Paths

Module Overview

This module looks at many different kinds of paths and considers why paths are where they are and how they look from space. Paths are usually not arbitrary ways to reach a destination. People and animals make paths that take into account the terrain and other features of the landscape. Rivers, lava, smoke, and other natural phenomena follow paths. The Space Shuttle and satellites follow paths. Are some paths only visible from satellite or aerial images? Are there paths that can only be seen by remote sensing and not by the eye? What do these images tell us about links between the past and present? Paths imply movement: movement of people, goods, animals, ideas, matter, and energy. How is movement influenced by the environment and how does it affect the environment?

***Investigation 1:* Paths—What are they and who makes them?**
Students use their immediate environment to determine what kinds of paths are visible, who makes these paths, where the paths are located, and why the paths are located where they are. This investigation develops field excursion skills and introduces students to the need for "ground truthing." Students are introduced to the skill of locating a variety of human-made paths in satellite images.

***Investigation 2:* How do paths look from different perspectives?**
This investigation uses literature about paths to help students understand how the world looks from different heights. Students also identify natural and human-made paths in satellite images.

***Investigation 3:* Paths—Usual or unusual?**
NASA images introduce students to some unusual physical and human-made paths. These include ancient camel caravan tracks, lava flows, ship channels, and smoke paths. The investigation introduces the idea of one-way or two-way paths. It provides an opportunity for students to work together to study images of paths and to pose and answer many questions about them.

***Investigation 4:* How do disaster paths affect people's lives?**
Four scenarios illustrate natural disaster paths. Letters from imaginary pen pals describe how the disaster paths affected their lives. Students match satellite images with the locations of the pathways described by the pen pals. They learn about the importance of satellite imagery in alerting people to possible natural disasters.

Geography Standards

The World in Spatial Terms
- **Standard 1:** How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective
- **Standard 2:** How to use mental maps to organize information about people, places, and environments in a spatial context

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

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

Science Standards

Unifying Concepts and Processes
- Evidence, models, and explanation
- Constancy, change, and measurement

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Earth and Space Science
- Properties of Earth materials

Connection to the Curriculum

This module can be used in geography, social studies, and science classes to study the connections between and among places. Students develop skills in reading and interpreting maps and images as well as comparing different communities and world regions. They learn to use maps as a means of communication as well. Students practice language arts skills by reading to be informed, by honing their listening skills, reading to learn to perform a task, and by expanding their vocabulary and comprehension skills. They organize information and practice expository writing. The topic of paths would make an ideal focus for an interdisciplinary unit.

Time

Investigation 1: Two 45-minute sessions
Investigation 2: One or two 45-minute sessions
Investigation 3: One 45-minute session
Investigation 4: One 45-minute session

Mathematics Standards

Geometry

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

Measurement

- Understand measurable attributes of objects and the units, systems, and processes of measurement
- Apply appropriate techniques, tools, and formulas to determine measurements

Technological Literacy Standards

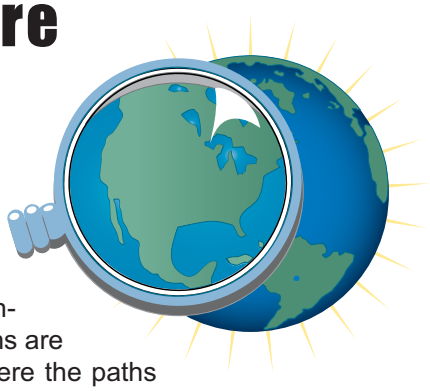
Nature of Technology

- **Standard 1:** The characteristics and scope of technology

Technology and Society

- **Standard 6:** The role of society in the development and use of technology

Paths—What are they and who makes them?



Investigation Overview

Students use their immediate environment to determine what kinds of paths are visible, who makes these paths, where the paths are located, and why the paths are located where they are. The investigation develops field work skills and introduces students to the need for "ground truthing." Students are introduced to the possibilities for locating a variety of human-made paths in satellite images.

