IYS Soils Activity

Soil Science Society of America

Where Does All the Rainfall Go?

Summary

Participants will explore various factors that influence the amount of runoff that occurs when rain falls on the landscape by comparing the amount of runoff generated from a given area of bare soil, the same area with a portion covered by an impervious surface (simulating pavement, roofs, etc.), and the same area with a portion of the impervious area converted to a simulated "rain garden". The activity can easily to modified to explore the effects of slope, soil texture, antecedent moisture content, soil bulk density, the amount of impervious area, or soil cover (e.g., mulch, vegetation, erosion control fabrics) on runoff volume.

Learning Objectives/ Outcomes

1. To investigate the influence of impervious surfaces on runoff volume, which can be directly related to how urban and suburban development can greatly influence hydrology and the need for stormwater management.
2. To investigate how rain gardens can reduce runoff volume and be a critical part of stormwater management.
3. Related topics include the ability of soil or composts in rain gardens to clean water before it is eventually discharged into surface waters.
4. For computations, the runoff coefficient (runoff volume/rainfall volume) can be calculated.

Materials (per student, group etc.)

All materials are readily available in retail outlets. Substitutions are easy to make if necessary. This demo used three runs total, using a single pan that was refilled with fresh, dry soil prior to each run. Additional pans could be purchased to fill with soil in advance.

- Set of two foil disposable rectangular cake pans, 12 1/4 by 8 ¼ by 1 3/32 inches. One pan is used to hold the soil and the other is used to capture runoff.
- 1000 mL measuring cup
- 3 pieces of 2 by 4 lumber, each 9 inches long
- Watering can, spray bottle, or sprayer
- Gridded template plastic (available where quilting supplies are sold), 12 × 18 inches
- Compost or small bag of potting soil. Less than 1 pound is required.
- Approximately 30-40 pounds of mineral soil (can use topsoil sold at a garden soil (40 lb bag) or collect local soil)
- Scissors
- Small binder clip
- Plastic spoon

Ages of Audience

1. Elementary
2. Middle School High School
3. Adults

Recommended group size?

20-50

Where could you offer this?

1. Local school
2. Any place with an audience that is interested in runoff or storm water management.

What type of room do you need?

Floor that can get wet and dirty, or outdoors on grass or cement.

Type of Lesson (may be more than one)

1. Hands-on (participants touch the stuff)
2. Outdoor
3. Indoor
4. Demonstration (scientist or teacher demo, outside professional)
5. Experiment (follow procedure, get results, interpret results)

Time Needed

1. Scientist prep time + cleanup time

   Most of the prep time will be acquiring the supplies. The actual setup of the experiment can be participatory, so no advance prep time is necessary. Cleanup time will depend on the location. If done outdoors on grass, no cleanup will be necessary other than disposal of the soil used in the runoff pans. If done outside on cement or indoors on a floor that can get dirty and wet, minimal time will be required to clean up spilled soil and water.
2. 30 to 60 min depending on how many variables are tested.

Methods/Procedures

1. Cut two, 3 by 12.5 inch pieces of the gridded template plastic using the scissors. Cut a rectangular section, 2 by 6 inches, out of the center of one of these pieces.
2. Fill a cake pan to the rim with soil. Gently tap on the floor a few times to settle the soil and add more if necessary. Use a board to strike off any excess soil and to create a uniform surface even with the top of the pan.
3. Place the narrow dimension of the filled pan on two pieces of 2 by 4 and the other end of the pan on a single piece of 2 by 4. The runoff will travel the long dimension of the pan.
4. Place the empty pan at the downslope end of the filled pan to collect runoff.
5. Measure 1000 milliliters (mL) of water into your watering can (or spray bottle or sprayer) and distribute uniformly over the surface of the soil in the filled pan. Try not to place water anywhere but on

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the soil surface and do not apply water in one place for very long. The water should be added over several minutes. The volume of water should be sufficient to generate at least several hundred milliliters of runoff. If it does not, use more than 1000 mL but keep track of the total amount of water added. After runoff has stopped, use the measuring cup to determine the volume of runoff.

6. To simulate the effects of impervious surfaces on runoff volume, fill another pan of soil as described above. Place the 3 by 12.5 inch piece of gridded template plastic lengthwise in the center of the pan and secure at the top using the binder clip. This would be equivalent to converting an agricultural field to a subdivision. Repeat the application of 1000 mL of water (or the same volume as the first run) and measure the runoff volume.
7. To simulate the effects of a rain garden on runoff volume, fill another pan of soil as described above and place the other 3 by 12.5 inch piece of gridded template plastic (with the 2 by 6 inch center piece removed) in the center of the pan and secure at the top with the binder clip. Using the plastic spoon, as best as you can, scoop out all of the soil in the 2 by 6 inch area of the template and replace with compost or potting soil. Repeat the application of 1000 mL of water (or the same volume as the first run) and measure the runoff volume.

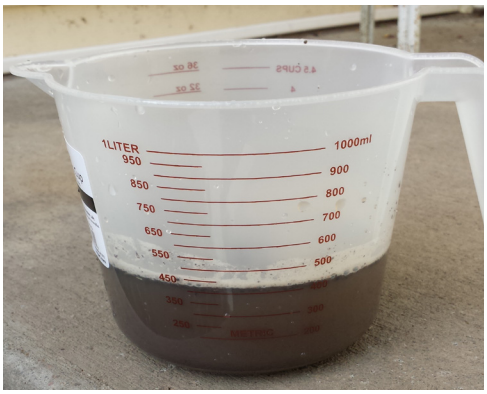
Discussion Questions

What would happen if:

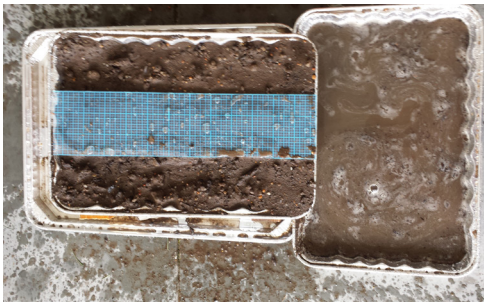
1. we placed three pieces of 2 by 4 under the pan at the upslope end (increasing the slope)?
2. we placed a piece of sod on top of the soil?
3. we increased the area of the pan covered by an impervious surface?
4. we increased the size of the rain garden?
5. we compressed the soil in the pan before we added the “rainfall”?
6. we used sand instead of soil?
7. we started with soil that was already wet?

A) Soil and potting mix are readily available in garden stores, or you can collect your own soil and use locally prepared compost.

B) Bare soil run ready to go.



C) We obtained 350 mL of runoff from 1000 mL of “rain” on bare soil. Plenty of soil moved too!



D) Simulated impervious surface in watershed increases runoff volume by 85%. Note the drastic soil erosion!

E) “Rain garden” construction. Potting mix was used to replace soil removed from the center of the pan. The rain garden helps to absorb water and slow runoff. Runoff volume was reduced by 23% compared to the impervious surface without the rain garden. Real rain gardens could function as wetlands, contain plants to use collected water, or simply retain water for slower discharge.