About the Guide

ecology center

The Ecology Center welcomes you to Terrain for Schools, a unique current events–based curriculum for colleges and high schools. Lessons in this guide address California State Content Standards for grades 9-12 in three categories: science, social studies, and language arts. Overviews and applicable standards are found on the first page of each lesson.

The lessons are designed to be used with articles in the Summer 2005 issue of Terrain, which is available available on the web at www.ecologycenter.org.

Teachers: Photocopy this material as needed. Loan the guide to fellow teachers. We welcome your feedback.

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SCIENCE

Urban Runoff

By Sarah Toas

Overview

Students will:
- Learn about the problem of urban runoff.
- Identify opportunities to store, route, and filter stormwater.
- Create an alternative stormwater management plan for their school.

Terrain Article: “Slower, Softer, Greener,” Summer 2005, pages 20-21.

Introduction

Water falls as rain, it churns as the ocean, and it courses rapidly over streets after a downpour. The rain that falls over a town or city, sliding off its roofs, down storm drains, and over driveways and streets, is called urban runoff. When rain passes over driveways, streets, and roofs, it picks up pollutants, including sediment, motor oil, pesticides, and fertilizers. The water that we use to wash our cars and water our gardens can also contribute to urban runoff. Because of its pollutants, urban runoff can harm the larger bodies of water into which it drains – like the San Francisco or the San Pablo Bay.

Rainwater that falls in a natural habitat runs over the soil surface into a nearby water body, and it also slowly percolates through the soil strata (layers) that mechanically and chemically remove contaminants from it. Paved city streets, driveways, and parking lots prevent rainwater from falling on the soil, which would filter pollutants with its network of plant roots and soil microbes. Unfortnately, when rain falls on lawns or gardens, the water often picks up chemicals that homeowners apply to keep their lawns green and their gardens weed-free. But pollutants aren’t the only problem – the paved environment of the city guides the pace and volume of the runoff, resulting in erosion, flooding, and overflowing storm sewers. These sewers drain enormous amounts of water directly to nearby lakes, streams, and bays, without any treatment of contaminants in the runoff.

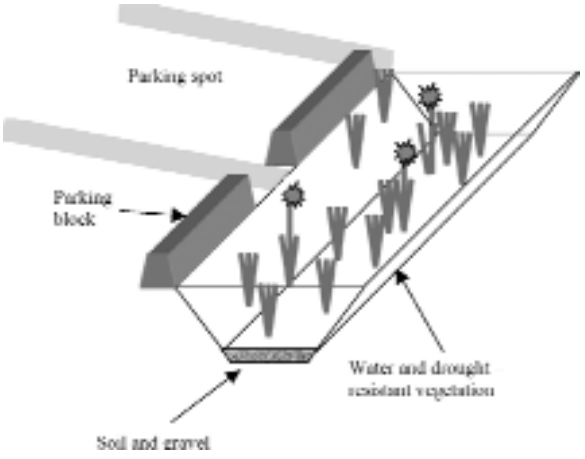
Innovative cities such as Portland, Oregon are replacing portions of roofs and streets with plants and soil to restore the filtration of stormwater. By putting soil and plants along sidewalks and on roofs, rain follows a slower, cleaner path through the city and back to the bay.

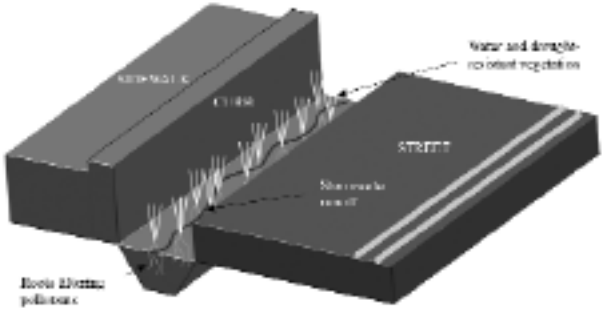
CA BIOLOGY/LIFE SCIENCES STANDARDS, GRADES 9-12: Ecology 6. Stability in an ecosystem is a balance between competing effects. b. Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of non-native species, or changes in population size. Investigation and Experimentation 1.m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include... land and water use decisions in California.

