

Landslide Hazards

Landslide hazards occur in many places around the world and include fast-moving debris flows, slow-moving landslides, and a variety of flows and slides initiating from volcanoes. Each year, these hazards cost billions of dollars and cause numerous fatalities and injuries. Awareness and education about these hazards is a first step toward reducing damaging effects. The U.S. Geological Survey conducts research and distributes information about geologic hazards.

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Fast-moving Debris Flows

Debris flows start on steep slopes—slopes steep enough to make walking difficult. Once started, however, debris flows can even travel over gently sloping ground. The most hazardous areas are canyon bottoms, stream channels, areas near the outlets of canyons, and slopes excavated for buildings and roads.

A. Debris flows (also referred to as mudslides, mudflows, or debris avalanches) generally occur during intense rainfall on water-saturated soil. They usually start on steep hillsides as soil slumps or slides that liquefy and accelerate to speeds as great as 35 miles (56 km) per hour. Multiple debris flows that start high in canyons commonly funnel into channels. There, they merge, gain volume, and travel long distances from their source.

B. Debris flows commonly begin in swales (depressions at the top of small gullies) on steep slopes, making areas downslope from swales particularly hazardous.

C. Roadcuts and other altered or excavated areas of slopes are particularly susceptible to debris flows. Debris flows and other landslides onto roadways are common during rainstorms, and often occur during milder rainfall conditions than those needed for debris flows on natural slopes.

D. Areas where surface runoff is channeled, such as along roadways and below culverts, are common sites of debris flows and other landslides.

What Can You Do If You Live Near Steep Hills?

Prior to Intense Storms:

1. Become familiar with the land around you. Learn whether debris flows have occurred in your area by contacting local officials, State geological surveys, or departments of natural resources, and university departments of geology. Slopes where debris flows have occurred in the past are likely to experience them in the future.

2. Support your local government in efforts to develop and enforce land-use and building ordinances that regulate construction in areas susceptible to landslides and debris flows. Buildings should be located away from steep slopes, streams and rivers, intermittent-stream channels, and the mouths of mountain channels.

3. Watch the patterns of storm-water drainage on slopes near your home, and note especially the places where runoff water converges, increasing flow over soil-covered slopes. Watch the hillsides around your home for any signs of land movement, such as small landslides or debris flows or progressively tilting trees.

4. Contact your local authorities to learn about the emergency-response and evacuation plans for your area and develop your own emergency plans for your family and business.

During Intense Storms:

1. Stay alert and stay awake! Many debris-flow fatalities occur when people are sleeping. Listen to a radio for warnings of intense rainfall. Be aware that intense short bursts of rain may be particularly dangerous, especially after longer periods of heavy rainfall and damp weather.

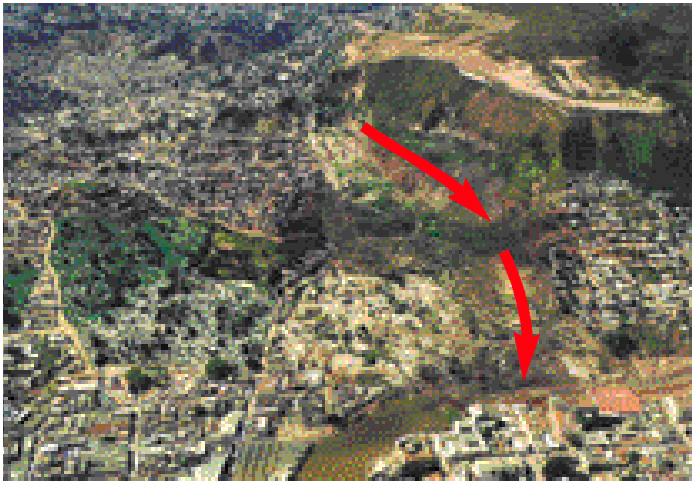
2. If you are in areas susceptible to landslides and debris flows, consider leaving if it is safe to do so. Remember that driving during an intense storm is hazardous.

3. Listen for any unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together. A trickle of flowing or falling mud or debris may precede larger flows. If you are near a stream or channel, be alert for any sudden increase or decrease in water flow and for a change from clear to muddy water. Such changes may indicate debris flow activity upstream, so be prepared to move quickly. Don't delay! Save yourself, not your belongings.

4. Be especially alert when driving. Embankments along roadsides are particularly susceptible to landslides. Watch the road for collapsed pavement, mud, fallen rocks, and other indications of possible debris flows.



In December 1999, heavy rains caused extensive damage in northern Venezuela. Landslides and debris flows initiated high on steep hillsides and entered minor and major drainages. Large volumes of sediment, remnants of buildings, and other debris were transported by debris flows and high flood water. (Photo: United States Southern Command)



In October-November 1998, in Tegucigalpa, Honduras, Hurricane Mitch triggered El Berrinche landslide, which dammed the Rio Choluteca and impounded a sewage-filled lagoon. Arrows show the path of landslide debris that dammed the river. (Photo: USGS, Ed Harp)

Slow-moving Landslides— What to do and look for during and immediately after heavy rains

Areas that are generally prone to landslides:

- ▶ On existing old landslides
- ▶ On or at the base of slopes
- ▶ In or at the base of minor drainage hollows
- ▶ At the base or top of an old fill slope
- ▶ At the base or top of a steep cut slope
- ▶ Developed hillsides where leach field septic systems are used

