



Exploring our planet from above

Module Overview

Students view Earth by studying aerial photographs, Space Shuttle photographs, and satellite images. They learn how remote sensing can help identify ways in which people have changed the physical environment.

Investigation 1: Does what you see depend on where you are?

How does viewing an object from a distance change what the observer sees? Students compare different viewing distances on the ground, from the air, and from space.

Investigation 2: How can we compare maps with images from space?

Students examine maps at different scales and make observations about the amount of detail they can see. They compare remotely sensed images with maps, and measure and map changing land use with remotely sensed images.

Investigation 3: What can satellites tell us about Earth?

Students compare an aerial photo and a satellite image of the same place in order to identify basic characteristics of satellite images. They track the orbits of a satellite over the eastern United States and demonstrate how satellite signals are interpreted by simulating the creation of a satellite image. By overlapping two images, the students show how mosaics are created to show large areas. A concluding investigation matches different scientists with the kinds of remote sensing images they are likely to use in their work.

Investigation 4: How does color help us understand images from space?

Students learn to interpret colors in images from space. A mapping activity helps them to recognize global vegetation patterns from the colors they see in remote sensing images. They also distinguish between true color and false color images and examine how geographers and scientists use false color images to study the surface of Earth.



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

Places and Regions

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

Physical Systems

- **Standard 8:** The characteristics and spatial distribution of ecosystems on Earth's surface

Science Standards

Unifying Concepts and Processes

- Systems, order, and organization

Science as Inquiry

- Abilities necessary to do scientific inquiry

Earth and Space Science

- Objects in the sky
- Changes in earth and sky

Science and Technology

- Understandings about science and technology

Science in Personal and Social Perspectives

- Changes in environments
- Science and technology in local challenges

Connections to the Curriculum

This module can be used in social studies classes in the study of maps and globes and as students learn about Earth's physical characteristics such as its climates, weather patterns, plants, and animal life. The investigations strengthen science and social studies skills of observation, prediction, inference, and classification. Students are given many opportunities to practice their measurement skills and to study the effects of technology on the environment. Students practice language arts skills by reading to be informed and by reading to learn to perform a task.

Time

Investigation 1: One 45-minute session

Investigation 2: Two 45-minute sessions

Investigation 3: Two 45-minute sessions

Investigation 4: Two 45-minute sessions

Mathematics Standards

Number and Operations

- Compute fluently, and make reasonable estimates

Technological Literacy Standards

Nature of Technology

- **Standard 1:** The characteristics and scope of technology
- **Standard 3:** Relationships among technologies and the connections between technology and other fields

Abilities for a Technological World

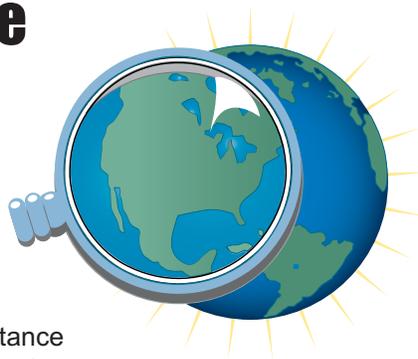
- **Standard 11:** Apply design processes

The Designed World

- **Standard 17:** Information and communication



Does what you see depend on where you are?



Investigation Overview

How does viewing an object from a distance change what the observer sees? Students compare different viewing distances on the ground, from the air, and from space. This investigation has two parts. First students view simple shapes from varying distances and record their observations. Then they view NASA images and make observations about what can be seen from ground level, from an airplane, and from the Space Shuttle.

Time required: One 45-minute session

Materials/Resources

Part 1:

- Paper towel tube
- Paper or styrofoam cup
- Two lengths of string, 1 and 4 meters long
- Felt marker
- Meter stick
- Scissors
- Colored paper
- Any wall map
- A map that shows the following places in Florida: Miami, Orlando, Cape Canaveral, Lake Okeechobee (can be the same as the wall map)
- Erasable marker
- Masking tape

Part 2:

- Figure 1: Ground view of Space Shuttle on launch pad (transparency)
- Figure 2: Aerial view of Kennedy Space Center launch pad (transparency)
- Figure 3: Space Shuttle lift-off (transparency)
- Figure 4: Florida as seen by astronauts (transparency)
- Map showing major cities and lakes of Florida
- Logs 1, 2, 3, and 4 (one copy of each per student)

Content Preview

As the distance between an observer and an object increases, a larger area surrounding the object is visible. Many details, however, cannot be seen when the viewing distance increases. High altitude photographs provide viewers with the “big picture,” but when detailed information is needed, regions must be observed from less distant positions or with equipment that compensates for the distance, such as a camera with a zoom lens. Measurements of land area can be made on satellite images.

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

- Use geographic representations, tools, and technologies to answer geographic questions.

