Title: It's About to Sink In!

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Grade Level: 5 - 8

Estimated Lesson Time: Two 50-minute class periods

Overview: In this lesson, students will use topographic maps and GPS units to measure asphalt or concrete covered surfaces around their school (impervious surfaces). Using the GPS coordinates and basic measuring skills, students will determine how much area around their schools are impervious and pervious.

Standards:

Science:

Standard 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.

Standard 4.3: Students know major sources of water, its uses, importance, and cyclic patterns of movement through the environment

Standard 5: Students know and understand interrelationships among science, technology, human activity and how they can affect the world.

Math:

Standard 4. Students use geometric concepts, properties, and relationships in problem-solving situations and communicate the reasoning used in solving these problems.

Standard 5. Students use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.

Standard 6. Students link concepts and procedures as they develop and use computational techniques, including estimation, mental arithmetic, paper-and-pencil, calculators, and computers, in problem-solving situations and communicate the reasoning used in solving these problems.

Geography:

Standard 1. Students know how to use and construct maps, globes, and other geographic tools to locate and derive information about people, places, and environments.

Standard 3. Students understand how physical processes shape Earth's surface patterns and systems.

NETS:

Standard 5.1 Technology research tools

- Students use technology to locate, evaluate, and collect information from a variety of sources.

Standard 6.2 Technology problem-solving and decision-making tools

- Students employ technology in the development of strategies for solving problems in the real world.

Student Learning Goals: In this lesson, students will know and understand what impervious surfaces are and how they affect the environment as well as the advantages and disadvantages of the basic technology of paving or artificially covering surfaces on Earth.

Guiding Questions: What percent of your campus is covered with impervious surfaces? How does this affect where water goes when it rains or snows?

Instructional Plan:

Prerequisite Skills – Preparation:

1. Students should understand how to estimate the percentage or fraction of an area using basic mathematical principles.

2. Students should understand the difference between surfaces that have vegetation on them and surfaces that have been paved or otherwise "sealed" off from water permeation. Have students take a quick "fieldtrip" into the schoolyard where students ask themselves some questions about the various surfaces they see. Give the students the following questions to help to focus their questions about what they see.

1. You've no doubt wandered about your schoolyard in your time as a student. On rainy days, the sidewalk and asphalt have made the grounds a much cleaner place to travel across. In heavy rains where does all this water go?
2. Have you ever thought this might also have a negative effect on the environment around your school?
3. The larger areas that are covered by hard surfaces cause more water to quickly leave an area. What ways can that cause problems downstream?
4. If water quickly leaves an area after raining, what will happen to the plants around the covered areas?

There is another term for areas that have been covered by concrete, asphalt or other surfaces that water can no longer go through. They are called impervious. Lets determine how much area around your school has been covered with impervious surface area.

Instruction and Activities:

1. Use the topographic maps provided by your teacher to outline different types of ground cover around your schoolyard such as concrete sidewalks, asphalt tracks, metal roofs, grassy fields, and open dirt.

2. Shade the areas that do not absorb water and determine what fraction of your schoolyard is impervious. Determine the percentage of impervious ground cover by adding up the areas you have shaded and dividing it by the total area of the school. This is an estimate for now. If shapes are irregular, approximate that shape with a geometric shape that you do know how to calculate the area for.

3. Break students into groups by how many GPS units you have and have them walk around the features they have identified to be impervious. Be sure to include such areas such as the school building, parking lots, or any other surfaces that don't absorb water as well as to walk around the entire school grounds, saving a point at any corner of the property.

Plotting GPS Points without Computer

4. Without computers students could hand write their coordinates onto a sheet of paper so that they could plot the points by hand. It is recommended that you change your coordinates system in your GPS units to UTM as students will have less difficulty using the whole numbers on which these coordinate systems are based. Use a sheet of graphing paper with a scale of 1 box = 20 to 50 meters in order to have a good scale map. Note: The origin of the graph will not be at the origin (0,0) but whatever the southwest most point the student saved on their GPS. For example, the coordinates of the southwest corner of the schoolyard may be N4200006 and W628000. Your students will only be interested in graphing the last several digits in each UTM coordinate because the largest part of the coordinates won't change while walking around the relatively small area of the schoolyard.

Plotting GPS Points with Computer

5. Have the students download the GPS points using one of the GPS download programs available on the internet. DNR Garmin can be downloaded by a quick web search on "DNR Garmin", following the first link to the download program. Other free programs include the free versions of GPS Trackmaker, or EasyGPS. These both link to a wider variety of GPS units and have pay versions with more functionality as well. Another pay program that allows you to link digital photos to coordinates is ROBOgeo. One other GPS download program is OziExplorer. The GPSy program provides a download solution for the Macintosh computer. While each of these programs has a few features that are different from others they all work quite similarly. They enable to download the coordinates from your

GPS into different files with other useful formats that can be useable in your classroom.

6. Once students have hooked up the download cables to the computer and turned on their GPS units, make sure that the program recognizes the GPS. You may have to search through the ports to make sure the program finds which USB or serial port your GPS is attached to. Many laptops no longer come equipped with serial ports and you may have to buy a USB to Serial converter. Download the points that the students have saved from their treks around the schoolyard. You should see the list of points in a spreadsheet-like format showing on the computer screen.

7. Students may now use the File pull down menu of whatever program they are using to save the file in a useable format. If you only have Excel then save the file as either a .dbf or .xls format. Use the Insert pulldown menu to create an X,Y graph of your longitude (x axis) and latitude (y axis). If you are working with one of the programs that plots the points automatically then you may print your map directly. If you are using a GIS, export your files out to a shapefile so that you will be able to add in these points within the GIS with a single click of the button.

8. Once you have plotted the outline of your school and the outline of all the impervious surfaces, again shade in the areas that do not absorb water in your graph. If you are using a printed map or one drawn by hand, cut the impervious areas up into easy to calculate areas such as rectangles and right triangles to figure out the total area of the school ground and total impervious surface. Have the students divide the two areas and represent this fraction with an easier to understand fraction they may have dealt with in your classroom such as ½, 2/3 or ¾.

Resources:

1. Provide one GPS unit for each student or student group.

2. Provide Dry Erase or colored pencils to manually shade topo maps.

3. Obtain a topo map or aerial photo of your schoolyard. Several sources can be of use at this point. Terraserver-USA.com, Topozone, or NASA's Worldwind dataviewer, are excellent sources of topographic maps for anywhere in the US. Terraserver-USA, Google Maps, Microsoft Virtual Earth (maps.live.com) are great sources of aerial photography across the US.

4. Use the print screen function to capture the image from your screen and paste into a Word document, or print directly from your web browser once you've zoomed in to the school area of interest. Try to include the scale bar for reference in the picture.

5. Topo maps can also be purchased from the United States Geological Survey for your particular area if you have no access to internet resources. Laminating a full topo map allows you to use dry erase markers to color areas of your school re-usably.

Student Assessment / Reflections:

At the completion of the exercise, ask students to think about where the water that used to sink into the ground before it was covered up with concrete or asphalt might end up in a heavy rain?

Next time it rains see have students check if this is where the water goes.

Have half the students make a list of the benefits and disadvantages of getting the water to clear off the school grounds faster. Have the other half of the class make a list of the advantages and disadvantages of keeping the rainwater around longer.

What ways might the school keep help keep more of the rain water around to support a living environment?

Have students draw possible solutions to keeping a more pervious schoolyard.