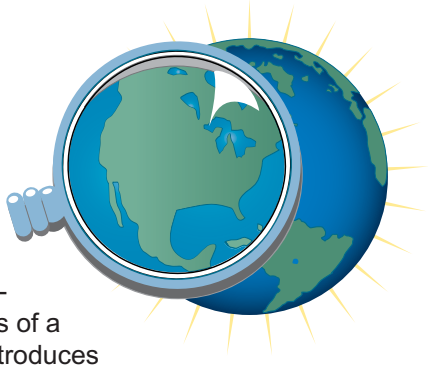
What's hot at the mall?



Investigation Overview

This investigation examines how shopping malls change natural environments. Studying NASA thermal images of a mall and its immediate surroundings introduces students to urban deforestation and to the formation of urban heat islands. Studying malls from an environmental perspective demonstrates the usefulness of geography in daily life and offers opportunities for direct observation and fieldwork.

Time required: Two 45-minute sessions

Materials/Resources

Briefings 1 and 2 and Logs 1, 2, and 3 (one copy per student)
Figures 1 and 2
Color transparency or color copies of Figure 3 (student materials p. 7)
World Atlas
Political map of the United States
Road atlas of the United States
Blank sheets of paper
Overhead transparencies
Markers

Content Preview

It is important for us to know how human activities influence the environment. Scientists use aerial photos, satellite images, maps, census data, and other information to examine land use changes and the impact they have on the environment. Shopping malls and their surrounding areas provide excellent examples of temperature changes produced when trees and vegetation are replaced by buildings and pavement. There are intended and unintended environmental consequences when a shopping mall is constructed.

Classroom Procedures

Beginning the Investigation

If you have completed Investigation 1 in this module, proceed directly to 5 in **Developing the Investigation**.

1. Have students develop a list of topics that they think NASA scientists are studying. Share the list with the class. Discuss the topics and have students identify which topics are local issues and which are global issues.

2. Using the class discussion as a starting point, explain to students that NASA scientists study many topics and use photos and data gathered by airplanes as well as images and data gathered by satellites. Sometimes the topics that the NASA scientists study are very important to

Geography Standards

***Standard 14:* Environment and Society**

How human actions modify the physical environment

- Analyze the environmental consequences of humans changing the physical environment.

Geography Skills

Skill Set 3: Organizing Geographic Information

- Prepare various forms of diagrams, tables, and charts to organize and display geographic information.

Skill Set 4: Analyzing Geographic Information

- Interpret information obtained from maps, aerial photographs, satellite-produced images, and geographic information systems.

our local communities. One example is studying how land heats up when forest cover and other vegetation is removed and replaced by buildings and roads.

3. Open the discussion of shopping malls by asking students to write down some reasons why it is important to have convenient places to shop. List the reasons on the board or overhead transparency.

   Reasons may include:
   - People have diverse needs and wants that are filled by buying goods and services.
   - People like to go to nearby places to buy everyday items.
   - It saves time to shop near one's home or work.
   - Places to shop should be easy to get to and easy to use.
   - People like to save money getting from place to place.

Developing the Investigation

4. Provide a copy of **Figure 1**, the Huntsville day image, and ask students to identify the feature that is most likely a mall and to give some reasons for their answers. Ask them to speculate about other features on the image and to try to identify what they are. For example, they may mention forests, open land, major highways, residential areas, strip malls, movie theaters, and industrial areas.

5. Distribute **Briefing 1** and have students read the Background, Objectives, and Procedures.

6. Distribute **Log 1** and ask students to consider how the construction of a mall affects the surrounding environment. For example, malls sometimes replace ecosystems such as forests, wetlands, or open grasslands. These ecosystems provide habitats for wildlife and play an important role in pollution control. Have students identify what will happen to the environmental features listed in the Log when a mall is built.

7. Distribute **Log 2** and **Figure 2**. Ask students to examine the daytime thermal image of Huntsville. In the thermal image warmer temperatures are represented by lighter shades of gray & white; the darker shades show cooler temperatures. Students should answer the questions in the Log.

Concluding the Investigation

8. Have students read the NASA research in **Briefing 2**. Distribute **Log 3**. Ask students to examine the thermal images of the tree in a parking lot and notice differences in the night and day temperatures around the tree.

   Provide large sheets of paper and ask students to develop sketch maps (as described in **Log 3**) that show arrangements of trees that would more effectively cool a mall parking area.

   As a final activity, if you have not already done this, have students discuss or write about the following questions:

   1. What are some of the major environmental impacts caused by a shopping mall?
   2. Would you want a new mall to be built across the street from your house? Why or why not?

Background

NASA uses an ATLAS imager to gather thermal images of parts of Earth's surface. These images help scientists understand how the heat captured and then released by a city's buildings and pavement coupled with the loss of trees and other vegetation affect local weather, air quality, and air and surface temperatures.

