

# Measuring Vegetation's Effect on Erosion

## Summary

### Subject(s)

ESS: Earth's Systems & Processes

### Grade/Level

Grades 4-6

### Activity Type

Constructing explanations & Designing solutions

### MN Science Standard

4E.1.2.1.1

### SEP / CCC

SEP: Planning & Carrying Out Investigations

CCC: Cause & Effect

### Est. Lesson Time

45 Minutes

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## Implementation

### Introduction

Soil erosion is when silt, sand, or clay is broken loose into small pieces of sediment and moved either by the force of wind or water. Sediment can come from a number of places including sloping hills, streambanks, bluffs, urban stormwater runoff, or areas of exposed soil like a construction site or plowed field. When wind or water moves, it carries the loose sediment with it, typically draining into waterways and flowing downstream. The effect is twofold: Erosion moves soil from where it belongs, usually resulting in the new topsoil having less nutrients, and therefore less fuel for plants to grow. Erosion then deposits the sediment downstream/downwind in a place it does not belong, clogging the new site with sediment it cannot accommodate. The sediment can also contain harmful chemicals/pollutants impacting the health of the downstream environment.

The Minnesota River collects sediment erosion from all of the waterways in the watershed, which is why the Minnesota river has muddy (turbid) water. The amount of sediment a waterway can handle before it is impaired is called the Total Maximum Daily Load (TMDL). A Minnesota waterway's TMDL is determined by the MN Pollution Control Agency, and helps them measure the effectiveness of sediment reduction strategies in the watershed by comparing daily sediment loads against the TMDL.

When the amount of sediment is too high (it exceeds the TMDL) it can negatively affect the plants and creatures that live in the water. Plants lose out on sunlight, because the sediment blocks the light from penetrating deep into the water. Too much sediment can harm creatures in a number of ways: raising the temperature of the water, filling in nesting spots with mud, making it hard to hunt by sight, and decreasing the oxygen in the water.

There are a number of ways to try to reduce erosion, many of which focus on stabilizing the soil so it does not become loose and move under the force of wind or water.. This lab explores how vegetation roots affect the levels of soil stability and contribute to or decrease soil erosion..

### Key Terms

- **Erosion:** The process by which a surface of soil or rocks break down into small particles and travel from their source by water and wind.
  - **Streambank Erosion** - The soil of the streambank is broken loose by the flowing water and carried downstream, causing wider streams and water full of sediment.
  - **Top Soil Erosion** - The top layer of soil, containing the most nutrients for plants, is worn away and moved by wind or water, leaving a less nutritious layer of soil exposed.
- **Runoff:** The portion of precipitation on land that ultimately reaches streams, often carrying dissolved or suspended sediment.

- **Sediment:** Loose solid material moved and/or deposited by human travel, water, wind or glaciers. Typically consists of silt, sand, or clay.
- **Sediment Load** - The amount of sediment being transported by a waterway.

### Objective

Make observations and measurements to provide evidence of the effects of weathering or the rate of erosion by the forces of water, ice, wind, or vegetation.

### Essential Questions

- How are the roots of plants helpful in reducing soil erosion?  
*Roots help stabilize the area and hold the soil together.*
- How do plants (cover crops) help slow the flow of overland runoff?  
*Plants absorb water, lessen the erosive impact of heavy rain, and slow evaporation of water. Their stems and vegetation also act as a barrier that slows the flow of overland water.*
- What can be done to reduce the impact of raindrops on bare soils?  
*Plant cover absorbs the erosive force of raindrops, reducing the amount of soil that breaks loose during a rain event.*
- What plants are the best choice to use when trying to avoid soil erosion?  
*Native grasses are particularly effective due to their fibrous roots that grab and hold the soil.*
- Does the method of crop tillage (no-till, minimum till, conventional till) affect how vulnerable the soil is to erosion?
- We have mentioned that bare soil and conventional tillage makes the land more vulnerable to erosion. Can you name three other farming methods not mentioned yet that help prevent soil erosion?  
*Regenerative Livestock Rotation; Terracing; Vegetative Buffer Strips*

### Materials & Resources

- Aluminum bread pans, approximately 8 × 3 × 3 inches (6)
- Aluminum cake pans, approximately 12 × 8 × 1 inches (2)
- Fertile Soil (enough to fill all six bread pans with 2 inches deep)
- Radish seeds (1 small bag)
- Ruler
- Sticky notes
- Permanent marker
- Scissors or sharp knife
- Full-size watering can with "rain" spout
- Sunny area for plants
- Sieve/Cheesecloth
- Short plastic container, or other object that can be used to prop up one edge of a bread pan to a height of roughly 3–5 cm. Do not use an object that you do not want to get wet, like a book.
- Test area that is easy to clean
- Kitchen scale

### Procedure

#### Part 1: Preparing the Pans

- A. Fill each of the six bread pans with soil, leaving at least a half inch of room between the top of the dirt and the lip of the pan.

