FLOODS OF 1972

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Whereas during an average year floods claim about 100 lives and $1 billion in damage, during 1972 the losses were four to five times that great. Although Hurricane Agnes caused severe flooding from North Carolina to New York, a variety of phenomena, including rainfall, snowmelt, ice jams, structural failures, and lake stages, caused flooding in Idaho, Washington, Oregon, Arizona, and other places. The floods described in this paper, all of which exceeded the magnitude of the 50-year recurrence interval, were selected to demonstrate the variety of causes.

•THE PURPOSE of this paper is to describe in general terms some of the significant floods of 1972. By any yardstick, 1972 must be known as a year of exceptional flooding. During an average year, we lose 100 lives and about $1 billion to floods; during 1972 the losses were four to five times that great.

Selecting the floods to describe was difficult, inasmuch as there was such a variety to choose from. Those selected had magnitudes exceeding the 50-year recurrence interval and some special significance. Most were selected to accentuate the variety of causes, including rainfall and snowmelt, structural failure, ice jams, and lake stages. The floods are described in chronological sequence.

The first significant flooding of the year occurred at Buffalo Creek, West Virginia, February 26, 1972. This was the largest and most destructive flood in the history of West Virginia. There were 118 lives lost, 500 homes destroyed, and 4,000 people left homeless. Property damage amounted to about $50 million, $15 million of which was damage to highway structures. The primary cause of this flood was a coal-waste dam failure. Natural runoff from rainfall and snowmelt on surrounding streams may have reached the 10-year recurrence interval. In general, the natural runoff was less than 100 cubic feet per second per square mile (cfsm) on a 1-square-mile basin and less than 50 cfsm on a 10-square-mile basin. At a point below the coal-waste dam failure, the peak discharge was about 8,500 cfsm from a 6-square-mile basin, and the discharge was at least 40 times the magnitude of a 50-year flood. The hydrologic and geologic evidence documenting this structural failure is given in U. S. Geological Survey Circular 667.

June was the month when widespread flooding really began in 1972, as shown in Figure 1. First flooding in the month started in central Washington during the period May 30 to June 3. Flooding was caused by the delayed snowmelt, after an exceptionally cool May. Discharge was the greatest since 1894 on many streams. The town of Okanogan, Washington, was inundated by 6 ft of water; otherwise, the area inundated was sparsely settled, and damage was minimal. Discharge rates on the Similkameen and Okanogan Rivers, having drainage basins from 3,500 to 7,000 square miles, were about 5 to 15 cfsm and had recurrence intervals greater than 50 years.

Between June 3 and 10 snowmelt flooding occurred in Idaho and Montana. Flood magnitudes were generally comparable to the record 1948 floods in the area, which are rated at about the 50-year recurrence interval. Unit runoff rates were 5 to 15 cfsm on very large basins such as the Clark Fork. Peak stages lasted for several days, and, fortunately, rains forecast for this period did not occur.

During the period June 7 to 10 there were three thunderstorm floods of considerable hydrologic similarity but greatly different social consequences.

On June 7, near Bakersfield, California, a thunderstorm flood caused one death and $0.25 million worth of damage. Flow rates near the center of this 500-square-mile

flood area were about 500 cfsm on small basins. On June 8 in a remote area of northwest Nevada, thunderstorms hit an area about 50 miles long and 10 miles wide. Flow rates of more than 500 cfsm were observed on a 3-square-mile basin. Mud and sediment loads transported by these flows were extreme, but because the storm hit a very remote area there was no dollar damage or loss of life.

On June 9 to 10 thunderstorm floods again covering a 50- by 10-mile area struck in the vicinity of the Black Hills and Rapid City in South Dakota. Damages from this flooding exceed $160 million, with 237 lives lost and 28 persons missing. The floods damaged 2,805 houses and destroyed 770; inundated 1,305 trailers and destroyed 565; and inundated 402 businesses and destroyed 35. Discharge and runoff rates at a few selected sites are given in Table 1.

Of special interest is the effect of the failure of the Canyon Lake Dam on the peak discharge at Rapid City. Peak flows were 31,200 cfs above Canyon Lake Dam and 50,000 cfs at Rapid City below the failed dam. However, the intervening 40 square miles of drainage area produced extremely high runoff, e.g., a flood peak of 12,600 cfs from 7 square miles of Cleghorn Canyon. Because of this, it was concluded that the dam failure did not contribute a great deal to the peak flow rate at Rapid City, one of the most damaging floods in U.S. history.

