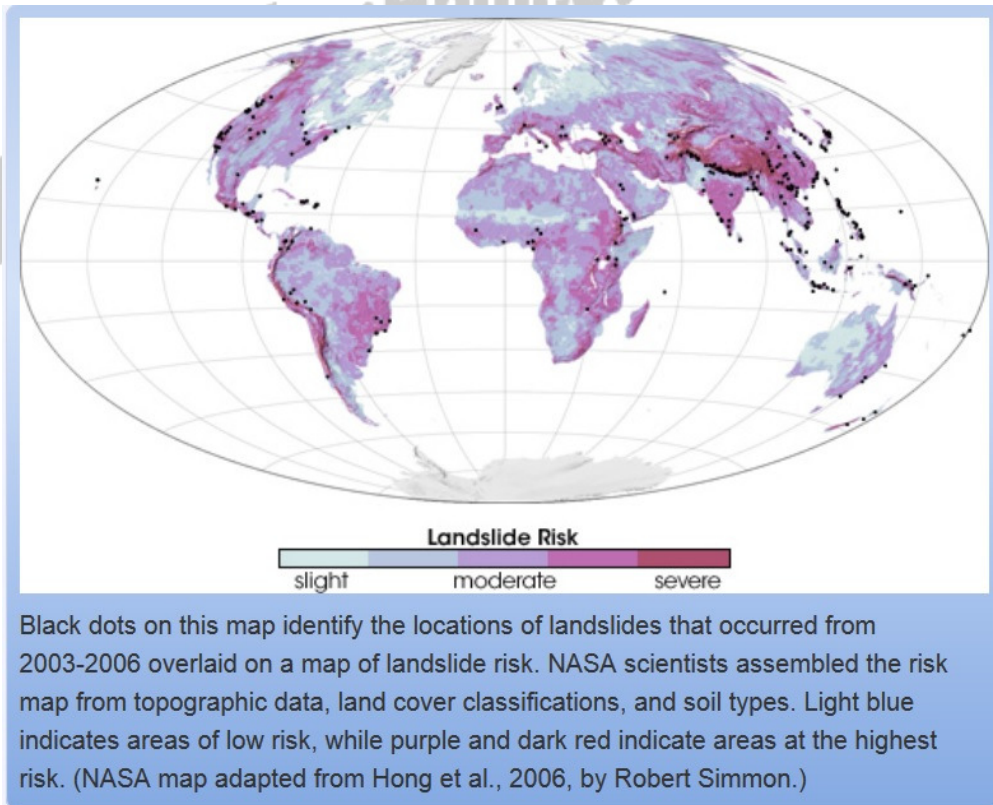


# Landslides & Mudslides

Landslides, also known as mudslides and debris flow, occur in all U.S. states and territories. In snowy mountainous areas winter snow landslides are called avalanches.

Landslides are not individual events, they occur in conjunction with other factors Landslides occur when the hill or mountain side is unstable. Factors that can allow gravity to overcome the resistance of earth material are:

