Digging Deeper

LESSON

GRADE LEVEL 6-12

CATEGORY Earth, Ecosystems and Ecology

TOPIC Soil

TIME
60-90 minutes

MATERIALS
- Hand trowels
- Shovel (optional)
- Water spray bottles
- Cloth for cleaning hands
- Soil profile worksheet (copy page)
- Soil Data Tables (copy page)
- Soil Profile Conclusion Sheet (copy page)
- pH measurement instrument (optional)
- Soil thermometers (optional)
- Camera (optional)

SETTING
Outdoors (indoors for preliminary soil inquiry (optional)

GROUP SIZE 4-6

SUBJECTS Science

SKILLS
Observation, measurement, use and care of science equipment (pH, thermometers, and other field gear), recording findings, analysis, evaluation and conclusions

KEYWORDS
Soil, ecosystem, climate, organisms,

HCTF Education

Overview

Students work in small groups, outdoors, conducting hands-on investigations of soil properties by examining the physical and chemical characteristics of soil that provide habitat for biological life in and on top of the soil.

Objectives

Students will be able to:

- Develop awareness about soil – its characterization, function and significance.
- Measure and describe the physical and chemical attributes of a soil ecosystem through hands-on investigations.

Making Connections

Soil is considered the great integrator. It connects many processes; for example, the water cycle, the carbon, nitrogen and phosphorus cycles; and different systems, such as the atmosphere and biosphere. Soil is part of a larger system, the geosphere that includes the Earth itself, and the rocks, minerals and landforms of the surface, as well as its interior. Soil affects global climate through gas exchange and storage. Soil stores heat, stores and filters water and air, and is a place of recycling and decomposition. The soil is an ecosystem onto itself with biotic and abiotic components. Soil sustains plant growth on which terrestrial herbivores and ultimately carnivores exist. It supports natural ecosystems, including forests, and wildlife habitat. Soil is used in many technological applications (construction, medicine, art, etc.) and serves as a substrate for building structures such as roads, airports, and office towers. In British Columbia, soil plays a key role in the economy, society, and environment.

Background

Getting the dirt on soil. Dirt is usually a term used when the material is not wanted while soil represents an essential ecosystem. Soil rocks. In fact it is by means of a slow geological process that soil is formed in any abundance from the breakdown of rocks, plus organic matter.

Soil is Critical to Life

The thin layer of soil that was eons in the making is precious and integrates many systems to one another. Soils hold nutrients, air and water. The soil ecosystem is integral to the water cycle: filtering and cleaning water that passes through (percolation), changing the chemistry of the water, influencing the amount of water that recharges the groundwater, influencing the amount that is available for plant growth, or returns to the atmosphere as water vapour. The foods we eat (as well as other herbivores and predators or carnivores) and most of the materials we use for paper, building and clothing are dependent on soil.

Healthy soil abounds with life. Biological activity in the soil releases CO_2 into the atmosphere. Decomposing plant and animal matter is reduced to elemental form, such as nitrogen and phosphorus, by soil decomposers. Whether these nutrients are available for plant growth depends in part on the soil pH. Soils store and transfer heat affecting the temperature of the atmosphere and controlling the activities of plants and other organisms living in the soil.

Four Components of Soil Composition

1. Minerals;
2. Organic matter;
3. Air, and
4. Water.

Minerals include sand, silt and clay. Organic matter includes the dead remains of plant and animals. Air and water can be found in the soil pores or spaces where the soil structure enables this. The overall composition of each of these four components within a given soil varies between soil types.

Five Factors Influencing Soil Formation

1. Parent material;
2. Climate;
3. Organisms;
4. Topography; and
5. Time (for the other factors to act together).

Parent material is often bedrock but can also be organic material, or loose soil deposited by wind, water, glaciers, volcanoes or material moving down a slope. Climate plays a role in the breakdown of the parent material and also the rate of soil processes as influenced by temperature and amount of moisture. For example, cold, dry climates have a slower rate of soil formation than warm, moist climates. Heat, rain, ice, snow, wind and sunshine all play a role in soil formation. Organisms, including fungi, bacteria, plants and animals live in or on the soil. Decomposers in the soil affect the rate of decomposition of organic matter, nutrient content of the soil and how easily matter will be moved around in the soil. The demands for water and nutrients from plants rooted in the soil also influence soil formation, as well as the specific vegetation growing from the soil. Topography refers to the location of the soil on the landscape: at the top of a slope or mountain, mid- slope, at the bottom of the slope, or in the valley bottom. Soils in valley bottoms tend to be moister that sites upslope or at the apex. Time, as an influencing factor on soil formation is measured in geological terms, spanning hundreds or thousands of years.