STORMWATER TREATMENT ALTERNATIVES

Bioswale

A bioswale is a wide, shallow, man-made ditch meant to replace traditional gutters and curbs in parking lots and streets. The bioswale slows the speed of urban runoff and stores water until it can be filtered by the vegetation and soil in the bioswale. By serving as a temporary storage, a bioswale reduces the volume of runoff during a storm. A bioswale is usually trapezoidal with a flat bottom. Both the sides and the bottom of the trapezoid are planted with water and drought-tolerant plants. The plants must be as tall as the expected depth of stormwater flow. Bioswales are often 200 feet in length and 6 feet in width, but will vary in dimensions depending on the site and soil conditions.



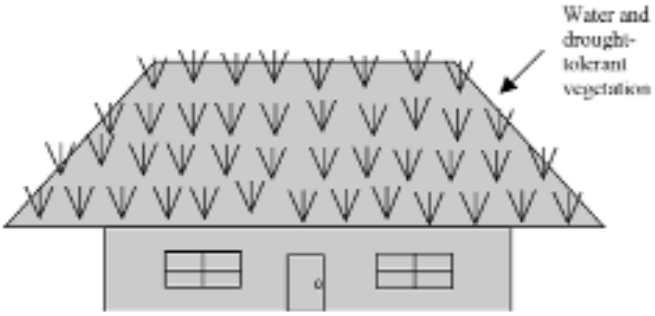


Stormwater Planter

A stormwater planter is a small garden planter with water-tolerant vegetation. Stormwater planters can be located in a plaza and have storm drain spouts routed underground to them. They can also be located at the edges of roads, below the grade of the curb and street, to store and filter stormwater during a storm. A cut in the curb allows stormwater to drain into the planter.

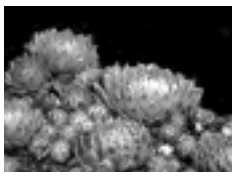
Greenroofs

A greenroof replaces a standard roof with vegetation and soil and/or gravel over a waterproof membrane. The roof's soil and vegetation capture rainfall, which either evaporates, transpirates, or is slowly filtered and discharged to the stormwater system.



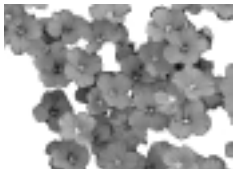
Greenroofs are designed to support the increased weight of the soil and vegetation. Because plants convert the sun's energy into humidity and soil moisture, greenroofs keep houses cooler. Greenroofs can help dampen the "urban heat island" effect, which is the increase in temperature in a city due to the prevalence of dark surface areas that absorb the sun's energy. Greenroofs also provide habitat for insects and birds.

Greenroof plants are low maintenence and suited to live in a shallow soil bed. They are able to tolerate harsh conditions on a rooftop, such as high sun exposure, little to no water, and high winds. Many of the following plants are used on greenroofs:



Sempervivum

Phlox



Aubrieta

Antenaria

Armeria

Sedum

Rainy Day Schoolyard Tour

Activity

Students will examine and chart how stormwater flows on school grounds.

Materials Needed
- Umbrellas, raincoats, or trash bags as improvised raincoats
- Copies of a map of the school grounds, one per pair of students. (Or maps that depict sections of the grounds.)
- Copies of the symbols key, one per pair of students
- Clipboards or old books to be used for writing surfaces
- Transparencies (optional) to cover the map on the clipboard to keep the map dry during the activity

Teacher Directions
Assign students to pairs. Choose four areas of the school grounds that you would like to explore with your students. Recommended areas: near a downspouts, a parking lot, a driveway, aa playing field, or a school garden. Prior to going outdoors, have class create pollutant symbols and add them to their symbol legend.

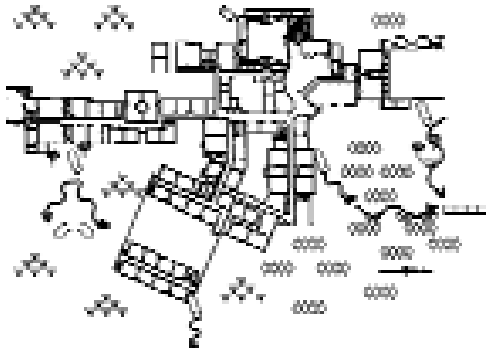
Student Directions
On a rainy day, grab your raincoat and umbrella and go on a stormwater runoff hunt! Draw and note your findings on a map of your school property using the symbols on the attached legend.