Geography Skills

Skill Set 2: Acquiring Geographic Information

- Use aerial photographs, satellite images, or topographic maps to identify elements of the physical and human environment.

Classroom Procedures

Beginning the Investigation

1. Ask the students to place the palm of one hand on the tip of their nose. Ask them to keep looking at the hand and to describe the changes they see as they move the hand away from their noses. (*At first they will see only part of the hand, then the whole hand, then part of the arm, as well as the hand.*)
 - Older students can do this activity following the directions in **Log 1**. In preparation, have students fold a sheet of paper lengthwise and mark distances of 5, 15, and 30 centimeters along the fold. Then they can hold the paper in one hand and move the other hand to each of the three distances.
2. Position a student approximately 15 centimeters from a wall map. Ask the student to describe what he or she sees. From this position the student may be able to identify a state or region. Have the student take a large step away from the map and ask what he or she sees while looking straight ahead at the map. The student should be able to describe a larger area, several states or a country. Repeat with one more large step.

Ask the student to explain how moving away from the map changed what he or she saw. (*More area is visible but fewer details.*)
3. Discuss with students the change they see when distance between observer and object changes. (*As you move further away from an object, the boundaries of your field of vision are extended, revealing new information. Your interpretation of what you see changes because you have more information.*) Have older students express this in their own words in **Log 1**.
6. Have the students place the 4 meter string on the floor with one end touching the midpoint of the wall on which the paper shapes are mounted. Extend it away from the wall. Use small pieces of masking tape to mark 1 meter increments along its length.
7. Provide students with a small paper cup with the bottom cut out.
8. Follow the instructions in **Log 2** with groups of students lining up together to view the paper shapes. Note that each student should select his or her own *target* and stand one meter in front of it. Ask the students to view one of the shapes through the large open end of a paper cup. Older students can write their responses on **Log 2**; younger students can give verbal responses.
9. Ask the students to view the same shape after moving distances equal to two and four times the original viewing distance (2 and 4 meters) and repeat the description process using **Log 2**.

Concluding the Investigation

10. Simulate a NASA remote sensing mission with students. Tell the students that they will examine photos of a Space Shuttle launch taken at the Kennedy Space Center. Ask them to imagine what the astronauts will see as the shuttle leaves the ground. (*The launch site, the Space Center, the Florida coast, all of Florida, etc.*)
11. Display **Figures 1, 2, and 3** as overhead transparencies. Ask older students to write their observations on **Log 3**. Younger students can give verbal responses.

Begin by asking students to identify the Space Shuttle in **Figures 1, 2, and 3**. Also point out the fuel tank and solid-fuel booster rockets that carry the shuttle into space. Ask students to outline the shuttle and the rocket with erasable markers. When showing **Figure 4**, have students mark the location of each place on the transparency.

Figure 1: Ground view of Space Shuttle on launch pad at Kennedy Space Center, Florida

Figure 2: Aerial view of Kennedy Space Center Launch Pad 39 from a distance of approximately 1.6 kilometers with the Space Shuttle being prepared for STS-39 mission. Image S91-32599

Developing the Investigation

4. Cut 8 to 10 circles, squares, and rectangles from colored paper. Cut the circles with a diameter approximately 2 centimeters, the squares with sides 2 centimeters in length, and the rectangles with sides of 2 and 3 centimeters.
5. Place these shapes at student eye level over a large section of a classroom wall so that only one is visible at a distance of 1 meter. They can be positioned near other objects, figures, or markings on the wall. As students move farther away from the wall, they should be able to see more of the shapes.

Figure 3: Space Shuttle lift-off

Figure 4: Picture of Florida from a distance of approximately 546 kilometers as seen by astronauts aboard the Space Shuttle in 1998.

Background

Researchers and scientists determine the distance from which to view an object based on the type of information needed. For example, scientists may use pictures taken from a satellite orbiting 35,200 kilometers from Earth to study large areas of cloud cover or weather patterns, whereas they might employ satellites orbiting 320 kilometers above Earth to study river drainage in detail.

Determining the length and width of lakes or other objects can be accomplished using satellite images. On an image, the physical dimension of a land feature can be determined by a technique known as scaling. The dimensions of Lake Okeechobee can be determined by comparing its length and width to the known width of Florida. The east-west distance across Florida through Lake Okeechobee is 224 kilometers. When scaled on the image, Lake Okeechobee is approximately one-fourth that distance, or 56 kilometers.

Evaluation

Log 1

- 5 centimeters—palm of hand, base of fingers
15 centimeters—whole hand
30 centimeters—whole hand, part of arm
- You can see more of the map but not as much detail.

*Log 2

- 1, 2, and 3. What you see will vary with the placement of the paper shapes.
- No, you would not be able to tell the shapes apart. 100 meters. You would see the wall and very large objects on it, like a bulletin board.
- As you move farther away from something you see less detail, but you can see more of the area.