It is important for us to know how human activities influence the environment. Scientists use aerial photos, satellite images, maps, census data, and other information to examine land use changes and the impact they have on the environment. For example, aerial photos and thermal measurements of an area in Huntsville, Alabama, are used in this investigation to study the effect of urbanization on surface temperatures. Interestingly, shopping malls and their surrounding areas provide excellent examples of temperature changes produced when trees and vegetation are replaced by buildings and pavement.

NASA collected the Huntsville images used in this investigation with ATLAS (Airborne Thermal/Visible Land Application Sensor), which sees in 15 colors, aboard a Lear 23 jet. The ATLAS imager scans and maps heat patterns in urban areas. ATLAS is the same basic instrument as the one on board Galileo, the unmanned NASA spacecraft now orbiting Jupiter.

Studying malls helps students to develop an ecological perspective by considering the environmental consequences of land use change, in this case the removal of vegetative cover and natural habitat. There are intended and unintended environmental consequences when a shopping mall is constructed. Intended consequences include construction of roads and clearance of land to provide parking. Unintended consequences include creation of traffic problems, absorption and consequent radiation of heat after sundown by large areas of pavement, and an increase in water pollution from oil and salt runoff from parking lots.

Evaluation

Log 1

1. An example is provided in the Log.
2. Trees are cut down and other vegetation removed. A small amount of replacement vegetation is planted in landscaped areas around the mall.
3. Some animals lose their habitats. They must move to other forested areas.
4. Moving Earth material will alter the way that water flows. More sediment may enter streams due to erosion of disturbed land.
5. Temperatures of air and land will sometimes increase due to heat retained and then released by pavement and buildings. This will warm the area.

Log 2

1. Madison Square Mall parking lot
2. Areas of tree cover in lower right of the image. Other tree-covered areas appear at top left and right of the image.
3. The Sun's rays cause paved areas and buildings to heat up. Trees and other vegetation help cool areas around the mall.
4. Cool spots are indicated by the dark dots scattered around the mall parking lot. Trees are the cause of the dark dots and indicate cool spots.
5. Parking areas around malls could be made cooler by planting more trees.

Module 3, Investigation 2: Briefing 1
What's hot at the mall?

Background
This investigation examines how shopping malls change natural environments.

NASA scientists have been studying how hot it gets around shopping malls. Wherever malls are built trees and wildlife habitat are lost. Malls use a lot of land, stand out on the landscape, and are visible on aerial photos and satellite images.

Vegetation shades areas, preventing a build up of heat. Trees absorb and use the Sun's energy for photosynthesis. The loss of vegetation in built-up and paved areas causes the formation of hot spots. Heat builds up during the day because the Sun's energy is retained by buildings and pavement. This causes surface temperatures and the surrounding air temperature to rise. Much of this stored-up heat is released at night.

On a hot summer day we may feel a blast of heat when we walk from an air-conditioned mall across an asphalt parking lot to our car. The heat rises from the pavement to meet us and warms us all the way across the lot. While we shopped, our car absorbed the Sun's rays and heated up. During the summer, temperatures in parking lots are as high as 49°C (120°F). When you add up all the heat from parking lots, buildings, cars, and roads, and remove the trees that might soak up the heat and keep things cool, it is no wonder that temperatures rise in built-up areas.

Objectives
In this investigation you will
- identify topics that NASA scientists study;
- explain why NASA scientists are interested in studying malls;
- correctly identify a mall on the Huntsville, Alabama, thermal image;
- distinguish between hot and cool areas on thermal images; and
- explain some of the environmental consequences of constructing a shopping mall.

Procedures for the Investigation
You will consider environmental changes caused by shopping malls by examining thermal images gathered by NASA showing an area in Huntsville, Alabama. A thermal image shows differences in temperature on Earth's surface. You may be working alone or in groups to complete Logs distributed by your teacher.

References
Geography for Life: National Geography Standards 1994
http://science.msfc.nasa.gov/newhome/headlines/essd08may97_1.htm
Background on Huntsville and features of the Madison Square Mall vicinity was provided by Blaine Adams, geography graduate student at Virginia Tech and native of Huntsville, Alabama

Module 3, Investigation 2: Log 1

What's hot at the mall?

The construction of a mall affects the surrounding environment. Malls sometimes replace ecosystems such as forests, wetlands, or open grasslands. These ecosystems provide habitats for wildlife and play an important role in pollution control.

Identify what happens to the following environmental features when a mall is built. An example is provided for #1.

1. Land and soils
   A mall will cover a lot of soil with buildings and pavement. Rainwater cannot soak into the pavement and may run off to nearby land, causing erosion.

