The Great Flood of 1993 on the Upper Mississippi River—10 Years Later

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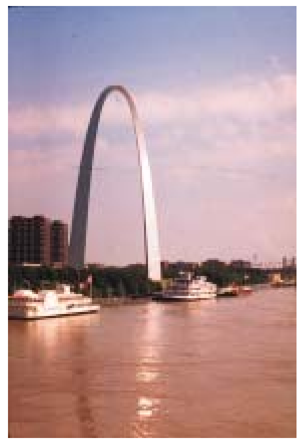
> *"The Mississippi River will always have its own way; no engineering skill can persuade it to do otherwise..."*
> - Mark Twain in Eruption

Background

Ten years ago, the upper Mississippi River Basin in the Midwestern United States experienced the costliest flood in the history of the United States. The flood came to be known as " The Great Flood of 1993".

The Mississippi River drains approximately 40 percent of the continental United States (approximately 1.25 million square miles) --all or part of 31 States, and two Canadian provinces, Ontario and Manitoba (fig. 1). During the summer of 1993, extremely high rainfall fell on the upper Midwest. An abnormally persistent atmospheric weather pattern consisting of an almost stationary jet stream was positioned over the central part of the Nation during this time. Moist, unstable air flowing north from the Gulf of Mexico converged with unseasonably cool, dry air moving south from Canada.



The Arch in St. Louis, Missouri: taken close to the peak of the Great Flood of 1993 on the upper Mississippi River.

The magnitude and severity of the resulting flood event was overwhelming. The areal extent, intensity, and long duration of the flooding makes this one of the greatest natural disasters ever in the United States. At least 48 people lost their lives as a result of this extreme flood (Interagency Floodplain Management Task Force, 1994). Over 500 river forecast points in the Midwest were above flood stage at the same time. Nearly 150 major rivers and tributaries flooded. Banks and channels of many rivers were severely eroded, and sediment was deposited over large areas of the Mississippi River flood plain. Economic damages approached $20 billion (National Oceanic and Atmospheric Administration, 1994). Le-

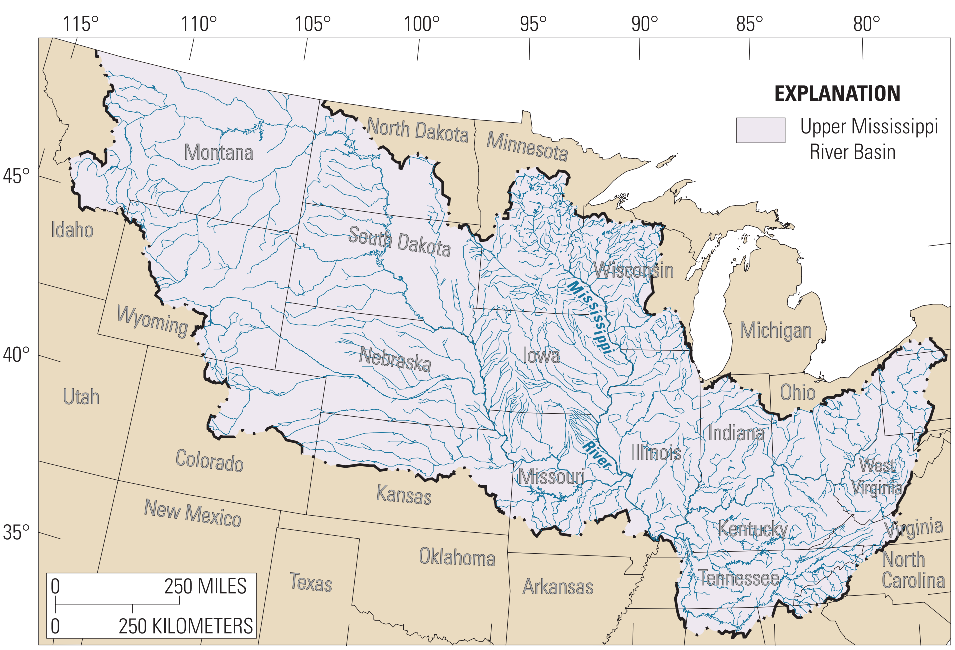


Figure 1. Upper Mississippi River Basin in the United States.

Downtown St. Louis, looking west, showing lateral variability in the sediment concentration. Lighter areas have a greater suspended sediment concentration. (Photo from Srenco Photography, St. Louis, Missouri, taken July 30, 1993, and published with permission).

vees were broken, farmland, town, and transportation routes were destroyed, and more than 50,000 homes were damaged or destroyed (Josephson, 1994). Water-quality threats to public health and safety were of paramount concern. These threats included contamination of drinking-water supplies, disruption of wastewater-treatment plant operations, failure of septic systems, and risks associated with the inundation of facilities that handle hazardous materials.

