Human footprints on Earth as seen by NASA scientists

Module Overview

This module draws upon NASA images and research to introduce students to the various ways humans interact with Earth's diverse environments. Many human activities are clearly visible from space through satellite imagery. Remotely sensed images help people understand Earth as the home for humanity. We can learn a great deal about physical and human processes by analyzing remotely sensed images.

The human footprint on Earth's surface is barely perceptible in some areas, whereas it is very intense and highly noticeable in others. We cannot detect the effects of some environmental changes without the use of powerful technologies, and some remain invisible even on photography and satellite imagery. For example, some forms of air pollution cannot be seen even though they affect people's health. Interpretation of imagery relies heavily on visual cues but excludes other sensory information such as sounds and odors.

The investigations in this module begin with an examination of the spatial and environmental aspects of a shopping mall in Huntsville, Alabama. Next, comes a study of Atlanta's urban heat island and the consequences of urban deforestation. Then students are asked to consider significant environmental changes in different parts of the world. Deforestation in Rondonia, Brazil, provides a case study of a major environmental change. The investigations in the module proceed from the local to the global scale. This sequence allows students to apply what they learn to environmental change at different scales.

Investigation 1: Let's go to the mall

This investigation examines the significance of the location of shopping malls. Huntsville, Alabama, is used as an example to illustrate that different human activities have different location requirements. Studying malls from a spatial perspective demonstrates the usefulness of geography in daily life and offers opportunities for direct observation and fieldwork.

Investigation 2: What's hot at the mall?

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

Geography Standards

Places and Regions
- **Standard 4**: The physical and human characteristics of places

Human Systems
- **Standard 11**: The patterns and networks of economic interdependence on Earth's surface
- **Standard 12**: The processes, patterns, and functions of human settlement

Environment and Society
- **Standard 14**: How human actions modify the physical environment
- **Standard 15**: How physical systems affect human systems

Uses of Geography
- **Standard 18**: How to apply geography to interpret the present and plan for the future

Science Standards

Unifying Concepts and Processes
- Systems, order, and organization

Science in Personal and Social Perspectives
- Populations, resources, and environments
- Risks and benefits

Investigation 3: Why is the city hot?

This investigation examines the formation of urban heat islands. NASA scientists are studying the urban heat island of Atlanta and other cities. This investigation uses thermal images and research by NASA scientists to examine causes of environmental change in Atlanta and actions that might be taken to reduce the harmful effects of that change.

Investigation 4: Where in the world are major environmental changes?

This investigation introduces students to significant environmental changes occurring in different parts of the world. The investigation uses NASA satellite images of Brazil to illustrate deforestation as an example of environmental change. Students learn that satellite images provide useful information for interpreting, understanding, and predicting environmental change.

Connection to the Curriculum

Investigations in the module require students to locate places and regions on maps, make simple maps, interpret maps and satellite images, and obtain and use information from atlases. Local community studies are incorporated through consideration of the expansion of urban areas and transportation systems in the students' home areas. The module emphasizes the nature and consequences of human–environment interactions and examines changes in ecosystems and in how societies organize themselves in space. The module is linked to earth science through physical geography and to history and social studies through the study of changes in urban areas and local communities. In addition, students learn about applying remote-sensing technology to environmental issues.

Time

Investigation 1: Two 45-minute sessions
Investigation 2: Two 45-minute sessions
Investigation 3: Three 45-minute sessions
Investigation 4: Four 45-minute sessions

Module Assessment

The successful completion of the Logs should provide a means to assess student learning. A more comprehensive assessment could use the learner objectives to shape assessment activities.

Mathematics Standards

Geometry
- Use visualization, spatial reasoning, and geometric modeling to solve problems

Measurement
- Apply appropriate techniques, tools, and formulas to determine measurements

Representation
- Use representation to model and interpret physical, social, and mathematical phenomena

Technological Literacy Standards

Nature of Technology
- The characteristics and scope of technology

Technology and Society
- The cultural, social, economic, and political effects of technology
- The effects of technology on the environment