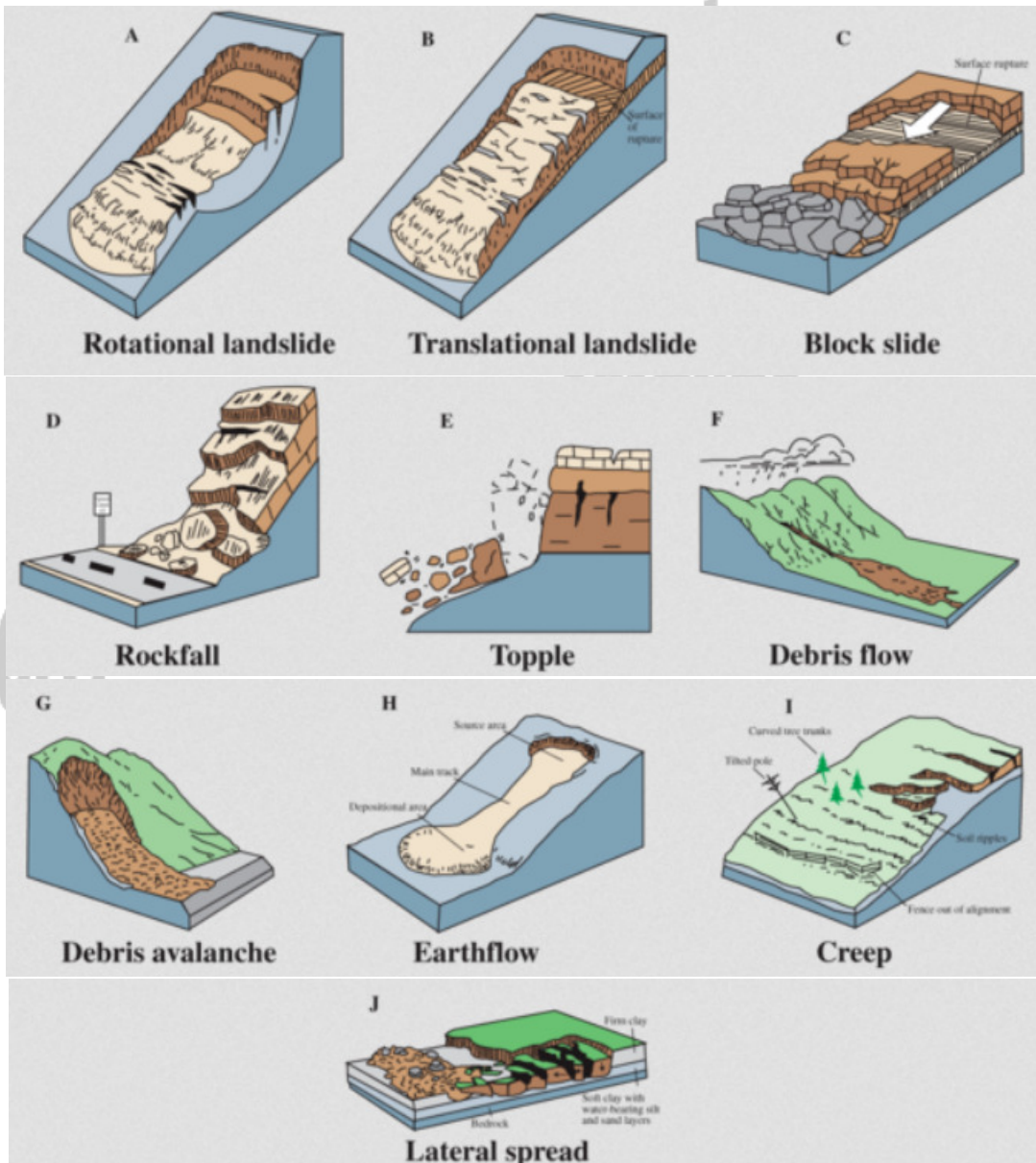
- *Erosion* (the natural wearing away of rocks and soil) by rivers, glaciers or oceans can overly steepen slopes. (USGS)
- *Addition of moisture* - Moisture equals weight and water from heavy rainfall, flooding, rapid snow melting, glacier melting, and an increased water table can all saturate the hillside and cause a landslide. El Nino, the weather phenomenon that can increase precipitation, led to thousands of landslides in 1982-83 and 1997-1998. (USGS)
- *Shocks and Vibrations* - Earthquakes, typically those of 4.0 magnitude and above, can create stresses that weaken slopes. Earthquakes tend to produce the largest and most destructive landslides. The earthquake-induced Alaskan landslide of 1964 happened when the vibrations disrupted the clay soil particles and the water contained in them rose to the surface.
- *Volcanic eruptions* can produce loose ash deposits, heavy rain, and debris flows. The eruption of Mount St. Helens on May 18, 1980 triggered massive landslides, including the largest landslide in the world, which moved 2.8 km<sup>3</sup> of earth material. (USGS)
- *Overdevelopment* - Human activities such as construction, building, transportation, building dams and canals, and mining can disturb large volumes of earth materials. In fact, landslide damage is increasing every year as our population expands further into hilly regions. The San Francisco Bay region is turbulent enough on its own, but as more people overdevelop the land becomes less and less stable. The picture to the right displays the devastating effects of building too close to a hill with landslide potential.
- *Deforestation* - As the human population grows the demand for clear land for crops and housing grows too. So forests, with trees that hold the soil in place, are logged, burned, and developed. And while this alone will usually not cause a landslide, the land becomes much more susceptible to heavy rains and floods and landslides can occur with much less rain than if a forest was still there. Wildfires, either natural or manmade, also have the same effect. (Socioeconomic and environmental...)



Landslides happen quickly and with little notice and can travel several miles from their source, growing in size, picking up trees, cars, boulders, and other objects and materials. Or they can occur slowly over a period of weeks or months.



There are different types of landslides



A variety of factors, including earthquakes, storms, fires, deforestation and heavy rains can cause landslides.

Landslides generally happen in areas where they have occurred in the past. Many times there are telltale signs of past slides and debris flows.

Heavily saturated steeply sloped ground is very susceptible to mudflows and debris flows. Debris flows and other landslides onto roadways are common during rainstorms.

