

Post-wildfire Hazards:

Mud Slides :: Debris Flows

What Are Debris Flows?

Debris flows (commonly called mud slides, mud flows or debris avalanches) are shallow landslides, saturated with water, that travel rapidly downslope as muddy slurries. The flowing mud carries rocks, trees, and other debris as it pours down the slopes.

Sudden debris flows gushing down rain-sodden slopes and gullies are widely recognized as a hazard to human life and property. Most debris flows are localized in small gullies, threatening only those buildings in their direct path. But the bare slopes left denuded by wildfires are especially susceptible to more catastrophic debris flows during and immediately after rainstorms. Debris flows often occur without warning in areas where they have never been seen before.

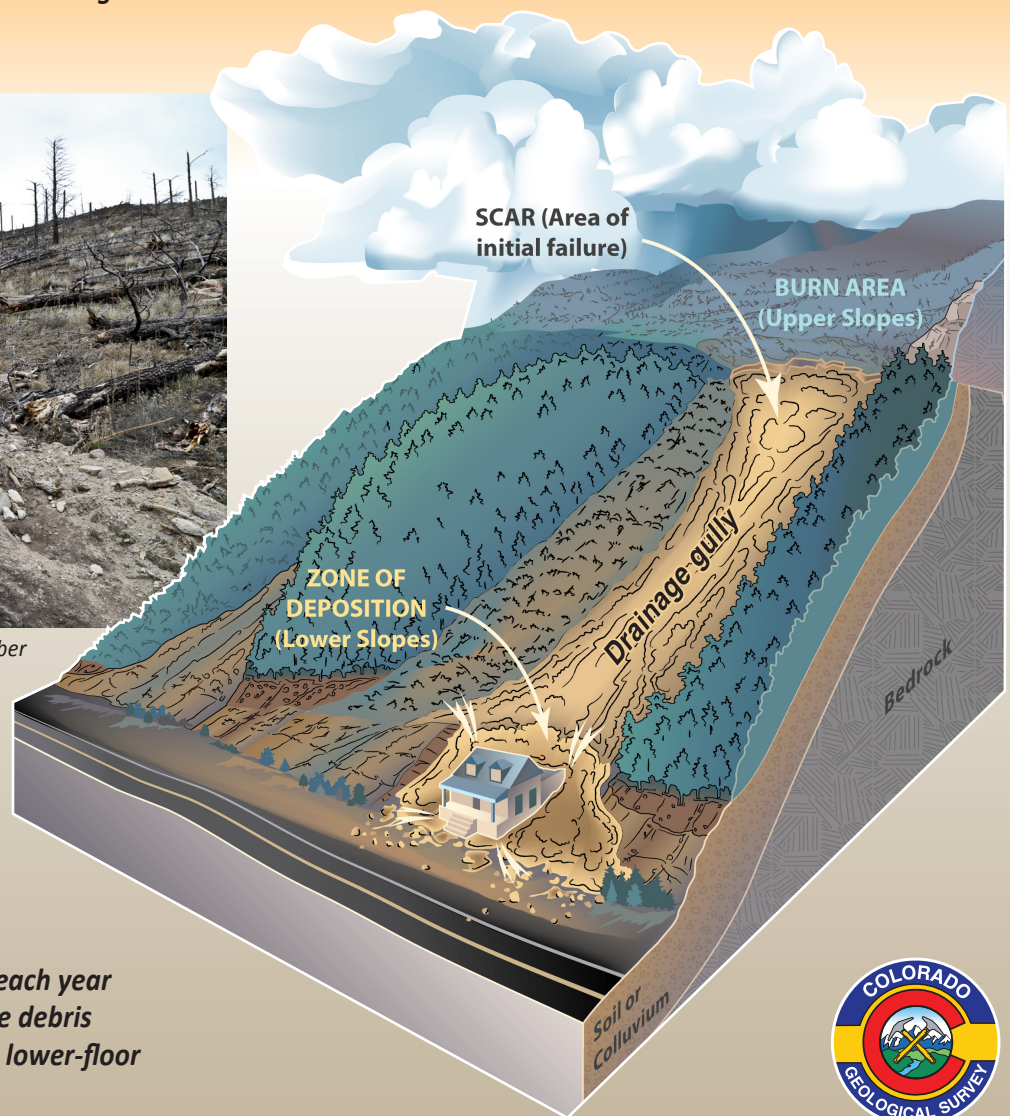


Post-wildfire debris flow in Jamestown, Colorado, September 2013. Photo credit: Jon White for the CGS.