*Log 3

Figure 1

- Far away
- From the ground

Figure 2

- Yes, because the Space Shuttle looks smaller
- From the air. You are looking down at two airplanes flying over the Space Center.

Figure 3

- No, because the Space Shuttle looks larger

*Log 4

- 546 kilometers
- Yes
- See map for locations.
- You can't see the Space Center because the photograph was taken from too far away.
- 56 kilometers.
- No, because it would be too small to be seen from that distance. The 56 kilometers width measures only about 1 centimeter in the photograph. A 1 kilometer wide lake would be 1/56 the size—too small to be seen.



Module 1, Investigation 1: Log 1

How does distance affect what we see?

Every day our eyes help us gather the information we need to discover and understand what is around us. In this activity, you will describe what your eyes see as you move farther away from an object.

1. Place your hand flat against the tip of your nose. Move it 5, 15, and 30 centimeters away and describe what you see at each distance in the space below. Include in your description the answer to the following questions:
 - a. Can you see your whole hand or just part of it?
 - b. Can you see the tips of your fingers?
 - c. How much of your arm can you see?

Location	Description
Hand 5 cm from nose	
Hand 15 cm from nose	
Hand 30 cm from nose	

2. How does what you see on a wall map change as you move away from it?



Module 1, Investigation 1: Log 2

How does distance affect what we see?

1. Move 1 meter from a shape pasted on the wall and look at it through the large open end of a paper cup. This shape is your *target*.

Can you see any of the other shapes near your target? How many can you identify? Name them (for example, two circles and one square).

2. Move away from the target to a distance equal to two times the original distance. How many meters are you from the target? _____
Record what you see. _____

3. Move away from the target to a distance equal to four times the original distance. How many meters are you from the target? _____
Record what you see from this distance. _____

4. Would you be able to tell the shapes apart if you saw them from a distance equal to a hundred times the original distance? _____
Your distance from the target would then be _____ meters.
Record what you *think* you would see at that distance.

5. Conclusions: Explain how what you see changes when you move farther away by circling the words that finish these sentences correctly.

As you move farther and farther away from something, you see more detail or less detail.

As you move farther away from something you see more of the area around it or less of the area around it.



Module 1, Investigation 1: Log 3

How does distance affect what we see?

Figure 1

1. The Space Shuttle looks small in the photograph, even though it is the size of a large airplane. This tells you something about the distance between the photographer and the launch site. Was the photographer close to the site or far away?

2. Was the photograph taken from the ground or from the air? _____
How can you tell?

Figure 2

3. Was this photograph taken from a greater distance than the first photograph? _____
How can you tell?

4. Was this photograph taken from the ground or from the air? _____
How can you tell?

Figure 3

5. Lift-off! Was this photograph taken from a greater distance than Figure 2? _____
How can you tell?



Module 1, Investigation 1: Log 4

How does distance affect what we see?

Figure 4

1. The Space Shuttle has circled Earth and come back over Florida. This photo was taken by the astronauts on board. How far above Florida is the shuttle?

_____ kilometers

2. Compare the photograph with a map of Florida. Can the astronauts see the whole state?

3. Find Miami and Orlando on the map. Figure out where they are in the photograph.

4. Now find Cape Canaveral in the same way. This is the location of the Kennedy Space Center. Why can't you see the launch site in this photo that you saw in Figure 2?

5. Find Lake Okeechobee in the photograph. The distance across Florida through Lake Okeechobee is 224 kilometers, and the lake is about $\frac{1}{4}$ as wide as that part of the state. Can you figure out how wide the lake is?

_____ kilometers

6. Do you think that you would see the lake if it was 1 kilometer wide? _____
Why or why not?



Module 1, Investigation 1: Figure 1

Ground view of Space Shuttle on launch pad



Lite pre-launch activities and Lite flight - KSC
NASA Langley Research Center 3/13/1995

Image # EL-1996-00059

Source: <http://lisar.larc.nasa.gov/LISAR/IMAGES/SMALL/EL-1996-00059.jpg>



Module 1, Investigation 1: Figure 2

Aerial view of Kennedy Space Center launch pad



This photograph provides an aerial view of Kennedy Space Center Launch Pad 39 from a distance of approximately 1.6 kilometers with the Space Shuttle being prepared for STS-39 mission.

Source: http://images.jsc.nasa.gov/images/pao/NASA_JSC/10076653.jpg



Module 1, Investigation 1: Figure 3

Space Shuttle lift-off



LDEF: Liftoff of Space Shuttle Columbia/STS-S32 for Retrieval
NASA Langley Research Center 2/6/1990 Image # EL-1994-00476

Source: <http://lisar.larc.nasa.gov/LISAR/IMAGES/SMALL/EL-1994-00476.jpg>



Module 1, Investigation 1: Figure 4

Florida as seen by astronauts



This photograph of Florida was taken by astronauts aboard the Space Shuttle in 1998, from a distance of approximately 546 kilometers.