Precipitation

From June to August 1993, rainfall totals surpassed 12 inches across the eastern Dakotas, southern Minnesota, eastern Nebraska, Wisconsin, Kansas, Iowa, Missouri, Illinois, and Indiana. More than 24 inches of rain fell on central and northeastern Kansas, northern and central Missouri, most of Iowa, southern Minnesota, and southeastern Nebraska, with up to 38 inches in east-central Iowa. These amounts were approximately 200-350 percent above normal. From April 1 to August 31, precipitation amounts approached 48 inches in east-central Iowa, easily surpassing the area's normal annual precipitation of 30-36 inches. Record summer rainfalls achieved 75- to 300-year frequencies (Stallings, 1994).

A critical factor affecting the record flooding was the near continuous nature of the rainfall. It is notable that the flooding was not the result of one large precipitation event. Many locations in the Midwest experienced rain on 20 days or more in July, compared to an average of 8-9 days with rain. Measurable rain fell in parts of the upper Mississippi Basin every day between late June and late July. The persistent, rain-producing weather pattern in the Upper Midwest, typical in the spring but not summer, sustained the almost daily development of rainfall during much of the summer (fig. 2).

The Great Flood of 1993

The Great Flood of 1993 began in early June with saturated soils and streams filled to capacity across the upper Midwest. Runoff from the ensuing persistent heavy rains of June, July, and August filled the streams and river chan-

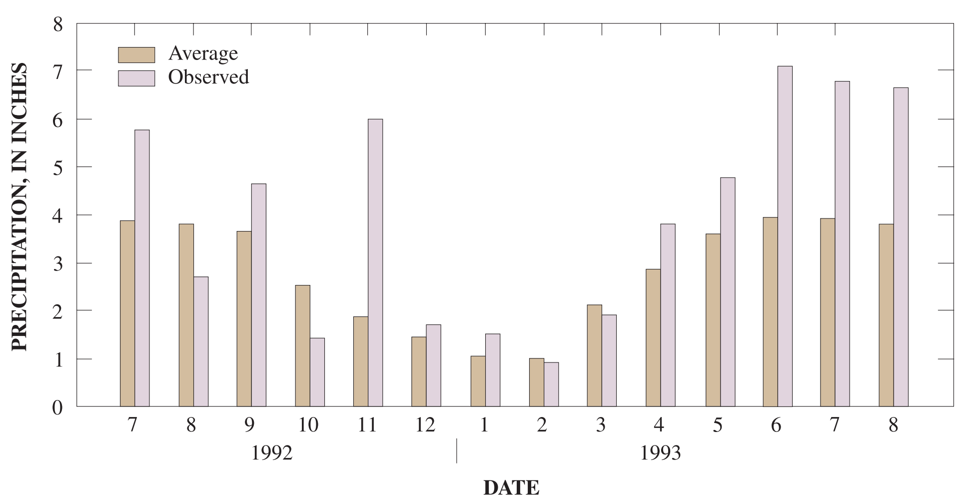


Figure 2. Comparison of average and observed monthly precipitation totals from July 1992 to August 1993 for the upper Mississippi River Basin (from National Oceanic and Atmospheric Administration, 1994).

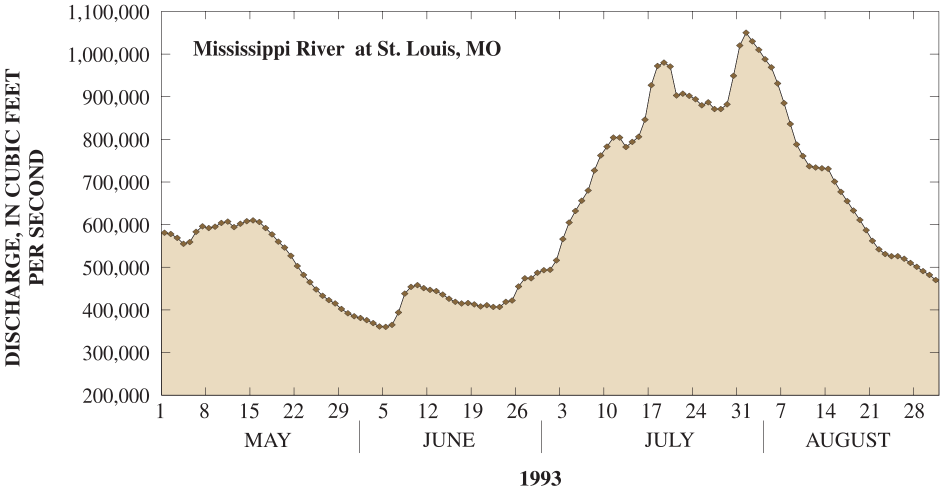


Figure 3. Hydrograph of Mississippi River at St. Louis, Missouri from May to August 1993.

nels. Flooding began on rivers in Minnesota and Wisconsin and eventually to the Mississippi River, cresting at St. Louis on July 12 of about 43 feet, equaling the previous stage of record. The Missouri River crested at 48.87 feet at Kansas City on July 27. This crest moved down the Missouri River setting new records at Boonville, Jefferson City, Hermann, St. Charles, and other locations. This record flow added to the already full Mississippi River just north of St. Louis, and resulted in another record crest of the Mississippi River at St. Louis on August 1st of 49.58 feet, and record flow of over 1 million cubic feet per second (fig. 3). A new record