2. Forest and vegetation

3. Wildlife habitats

4. Streams and drainage patterns

5. Temperature of air and ground

Module 3, Investigation 2: Figure 1

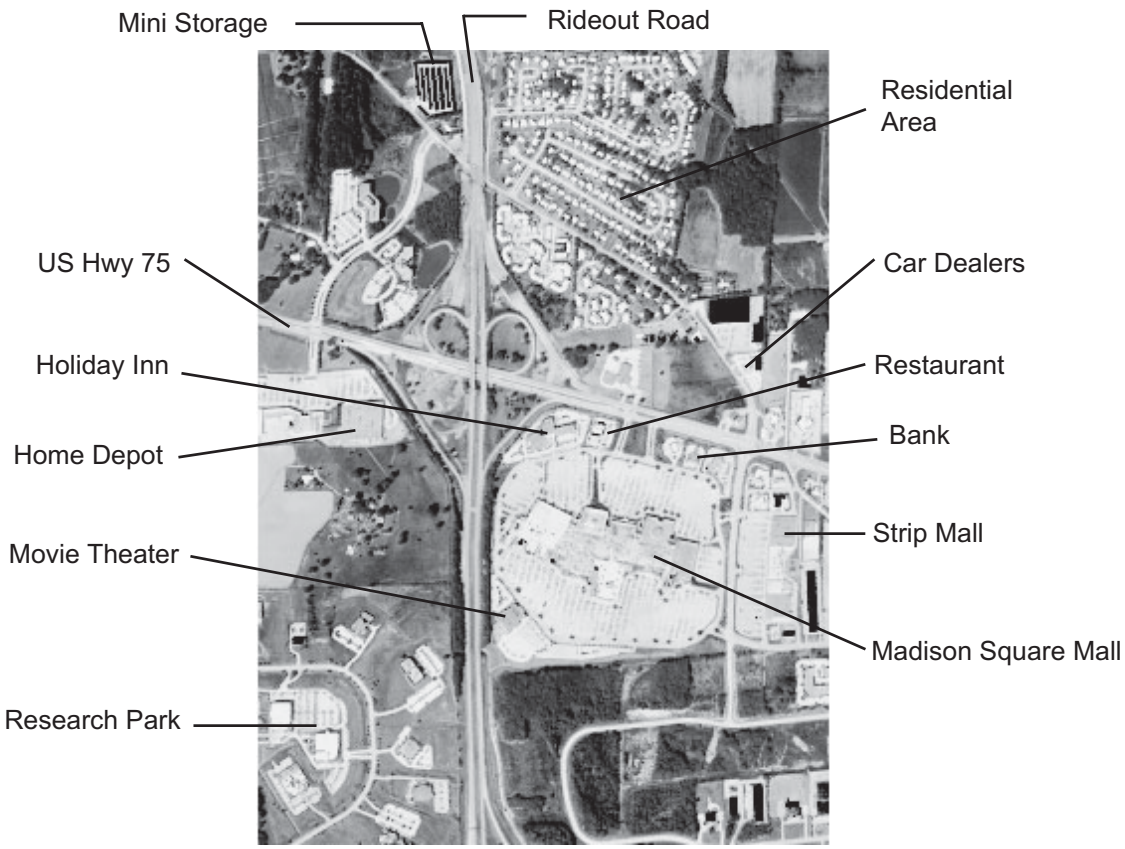
What's hot at the mall?

Source: http://science.msfc.nasa.gov/newhome/headlines/atlanta/hsv_IR.gif

Module 3, Investigation 2: Figure 2

What's hot at the mall?

Huntsville, Alabama, by day



Module 3, Investigation 2: Log 2

What's hot at the mall?

Now that you have considered some of the environmental effects of malls, examine the daytime thermal image of Huntsville. In the thermal image, warmer temperatures are represented by lighter shades of gray and white, and cooler temperatures by darker shades. Use Figures 1 and 2 to answer the following questions.

1. What is the largest warm feature on the image?

2. What is the largest cool feature on the image?

3. Why are some areas warmer than other areas? For example, why is the shopping mall parking lot warmer than the trees and grassy areas in the highway cloverleaf?

4. Can you find any cool spots in the mall parking area? What causes those cool spots?

5. Do you have any suggestions for making the parking areas cooler during the day?

Module 3, Investigation 2: Briefing 2

What's hot at the mall?

It is important to understand that just as much sunlight falls on cities as on woodlands of the same size. The difference is in how urban materials react to solar energy. Asphalt in parking lots and on rooftops, in particular, soaks up heat and reradiates it as thermal infrared radiation.

On the other hand, water absorbs a large amount of heat before its temperature rises, and it takes a long time to release it. That means that trees, which have a large water content and release water into the atmosphere to keep cool, absorb a lot of the incoming heat and release it over a longer period of time.

