

Land for Life

Soil Stewardship

Respect Rule: Look, Listen, Learn, and Leave Alone (until instructed).

Overview

“Soil supports life and life enriches soil.” (California Framework). If people take care of the world’s soils, the earth will continue providing food and shelter to people for many generations and will continue supporting all life in balanced ecosystems. Soil is a part of that balanced ecosystem. Topsoil is the most biologically active and nutrient rich top layer of soil. Soil is degraded because people often do not understand soils and how they act under various conditions to prevent erosion. People can participate in soil conservation practices and teach others to do so. Acquiring an understanding of soil and its value to life is the beginning to the stewardship.

Background

Erosion

Erosion is the process by which wind and water remove soil from one area and carry it to another area. Each year 6.4 billion tons of soils are eroded from land in the United States. This amount would fill 320 million dump trucks, each carrying 20 tons of soil. Erosion happens naturally, but people do many things to soils that increase the amount of erosion that takes place. For example, when trees are removed, roots no longer hold the soil. The soil then becomes more susceptible to erosion. In addition, plant leaves and stems are no longer there to slow down and block the force of rainwater as it falls. As raindrops hit the ground harder, some of the soil is loosened and eroded. As a result, large amounts of soil are quickly washed away in a storm.

Some farming practices leave the soil susceptible to erosion. In the 1930s, most American farmers in the Midwest did not practice soil conservation. Many were not aware of conservation practices as they are today. Rangelands were overgrazed leaving topsoil exposed. Drought-resistant natural vegetation was plowed under and replaced with crops that required more water for growth. Then drought

conditions killed crops, and no vegetation was left to hold the soil in place. When the winds started to blow, all of the dry, unprotected soil blew up into the air in big dust storms. The wind and dust storms resulted in what became known as the “dust bowl.” Entire farms were ruined because of soil erosion.

Overgrazing by sheep and cattle also intensifies soil erosion. Land areas have a capacity to maintain a specific population size of various species. If too many animals are forced to graze in an area, too much vegetation is eaten. Stripped of soil-holding vegetation, the soil erodes into the streams and rivers, polluting them with sediment.

Tires from off-road vehicles, including dirt bikes (motorcycles), mountain bicycles, and four-wheel-drive cars and trucks, uproot and destroy vegetation, allowing wind and water to erode the soil. Fragile desert soils are particularly susceptible to such erosion. Because of the harsh conditions in the desert, plant communities take a very long time to become established. Forest soils are also destroyed as off-road vehicles create paths up the mountainsides. These paths collect and channel water, accelerating erosion. In an effort to address the problem, public agencies have designated specific areas for use by off-road vehicles. In other designated areas, their use is prohibited.

Erosion is not only devastating for the area where the soil originates, but it also becomes a problem for the area where the eroded soil is finally deposited. When water washes soil away, the sediment runs into streams, rivers, and lakes, eventually causing sedimentation of waterways. Sedimentation can harm the plants and animals living in the streams and rivers by making the water cloudy and muddy. The gills of fish and other animals become clogged by soil particles, and these animals often die from suffocation. In addition, the stream or river becomes shallower and warmer, to the detriment of cold-water fish and fish eggs. Many insects that cold-water fish eat cannot survive in warm water. Sometimes there is so much eroded soil



Objectives

Student will:

1. appreciate the valuable role soil plays in our lives and life on earth in general;
2. identify the makeup of soil as living and nonliving things and analyze and compare soil in a variety of locations;
3. recognize that soil is necessary for most terrestrial plants to complete their life cycles as well as for some animals and many insects;
4. recognize how the quality of soil can be diminished by human action through erosion, compaction and pollution.

Grade Levels

5–8

Adult/Student Ratio

1 to 20

Where

School grounds

Skills

Observing, exploring, comparing, sorting, recording

Key Words

Soil
Texture
Organic matter
Loam
Compaction
Silt
Pollution

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**Keep it,
guard it, care
for it, for it
keeps man,
guards man,
cares for
man. Destroy
it, and man
is destroyed.**

—Alan Paton
Cry the Beloved Country

in waterways that sediment, sand, and gravel bars form. When these bars become large, the waterways dam up, forcing the running water into the stream banks and causing stream bank erosion. Dammed waterways are extremely harmful to the aquatic ecosystem. They also make the water-ways difficult for humans to navigate. Although intended to clear sedimentation out of the waterways, dredging often creates additional problems for aquatic ecosystems by altering the habitats of aquatic life.

