TeachEngineering STEM curriculum for k-12
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MAKE YOUR OWN LANDSLIDE! (Grades 3-5)

QUICK LOOK

Grade Levels: 3-5

Time Required: 45 minutes

Full version: https://bit.ly/czoagi19

Subject Areas: earth science, geology, physics, critical zone science

Educational Standards: NGSS: Next Generation Science Standards - Science
More about Educational standards met: https://bit.ly/czoagi19

ACTIVITY SUMMARY

Earth's inhabited surface, known as the critical zone, is shaped by processes like landslides. To understand landslides, students use a small-scale model to explore how Earth materials (i.e., sand, gravel, lava rock) and water on varying slopes result in landslides of different severity. Students consider how the impact of natural hazards spawned in the critical zone affect their communities.

LEARNING OBJECTIVES

After this activity, students should be able to:

- Explain how different Earth materials affect landslide dynamics.
- Describe how landslide dangers are affected by slopes and storms.
- Describe how studying landslides allows scientists to determine where and when there are risks to buildings and people from landslides.

THE CRITICAL ZONE AND LANDSLIDES

We live in Earth's critical zone, where rock is altered by water, biota, and even air. Sediment and soil in the critical zone can move in dramatic ways during storms. For instance, a record-setting storm in Colorado in September 2013 unleashed more than 1,000 landslides, damaging roads and property.

Question: Why did landslides occur in some locations but not others?

Fourmile Canyon Creek near Lee Hill Drive in NW Boulder destroyed the road, carrying a van downstream, which created a dam for timber and sediment (photo credit Frederick Blume).

MATERIALS LIST

Each group needs:
- 1 model house template (link other side) printed on 1 sheet of cardstock
- Transparent tape, scissors, markers, crayons or colored pencils
- 2 small paper cups
- Mini-Landslide worksheet, one per student (link other side)

To share with the entire class:
- 2 ft section of plastic downspout (~$5)
- 1 bag small bag of sand (~$20), pea gravel (~$4), and volcanic (lava) potting rock (~$6)
- 1 large, shallow, plastic waterproof tub (8-in x 14-in x 30-in, ~$10-$20)
- Duct tape, scissors, ruler
- Stack of books, stool or chair, to support downspout
- Plastic scoop or small paper cup

BACKGROUND FOR TEACHERS

The critical zone is Earth's outer surface, from treetops to groundwater, a distinct environment shaped by organisms and essential to life. Landslides are one of many critical zone processes that affect our communities and shape landscapes. Sediment and soil formed in the critical zone can mobilize during storms or earthquakes, producing devastating landslides. Landslides, or the rapid downslope movement of sediment under the influence of gravity, occur when the balance between the pull of gravity on material on a slope and the forces (friction and cohesion) acting to hold it in place is upset. Common triggers are either increased water content or rearrangement of the load on the slope, such as earthquakes. Since it is difficult to observe and measure real landslides, U.S. Geological Survey engineers and scientists constructed a model flume (310 ft long, 6.6 ft wide, and 4 ft deep) in Oregon to conduct controlled experiments. A variety of materials (soil, rocks, gravel) are placed behind a steel gate at the top, saturated with water and released. Sensors in the flume measure sliding and colliding forces in the flows. Side windows allow flows to be observed and photographed as they sweep past. Measurements from this experimental flume help engineers create computer models to forecast debris-flow behavior and develop technologies to mitigate the destructive effects of debris flow from landslides. (https://youtu.be/F5OK_xUimFs)

This activity uses a small-scale version of the experimental flume to allow students to conduct similar experiments.

PROCEDURE

Note: Mixing water with the sand, gravel and lava rocks, can get messy and slippery. Conduct outside if possible.

BEFORE THE ACTIVITY

• Print the model houses template on cardstock.
• Set up the mini-landslide model activity. First cut the downspout in half so you have two equal sections. Tip: Cut through the narrow sides of the downspout to create the widest chutes.
• Duct tape one end of the downspout section to the bottom of the plastic tub, in the middle, to create a shallow angle (see Figure 1) Secure the top end of the downspout by taping it to a stack of books, stool or chair.