What You Need to Know:

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In the western US, tens of people are killed each year by debris flows. Most deaths occurred where debris flows buried residents who were sleeping in lower-floor bedrooms below steep slopes or drainages.





What Dangers are Posed by Debris Flows?

Debris flows pose hazards that are often overlooked. Houses, roads, and other structures in the path of a flow may be severely damaged or demolished. People in these structures may be injured or killed.

When an environment is damaged from wildfire, even relatively short high-intensity rainstorms may trigger debris flows. They are typically generated when hillside soil, rock, or landslide material becomes rapidly saturated with water and flows into a channel. Intense rainfall, rapid snowmelt, or high levels of groundwater flowing through fractured bedrock can trigger these events. Debris flows and floods may also occur when precipitation on slopes causes extensive hillside erosion and channel scour.

Where do Debris Flows Occur?

Commonly occurring in mountainous areas, debris flows are all too frequent in Colorado. Known to start on slopes as low as 15 degrees: more dangerous and faster moving debris flows are increasingly likely to develop the steeper the slopes. About two-thirds of all debris flows start in hollows or troughs at the heads of small drainages. Commonly, a debris flow will coalesce on a hillside and flow quickly downslope, inundating everything in its path. Topography controls a debris flow path just like moving water, so the flows generally follow stream courses and spread out onto flatter depositional areas like alluvial fans where streams exit steep areas.

Above: East Troublesome fire, Grand County, Colorado, 2020. Photo credit: Jessy Ellenberger. **Below:** Post-wildfire debris flow deposit, Paradise Acres, Huerfano County, Colorado 2018. Photo credit: Kevin McCoy for the CGS.



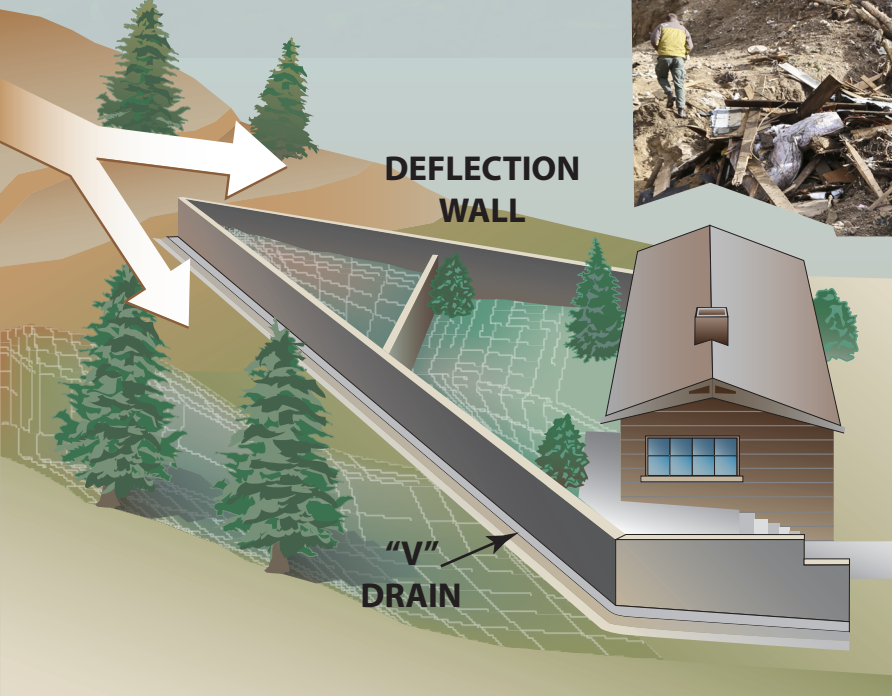
Slopes burned by wildland fire are especially susceptible to debris flows because of the absence of vegetation and roots to bind the soil. Alluvial fans and areas directly downslope are especially subject to damage from debris flows.

