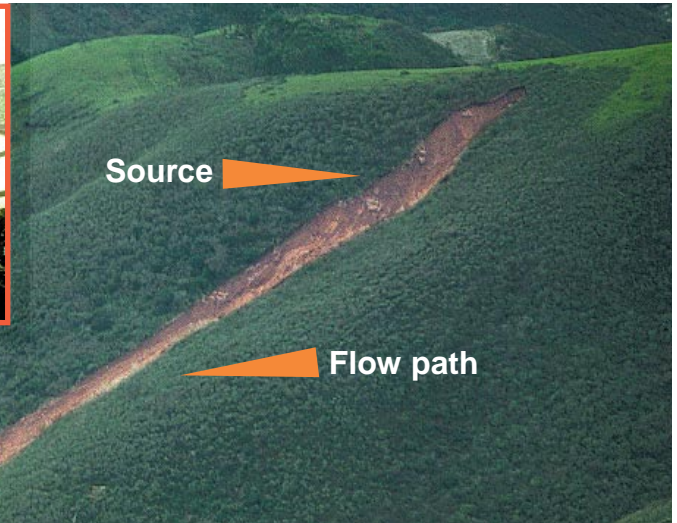


Debris-Flow Hazards in the San Francisco Bay Region

To help prepare for debris flows and lessen their impacts, USGS scientists assess debris-flow susceptibility for selected areas; compile and provide information on debris-flow problems; conduct research on debris-flow processes; and respond to debris-flow emergencies.



Debris flow from a steep hillslope in Pacifica, California, about 10 miles south of San Francisco, where three children were killed and two homes destroyed on January 4, 1982. Above—Distant view of the landslide source, flow path, and site of destroyed homes. Above left—View of destroyed homes from the street.

What Are Debris Flows?

Some landslides move slowly and cause damage gradually, but others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. Debris flows (also referred to as mudslides, mudflows, or debris avalanches) are a common type of fast-moving landslide that generally occurs during intense rainfall on previously saturated soil. They commonly start on steep hillslopes as soil slumps or slides that liquefy, accelerate to speeds of 35 miles per hour or more, and flow down hillslopes and channels onto gently sloping ground. Their consistency ranges from watery mud to thick, rocky mud, and they can carry boulders, trees, and cars. Debris flows from different sources can combine in canyons and channels, where their destructive power can be greatly increased.

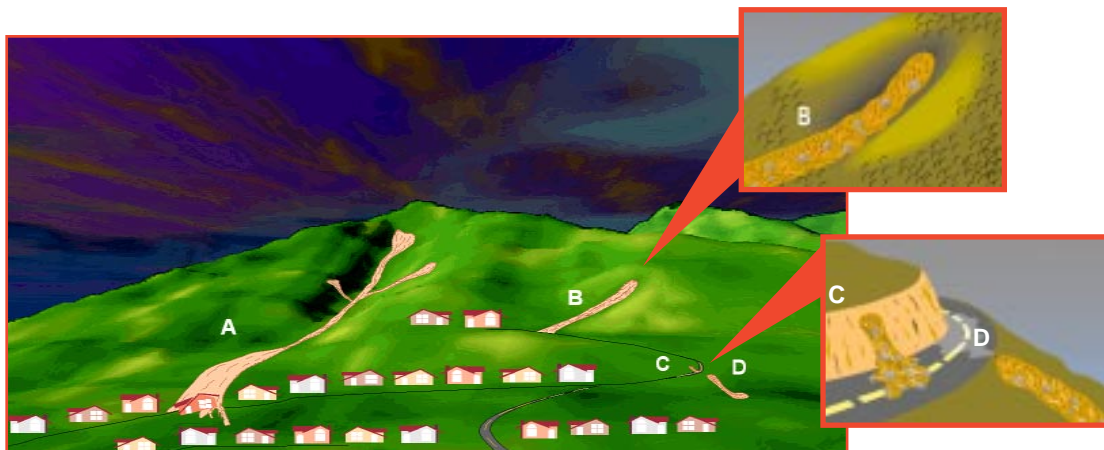
Fast moving flows of mud and rock, called debris flows or mudslides, are among the most numerous and dangerous types of landslides in the San Francisco Bay region. When prolonged, intense rain falls on steep hillslopes, the saturated soils can become unstable and move rapidly downhill as debris flows. These catastrophic flows are capable of destroying homes, washing out roads and bridges, sweeping away cars, knocking down trees, and obstructing streams and roadways with thick deposits of mud and rocks.

Past storms that triggered damaging debris flows in the Bay region occurred in 1982, 1986, and 1995. In 1982 alone, thousands of debris flows and other fast-moving landslides caused \$66 million in damage and 25 fatalities. As more and more people build in the hills around the Bay region, the potential impact of debris flows on life and property is increasing.

Because debris flows can begin suddenly with little or no warning, it is essential to be prepared. This fact sheet provides some basic information. Illustrations of hazardous areas can help residents assess hazards in their neighborhood. Understanding debris-flow hazards and keeping alert during intense storms can save lives!

Hazardous Areas

Debris flows start on steep slopes but, once started, can travel over even gently sloping ground. The most hazardous areas are shown at right.



A. Canyon bottoms, stream channels, and areas near the outlets of canyons or channels are especially hazardous. Multiple debris flows that start high in canyons can be funneled into channels, where they can travel long distances to canyon mouths and beyond.

B. Debris flows commonly begin in swales (depressions) on steep hillslopes, making areas downslope from swales particularly hazardous.

C. Roadcuts and other areas where hillslopes have been excavated or altered are especially susceptible to fast-moving landslides. Rock falls and debris flows onto roadways are common during rainstorms and often occur during milder rainfall conditions than needed for debris flows on natural slopes.

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

What You Can Do If You Live Near Steep Hills

Prior to Intense Storms

1. Become familiar with the land around you. Compare the setting of your home and streets to the hazardous areas shown above. Learn whether debris flows have occurred in your area; hillslopes where debris flows have occurred in the past are likely to experience them in the future.
2. Watch the hillslopes around your home throughout the rainy season for any signs of land movement, such as widening cracks and fissures, small debris flows, or progressively tilting trees and poles. If you become concerned, consult a professional engineering geologist or geotechnical engineer.
3. Watch the patterns of storm-water drainage on hillslopes near your home. Places on a hillslope where runoff water converges from blocked drainages or other diversions may have an increased potential for landsliding.
4. Clear debris from culverts and other drainage systems before storms hit. It can be dangerous to clear large plugged culverts in swiftly moving water during a storm!

During Intense Storms

1. Stay alert and stay awake! Many debris-flow fatalities occur when people are sleeping. Listen to a weather radio station to receive Flash-Flood Watches or Warnings that pertain to your area. Be aware that intense bursts of rain may be particularly dangerous.
2. Avoid the hazardous areas described above. If you are in a hazardous area, consider leaving, if it is safe to do so. Remember that driving during an intense storm can itself be hazardous.
3. Listen for any unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together. A trickle of falling mud or debris may precede larger landslides. If near a stream or channel, be alert for any sudden increase or decrease in water flow, and for changes in water quality, from clear to muddy. Be prepared to move quickly.
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 debris.

For more information, please contact:

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<http://geohazards.cr.usgs.gov/landslide.html>

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