Significant Floods in the United States During the 20th Century—USGS Measures a Century of Floods

—Charles A. Perry

Confluence of Mississippi and Missouri Rivers, August 1993. Extensive floods in the Mississippi River Basin during the spring and summer of 1993 caused $20 billion in damages. (Photograph, Srenco Photography, St. Louis, Mo.)

During the 20th century, floods were the number-one natural disaster in the United States in terms of the number of lives lost and property damage. For more than 110 years the U.S. Geological Survey (USGS) has measured floods for the Nation's benefit while supplying additional streamflow data with its extensive stream-gaging network. Thirty-two of the most significant floods (in terms of number of lives lost and (or) property damage) in the United States during the 20th century are listed according to the various types of floods. Internet sites for acquiring near-real-time streamflow data and other pertinent flood information are provided.

USGS Flood Measurements

The USGS currently (2000) maintains more than 7,000 stream-gaging stations throughout the United States, Puerto Rico, and the Virgin Islands that monitor streamflow and provide data to various Federal, State, and local cooperating agencies as well as the general public. Some of these stream-gaging stations have been in operation since before 1900, providing more than a century of water informaton for the Nation. In addition to providing critical information on flood heights and discharges, these stations provide data used in the effective management of water-supply and water-quality needs, protection of aquatic habitat, recreation, and water-resources research.

The basic building block for a streamflow data network is the stage-discharge relation that is developed at each gaging-station location. Measurements of the flow (discharge) are related graphically to the respective water depths (stage), which then enables discharge to be determined from stage data.

Discharge measurements can either be direct, using a current meter, or indirect, using mathematical flow equations. Both methods require that an elevation of the floodwater surface be determined by a water-depth gage or by a detailed survey of high-water marks. If time allows and conditions are safe, a direct measurement by USGS hydrographers is preferred. However, during major floods, direct measurements are often impossible or extremely dangerous, and indirect methods must be used.

Accurate identification and measurement of high-water marks from floods are very important in the accurate mapping of inundated areas as well as in the analysis of water-surface profiles for indirect discharge measurements. These elevations, in combination with flood-frequency analysis using many years of annual flood maximums, are used by the Federal Emergency Management Agency (FEMA) to determine flood-insurance rates.

Significant Floods of the 20th Century

During the 20th century, floods were the number-one natural disaster in the United States in terms of number of lives lost and property damage. They can occur at any time of the year, in any part of the country, and at any time of the day or night. Most lives are lost when people are swept away by flood currents, whereas most property damage results from inundation by sediment-laden water. Flood currents also possess tremendous destructive power, as lateral forces can demolish buildings and erosion can undermine bridge foundations and footings leading to the collapse of structures. The accompanying map and table locate and describe 32 of the most significant floods of the 20th century.

Floods are the result of a multitude of naturally occurring and human-induced factors, but they all can be defined as the accumulation of too much water in too little time in a specific area. Types of floods include regional floods, flash floods, ice-jam floods, storm-surge floods, dam- and levee-failure floods, and debris, landslide, and mudflow floods.

Regional Floods

Some regional floods occur seasonally when winter or spring rains coupled with melting snow fill river basins with too much water too quickly. The ground may be frozen, reducing infiltration into the soil and thereby increasing runoff. Such was the case for the New England flood of March 1936 in which more than 150 lives were lost and property damage totaled $300 million.

Discharge measurements made during floods are used to develop stage-discharge relations at each gaging station. (Photograph, Lawrence Journal World, Lawrence, Kans.)

