

# LANDSLIDES

# NATURAL PHENOMENA THAT OCCUR WITH OR WITHOUT HUMAN ACTIVITY

**Types: Falls, Topples, Slides, Spreads, Flows**

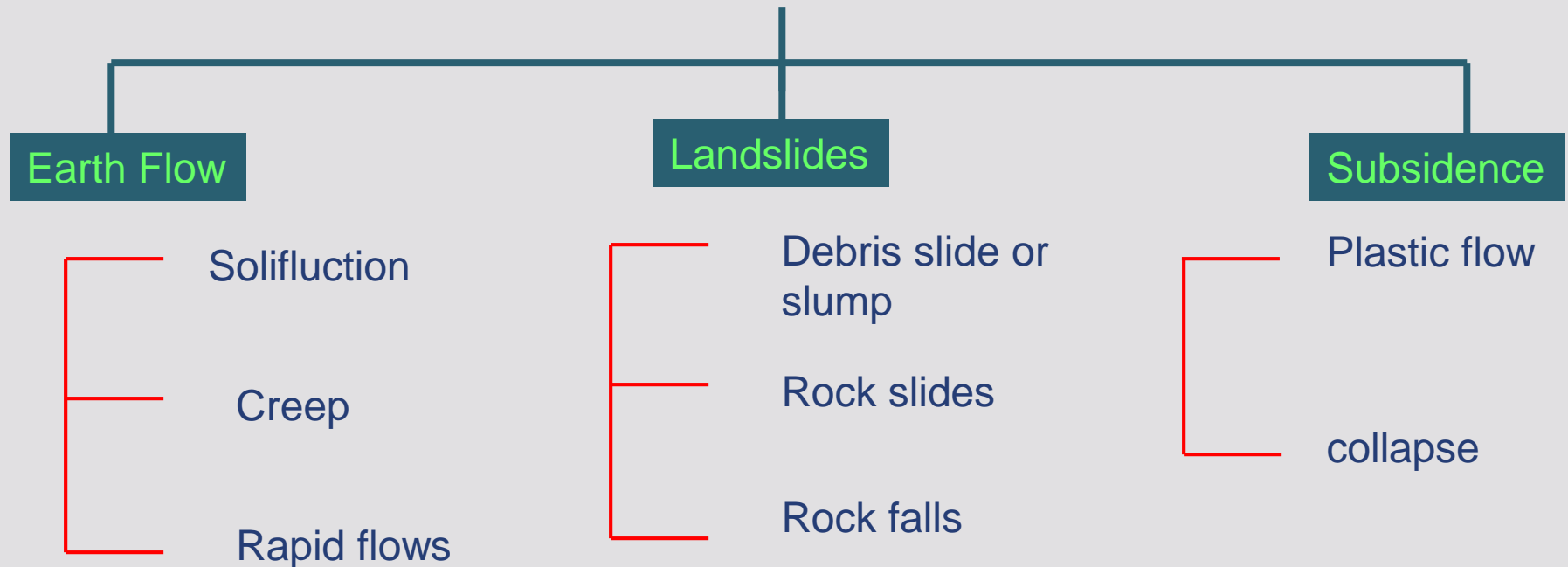
Landslides are rock, earth, and/or debris flowing or sliding down slopes due to gravity

- ❑ Landslides encompass all categories of gravity-related slope failures in Earth materials.
- ❑ Slopes are the most common landforms.
- ❑ Although they appear stable and static, slopes are actually dynamic, evolving systems.

- ❑ Material is constantly moving down slope at rates varying from imperceptible creep to thundering avalanches and rock falls moving at high velocities.
- ❑ Slope failures are triggered by earthquake ground shaking or excess precipitation of water within the rockmass.
- ❑ The slope does not need to be very steep for a landslide to occur, geological discontinuities play an important role.

