STORMWATER RUNOFF CALCULATION

Purpose & Goals

Purpose: This activity aims to discover how land use impacts surface water quality. With mathematical techniques used by stormwater professionals, we can assess how water ineracts with the landscape and therefore how human activities on the landscape effect water.

Goal: To connect the schoolyard's various land surfaces to local water quality by calculating rainfall and runoff coefficients. Students will be able to explain how landuse influences water quality.

Standards

Time: 45 min - 1 hr **Grades:** 4-9

STEM Math: 4.1.1.5., 4.2.1.1., 4.2.2.1., 5.1.1.4., 5.1.3.4., 5.2.1.1., 6.3.1.3.
STEM Science: 4.1.2.1.1., 4.1.2.2.1., 4.3.2.3.1., 4.3.4.1.1., 5.1.1.1.4., 5.3.1.2.2., 5.1.3.4.2., 6.1.2.1.1., 7.1.3.4.1., 7.1.3.4.2., 8.1.3.4.2., 8.3.2.3.1., 8.3.2.3.2., 8.3.4.1.2., 9.1.2.2.2.

Preparation & Materials

- Map of schoolyard (PDF provided by VLAWMO)
- Calculators (optional)
- Runoff coefficient tables & calculation worksheet (displayed or printed)
- Surface coverage measurements (optional, provided by VLAWMO)
- String (optional, if not using VLAWMO measurements)
- Pencils & scratch paper

Procedure

1. Referring to the schoolyard map provided by VLAWMO. Either refer to the measured areas provided by VLAWMO or make this measurement a part of the activity using string and the map scale. Use the runoff coefficient table to match the surface areas to the coffeciecents for each surface. While coefficients may not be exact according to the actual conditions on the site, an estimate demonstrates the themes of stormwater runoff.
2. Apply the coefficient value from the table to each surface cover on the schoolyard. Express these values on printed maps or on a projector/SmartBoard. VLAWMO can help with delniating surface covers and obtaining clear square foot measurments for each surface.
3. Do the math. For each surface area/coeficient region on the map, follow the equation. Make sure surface area and rainfall depth are in the same units.

Volume of runoff = surface area x runoff coefficient x rainfall depth

4. For better visualization of results, convert volume in cubic feet to gallons: multiply by 7.48 gal/ft^3
5. Clear the schoolyard map or use another map to again label each surface cover, this time with gallons of runoff. By setting a hypothetical rainfall event at a certain depth, you can now calculate the amount of runoff generated on the schoolyard during that rain event.

Reflection

Essential questions to promote real-life application.

1. Which surfaces shed more water, and which shed less? Why is this so?
2. What happens on pavement and turf grass that might effect water quality? How should this be managed?
3. If you were to design a schoolyard, which surface types would you use more of? Which would you use less of?
4. What would you tell visitors to your school if they wanted help keep water clean?

Assessment

At the end of the activity, students will have obtained an estimated total volume of runoff for a hypothetical rain event, and will be able to explain which land surface covers are benefitial, and which are risky to water quality.

Additional Notes

Coefficients: Coefficients are rates of runoff generated by research. Different surface areas have different rates of runoff. So depending on the surface, some water will infiltrate into the ground, some will runoff, and some will be taken up by plants, and some lost to evaporation.

While pavement is an easy and consistent estimation, coefficients for natural areas varies depending on soil type. Consolidating insight from a variety of sources, VLAWMO has gathered coefficients that are used in the Twin Cities region. The class may walk around the schoolyard to better observe soil types for a closer estimation of runoff. If soil is generally sandy, decrease the turf grass coeffficient by .5 and if clay, increase it by .5. You may choose to deliniate between sloped turfgrass or flat and estimate the square footage on the map by roughly dividing the provided square footage, or simply refer to the cofficient as flat, which is most common for schoolyards.

Spreadsheet calculation: The excel spreadsheet can be a post-lesson tool to show students the interplay between rainfall and runoff, experimenting quickly with different rainfall events. By consolidating the suface areas by their types, we can determine the percentages of runoff from each surface cover according to the total volume of runoff. This demonstrates which surface covers are shedding greater percentages of water, and can be of reference for the reflection questions.

Reflection questions: Common surface contaminants on pavement are road salt, leaky oil and brake dust from cars, leaves getting into stormdrains, sand and other sedmient, and litter. Grass, while having a lower runoff rate, still has fertilizer that bring excess nutrients and algae blooms into water, and pet waste, which has many nutrients, parasites, and worms, and harmful bacteria that should be kept out of water.

Rainfall depth: Most rainfall events are about 1.25 inches. You may use a recent rain event, or light/heavy rain events to provide a comparison in runoff volume. The worksheet shows two boxes at the top for rainfall, one for inches and one for converting it into feet for the calculation.

Supplemental tools:

Videos about stormwater runoff
University of Minnesota: https://www.youtube.com/watch?v=_sl-GBwNbLM
Puget Sound: https://www.youtube.com/watch?v=8b0X6EEJs3Q
Michigan: https://www.youtube.com/watch?v=N9HUoMnvsRw