- B. Plant radish seeds in three of the bread pans. You can plant them closer together than the packages recommend because these plants do not need to be full grown.
  - a. (Recommended) You can plant a different density of seeds in the 3 pans if you wish to observe the effect of a high density, medium density, and low/no density of roots on levels of soil erosion.
- C. Using sticky notes, label the pans indicating the trial number and whether it has seeds or not.
- D. Use scissors or a sharp knife to puncture holes along the bottom edge of the pan, approximately 1 cm apart, to prevent overwatering.
- E. Place the bread pans in the cake pan to collect excess water and set in a spot with plenty of direct sun.

### **Growing the Plants**

- F. Water each bread pan (seeded and seedless) once a day for 7-10 days.
  - a. The soil should be wet, but not flooded. Gently pour the water so its force does not knock soil loose or move seeds around.
- G. Once your plants are 8 to 10 centimeters tall, they are ready to be used in the next part of the experiment.

### **Part 2: Testing Soil Erosion**

- A. Begin by hypothesizing how the roots, or more specifically the different density of roots, will affect the amount of sediment collected in the cake pan.
- B. Weigh the mass of the empty cake pan on the kitchen scale. Record this for later use.
- C. Set up the testing area. Begin by cleaning and drying out the cake pan. Place it where you are testing and set the 3-5 cm container next to the cake pan. This will elevate an end of the soil pan, creating a slope for sediment to drain into the cake pan.
- D. Along one short side (width) on each of your bread pans cut 2 vertical slits 1 cm in from the corner of the bread pan. The slits should go half-way down the side. Then fold the side down so the soil is exposed.
- E. Place the cut side of the bread pan into the cake pan, propping the other side on the 3-5 cm container. The bread pan should be positioned diagonally, with the downward side cut open.
- F. Fill the watering can with 475 ml (16 oz) of water. Slowly pour the water across the pan you are testing.
- G. As the water moves through/across the soil, it will drain into the large cake pan. Allow it 1 minute to drain after you are done pouring the water.
- H. Weigh the mass of the runoff-filled collection pan, and subtract the mass of the pan from the total. This will give you the mass of the soil and water runoff. Record this total.
- I. (Optional) Pour the runoff from the collection pan through a sieve or cheesecloth, collecting the water below. Record the volume of water. Place the soil back in the collection pan, and weigh the pan again, subtract the pans mass from the total. Record the mass of the soil.
- J. Repeat Steps D through H for each pan.

**Small Group Discussion (10 Minutes):** Pair off with another student and discuss the following questions:

- A. What differences did you observe between the runoff of different pans? Did the density of plants impact the amount of runoff?
- B. Did the results confirm or reject your hypothesis? How?

- C. Did you find that a particular pan held more water/had less water in the runoff than another? Why do you think this is?
- D. Based on this experiment, what characteristics might make an area of land prone to erosion?

**Large Group Discussion (15 Minutes):** As a whole class, have some pairs share their answers with the group. Then discuss the following questions/topics:

- E. How does vegetation affect the amount of soil erosion/runoff?
- F. How can we use our results to help us develop methods to reduce soil erosion along erosion prone areas?
- G. Was there a difference between the amount of water held by soils with different plant densities? Was there less water in the runoff of a particular pan?
- H. How does vegetation affect the amount of water soil can store? Why might it be important for soil to store water?
- I. Are there areas near your house that are prone to erosion? Why do you think they are prone to erosion? Is there vegetation in these areas?

**Wrap-up (5 Minutes):** The Key Ideas from the lesson are:

- Soil erosion is the process by which wind or water carries loose sediment from one place to another.
- Sediment from one part of a watershed can be carried to another part of the watershed, which can increase the total sediment load of the water downstream river.
- A waterway can only accommodate the Total Maximum Daily Load of sediment before it is considered impaired for sediment pollution.
- There are a number of ways to prevent soil erosion/sediment pollution, most of which involve stopping the soil from breaking up, and reducing the power of the erosive force.
- Plant roots help stabilize the land where they are planted by absorbing water, breaking the impact of raindrops and slowing down the speed of overland runoff.
- Strong winds, hard rains, flowing water, human activities, farming and land clearing leave the soil vulnerable to erosion.