U.S. Department of the Interior
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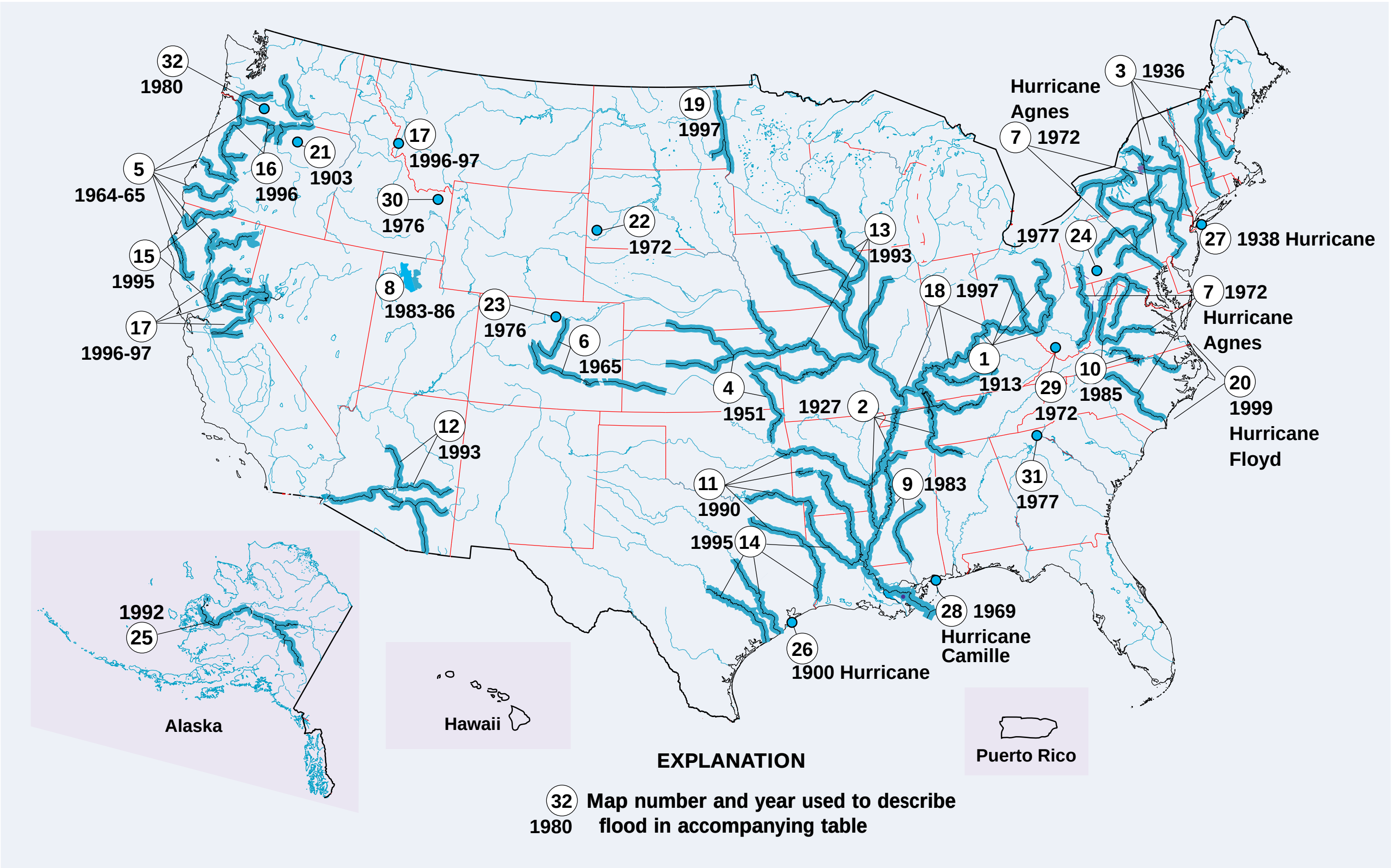


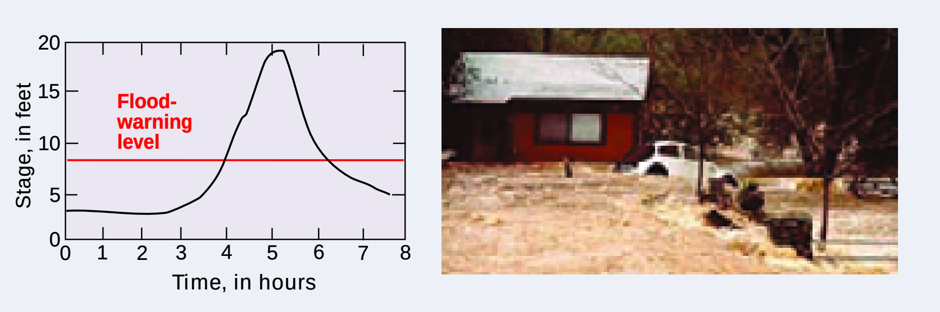
Extended wet periods during any part of the year can create saturated soil conditions, after which any additional rain runs off into streams and rivers, until river capacities are exceeded. Regional floods are many times associated with slow-moving, low-pressure or frontal storm systems including decaying hurricanes or tropical storms. Persistent wet meteorological patterns are usually responsible for very large regional floods such as the Mississippi River Basin flood of 1993 wherein damages were $20 billion.

Flash Floods

Flash floods can occur within several seconds to several hours, with little warning. Flash floods can be deadly because they produce rapid rises in water levels and have devastating flow velocities.

