FLOODING IN SOUTH DAKOTA

What Is A Flood?

A flood occurs when water rises to flow over land that is normally dry. Floods happen in low-lying areas, such as valley bottoms, lake basins, and coastal areas. In South Dakota, flooding occurs mainly in valley bottoms, deep canyons, and lake basins when the amount of water moving through a river, or entering a lake, is so great that the natural or artificial banks can no longer contain all of the water. Therefore, the water overflows the banks of the river or lake and spreads out onto low-lying areas that are not normally covered with water.

What Causes A Flood?

In South Dakota, there are two main *climatological* causes of flooding: *runoff* from rainfall and *runoff* from melting snow. The water from rainfall or melting snow flows overland until it reaches a nearby river or lake. If the river or lake cannot hold all of the water that is entering it, some of the water will begin to overflow the banks of the river or lake, causing flooding. The size of the flood is commonly influenced by such factors as the intensity of the rainfall, length of the rainfall, melting rate of the snow, and the *infiltration* rate of the water into the ground.

In addition to *climatological* reasons for flooding in South Dakota, floods can also result from the failure of dams. Dam failure can result from defective construction or a poor foundation. Many small dams in South Dakota fail because their spillway is not big enough. Often, failure occurs as a result of extremely heavy rainfall that causes a large increase in the amount of water held by the dam. This increase in water behind the dam could place more stress (pressure) on the dam than it was designed to handle, causing the dam to fail.

What Types Of Floods Occur In South Dakota?

Four types of floods can occur in South Dakota. The first type is commonly called a flash flood. A flash flood is the result of several inches or more of rain falling in a very short period of time, often tens of minutes (Ward, 1978). This high intensity rainfall is commonly caused by powerful thunderstorms that cover a small geographic area. Because so much water is falling onto the ground very rapidly, there is little time for the water to soak in, and most of the water runs off into nearby rivers or lakes. The flood that occurs as a result of this *runoff* happens very rapidly, hence the term "flash." This type of flood is generally very destructive, affecting a fairly small, localized area, commonly several tens of square miles or less. The flash flood often ends almost as quickly as it started. Probably the best-known flash flood in South Dakota occurred when Rapid Creek left its banks on June 9, 1972, in Rapid City. Fifteen inches of rain that fell in less than 6 hours caused the flooding. This flood was devastating both in terms of loss of human life and property damage. Two hundred thirty-eight people lost

their lives in this flood and about $150 million (in 1972 dollars) of property damage occurred (FEMA, 1987).

The second type of flooding is sometimes termed the long-rain flood, and is the most common cause of major flooding (Ward, 1978). This type of flood results after several days or even weeks of fairly low-intensity rainfall over a widespread area, often hundreds of square miles. As a result, the ground becomes "water logged," and the water can no longer infiltrate into the ground; therefore, the water begins to flow toward rivers or lakes. The flooding that can result is often widespread, covering hundreds of square miles, and can last for several days or many weeks. Much of the flooding that occurred in eastern South Dakota during the summer of 1993 was this type of flooding.

The third type of flood in South Dakota is the result of melting snow in the spring. This type has characteristics that are almost a combination of the flash flood and long-rain flood. The area covered by this type of flood is generally not as large as that covered by the long-rain flood, but is typically larger than that covered by the flash flood. Generally, the flood lasts for several days, occurring when large amounts of snow melt rapidly due to warm temperatures. The flooding can be made worse if the ground remains frozen while the snow is melting; this causes all of the melt water to run off to nearby rivers and lakes rather than infiltrate into the ground.

Some of the largest floods that have occurred in South Dakota were the result of melting snow and ice. These large floods have occurred along the entire length of the Missouri River. The Great Flood of 1881 is probably the most well known of all the floods to take place in South Dakota. *Ice jams* on the river caused the flooding to become extremely devastating, destroying large amounts of property and causing many lives to be lost. Towns such as Yankton, Vermillion, Burbank, Meckling, and Pierre were all severely damaged by the flooding (The Great Flood, 1881).

The fourth type of flood results from the failure of dams. The four largest dams in South Dakota -- Oahe at Pierre, Big Bend at Fort Thompson, Fort Randall at Pickstown, and Gavins Point at Yankton -- are all located on the Missouri River. Large dams in the Black Hills are the Deerfield, Pactola, Sheridan and Angostura dams. If any of these large dams were to fail, flood damage could be very great. Fortunately, all of these dams are considered to be properly constructed, and have been designed to hold back very large amounts of water; therefore, they are considered to be very safe, and the likelihood of failure is extremely small. Except for these Missouri and Black Hills dams, the majority of the dams in South Dakota are very small, and if they were to fail, flooding would likely be minimal.

How Do We Prepare For Floods?

Looking back at historical data, we know that floods have occurred throughout history all over the world, and South Dakota is no exception. Even in our lifetimes, we often see many floods occur and hear stories of others that have occurred. Therefore, it is necessary to be prepared for floods.