The next significant flooding occurred June 18 and 19 in Westchester County, New York, and southwestern Connecticut. Peak flow rates of 70 to 170 cfsm occurred on streams draining 10 to 25 square miles. These flow rates had about a 50-year recurrence interval and are the largest on record for most sites. While this Westchester County flooding was going on, we had eyes on Hurricane Agnes along the Florida coast, but we were looking in the wrong direction.

On June 21 in the Sacramento-San Joaquin River delta, about 150 ft of dike failed. This failure caused $41 million worth of damage and necessitated the evacuation of 2,000 people, but no lives were lost. This flooding was strictly a structural failure. Upland runoff at the time was low, and tides and winds were only moderately high.

On June 21, the rains of Hurricane Agnes began in earnest, but there was one other flood of interest to be reported. That occurred on June 22 at Phoenix, Arizona, when heavy rainfall on a small basin northeast of Phoenix caused significant flooding. One stream gauger had to be rescued by helicopter. Flow from this 4-square-mile basin ruptured an irrigation ditch and caused major flooding of a large portion of Phoenix; however, no lives were lost.

During June 21 to 24 flooding was in progress from Hurricane Agnes, not in Florida, but from North Carolina to New York. In terms of people affected, extent of area damaged, and dollars lost, this is the greatest natural disaster in U.S. history. There was $3.2 billion worth of damage; one-half million people suffered losses, 116,000 dwellings and mobile homes were destroyed or damaged, 5,800 businesses were destroyed, 5,000 square miles were inundated, and 118 lives were lost. It is difficult to generalize on a storm of this size. Over one-half of the gauge sites in Maryland and Pennsylvania recorded flood peaks having recurrence intervals greater than 50 years. Flooding was extreme on both large and small streams. The Susquehanna River produced a flood peak of 1.13 million cfs (42 cfsm) from a drainage area of 27,000 square miles. And a tributary to Gunpowder River in Maryland had a peak discharge of 2,000 cfsm from a $\frac{1}{4}$-square-mile drainage basin. All in all, Hurricane Agnes caused big floods, the biggest of a big month of floods.

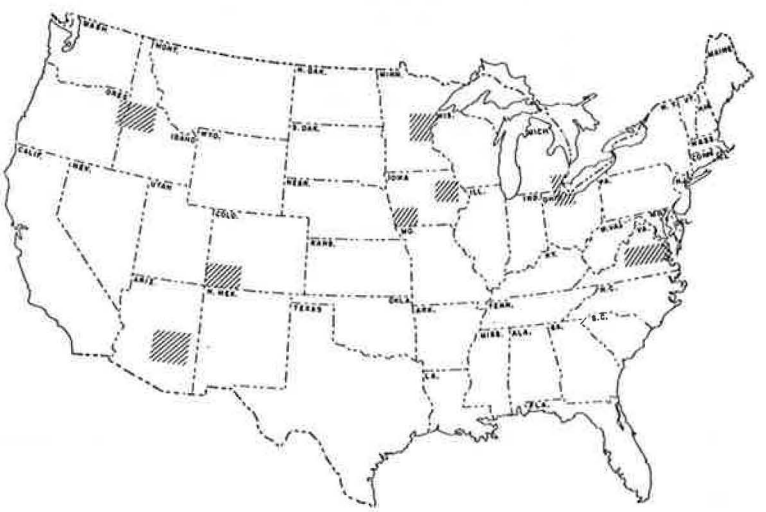
Areas of significant flooding during the second half of 1972 are shown in Figure 2. On July 21 to 23 heavy rains in the lake region of central Minnesota caused extensive flooding, which caused more than $17 million damage to railroads, roads, homes, businesses, and agricultural land. Flooding covered a 50-mile wide swath of poorly drained land in the Rum, Snake, and Kettle River basins. A dam failure on Knife Lake compounded the flood problems and contributed 5,000 cfs to the peak rate of 18,600 cfs at Mora. Flows exceeded the 50-year recurrence interval and ranged from less than 10 to about 45 cfsm. The greatest problem was high lake stages and slow drainage rather than flow magnitudes. Large lakes had seiches of over 1 ft, and winds caused extensive wave damage for long periods of time.

