

# What Causes Floods in Washington State?



Photo by Geff Hinds, Tacoma News Tribune

## MOST FLOODS IN WASHINGTON ARE CAUSED BY:

1. Persistent, heavy rainfall,
2. Heavy, warm rainfall that melts a snow-pack, or
3. Rapid snowmelt during an extremely hot spell.

## WHAT FACTORS COMBINE TO CAUSE THE BIG FLOODS IN WASHINGTON?

The magnitude of most floods in Washington depend on the particular combinations of intensity and duration of rainfall, pre-existing soil conditions (was the ground wet or frozen before the storm?), area and elevation of a basin, and amount of snowpack. Man-made changes to a basin also can affect the sizes of floods.

## FLOODS IN WASHINGTON HAPPEN NATURALLY THROUGHOUT THE YEAR

Although floods can happen at any time during the year, there are some typical seasonal patterns for flooding in Washington State, based on the variety of natural processes that cause floods.

Fall and early winter floods are produced by heavy rainfall on wet ground, before a snowpack has accumulated. Winter and early spring floods typically are caused by rainfall and a melting snowpack. Late spring floods result primarily from melting of the snowpack. Summer flash floods are caused by thunderstorms.

## HOW CAN SNOW PRODUCE FLOODS?

During cold winter storms when most of the precipitation falls as snow, the chance of flooding is low. However, the

accumulation of a large snowpack increases the possibility of flooding caused by rapid melting later in the season. Rapid snowmelt can happen when a warm storm during the winter (a "pineapple express") drops a large amount of rainfall on the snow-pack. The snowpack can also melt in a matter of days during the spring as a result of an extremely hot spell. Either way, rapid snowmelt may result in significant flooding.

## SOIL THAT IS WET OR FROZEN BEFORE A STORM INCREASES THE POTENTIAL FOR FLOODING

More of the rain during early fall storms soaks into the ground rather than running off into rivers because the soil is still relatively dry. The same size storms, occurring later in the rainy season, may cause flooding because the soil is saturated.

Heavy rains that fall on frozen ground, which is common in parts of eastern Washington, can also cause larger-than-normal floods.

## HOW DOES THE VEGETATION IN A BASIN REDUCE FLOODING?

From 10 to as much as 50 percent of the annual precipitation in a basin is intercepted by the plant foliage and evaporated. Up to 0.2 inches of water can

## WHY DON'T FLOODS ALWAYS HAPPEN AT THE SAME TIME OF YEAR?

*In western Washington basins at elevations below about 3,500 feet, floods are most likely to happen during the winter, when most of the rainfall occurs, because the rivers are less affected by melting snow.*

*At higher elevations with less annual snowfall and more rainfall, floods also may occur during the winter or spring, but the winter peaks are usually larger.*

*In basins at higher elevations in western Washington with a lot of annual snowfall, floods may occur in either winter or spring, depending on when the snow melts.*



*On the eastern slopes and northern-most western slopes of the Cascade Range and in the northern border mountains, floods generally occur during the springtime because the snowpack that accumulates during the winter is most likely to melt rapidly during this part of the year.*

*Floods in southeastern Washington generally last from late winter to early spring because the mild climate results in a gradual, sustained period of snowmelt.*

be stored this way during a single rain or snow storm instead of reaching the ground, where it would have added to direct runoff or accumulated in the snowpack.

The layer of decaying plant material that forms under natural vegetation functions very much like a sponge, absorbing much of the rain and slowly releasing the water later.

### **HOW DO MAN-MADE CHANGES IN A RIVER BASIN AFFECT FLOODS?**

Increased urbanization replaces natural vegetation with sealed surfaces like roads, parking areas, homes, and other buildings. Such changes have led to more frequent and severe flooding in many Washington streams.

Dikes and levees may reduce flooding in some parts of a river basin but can actually worsen flooding by cutting off a river from its floodplain. The floodplain naturally reduces the size of a flood by temporarily storing a portion of the floodwaters.

Some dams are designed to reduce downstream flooding by storing a portion of the floodwaters in a reservoir to be released later; not all dams are operated this way.

Other natural and man-made changes to a river channel also can affect flooding. An aggraded channel (filled with sediment) may flood more frequently and during smaller storms.

### **WHY DO SOME FLOODS LAST FOR DAYS OR CONTINUE TO GET BIGGER AFTER THE RAINS HAVE STOPPED?**

Floods caused by thunderstorms in small basins often last only a few minutes to an hour or so. In large basins, however, floods typically last from a few hours to several days.

Floods last longer in large basins because the floodwaters must travel longer distances from the headwaters to the mouth of the river. Also, because rain tends to fall at different rates and times in different parts of a basin, tributary streams typically flow into the river at different times, thus prolonging the flood.

### **WHAT IS A GLACIER OUTBURST FLOOD?**

A glacier outburst flood is caused by the rapid release of a large volume of water stored within a glacier. Glacier outburst floods typically occur on hot summer days or during the first intense rainstorms of winter, often with little or no warning. Although these floods do not usually travel far downstream, they can be very destructive. They frequently pick up enough sediment to become debris flows or mudflows rather than typical river floods.

Several outburst floods originating from South Tahoma Glacier on the west side of Mt. Rainier covered the Westside Road with mud and boulders during the late 1980s. These floods deposited more than 3 feet of sediment at the Tahoma Creek picnic area and trail head.

### **HOW ARE FLOODS FORECAST?**

Emergency response personnel need flood forecasting estimates to help them make split-second decisions about evacuations and road closures in anticipation of a flood.

Forecasting the approximate peak flow and timing of a flood can be done in many ways. Previous floods on the same stream may be studied and used to help scientists estimate how a river will respond to future storms. More accurate predictions require complex mathematical models that use updated climate data, information about the characteristics of the river basin, and information about current streamflow and conditions in each basin.

The USGS monitors streamflow continuously at hundreds of sites on rivers throughout Washington and routinely provides data to more than 25 Federal, State, and local agencies that use the data to manage the water resources of Washington State. USGS streamflow data are also available to private citizens via the USGS Washington "home page" on the World Wide Web. Users can access real-time and historical data for more than 160 of our currently active stream-gaging sites throughout the State.

Floods are natural processes that sometimes become natural disasters. By improving our understanding of how floods happen, and planning for their inevitable occurrence, we can prevent much of the damage caused by floods in Washington.

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*The U.S. Geological Survey has served the public and Federal, State, and local governments since 1879 by collecting, analyzing, and publishing detailed information about the Nation's mineral, land, and water resources. The USGS has been studying the water resources of Washington State since the turn of the century. This information is in a variety of map, book, electronic, and other formats and is available by contacting:*

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*Selected data and interpretive reports are available on the USGS Washington "home page" on the World Wide Web at this URL --*

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