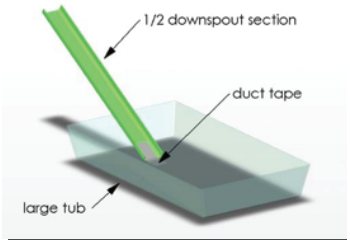

Figure 1. Pre-activity setup.

WITH THE STUDENTS

Note: It is best if the three materials and chute are damp when performing the trials. The materials react differently when wet. Damp materials produce greater uniformity in spreading.

1. Divide the class into three teams.
2. Have each team use the printed model house template to construct three houses per team. Label houses: 1, 2, 3 with the numbers on the rooftops.
3. Assign each team to one of the following materials: sand, gravel or lava rock. Note: Each group performs three trials with their material, assisted by the instructor, while the rest of the teams watch and record measurements on their worksheets.
4. For all trials: Clean off the runout zone (tub) and have students place their houses in three locations relative to the debris chute. Suggested locations: (a) 2" in front of and 2" to the side of the chute path, (b) 4" in front of and 2" to the other side of the chute path (c) 6" directly in front of the chute path (see Figure 2).

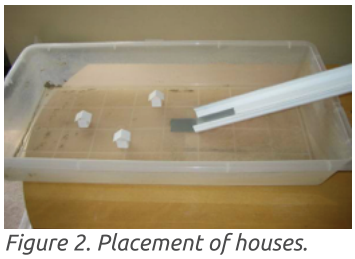
Figure 2. Placement of houses.

5. Ask the students to make predictions. Which of the model buildings will be "damaged" (moved from their original location, or worse) during each landslide trial? Have students record their prediction on their worksheets.
6. Note: For consistency throughout the experiment, make sure the sand, gravel or lava rock and the chute are already damp before the first trial begins.

7. TRIAL 1 EARTHQUAKE: Make sure the chute is at the shallowest angle allowed by the bin. Using a small paper cup, place one cup of damp sand at the top of the chute (see Figure 3). The material should not slide down the chute at this shallow angle.

8. Next, increase the angle of the slope until the material is on the verge of sliding. Then, simulate an earthquake, a common trigger for landslides, by gently shaking the chute. The material is not expected to go very far on this trial. It may not even make it out of the chute.


Figure 3. Placing material in the landslide chute.

9. Secure the chute at this angle by placing books (or a stool or chair, as necessary) under it and taping it in place. Prepare for the next trial with the same material.

10. TRIAL 2 SMALLER FLOOD: This time, place the material in the chute and pour a paper cup one-quarter full of water above the material. Observe what happens (see Figure 4). Have students record their observations on their worksheets.


Figure 4. Houses after trial using ¼ paper cup of water.

11. TRIAL 3 BIGGER FLOOD: The third trial is similar to the second, except with more water. Pour a paper cup half full of water into the chute and watch what happens. Have students record their observations on their worksheets.
12. Repeat the procedure with the other two teams for the other two materials.

13. CONCLUSION: Conclude with a class discussion comparing results. Have students share and compare their observations about which landslide scenario produced the largest runout and caused the most damage. How good were student predictions? Have students consider in turn the effects of steepness, of water additions, and of Earth materials on the landslide behavior. How can these observations be used to develop an analysis of where and under what conditions landslides might be expected, and whether some locations are safer than others? What factors would students use to create a landslide hazard map? As an extension, consider engaging students in thinking about how the sediment mobilized in landslides is generated by critical zone processes. How would students apply what they've learned to real-world landslide situations? Review students' worksheets to gauge their mastery of the subject.

LINKS:

This handout with extensions: https://bit.ly/czoagi19
Video: https://youtu.be/9oCWkElPK_4
Houses: https://bit.ly/czomodelh
Work Sheet: https://bit.ly/czosheet
Story: https://bit.ly/czonews13