There is a digital **Landslide Risk Overview Map of the Conterminous US** done in 1982 @ [http://landslides.usgs.gov/state\\_local/nationalmap/](http://landslides.usgs.gov/state_local/nationalmap/) You can click on areas to see detailed renditions of various sections of the larger map:

Legend [http://landslides.usgs.gov/state\\_local/nationalmap/legend.php](http://landslides.usgs.gov/state_local/nationalmap/legend.php)

Pacific Northwest [http://landslides.usgs.gov/state\\_local/nationalmap/images/pnw.gif](http://landslides.usgs.gov/state_local/nationalmap/images/pnw.gif)

California & Southwest [http://landslides.usgs.gov/state\\_local/nationalmap/images/psw.gif](http://landslides.usgs.gov/state_local/nationalmap/images/psw.gif)

Central/Midwest [http://landslides.usgs.gov/state\\_local/nationalmap/images/midwest.gif](http://landslides.usgs.gov/state_local/nationalmap/images/midwest.gif)

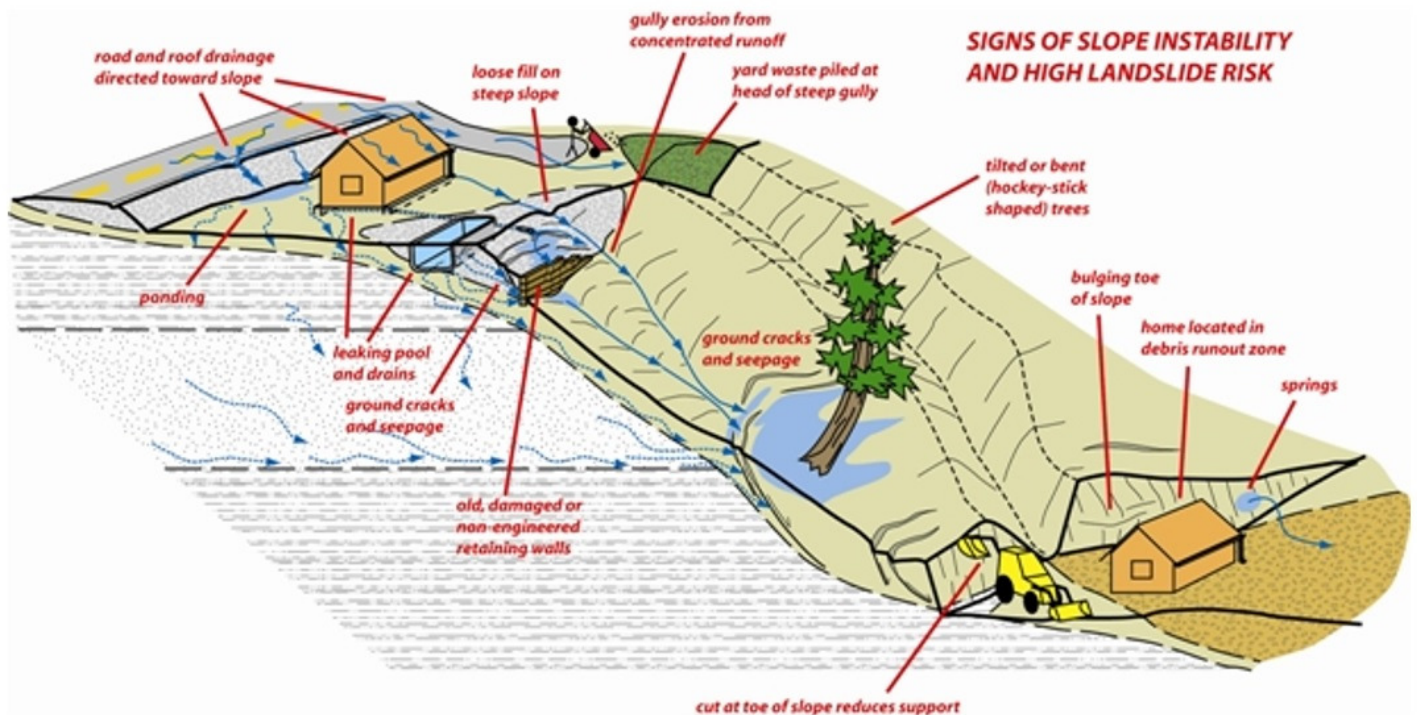
Southeast [http://landslides.usgs.gov/state\\_local/nationalmap/images/ase.gif](http://landslides.usgs.gov/state_local/nationalmap/images/ase.gif)

East Central [http://landslides.usgs.gov/state\\_local/nationalmap/images/ecentral.gif](http://landslides.usgs.gov/state_local/nationalmap/images/ecentral.gif)

Michigan [http://landslides.usgs.gov/state\\_local/nationalmap/images/michigan.gif](http://landslides.usgs.gov/state_local/nationalmap/images/michigan.gif)

Northeast [http://landslides.usgs.gov/state\\_local/nationalmap/images/ane.gif](http://landslides.usgs.gov/state_local/nationalmap/images/ane.gif)

NASA also monitors for landslide risks via satellite. Their world map can be found @ <http://pmm.nasa.gov/education/articles/satellite-monitors-rain-triggers-landslides>



### Before a potential Landslide

- Learn about your area's landslide risk.