Source: <http://eol.jsc.nasa.gov/sseop/mrf.stm> (STS-095-743-33.jpg)



Module 1, Investigation 1: Log 1

How does distance affect what we see?

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 - c. How much of your arm can you see?

Location	Description
Hand 5 cm from nose	
Hand 15 cm from nose	
Hand 30 cm from nose	

2. How does what you see on a wall map change as you move away from it?



Module 1, Investigation 1: Log 2

How does distance affect what we see?

1. Move 1 meter from a shape pasted on the wall and look at it through the large open end of a paper cup. This shape is your *target*.

Can you see any of the other shapes near your target? How many can you identify? Name them (for example, two circles and one square).

2. Move away from the target to a distance equal to two times the original distance. How many meters are you from the target? _____
Record what you see. _____

3. Move away from the target to a distance equal to four times the original distance. How many meters are you from the target? _____
Record what you see from this distance. _____

4. Would you be able to tell the shapes apart if you saw them from a distance equal to a hundred times the original distance? _____
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Module 1, Investigation 1: Log 3

How does distance affect what we see?

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Figure 2

3. Was this photograph taken from a greater distance than the first photograph? _____
How can you tell?

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Module 1, Investigation 1: Log 4

How does distance affect what we see?

Figure 4

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_____ kilometers

2. Compare the photograph with a map of Florida. Can the astronauts see the whole state?

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_____ kilometers

6. Do you think that you would see the lake if it was 1 kilometer wide? _____
Why or why not?



Module 1, Investigation 1: Figure 1

Ground view of Space Shuttle on launch pad



Lite pre-launch activities and Lite flight - KSC
NASA Langley Research Center 3/13/1995

Image # EL-1996-00059

Source: <http://lisar.larc.nasa.gov/LISAR/IMAGES/SMALL/EL-1996-00059.jpg>



Module 1, Investigation 1: Figure 2

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Source: http://images.jsc.nasa.gov/images/pao/NASA_JSC/10076653.jpg



Module 1, Investigation 1: Figure 3

Space Shuttle lift-off



LDEF: Liftoff of Space Shuttle Columbia/STS-S32 for Retrieval
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Module 1, Investigation 1: Figure 4

Florida as seen by astronauts



This photograph of Florida was taken by astronauts aboard the Space Shuttle in 1998, from a distance of approximately 546 kilometers.

Source: <http://eol.jsc.nasa.gov/sseop/mrf.stm> (STS-095-743-33.jpg)



How can we compare maps with images from space?



Investigation Overview

Students examine maps at different scales and make observations about the amount of detail they can see. They compare satellite images with maps and use satellite images to measure and map changing land use.

Time required: Two 45-minute sessions

Materials/Resources

Fire drill map of the school

Maps of the community, county or parish, state, the United States, North America, and the world. The last four maps can be printed from <http://www.nationalgeographic.com/xpeditions/main.html?main=atlas> if wall maps are unavailable.

Aerial photograph of the school community (<http://www.terraserver.com>)

Log 1: Why do we need satellites? (one for each student)

Log 2: It's a map! or It's an image!—Boxes (one for each student)

Log 3: It's a map! or It's an image!—Poster (one for each student)

Log 4: What do you see in this image? (transparency and one copy for each student)

Log 5: How has this place changed? How do you know? (transparency and one copy for each student)

Ruler

Fine black markers for students

Black transparency marker

Content Preview

Maps, aerial photographs, and satellite images show different information about Earth. Maps are graphic representations of selected Earth features. Aerial photos are photographs of Earth's surface taken from an airplane at different distances from Earth. Satellite images are digitally produced representations of Earth taken from orbiting sensing devices on satellites. Both aerial photographs and satellite images can capture all recordable detail. Maps can be drawn to portray just one or a few themes. Each representation is useful for different purposes. Satellite images are analyzed to identify meaningful categories; then the image can serve as the basis for a thematic map when a theme is selected, for example, land use change. Some satellite images are true color; some are false color. Various kinds of surface materials can be distinguished from each other by differences in the energy they reflect. At certain energy wavelengths sand reflects more energy than green vegetation, while at other wavelengths it absorbs more (reflects less) energy. In the near infrared wavelength, vegetation appears bright red.

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.

Geography Skills

Skill Set 4: Analyzing Geographic Information

- Use maps to observe and interpret geographic relationships.

Classroom Procedures

Beginning the Investigation

1. **Maps of smaller and larger areas.** Show students the fire drill map of the school. Ask students to describe what they know about the school from looking at this map. (*The map shows the locations of selected features such as classrooms, cafeteria, offices, hallways, etc.*) Explain that this map is a drawing that shows where some things and places are located. Ask why schools have maps like this.

