Slips and Slides

Grade: 4

Subject Areas:
Life Science, Earth Science, Physical Science

Skills: predicting, modeling, observing, investigating, describing

Duration: 1-2 hours

Connections:
geology, engineering, watersheds, physics

Vocabulary
Franciscan Complex
sedimentary rocks
shale
sandstone
erosion
landslide
mass movement
cohesion
friction
kinetic energy
potential energy
creep
slump

Objective:

Students will model a landslide using different materials to learn about geological forces associated with erosion.

Materials

- 1–2 foot wide boards w/ wooden borders
- 1 full coffee can or equivalent of different sediments (gravel, pebbles, sand, soil and rock)
- cups with holes in the bottom or watering cans
- large cups or cans of equal volume to hold mixtures sediments
- power point on landslides
- samples of local shale and sandstone
- materials to prevent erosion
- monopoly pieces (optional)

Standards

Strands: Excellence in Environmental Education Guidelines
Strand 1 — Questioning and Analysis Skills: B) Designing investigations: Learners are able to design simple investigations. **F) Working with models and simulations:** Learners understand that relationships, patterns, and processes can be represented by models. **G) Developing explanations:** Learners can develop simple explanations that address their questions about the environment.
Stand 2.1— The Earth as a Physical System: A) Processes that shape the Earth: Learners are able to identify changes and differences in the physical environment.
Strand 2.3 — Humans and Their Societies: D) Global Connections: Learners understand how people are connected at many levels—including the global level—by actions and common responsibilities that concern the environment.
Strand 2.4 — Environment and Society: A) Human/environment interactions: Learners understand that people depend on, change, and are affected by the environment. **C) Resources:** Learners understand the basic concepts of resource and resource distribution.

California State Educational Standards:
Earth Sciences (ES) 5a: Students know some changes in the earth are due to slow processes, such as erosion, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.
ES 5c: Students know moving water erodes landforms, reshaping the land by taking it away from some other places and depositing it as pebbles, sand, silt, and mud in other places (weathering, transport, deposition).
Investigation and Experimentation (I and E) 6c: Students will formulate and justify predictions based on cause-and-effect relationships.

Background

Loose Lands

In addition to living with frequent earthquakes, Californians also live with another geological hazard: landslides. Landslides certainly don't just occur in California, however. They occur in all 50 states from Hawaii to Alaska and end up costing over one billion dollars in damages every year. There are many types of landslides including rock falls and debris flows; some of which can be caused by volcanic eruptions. On the Northcoast of California, many landslides are attributed to earthquakes, steep slopes and high amounts of rainfall, combined with loosely compacted rocks. The dominant rock type here is called the Franciscan Formation or Franciscan Complex.

The **Franciscan Complex** is a mixture of several types of rocks, but is mostly made of sand and shale. These two kinds of rocks are sedimentary in origin and are loosely compacted. **Sedimentary rocks** are usually formed by the compaction and cementation of existing rocks and sediments. Sediments are classified by the size of particles from which they are made. **Shale** is mostly made of fine sediments like mud and clay. **Sandstone** is made of sand sized sediments. The Franciscan complex is partly associated with the San Andreas fault. As the Pacific plate moves northwards along this major fault it uplifts sea floor sediments which overtime has built the Coast Ranges. The Coast Ranges are young compared to other mountain ranges like the Sierra Nevada. The loosely consolidated sedimentary rocks that sit atop the Franciscan Formation along with frequent tectonic activity produce an area of instability.

Sliding Forces

As land slowly builds up from tectonic forces, erosional forces slowly wear it down. **Erosion** is the process that breaks down surface materials and moves them from one place to another. Erosion is caused by wind, water, and glaciers combined with the force of gravity. Running water is by far the largest erosional force. Over time, running water can carve away entire mountain ranges and gouge out deep canyons.

A **landslide** is the downward and outward movement of materialscaused by mass wasting or mass movement. **Mass movement** is the movement of materials caused by the force of gravity. It is effected by the degree of slope, the slope material's strength and cohesiveness, and the degree of friction acting upon the material. **Cohesion** is the attractive force between different materials. **Friction** is the force that acts upon two objects when they are touching each other. Water reduces the force of friction which is why saturated ground is more likely to cause a landslide.