1. On your map, locate the storm gutters and the downspouts. Where do the downspouts end? In a drain in the ground or gravel? On to a paved surface or into a garden? Draw these on your map using the appropriate symbols from the legend.
2. Are there any city storm drains within the mapped area? Mark them on the map using the appropriate symbol.
3. Mark any gravel, mulch, or pavement on your map using the symbols from your key.
4. Is there water running through vegetation? Indicate the path of the water using a dotted line. Use an arrow to indicate the direction of flow along the ground. It should look like this:

5. Identify any natural bodies of water on the school property by drawing these on your map using the solid line symbol.
6. Identify any pollutants you see using the symbol you created.
7. Where is water collecting on school property? Indicate these on your map using the symbol for depressions.
8. Is there a high point on the school property from which the rain water is flowing down? Indicate these on your map using the symbol for elevations.
9. Do you see rivulets of rainwater? Indicate these on your map using the appropriate symbol from the key and an arrow to indicate direction.

Stormwater Legend

Sample of Final Product



Discussion Questions

Students will discuss their stormwater runoff findings.

1. If you identified any pollutants, where were they coming from?
2. Does the water flow you saw end up in one place? Two places? Where?
3. Where does the system of storm drains on your school building channel the stormwater? Does it end up on a paved surface or a pervious surface?
4. Where does stormwater flow in the school parking lot? Does it lead to a garden? Is it routed through a bioswale? Does it run rapidly to a low point in the parking lot?
5. Is your school using stormwater treatment alternatives such as bioswales, stormwater planters, or ecoroofs to store, route, and filter stormwater?
6. What is one thing you could do to filter stormwater runoff at your location?

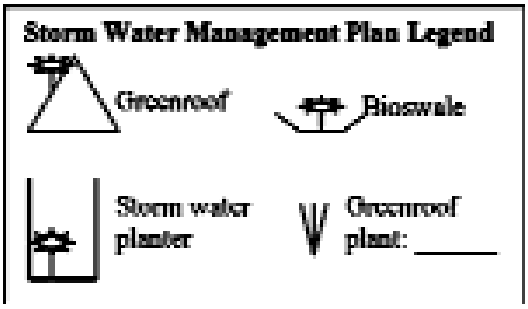
Planning for Stormwater Runoff

Activity Extension

Using their findings from the rainy day lab, students will design improvements in the way the school slows, routes, and filters its stormwater before it drains into the city stormwater system.

Teacher Directions
Pair students with their partners from the rainy day lab. Have them take out their runoff maps. Give them a large sheet of paper (butcher paper works great) or have them tape two pieces of recycled 8.5" x11" paper together.

Student Directions
1. With your partner, copy the map section that you focused on during your rainy day tour on to a large piece of paper.
2. Once you are done, look again at the stormwater map you created with your partner. Where do you think the stormwater runoff the most polluted? Circle it. This will be the basis for your stormwater runoff plan.
3. What is the best way to manage the stormwater here? Consider the various options, including stormwater planters, bioswales, and greenroofs.
4. Identify opportunities for re-landscaping your site to modify the flow of stormwater and improve water filtration. Will you use special plants?
5. Identify barriers to implementing your improvement. Is there adequate space to implement your stormwater runoff solution? How would you go about making space for your improvment?
6. Draw your changes. You may use symbols from the legend below to help. Once you are done with you changes, use arrows to indicate how stormwater flow will be modified as a result of your design changes.



Wrap-up and Assessment

Students will develop a presentation which defends their storm water management plans.

Student Directions
On a piece pf paper, answer the following questions thoroughly with a partner. These answers will form the basis for your informal class presentation. The stormwater plan will be your visual aid.

**** Assessment Short Cut****
Via a lottery, pick only two groups to give the presentation. The average of the two grades is recorded in the grade book for all the students in your class.

1. Where is your runoff management plan located?
2. What is your major change or improvement? Why did you choose this particular area for improvement?
3. Where is the stormwater being routed? What is filtering the stormwater?
4. How is your site used? How did students, teachers, and staff use your site before you redesigned it? Is there enough space for the same number of students and teachers to use your redesigned site?
5. What other things might need to be redesigned as a result of your proposed changes in stormwater management? (eg. changes in transportation, parking structures, or the use or design of playing fields)
6. How will the modifications you propose change the way people use and experience your site?
7. If you were selling this plan to the principal, would you foresee any resistance to the changes you propose?
8. How would you encourage the prinicipal to adopt the changes you propose?