Several factors can contribute to flash flooding. Among these are rainfall intensity, rainfall duration, surface conditions, and topography and slope of the receiving basin. Urban areas are susceptible to flash floods because a high percentage of the surface area is composed of impervious streets, roofs, and parking lots where runoff occurs very rapidly. Mountainous areas also are susceptible to flash floods, as steep topography may funnel runoff into a narrow canyon. Floodwaters accelerated by steep stream slopes can cause the floodwave to move downstream too fast to allow escape, resulting in many deaths. A flash flood caused by 15 inches of rain in 5 hours from slow-moving thunderstorms killed 237 people in Rapid City, South Dakota, in 1972.

Floodwaves more than 30-feet high have occurred many miles from the rainfall area, catching people unaware. Even desert arroyos are not immune to flash floods, as distant thunderstorms can produce rapid rises in water levels in otherwise dry channels. Early-warning gages upstream save lives by providing advanced notice of potential deadly floodwaves.



USGS stream-gaging stations quickly provide early flood warnings for many flash-flood-prone-areas. (Photograph, Darel Noceti, Rapid Shooters, Coloma, Calif.)

Ice-Jam Floods

Ice-jam floods occur on rivers that are totally or partially frozen. A rise in stream stage will break up a totally frozen river and create ice flows that can pile up on channel obstructions such as shallow riffles, log jams, or bridge piers. The jammed ice creates a dam across the channel over which the water and ice mixture continues to flow, allowing for more jamming to occur. Backwater upstream from the ice dam can rise rapidly and overflow the channel banks. Flooding moves downstream when the ice dam fails, and the water stored behind the dam is released. At this time the flood takes on the characteristics of a flash flood, with the added danger of ice flows that, when driven by the energy of the floodwave, can inflict serious damage on structures. An added danger of being caught in an ice-jam flood is hypothermia, which can quickly kill. Ice jams on the Yukon River in Alaska contributed to severe flooding during the spring breakup of 1992.

Significant Floods of the 20th Century

[M, million; B, billion]

Flood type	Map no.	Date	Area or stream with flooding	Reported deaths	Approximate cost (uninflated)	Comments
Regional flood	1	Mar.–Apr. 1913	Ohio, statewide	467	$143M	Excessive regional rain.
	2	Apr.–May 1927	Mississippi River from Missouri to Louisiana	unknown	$230M	Record discharge downstream from Cairo, Illinois.
	3	Mar. 1936	New England	150+	$300M	Excessive rainfall on snow.
	4	July 1951	Kansas and Neosho River Basins in Kansas	15	$800M	Excessive regional rain.
	5	Dec. 1964–Jan. 1965	Pacific Northwest	47	$430M	Excessive rainfall on snow.
	6	June 1965	South Platte and Arkansas Rivers in Colorado	24	$570M	14 inches of rain in a few hours in eastern Colorado.
	7	June 1972	Northeastern United States	117	$3.2B	Extratropical remnants of Hurricane Agnes.
	8	Apr.–June 1983 June 1983–1986	Shoreline of Great Salt Lake, Utah	unknown	$621M	In June 1986, the Great Salt Lake reached its highest elevation and caused $268M more in property damage.
	9	May 1983	Central and northeast Mississippi	1	$500M	Excessive regional rain.
	10	Nov. 1985	Shenandoah, James, and Roanoke Rivers in Virginia and West Virginia	69	$1.25B	Excessive regional rain.
	11	Apr. 1990	Trinity, Arkansas, and Red Rivers in Texas, Arkansas, and Oklahoma	17	$1B	Recurring intense thunderstorms.
	12	Jan. 1993	Gila, Salt, and Santa Cruz Rivers in Arizona	unknown	$400M	Persistent winter precipitation.
	13	May–Sept. 1993	Mississippi River Basin in central United States	48	$20B	Long period of excessive rainfall.
	14	May 1995	South-central United States	32	$5-6B	Rain from recurring thunderstorms.
	15	Jan.–Mar. 1995	California	27	$3B	Frequent winter storms.
	16	Feb. 1996	Pacific Northwest and western Montana	9	$1B	Torrential rains and snowmelt.
	17	Dec. 1996–Jan. 1997	Pacific Northwest and Montana	36	$2-3B	Torrential rains and snowmelt.
	18	Mar. 1997	Ohio River and tributaries	50+	$500M	Slow-moving frontal system.
	19	Apr.–May 1997	Red River of the North in North Dakota and Minnesota	8	$2B	Very rapid snowmelt.
	20	Sept. 1999	Eastern North Carolina	42	$6B	Slow-moving Hurricane Floyd.
Flash flood	21	June 14, 1903	Willow Creek in Oregon	225	unknown	City of Heppner, Oregon, destroyed.
	22	June 9–10, 1972	Rapid City, South Dakota	237	$160M	15 inches of rain in 5 hours.
	23	July 31, 1976	Big Thompson and Cache la Poudre Rivers in Colorado	144	$39M	Flash flood in canyon after excessive rainfall.
	24	July 19–20, 1977	Conemaugh River in Pennsylvania	78	$300M	12 inches of rain in 6-8 hours.
Ice-jam flood	25	May 1992	Yukon River in Alaska	0	unknown	100-year flood on Yukon River.
Storm-surge flood	26	Sept. 1900	Galveston, Texas	6,000+	unknown	Hurricane.
	27	Sept. 1938	Northeast United States	494	$306M	Hurricane.
	28	Aug. 1969	Gulf Coast, Mississippi and Louisiana	259	$1.4B	Hurricane Camille.
Dam-failure flood	29	Feb. 2, 1972	Buffalo Creek in West Virginia	125	$60M	Dam failure after excessive rainfall.
	30	June 5, 1976	Teton River in Idaho	11	$400M	Earthen dam breached.
	31	Nov. 8, 1977	Toccoa Creek in Georgia	39	$2.8M	Dam failure after excessive rainfall.
Mudflow flood	32	May 18, 1980	Toutle and lower Cowlitz Rivers in Washington	60	unknown	Result of eruption of Mt. St. Helens.