Compaction

Accelerating the erosion process is not the only way people change soil. People also cause soil to become compacted. Plants have a difficult time growing in compacted soil because the size of pore spaces is reduced, restricting water to and aeration for plant roots. As a result, root growth is inhibited.

Tires from heavy farming equipment on farmlands or recreational vehicles on deserts, grasslands, and forests, along with overgrazing by livestock, can compact soil. However, soil compaction is most common in cities, where the soil is flattened and usually covered with pavement.

Since compacted soil does not absorb water very well, the water table might not be replenished as quickly as before. If the soil gets too compacted, rainwater will not be absorbed at all. Instead, large sheets of water will run over the top of the compacted soil, washing it away little by little.

Pollution

People change soil. When farmers and home owners use pesticides, the pesticides often remain in the soil. After some time the pesticides in the soil can build to hazardous amounts, killing the living things in the soil such as bacteria and other decomposers that decompose organic matter and help in the recycling of nutrients. People also change the soil by adding waste through the creation of dump sites and landfills. If hazardous material is dumped in waste sites, it can sterilize the surrounding soil, making it no longer capable of sustaining plant and animal life.

Working Together

Presently, numerous organizations and public entities are working together to attempt to solve or reduce problems associated with the

degradation of soil. Students can help to alleviate some of the problems associated with soil erosion, compaction, and pollution.

Neither sand, dirt, nor dust alone is considered to be soil. Soil is part of a balanced ecosystem. Soil is the surface layer of earth, supporting plant life. Typical soils are made up of rock particles, water, air, organic matter (which was once living), and living things such as earthworms, centipedes, ants, beetles, and microorganisms (bacteria, fungi, algae). Topsoil is the most biologically active and nutrient-rich top layer of soil. Good topsoil is usually dark, moist, and crumbly. It provides the essential materials for plants, including the food crops farmers grow.

The exact composition of soil varies from one area to another. An “average” soil sample is composed of 45 percent minerals (clay, silt, sand, gravel, and stones), 25 percent water, 25 percent air, and 5 percent organic matter (both living and dead organisms). Mineral particles of different sizes give soil its texture. Therefore, texture refers to the size and shape of the individual soil particles as well as the proportion in which they occur.

Before-the-Field-Trip Activities

Activity 1: What is This?

Time: 30 minutes

Materials: Two cups of topsoil from a garden, field, or along a fence; two cups of sand

1. Lead the students outside with cups of topsoil and sand and ask them to form a circle.
2. The cups contain a very precious substance. Ask them to close their eyes. “Something” will be placed in their outstretched hands. It will not hurt them but in order to play this game, they must keep their eyes closed.
3. Give each student a teaspoon full of topsoil.
4. Encourage students to describe how it feels. Ask students to identify what it is. Ask students to open their eyes and feel, smell and observe it.
5. Put all soil back into container.
6. Conduct a similar exercise using sand for students to feel, smell and observe.

7. Back in the classroom, have students compare the difference between topsoil and sand. Examples are:

Topsoil	Sand
wet	dry
moist	light
dark	scratchy feeling
crumbly	falls apart
stays together	

Activity 2: Separating Soil

Time: 1 hour

Materials: Several sponges and/or towels, quart jar with lid. *Provide to each pair of students:* transparent container (cup with lid), ¼ cup of potting soil, one or two magnifying lenses, strainer or piece of screen, coffee filter, teaspoon, paper towels, blunt-ended tweezers, one cup of water, KWL (complete on “What’s in Soil,”), What’s in Soil Teacher Worksheet

1. Assess the students’ understanding by constructing a KWL (complete on “What’s in Soil,”).
2. Tell students that they will have an opportunity to figure out a way to separate soil into its parts. Then do the following:
3. Have students spread newspapers over their work area and provide student materials.
4. Allow students several minutes to explore with the magnifying lenses.
5. Instruct students to separate the soil into different components or parts. They can use paper towels on which to place different soil parts. Some students will use tweezers to select large particles. Some might place the soil in water to see if it will separate.
6. After students have had opportunities to separate their soil, conduct a sharing session. If students have not used water to separate various particles, complete the teacher demonstration described below. Whenever possible, encourage students to come up with the various steps on their own. They can do their own demonstrations using two teaspoons of soil, their transparent container with lid, and about one-half cup of water. Students can stir the soil and water instead of shaking their jars.

