4.4 Great Terrain Robbery

A Model of Land Use and its Effects on Runoff & Erosion

Overview

Students will investigate the rate of runoff and erosion on different land surfaces.

Lesson Planner

Use the table below for lesson planning purposes.

Grade Level(s)	3– 6
Time Required	**Preparation**: 1 hour **Experiment**: 30 minutes
Key Concepts/Terms	Water Cycle; Watershed; Erosion & Runoff; Soil Conservation; Water Quality; Scientific Method
Prerequisites	Watershed, Water Cycle, Scientific Method
Setting	Outdoors/Indoors with a large table, Whole Class

Learning Objectives

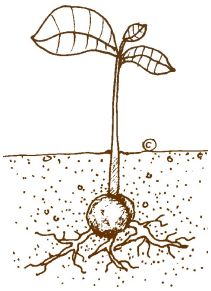
After completing this activity, students will be able to…

- Explain the effect of land use on runoff, erosion, and water quality.

Materials Required

The following materials are required for this activity:

- 3 dishpans notched in one end, with spouts attached (see the illustration of the experiment setup below)
- Soil for all the bins (the same amount and type)
- Soil cover materials: mulch and grass sod
- One watering can per dishpan of soil (each one needs to be the same size watering can, with the same type of spout on each one)
- 1 liter measuring containers
- A large-mouthed collection vessel for the runoff from each dishpan – these should be identical in size and shape and clear
- A prop for each dishpan (2x4's work well for this. All the bins need to be at the same slope.)



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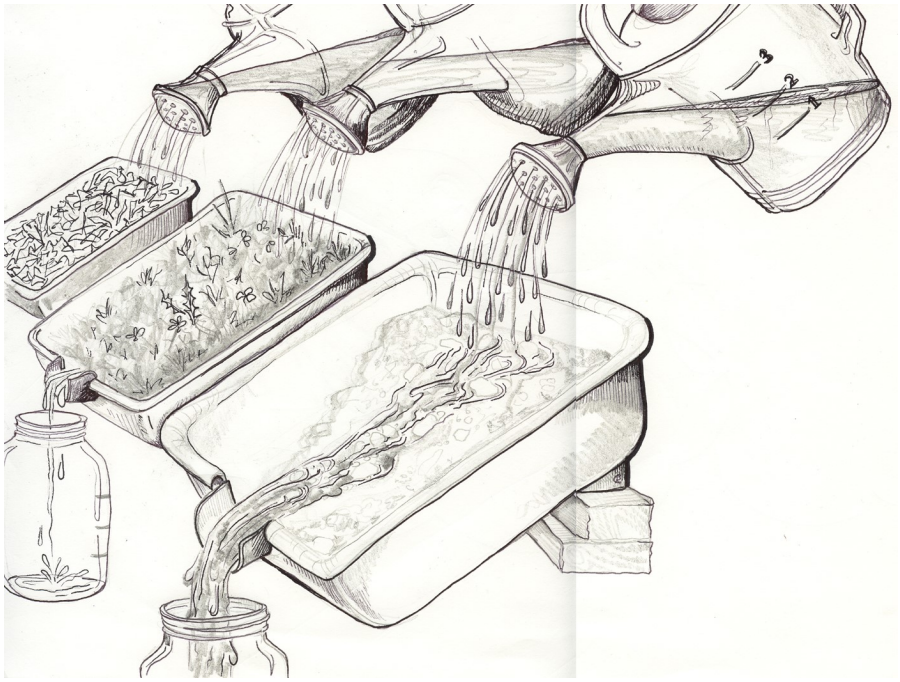
Experiment Set-Up Diagram



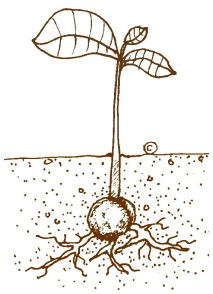
Background Information

Soil as a Natural Resource

Soil can be considered a non-renewable natural resource because the formation of new soil is a very slow process. In temperate areas like the Chesapeake Bay watershed, it takes two hundred to one thousand years, depending on soil and climate type, to renew just one vertical inch of topsoil.

What is the Problem?

During farming and building activities, the plant material that covers, protects and holds the soil in place is disrupted, removed, or paved-over. When soil is left uncovered, it is more easily moved by wind and water, which is called **erosion**. Erosion often moves soil into creeks, rivers, and bays, a process called **sedimentation,** which decreases water quality and disrupts aquatic life. Worldwide, soil is eroding on farmland at seven to two hundred times the natural rate of soil renewal.



As more land is covered by impermeable surfaces such as pavement or asphalt, water cannot soak into the soil and runoff increases. Water moves more quickly over impermeable surfaces, and this fast water has more power to carry sediments, pollutants and trash into the nearest waterway.