# Classification of Earth Movements

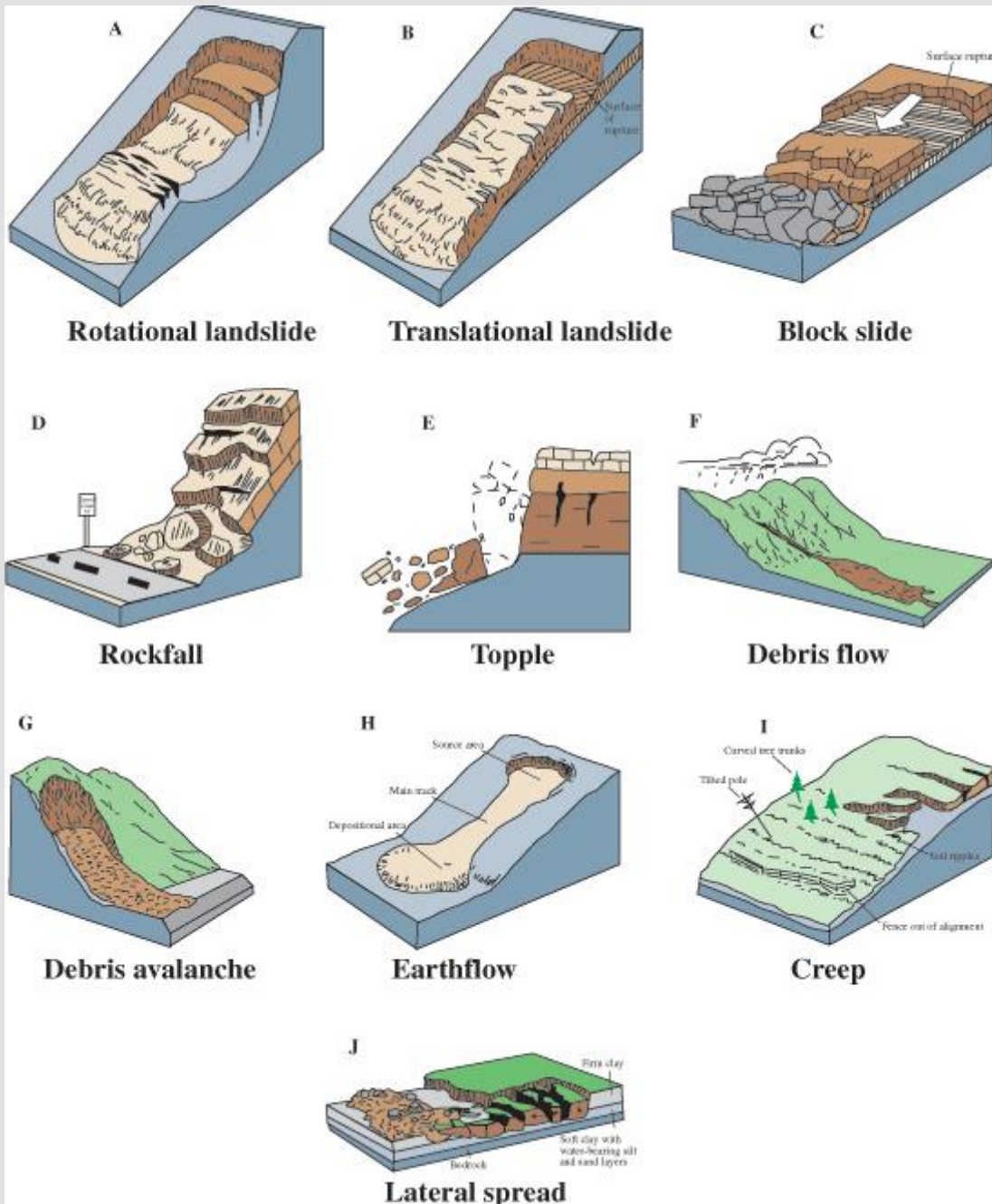
- All movements of land mass are referred as landslides, but differ in many respects, therefore all types of landslides are categorized as Earth Movements.



# Types of Landslides

← Major types of landslide movements

- ❑ Landslides occur at different speeds — very slow to very fast
- ❑ All landslides are the result of gravity, friction and their materials
- ❑ Both natural and human-made factors contribute to landslides



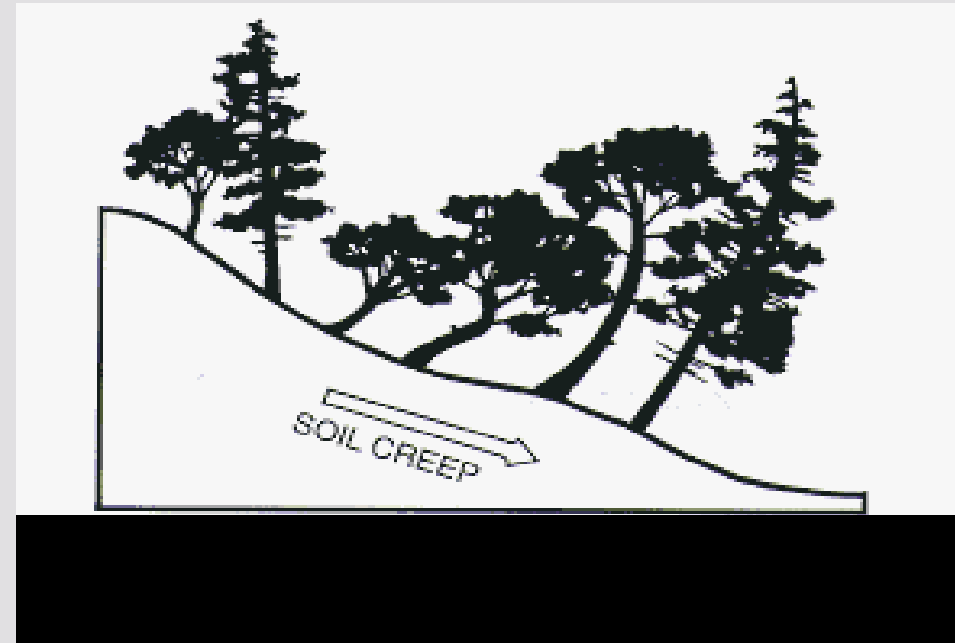
Source: U.S. Geological Survey,  
<http://pubs.usgs.gov/fs/2004/3072/pdf/fs2004-3072.pdf>

