NORTH CAROLINA COOPERATIVE EXTENSION
4-H GROW FOR IT PROGRAM

SOIL TO SEED

Protecting Water Quality Through Soil Erosion, Sediment and Turbidity Control

NC STATE UNIVERSITY

INTRODUCTION

From the food we eat, to the water we drink, to the places where we live and play, soil erosion and sedimentation profoundly affects our everyday lives. Erosion is a natural occurrence, shaping sand dunes, creating river deltas, or carving out enormous rock features like the Grand Canyon. The loss of soil from our landscapes and its deposition into our waterways, however, reduce the ability of the land to be productive in supporting plant growth and the capacity of the water to nurture aquatic habitats, host recreation and have municipal usefulness. This curriculum focuses on the accelerated processes of erosion and sedimentation that transpire as a direct result of agricultural and construction development activities. It is through abuse that our waters and soils are becoming increasingly compromised. With careful management of the soil, however, we can preserve water quality and keep our soil in place for future generations.

Soil to Seed is designed to cultivate high school aged-youth in understanding the principles of erosion and sediment control. Using the 4-H Experiential Learning Model, youth delve into hands-on lessons, working together to solve problems and share reflections on what they learned. The curriculum begins with the fundamental mechanics behind erosion and sedimentation, then teaches students how to assess physical spaces for evidence of these processes and eventually builds their knowledge base of how to manage and control soil loss and deposition. Students strengthen their connections to these concepts through the process of doing, reflecting and then applying what they know to other situations in their life. Each lesson is crafted to build in life skills that can be used in any context, fostering critical thinking, teamwork, record keeping, collaboration and communication.

This curriculum is a collaborative project that drew directly from the research of NC State University's Soil Erosion, Sediment and Turbidity Control program within the Department of Soil Science in partnership with North Carolina Cooperative Extension's 4-H Youth Development Program. Throughout the country, each state has a Cooperative Extension organization that brims with knowledgeable people that can provide educators with content support and resources.

Soil to Seed will take educators and students on a journey to explore a world that is just a step beyond the boundaries of a building. By understanding erosion and its impact on water quality, we can grow another generation that is engaged about important environmental challenges and deeply motivated to practice strategies that steward our soil and water.

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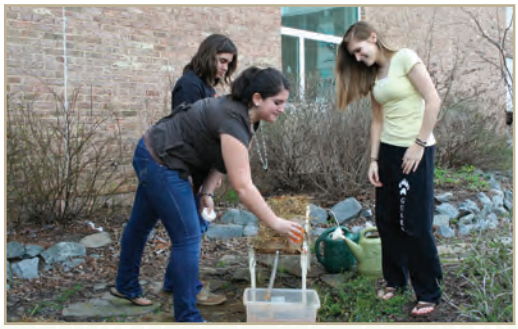


NORTH CAROLINA COOPERATIVE EXTENSION
4-H GROW FOR IT PROGRAM

LESSON ONE

Introduction to Soil Erosion

Learner Outcomes

Students will broadly explore soil erosion to understand the physical mechanisms behind the process of erosion and the impacts that sediment has on water quality. Students will form a scientific learning community and share their ideas and findings through a blog.

Success Indicator

Describe how erosion impacts water quality

Skill Level

Advanced; ages 14-18

Time Needed

One 90-minute class or two 45-minute classes

Next Generation Science Standards

Earth and Human Activity (HS-ESS3-1.)

Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activities.