Time required: Two 45-minute sessions

Materials/Resources

NASA images (Make overhead transparencies):
- Figure 1: Boston, Massachusetts
- Figure 2: Paris, France
- Figure 3: Houston, Texas

World Map
Log 1: Paths
Log 2: A favorite path
Log 3: An imaginary path
Satellite image of your community, if available. You may be able to download it from www.terraserver.com. Use a map of the community if no satellite image is available.

Content Preview

A path is any visual connection between two points. Paths are visible in many ways including from remotely sensed images. When scientists compare features on the surface of Earth to the images obtained from satellites it is called ground truthing—does what really exists on the ground confirm the remotely sensed image? Five geographic skills can be used to organize field research for young students: asking geographic questions, acquiring geographic information, organizing geographic information, analyzing the geographic information, and answering geographic questions.

Classroom Procedures

Beginning the Investigation

1. With the class, brainstorm answers to some of the questions in **Log 1** and have them complete it in small groups. Then have them compare their responses. Younger students can do the exercise as part of a class discussion with the educator listing their responses on the chalkboard.

Geography Standards

Standard 1: The World in Spatial Terms

How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective

- Identify and describe the characteristics and purposes of geographic representations, tools, and technologies.

Standard 14: Environment and Society

How human actions modify the physical environment

- Identify ways in which humans alter the physical environment.

Geography Skills

Skill Set 2: Acquiring Geographic Information

- Make and record observations about the physical and human characteristics of places.

2. Have students describe their pathways from home to school. Older students can draw a map that shows important places along this path.

Developing the Investigation

3. Have students form small groups to talk about paths they have taken, either in the immediate area or at some other location. Encourage students to describe the landscape or setting around the paths and to talk about obstacles that may have diverted the path. Share this information with the class. For kindergarten and grade 1, this can be done as a class rather than in groups.

4. Ask students to draw a map of a favorite path that they have taken. The maps should include landmarks, features of the terrain, and the reason for taking the path. Encourage the students to describe the paths to answer the following questions:

   - Was the path straight or curved? Why?
   - Were there features in the environment that made the path less direct?
   - Did the path cross water, cross a street, etc.?
   - How long was the path?
   - How long did it take to get from the starting to the finishing point?

5. Ask students to talk with a family member about a pathway he or she has taken. Use **Log 2** for this activity. Have students show the map drawn by a family member or read their reports to the class. Emphasize the landscape along the path.

6. Ask students if they would like to see how paths look in images from space. Tell the students that they will be examining satellite images of three cities and talking about what they see. Project transparencies of **Figures 1**, **2**, and **3** and have the students point out streets, roads, bridges, runways, rivers, and any other paths they can find.

7. Compare the paths of Paris with those of Boston and Houston. How are they different? (*Many streets radiate from the center of the city outward. The Seine River forms a major path through the city. A big highway circles much of the city. See* ***Background*** *for more information about the images.*)

8. Talk about why it is important to look at paths from aerial photos and satellite images. What can you see that you can't see from the ground?

9. Ask students to think about good ways to verify that the images show what students think they show. Talk with students about "ground truth." (*Images are important to the study of Earth. However, locations must be observed on the ground to verify that the information gleaned from images is correct. See* ***Background*** *for additional information. Only selected images can be verified in this way. Regular ground truthing helps to determine what kinds of information is reliable and what kinds of information may require more careful interpretation.*)

10. If you have access to a satellite image of your community (It may be available on www.terraserver.com), students can do their own ground truthing. Ask them to identify specific paths shown in the image (bridges, roads, rivers) that they can visit on the ground. Visit those locations to verify the information in the image. It is important to check the dates on images for ground truthing.

11. If a satellite image is not available, the class can explore the concept of ground truthing using a local map. Explain that maps also need to be verified by the same process. Select a feature on the map that is likely to change over time and visit it to verify that it still is the way it is shown on the map. (*It could be an old bridge, a park, a shopping center.*) If possible, select a feature that *has* changed since the map was made so that students can update the map.

12. Take a walk outside the school and look for signs of paths. Look for paths that lead to the play area or other sites. Have students make maps of the paths they observe and label the important items on each map. On the back of the map, have them write a couple of descriptive sentences about the paths. Answer questions such as, "Is the path straight or crooked? Why? Does the path go directly to the destination?" In an urban environment, ask students to look for signs of heavily used pathways: litter, street lights, etc. Discuss the findings. These skills can organize the outdoor field excursion. The first two can be answered outdoors, and the last three can be completed as a group indoors.

