Water Wonders

PLT activity #44 **Goal 2: Urban Forests' Benefits and Costs**

Overview

An urban forest has the ability to mitigate the negative effects of urban development by reducing storm water runoff, lessening soil erosion, decreasing water pollution, and recharging aquifers. This exercise is an extension to the PLT Activity #44, *Water Wonders.* It uses three different models to demonstrate how land use can affect water quality and water supply in urban areas.

Grade Level: 3 – 8
Time Considerations: 1-2 days
Subject Area: Science
Skills: Observing, Measuring, Predicting, Comparing, Contrasting, Evaluating, Analyzing, and Concluding
Relevant Standards:
SC.D.2.2, SC.D.2.3 – The student understands the need for protection of the natural systems on Earth
SC.G.1.2, SC.G.1.3 – The student understands the competitive interdependent cyclic nature of living things in the environment
SC.H.1.2, SC.H.1.3 – The student uses scientific processes and habits of mind to solve problems

Objectives

Students will be able to **1)** state how an urban forest, paved area, and compacted area respond after rainfall; and **2)** explain how an urban forest can help communities reduce erosion and flooding, improve water quality, and recharge aquifers.

Materials

Each Group Should Have: Three 2-liter soda bottles, 1 empty plastic juice/milk jug, 3 pie pans, blocks or books, watch with second hand, 1 measuring cup, 1 tablespoon, soil, small section of grass, plastic wrap, food coloring, vegetable oil, colored sprinkles, and water. The teacher should have a box cutter.

Background

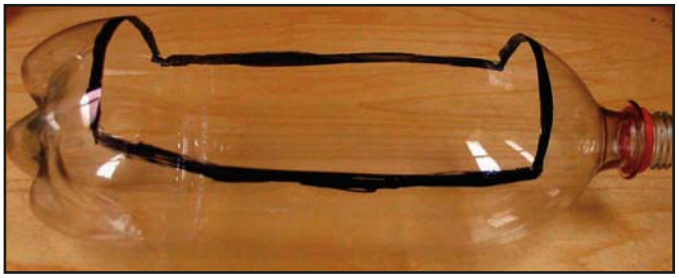
When it rains, leaves, branches, and stems intercept rainfall, reducing the speed water reaches the ground; this allows water to infiltrate underground more slowly. Trees and other vegetation have the ability to keep soil in place and absorb water. In fact, the roots of a moderately sized tree can absorb up to 400 gallons of water a day.[1] In addition, roots can absorb some chemical pollutants while soil can help filter out most particulates. Examples of pollution in urban areas include oil from cars, excess fertilizers from lawns, and litter.

If rain falls on impervious surfaces such as a street or parking lot, it will run quickly along the surface and pick up chemical and particulate pollution. Fast moving water is less able to soak into the ground and has the potential to cause flooding.

If rain were to fall on bare soil, that water could wash away a variety of loose materials and chemicals. This could cause soil erosion and sedimentation problems in streams, rivers, or storm drains. A 1996 study by the American Forests found that Fort Lauderdale's urban forest reduced the volume of storm water by as much as 18%. If some of that water were filtered through the urban forest it could recharge underground aquifers. Thus, towns and cities that remove their trees and fill in their open space will need to construct and maintain a larger storm water drainage system to handle the increased runoff. Maintaining or increasing the urban forest can help communities be more cost effective by conserving water, reducing erosion and flooding, and decreasing chemical pollution which improves quality of water.

Getting Ready

1) In advance, collect enough 2-liter bottles so that each group of students can have 3 bottles. Then cut all of the bottles with a box cutter to make a hole along their lengths.



2) Make a watering can for each group by puncturing small holes in the cap of a plastic jug.

Pre-Activity Questions

1) How can water become polluted in urban areas?
2) How can trees and other vegetation improve water quality?
3) Define: aquifer, erosion, impervious surface, pollutant, runoff, and watershed.

Doing the Activity

1) Group students into teams. Each team member should be assigned a role: model builder, timer, recorder, or pan holder.
2) Give each team three pre-cut 2-liter bottles and ask them to prepare the following models: Urban Forest, Paved Area, and Compacted Soil Area.

Urban Forest Model

Place 1 cup of soil in bottle. Dig up a small section of grass from the study site and place it in the bottle on the soil.

Paved Area Model

Place 2 cups of soil in bottle. Cover with 4 layers of plastic wrap. Tuck wrap around edges inside the bottle.

Compacted Soil Area Model

Place 2 cups of soil in the bottle. Press down with hands.

For best results, allow all models to sit in sun for 1 day which allows soil to dry evenly.

3) While keeping model level add the following pollutants:

a) 1 tablespoon of colored sprinkles to represent litter.

b) 2 drops of food coloring or quarter of a teaspoon to represent nitrogen and phosphates found in most fertilizers.

c) 1 tablespoon vegetable oil to represent motor oil.

4) Predict what might happen when "rain" falls on each model using the data sheet.

5) Have groups prop up one model at a time 30 degrees or three thumbs high with a book or wood block. Place an empty pie pan at the open end of the model to catch runoff. The timer and recorder should get ready. One person should hold the pie pan.

6) Add 2 cups of water into watering can.

7) SLOWLY sprinkle 2 cups of water to represent rain on model for at least **ONE MINUTE.**

8) Immediately note the time in seconds when runoff starts to enter the empty pie pan. After sprinkling all two cups of water into the model students should observe the following using the data sheet as a guide: color of water and presence of oil, soil, and sprinkles in the pie pan.

9) Pour runoff from the pie pan into a measuring cup, measure its volume, and record it on the data sheet.

10) Repeat steps 3-9 for the other models.

11) After all of the models have been tested ask student groups to analyze their results and draw their own conclusions.

Post-Activity Questions

1) What happened in each model? Did it match your prediction?

2) In which model would groundwater recharge be best?

3) In which model would soil erosion be greatest?

4) Which model reduces water pollution the most?

5) How does an urban forest improve the quality of water, reduce runoff, lessen soil erosion, and recharge aquifers?

Assessment

Ask students to write a paragraph explaining how trees can improve water quality, reduce runoff, recharge aquifers, and cost cities less money.

Enrichment

The next time it rains students should observe how water moves across their study site. Ask students to point out where water soaks into the ground and where it runs into storm drains. Then discuss as a group how vegetation can change the flow of water running across their site.

Related PLT Activities

Every Drop Counts #38
Improve Your Place #96

Endnotes

[1]American Forests. Urban Ecological Analysis of Dade County: Executive Summary, April 1996, For Urban Ecosystem Analysis Reports in U.S. Metropolitan Areas
http://www.americanforests.org/resources/rea

Urban Forest Extension – Water Wonders: Data Sheet

What do you predict will happen when water falls on each model?

Urban Forest:

Paved Area:

Compacted Soil Area:

What did you observe?	Urban Forest	Paved Area	Compacted Soil
When did runoff start flowing into the pan? (measured in seconds)			
What color is the water in the pan?			
Do you see soil, sprinkles, or oil in the pan?			
Measure the water in the pan. Is it the same amount as when you started?			
How has the model changed?			

What are the variables in this experiment?

How did you control those variables?

How does replicating an experiment improve a conclusion?

Make a chart or graph of your results. Do you see any patterns or trends?

Did your result support your initial hypothesis?

If these three different models demonstrate how land use can affect water quality and water supply in urban areas, what would you conclude?