infrastructure in southern Nebraska was not designed for flood control. Many of the communities in the area have focused on securing scarce water in the summer months rather than on flood control. The dam and reservoir system that serves southern Nebraska had 22% of its space set aside for flood storage.[6]

Difficult Cascade Reservoir Operation in Missouri River

Missouri River is a hydraulic miracle. From 1933 to 1964, the main-stem system included six large dams: Fort Peck in northeastern Montana; Garrison in central North Dakota; Oahe, Big Bend, and Fort Randall in South Dakota; and Gavins Point along the Nebraska and South Dakota border. Together they comprise the largest reservoir system by storage volume in North America.[8] The Corps operates the six main stem dams as a system, governed by the Missouri River Master Water Control Manual and consistent with the authorized purposes while maintaining compliance with all Federal laws.[8] Generally, the Corps operates the Missouri River Main-stem Reservoir System consistent with eight authorized project purposes - flood control, navigation, hydropower, water supply, water quality, irrigation, recreation, and fish and wildlife. The operation of reservoir system in order to balance the authorized purposes becomes a hard mission. For many years, the Corps has been consulting the Missouri River Master Water Control Manual which is the water control plan that guides how much water will be released, and when and for how long it will be released from the six reservoirs.

Figure 7. Distribution of six reservoirs in Missouri River, retrieved from www.engineering.com

Nearly all of the storage volume of the system (roughly 99 percent) is in the upper five of these dams. Together, these five upper dams can capture runoff from approximately half of the Missouri River drainage basin.[8] However, they cannot hold back runoff from the rain that falls in the Missouri River watershed below these five dams. That is where most of the rain from the March 2019 storm, which flooded the lower Missouri River basin, fell.[8] Gavins point reservoir has capacity to hold back less than 1% of the water in those six reservoirs.[6]

Dams on the Missouri River

Dam	State(s)	Height	Reservoir	Capacity (Acre.ft)	Capacity (MW)
Fort Peck [174]	MT	250 ft (76m)	Fort Peck Lake	18,690,000	185
Garrison [175]	ND	210 ft (64m)	Lake Sakakawea	23,800,000	515
Oahe [176]	SD	245 ft (75m)	Lake Oahe	23,500,000	786
Big Bend [177]	SD	95 ft (29m)	Lake Sharpe	1,910,000	493
Fort Randall [178]	SD	165 ft (50m)	Lake Francis Case	5,700,000	320
Gavins Point [179]	SD	74 ft (23m)	Lewis and Clark Lake	492,000	132
Total				**74,092,000**	**2,787**

Table 1. Distribution of six reservoirs in Missouri River, retrieved from Wikipedia, "Missouri River"

In spite of that, victims and local communities did not buy what the Corps told due to their misoperation of the reservoirs. Major General Scott A. Spellmon, Deputy Commanding General for Civil and Emergency Operations and John I. Remus II, Chief of Missouri River Basin Water Management were before Committee on Environment and Public Works United States Senate on The U.S. Army Corps of Engineers Management of the 2019 Missouri River Basin Flooding, April 17, 2019.

Figure 8. April 17, 2019, the Hearing, where Major General Scott A. Spellmon is on the left and Mr. John I. Remus II is on the right, retrieved from AP News

The Corps said "Our current focus remains to protect life, and work with the other Federal agencies and state and local authorities to help these communities recover from this flood."[8] The Corps designed this system of the six main stem reservoirs to capture runoff from mountain and plains snowpack, and rainfall in the upper basin that could otherwise (in the absence of the reservoirs) result in flooding, and then release that water gradually over the year to serve the other seven authorized project purposes. However, the intent is to do this in a way that will also provide the greatest amount of flood risk reduction. The Corps achieves this objective by evacuating all of the water in the flood storage space before the beginning of the next year's runoff season to create the flood storage space need for that next year. The Corps did not design the System to carry over flood water from one year to the next. They also said, "During this critical period, our principal and sole focus has been on the flood control purpose of the system. For example, considerations related to the endangered and threatened fish and birds of the main stem did not influence our reservoir operations during this flood event."[8] Plaintiffs are asserting that the Corps' priority for flood control and the policies and procedures, which endeavored to protect landowners near the river from flooding, changed by 2004 to conform to environmental laws and regulations.[7] The Corps, Massive, atypical flooding along the Missouri River since 2006, including the catastrophic flood of 2011, threatened the livelihoods of landowners, farm communities and agri-businesses in Missouri, Kansas, Iowa, Nebraska, South Dakota and North

Dakota.[7] On March 13, 2018, Judge Firestone issued her Trial Opinion on Phase 1 addressing causation of the flooding and found in favor of Plaintiffs in major respects.[7]

Figure 9. April 10, 2019, a barn destroyed by flood in Nebraska, retrieved from AP News

Three charges were founded: (1) de-prioritization of flood control in the pursuit of the Missouri River Recovery Program (see "MRRP" below) to benefit fish and wildlife which began in 2004; (2) changes in the management of the main-stem system (the six dams and reservoirs) by modifying storage and releases; and (3) geomorphic changes to the lower river below the dams by destabilizing the banks, constructing "pallid sturgeon chutes" and "interception rearing complexes" or IRC's which serve to widen the river like in the past, and modifying or eliminating the river control structures (revetments, wing dikes, chevrons).[7] Due to the changes to the lower river, the river no longer has the carrying capacity it once had over the last five decades leading up to 2004, the river level rises more rapidly, the river runs higher, and the flow is slower which facilitates flooding.[7] The Court found that changes made to river management and operations deprioritizing flood control in conjunction with MRRP beginning in 2004 changed the river and caused flooding in 2007, 2008, 2010, 2013, and 2014.[7]

Under the circumstance, many stakeholders and experts believe that Missouri River will flood continuously and more frequently. A 2012 report, commissioned by the United States Bureau of Reclamation, predicted that by mid-century there would be a 6 percent average annual increase

in lower basin runoff. In other words, this anomaly might become the new normal.[9]

We cannot attribute the 2019 flooding to just weather events including the "bomb cyclone" as the Corps wants to do. Such ignores the current modified state of the river as well as river management. It should go without saying that you cannot have flooding without water. The question is how is the water managed once it comes from whatever sources? Again, the "ditch" the "drain" has changed significantly. If the river does not drain as before, as it should to facilitate flood control, then flooding will result. That is the reality of the present situation.[7]

Words in Action (in the order of appearance)

- Niobrara
- Spencer Dam
- U.S. Army Corps of Engineers (USACE)
- The Missouri River
- Gavins Point
- Nabraska Public Power District (NPPD)
- The Nebraska Dept. of Natural Resources (NDNR)
- Nebraska
- South Dakota
- Lowa
- Kansas
- Fort Randall
- Luis and Clark Lake
- The World Herald
- Bomb cyclone, refers to the rate at which air pressure decrease, such as an explosion, resulting in severe meteorologic events.
- the James
- Vermillion
- Big Sioux
- Floyd
- Elkhorn
- Papillion
- Platte
- Elkhorn
- Missouri Mainstem Reservoir System
- Fort Peck
- Garrison
- Oahe
- Big Bend
- Fort Randall
- Gavins Point
- Master Water Control Manual
- Committee on Environment and Public Works, United States Senate
- Major General Scott A. Spellmon, Deputy Commanding General for Civil and Emergency Operation
- John I. Remus II, Chief of Missouri River Basin Water Management
- The US Court of Federal Claims
- The Missouri River Recovery Program (MRRP)

This article is excerpted and compiled by ICFM Secretariat from the following sources.

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International Conference on
Flood Management