Physical and Chemical Weathering

Falling or flowing water, glaciers, freezing and thawing of rock, and erosion are examples of physical weathering processes in soil formation. An example of chemical weathering is the reaction between soil water and excretions from plant roots or other organisms, producing acidic conditions that erode the bedrock.

Soil Profile & Characteristics

The soil profile is a cross-sectional view through the soil depth from the surface down to parent material. Each layer in the profile, termed horizon, has distinct characteristics produced by soil forming processes.

The different soil horizons are visually recognizable. Soil horizon characteristics include: colour (sometimes a secondary colour is present), the presence/absence of roots and rocks; structure; and texture as well as moisture, temperature and pH. Each horizon is physically different from the horizon above and below.

On top of the soil can be humus, duff and/or litter. Litter is the recognizable dead matter on the soil surface. Duff is the partially decomposed organic matter. Humus is almost completely decomposed and non-identifiable. Below this lies the first horizon in the profile, often referred to as topsoil. The topsoil is, in itself, a complex ecosystem that supports most of the life below ground, and offers life support to the plants rooted within it.

Soil depth determines the available area in which plants can root. Soil colour can indicate the nature of the parent material, what minerals are present, or the amount of organic matter present. The chemical coatings on soil particles and the moisture of the soil also determine soil colour. The soil pH (acidity or alkalinity) directly affects the availability of various minerals and nutrients necessary for plant growth. The pH affects nutrients for plant growth, and what plants can grow well in the soil. Alternately, the plants that grow in the soil influence the pH of the soil.

Soil temperature differs between the horizons and can change relatively quickly as a soil characteristic. The topsoil is most influenced by air temperature while deeper horizons experience less fluctuation in temperature. The top horizon (and cover vegetation) can serve as an insulator of temperature changes deeper within the profile. Soil temperature influences the amount of chemical and biological activity that occurs in the soil. Warmer soils, in general, support greater biological activity. Soil moisture classification ranges from xeric (dry) to hydric (saturated) and can also be measured by subjectively feeling the soil between the fingers and thumb for moisture. Moisture influences the biological, chemical and physical activities in the soil. Different plants are adapted to different soil moisture conditions. Chemically, soil moisture moves matter through the soil profile. Physically, the soil stucture (i.e. compacted or loose) influences soil moisture.

Soil structure refers to the shape of an individual amount, or ped, of soil. Structures are described as columnar/prismatic, blocky, granular, or platy. Pure sand is considered as single-grained; and soil with no structure yet a large ped is considered as massive.

The composition of the minerals in the soil determines soil texture. Soil texture is the way a soil feels when squeezed or rubbed between the thumb and fingers. The texture or feel of the soil depends on the amount of sand, silt or clay in the sample. Sand is the biggest mineral or particle (0.05 – 2 mm), and clay is the smallest (<0.002 mm). Silt particles range in size from 0.0002 – 0.05 mm. Soil texture and soil structure influence the amount of pore space within the soil for air and water to move and life to exist.

Soil Characteristics are Dynamic

Soil properties change over time. Some properties change within a short period of minutes or hours (moisture, temperature), others change over months or years (pH, colour, structure, fertility, biota, organic matter), and some properties change over hundreds and thousands of years (mineral composition, horizons).

Materials

Organize into groups (4-6 people in each) with each group equipped with field equipment of a trowel, shovel (optional and site dependent), (thermometer and pH measurer – both optional), spray bottle of water, cloth to clean hands, Soil Profile Data Sheet, and Soil Data Tables.