Areas that are typically considered safe from landslides:

- ▶ On hard, nonjointed bedrock that has not moved in the past
- ▶ On relatively flatlying areas away from sudden changes in slope angle
- ▶ At the top or along the nose of ridges, set back from the tops of slopes

Features that might be noticed prior to major landsliding:

- ▶ Springs, seeps, or saturated ground in areas that have not typically been wet
- ▶ New cracks or unusual bulges in the ground, street pavements, or sidewalks
- ▶ Soil moving away from foundations
- ▶ Ancillary structures such as decks and patios tilting and (or) moving relative to the main house
- ▶ Tilting or cracking of concrete floors and foundations
- ▶ Broken water lines and other underground utilities
- ▶ Leaning telephone poles, trees, retaining walls, or fences
- ▶ Offset fence lines
- ▶ Sunken or down-dropped road beds
- ▶ Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- ▶ Sudden decrease in creek water levels though rain is still falling or just recently stopped
- ▶ Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb

What to do if you suspect imminent landslide danger:

1. Evacuate.
2. Contact your local fire, police, or public works department.
3. Inform affected neighbors.

Flows and Slides Initiating from Volcanoes

Pyroclastic Flows

Fast-moving avalanches of hot ash, rock fragments, and gas can move down the sides of a volcano during explosive eruptions or when the steep side of a growing lava dome collapses and breaks apart. These pyroclastic flows can be as hot as 1,500° F and move at speeds of 100 miles (160 km) per hour, up to 150 miles (240 km) per hour. Such flows tend to follow valleys and are capable of knocking down and burning everything in their path. Lower density pyroclastic flows, called pyroclastic surges, can easily overflow ridges hundreds of feet high.

The climactic eruption of Mount St. Helens, Washington, on May 18, 1980, generated a series of explosions that formed a huge pyroclastic surge. This so-called “lateral blast” destroyed an area of 230 square miles (368 square km). Trees 6 feet (2 meters) in diameter were mowed down like blades of grass as far as 15 miles (24 km) from the volcano.

Volcano Landslides

A landslide or debris avalanche is a rapid downhill movement of rocky material, snow, and (or) ice. Volcano landslides range in size from small movements of loose debris on the surface of a volcano to massive collapse of the entire summit or sides of a volcano. Steep volcanoes are susceptible to landslides because they are built partly of layers of loose volcanic rock fragments. Some rocks on volcanoes have also been altered to soft, slippery clay minerals by circulating hot, acidic ground water. Landslides on volcano slopes are triggered when eruptions, heavy rainfall, or large

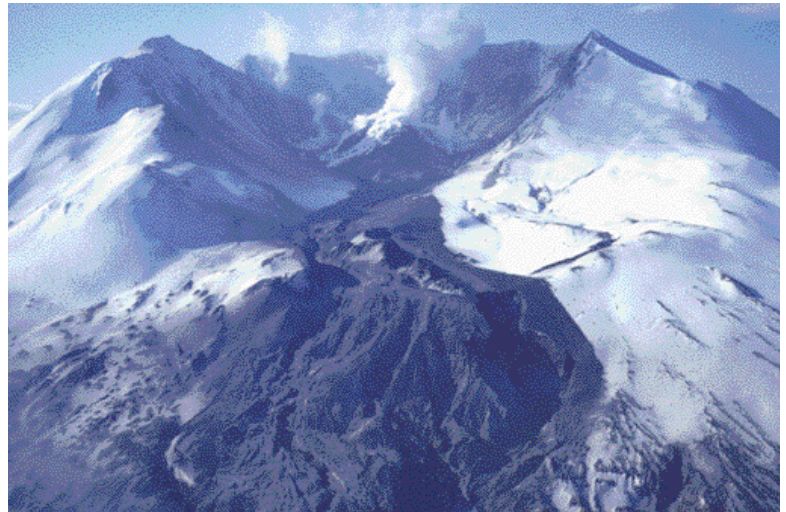
earthquakes cause these materials to break free and move downhill.

At least five large landslides have swept down the slopes of Mount Rainier, Washington, during the past 6,000 years. The largest volcano landslide in historical time occurred at the start of the May 18, 1980, Mount St. Helens eruption.

Lahars

Mudflows or debris flows composed mostly of volcanic materials on the flanks of a volcano are called lahars. These flows of mud, rock, and water can rush down valleys and stream channels at speeds of 20 to 40 miles per hour (32 to 64 km per hour) and can travel more than 50 miles (80 km). Some lahars contain so much rock debris (60 to 90 percent by weight) that they look like fast-moving rivers of wet concrete. Close to their source, these flows are powerful enough to rip up and carry trees, houses, and huge boulders miles downstream. Farther downstream they entomb everything in their path in mud.

Historically, lahars have been one of the deadliest volcano hazards. They can occur both during an eruption and when a volcano is quiet. The water that creates lahars can come from melting snow and ice (especially water from a glacier melted by a pyroclastic flow or surge), intense rainfall, or the breakout of a summit crater lake. Large lahars are a potential hazard to many communities downstream from glacier-clad volcanoes.



Following the 1982 eruption of Mount St. Helens, Washington, melting snow and ice triggered this lahar, which traveled down the north flank of the mountain, following the channel of the North Fork of the Toutle River. (Photo: USGS/CVO)

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