



**Title: It's Going to Be a Hot One Today!**

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**Grade Level: 9 - 12**

**Estimated Lesson Time: Two 50-minute class periods**

**Overview:** Using GPS units and thermometers, students will measure the “heat island” affect that non-vegetative surfaces have on Earth experiencing these changes of temperature as they walk outside on a warm day.

**Standards:**

*Science*

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

Standard 3.2: Students know and understand interrelationships of matter and energy in living systems.

Standard 4.2: Students know and understand the general characteristics of the atmosphere and fundamental processes of weather.

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, and human activity and how they can affect the world.

*Math*

Standard 3: Students use data collection and analysis, statistics, and probability 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.

## ***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.

Standard 5: Students understand the effects of interactions between human and physical systems and the changes in meaning, use, distribution, and importance of resources.

Standard 6: Students apply knowledge of people, places, and environments to understand the past and present and to plan for the future.

## ***NETS***

Standard 1.2 Basic operations and concepts

- Students are proficient in the use of technology.

Standard 2.3 Social, ethical, and human issues

- Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.

Standard 3.2 Technology productivity tools

- Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.

Standard 4.1 & 4.2 Technology communications tools

- Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
- Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

Standard 5.1 & 5.2 Technology research tools

- Students use technology to locate, evaluate, and collect information from a variety of sources.
- Students use technology tools to process data and report results.

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:** Students will be able to use GPS units to record latitude and longitude coordinates and record temperature data associated with those coordinates. Students will be able to predict higher and lower temperatures relative to structures and vegetation on Earth's surface.

**Guiding Questions:** How have roads and buildings within cities affected local temperatures? Are there any disadvantages to urban hotspots?

## **Instructional Plan:**

### **Prerequisite Skills – Preparation:**

Prior to starting this lesson, have students read the Student Reading provided. After completing the reading, provide an opportunity for students to visit the United States Environmental Protection Agency website to learn more about the urban heat island affect.

### **Student Reading:**

Urban heating does more than just make it uncomfortable to walk across the parking lot on hot days. The extra heat absorbed by the earth heats up the air causing it to rise and change weather patterns. The rising air expands and cools but also draws with it dust and debris from the activity on the streets below. This phenomenon provides places for the rising moisture in the air to condense, creating slightly higher rainfall than normal around the city, yet robs areas downwind of rainfall. The increase in rainfall within the city runs off more quickly causing storm sewers and local creeks to rise and fall more quickly increasing erosion damage and washing pollution downriver. Since ground water is replenished slowly, quick runoff coupled with higher city demand drains underground stored water resources. With increased worldwide population migration to cities, climate change and access to ground water resources will become more problematic. The environmental protection agency has worked with some cities to remedy these impacts. Take some time to look through solutions that might help you come up with solutions to reduce the heat sources around your school. The site is [www.epa.gov/heatisland](http://www.epa.gov/heatisland).

### **Instruction and Activities:**

1. Prior to going outside to collect data, have the students create a table to record coordinates and temperature from their walk.

Longitude	Latitude	Temperature

2. In order to involve as many students as possible, break class into teams of three where one student operates the GPS, one writes down the coordinates and temperature observations (for a backup) and another is taking the temperature data or any other data you may want students to gather.
3. Give each group a regular or digital thermometer and GPS unit. (Some electronic thermometers come with data loggers that will automatically download the temperature readings into a table that can be joined to the GPS coordinates back in the lab.)
4. Spread teams out forming a line to collect one set of data that will be shared or assign groups to gather data in different areas around the school and then return to share the information. Working together will be more exciting and helpful if this is the first time everyone is using the GPS units.

5. Have students take coordinate and temperature data every 20 to 30 meters (strides) apart as they slowly walk across the school grounds. This may take several sweeps to cover most of the outside area. Make sure to get temperature data under trees, in the shade of the buildings, in grassy fields and parking lots, etc.
6. Instruct the students to look for patterns as they mark down the temperatures and the GPS points in the table to see where the heat builds up during hot days and where it stays the coolest.
7. When back in the lab, download the GPS points with the temperature data. Have students share their collected data and create a master file of all of the groups' data. Once one master file is created, place a copy of the master data file electronically where each student can download their own copy.
8. Manually, plot the points with their temperature data joined to the GPS coordinates (students can still plot the points using Excel, or by hand. These solutions are less than optimal and you will need to create a scale with color pencil for the temperatures for the rest of the exercise.)
9. Electronically, in a GIS package, thematically map the points to show their temperature data. A blue to red scale is often quite effective to remind students of cooler and warmer places around the school.
10. This step can be done in some GIS packages otherwise skip to the next step. Certain GIS packages allow you make a continuous picture of temperature across your school yard from the separate points of data you had collected. This is called interpolation and may require a spatial analysis package. This function would be grouped with analysis tools. Look for a pull down menu or a tab that features such tools to make a grid of continuous temperatures for your schoolyard. These grids can be made partially transparent so that you can see the aerial photograph to determine the cause of higher or lower temperatures. You can also turn on or off this layer to achieve the same affect.
11. A more dramatic way to see urban heating is to send students home with GPS units to measure the temperatures across the city. Even if they just take readings between school and their homes after school on sunny days they should be able to see that there are warmer and cooler areas of town. Use the temperature data to determine where the city might consider a new urban forestry project, or some other green space such as community gardens, hiking and bicycle paths, etc to deal with these urban hotspots. Invite your local city council member for your area or perhaps a city planner or a representative of the parks department to visit to give feedback on your students proposed plans.

### **Resources:**

1. Provide one GPS unit and thermometer for each student or student groups.
2. 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 U.S.

3. 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.
4. 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 the students to manually record data over and over on the same map.
5. If you will be using a GIS, unregistered photos can be obtained from Google maps or MSN Virtual Earth (maps.live.com) using the print screen button on your keyboard then pasting the screen capture into a photo editor, Word or Excel document. This image can then be referenced in several GIS packages.
6. Once your data points and aerial photos are in the same media. Determine what type of ground cover creates the coolest areas around your school grounds. Make a rank list from hottest to coolest. Parking lots, open dirt, grassy fields, sidewalks, sunny sides of buildings, shaded sides of buildings, under a tree, under canopy of trees, near bushes.

### **Student Assessment / Reflections:**

After the students complete their data collection and mapping exercise, have them answer the following questions to check for understanding.

Are there any disadvantages to urban hotspots?

How have the roads and buildings within cities affected local temperatures?

What can be done to help regulate these temperature increases?

What can be done around your home to reduce heating bills?

What can be done within industrial areas of a city to reduce heat buildup?

How does color of manmade surfaces affect temperatures?