Storm-Surge Floods

Storm-surge flooding is water that is pushed up onto otherwise dry land by onshore winds. Friction between the water and the moving air creates drag that, depending upon the distance of water (fetch) and the velocity of the wind, can pile water up to depths greater than 20 feet. Intense, low-pressure systems and hurricanes can create storm-surge flooding. The storm surge is unquestionably the most dangerous part of a hurricane as pounding waves create very hazardous flood currents.

Some floods are measured by USGS hydrographers using indirect methods that involve surveys of valley cross sections, bridge-opening measurements, and high-water marks that are used in mathematical flow equations to compute discharge.

Nine out of 10 hurricane fatalities are caused by the storm surge. Worst-case scenarios occur when the storm surge occurs concurrently with high tide. Stream flooding is much worse inland during the storm surge because of backwater effects. In September 1900, the hurricane and storm surge at Galveston, Texas, killed more than 6,000 people, making it the worst natural disaster in the Nation’s history.

Dam- and Levee-Failure Floods

Dams and levees are built for flood protection. They usually are engineered to withstand a flood with a computed risk of occurrence. For example, a dam or levee may be designed to contain a flood at a location on a stream that has a certain probability of occurring in any 1 year. If a larger flood occurs, then that structure will be overtopped. If during the overtopping the dam or levee fails or is washed out, the water behind it is released to become a flash flood. Failed dams or levees can create floods that are catastrophic to life and property because of the tremendous energy of the released water. Warnings of the Teton Dam failure in Idaho in June 1976 reduced the loss of life to 11 people.

Debris, Landslide, and Mudflow Floods

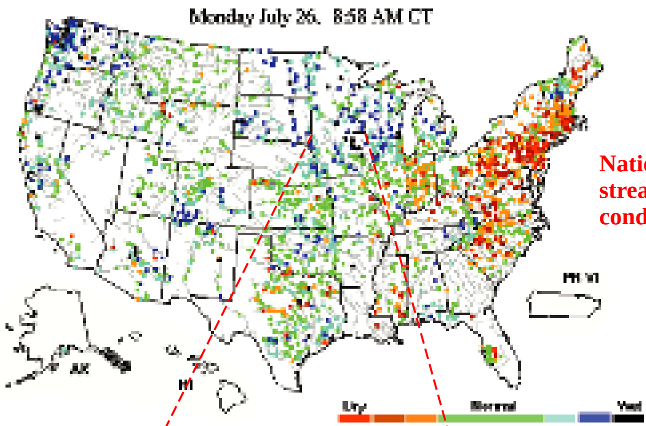
Debris or landslide floods are created by the accumulation of debris, mud, rocks, and (or) logs in a channel, which form a temporary dam. Flooding occurs upstream as water becomes stored behind the temporary dam and then becomes a flash flood as the dam is breached and rapidly washes away. Landslides can create large waves on lakes or embayments and can be deadly. Mudflow floods can occur when volcanic activity rapidly melts mountain snow and glaciers, and the water mixed with mud and debris moves rapidly downslope. These mudflow events are also called lahars and, after the eruption of Mt. St. Helens in 1980, caused significant damage downstream along the Toutle and Cowlitz Rivers in southwest Washington.