As gravity pulls materials downwards it can do so at different rates. Wind and water will only erodematerials if they have enough energy associated with them. All energy can be considered to be either kinetic energy

Local Connection

One of the oldest and most prevalent rock formations throughout northern California is the Franciscan Complex. It dates back to the late Jurassic to Tertiary periods, approximately 50—100 million years ago. On top of these older rocks lay younger rocks, some of which belong to the Wildcat Formation Group. This mosaic of various geologic formations is mostly made of loosely consolidated sedimentary rocks and is well exposed south of Ferndale. Common sediments found here are mudstone, sandstone, conglomerate and shale.

Some sandstones associated with the Wildcat Formation posses marine fossils large enough to collect with a simple rock hammer. There are several places to find fossils including places along the Eel River, however, the favorite spot is along the Scotia Bluffs. Here the steep tilted bluffs reveal fossils dating back approximately one million years. Fossils found here include clams, scallops, and sand dollars. These types of fossils suggest a shallow marine environment with water 30 m or less.

or potential energy. **Kinetic energy** is the energy associated with movement. The faster something moves, the higher its kinetic energy. **Potential energy** is the energy associated with position. The higher the object, the greater potential energy it has. There is more potential energy associated with a rock 100 feet above the ground compared to sitting only one foot off the ground.

Landslides can happen on steep slopes or flat ground. The term landslide describes a wide variety of processes including slides, falls, creeps and slumps. A **creep** occurs when material slow shifts downhill. When mass movement occurs along a curved surface it is called a **slump**. Both of these features are commonly seen around Humboldt and Mendocino counties.

Roads to Rivers

Many things can trigger a landslide. Some natural causes are earthquakes, floods, and heavy rain. However, landslides can be a by-product of human activity as well like grading, filling, and excessive development. The maze of roads built mostly for logging access, is a major source of landslides in and around Humboldt County. Some studies show that 50-80% of the sediment reaching rivers is caused by road building. Road failures can cause both fine and coarse material to enter streams which is detrimental to salmon habitat. Sediment fills in pools and settles between spaces in the gravel used for salmon nesting sites. Sediment-filled gravel reduces available oxygen which chokes immature fish, called fry, and other aquatic organisms living there.

Adjacent to the Mattole River Watershed which is located in the King Range National Conservation Area (NCA) is the Eel River drainage basin. The Eel River has the highest sediment load per unit area of any stream in theUnited States. It brings down so much sediment based on its size that it is compared to much greater rivers like the Mississippi and Yangtze. The high levels of sediment are largely caused by landslides.

Humboldt County was hit hard by landslides during the 1955 and 1964 floods. The 1964 flood wiped out most bridges and many roads. These two flooding events could not have come at a worse time. This was a period following the post WWII logging boom and clear cuts dominated the landscape. This massive flurry of water sent tons of sediment into the nearby rivers and streams and caused hundreds of landslides. One huge landslide that happened during this event was a result of both logging and heavy rain. Over 40 feet of sediment filled portions of Bull Creek, a tributary of the Eel River, from a massive slide.

There can be many negative consequences associated with erosion. Landslides move sediment into rivers, buildings can be destroyed and roads can get washed out. As people learn about landslides and the human activities that promote them, we can do things to help avoid them. Today, better planning and management practices have been put into place in many areas of California to help reduce erosion. For example, great effort and expense is put towards better road building. We have learned that planting vegetation on slopes can slow down and absorb runoff. Road building has strict guidelines and logging operations may not be allowed during wet weather. The more we learn about this aspect of geology, the closer we get to understanding our natural world and all of its complexities.

Activity 1: An Investigation into Landslides

Preparation

You may need to separate the different sized sediments if collecting them locally using a sieve. Pour water into the watering cans and place them next to the boards in an outside location.

Materials

- 1 –2 foot wide boards w/wooden borders
- 1 full coffee can or equivalent of different sediments (gravel (pebbles), sand, soil and rock)
- cups with holes in the bottom or watering cans
- large cups or cans of equal volume to hold mixtures sediment
- samples of local shale and sandstone
- materials to prevent erosion (leaves, grass, fake turf, plastic, etc.)
- monopoly pieces (houses, people, etc) (optional)

Procedure

1. Begin this lesson by writing the definition of erosion on the board. Have the students write down five words that come to mind when they think of this word. Next, show a power point or other slide show on erosion and erosional features . Have the students write ten words that come to mind while watching the slide show. After this brief introduction, have them share some of their responses and continue to discuss erosion and landslides. Define the terms friction and cohesion. You may also need to define the word mass which is: how much matter there is in something. On earth we find mass by finding an object's weight.