What Can Be Done to Avoid or Reduce the Hazard Posed by Debris Flows?

To be safe, assume that all drainages in steep, hilly, or mountainous areas are capable of carrying debris flows, especially if loose, sandy soils are present in the watershed.

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 flows can "ride up" out of the bottom of the stream channel where it bends.

Below: Schematic of a wedge-shaped deflection wall serving to split and deflect debris flows from the dwelling. These and other similar structures should be professionally engineered and carefully constructed. Particular design solutions will depend on the specific site.



About Debris Flow Dangers

If areas like this must be used, consult with a geotechnical engineer, a hydrologist, and an engineering geologist. In some cases, walls, or other structures can be built to deflect potential debris flow away from or around structures. To be effective, deflection walls must be properly designed, constructed, and maintained.








House that could possibly have been saved by a deflection wall system, Jamestown, Colorado, 2013. Photo credit: Jon White for the CGS.

Mud Floods

People living directly downslope of mountainous wildfire areas should be aware that, in addition to debris flows, landslides, and rockfall; there is another, potential deadly hazard—mud flooding at and near the mouths of channels that drain burned-over, ash-laden slopes. Studies have shown that, in the first year following a wildfire, the volume of sediment and water runoff in streams greatly increases. People living, working, or traveling near such streams could be killed or injured by flooding that contains enormous amounts of debris and mud washed off burned hillsides.

Prior to a "1,000-year rain event" in September 2013—more than 18 inches in 24 hours—the area around Jamestown in Boulder County, Colorado had already experienced a number of wildfires. The momentous flash-flooding and debris flows following that rain caused extensive infrastructure damage to much of the town, along with a number of fatalities and more than 1,500 homes destroyed in the wider Boulder and Larimer County region.

Tips and Clues That May Save Your Life

-  **Before and during rains, watch for 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 the increased muddiness of streams. Any sudden increase in runoff or debris should be cause for concern.**
-  **Listen for unusual rumbling sounds or noises that may indicate shifting soil, rock or breaking vegetation or structures.**
-  **Remain informed as to local rainfall levels during intense rainstorms. Check frequently for early flood warnings.**
-  **Debris flows can be triggered when rainfall exceeds ¼-inch per hour, especially when soil may be water-logged.**
-  **It takes time for bare slopes to recover from a wildfire. In the meantime, be prepared for rapid evacuation should it become necessary.**



Post-wildfire debris flow deposited in burned forest below a steep mountain grade, Paradise Acres, Huerfano County, Colorado, 2018. Photo credit: Kevin McCoy for the CGS.

More Information:

- For general statewide information about debris flows and other kinds of landslides, contact the Colorado Geological Survey at (303) 384-2655 or visit <https://coloradogeologicalsurvey.org>.
- For an assessment of the debris flow risk to an individual property or homesite, obtain the services of a professional engineering geologist.
- For more information about the design and construction of debris basins, debris fences, deflection walls, or other protective works, consult a local or county engineer, local flood control agency, or the U.S. Department of Agriculture, Natural Resources Conservation Service.

REFERENCES

- Barrows, A., and Smith, T. CGS Note 33, California Geological Survey.
- Hollingsworth, R. and Kovacs, G.S., 1981, *Soil slips and debris flows, prediction and protection*: Bulletin of the Association of Engineering Geologists, v. 18, no. 1, p. 17-28.

The two most important actions that should be taken by residents on rainy nights is to heed flood warnings and NOT to sleep in lower-floor bedrooms on the sides of houses that face steep slopes or drainages.