Let's go to the mall

Investigation Overview

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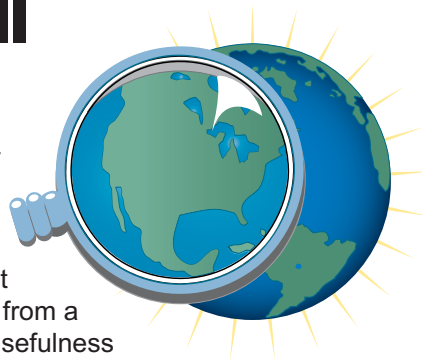
Time required: Two 45-minute sessions

Materials/Resources

Briefing and Logs 1, 2, 3 and 4 (one copy of each per student)
Newsprint
Overhead transparencies
Markers

Content Preview

Studying malls helps students to develop a spatial perspective. Students use this spatial perspective to explore how malls and other commercial land uses relate to the location of residences, roads, and local traffic. Studying malls helps students understand economic patterns in the landscape.

Checklist of Classroom Procedures

Beginning the Investigation

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

2. Using this discussion as a starting point, explain to students that NASA scientists study many different topics and use photos and data gathered by airplanes as well as images and data gathered by satellites. Sometimes the topics that NASA scientists study are very important in local communities. In all locations, it is important for us to know how human activities affect the use of land.

3. Open the discussion of the impact of shopping malls on the landscape by asking students to write some reasons why it is important to have convenient places to shop. List the reasons on the board or overhead transparency. The ideas 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 keep travel costs low.

Geography Standards

Standard 11: Human Systems
The patterns and networks of economic interdependence on Earth's surface
- Analyze and evaluate issues related to the spatial distribution of economic activities.

Geography Skills
Skill Set 2: Acquiring Geographic Information
- Use maps to collect and compile geographic information.

Skill Set 3: Organizing Geographic Information
- Prepare various forms of maps as a means of organizing geographic information.

Skills Set 4: Analyzing Geographic Information
- Interpret information obtained from maps, aerial photographs, satellite-produced images, and geographic information systems.

4. Ask students to identify some advantages and disadvantages of walking versus driving to shopping places. Discuss the differences between walking to shopping places and driving to shopping places. Discussion may include:
   - Walk-to places may have few parking spaces.
   - Drive-to places may have many parking spaces.
   - Having a car influences where people go to shop.
   - Places farther away from home are more accessible with a car.

Developing the Investigation

5. Ask students to read the **Briefing** on malls and distribute **Log 1**. Small groups may discuss the questions and complete the rankings of land uses most important for malls to be near. This Log will help students think about why activities and facilities are located in different places. Group responses may be displayed on newsprint, on overhead transparencies, or on the chalkboard.

6. Distribute **Log 2**. Ask students to complete the activity ranking the features that are most important and least important to the location of community facilities (sports stadium, airport, high school, fire station, and hospital). Discuss the results.

7. Distribute **Log 3** containing the Huntsville image and ask students to identify the feature that is most likely a mall and 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 major highways, residential areas, strip malls, movie theaters, and research parks. Have students complete the questions on **Log 3**.

8. Once students have identified the shopping mall (Madison Square Mall) and completed **Log 3**, ask them to list and rank the features which they believe were important in locating the mall. They should offer reasons for their answers. For example, they may say that land was available or that it is important for the mall to be near the intersection of major highways, near residential areas, or close to other businesses that create customer traffic.

Concluding the Investigation

9. Distribute the Huntsville image with the features labeled and ask them to study it, complete **Log 4,** and share the results with the class.

Background

Malls are prominent cultural landscape features and are a part of everyday life for most students. Studying mall locations helps students understand economic patterns in their communities and applies geography to daily life.

Malls use a lot of land and are easily seen on aerial photos and satellite images. Factories, large school campuses, and office parks may look similar to shopping malls on remotely sensed images. Distinguishing between different land uses provides opportunities for critical thinking.

A mall's location and parking spaces display our dependence on cars. Malls are usually located near major highways, have large parking lots, are close to other shopping areas, and have many retail stores under one roof. People drive to malls because they want convenient and accessible places to shop and socialize.

NASA Image

NASA collected the Huntsville image used in this investigation in 1994 with ATLAS (Airborne Thermal/Visible Land Application Sensor), which sees in 15 colors, aboard a Lear 23 jet. The ATLAS imager scans and maps patterns in urban areas and records temperatures. ATLAS is the same basic instrument as the one on board Galileo, the unmanned NASA spacecraft now orbiting Jupiter. The images of Huntsville show residences, roads, and different commercial activities in urban areas.

