

March 22, 2021

Geohazards - Landslides



Figure 1 - Last Chance Grade Landslide ¹

Stevie Nicks wrote her song, [Landslide](#), in response to the many professional troubles that she and her band, Fleetwood Mac, were having at the time. Everything seemed to be crashing down at once, just like a landslide ². It's a beautiful song about coping with change and loss and is a good place to start a discussion on landslides.

Landslide Causes

The basic cause of landslides is the action of gravity on a vulnerable geological feature combined with something that triggers the failure. More specifically, landslides may be caused by one or more of the following factors:

1. Geological causes

- Weak or sensitive materials

- Weathered materials
- Sheared, jointed, or fissured materials
- Adversely oriented discontinuity (bedding, schistosity, fault, unconformity, contact, and so forth)
- Contrast in permeability and/or stiffness of materials

2. *Morphological causes*

- Tectonic or volcanic uplift
- Glacial rebound
- Fluvial, wave, or glacial erosion of slope toe or lateral margins
- Subterranean erosion (solution, piping)
- Deposition loading slope or its crest
- Vegetation removal (by fire, drought)
- Thawing
- Freeze-and-thaw weathering
- Shrink-and-swell weathering

3. *Human causes*

- Excavation of slope or its toe
- Loading of slope or its crest
- Draw down of reservoirs
- Deforestation
- Irrigation
- Mining
- Artificial vibration
- Water leakage from utilities

(From USGS, 2004 ³)

Features of a Landslide

Before discussing the types of landslides, it is helpful to identify the features of a landslide, as shown in Figure 2, below.

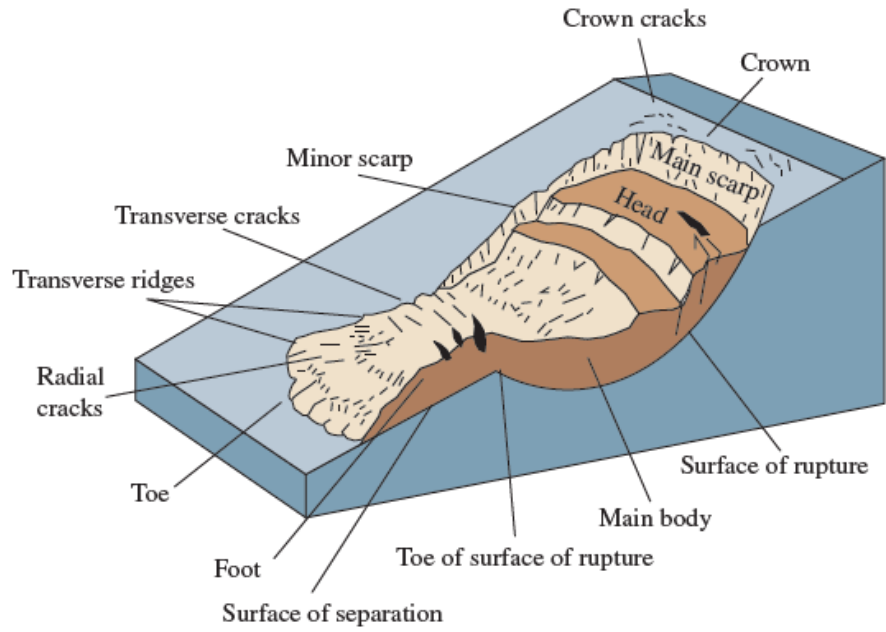


Figure 2 -Features of a Landslide ³

Types of Landslides

Figure 3, below, illustrates the main types of landslides.