# Types

- ❑ Rockfall- large chunks of rock that tumble down a cliff or steep slopes
- ❑ Lahars- ash from a volcano mixes with water, to form a thick river of mud
- ❑ Earthflows- contain less water and flow more slowly; move shorter distances
- ❑ Slope Failure- involve one block or a series of blocks
- ❑ Slump- large masses move downward and outward due to a gravity pull
- ❑ Debris Slides- consist of moving masses of mud, soil, and rocks mixed with water

# SOIL CREEP

- ❑ Creep is extremely slow downward movement of dry surficial matter.
- ❑ Movement of the soil occurs in regions which are subjected to freeze-thaw conditions. The freeze lifts the particles of soil and rocks and when there is a thaw, the particles are set back down, but not in the same place as before.
- ❑ It is very important for CEs to know the rate of movement





# Effects

- ❑ Bury entire villages that are at the bottom of the mountain range
- ❑ Close roads
- ❑ Broken gas, electric, water, and sewage lines

# Effects

- ❑ Landslides also sweep up trees, cars, and buildings



[http://landslides.usgs.gov/  
research/other/centralamerica.php](http://landslides.usgs.gov/research/other/centralamerica.php)



[http://landslides.usgs.gov/  
research/other/  
centralamerica.php](http://landslides.usgs.gov/research/other/centralamerica.php)



[http://web.ndmc.gov.za  
/images/landslide1.jpg](http://web.ndmc.gov.za/images/landslide1.jpg)

# CAUSES OF LANDSLIDES

- ▣ **Anthropogenic factors**
- ▣ **Natural factors** are subdivided into the following:
  - ▣ **Inherent factors** indicate the inherent characteristic of hill slope and they can be evaluated on the slope itself. These are geology, slope gradient, local relief, hydrological conditions, land use and land cover.
  - ▣ **External factors** indicates the outside factors and they can not be studied on a hill slope. These are rain fall and earthquakes.

# Inherent factors

## □ Change in slope gradient:

- Natural or artificial interference causes the change in slope gradient during the process of erosion. Due to tectonic processes like upliftment or subsidence the slope angle becomes steeper. Increase in slope gradient on hard rock slopes results in highly unstable conditions of slope stability.
- Provides favorable condition for landslides; steeper slope are prone to slippage of land. It is known that most of the materials are stable up to certain angle- “Critical angle” or “angle of repose” – it varies from 30 degrees for unconsolidated sediments to 90 degrees for massive rocks and 60-90 degrees for partially jointed rocks.

# Inherent factors

- **Steep slope embankments of fills and soil heaps:**
- The soil may be stable over a range of slope conditions due to its inherent strength properties. If the slope of embankment exceeds this limit, the soil may undergo slip circle failure; especially in presence of water shear strength of the material decreases.



## ❑ **Geology:**

- ❑ Highly fractured and jointed rockmass are very susceptible to failure.
  - ❑ Weak rocks like phyllite and slates with calcareous veins or layers may lead to high porosity and void due to dissolution of rockmass.
- ## ❑ **Weathering:**
- ❑ weathering affects the strength properties of the rockmass, which is also one of the major factors for slope failure.

## ❑ **Changes in water content:**

- ❑ Water penetrates into fractures and joints which increases pore water pressure which reduces the shear strength of the rockmass and results in slope failure.
- ❑ In the presence of water, the clayey soil swells and causes instability. Increase in subsurface water may lead to plastic deformation.
- ❑ Water being a powerful solvent not only causes decomposition of minerals but also leaches out the soluble matter of the rock and reduces the strength.



**A sectional view of  
the Mandakini  
River and road turn  
with almost vertical  
slope above and  
below the road**



**Road  
Level**





# External factors

- ❑ **Shocks and vibrations:**
  - ❑ Earthquakes, explosion, vibration due to machinery affect the stability of the slope by change in stress level.
  - ❑ Sometimes earthquake generated stresses causes catastrophic slope failure.
  - ❑ Earthquakes often initiate mass failures on large scale eg. 1897 Assam quake produced gigantic landslide ever recorded in the region.
  
- ❑ **Cloud burst:**
  - ❑ The important external factor is cloud burst (Concentrated precipitation) which triggers slope failure.

# Anthropogenic factors

- ❑ **Plan roots :**
- ❑ Due to increase in the size of plant roots and other vegetation in pre-existing plane of slope failure or jointed rock may also causes the failure.
- ❑ **Deforestation** especially in soil slopes which exposes barren soil erosion and destabilization is one of the major factors of slope failure.
- ❑ **Improper land use:**  
Improper land use like irrigation on steep slopes, overgrazing and agricultural practices on vulnerable slopes accelerate slope failure.
- ❑ **Construction activities:**  
Improper site selection or lack of terrain safe bearing capacity evaluation before going for any civil construction