- *What are some ways we can describe landslides?*
- *Who has observed a landslide?*
- *Has any body been inconvenienced from a landslide?*
- *What problems do landslides create?*
- *Where do slides occur generally? (grassy vs. forested, steep vs. flat)*
- *What factors might influence whether a slide will happen or not? (slope, friction, force, energy, etc.)*
- *What human activities add to the chance of a landslide happening? (land clearing, road building, improper culverts, etc.)*
- *What kinds of things can we do to reduce the chance of a landslide?*

2. Explain to the students that they are going to perform and experiment as a group to see what mixtures of sediment are most prone to sliding. The mixtures will be: sand/gravel, sand/rocks, gravel/rocks, soil/gravel, and soil/rocks. Before they begin, have the students make a prediction. Have each sediment labeled and placed in an area for students to see them. Ask each student to make a prediction for which mixture (not the lone sediment) will have the greatest chance of a slide, and for which mixture will have the smallest chance of developing a slide.

Activity 1 continued...

3. During the investigation, each mixture will be packed on the end of a tilted board as a "mountain". Next, water will be poured down it at different rates (light rain vs. heavy rain). Each group will get a different mixture but will use the same volume of material. Because there are five mixtures, five groups need to be formed.

4. Each student should be assigned a different role within their group. One student can make the mixture. Have a few of the students can make a "mountain" on one end of an inclined board. Another student can set up the board up at a predetermined angle. Another student can be the "rainmaker" by adding water to the slow when ready using a watering can. All groups should begin at the same time. Students are great judges. Have most gather around and make sure every group is performing the activity in a similar fashion. Every group should have their board tilted the same. Have them begin with a light rain. Look for a slide. Increase the amount of water and look for a slide. Record which mixture slid the most. If no slide occurs, have them increase the slope.

5. Next, tell the students that once they have performed the investigation, they are to make another mountain. This time they should try and prevent a slide from occurring. Have materials available for them to place onto their mountain. These objects may possibly reduce erosion like leaves, grass, artificial turf or plastic. In addition, they can place toy figures of people or houses on their mountain to see what happens to them. This activity is exploratory.

6. An option is to have the students photograph their actions and share it with the rest of the class at the end. As a conclusion, have the students either describe or draw what happened during their exploration.

- *How did the rate of rain influence land sliding?*
- *What other factors influenced land sliding?*
- *What methods and materials worked the best to reduce land sliding? How do these things apply to real life?*
- *What are some ways people try to reduce the threat of land slides?*

Extensions

- Compare weathering to erosion. Have the students design a way to model weathering.
- Have the students take pictures of local erosional features.
- Invite a Cal Trans worker or other road worker to explain how they build roads to reduce erosion.
- Plant trees along a stream bank to help reduce erosion.
- Review the salmon cycle and have the students write a story from the salmon's point of view. Their story should include some of the obstacles a salmon might face throughout its life.
- Watch the 1964 Flood movie about flooding in Humboldt and other northern counties.

References

Geology, Coastal Watershed Program, http://coastalwatersheds.ca.gov/Watersheds/NorthCoast/SaltRiver, 2011

Geology of the Humboldt Area, Field Trips by Ellin Beltz, http://ebeltz.net/fieldtrips/humgeol.html, 2008

Landslide type and processes fact sheet, http://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html, July 2004

Lesson: Land on the Run, http://www.teachengineering.com, 2011

Landslides, http://www.uen.org/Lessonplan/preview.cgi?LPid=15092, 2011

Landslides: http://www.ussartf.org/landslides.htm, 2011

Lisle, Thomas E. The Eel River, Northwestern California: High sediment yields from a dynamic landscape, http://www.fs.fed.us/psw/publications/lisle/lisleGSA90.pdf

Roads and erosion: http://www.krisweb.com/watershd/roads.htm, 2011

Virtual Fish Tent: Flood, http://eelriver.org/outreach/tent-flood/, 2011

FOSS Connection

Grade 4

Earth Science: Earth Materials

Alternative Modules:

Matter and Energy