THIS LAND IS Your Land

Hands-on activities and demonstrations using readily available materials help students learn how to prevent soil erosion.

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<< back

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Feature

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Soil is all around us, in fact there is so much of it that we often don't think of it as a valuable natural resource, and we might even take it for granted! We rely on its productivity for our food and fiber and its firmness to support our buildings and roads. Rain and wind can cause soil loss or erosion when there are no plant roots or surface cover to keep soil in place. Farmers want to prevent erosion to preserve high-quality topsoil that contains organic matter and provides nutrients for crops. Construction and some forestry techniques can lead to erosion that causes the negative effects of sediment buildup in waterways, damage to land and structures due to runoff, degradation of water quality, and reduced air quality because of wind-borne soil particles. We can conserve soil and reduce rates of erosion by planting grass, trees, or other plants to protect the soil from movement. Farmers can reduce erosion by planting with little tillage (digging) and leaving crop residues on the soil surface.

With this series of active-learning exercises, your students will practice scientific inquiry while learning about soil as a valuable resource. After demonstrations on the amount of soil covering Earth and how it is retained/eroded, students work creatively as "farmers" to prevent soil erosion and save their farm, learning about a real-world problem. These lessons are appropriate for students in second through fifth grades. These exercises can be completed in about 35 minutes combined, but don't be surprised if the students have so much fun building their farms that they want to do it again!

SCILINKS
Explore the topic of Soil

Our Thin Layer of Soil

Adults and children alike enjoy this visual example of just how little soil we have to produce the crops that feed us and feed the animals that provide food and clothing for us. The materials needed are two apples of similar size and a sharp knife. An adult should do this demonstration and keep the knife away from students.

CAUTION

Begin by showing students one apple to represent Earth. As the demonstration progresses, each apple slice will represent different portions of Earth. Prompt older students to guess the fractions represented by each slice. With younger students, we focus on the size of the apple and place less emphasis on the proportional math. The procedure is as follows:

1. Slice the apple into four quarters. Three-fourths of the apple represents water—set aside.
2. Slice the land quarter in half, giving two 1/8 pieces. One-eighth of Earth is inhospitable to people (polar ice caps or mountain peaks)—set aside; 1/8 of Earth is the land area upon which people live and grow crops.
3. Slice the 1/8 portion in half, giving two 1/16 pieces. One-sixteenth of Earth is too cold, wet, rocky, or dry to grow anything, especially food crops—set aside; 1/16 of the Earth can produce food for humans and animals.

4. Slice the 1/16 in half again, giving two 1/32 pieces. One thirty-second of Earth is covered with highways, parking lots, malls, houses, and cities, so we are left with only 1/32 of Earth that can be used to grow food for humans and animals.
5. The soil that we can use to grow food is even less. Carefully cut the peel off the 1/32 section, and compare it to the whole apple. This represents the surface of Earth and the soil that is used to grow food for humans and animals. We grow food in the top couple feet (that’s less than one meter!) of soil surface.
6. Ask students why soil is important to us. Students will volunteer that we grow food in soil. Discuss that almost all food is grown in or raised on soil. Ask the students where hamburgers, french fries, and milk come from. Cattle and dairy cows graze on plants growing in soil. Ask students how large they think Earth’s population is (about 6.5 billion people). Reinforce that the 1/32 section is all we have to feed Earth’s population, and that the population continues to grow, but the 1/32 slice will never grow any larger; so it is the responsibility of all of us to protect the soils of the 1/32 slice. Point out careers in soil science, agriculture, and engineering. Agricultural scientists want to learn more about soil to help people protect their soils and grow crops.

Plants Make the Difference!

Now that students have an idea of the small amount of soil available for farming, they can see another demonstration that shows them how this soil is conserved and what detrimental effects can occur if it is not.