Procedure

Warm-up

Consider having students explore soil on the internet, especially at this site: Virtual Soil Science Learning Resources; **http://soilweb.landfood.ubc.ca/promo/**

Also: Soil Lab Modules
http://soilweb.landfood.ubc.ca/labmodules/

Ignite student thinking around soil with some questions and dialogue.

- What does soil mean to you?
- What does soil have to do with pizza?
- Is the sand at the beach different from the sand used to make concrete; the sand in the soccer field?

In small groups, consider the question: What is soil? As a group, discuss and develop a definition. As a class, share the definitions, compile attributes of each, and arrive at a collective definition for soil.

The Activity

1. Each group needs to gather up their equipment, Soil Profile Data Sheet, and Soil Data Tables.
2. Head outside to the sampling site – it could be a cutbank in a ditch, the schoolyard, or forest. Choose a place to sample the soil, being mindful to cause no harm to the habitat (i.e. avoid intrusive soil pits). Each group needs its own site for sampling and observations. Once at the site, clear away the duff and litter if it occurs, and proceed to excavate a soil profile. Ideally, the entire soil profile can be viewed, but if this requires a lot of digging (as opposed to finding a cutbank in a ditch), then dig to complete at least one horizon with the second one apparent. For each horizon, observe and record each of its characteristics, as per the Soil Profile Data Sheet. Take a photo(s) of the profile. Once sampling is completed the site should be returned to its natural state prior to sampling activity.
3. With observations and data collection are complete, use the Soil Data Tables for making inferences about the soil. Note your conclusions.
4. Convene as a class together (either outside or inside) to compare findings. Build a chart of collective findings and conclusions, include photos (if available).

Assessment

1. Consider soil as an ecosystem and detail (through diagram or/& words) how it functions as a system, how soil is considered the great integrator.
2. How is matter cycled through the soil? What are examples of the matter?
3. What is the relationship between a soil and the vegetation growing from it? (use the sampling site as one example)
4. Brainstorm different characteristics of soil and how these influence how soil is used. (Consider sand and concrete, loam & gardening soil, building sites for structures, bird nests, beaver dams, permafrost, septic systems, bear dens, bogs and wetlands, soils for paints, clay of pottery, etc).
5. What are the implications of loss of viable soil?

Extensions

1. Sample from other soil ecosystems and compare findings.
2. Sample different garden soils.
3. Detail a cycle of one kind of matter through soil and other systems or spheres. Consider any of these cycles: nitrogen, carbon, phosphorus, carbon dioxide, water
4. Explore the world of soils on the Internet, identify conservation issues and propose(d) solutions. i.e. What is saline soil and why is this a concern? What is the purpose of no-till farming?
5. What is the relationship between soil and climate?

References

BC Ministry of Environment, Ecosystems Branch, Soils
http://www.env.gov.bc.ca/soils/index.html (2014)

The GLOBE Program, Soil
http://www.globe.gov/web/soil/overview (2014)

Resources

Virtual Soil Lab Modules: Krzic, M., T. Naugler, S. Dyanatkar, and C. Crowley. 2010. Virtual Soil Lab Modules. The University of BC, Vancouver.
http://soilweb.landfood.ubc.ca/labmodules/

Virtual Soil Science Learning Resources
http://soilweb.landfood.ubc.ca/promo/

How much soil is there? A Learning Activity to illustrate the amount of soil on Earth
http://soils.gsfc.nasa.gov/index.php?section=70 (2014)

Virtual Soil Science Learning Resources
http://soilweb.landfood.ubc.ca/promo/

Online film
Drawing from ancient knowledge and cutting edge science, Symphony of the Soil is an artistic exploration of the miraculous substance soil. By understanding the elaborate relationships and mutuality between soil, water, the atmosphere, plants and animals, we come to appreciate the complex and dynamic nature of this precious resource. The film also examines our human relationship with soil, the use and misuse of soil in agriculture, deforestation and development, and the latest scientific research on soil's key role in ameliorating the most challenging environmental issues of our time. Filmed on four continents, featuring esteemed scientists and working farmers and ranchers, Symphony of the Soil is an intriguing presentation that highlights possibilities of healthy soil creating healthy plants creating healthy humans living on a healthy planet.

http://www.symphonyofthesoil.com