Life Skills

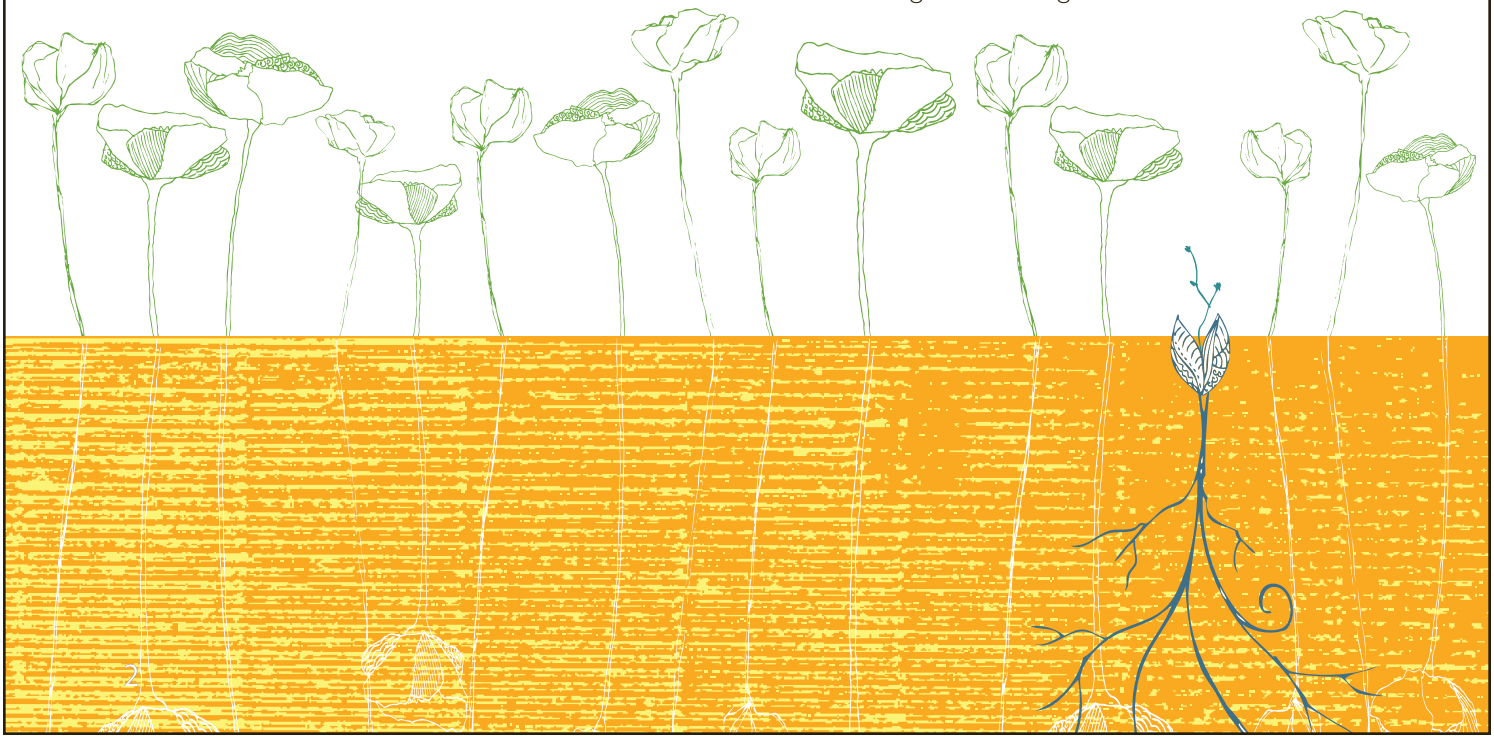
- Teamwork
- Critical Thinking
- Record Keeping
- Communication

Materials

- Lesson One Teacher PowerPoint (www.growforit.org/soiltoseed)
- Computer
- LCD projector
- Internet access
- Rainsplash video (www.youtube.com/user/soiltoseed)
- Rill Video (www.youtube.com/user/soiltoseed)
- Copies of Soil Splash Test handout (p. 6-8)
- 20-30 (depending on group size), 16-oz paper cups
- 4-5, 10 or 15ml pipettes
- 4-5 turkey basters
- 10-15 (depending on group size) cups of sandy soil
- 10-15 (depending on group size) cups of clayey soil
- Water
- Copies of the Word Wall (p. 12)

Logistics Note

Students will be asked to work in teams of 5 or 6 students on a number of assignments throughout this curriculum.



Background Information

Soil erosion is the process of wind and water moving soil particles from one location and transporting and depositing them elsewhere. Erosion is a natural occurrence, shaping sand dunes, creating river deltas, or carving out enormous rock features like the Grand Canyon. Humans, however, have dramatically accelerated this process through agricultural practices, mining, logging and clearing and grading for construction. These activities can cause detrimental effects on the environment, degrading water quality, compacting the soil, limiting water infiltration, removing vegetation, and exposing the soil surface, thereby increasing both **runoff** and erosion. Erosion rates are usually higher on lands that are **denuded** and reshaped for urban development, than on agricultural land. **Sedimentation** is the gravitational deposition of transported materials in flowing or standing water. Sediment can carry polluting chemicals, destroy fish habitat, decrease the storage capacity of water bodies, and increase the risk of flooding. Deposition of sediment on roads, and in stream channels, reservoirs, lakes, estuaries, and harbors, reduces recreational and municipal usefulness and may require expensive removal operations. Soil erosion reduces the productivity of agricultural lands by removing topsoil, exposing less desirable subsoil. This results in a loss of organic matter and nutrients causing a reduction of fertility and water-holding capacity.

