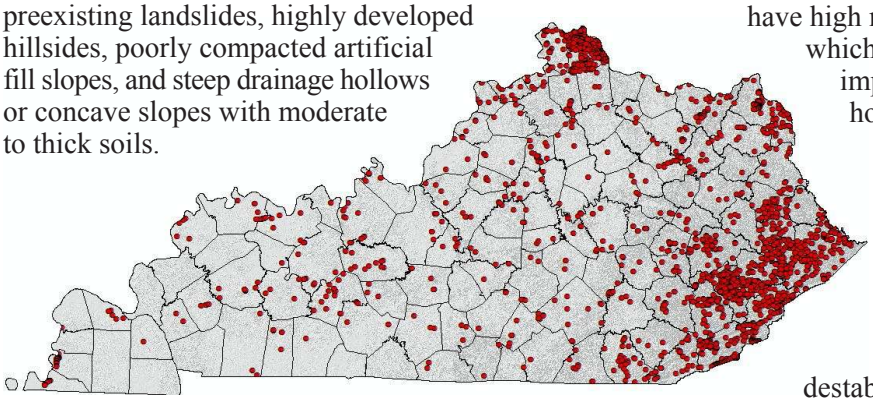
Landslide Hazards in Kentucky

What is a landslide?

Landslides are the downslope movement of rock, soil, or both under the influence of gravity. Different landslide types are classified by rate of movement and the type of material. Velocity of landslide movement can also vary from slow to very rapid.

Where do landslides occur?

Landslides pose a hazard to hundreds of thousands of people in the United States every year, occurring in every state and U.S. territory. Kentucky's landslides occur in all regions of the state, mostly in the Eastern Kentucky Coal Field, Outer Bluegrass, the Knobs region, and along the Ohio River Valley. Areas generally prone to landslides include preexisting landslides, highly developed hillsides, poorly compacted artificial fill slopes, and steep drainage hollows or concave slopes with moderate to thick soils.



There are over 2,300 landslides in the Kentucky Geological Survey landslide inventory database. Data sources include existing maps, state and local government agencies, KGS field work, LiDAR mapping, media alerts, and the public. However, there are many landslides that go unreported and it's important to know the causes and risks of landslides.

Socioeconomic significance:

According to the U.S. Geological Survey, landslides cause $1 to 2 billion dollars in damages and more than 25 deaths on average each year in the U. S. Population increase, rapid urbanization, and development will cause a rising trend in landslide activity. Direct costs of landslides include repairs and maintenance of roads and other property. Indirect costs (loss of tax revenue on devalued property, loss of real estate value in landslide-prone areas, and environmental effects such as water quality) may even exceed direct costs.

In Kentucky, costs of landslides and rockfall repair exceed $4 million annually, largely costs incurred by the Kentucky Transportation Cabinet. However, many slides unrelated to transportation which go unreported also pose significant hazards to people and infrastructure. Landslide projects from 2003 to 2013 funded from a Kentucky Hazard Mitigation Grant Program that acquires landslide damaged homes or stabilizes the area totals approximately $5 million. The most expensive landslide mitigation effort in the state occurred in Hickman where the federal government secured $17 million to stabilize a large slide on the bluff of the Mississippi River.

Causes and Triggers:

A stable slope is one whose resisting forces are greater than the downslope driving forces. Landslides occur when gravity and other driving forces exceed the strength of slope materials (rocks and soil), destabilizing the slope. Triggering mechanisms coincide with the pre-existing causes that create potential for slope failure.

Causes:

Geology, soils, and steep slopes – Easily weathered rock types and soils, especially on steep slopes, form the underlying causes; when combined with the triggers below, create landslide susceptibility.

Triggers:

Intense rainfall–Soil and rock material on slopes may have high moisture levels, increasing pore-water pressure, which destabilizes the slope and causes slides. It is important to be aware of storm-water drainage near homes, offices, and other buildings.

Water-level change–Rapid lowering of groundwater against a slope can trigger landslides, especially along dams, coastlines, reservoirs, and rivers. The pore pressure in soil or rock material may not be able to adjust to a sudden drawdown of water, causing slope instability.

Erosion–Natural stream water erosion can destabilize slopes and cause failure. This is common at the toe (bottom) of a slope.

Human activities–These include vegetation removal, excavation of toe slopes, loading on a slope, leakage from pipes, and surface and underground mining.

Earthquakes–Ground shaking during earthquakes can cause landslides in many different topographic and geologic settings.

What to look for:

Steep Slopes–The steeper the slope, the greater the likelihood of slope failure.

Modified slopes–Human activities are a principal cause of slope failures: cuts and fills; addition of runoff from new roads, roofs, and parking lots; water from overuse of septic tanks and excessive lawn watering.

Stream banks–These fail from erosion (under cutting) on outside stream bends and from a rapid drop in water level in the stream, which leaves excess pore pressure in silts and sands.

Broken or leaking pipes–Many landslides are associated with cracked or broken sewer lines or water lines that saturate the slope. Be sure to locate every one and check for leaks.

Scarps in soil–Offsets in the soil with displacement ranging from inches to feet that runs mostly parallel to slope; indicate active slide movement

over

Tilted trees, poles, posts, and walls–These conditions on a slope are easy-to-recognize indicators of hillside movement.

Cracks in buildings, walls and roads–Failures are much easier to see when they cut hard structures. Look for cracks that line up, that have a noticeable offset, or arc-shaped displacement.