Flood Information on the Internet

Streamflow information can be accessed through the Internet at several adresses, including:

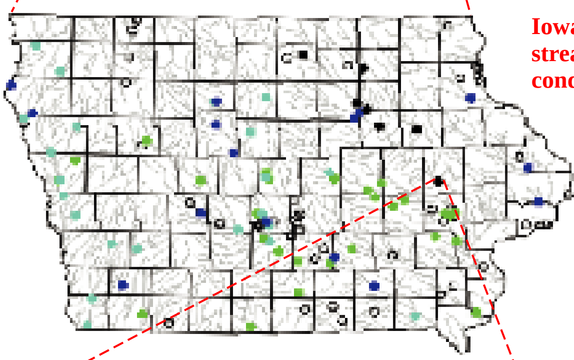
http://water.usgs.gov/public/dwc/

which will display the map shown below.

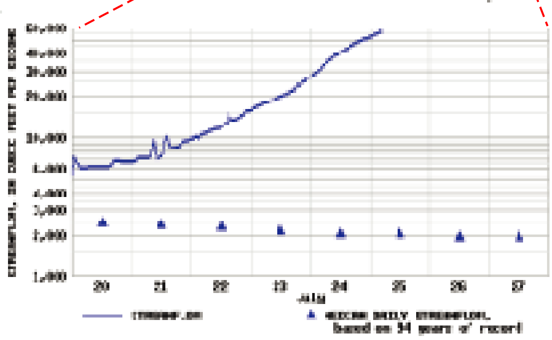


National streamflow conditions

By clicking on the area of interest, the State map for that area is accessed. Clicking on the station of interest results in the Web page for that station being displayed. Stage and discharge for several days and links to other data, such as the annual peak-flow file and historic data, are provided.



Iowa streamflow conditions



Streamflow for Cedar River at Cedar Rapids, Iowa

Other Internet Sites

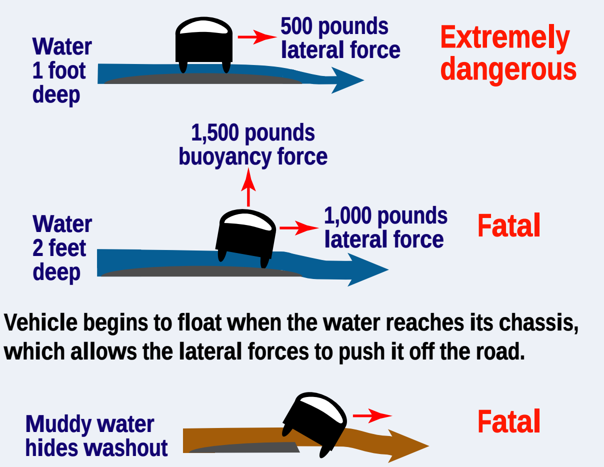
Flood Insurance—http: //www.fema.gov/library/frnfip.htm
Dam Safety—http://www.usbr.gov/laws/damguide.html
Hurricane Safety—http://www.nws.noaa.gov/om/nh-hurr.htm
Flash-Flood Safety—http://www.nws.noaa.gov/om/nh-flsfd.htm
Regional Flood Safety—http://www.nws.noaa.gov/om/nh-flood.htm
River Forecast Centers—http://info.abrfc.noaa.gov/rfc_wfo.html
U.S. Army Corps of Engineers regional sites and districts—
  http://www.usace.army.mil/inet/organization/actlist2.htm
USGS Streamflow Data
  Historical—http://waterdata.usgs.gov/nwis-w/US/
  Peak flow—http://h2o.usgs.gov/public/realtime.htm
USGS Homepage—http://www.usgs.gov/

Most USGS streamgaging stations transmit river stage and other water information directly to geostationary satellites and on to a national hydrologic data network that disseminates information to cooperating agencies and to the public through the Internet.

Flood Facts

- Most flood-related deaths are due to flash floods.
- Fifty percent of all flash-flood fatalities are vehicle related.
- Ninety percent of those who die in hurricanes drown.
- Most homeowners insurance policies do not cover floodwater damage.
- Individuals and business owners can protect themselves from property losses by purchasing flood insurance through FEMA's National Flood Insurance Program.

DO NOT DRIVE THROUGH FLOODWATERS!



Vehicle begins to float when the water reaches its chassis, which allows the lateral forces to push it off the road.

Washed-out roadway can be hidden by muddy water allowing a vehicle to drop into unexpected deep water.

Some information in this fact sheet was obtained from U.S. Army Corps of Engineers, Federal Emergency Management Agency, and National Weather Service.

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