Evaluation

Log 1

Additional features may include g) a public bus system and h) being near a large population center.

As the three most important features for a mall to be near, students may select a, c, and h. They may say that these features make it easy for a large number of people to get to the mall. Students may select other features and offer reasons for those choices.

As the three least important features for a mall to be near, students may select b, d, and e. They may say that these features may cause conflicts with the traffic coming in and out of the mall. Students may select other features and offer reasons for those choices.

Log 2

An example is provided in the Log.

Log 3

Examples of human-built features in the image include roads, parking lots, houses, and other buildings that could be factories or research parks.

Natural features in the image are very limited. The best examples are tree-covered and grassy areas.

Log 4

An example is provided in the Log.

Module 3, Investigation 1: Briefing
Let's go to the mall

Background
This investigation examines why malls are located where they are.

You may have noticed that there are different types of malls. For example, strip malls may have several stores lined along a busy street or may be arranged around a shared parking area. Outlet malls usually have brand name discount stores in separate buildings with ample parking. Other malls have many stores under one roof surrounded by large parking lots. Often these malls are multilevel and very large. Over time malls have increased in size and in the range of goods and activities they offer. In addition to numerous retail stores, they may have food courts, movie theaters, skating rinks, video arcades, and other forms of entertainment. This type of large mall is the topic of this investigation.

Malls use a lot of land and stand out on the landscape. They are large enough to appear on aerial photos and satellite images. Malls affect other places in a community and encourage dependence on automobiles. Wherever malls are built, vegetation and wildlife habitat are lost.

Shopping malls are found in large and small communities and are a part of everyday life for most people in the United States. Studying mall locations helps us understand patterns of economic activity in our communities and applies ideas about geography to daily life.

Objectives
In this investigation you will
- describe why malls are located in some places and not other places, and
- explain why NASA scientists are interested in studying malls.

Procedures for the Investigation
You will consider different aspects of the locations of shopping malls and examine images gathered by NASA showing an area in Huntsville, Alabama. Complete Logs distributed by your teacher.

Module 3, Investigation 1: Log 1
Let's go to the mall

Assume that you want to build a large shopping mall in your community. You will need a big parcel of relatively flat land. If you did field work in the area, you might identify several suitable parcels of land. To aid you in making a site selection, here is a list of features which may be important to the location of a mall. Add any features you think are missing.

a. A four-lane road or interstate highway
b. A manufacturing area
c. A residential neighborhood
d. A neighborhood shopping area
e. An elementary school
f. A sewage treatment plant

g. _____

h. _____

Select from the list the three most important and the three least important features for the mall to be near. Give reasons for your answers.

Most important and why?

1. _____

   _____

2. _____

   _____

3. _____

   _____

Least important and why?

1. _____

   _____

2. _____

   _____

3. _____

   _____

Module 3, Investigation 1: Log 2
Let's go to the mall

There are good reasons why things end up in different locations. Now that you have considered the best site for a mall, you may examine other facilities in our communities. In this Investigation Log you consider locations of certain *features* and various community *facilities*. What are the consequences of different land uses being near each other? For example, what are some possible positive and negative relationships of a stadium being near a residential neighborhood? A sample set of answers is provided for **stadium**.

Community Facilities	Features					
	Highway	Manufacturing	Shopping	Neighborhood	Elementary School	Sewage Plant
Stadium	Easy to get to events	Possible noise and competing traffic	Fans like shopping	Stadium too noisy for residents	Too much traffic	Odors distract fans
Airport						
High School						
Fire Station						
Hospital						

Module 3, Investigation 1: Log 3
Let's go to the mall

Figure 1: Huntsville, Alabama by day

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

Examine the Huntsville image and identify which feature is most likely a shopping mall. Using the major roads for orientation and assuming that the top of the image is north, describe the location of the mall. Give reasons to support your choice.

_____

_____

_____

_____

Continue to examine the image of Huntsville and list what types of human-built features are in the vicinity of the mall.

Human-Built Features

1. _____   3. _____

2. _____   4. _____

Natural Features

What are some natural features that you can identify on the image?