Table 1. Some locations with new record stages in the Mississippi River Basin [ft, feet; mm/dd/yy, month, day, and year]

		Old Record		New Record	
	Flood Stage (ft)	**Stage (ft)**	**Date (mm/dd/yy)**	**Stage (ft)**	**Date (mm/dd/yy)**
Mississippi River					
Rock Island, IL	15	22.5	04/28/65	22.6	07/09/93
Keithsburg, IL	13	20.4	04/27/65	24.2	07/09/93
Quincy, IL	17	28.9	04/23/73	32.2	07/13/93
Hannibal, MO	16	28.6	04/25/73	31.8	07/16/93
Clarksville, MO	25	36.4	04/24/73	37.7	07/29/93
Winfield, MO	26	36.8	04/27/73	39.6	08/01/93
Grafton, IL	18	33.1	04/28/73	38.17	08/01/93
Alton, IL	21	36.7	04/28/73	42.7	08/01/93
St Louis, MO	30	43.23	04/28/73	49.58	08/01/93
Chester, IL	27	43.32	04/30/73	49.74	08/07/93
Missouri River					
St. Joseph, MO	17	26.82	04/23/52	32.07	07/26/93
Kansas City, MO	32	36.20	07/14/51	48.87	07/27/93
Boonville, MO	21	32.62	07/17/51	37.10	07/29/93
Jefferson City, MO	23	34.2	07/18/51	38.6	07/30/93
Hermann, MO	21	35.79	10/05/86	36.97	07/31/93
St. Charles, MO	25	37.50	10/07/86	39.50	08/01/93
Illinois River					
Hardin, IL	25	38.2	04/29/73	42.36	08/03/93

Table 2. Levee failures during the Great Flood of 1993

CORPS OF ENGINEERS DISTRICT	**NUMBER OF FAILED OR OVERTOPPED LEVEES**	
	Federal	**Non-Federal**
St. Paul	1 of 32	2 of 93
Rock Island	12 of 73	19 of 185
St. Louis	12 of 42	39 of 47
Kansas City	6 of 48	810 of 810
Omaha	9 of 31	173 of 210
Totals	40 of 226	1043 of 1345

crest occurred on the Illinois River at Hardin on August 3, over 4 feet higher than the previous record. Every streamflow-gaging station on the Mississippi River from Rock Island, Illinois to Thebes, Illinois experienced a new flood of record. Selected locations that set new record stages during the Great Flood of 1993 are shown in table 1.

Thousands of acres were inundated as a result of the record flooding. The first levee was overtopped on June 7, but levee failures soon became common. Over 1,000 Federal and non-Federal levees were topped or failed (table 2) during the flood (Larson, 1996).

Streamflow-Gaging Stations--An Essential Resource

Was the Great Flood of 1993 an anomalous, unique event? Was it caused by levees? Was it exacerbated by other actions of man? -- We'll never know without good, long-term streamflow-gaging stations.

Streamflow monitoring on the mainstem of the Mississippi River began in the 1860's when the first gage began operation at St. Louis, Missouri. Currently (2003), the

Levee surrounding Clarence Cannon National Wildlife Refuge, Missouri, damaged by the Great Flood of 1993 (Courtesy of U.S. Fish and Wildlife Service)

USGS maintains more than 7,000 streamflow-gaging stations nationwide in cooperation with various local, State, and Federal agencies. Real-time streamflow data from the USGS are used by the National Weather Service River Forecast Centers to determine flood stages for various streams, and to help forecast when and where streams will crest during floods (http://www.noaanews.noaa.gov/stories/s334c.htm). The U.S. Army Corps of Engineers uses real-time streamflow data to schedule reservoir releases that are designed to lessen the amount of potential damage from overflowing streams and to prevent water from backing up into smaller tributaries when the mainstem already is bankfull. USGS streamflow data also are used to design bridges, highways, and culverts that will convey sufficient streamflow so that transportation infrastructure will remain above water during flooding. The Federal Emergency Management Agency uses USGS streamflow data to address emergency response needs, before, during, and after the flooding, and to develop flood-insurance rate maps.

Deaths and damage from floods can be mitigated by real-time streamflow data and reliable forecasting. Information on the quantity and timing of the streamflow in the Nation's rivers is a vital asset that safeguards lives and property and helps to ensure adequate water resources for a healthy environment and economy. The USGS streamgaging network is operated as a partnership between the USGS and over 800 Federal, State, Tribal, and local agencies. This partnership has great value but the number of streamgages has declined in recent years. Stakeholders agree that a plan is needed to reverse the loss of streamgages and to provide for a stable and modern streamflow monitoring network for the future.

Inundated flood plain and farmstead during the Great Flood of 1993 on the upper Mississippi River.

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For more information about the water resources in Illinois, visit the USGS Web site:
http://il.water.usgs.gov/
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