W1363

SOIL GLUE

HOW STRONG IS YOUR SOIL STRUCTURE?

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Soil Glue

How strong is your soil structure?

Skill Level
Beginner (4^{th} & 5^{th} grades)
Intermediate (6^{th}-8^{th} grades)

State Standards Addressed:
4-ESS2-1
MS-LS2-4
MS-LS2-5

Learner Outcomes
The learner will be able to:

- Investigate soil structure using a wet aggregate stability test.
- Describe the relationship between strong aggregates and pore spaces.
- Provide examples of ways we protect and build soil structure.

Tag(s)
4-H Science

Time Needed
30 minutes

Materials Needed
-At least two soil samples to compare: one from an undisturbed site, one from a disturbed site
-two mason jars
-two 3.5-inch drain strainers (or pieces of wire mesh bent to hold a clump of soil) – should be wide enough to rest on the top of the mason jar with a middle part that dips down into jar (see figures 1 and 2)
-Water

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Adapted from: "Soil Glue" NRCS Soil Quality Factsheet 2010. www.soils4kids.org/files/s4k/soil-glue-lesson-plan.pdf

Introduction to Content
A healthy soil has good structure: pieces of soil are stuck together as aggregates, leaving pore spaces in between. In this activity, students will learn about soil aggregation and why it is important for a healthy soil.

Introduction to Methodology
Students will perform a simplified version of a wet aggregate stability or slake test, which immerses soil aggregates in water to determine how strong they are. Students will compare an undisturbed healthy soil to a disturbed soil and think about ways we can preserve soil's structure and prevent erosion.

Terms/Concepts

Pores – the empty spaces between soil aggregates
Aggregates – clumps or clods of soil held together by organic matter
Aggregate stability – a measure of the ability of aggregates to resist breaking apart
Soil structure – the arrangement of aggregates and pore spaces. Soil has good structure when aggregates are strong, and there is a mix of large and small aggregates and pore spaces. A healthy soil has good soil structure
Erosion – the transport of soil, rocks or sediments over time from one location to another by wind and water
Microbes – Microscopic organisms, including bacteria, fungi and protists
Organic Matter – Material derived from living organisms, such as leaf litter, decomposing roots, etc.

Setting the Stage/Opening Question

Ask: "Is soil solid?"

Show students a soil sample and allow students to look closely at it. Help them notice that soil has both solid particles, called **aggregates**, and empty spaces, called **pores**. Explain that soil particles stick together in clumps, called "aggregates." The "glue" that holds them together is a combination of plant roots, organic matter, such as dead plants and microbes, and sticky gel-like compounds produced by microbes. In this way, microbes help build their own house.

Soil structure is the arrangement of aggregates and pore spaces in soil. A healthy soil has good structure, which means a mix of large and small aggregates and pore spaces.

Ask: "Why is it important to have strong aggregates?"

The stronger these aggregates are the more the soil can resist being eroded away by wind or water. Consider showing your students images of eroded soils so they can connect to real world scenarios.

Ask: "Why are the empty spaces, or pores, important?"

Strong and large aggregates also means that there is more pore space in soil. Pore spaces allow water to infiltrate and drain, allow oxygen/air flow and give space for soil organisms to live.

Strategies to Increase Student Engagement

DEMONSTRATE: Show students that soil is not solid by gently pouring water over a well-aggregated dry soil sample until it is submerged. The bubbles rising from the soil is the air that was trapped in soil pores!

DEMONSTRATE: As an analogy, pour water over a pile of flour (representing unstructured soil) and then on a piece of bread (representing a structured soil with lots of "glues"). Which is eroded more easily?

TRY TECHNOLOGY: SLAKES is an app that lets you measure aggregate stability using your smartphone! https://soilhealthinstitute.org/our-work/initiatives/slakes/

Ask: "What are some things we do that can break down aggregates and disrupt soil structure?"

Disturbing or breaking up the soil by digging or tilling will break down aggregates. Walking on soil while it is wet also can compact and break down aggregates. Removing organic matter (e.g. having bare soil instead of mulching or planting) means less "glue" to help soil hold together.

Experience

1. Collect soil samples (may be done ahead of time and dried):
    a. Select at least two locations: one should be an undisturbed place, like a forest, and one should be from a disturbed location, such as a construction site, lawn, tilled farmers field or garden.
    b. Using a trowel, gently loosen and lift soil, being careful not to disturb the clumps of soil.
2. Have students work in small groups. Give each group two mason jars filled with water to about 1 cm below the top and two strainers.
3. Select an aggregate from each soil sample that is approximately the size of a golf ball. Place one aggregate into each strainer.
4. Gently lower the strainers into the top of jars at the same time. The bottom of the mesh should be submerged in water. Record observations.
5. After five minutes, raise and lower the strainer in and out of the water five times.
6. Record observations, noticing if the aggregates are disintegrating.

Figure 1. Wet aggregate stability test using sink strainers and canning jars. The soil sample on the left is from an undisturbed forest site and has a higher aggregate stability – it is holding together well when submerged in water. The sample on the right is from a managed turfgrass lawn and disintegrates when submerged in water - note the particles clouding the water and accumulating at the bottom of the jar.

Share

Ask, “Which sample had the greatest aggregate stability? Which had the least?”

Process

Ask, “Why do you think the sample with greater aggregate stability held together more strongly? (Think about where it was collected .)”

Ask, “Why is organic matter important in aggregate formation?”

Generalize

Ask, “Which of these soils would be more likely to be eroded from wind or rain?”

Ask, “Which of these soils makes a better habitat for soil organisms? Why?”

Ask, “Which of these soils would a plant prefer to grow in? Why?”

Apply

Ask, “What are some ways we can preserve soil structure?”

References

Hetrick, Ketterings et al. ***Improving Aggregate Stability.*** Cornell University Cooperative Extension Agronomy Fact Sheet 95.

Wszelaki and Broughton. ***Building Healthy Soils.*** UT Extension W235-C.

Notes

Supplemental Information
Educational Standards Met

4-ESS2-1. **Earth's Systems.** Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.]

MS-LS2-4. **Ecosystems: Interactions, Energy, and Dynamics.** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

MS-LS2-5. **Ecosystems: Interactions, Energy, and Dynamics.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

TIPPS
Life Skills

- Head – Thinking
- Health - Living

Student Worksheet

Name: ______________________________ Date: _______________

1. **On the table below, fill out the following information:**

    a. **What type of soil was in each jar? Where was it collected?**
    b. **What did you observe when the soil was placed in water? Write a description or sketch a diagram.**

	Jar 1	**Jar 2**
Soil sample description		
Observations		

2. **How did the soil samples react when placed in water?**

3. **Did both soil samples react the same way? Which had the greater aggregate stability (resistance to breaking apart)?**

4. **Which soil do you think would be more resistant to erosion from a rainstorm?**

5. **Which soil would make a better habitat for soil organisms and plant roots? Why?**

6. **What are some ways we can protect soil structure?**

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