- Learn about local emergency response and evacuation plans.
- Be aware that, generally, landslide insurance is not available, but debris flow damage *may* be covered by flood insurance policies from the National Flood Insurance Program (NFIP) at [www.FloodSmart.gov](http://www.FloodSmart.gov). Talk to your insurance agent to find out if flood insurance could cover your property and belongings.
- Become familiar with the land around where you live and work so that you understand your risk in different situations.
- Talk to everyone in your household about what to do if a landslide occurs.
- Consult an appropriate professional expert for advice on any corrective measures.
- Contact your local fire, police, or public works department if you suspect imminent landslide danger. Also, let neighbors know of the potential risk.
- Create and practice an evacuation plan for your family and your business.
- Follow proper land-use procedures and avoid building near steep slopes or along natural erosion valleys.
- Get a ground assessment of your property.
- Have flexible pipefittings professionally installed to avoid gas or water leak.
- In mud flow areas, build channels or deflection walls to direct the flow around buildings. Keep in mind, though, that you may be liable for damage if you divert debris flow onto someone else's property.
- Plant ground cover on slopes and build retaining walls.
- Watch the patterns of storm water drainage on slopes near your home, especially where runoff water converges.



### If a Landslide is Imminent

- If you suspect imminent danger, evacuate immediately. Inform affected neighbors if you can, and contact your public works, fire or police department.
- Consider a precautionary evacuation of large or numerous animals as soon as you are aware of impending danger.
- If you are ordered or decide to evacuate, take your animals with you.
- Listen for unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together.
- If you are near a stream or channel, be alert for any sudden increase or decrease in water flow and notice whether the water changes from clear to muddy. Such changes may mean there is debris flow activity upstream so be prepared to move quickly.



### Signs a Landslide is Imminent

In most cases, landslides do not happen in an instant. There are often warning signs that can tell you that a landslide is coming. This gives you precious time to take safety measures.

- Bulging ground appears at the base of a slope.
- Changes occur in your landscape:
  - Patters of storm-water drainage on slopes (especially where runoff converges) like Land movement, small slides, flows.
  - Progressively leaning trees.
  - Changes in patterns of storm-water drainage
  - Small land movement or shifting,
  - Small slides, flows
- Doors or windows stick or jam for the first time.
- Fences, retaining walls, utility poles, or trees tilt or move.
- New cracks appear in plaster, tile, brick, or foundations.
- Outside walls, walks, or stairs begin pulling away from the building.
- Slowly developing, widening cracks appear on the ground or on paved areas, such as streets or driveways.
- Underground utility lines break.
- Water breaks through the ground surface at a new location.
- Fences, retaining walls, utility poles, or trees tilt or move.
- Rapid water or muddy flow, where it has not been observed before
- Irregular or suddenly stopped stream flow
- Cracking or falling trees, particularly in the absence of strong winds
- Collapsed pavement, mud, fallen rocks, etc. on roadside embankments.
- Faint rumbling sounds that are noticed and increase in volume.
- The ground slopes downward in one direction and may begin shifting that way under your feet.
- Unusual sounds, such as trees cracking or boulders knocking together, might indicate moving debris.



### During the Landslide

- Pray
- If you can, move away from the slide's path as quickly as possible.
- Consider leaving if it is safe to do so. Be cautious as driving during an intense storm can be dangerous. Watch for collapsed pavement, mud, fallen rocks, and other indications of possible debris flow.
- Curl into a tight ball and protect your head if you can't get out of the landslide's path.
- Move to a second story, if possible.
- Listen for any unusual sounds that may indicate moving debris, such as trees cracking or boulders knocking together, then move away from the sound.



### After the Landslide

#### If you were in or near the slide:

- Get clear of the area as additional slides may occur.
- Help family and neighbors and animals who may need assistance to get out of the area and away from the slide.
- Help people who require special assistance to get out of the area and away from the slide.
- Make a note of the smell of gas and any downed electrical lines, get out of the slide area and report to authorities.
- Check for injured and trapped persons and animals near the slide, without entering the area, Direct rescuers to their locations.



**If you escaped the slide:**

- Stay away from the slide area, until the authorities say it is safe. Additional slides may occur.
- Listen to local radio or television stations for the latest emergency information.
- Check your home's foundation, chimney and surrounding land for damage.
- Replant damaged ground as soon as possible because erosion caused by loss of ground cover can lead to flash flooding.
- Watch for associated damage and report to appropriate authorities:
  - Electrical, water, gas, and sewage lines.
  - If you smell gas, get out of the area and only use your phone to call the gas company if you can safely distance yourself from the odor of the gas. Remember not to use any appliance or open flame in areas where you still smell gas.
  - Damaged roadways and railways.
- Watch for flooding—floods sometimes follow landslides and debris flows.



TNT