Caltech Geological and Planetary Sciences Outreach Outdoors

***Note:** sections of the lesson plan template marked with * are optional, but may be useful for your planning.

Debris Flows around California	
Short Description	This is a classroom lesson where students will test hypotheses about debris flows (also known as landslides) using hands-on experiments. This classroom lesson can be offered in tandem with a field trip to a local debris basin. The corresponding field trip is visible on our “Field Trips” page.
Grade level	2-4
Standards	2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly. 2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. 4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. 4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
Goals	- Students will define a debris flow and discuss where they occur and what can trigger them - Students will test hypotheses on the factors that can change debris flow strength, such as dirt type, water content, and slope - Students will present the results of their experiments
Time	2 hours
# students	5-30 Experiments should be performed in groups, ideally 2-4 students.

Materials	- Print outs of images of debris flows or projector to show movies - Different textures of dirt (such as sand and potting soil) and plastic bins to store them—about 1 cup of each per group of students - Tap water—about 1-2 cups per group of students - Plastic downspout (~$5 at local hardware store) or pre-cut PVC pipe, cut in half lengthwise so it is a C-shaped tube—1 12” length per group of students - Large, shallow, plastic waterproof tub (for example, a large planter dish)—1 per group of students - Plastic cups to distribute water and dirt—4 per group of students, plus extras - Duct tape - Scissors (to cut downspout plastic) - Lego people, toy dinosaurs, or other models to put in the paths of miniature debris flows—3 per group of students
Caltech student needed?	Caltech student not needed. However, we have all of the materials stored in the GO-Outdoors closet.
Accessibility	This lesson involves visual observation. If students are visually impaired, pair them with partners who can describe observations out loud. Some fine motor manipulation is also involved in setting up the experiments. Group partners can help with physical experiment setup if needed.

Lesson activities

Engage: (30 min)

- As you enter, make the start of a word map with “debris flow” at the center. Draw branches connecting to the words “What,” “Where,” and “How.”
- Ask students who has heard of debris flows or landslides before and in what context. They may also have heard them called mudslides or landslides. Add relevant ideas to the word map.
- Begin by showing students videos, images, and news articles of debris flows and landslides

Links:

Mud Creek Landslide at Big Sur:
https://www.youtube.com/watch?v=GCSimHiFNDA&ab_channel=BrianMack

Las Lomas Canyon after Fish Creek Fire:
https://www.youtube.com/watch?v=OTuHQOHjC6Q&ab_channel=USGS

Orange County after Silverado Fire:
https://www.youtube.com/watch?v=VwPnKCx2SNM&ab_channel=USGS

- After watching the videos or looking at photos from the videos, work as a group to add more information about debris flows to the word association map on the board. Students can raise their hands to add words. It is important to include that debris flows need water and dirt. They typically occur during rainstorms and after fires, when plants can no longer hold the dirt on hillslopes in place.

Explore part 1: (60 min)
- Show students a video of the USGS debris flow flume to motivate their own experiments in understanding debris flows
https://www.youtube.com/watch?v=EUFSuKVnDLc&ab_channel=DanielGarc%C3%ADa-Castellanos
Example of USGS experiments with pure water and a mix of water and dirt.
- Split the students into groups and provide them paper handouts (attached below). Guide them to use the handouts to form hypotheses about the debris flow behavior.
- Once students have filled out their hypotheses, hand out materials for students to make their own miniature debris flows. Make sure the sand and other materials have been pre-packaged to distribute to the groups quickly.
- Guide students to test their hypotheses and write their observations on the handout.
- Each group will pick a team leader who will share their results with the class.

Explore part 2: (30 min)
- Clean up the experimental setups so they are not a distraction to students during a group discussion.
- Guide a group discussion of students' findings. Write different findings on the board.

Optional extension activities
- A field trip plan that corresponds to this lesson is available at
https://go-outdoors.caltech.edu/teachers/resources-for-teachers/field-trips
- Have students propose structures to stop debris flows. Students can construct their proposed structures and repeat Activity 1 with those structures built in miniature.
- If students have tablets or phones, they can videotape their experiments.
- Have students think-pair-share to brainstorm ways to prevent debris flows from damaging buildings around LA. Have students share their solutions. Then show students images of debris flow basins, dams, and other structures around LA that protect them from debris flows. Every canyon has a debris basin, so pick the one closest to their school.
Bailey Canyon Debris Basin:
http://history.lacountylibrary.org/digital/collection/p15952coll17/id/394

https://lacountylibrary.contentdm.oclc.org/digital/collection/p15952coll17/id/652/
Devil's Gate Dam:
https://www.latimes.com/socal/la-canada-valley-sun/news/tn-vsl-me-devils-gate-cleanup-20190228-story.html
https://geophile.net/FieldTrips/ArroyoSeco/stop05.htm
Highway netting in San Bernadino:
https://www.sbsun.com/2019/09/18/helicopter-hoists-huge-net-to-keep-rocks-off-highway-330-in-san-bernardino-mountains/
- Do a "4 corners" activity where students vote on their preferred solution by moving to a corner of the room for the most common suggestions. Write the question on the board and have each corner write their solution on a piece of paper. Then, have each corner discuss advantages and disadvantages of their solution. Each corner will pick a representative to share that with the class, and then do another vote by moving if students changed their preferred solution.
- Encourage walks/hikes with their family to local trails (e.g., Bailey Canyon, Arroyo Seco) that have debris flow catchments
- Link debris flows to other topics students are currently covering in class

***Instructor support**

Debris flows often occur following wildfires, and these events may be disturbing to students. Please be mindful that students may have negative personal experiences with these topics throughout the discussion.

This lesson was designed through the Caltech GO-Outdoors program, but teachers may offer this lesson plan without GO-Outdoors volunteers present. Instructors in the Pasadena area may contact GO-Outdoors to borrow our existing materials for this lesson if desired.

***Handouts**

See attached handout to guide student hypotheses and observations.

Name: _____

Debris Flow Experiment

Debris flows form from water and dirt and flow downhill. How do you think changing water, dirt, and slope will affect the speed and power of your mini debris flow? Fill in the blanks below with your predictions to create ***hypotheses***.

1. If the debris flow moves _____, then more of the dinosaurs will be knocked down.
faster / slower

2. If we add _____ water to the debris flow, then more of the dinosaurs will be knocked down.
more / less

3. A mixture of sand and water will knock down _____ dinosaurs than a mixture of soil and water.
more / fewer / the same number of

4. If we increase the slope of the debris flow, then _____ dinosaurs will be knocked down.
more / fewer / the same number of

Test one **hypothesis** at a time in an experiment. Fill out the chart below as you **observe** how your mini debris flows change as you change the amount of water, the kind of dirt, and the slope.

Make **observations** about how fast or slow the debris flows are moving, and whether or not they knock down your dinosaurs.

Experiment setup	Observations
1. Adding more or less water to the debris flow	
2. Making the debris flow out of sand and water vs. soil and water	
3. Increasing the slope of the debris flow	

Were your original hypotheses correct? Why or why not?