    Ask geographic questions: Where is the path located? Why is it there? What is the place like?
    Acquire geographic information: What is the description of the path? Where does it go? Who uses the path? (This information can be acquired through looking at photographs, talking to people, in addition to observing the path.)
    Organize the geographic information: This can be done through drawing maps and making

graphs. Geography has been called "the art of the mappable." Making maps should be a common activity for all students.

Analyze geographic information: Look for patterns on the maps, draw inferences, and identify relationships.

Answer geographic questions: Generalize and conclude based on the above four skills. Why *is* the path where it is?

Concluding the Investigation

13. Have students write a journal page or draw a picture describing an imaginary path from the beginning to the end on **Log 3**. Set the scene for either an urban, suburban, or rural area depending on students' locale.

Background: Satellite Images

Figure 1: Boston <http://southport.jpl.nasa.gov/pio/srl2/sirc/boston.html> This image is of the area surrounding Boston, Massachusetts. The bright white area at the right center is downtown. The wide river below and to the left of the city is the Charles River. The bridge across the north end of Back Bay connects the cities of Boston and Cambridge. Ponds are shown as dark irregular spots. Many densely populated urban areas show up as red in the image due to the alignment of streets and buildings to the incoming radar beam.

Figure 2: Paris <http://svs.gsfc.nasa.gov/imagewall/LandSat/paris.html> This LandSat scene shows Paris from above, facing (roughly) south, looking across the city and the Seine River which snakes through the center of Paris. Features such as concrete buildings and roads appear as dark gray/black, water as dark blue, while green spaces are vegetation such as grass and trees. Note the radial street pattern and the highly visible highway that encircles Paris.

Figure 3: Houston <http://southport.jpl.nasa.gov/pio/sr12/sirc/sr12-jsc.gif> This image shows Houston. North is toward the upper left. Black areas are bodies of water, including Galveston Bay. Clear Lake is the dark body of water in the middle right of the image. Interstate 45 runs from the top to the bottom through the image. The dark cross in the upper center is Hobby Airport. The green square just north of Clear Lake is Johnson Space Center, home of Mission Control and the astronaut training facilities.

Background: Ground Truthing

When scientists compare features on the surface of Earth to the signals or pictures from satellites or other remote sensing devices, it is called "ground truthing." There are three main purposes of ground truthing. The first is simply to check or confirm the accuracy of the images. The second is identification—sometimes it is difficult to interpret features in an image without checking them out on the ground. The third purpose of ground truthing is to develop relationships between ground features and the signals detected by remote sensors. For example, by measuring soil moisture in a field and comparing it to remote sensing measurements taken at the same time, we can use remotely sensed information to monitor soil moisture. In short, ground truthing involves comparing remotely sensed images (or data sets) with actual on-site observation.

Related Resources

http:edu.larc.nasa.gov/connect. Online Road Rally using images

http//www.TOPOZONE.com Excellent topographic maps of local areas

NASA's Student Involvement Program, Earth systems in my neighborhood, educators' resource guide, pp. 2-5

Module 4, Investigation 1: Log 1

Paths

Directions: Talk in your group about different types of paths. Be creative! Fill in all the blanks and then have each person in your group put her/his name beside her/his favorite path.

Name some paths	Who makes paths?	Where are paths located?	Why are paths where they are?

Module 4, Investigation 1: Log 2

A favorite path

Homework: Interview a family member or a friend. Tell the person that you are studying pathways and you would like to ask her/him questions about a pathway that is important to her/him. You may fill in the blanks or ask for help in doing this project. You will report back to your class about your findings.

Name of family member: _____ Age (optional): _____ Date: _____

Type of path: _____

Location of path: _____

Why was the path important or special? _____

_____

_____

_____

Describe the path (estimate length, time it takes to walk or ride it, what it is made of, what is special about it, what its surface is, etc.).

_____

_____

_____

_____

What special things do you see on the path?

_____

_____

_____

_____

Ask the person you interview to draw a map of the path and to label important landmarks (trees, houses, signs, waterways, etc.) on the back of this page.