_____   _____

Module 3, Investigation 1: Log 4
Let's go to the mall

Now examine the Huntsville image with the land uses labeled (Figure 2). For each of the uses listed below identify **one advantage** and **one disadvantage** of being near the mall. A sample set of answers is provided for the movie theater.

	Advantage	**Disadvantage**
Movie theater	People shopping can easily go see a movie.	The mall and the movie theater compete for parking.
Auto dealership		
Residential area		
Strip mall		
Manufacturing area		
Restaurants		
Bank		

Discussion Questions

1. According to people in the Huntsville area, the Madison Square Mall was built before all of the other commercial facilities shown in the image. Why would restaurants, a bank, a hotel, movie theater, and car dealers move near a shopping mall? _____
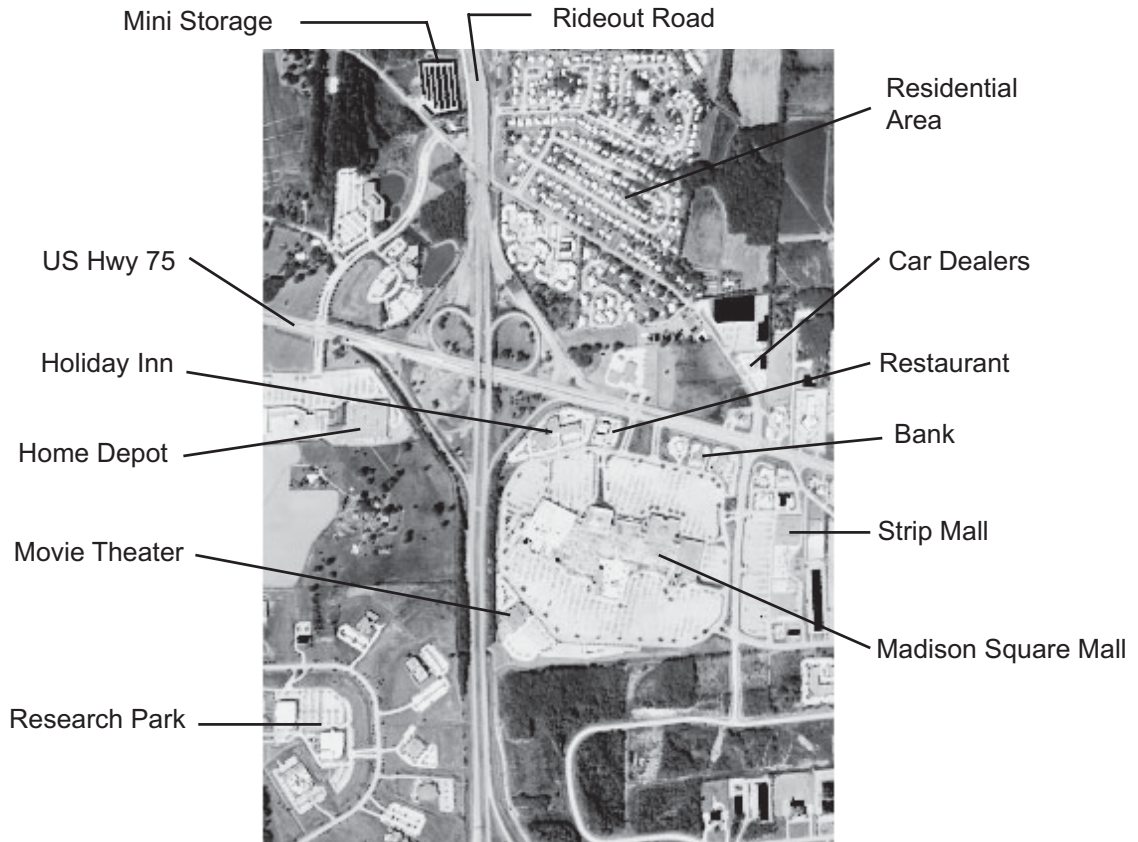
   _____

   _____

   _____

2. Would you want a new mall built across the street from your home? Why or why not?

   _____

   _____

   _____

   _____

Figure 2: Madison Square Mall and Surroundings

Mini Storage — Rideout Road — Residential Area — US Hwy 75 — Car Dealers — Holiday Inn — Restaurant — Home Depot — Bank — Movie Theater — Strip Mall — Research Park — Madison Square Mall

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