

Lesson Plan

Description
 The presence of healthy trees is one of the best ways to prevent erosion. Trees intercept rain, reduce the water in soil, break the wind and the roots bind soil together. This hands-on activity simulates the difference between levels of erosion with or without trees and their impacts on soil.

- Learning Outcomes**
- Soil is made up of material such as organic matter, minerals, and gases
 - A soil profile consists of topsoil, subsoil, and parent material
 - Students will learn the 5 important functions of soil and how they impact society and the environment
 - Students will learn about wind and water erosion and how it affects soil and the landscapes around us
 - Students will explore the importance of trees and how they help prevent erosion

- Specific Expectations**
- A3.2** investigate how science and technology can be used with other subject areas to address real-world problems
- E1.1** assess the importance of soils for society and the environment
- E2.4** explain the process of erosion, including its causes and its impact on soils

Introduction

The Significance of Soil

Healthy soil is an incredibly vibrant and dynamic substance. It is made up of a mixture of organic matter such as plant and animal-based material, minerals, gases, and is home to various organisms such as earthworms, moles, and snails. The average soil sample is approximately 45% minerals, 25% water, 25% air, and 5% organic matter.

Soil gets its texture from the size of rocks and mineral particles that it is composed of. Sandy soil has larger particles, silt is made of finer particles, and clay soil’s particles are so fine that they are difficult to be distinguished with the average microscope.

Each soil type has its own unique composition which we call a soil profile. A soil profile is made up of *three* major layers: the topsoil, subsoil, and parent material.

The *topsoil* layer is where we will find a plethora of biological activity such as worms, insects, snails, plant roots, and burrows of the animals that call this thriving ecosystem home. The *subsoil* layer has far less activity than the topsoil layer. Here, there are more minerals, clay, as well as a higher quantity of water. The bottom *parent material* layer is comprised of partially

broken up rocks that are the base of the soil. In this layer, we can see that some weathering and erosion has taken place on the rocks that are found here.

Soil has five very important functions. They are as follows:

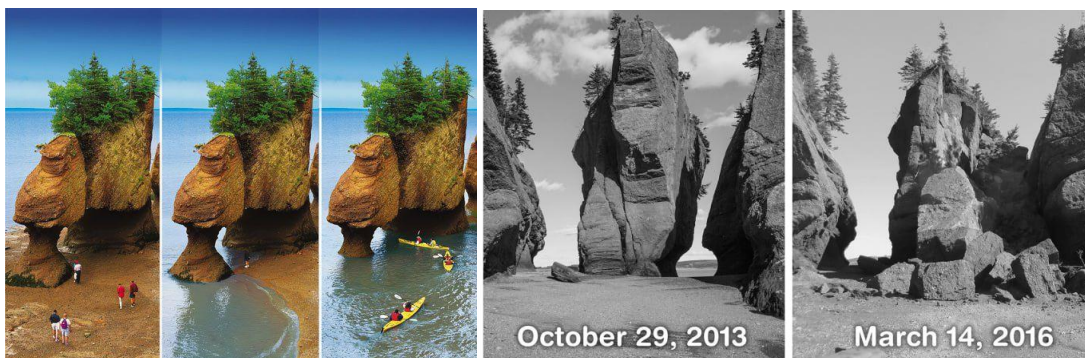
1. It is a *medium for plant growth* which allows us to grow food as well as provide nutrients for wildlife
2. It *regulates water level* and helps impede flooding
3. It *recycles raw materials* such as leaves, sticks, and animal waste
4. It acts as a *habitat for soil organisms* such as snails, earthworms, and moles
5. It is a *landscaping and engineering medium* for building structures such as houses, schools, and commercial properties

Erosion and Its Effects

Erosion is the geological process – a way by which the Earth changes – which causes soil or dirt to be worn away and transported by forces such as wind, ice, and water. Erosion can be seen all over the world and Canada has some incredible examples of the impact these three forces can have on the land around us.

Hopewell Rocks in Hopewell Cape, New Brunswick

These famous rock formations were molded by years of erosion from wind, rain, and the daily tide moving in and out. On March 14th, 2016, the power of erosion was demonstrated when 100 to 200 tonnes of rock came tumbling down after the morning tide had receded.