Next, show students a variety of maps at different scales (the community, county/parish, state, United States, North America, and the world). Have students discuss the features shown on the maps. What is the purpose of each map? What information does each present? What is a map?

Developing the Investigation

2. **Aerial photograph.** If available, show students an aerial photograph of their school community. Explain that it was taken from an airplane. Have them locate the school in the photograph. Ask students to identify other places that they recognize. Then, look at the map of the same community. Ask if the photo and the map look the same or different. Ask students to indicate how the map is different. What objects can they see in the photograph that are not on the map? (*Buildings, farms, trees, parks, maybe some streets and roads.*) Summarize that maps show selected features and often have a theme or purpose; aerial photos show more detail and do not have a theme. They are pictures.
3. Have students study a map of the United States and ask them if they can see any of the streets, roads, lakes, rivers, etc. on this map that they saw on the community map. Ask why they can't see these features on the U.S. map. Compare the size of the area covered on the community map to the area on the U.S. map. Unless it is a large city, the community may not even be named on the U.S. map. Why not?
4. Compare the U.S. map to the North America and world maps. Ask students to identify features that can be seen on each map. Ask which features are visible on the U.S. map but not on the North America map. Which are visible on the North America map but not on the world map? Why? (*The larger the area shown the less detail can be mapped.*)
5. **Satellite images.** Give each student a copy of **Log 1**. Ask the students to describe what they see in the drawing. Explain that a satellite is a small spacecraft that orbits Earth many miles above it. Some satellites have special instruments that create images of Earth. Have students color the continents green and the oceans blue and label them.
6. **Comparing maps and images from space.** Give each student **Log 2** and **Log 3**. Tell students to cut out all the boxes and place them under the correct title on the poster. Discuss the differences between satellite images and maps, and point out that the images show what is actually on the ground like a photograph while maps are human-made representations to show specific information (*political boundaries, place names, roads, vegetation regions, etc.*) about an area.
7. **Using images from space.** Satellite images can help humans understand how some things change. Tell students that NASA images are used to measure ways humans change the environment by changing how land is used. Distribute copies of **Log 4** and **Log 5** and show them as transparencies.
8. Have the students compare the images in **Log 4** with the **Log 5** transparency. The images show the rapid growth of Las Vegas, Nevada. Help students interpret the images and recognize key features. Ask students when the images were taken. How many years passed from the date the first image was captured to the second? Identify the parts of Las Vegas that were built since 1972. The images use false color. Explain that red indicates vegetation. Vegetation reflects brightly in the near infrared. Mark changes on the transparency as the students identify them.
9. Have the students answer the questions on **Logs 4** and **5**. They will measure the growth of the city over 20 years and create a map of land-use change and urban growth.

Have the students compare their answers and their maps, and discuss the value of satellite images for map making.

Concluding the Investigation

10. Have two students draw a line around Las Vegas on each of the transparencies. Overlay them and project the image on a large sheet of paper. Have two other students trace the two city boundaries on the paper. Ask a student to color the area that shows the city in 1972 and another student to color the area of growth between 1972 and 1992. Collaborate on appropriate colors, a good title for the map, and a legend explaining the boundary lines and the two colors on the map.

Discuss the importance of monitoring urban growth, especially in Las Vegas where a growing population places heavy demands on scarce water resources, and the value of satellite images in monitoring such growth.

Evaluation/Key

*Log 3:

- "It's a map!"
 - North America Map
 - Can show borders of countries
 - Can show drawings of land and water
- "It's an image from space!"
 - Satellite image of land from space
 - Can show actual landforms
 - Can show actual water bodies
 - Can show quick changes to the land

*Log 4: What do you see in this image?

2. About 16 kilometers

*Log 5: How has this place changed?

2. About 24 kilometers
3. About 8 kilometers

Related Resources

Me on the Map by Joan Sweeney, illustrated by Annette Cable (Crown Publishers, Inc., New York, 1996) ISBN 0-517-70095-6