Avoidance and remediation:

The best method for avoiding damages from landslides and having to mitigate the hazard is to avoid construction on steep slopes. As this is not an entirely possible, consulting soil and geologic maps in the early investigation for development of a property is important. Check for descriptions of soil and rock types that may be susceptible to landslides. Simple practices to avoid slope failure include:

- Good site selection
- Proper drainage well away from slide area
- Avoiding removal of trees and vegetation where possible
- Adding no unnecessary weight (i.e. fill material) to the slope

Remediation efforts of existing landslides should always be done with the help of a professional geotechnical engineer. Basic rules of thumb include:

- Draining water well away from the slope
- Removal of soil from the head of the landslide (do not remove material at the toe of the slide, as this will further reduce stability)
- Planting trees and bushes to help remove water from the slope
- Reducing the height of the slope and adding cover of rip-rap toward the lower part of the slope to stabilize.

Advanced retaining wall remediation techniques, such as drilled piers, piles, steel or timber bins, gabions, or tie-backs are expensive and require professional geotechnical expertise.

Technical assistance:

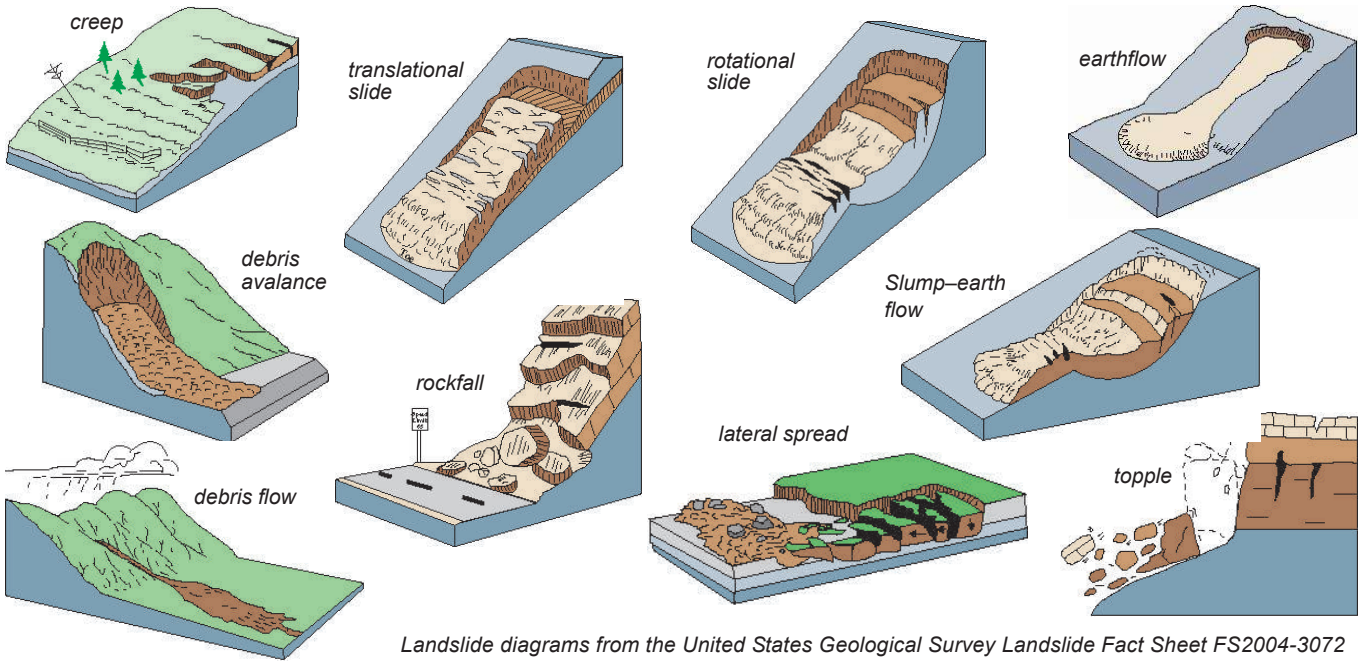
- Kentucky Emergency Management: **www.kyem.ky.gov**
- Federal Emergency Management Agency (FEMA): **www.fema.gov**
- United State Department of Agriculture, (USDA), Natural Resources Conservation Service (NRCS): **www.nrcs.usda.gov.** County offices provide detailed soil maps and engineering properties of soils.

You should be aware of government agencies (county, municipality managers, planning commissions, etc.) who may help or respond to a landslide.

Helpful resources:

- Kentucky Emergency Management Hazard Mitigation Program: **http:kyem.ky.gov/recovery/pages/hazardmitigation.aspx**
- Kentucky Geological Survey, Landslides: **www.uky.edu/kgs/geologicalhazards/landslide.htm**
- United States Geological Survey Landslide Hazards Program: **http://landslides.usgs.gov/**
- Highland, L. M., and Bobrowsky , Peter, 2008, The landslide handbook – a guide to understanding landslides: U.S. Geological Survey Circular 1325, 129p **http://pubs.usgs.gov/circ/1325/**
- Crawford, M.M., 2012, Using LiDAR to map landslides in Kenton and Campbell Counties, Kentucky: Kentucky Geological Survey, ser. 12, Report of Investigations 24, 12p.

Common landslide types:



Landslide diagrams from the United States Geological Survey Landslide Fact Sheet FS2004-3072