Badlands in Drumheller, Alberta

This 90,000 square kilometer area in Alberta was formed around 13,000 years ago as a result of the glacial meltwater from the Laurentide ice sheet. Rapid runoff from the melting glaciers was caused by heavy rainstorms which created shallow channel called rills as well as gullies

throughout the rock. This led to high rates of erosion of several millimetres throughout the span of just one year.



The Alberta badlands are also home to an intriguing rock formation known as hoodoos. Thanks to millions of years of erosion caused by wind, rain, and ice melt, pillars of sandstone rock are crowned with a harder, more resilient cap. This allows the softer, more vulnerable rock beneath the cap to be protected from the harsh elements.



Flowerpots Rocks in Tobermory, Ontario

While their structure may be similar in appearance to the Hopewell Rocks in New Brunswick, the Flowerpot Rocks in Tobermory, Ontario were formed in a different manner. The Hopewell Rocks are entirely made of sandstone and are slowly eroded by the ever-moving tide, whereas the Flowerpot Rocks are known as “sea stacks”. This means that the bottom of the rocks are made up of fossilized sea floor and the tops are made of fossilized coral. The sea floor bottoms of the rocks were eroded more slowly than their tops, which gave them the shape that we know today,



Wind erosion causes soil to be detached and moved from its original location to another. This normally occurs in an area with high wind speeds such as large open fields or open water. Wind erosion can cause the loss of topsoil as well as nutrients in crops which can lead to a loss in agricultural productivity.

Water erosion is also the detachment and removal of soil but is caused by water. The rate of erosion may vary from slow to quick depending on variables such as the soil itself, weather conditions, and the surrounding landscape.

The Importance of Trees

It is important to remember that soil erosion is a natural process, but it has been severely impacted by human action. Erosion can create fascinating landscapes such as the ones mentioned above, but it can also wreak havoc on the soil it encounters. Soil is one of our most precious and limited resources as it takes about 1000 years to form just 3 centimetres of topsoil. More than 94% of our food comes from soil and if we continue to use the same agricultural practices that we presently do, we may run out of topsoil in the next 60 years.

Healthy trees are one of the best ways to prevent erosion. Here are some of the many ways trees help maintain valuable soil:

- They *help slow down/impede rainfall* – This prevents splash erosion which occurs when rain drops contact the soil. It is said that raindrops can cause soil particles to detach and rise to a height of 0.6 metres and move up to 1.5 metres horizontally.
- They *diminish the amount of water in the soil* through the process of transpiration.
- *A tree's roots will bind soil together.*
- They *can reverse nutrient depletion* – Nutrient depletion is a loss of plant nutrients which is mostly caused by human activity such as overcropping, overwatering, and overgrazing on farms. This can lead to weak, loose soil which is highly susceptible to

soil erosion. By planting trees in an area that is deprived of nutrients, we can re-introduce a healthy nutrient cycle. This occurs because a tree's roots can help breakdown organic matter, release minerals and nutrients back into the soil, produce dead leaves to be decomposed, etc.

- Trees will *obstruct incoming wind* – Trees will act as a barrier and cause the wind to go directly over the tall trees. This slows down the wind's speed, protects the soil that is found directly underneath, and prevents it from blowing away.

Materials

Matching activity:

- Scissors
- Glue stick or white glue
- Crayons, colouring pencils, and/or markers

Forest Erosion activity:

- Paint tray (1) – Two holes should be made at the bottom of the paint pan in the area where paint is poured in
- 500 ml measuring cup filled with water (1)
- Pitcher filled with water (1)
- 500 ml of sand
- Sponge – Must be long enough to stretch from side to side of the paint tray (1-2 depending on size)
- Duct tape
- Clay (At least 2"x2" piece)
- One container – Large enough to fit the paint tray flat at the bottom
- Toy model of a house or a Lego block to symbolize a building

Action

Matching Activity

Using the accompanying slideshow, discuss as a group the three major layers of a soil profile: topsoil, subsoil, and parent material. Ask students why they believe soil is important to the environment as well as society before going over the 5 functions of soil listed in the presentation. Furthermore, explore the different landscapes that have been created by erosion as well as the impacts of wind and water erosion. Lastly, examine the importance of trees regarding erosion and the many ways they benefit the soil.