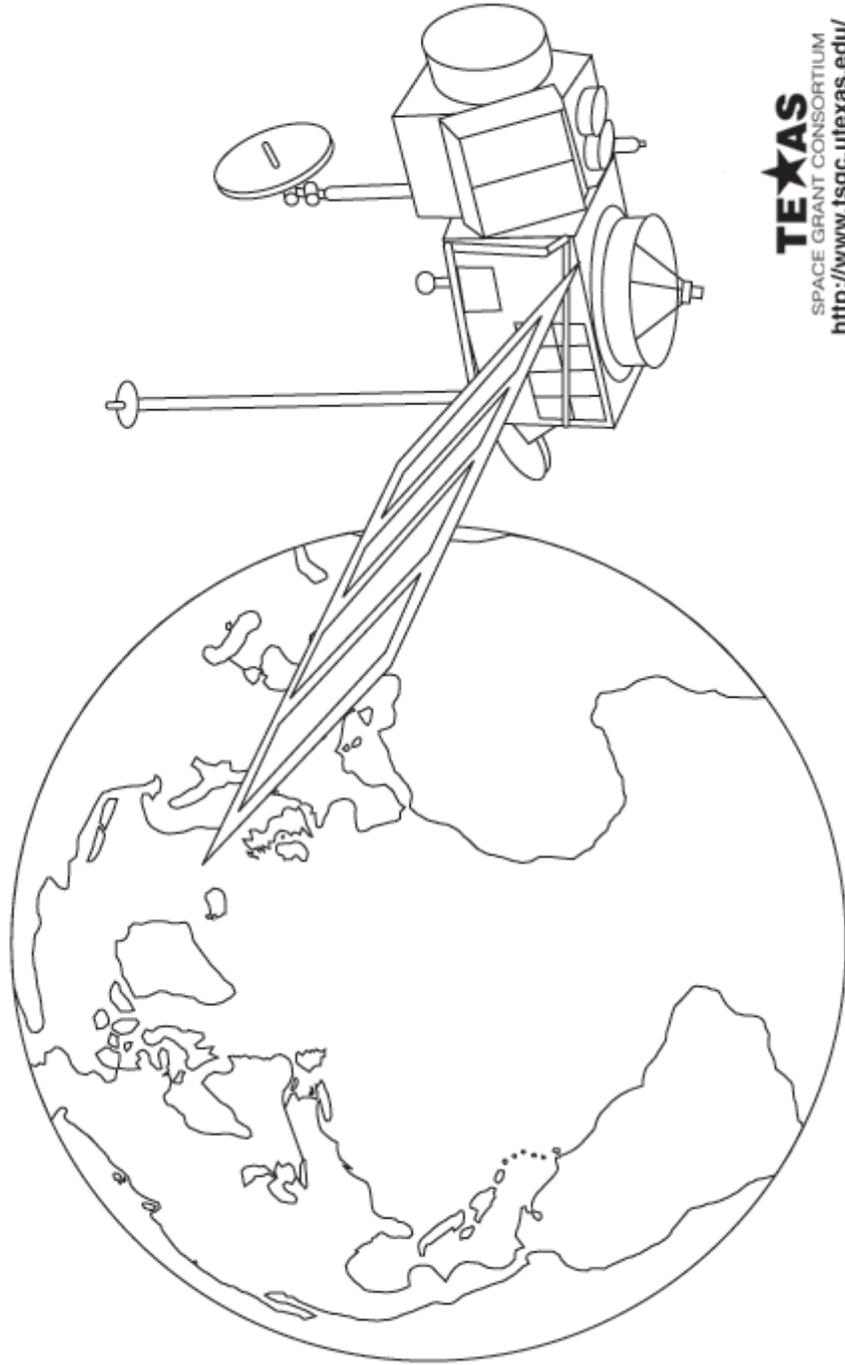
(This picture book opens with a child in her bedroom. A map of the bedroom is shown with her on the bed. The book maps the child from her bedroom to her town, in her town, in her state, in her country, and in the world.)

Looking Down by Steve Jenkins (Houghton Mifflin Co., New York, 1995) ISBN 0-395-72665-4

(This book is double-page-spread cut-paper collages that illustrate traveling from Earth into space to look at Earth. The book begins in space and then moves closer and closer to Earth. Each picture shows more details of Earth.)

Module 1, Investigation 2: Log 1

Why do we need satellites?

