Chapter 34

Floods

Floods make the news each year, and although control structures and dikes are built, as well as limiting building within flood plains, these disasters, along with major property damage and loss of life, still occur. It goes to show that nature will always be a force to be reckoned with regardless of our attempts to control our environment. But why do floods occur at all? This is because of many factors, some of which will be discussed in this chapter.

The National Flood Insurance Program defines a flood as, "A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is your property) from:

- Overflow of inland or tidal waters,
- Unusual and rapid accumulation or runoff of surface waters from any source, or
- A mudflow.

[The] collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood." (Federal Emergency Management Agency, 2004).

That is a comprehensive definition that has a lot of good information. Most of the flooding we see inland in the U.S. is due to unusual and rapid accumulation or runoff of surface waters. Generally, flooding can occur if there is significant amounts of rainfall or snowmelt, or if the rainfall or snowmelt (or both) occur rapidly.

A process that scientists refer to as Horton Overland Flow (discussed in Chapter 5) relates to three steps that occur during precipitation or snowmelt. The first step is infiltration, where the water accumulating on the land surface infiltrates into the soils. The second step is when either the soils become saturated or the accumulation of rainfall/snowmelt exceeds the rate of infiltration into the soils and puddling occurs (filling of low areas). The third step is when puddles/depressions overfill and overland flow occurs. Excessive overland flow can contribute to flooding.

Obviously, many factors affect the occurrence of overland flow and flooding. The geology and soil types, land slope, vegetation cover, and depth to ground water are just some variables to consider. Another important variable is urbanization. Impervious land cover, such as streets and parking lots, do not allow infiltration of the precipitation and snowmelt. This water runs off these surfaces and drains into low areas or stormwater systems. Because of the limited infiltration in urban areas, much of the precipitation and snowmelt is channeled to the local streams, which can cause streams to overfill and flood. Plus, low areas such as underpasses and valleys can become flooded by the runoff.

The main meteorological factors related to the occurrence of flooding are quantity and duration of rain and snow during an event (how long it rains or snows), the intensity of precipitation (how heavy it rains or snows for a given period of time), the quantity of snowpack, and the speed of melting of snow pack. The following are some examples of how these factors have caused major flooding in the past.

Intensity of precipitation — In 1972, Rapid City, South Dakota, experienced a devastating flood that killed 238 people, injured 3,000 more people, and destroyed 1,335 homes, 5,000 cars, and 15 bridges. This happened because up to 15 inches of rain fell in the Black Hills to the west of Rapid City. The rain fell with such intensity that water rose as fast as 3.5 feet in 15 minutes in Rapid Creek and the peak flow in the creek was more than 50,000 cubic feet per second (more than 10 times the previous flood record).

What is most frightening is that the event happened over a short timeframe of little more than 7 hours, with rains beginning at 5 p.m. local and the flood cresting through downtown Rapid City at 12:15 a.m. By 5 a.m. that following morning, Rapid Creek was back within its banks. The setting for Rapid City is not that different from many of the cities and towns in Nevada.

QUANTITY AND DURATION OF PRECIPITATION — In 1993, the Mississippi River Basin in the Midwestern U.S. experienced a record flood that affected about 20 million acres of land in 9 states, resulted in 50 deaths, about 54,000 people evacuated, approximately 50,000 homes damaged or destroyed, 75 towns entirely flooded, and cost (in 1993 dollars) about $20 billion. Part of the cause for the flood was saturated soils (too saturated to absorb much more precipitation) in the upper Mississippi River Basin due to a wet fall in 1992 and a normal to above normal snow pack for the basin. Late March rains quickened snowmelt in the northern part of the basin, and persistent storms of high intensity and duration over the Midwest added large quantities of precipitation to the region. The Mississippi River at St. Louis rose above flood stage on April 8, then declined, rose again above flood stage on April 11, stayed above flood stage until May 24, then rose again above flood stage on June 27 and remained there until October 7 (146 days above flood stage).

QUANTITY OF SNOWPACK AND SPEED OF MELTING — The January 1997 flood of the Truckee, Carson, and Walker River Basins and the Lake Tahoe Basin impacted many people in western Nevada. The flood was triggered by above-normal snowpack during November and December for the Sierra Nevada, with an estimated water content for the snow pack at 150 to more than 200 percent of normal for late December and early January. In late December, a warm low-pressure system moved into the area and intense rainfall of up to 24 inches fell in some locations. Up to 80 percent of the snowpack in the lower elevations was melted by the rain, resulting in widespread runoff and record flooding. Millions of dollars in damage were estimated for each of the basins affected by the flooding.

Most recently, and maybe of most interest to local readers, is the flooding that has occurred in southern Utah, northwestern Arizona, and southern Nevada during the winter of 2004–05. Heavy rains in December and January resulted in some rivers reaching record flows. Floods damaged or destroyed several USGS gages along the Virgin and Muddy Rivers and on Beaver Dam and Meadow Valley washes. Preliminary estimates of the maximum (peak) discharge for the Virgin River near Littlefield, Arizona, are between 30,000 and 40,000 cubic feet per second, which, once the estimates are refined, may surpass the second-highest peak flow at this site of 35,000 cubic feet per second recorded in 1966. The highest flow for this site occurred in 1989 following the Quail Creek Dam failure, when 61,000 cubic feet per second was measured. Beaver Dam, near Enterprise, Utah, saw some very large flows, with peak stage (water level in the river) reaching 13.91 feet. This is more than 3.7 feet above the previous peak stage. USGS estimates of the peak discharge range from 8,000 to 10,000 cubic feet per second.

Flooding at Beaver Dam Wash, looking downstream. Photographs by D.A. Beck and R.J. Spaulding, USGS.

One can see that there are various factors that can result in flooding, and the degree of flooding and damage is strongly related to many meteorological, geological, and land-use conditions. Floods are a natural hazard that will always occur, but with improved capabilities to predict where and when floods will occur, along with better controls and land-use planning, the impacts from these events can be minimized.

Carson Valley during the 1997 flood. Photograph by P.A. Glancy.

Heavy flows in the Amargosa River, 2005. Photograph by B.J. Andraski, USGS.

Carson River during normal low flow (left) at about 55 cubic feet per second and at flood stage in January, 1997 at about 27, 500 cubic feet per second. Photograph on left by Rick Pruska. Photograph on right by Rhea Williams.