Module 4, Investigation 1: Log 3

An imaginary path

Describe the setting surrounding the path. _____

Who made the path? _____

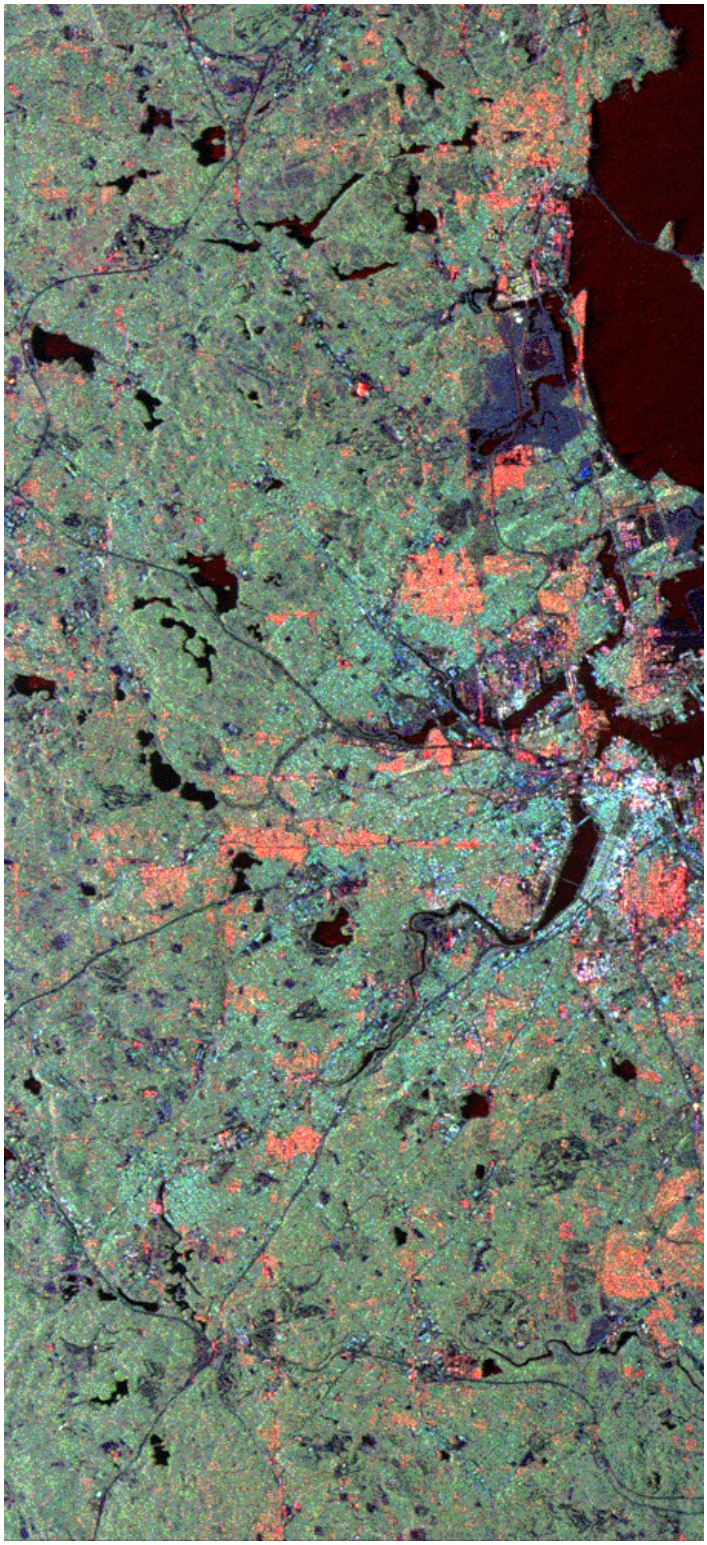
Where does it begin? _____ Where does it end? _____

Why was the path made? _____

Draw your path and label things that you see along the path.