Figure 1. Areas of significant flooding during June 1972.

Table 1. Peak flow rates for selected sites in South Dakota for June 9 and 10.

Identification No.	Site Name	Contributing Drainage Area (square miles)	Flow Peak Rate (cfs)	Recurrence Interval (years)
—	Battle Creek at Keystone	13.6	10,800	>100
4040	Battle Creek near Keystone	66	26,200	>100
—	Battle Creek at Canyon Mouth	110	44,100	>100
4060	Battle Creek at Hermosa	176	21,400	>100
4115	Rapid Creek below Pactola Dam	1	378	
—	Rapid Creek at SD-40	8.35	5,750	>100
4125	Rapid Creek above Canyon Lake	52	31,200	>100
—	Cleghorn Canyon at Rapid City	6.95	12,600	>100
4140	Rapid Creek at Rapid City	91	50,000	>100
4215	Rapid Creek near Farmingdale	283	7,320	>100
—	Boxelder Creek at Benchmark near Nemo	37.2	1,180	7
4225	Boxelder Creek near Nemo	96	30,100	>100
—	Boxelder Creek at Nemo Road near Rapid City	117	51,600	>100

Figure 2. Areas of significant flooding during July to December 1972.



Some extensive flooding occurred in Iowa during August and September. On August 2, floods of twice the 100-year recurrence interval magnitude occurred on the Little Maquoketa River in northeast Iowa, where peak flows of 300 to 500 cfsm were recorded. On September 11 to 13 storms again hit Iowa, causing floods with magnitudes of 1½ to 2 times the 100-year recurrence interval flood. The Little Maquoketa River again experienced flooding greater than the 100-year recurrence interval magnitude, the second such flood in a 2-month period.

As proof that more than one extreme flood can occur in a year, on October 5 to 7 there was significant flooding again in southern and central Virginia. Flows exceeded the 50-year recurrence interval for the second time in 1972 at several sites. Richmond was flooded for the third time since 1969.

Some widespread and significant flooding occurred in Colorado, Arizona, and New Mexico during October 19 to 21. Total damages exceeded $20 million, and 9 lives were lost. Flow rates of 10 to 20 cfsm from 1,000-square-mile basins set new records for peaks at sites with 40- to 50-year gauging records.

On November 14 to 15 there was some extreme flooding along Lake Erie, from Vermillion westward to Toledo, Ohio, and Monroe, Michigan, and also along the west shore of Lake Huron. The Lake Erie water surface was 2 ft above the previous known maximum and 8.4 ft above the low-water datum. Several thousand people were evacuated; 2,000 homes and businesses were flooded.

On December 4 to 15, severe ice-jam flooding struck areas of Idaho. Stages exceeded previous known maximums at places on the Snake and Salmon Rivers. The water surface on Snake River was 12½ ft above the normal open-water surface elevation, and the towns of Weiser, Idaho, and Ontario, Oregon, were flooded. We can all sympathize with the victims of any river floods, but consider the problems of people who are flooded at temperatures of 20 deg below zero.

SUMMARY

In summary, floods during 1972 were the result of various phenomena: rainfall, snowmelt, structural failure, ice jams, high lake levels. They present many problems for hydrologists. How do we assign probabilities to a flood such as that in Rapid City? What are the probabilities of having two extreme floods such as were recorded in Iowa and Virginia? What are the consequences of extreme flooding on land use planning, and how does our knowledge of extreme floods affect structural design and inspections? These are challenging problems, but hydrologists will find that the solutions are particularly rewarding.

SUBSEQUENT INFORMATION

The Texas Highway Department called attention to severe flooding on May 11 and 12 in the Guadalupe River Basin, near New Braunfels, in south central Texas. At least 16 persons drowned, and total damage was estimated at $15 million. Unit runoff rates were extreme. A 0.48-square-mile drainage basin on Trough Creek had a peak flow rate of about 5,200 cfsm, and a 15-square-mile drainage basin on Blieders Creek had a peak rate of about 3,200 cfsm. These flow rates are among the largest ever measured in the United States.