

# California Department of Conservation: Geological Survey of Mudslides

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Sudden "mudslides" gushing down rain-sodden slopes and gullies are widely recognized by geologists as a hazard to human life and property. Most "mudslides" are localized in small gullies, threatening only those buildings in their direct path. They can burst out of the soil on almost any rain-saturated hill when rainfall is heavy enough. Often they occur without warning in localities where they have never been seen before.

The ashy slopes left denuded by wildfires in California are especially susceptible to "mudslides" during and immediately after major rainstorms.

Those who live downslope of a wildfire area should be aware of this potential for slope failure that is present until new vegetation rebinds the soil.

## **What Are Debris Avalanches and Debris Flows?**

Debris avalanches and debris flows (both popularly called "mudslides") are shallow landslides, saturated with water, that travel rapidly downslope as muddy slurries. The flowing mud carries rocks, bushes, and other debris as it pours down the slopes.

A debris avalanche (Figure 1) is a fast-moving debris flow that travels faster than about 10 mph or approximately 25 yards in about 5 seconds. Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, do occur locally.

## **What Dangers Are Posed by Debris Avalanches?**

Debris avalanches pose hazards that are often overlooked. Houses in the path of debris avalanches can be severely damaged or demolished. Persons in these structures can be severely injured or killed.

Most rainstorms are of such low intensity that they do not trigger debris avalanches. Some intense storms may trigger only a few debris avalanches. However, when the ground is already saturated from previous rain, even relatively short high-intensity rainstorms may trigger debris avalanches. For example, in January 1982, an intense rainstorm triggered literally tens of thousands of debris avalanches in the San Francisco Bay Area. These 1982 debris avalanches caught people unaware and caused 14 deaths and many injuries and destroyed or damaged several hundred homes and other structures.

## **What Causes Debris Avalanches and Debris Flows?**

The most common cause of debris avalanches and debris flows is the combination of heavy rainfall, steep slopes, and loose soil. Most fairly steep slopes have enough soil and loose rock for potential

landslides. Although "stable" when dry, such slopes can produce local debris flows, often without warning.

Normally the source of the excess water is intense rainfall, although broken water pipes or misdirected runoff concentrated by roads, roofs, or large paved areas may trigger, or help to trigger, debris avalanches and debris flows. In California, most debris flows occur during wet winters.

### **What Can Be Done to Avoid or Reduce the Hazard Posed by Debris Avalanches?**

To be safe, assume that all drainages in steep, hilly, or mountainous areas are capable of carrying debris flows, especially if relatively loose, sandy soils are present in the watershed. Areas that have been burned by regional fires are especially vulnerable.

Avoid building sites at the bottoms and mouths of steep ravines and drainage courses. These areas are the most likely to be inundated by debris flows. The outer "banks" of bends along such ravines also should be avoided because swiftly flowing debris avalanches can "ride up" out of the bottom of the stream channel where it bends.

Avoid building on or below steep slopes. In general, the steeper the slope the greater the risk. If these areas must be used, consult with a soils engineer and an engineering geologist. These specialists will be able to evaluate the potential for mudslide problems and give advice on the best way to minimize the risk to life and property.

The hazard from debris flows that occurs in modified slope cuts can be decreased by 1) limiting the height and slope of cuts and fills, 2) properly compacting fills and keying them into bedrock, and 3) properly controlling the flow of water onto slopes. If steep cuts or fills occur below the discharge points of runoff water from streets, downspouts, or similar drainage facilities onto a slope, it may be wise to obtain advice from an engineering geologist or erosion control specialist.

### **Tips and Clues That May Save Your Life...**

- Mitigation of hazards from debris flows and debris avalanches through construction of permanent engineering measures takes considerable time and money. In the meantime, preparation for rapid evacuations should be made.
- Before and during rains, frequent inspection of the slopes (above vulnerable sites) for extension cracks and other symptoms of downslope movements of slope materials can be a guide to impending failure and a warning to evacuate. In particular, watch for new springs or seeps on slopes; cracks in snow, ice, soil, or rock; bulges at the base of slopes; the appearance of holes or bare spots on hillsides; tilting trees; or increased muddiness of streams. Any sudden increase in runoff is cause for concern.
- Listen for unusual rumbling sounds or noises that may indicate shifting bedrock or breaking vegetation or structures.
- Stay alert to the amount of rain falling locally during intense rainstorms. Buy a rain gauge (an inexpensive plastic one will suffice) and install it where it can be checked frequently.
- Whenever rainfall has exceeded 3 or 4 inches per day or ¼ inch per hour, the soil may be waterlogged and more rain can trigger mudflows.
- Again, the single most important action that should be taken by residents on rainy nights is NOT to sleep in lower-floor bedrooms on the sides of houses that face hazardous slopes. More than 100 Californians have been killed by debris flows during the past 25 years. Most of these deaths occurred when debris flows buried people sleeping in lower-floor bedrooms adjacent to hazardous slopes.