Discuss the causes of erosion with students. Ask if anyone knows whether soils move; if so, how? Does anyone know what erosion is? Erosion is the movement of soil due to wind, water, or other means. Talk about how one of the ways soil can move is by the force of water from rain runoff. Ask what happens to rainwater. Rainwater is absorbed into the ground or flows across the surface of the land as runoff. What is carried with the water? The answer is soil. This movement of soil by rainwater is erosion. Where does the soil go? The soil is moved from the fields growing our food into ditches or roads and then into the rivers, where it cannot be used to grow crops. Ask students what they think keeps soil from washing away (plants and plant roots). Maintaining plant cover on the ground (and intact plant root systems below-ground) is the most effective way to prevent soil erosion. In this demonstration, the water we apply to the shoeboxes demonstrates how rainwater can erode soil. Students collect and compare “runoff” from a shoebox “soil system” and also make the connection between soil erosion and water quality.

Ahead of time, you will need to prepare three plastic shoeboxes of the same size using regular garden soil to fill boxes two-thirds to three-quarters full. (You’ll need about 3 L of soil per box.) Soil from a garden or lawn works best if you are sure it is not contaminated. Potting soil does not work as it sometimes contains perlite, which floats, but you can buy sterile garden soil inexpensively. No matter what type of soil is used, make sure students wash their hands after the activity. Boxes need to contain soil with varying degrees of plant cover: loose soil with no plants growing and no cover; soil with no plants growing and some type of cover (either straw or dried leaves); and intact soil with plants having well-developed root systems, like lawn sod. We cut a piece of sod from a lawn. The lawn sod works the best because an extensive root system has developed. On the day of the demonstration, you will need:

- Four 500 mL clear plastic containers—one to deliver water to the shoeboxes and three to collect the runoff;
- Three 5 cm × 10 cm blocks about 15 cm long; and
- A sink or washbasin to collect excess water.

A designed landscape before water was applied.

Photograph courtesy of the authors

This demonstration may be set up ahead of time. Begin by placing one end of each shoebox on a block so that the shoebox is on a slant and one end is 10 cm high. Measure 250 mL of water in a beaker. (The amount of water needed to create runoff will vary depending on the moisture in the soil and could be 150 to 500 mL or more. It is best to do a test run. It is not necessary to let the soil dry out after your test, just make sure there is no standing water on the soil surface.)

Discuss with students that you are using the same amount of soil and the same amount of water so that you will have a *fair test*. Have students predict what they think will happen and what the runoff from each of the three boxes will look like. Most of the students can reason that the exposed soil will wash away with water, but not all will be sure that surface residue can divert the water and cause less soil to move. The students also are not sure that the roots will hold the soil.

A designed landscape after water was applied.

Photograph courtesy of the authors

Pour the 250 mL of water at the elevated end of each shoebox, in the center and at the same height above the box, again pointing out that the procedures must be the same for a fair test. Have student volunteers collect the runoff water into a clear container. The students will record the volume of the water and what the runoff water looked like (i.e., clear, a little muddy, or very muddy).

The box containing plants with an intact root system will show less soil in the runoff water compared to the soil with minimal covering and the bare soil, which will have very muddy runoff. Ask students which type of soil system they think would result in the least erosion. Most students can visually see the amount of soil in the containers. They are ready to move onto the next activity when the class agrees that the best way to hold soil in place is by roots or some surface cover. You can also discuss how other features of the land (i.e., rocks, hills) might affect erosion.

Next, ask students how erosion might affect bodies of water. For example, which beaker of water would you want to swim in if you were a fish, and why? (Note this may depend on the type of fish—catfish prefer muddy water, for example.) What type of runoff would you want if you were a farmer—emphasize that farmers want to keep their soil on the land—this leads into the next activity.

Protecting Farmland

Now students are ready to put their knowledge about erosion to the test. Let students know that now they will each have a chance to be “farmers” with their own “farm” and protect their buildings. In this activity, students are responsible for designing and building a farm on their own land—a plastic shoebox filled with sand. (Sand, being more dense, is easier to work with and easier to clean up than soil or potting material.) The objective of this exercise is to protect the buildings and crops of the farm so that they are not flooded or washed away. This exercise illustrates the importance of root systems and landforms (rocks) in protecting soil. Most of the students can reason that the rocks will divert the water, but not all will be sure that the roots will hold soil.