7. Have students draw and label the soil separation.

Teacher Demonstration of Soil Separation Using H₂O

1. Place one cup of potting soil in a quart jar three-fourths full of water, cap the jar, and shake it at least twenty times. Note whether air bubbles are present.
2. Allow at least an hour for the particles to settle. The soil will separate into two or more layers.
3. The visible items floating on top of the water can be skimmed off and placed on a paper towel to dry. These particles are plant parts and other organic matter (material that used to be living).
4. The muddy water below the floating layer can be filtered and allowed to dry. Clay particles can be observed on filter paper.
5. Next, remove the evident layers under the water. This can be done by carefully spooning out each layer on a different paper towel.
6. The topmost layer below the water is most likely silt. The next layer with coarser grains is most likely sand.
7. Conduct a similar demonstration with topsoil and with soil from the school grounds. Note that after the soil settles, some gravel, pebbles, and stones might be present on the very bottom of these containers. Have students compare the layers of the topsoil to the potting soil.

Activity 3: Does Soil Contain Water?

Time: 20 minutes

Materials: Paper towels, jar, potting soil, piece of plastic wrap

Method 1: Press a soil sample between pieces of paper towel; students should see and feel the moisture remaining on the paper towel.

Method 2: Fill a jar about one-third full of potting soil and cover the mouth of the container with plastic wrap. Set the jar in the sun or other warm place. After several hours, observe the water drops which have condensed on the plastic inside the jar.

Activity 4: Observing Soil**Time:** 1 hour**Materials:** KWL from Before-the-Field-Trip Activity 2. *For each group:* a tablespoon, newspaper, two magnifying lenses, Soil Chart Student Worksheet, transparency of Soil Chart for class presentation, one tablespoon each of soils from containers of soil: Container A—sand; Container B—topsoil such as from a garden, field, or along a fence; Container C—school ground soil but not from a garden area

1. Ask students to help list some components of soil: air, water, rock particles such as clay, silt, sand, and gravel. Note that living things have not been found because commercial potting soil is usually sterilized, often by heating, to kill bacteria and other living things. This is done to keep pests and diseases from affecting the plants that are planted in this soil.
2. Set out soil sample containers A, B, and C. Tell students that different areas have different types of soil and that they will now observe three samples of “soil.”
3. Have groups spread newspapers in their working areas. Provide at least two magnifying lenses to each group.
4. Distribute a “Soil Chart” to each group.
5. Ask one member of the group to acquire one tablespoon of soil “A,” one tablespoon of soil “B,” and one tablespoon of soil “C,” for their group. Each sample should be placed in the top box on the “Soil Chart” sheet.
6. Ask students to observe the soils with magnifying lenses and to feel and smell each sample.
7. Brainstorm some descriptive words which might be applicable for the soil chart and write them on the board. For example:
Color—dark brown, light brown, yellow, orange, gray.
Feel—damp, dry, smooth, sticky, bumpy. Introduce students to the feel and definition of “texture” (rough, smooth, bumpy, squashy sticky). To feel the soil’s texture, have students add a little water to the soil and rub it between their fingers. If it is smooth and/or sticky, it is mostly clay or silt. If it is rough or loose, it is mostly sand. For comparison consider providing a cup

of sand, some modeling clay, and loose “dirt” from the school yard, which is often made up of silt.

Smell—sweet, pleasant, unpleasant. (It is interesting to note that the English words that describe smell are limited compared with those describing sight and hearing.)

8. Help students fill in one column in their “Soil Chart.” Then ask groups to complete their “Soil Chart.”
9. Encourage students to share their findings: What things did you see in the soil? Which soil seems to have the most components of rich topsoil? Good topsoil is usually dark, moist, and crumbly. It has particles of rock, a variety of living things, as well as material that was once living. The most desirable agricultural soil is loam, a mixture of sand, silt, and clay. In which soil might most plants grow best? How is it different from the other two soils? In which soil might plants grow the worst or even die? How is it different from each of the other two types of soil?
10. Have students clean up.
11. Revisit the KWL from Before-the-Field-Trip Activity 2. Encourage students to help complete the KWL and delete items listed they know not to be true. Make sure students understand that soil is not just a place where there is no grass or “the stuff we walk on.”