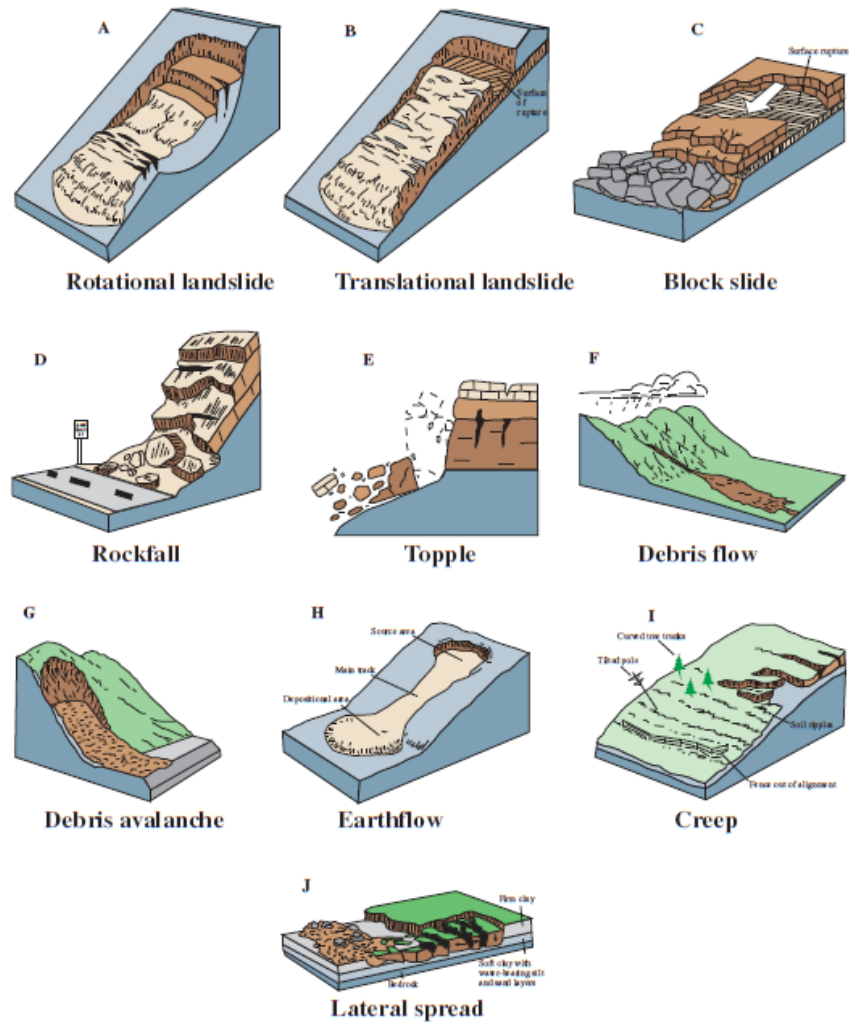


Figure 3 - Types of Landslides³

In a **rotational landslide** (Fig. 3A), the surface of rupture is curved concavely upward and movement of the slide is roughly rotational about an axis that is parallel to the ground surface and transverse across the slide³.

Translational landslides (Fig. 3B) are where the landslide mass moves along a roughly planar surface with little rotation or backward tilting³.

A **block slide** (Fig 3C) is a kind of translational slide where the moving mass consists of a single unit or a few closely related units that move downslope as a relatively coherent mass³.

A **rock fall** (Fig. 3D) is just as the name suggests; masses of geologic materials, such as rocks and boulders become detached from steep slopes or cliffs³.

In a **topple**, (Fig. 3E) the failure of the material unit is by the forward rotation of a unit or units about some pivotal point, below or low in the unit ³.

Debris flows (Fig. 3F) are a form of rapid mass movement in which a combination of loose soil, rock, organic matter, air, and water mobilize as a slurry that flows downslope ³. I discussed an example of this in the March 8 posting on debris flows from volcanic activity.

A **debris avalanche** (Fig.3G) is an extremely fast variety of a debris flow ³. A volcanic lahar is a good example.

Earthflows (Fig. 3H) have a characteristic "hourglass" shape; the slope material liquefies, runs out, and forms a bowl or depression at the head of the earthflow ³. Liquefaction of silt and sand deposits commonly happens during earthquakes.

In this context, **creep** (Fig. 3I) isn't the obnoxious fellow leering at passersby but, rather, is the slow, sometimes almost imperceptible, steady, downward movement of soil and/or rock ³.

Lateral spreads (Figure 3J) occur on very gentle slopes or flat terrain and are marked by lateral movement of the soil, often due to liquefaction of saturated soils with little cohesion. Lateral spreads are often triggered by earthquakes but can also be artificially induced ³.

Worldwide Risks of Landslides

Landslides are most common in areas of high relief, such as in mountainous terrain. Risks to human life increase where there are greater densities of population; both from the number of people in proximity to the potential unstable ground and from the likelihood of human activity that increases the instability. Areas of high rainfall are also prone to landslides where those areas coincide with the terrain and human factors. Figure 4, prepared by the NASA Earth Observatory, shows the worldwide risks of landslides to human life and property.

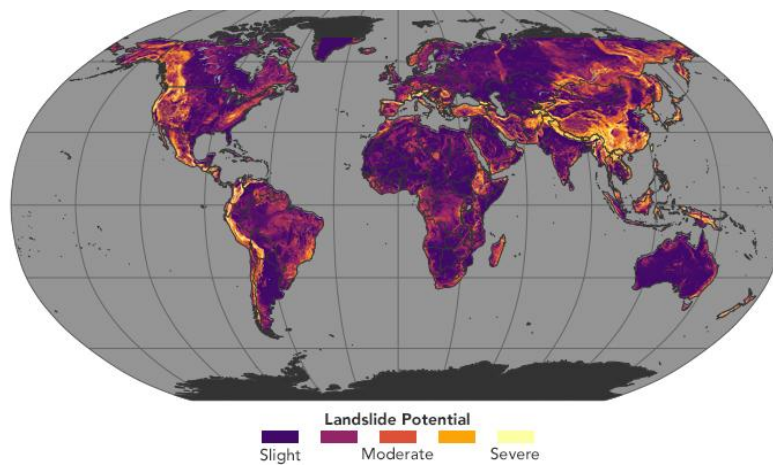


Figure 4 - Global View of Landslide Susceptibility ⁴

Afterword

As a geohazard, landslides are a serious threat to human life and property. Understanding the causes and mechanics of landslides is a necessary precaution in areas prone to them. Just as important is understanding how human activities can increase or mitigate the threat from landslides.

Back to where we started at the beginning of the post. We saw Stevie Nicks writing [Landslide](#) when her professional life seemed to be falling down. So, what happened next? Well, *Landslide* went on to be a big hit. Since then, Stevie Nicks has had a successful career, both with Fleetwood Mac and also as a solo artist. Other singers have covered the song and Stevie Nicks continues to sing it to this day. While having little to say on the science of landslides, art like the song *Landslide* can teach us lessons about coping with the inevitable grief and loss that will occur in our lives.

Where there's life, there's hope.

References

1. Wikimedia Commons, Feb. 2021, *File:2020-0301 LastChanceGradeLandslide.jpg*, https://commons.wikimedia.org/wiki/File:2020-0301_LastChanceGradeLandslide.jpg
2. Wikipedia, Mar. 2021, *Landslide (Fleetwood Mac song)*, [https://en.wikipedia.org/wiki/Landslide_\(Fleetwood_Mac_song\)](https://en.wikipedia.org/wiki/Landslide_(Fleetwood_Mac_song))
3. United States Geological Survey (USGS), Jul. 2004, *Landslide Types and Processes*, <https://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html>
4. NASA Earth Observatory, March, 2017, *A Global View of Landslide Susceptibility* <https://earthobservatory.nasa.gov/images/89937/a-global-view-of-landslide-susceptibility?src=ve>