Landslides – Activity 1
Mini-Landslide Model

Overview

This activity has students build a physical model of a hillslope and investigate the conditions that lead to slope failure. The design is similar to the debris flow flume of large scale used by USGS (see Digital resources). The model also allows students to learn impact analysis using model houses.

Focus Questions

1. What affects the vulnerability of a hillslope to failure?
2. What triggers landslides?
3. How will these vulnerabilities and triggers change in the future?
4. How can we minimize the risks from landslides?

Performance Expectations

By the end of this activity, students should understand the difference between hillslope vulnerability and landslide triggers. They will better understand the influence of gravity and friction, and how the latter can be altered by water. They will also be exposed to several new vocabulary words used in earth science. They will learn more about prediction and experimentation to enhance the understanding of engineering and mitigation strategies to minimize landslide risks.

Background Information

Teachers will need to understand that landslides occur because of local site traits that pre-condition a slope to be susceptible to failing. Then a triggering event, such as high rainfall or an earthquake, initiates the landslide. These pre-conditions and triggers influence the characteristics of the landslide and thus, its hazard. Climate change and its secondary impacts (i.e., increased fire) can alter both the hillsides vulnerability as well as the triggering events. Additional resources provided in links at end.

Materials

Physical resources:
- Plastic chute – downspout runout (e.g., “Dripper flipper” - $10)
- Piece of cardstock cut out in shape of chute cross-section (fits in vertically)
- Large tray – plastic, glass, metal
- Scissors and “duct” tape
- Printed houses/trees template
- Ruler or tape measure
- Measuring cups (1 c & ¼ c)
- Sand, gravel, or soil
- 2 bowls (for wet and “dry” sand)
- Misting bottle filled with water
- Small brush, towels, paper towels

Digital resources:
- USGS Flume experiments

Lesson Time

One 50-minute class period
- Introduction video and lecture
- Flume set up and experiments

Prep Time

Spend about 1 hour to review material, practice assembling and running the mini landslide. Previewing the NOVA movie and reading background papers could add 2 more hours.
**Prior Knowledge and Learning Assets**

For the Mini Landslide activity, it is helpful if students have some knowledge of soil materials and soil profiles. A basic understanding of gravity, friction, and trigonometry is warranted. Students would benefit from having some knowledge of projected changes in precipitation in their local area. Personal knowledge or experience hiking steep slopes in the area is helpful. Students aware of gardening may have insights into the influence of plants on soil moisture and the importance of their roots in holding soil.

**Anticipated Challenges**

Challenges associated with the Mini Landslide activity include potential mess from sand/soil and water used. If the sand/soil is not spread across the chute diameter, then the applied water can run around the edge of the sand/soil. Also, if the sand is very dry, it can slide down the chute upon pouring in; mist it with a little water and mix before placing at top of chute. If the angle of the chute is too shallow/gentle, the material may not slide down to the “houses” – just raise the slope or add more water. If the chute acquired is the “dripper flipper” type, then a piece of plastic could be attached to the bottom of the flipper cup (cut out and glued). This is what was used in the photos because it provided an easy way to pour water evenly above soil.

**Safety Issues**

In the Mini Landslide activity, sometimes the edges of the chute can be sharp; care should be exercised when handling. Mixtures of soil and water can get messy and slippery. Be prepared.

**Assessment Elements**

Mini Landslide activity provides opportunity to evaluate student’s ability to conduct a physical experiment, collect data, and evaluate data and observations. Questions for discussion:

1. Is this what you expected to happen? Why?
2. What features of the experiment might alter the behavior and results? (i.e., slope, length, soil material)
3. How might landslides change in the future as precipitation and temperature change?
4. What mitigation strategies can you think of that would protect the houses? (i.e., location, diversion structure).

**Standards**

- HS-ESS2-5
- HS-ESS3-5
- HS-ESS3-6
- HS-ETS1-4
Conducting the Lesson

Mini Landslide Activity

1. Collect the material needed for this “hands-on” activity (see Physical Resources above). Teacher note: material list is for 1 station.

2. Cutout and assemble houses and trees. Teacher note: print out before and distribute 1-2 per group.

3. Place one end of the chute in the collection dish and the other end on books or a stool leg.

4. Duct tape the bottom of chute to dish to keep it from sliding. Teacher note: alternatively, pre-glue a “stop” near the upper end of the chute on the bottom to hold the angled chute in place.

5. Place the houses and trees in the dish below the slide...to the front and to the sides. Teacher note: have students vary this configuration to learn how location matters; even measure this.

6. Measure out about 1 cup sand/soil. If the sand is “kiln dried,” mist it with water and stir in bowl to moisten, but don’t soak. Misting helps provide some water surface tension that increases bonding of sand and can be done for a larger quantity of sand in advance.

7. Mist chute lightly before placing sand/soil, being careful that the chute is not so slippery that all the sand slides down immediately.

8. Measure the length of the chute and the height of the chute from the floor or table top to about where you added the water. These measurements are used to calculate the slope angle of the chute. Hint: what is \( \sin \theta \) and how do you get \( \theta \)? Compare this angle with a cell phone app such as “Smart protractor” held up to the side of chute or the angle function part of “compass” in IPhone Utilities app.

9. Ready a cell phone or camera to record video of the slide to be able to review afterwards.

10. Use the cardboard cutout in the shape of the chute to hold the sand/soil near the top of the chute as you pour the sand/soil onto the chute behind the cardboard cutout. Teacher note: if you don’t have the cutout, expect some material to roll down chute.

11. Smooth the sand/soil toward the edges of the chute so that water won’t flow around the edges.

12. Pour about \( \frac{1}{4} \) cup of water at a time above the sand/soil until the material fails. It can be helpful to have several cups with \( \frac{1}{4} \) cup of water measured out ready to use (such as 2-3 paper cups). Teacher note: alternatively, you could using a graduated measuring cup and record how much was needed to cause slide.

13. Document what happened:
   a. What was the slope angle of your chute?
b. How much water did it take for the sand/soil to slide?
c. What was the behavior of the sand/soil as it slid?
d. What happened to the houses and trees? Which ones were affected and why/why not?

14. Remove the paper houses and trees before they get too wet so you can reuse them.

15. Cleanup:
   a. Remove the sand/soil and water into another container/bucket.
   b. You’ll likely need to remove the tape and reapply if doing another experiment
   c. Sweep out residual sand/soil with a small brush or paper towels. Dry the dish and chute.
   d. Setup as before, but alter the chute angle, house configuration, or other feature.

Additional Resources

Videos
When Nature Strikes - Landslides
https://www.youtube.com/watch?feature=player_embedded&v=dj44dpr80Hs
About a 5 minute video on landslides in Washington, specifically the one at Oso and near Mount Rainier. Features University of Washington scientist.

Nova’s “Killer Landslides” https://www.youtube.com/watch?v=VJ_ykqJuGl0
or http://www.pbs.org/wgbh/nova/earth/killer-landslide.html (2014)
53 minute video about landslides throughout the world and details about Oso landslide.

Tools
USGS website with lots of material! http://landslides.usgs.gov/learn/

International Consortium on Landslides (ICL) teaching tools (2014)

The Water Cycle and Climate Change
http://earthobservatory.nasa.gov/Features/Water/page3.php
Provides global maps of changes in precipitation intensity, stream runoff, and drought

Papers
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