The first step in flood preparation is to predict future flood conditions. By predicting how large the maximum flood in a particular area will be, structures can be designed that will accommodate the maximum amount of water that may flow through an area. These structures include dams, spillways, culverts, storm sewers, bridges, and *levees*. By designing such structures to handle flooding, it is hoped that the amount of flooding will be decreased and damage caused by the flooding will be lessened.

Another way of preparing for floods is to keep things like buildings, roads, housing, and industry out of flood prone areas. This solution is not always practical, especially for existing structures, but can certainly be put to use for planning of urban expansion and other new structures.

How Are Floods Predicted?

Flood prediction is generally done in one of two ways. The first way uses mathematical formulas that determine the maximum amount of rain that could fall on a given area. Calculations are made to determine how much water will run off to rivers and lakes, and how high the water in these rivers and lakes may rise. This method allows the maximum potential flood to be calculated.

The second prediction method relies on looking, in a statistical manner, at historical flow data for a particular river. This method allows a *probability* of a flood of a certain size to be calculated. Often, people speak of a 100-year flood. This flood is of a size that will probably occur only once every 100 years; in other words, it has a 1 percent chance of occurring during a given year. The 100-year flood is the measure that FEMA (Federal Emergency Management Agency) uses to regulate flood plain development (Rahn, 1994).

What Is Flood Forecasting?

Flood forecasting is used to warn people that a flood is likely to occur in the immediate future. If it is known that a flood will probably occur in a certain area, then flood forecasting becomes critical in attempting to keep damage to lives and property at a minimum. Advance warning may give people enough time to evacuate themselves and their belongings to safety.

At the present time it is not possible to forecast several months, or even weeks, in advance that a flood will occur. In fact, only rarely are such forecasts made with reasonable accuracy several days in advance. This means that even the most reliable flood forecasts are based on data from precipitation and snow melt events that have just occurred or are still taking place; thus, advance warning time is normally measured in hours and days, rather than weeks or months.

What Are The Impacts Of Flooding?

The overall impact of flooding can have positive ecological consequences, but very often has a negative impact on humans. One important ecological benefit of flooding is the increased soil fertility that develops in a flood plain. The fine sediment deposited on bottom lands along flooding rivers creates fertile soils that are valuable resources for farming. Flood plains also provide valuable habitat for wildlife. Some flood plain plant species, such as cottonwood, are so well adapted to river-side habitats, their seeds cannot germinate unless they are flooded.

Because people have persisted in their desire to build homes and towns in flood plains, flooding usually causes a tremendous amount of property damage. Some of the most common types of damage caused by flooding include the destruction of buildings, roads, bridges, and personal belongings. In severe floods, even valuable agricultural soil, which was deposited over the years by the overflowing river, can be washed away.

The result of this destruction in economic terms is often very costly. Hundreds of millions of dollars of damage can be caused by one single flood. Worse than economic losses are the losses on which a monetary value cannot be placed -- the loss of human life. Most of the floods in South Dakota have only taken a few human lives, but some of the larger floods such as the Great Flood of 1881 and the Rapid City flash flood of 1972 have taken several hundred lives.

Are Floods Preventable?

Many attempts at preventing floods have been undertaken in South Dakota. Along the Missouri River, four large dams have been constructed. These dams have served their original purpose of preventing downstream floods quite well. As an added benefit, these dams generate electricity and create large reservoirs of water that are used for irrigation and recreation. Many of the smaller dams in

the state were not designed for flood prevention, but instead, were constructed mainly to create bodies of water that could be used for recreation, public and private drinking water, and cattle watering.

Measures that can be taken to help prevent flooding include construction of *levees* along river channels, straightening out meandering river channels (*channelization*), and removing debris (trees, garbage, sediment, etc.) from river channels. All of these measures are helpful in preventing or alleviating the damage caused by small floods, but do very little to help prevent damage from occurring when large-scale flooding takes place. In fact, often these measures simply result in greater flooding downstream, protecting one area at the expense of another. Also, these measures usually are destructive to wildlife and fisheries habitat.

Floods are natural events that have occurred throughout history and will continue to occur. They are often impossible to prevent. The only way to minimize property damage and the loss of human life is for humans not to build or live in areas susceptible to regular flooding. Economic damage from floods can be diminished through zoning of property. Floodways can be maintained as parks, golf courses, bike paths, or hiking trails, allowing floods to pass through without causing major damage.

Glossary

Channelization – the process of straightening the curves and bends of a river's channel in order to allow water to flow more efficiently.
Climatological – closely related to the weather.
Ice jam – accumulation of pieces of ice in a river channel which obstructs the flow of water.
Infiltration – the soaking or passing of water into the ground.
Levees- a man-made ridge built along a river to protect nearby land from flooding.
Probability – the likelihood that an event will occur, often expressed as a percentage.
Runoff – water which is the result of rainfall or melting snow that runs over the land and enters nearby rivers, streams, and lakes.
Glossary terms are adapted from Bates, R.L. and Jackson, J.A., 1987, *Glossary of Geology*, American Geological Institute, Alexandria, Virginia.

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