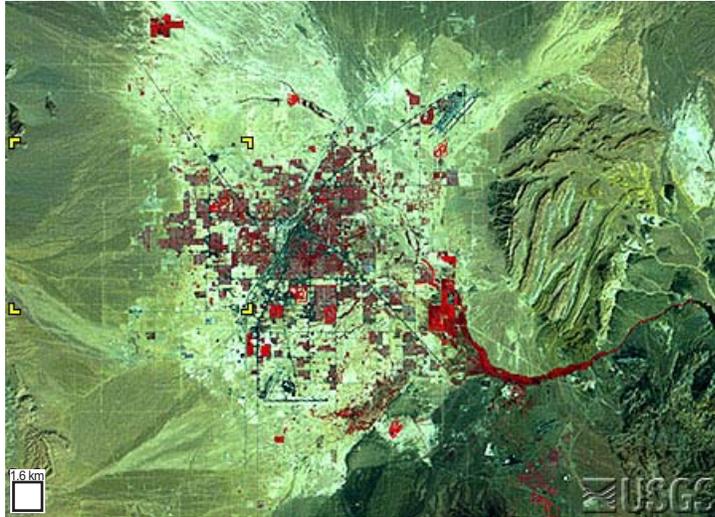


TEXAS
SPACE GRANT CONSORTIUM
<http://www.tsgc.utexas.edu/>



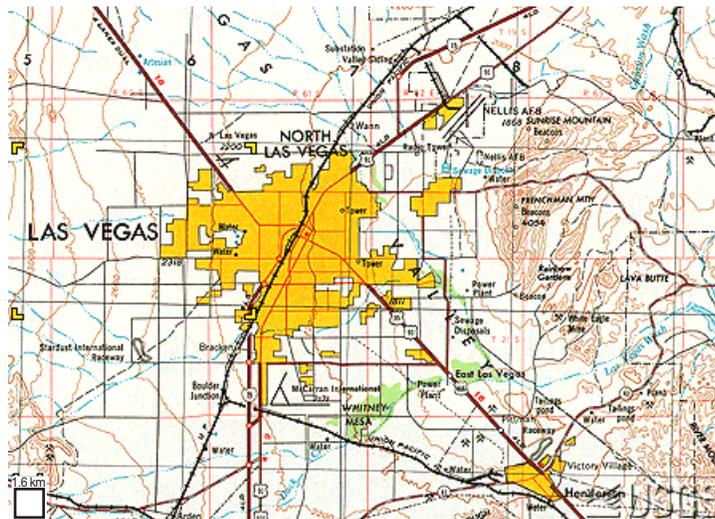
Module 1, Investigation 2: Log 2

It's a map! or It's an image—Boxes



Can show borders of countries

Can show actual water bodies



Can show actual landforms

Can show quick changes to the land

Can show drawings of land and water



Module 1, Investigation 2: Log 3

It's a map! or It's an image!—Poster

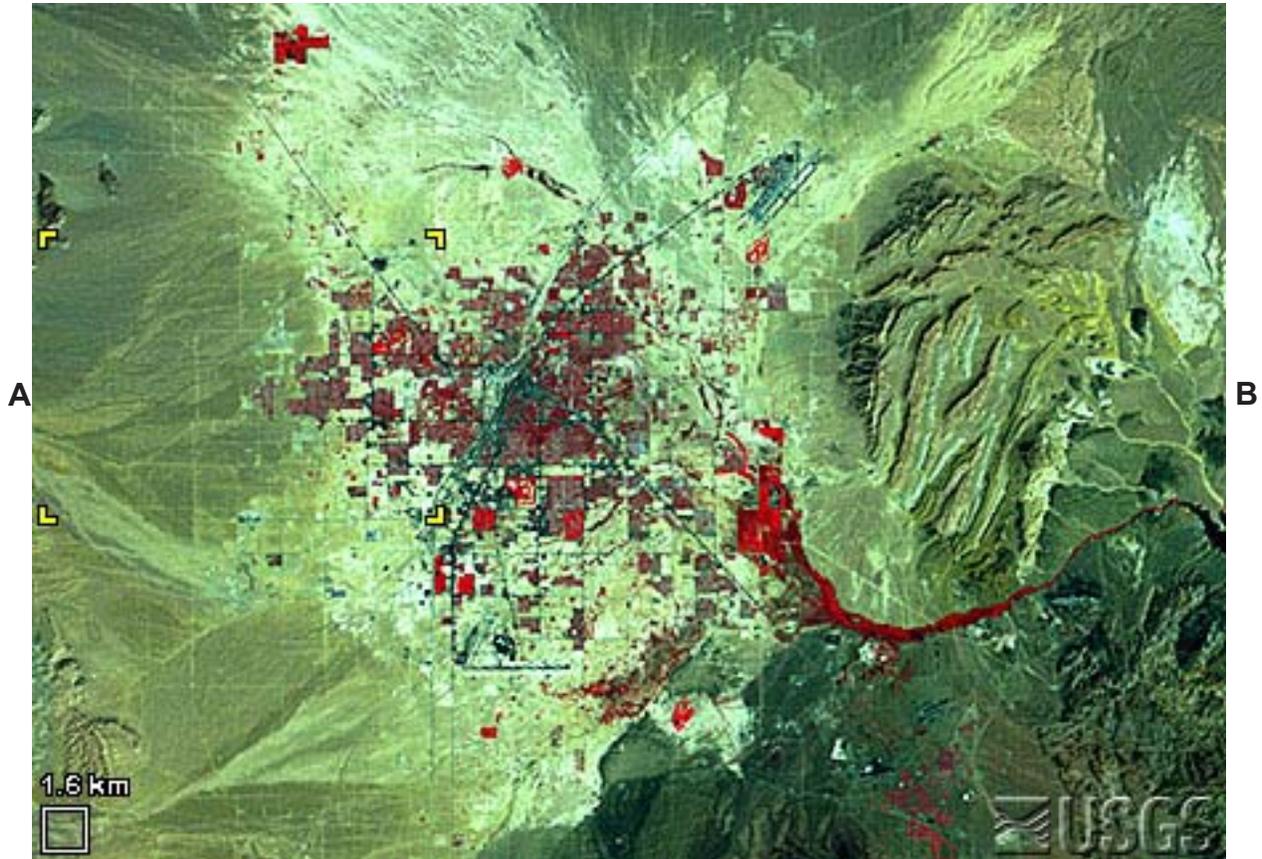
It's a Map!