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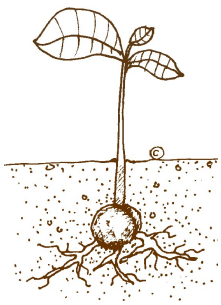
Procedure

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what teachers might say to students.** *Items in italics are possible student answers to questions.*

Phase	Step	Action
Engage	1	Prepare 3 bins of the same size, as depicted in the ***Experiment Set-Up Diagram***, pg. 4-20. The bins should each have the same amount and type of soil (constants in the experiment), but vary in the surface covering (independent variable). The soil coverings for the three bins should be: a) Mulch, b) Grass sod, and c) No cover.
	2	Place prepared soil bins in a central location so all students can view the surfaces. Bins should all be raised at the back (the end away from the runoff spout) the same height, so that the slope is the same for all of them (see ***Experiment Set-Up Diagram***, pg. 4-20).
Engage	3	**Say: "Where have you seen real life examples of ground that looks like each of these bins?"** *Answers will vary, but may include:* • *Mulch is found on flower beds, gardens, new roadcuts, lawns, and playgrounds.* • *Grass sod is found in lawns, parks, road sides, school yards, and playing fields.* • *Exposed soil is seen on farms/gardens before crops are planted, next to roads, under playground swings, and construction sites.* • *Impermeable surfaces are found on roofs, sidewalks, cement areas, roads, and parking lots.*
	4	**"Why is soil important to us?"** *Soil is needed for food production, used for building surfaces, provides homes for animals, supports plants, etc.*
Explore	5	**"We are going to conduct an experiment about water runoff and soil erosion** (review these terms with students, if necessary)**. These soil bins are models to demonstrate what happens to different land surfaces when it rains."**



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Procedure (continued)

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td rowspan="3">Explore</td><td>6</td><td>“What are the parts of a well-designed experiment?”

Use the table below to lead students to identify the parts of the experimental design.

<table>
<tr><th>For this Experiment the…</th><th>Is…</th></tr>
<tr><td>Independent Variable</td><td>• Soil Cover</td></tr>
<tr><td>Dependent Variable</td><td>• Amount of Runoff
• Clarity of Runoff</td></tr>
<tr><td>Constants</td><td>• Bin size, shape, material, slope
• Soil amount and type
• Water amount, type and temperature
• Watering can/applicator type
• Water application (speed, height, same start time)
• Runoff collection jar type, size, shape</td></tr>
</table>
</td></tr>
<tr><td>7</td><td>“We are going to model a rainstorm and catch the runoff in the jars. The jars represent the river.”</td></tr>
<tr><td>8</td><td>“We need to make some hypotheses before we run our experiment.”

Ask students the following questions to formulate hypotheses. Students do not need to all agree.

• “Which land surface will have the most runoff?”
• “Which land surface will have the least runoff?”
• “Which land surface will have the most erosion?”
• “Which land surface will have the least amount of erosion?”</td></tr>
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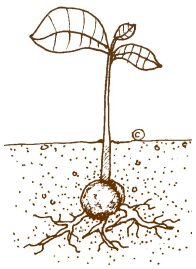

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Procedure (continued)

<table>
<tr><th>Phase</th><th>Step</th><th>Action</th></tr>
<tr><td rowspan="4">Explore</td><td>9</td><td>Assign student jobs as follows:

<table><tr><th>Job</th><th># of Students Needed</th><th>Location of Students</th></tr><tr><td>Measuring water</td><td>3</td><td>A flat surface</td></tr><tr><td>Pouring water</td><td>3</td><td>Above the top of the bin slope</td></tr><tr><td>Catching runoff</td><td>3</td><td>At the base of the bin slope, holding the collection jar under the lip of the spout.</td></tr></table></td></tr>
<tr><td>10</td><td>“We need to make sure that all rain-makers start the rain at the same time. Ready, set, go!”

Students simultaneously pour water at the same rate.</td></tr>
<tr><td>11</td><td>“We need to make some observations about the amount of runoff and erosion on each land type.

• “Which bin had the most runoff?” Uncovered soil (This is measured by the volume of water collected in the runoff collection jar.)
• “Which bin had the least runoff?” Grass Sod
• “Which bin had the most erosion, as demonstrated by water clarity?” Uncovered soil
• “Which bin had the least erosion, as demonstrated by water clarity?” Grass Sod</td></tr>
<tr><td>12</td><td>“So how do our results compare with our hypotheses?”</td></tr>
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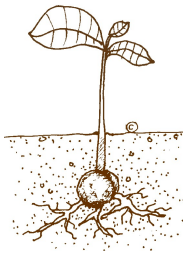
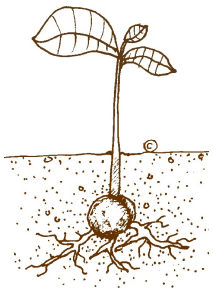


Procedure (continued)

Phase	Step	Action
Explain	13	**"How can we explain the results?"** *Student answers should include:* • *Grass and other plants slow the water down, so it cannot move as much soil as it can on bare earth.* • *Roots of the plants open up channels for the water to soak into the soil, so there is less runoff.*
	14	**"Why is erosion a problem?"** *Student answers should include:* • *The top soil layer is important for growing food, and takes a long time to form.* • *Soil isn't good in our waterways because it blocks the sun so plants cannot photosynthesize, which disrupts food webs; smothers gills and eggs; etc.*
	15	**"How can erosion and runoff be slowed or prevented?"** *Protecting/covering the soil with vegetation, or mulch if vegetation is not possible, will help slow/prevent runoff and erosion.*
Elaborate	16	Take a schoolyard "field trip" and have students explore water pathways to discover areas of runoff and erosion. This would be particularly effective on a rainy day!
Evaluate	17	***Designing a Schoolyard***, pg. 4-71



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Vocabulary

Understanding of the following terms is useful in this activity.

Term	Definition
Erosion	The movement of soil by water or wind
Runoff	Water that is not absorbed into the ground and flows over the land, often carrying sediments or pollutants
Infiltration	In the water cycle, water moving into the pores or spaces between soil particles
Impermeable	Not allowing passage of water to the ground beneath; examples of impermeable surfaces include cement and blacktop
Mulch	Straw, wood chips, leaves, or other material spread over the soil as protection; these also control weeds and reduce water evaporation from the soil