Extensions

1. Use the list of words generated in the lesson that describe soil. Write a haiku together using this list. A haiku is a Japanese style verse, often written about nature, containing three lines:
 - The first and third lines contain five syllables.
 - The second line contains seven syllables.

*Cool, dark, moist, and soft
I feel the soil in my hand
Living things need it.*
2. Discuss the difference between soil and dirt. Students might also want to compare the definition of soil with the definition of “earth” and/or the definition of “ground.”

Human Impact on Soil Field Trip Activities

Preparation

1. Locate areas on or near the school grounds that contain evidence of:
Erosion (gully by road cuts, vacant lot with water depressions, bare soil)
Compaction (very hard soil)
Land or soil pollution (such as a littered area)
2. Prepare two plastic two-liter beverage bottles in the following way.
 - Cut the container in half cross-wise. Tape the rim of each half with masking tape to prevent injury.
 - Poke the same number of holes in each cap
 - Keep the bottom portion of the container to use as a catch basin.
 - Piece of butcher paper

Materials: Unsharpened pencil for each pair of students, four cups of water, two cups of compacted soil, two cups of loose topsoil, two-cup measuring container, ripe banana and a lump of modeling clay, four-inch pot of soil with a plant growing in it (the plant should have an established network of roots that hold the soil, half-gallon milk carton containing 3½ cups of soil, one two-liter beverage container full of water, piece of cardboard to use as a fan

Field Trip Activities

Activity 1: Observation

Time: 1 hour

Materials: Pencils, journals

1. Tell students that they will be going on a 10-minute campus walk to observe areas of the school grounds where soil has been affected (changed) by humans. Remind them that the observing process is looking closely, noticing things from different viewpoints and quietly watching without much doing. Remind the students to breathe and to take time to use all of their senses to interpret the world around them.
2. Have students list or draw their findings in their journal. Encourage students to share their journal entries recording responses on the board.

3. Write the three words: compaction, erosion, pollution. Have students discuss the meaning of these three words.
4. Sort the responses into three categories.

Activity 2: Compaction

Time: 1 hour

Materials: Unsharpened pencils per pair of students, ripe banana, lump of modeling clay, two plastic two-liter beverage containers, two cups of topsoil, two cups of compacted soil, water

1. Demonstrate by using an unsharpened pencil pressed into a ripe banana versus a lump of clay. The compaction of soil is like pushing a pencil, with the palm of hand, into a ripe banana, a lump of clay or in between.
2. Lead students outside to pre-selected location and model a compaction test. Have students perform the compaction test in several areas on or around the school grounds. They may work in cooperative groups, pairs or individually to investigate the campus area for soil compaction by pushing an unsharpened pencil (tool) into the soil and recording their findings in their journals.
3. Bring the class together and instruct students to sit in a circle. Have students comment on the difficulty of pushing a pencil into compacted soil.
4. Ask students to think about and share the reasons why the compacted soil is not good for plants to grow in. The soil is too hard for plant roots to grow easily. Compacted soil has less pore space so it contains less air and water.
5. Outside or in classroom complete the following demonstration:
 - Cut the two plastic two-liter containers in half (vertically). Tape the rim of each half with masking tape to prevent injury. Poke the same number of holes in each cap. Keep the bottom portion of the container to use as a catch basin.
 - Invert the top half of the beverage container so the spouted end is on the bottom.
 - Make sure that the cap is screwed tightly.

- Place two cups of loose topsoil in one prepared two-liter size beverage container.
 - Place two cups of soil from a compacted area in the other container (make sure the soil is also compacted in the container).
 - Place or hold the bottles over the bottom halves of the cut-out portions of the containers to act as catch basins.
 - Pour two cups of water into each container and observe the results.
6. Encourage students to form a conclusion based on what they observed. Compacted soil loses its ability to absorb water.
 7. Have students compare the ease of compacting dry and moist soil. Explain that the moisture content of soil affects how compact the soil can become.