Module 4, Investigation 1: Figure 1

Boston, Massachusetts



Source: http://southport.jpl.nasa.gov/pio/srl2/sirc/boston.html

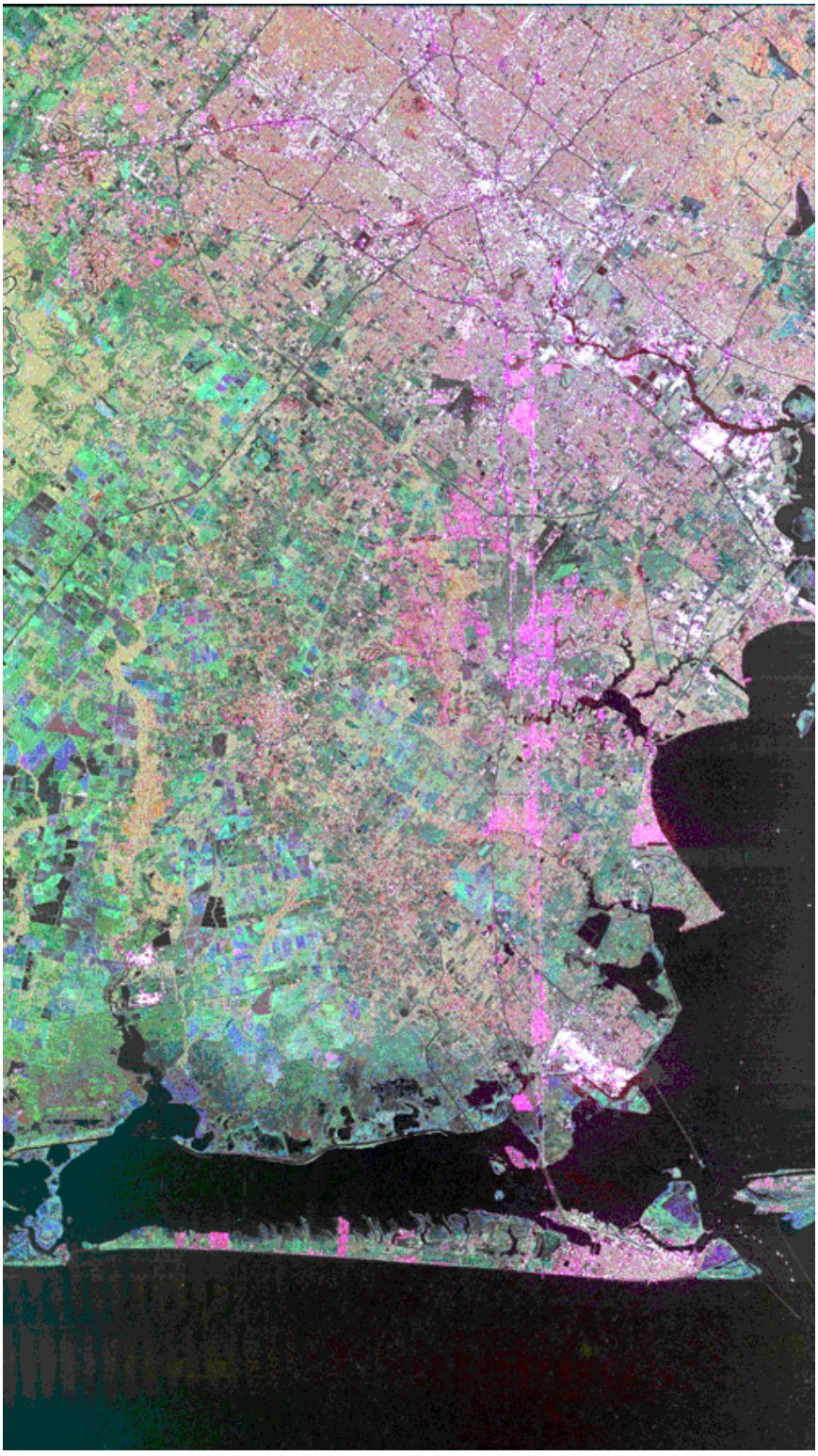
Module 4, Investigation 1: Figure 2

Paris, France

Source: http://svs.gsfc.nasa.gov/imagewall/LandSat/paris.html

Module 4, Investigation 1: Figure 3

Houston, Texas



Source: http://southport.jpl.nasa.gov/pio/srl2/sirc/srl2-jsc.gif