Once the slideshow presentation is completed, the students now can conduct the matching activity that can be found in the accompanying handout. They are welcome to colour the images as well as work in groups.

Forest Erosion Activity

This activity demonstrates the benefits that trees have against erosion. Students will see how forests can help modify the flow of water and even prevent flooding from occurring. Forests are particularly helpful in preventing flooding that can occur when water moves from a higher area to a lower area, and this will be shown by using a paint tray.

Step 1

1. Create two small holes in the low part of the paint tray (where paint would normally be poured in)
2. Place the paint tray in the bottom of the large bucket – Ensure that it is lying flat
3. Begin by using the piece of clay to secure the toy model or Lego in place in the low part of the paint tray (where paint would normally be poured in)
4. Using duct tape, secure the sponge(s) across the paint tray at the very edge of the slanted section – The sponge will act as a “forest” along the edge of a slope
5. Add the 500 ml of sand at the top of the paint tray, above the sponges – This will act as a model for soil
6. Once the sand has been added, pour 250 ml of water over the sand at the top of the paint tray – This will act as a heavy rainfall
7. After the water has been poured, ask students the following questions:
 - Once the water was poured, what did you notice with the water flow through the forest (sponge)?
 - Did the water enter the low region quickly or slowly?
 - Did sand enter the low region? If yes, was it a lot or just a little bit?

Review the following points:

- Forests will impede water flow from higher to lower regions and help prevent flood
- Forest help retain soil particles and help prevent detachment and displacement which helps maintain healthy soil

Step 2

1. Carefully remove the paint tray from the larger container and discard the water that has collected at the bottom
2. Return the paint tray to the bottom of the large container – Ensure that it is lying flat
3. Gently remove the sponges – This demonstrates the removal of trees which can be due to land development or resource consumption such as paper or building material
4. Once again, pour the remaining 250 ml of water over the sand and observe what occurs
5. After the water has been poured, ask students the following questions:
 - Once the water was poured, what did you notice with the water flow through the forest (sponge)?
 - Did the water enter the low region quickly or slowly?

- Did sand enter the low region? If yes, was it a lot or just a little bit?
- What happened to the house that was built in the low region?

Explain the following:

- The water rushed into the low region because there was nothing to hold it back. This causes the water level to increase very quickly which will flood the house.
- Just like there is nothing to hold back the water, there is nothing to hold back the soil. This caused the soil to detach and move into the low region. When this occurs, we risk the chance of increased pollution and sedimentation in streams and rivers which can cause clogged waterways and a decline in fish and other species. This can even cause a landslide!

Consolidation/Extension

Soil erosion is a natural process that has unfortunately been expedited by human activity. With viable and healthy soil being eroded at the present rate, we risk not having soil for our agricultural needs in the next 60 years. With that being said, we can do our part by placing crop covers overtop of garden, using the no-till method of gardening, as well as planting trees.

Trees are incredibly beneficial to us as well as our planet. Not only do they provide us with the air we breathe, but they also bind our soil together, impede heavy rainfalls, create nutrients for the soil and other organisms, and prevent wind and water erosion.

This lesson and associated activities may be a great opportunity to plant some trees with students in the school yard. Both coniferous and deciduous tree seedlings can be found locally.

Accommodations/Modifications

- This activity can be done outside
- The font on the handout and slideshow can be modified to be larger or a different colour according to visual needs
- Students can work in groups for the match up activity

Assessment

The handout can be collected and utilized as an Assessment **for** Learning to evaluate how well students have understood the lesson’s content and if they require anymore clarification. Furthermore, it can be used as an Assessment **of** Learning if you wish to evaluate your students in a summative manner.

Additional Resources

“Under Your Feet – Soil, Sand, And Everything Underground” is a wonderful book written by the Royal Horticultural Society. It helps students explore the many variations of soil, the organisms that live in its layers, the many reasons soil should be protected as well as strategies that will allow us to look after the health of the soil that surrounds us for years to come.

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