Activity 3: Erosion

Time: 1 hour

Materials: Four-inch potted plant, pieces of cardboard to use as fans

1. Show students a four-inch potted plant and gently remove the pot.
2. Have students observe the root structure of the plant. How do roots keep soil from eroding? The live plant holds the soil together with its roots. The soil anchors the roots. The soil and roots slow down the water, preventing the soil from being washed away.
3. Review the definition of erosion with students. Explain that they will be going outside to locate areas where soil has been eroded.
4. Lead students to the general area of the erosion example and ask students to locate evidence of erosion.
5. Ask students to verbalize how they know soil was eroded in this area and what probably caused the erosion—wind or water?
6. Ask students to recommend something that could prevent further erosion of soil.
7. Ask students to observe and compare what happens when students fan two soil areas, one uncovered and one covered with vegetation. Instruct half of the class to line up in an area of bare soil, crouch down, and use a piece of cardboard to fan the ground in the same direction and away from their faces.
8. Then have the other half of the class line up at an area covered with vegetation, crouch down, and use a piece of cardboard to fan the ground in the same direction and away from their faces. Discuss wind erosion and the difference they observed between the two areas.
9. Bring the class together and have students sit in a circle. Discuss with students why people might allow soil to erode: They do not know that what they are doing will cause erosion; They do not care; They do not believe that what is recommended to them will keep the soil from getting eroded or compacted; It costs too much, and they do not want to do it or do not have the time to do it.

Activity 4: Pollution

Time: 1 hour

Materials: None

1. Review the definition of pollution with students. Tell them that they will be going outside to locate areas where soil is being polluted. Pesticide, oils and other contaminants from farms and households, often pollute the soil. After some time the contaminants can build to hazardous amounts, killing the living things in the soil such as bacteria and other decomposers that decompose organic matter and help in the recycling of nutrients. People also change soil by adding waste through the creation of dump sites and landfills. If hazardous material is dumped in waste sites, it can sterilize the surrounding soil, making it no longer capable of sustaining plant and animal life.
2. Lead students on a walk of the area around the school grounds and have students identify ways the land or soil is being polluted. Look for litter, evidence of motor oil spilled on soil, etc.
3. Arrange students in a circle and ask them if they believe that land pollution is a problem in this area and to explain why or why not. If it is a problem, ask them to think about and share what they can do to help solve or lessen this problem.

After-the-Field-Trip Activities

Activity 1: How Has the Soil Been Affected?

Time: 45 minutes

Materials: Pencils, journals

1. Have students identify ways the soil on the school grounds has been affected by humans.
 2. Then have them compare their answers with their journal entries at the beginning of the lesson and discuss and support any changes they would make concerning their preconceptions.
 3. Guide students in recording their findings in their journals through pictures and notes.
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Activity 2: Stewardship of Soil (S.O.S.)

Class Project

Time: 45 minutes

Materials: None

1. Lead students outside and have them sit on the ground, preferably on a lawn. Allow students to feel the soil under the lawn with their fingers and feet (bare feet).
2. Explain because of technology and the places where people live, in recent times many people have lost touch with soil and the earth. Many do not seem to understand the connection between their survival and soil. Nor do they realize the impact hazardous chemicals, like pesticides, have on soil.
3. Explain that the American Indians of the pre-Columbian times had limited technology to alter the land and soils to produce items they needed. In general, their cultures evolved to fit the environment. Most

American Indians had (and still have) a feeling of reverence or deep respect toward the soil and land. Read from Native American stories in Appendix E or online at www.steonline.org.

4. In the classroom, identify areas on the campus where the soil is in need of help. Make a list of the responses.
5. As a class, choose one area to be awarded the Stewardship of Soil (S.O.S.) Class Project.
6. Work together to formulate a plan to reduce the problem associated with the degradation of soil they observed for their S.O.S. project.
7. Implement the plan.

Source

Adapted with permission from

A Child's Place in the Environment—Unit 2, California Department of Education, 1994.

Resources

For the Teacher

Cromer, Richard. *Soil*. 3–5 grades.

Keen, Martin L. *The World Beneath Our Feet: The Story of Soil* (Teacher Background).

Milne, Lorus J., and Margery Milne. *A Shovelful of Earth*.

Webb, Angela. *Talk About Soil*. (K–2).

What's in Soil

Teacher Worksheet



An average soil sample might contain:

- 25% Air
- 25% Water
- 45% Rock Particles
- 5% Organic Matter

Soil Chart

Student Worksheet

	A	B	C
Soil sample			
Color			
Feel (smooth or sticky; damp or dry)			
Smell			
Can parts of plants and/or animals be seen? (yes/no)			
Can parts of rock be seen? (yes/no)			