Mechanics of Soil Erosion

Erosion occurs in two steps: **detachment** of the soil particle and **transportation** of the soil particle down slope.

The physical impact of a raindrop on unprotected soil serves as the primary detachment mechanism, loosening soil particles and freeing them to be transported. When a raindrop strikes a surface, the force of the impact acts to destabilize the particles. The kinetic force disrupts soil aggregates, shattering them into individual soil particles. The loosened particles are then easily removed by runoff water. Dispersed soil may wash into soil surface pores, forming a crust that inhibits the emergence of seedlings and encouraging rapid runoff from subsequent rain events. Soil particle transport primarily occurs through water runoff across the land surface, causing sheet erosion. Soil particles are transported as the sediment is suspended in water and travels down slope. The rate of soil detachment and transport depends on soil texture, slope, vegetation, and rainfall.

Factors Affecting Soil Erosion

Soil Texture:

Soil texture refers to the size of soil particles. Sand is the largest sized particle, followed by silt, with clay being the smallest sized soil particle. Of all the soil particles, silt-sized particles erode most easily. Sand has large pore spaces that allow for a higher rate of infiltration. Clay particles, when wetted, become sticky and cohesive. These clay particles bind to each other becoming more difficult to dislodge and translocate.

Fig. 1-1. Detachment of bare unprotected soil from impact of the raindrop.

Fig. 1-2. Transportation of the soil downslope once it is detached and suspended in runoff water.

Slope (length and steepness):
Erosion can occur at different rates depending on the slope of the land. The steeper the slope, the greater the velocity of the water flowing across the surface and its capacity to transport and erode soil. Increase the length of the slope and the erosive energy of the water increases.

Vegetation:
Vegetation is the number one way to control erosion. Vegetative cover acts as a barrier that protects the soil particles from raindrop impact. Establishing grassed expanses provides a fast and effective measure to slow the velocity of water and allow sediment to drop out of suspension. Having a leaf canopy from trees, debris, and litter on a forest floor can reduce the impact on soil caused by the raindrops.

Rainfall (duration and intensity): Rainfall presents two parameters to consider: 1.) the rain intensity, or how hard the rain falls, and 2.) the length of time it rains. Overall, the amount of rain that falls and how quickly it falls determines how fast soils become saturated and runoff begins.

The combination of factors listed above determines the amount of erosion that will occur as well as the amount of sediment that may be transported and deposited elsewhere.

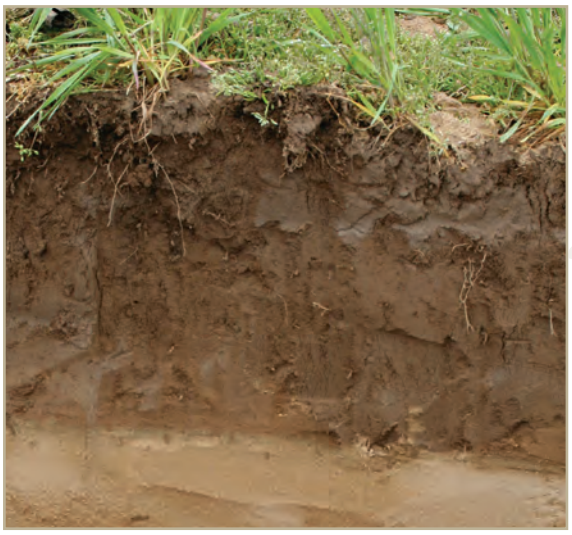


Fig. 1-3. Soil texture plays a role in rainfall infiltration.

Experience: What is Erosion?

Begin the unit of study on soil erosion by asking students to pause and visualize examples of erosion. Ask them to think about their neighborhoods, the drive to school, anywhere they visit throughout their day where they might have seen evidence of erosion. Give them a few minutes to write down their ideas and have them answer the daily opening questions listed above. Furnish students with the Word Wall handout (located at the end of this lesson). Explain that the Word Wall is a tool that enables them to organize their learning by recording important definitions related to soil erosion. Teachers may also instruct students to use a science journal to document these definitions.

Encourage students to share some of their thoughts; this will reveal their level of understanding and prompt the development of a deeper discussion of soil erosion throughout the unit. As students give their answers, record their ideas on the chalkboard. If not all of the basic soil erosion concepts are voiced, supplement the conversation with the information described in the Background Information section and the bullets below. Be sure to describe how soil erosion occurs and why it is important to study. Students will delve deeper into these concepts throughout the rest of the unit.

Ideas the students might mention or that you could suggest, include:

What is soil erosion?