The temperature differences shown in the image are related to how materials absorb and release heat. Asphalt absorbs heat from the Sun and quickly releases it as heat radiation. Temperatures in the parking lot during summer are as high as 48.9°C (120°F) during the day, while tree islands in the lot are only 31.7°C (89°F)—a difference of 17.2°C (31°F)! At the same time nearby wooded areas are as low as 29.4°C (85°F). High daytime temperatures result in the parking lot cooling to only 23.9°C (75°F) at night. The tree islands and the woods are much cooler at 17.2°C (63°F). Even grassy areas near the woods are hotter than the woods because the meadow has less vegetation and shade.

Edited excerpt from *Research at NASA's Global Hydrology and Climate Center*
http://science.msfc.nasa.gov/newhome/headlines/essd08may97_1.htm

Module 3, Investigation 2: Log 3
What's hot at the mall?

Now that you have considered how to interpret a thermal image, read the NASA research handout Briefing 2 provided by your teacher.

After reading it, look at Figure 3, the day and night thermal images of the individual tree in a parking lot. Notice that the tree produces a shaded, cool area. In the night image, notice that the tree's leaves become so cool that they become nearly invisible.

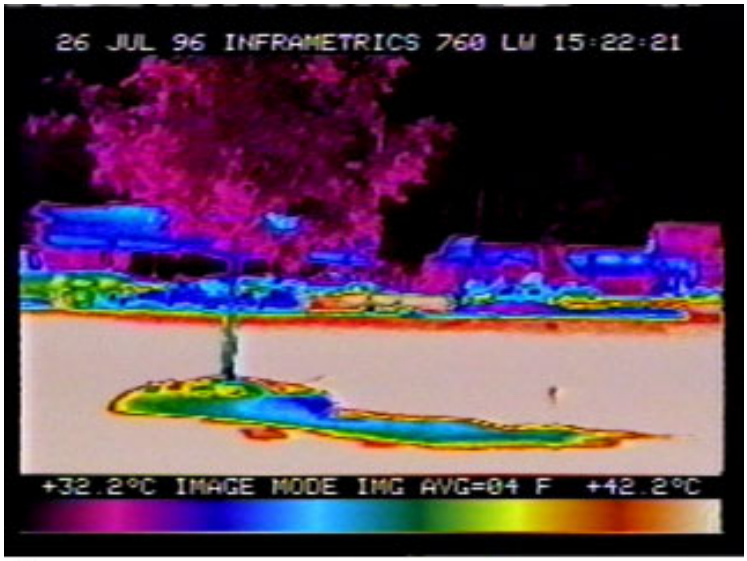
Now that you know about the effects that trees have on surface temperatures, consider how the temperatures of areas around a mall might be reduced if more trees were planted.

Using the Huntsville Madison Square Mall as a model, develop a sketch map of the ideal placement of trees in the parking areas. Use a large piece of paper so that you have plenty of space to draw your map. Keep in mind some of the disadvantages of having a large number of trees and vegetation around a shopping mall. For example, trees may reduce visibility, attract birds and other animals, and contribute to the loss of valuable parking spaces. When you share your map with others, be ready to explain why you located trees in certain sites and not in others.

Discussion Question

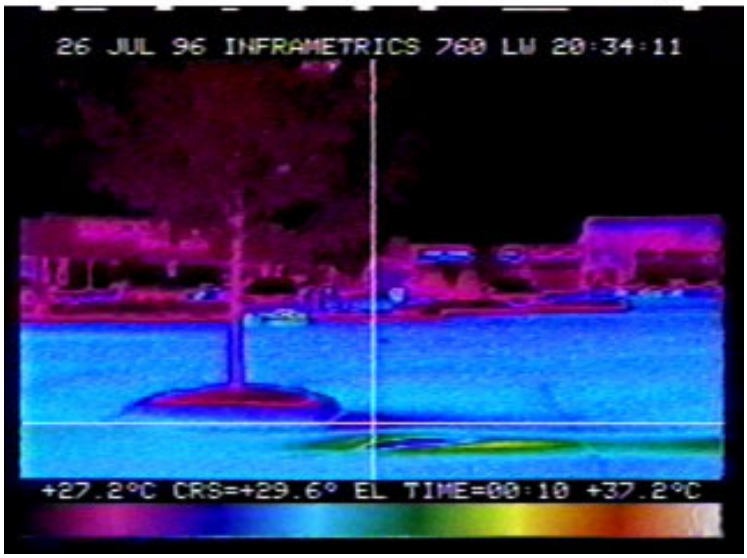
How would a new mall built across the street from your house affect your local environment? Write a brief answer on this sheet.

Figure 3: A tree in a parking lot



Day

Night



The color images are found at this NASA site:
http://science.msfc.nasa.gov/newhome/headlines/essd08may97_1.htm