Provide each student or pair of students with a plastic shoebox partially filled (two-thirds full, about 2.4 L per box) with moist sand and one 5 cm × 10 cm block about 15 cm long. Provide each student or pair of students the following landscape objects:

- 5 buildings representing the different buildings on a farm, such as Monopoly houses or blocks of styrofoam or light wood about 2 cm square;
- 4 to 5 rocks of different sizes to represent boulders or hills;
- 2 to 3 pieces of old sod, pompoms, artificial turf or doormat from a discount store cut in 3 to 5 cm square pieces to represent roots of a growing crop or plant;
- 2 to 3 pieces of Spanish moss or straw pieces from a craft supply store that will represent surface residue or bushes; and
- 3 or 4 trees from plastic floral arrangements or Christmas garlands. They work best if they have some part that can be used as roots. Pine garlands can be used as trees with roots.

Finally, you will need:

- Water;
- 500 mL containers for each student or pair of students;
- Big tubs or trays to catch water if working indoors;

- Paper towels for cleanup; and
- Data sheets.

The procedure is as follows:

1. The students place one end of their shoebox “farm” on a block about 10 cm high. The uphill end will be where the “rainwater” is poured. Students need to leave about 5 cm at the top and bottom with no landscape pieces for the water to collect. The students should think about which material would best protect their buildings and crops, while diverting the water or holding soil. Some students will want to dig drainage ditches to protect their farmstead—that is not allowed! Any sort of a ditch diverts water away from the landforms and students fail to understand the purpose of the exercise; also this is not widely practiced in real life.
2. The students then arrange the pieces on the surface of the soil. Buildings should be placed on the soil surface and not clustered together. The only pieces to be embedded in the sand are the sod, rocks, and the “roots.”
3. The students draw a diagram of the farm on a data sheet. They should make predictions of what will happen when the water is poured, what will stay where it was placed, and what will move.
4. The students measure water in a beaker (150 mL). (The amount of water required to create runoff depends on the amount of moisture you add to the sand. It is a good idea to perform a test run ahead of time to make sure that the volume is enough so that water drains into the bottom of the shoebox). The water is poured in the middle of the uppermost portion of the shoebox in a steady stream, using the same procedure as in the previous demonstration. If time permits, have students pour the water one shoebox at a time so they can observe each other’s results. They should complete their data sheets by drawing an “after” diagram of the farmstead.

The activity is followed by a discussion of the results. The students describe what happened to their landscape and if it was what they had predicted would happen. Discuss the importance of plants and roots in reducing erosion. The aboveground part of plants can reduce the force of rainwater hitting soil and reduce runoff. Roots can either hold the soil in place or absorb water to reduce the amount of water running off. In turn, plants rely on the soil for air and water the soil provides to grow. Students can redesign their farmsteads and repeat the experiment. Additional dry sand may need to be added to soak up standing water.

A successful farm would be one where students were able to protect their crops and buildings from being washed away. It is interesting to listen to students comment about their own farms, backyards, and what they have seen on television. There is usually one student in every group that tries their best to have their buildings wash away! In that case we use that as an example of what didn't work, while asking students to point out the things that did work best. We end by tying all three activities together with student self-assessment questions (Figure 1).

Figure 1.

Assessment questions.

1. What can you do to help stop soil erosion at your house or on your farm?
   Plant trees or grass
2. If a farmer came to you for help in stopping erosion on their land, what would you tell them?
   Try not to till or dig up the ground, and leave some plant material on the soil surface.
3. What was the most important thing you learned today?
   That there isn't very much soil to feed all the people and animals on Earth, so we need to take care of what we have.
4. What part did you most enjoy? Why?
   Seeing how to protect farms. Liked getting dirty; liked seeing the houses flood and move.
5. What other questions do you have about soil erosion or soil conservation?
   What are other ways to protect houses?

Encourage students to observe their backyard or the landscape as they drive with their parents. Notice the color of the water of a nearby stream or waterway after a heavy rainstorm. Do they see any examples of erosion? How might they apply what they learned from this activity to protect soil?

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Resources

National Research Council (NRC). 1996. *National science education standards*. Washington DC: National Academy Press.

Connecting to the Standards
This article relates to the following National Science Education Standards (NRC 1996):

Content Standards
Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry (K–8)

Standard D: Earth and Space Science

- Properties of Earth materials (K–4)
- Changes in Earth and sky (K–4)
- Structure of the Earth system (5–8)

Standard F: Science in Personal and Social Perspectives

- Types of resources (K–4)
- Changes in environments (K–4)