- The movement of soil from its source by wind or water to another location.

How does soil erosion occur?

- Soil particles are detached by raindrops (sometimes wind, but mostly through rain events) and transported down slope.
- Rates of erosion depend on slope, slope length, soil texture, vegetation and rainfall.

What role do humans play in this process?

- Humans can accelerate the erosion process through mismanagement of agricultural lands and the clearing activities caused by development, mining or logging.

Why is it important to limit soil erosion?

- Loss of plant essential nutrients from the eroded topsoil reduces the productivity of agricultural lands and in urban development makes it hard to establish vegetation like lawns.
- Sediment can carry polluting chemicals, destroy fish habitats, decrease the storage capacity of water bodies and increase the risk of flooding.
- Sedimentation reduces recreational and municipal usefulness of water bodies and may require expensive dredging.

After discussing student's initial ideas about soil erosion, introduce the activities they will be doing throughout the soil erosion unit, from exploring the basic physics of soil movement and soil properties to designing experiments that will determine the best practices to control soil erosion and sedimentation, helping to protect water quality. Outline expectations for their learning, beginning by asking students about their own expectations and interest in the subject. Inform them they will be expected to work as a team of scientists, continually observing and asking questions and communicating their ideas to each other. The students will be asked to record their ideas and experiences through a classroom blog or science journal.

The Start of Soil Erosion

Show the students the "Rain Splash" video (available for viewing and download at **http://www.youtube.com/user/soiltoseed**). Ask the students to report on their observations. Questions throughout the video should prompt students to focus on key points. Teachers may want to show the video two or three times.

Teachers might consider asking questions like:

- "What happened to the soil?"
- "How did the speed of the rain drop affect the soil movement?"
- "What role did soil particle size play in the dispersal distance?"
- "What happened when the larger rain drop hit the soil?"
- "Have you seen examples of this before?"
- "Why do you think this is important?"
- "What does this have to do with soil erosion?"

Explain that the video shows the mechanics of soil erosion, detachment and transport. The physical impact by the raindrops causes the soil aggregates to break apart, leaving fine soil particles that can be easily transported away by water runoff. In the videos, the finer sand particles travel farther than the coarser particles because they are lighter and easier to move. The students will have an opportunity to determine this themselves.

Name: _____

Date: _____

Soil Splash Test

What conditions cause soil erosion? How do different soil erosion factors affect soil displacement? How can you play a role in managing soil erosion? Complete this experiment to discover what variables play a role in the erosion of soil.

Do … the activity

1. In groups of two to three, place about a quarter cup of dry soil (one clay and one sand) in a small dish or plate. Alternatively, cut off the bottom of a paper cup to the height of 1-inch and fill with soil. Using a large piece of white paper (easel pad) placed on the floor (or the white back of a laminated poster/ piece of paper), place the plate with the dry sandy soil in the center.

2. Have one person from each group fill a pipette with water and from a height of about 4' release the water from the pipette aiming for the soil pile. Record your measurements of how far soil is displaced when it is dry.

3. Continue to rain on the soil until the point of saturation. Once the soil is saturated, observe soil particles that have been displaced from the plate onto the white paper. Measure the distance that some of the particles have traveled using a ruler and record your findings on the Splash Test Data handout. You may also choose to draw concentric circles on the paper, like a bullseye, with the rings providing a scale to measure the distance traveled by the soil particles.

4. Further explore variables that affect soil displacement by changing:
   a. The height of the pipette (rainfall)
   b. The volume of rainfall (use a different water dropper, like a turkey baster)
   c. The slope of the splash test

5. Observe differences in splash effect between the variables. Plot your measurements on the Splash Test Data Sheet and possibly on the chalkboard as well to share results of their experimentation with the entire class.

7. Repeat this experiment with another soil texture and record measurements on another Soil Splash Test Data Sheet.

The soil splash test lends itself to multiple variations, as a group come up with additional ideas to test. You might try additional soil textures or soils with well expressed or strong structure.

Name: _____
Date: _____

Soil Splash Test
Data Sheet

Record the distance your soil particles travel. You may or may not explore all of the variables listed below. For each additional soil texture, simply print another copy of this table and use again.

Variable	Distance soil traveled (cm)	Notes
_____Dry (record soil texture)		
_____Wet (record soil texture)		
_____Height of Rainfall		
_____Height of Rainfall		
_____Volume of Rain		
_____Volume of Rain		
_____% slope		
_____% slope		
_____Length of Slope		
Other, explain: _____		
Other, explain: _____		