It's an Image from Space!



Module 1, Investigation 2: Log 4

What do you see in this image?



Las Vegas, 1972

Source: <http://edc.usgs.gov/earthshots/slow/LasVegasa/LasVegas>

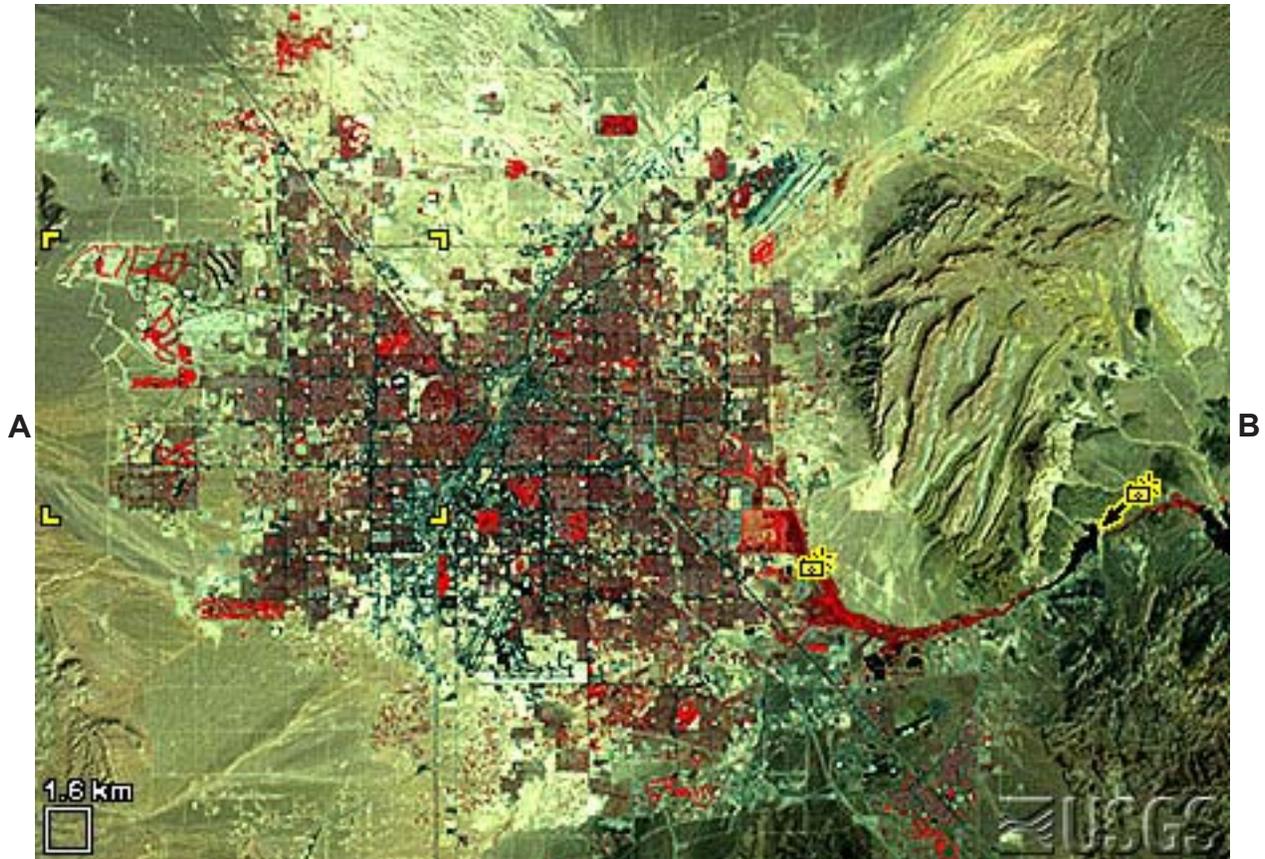
1. Draw a line around the city with a fine black marker.
2. Place a ruler between points A and B. Use the scale to figure out the distance across the city from the easternmost edge to the westernmost edge.

_____ kilometers



Module 1, Investigation 2: Log 5

How has this place changed? How do you know?



Las Vegas, 1992

Source: <http://edc.usgs.gov/earthshots/slow/LasVegas/LasVegas>

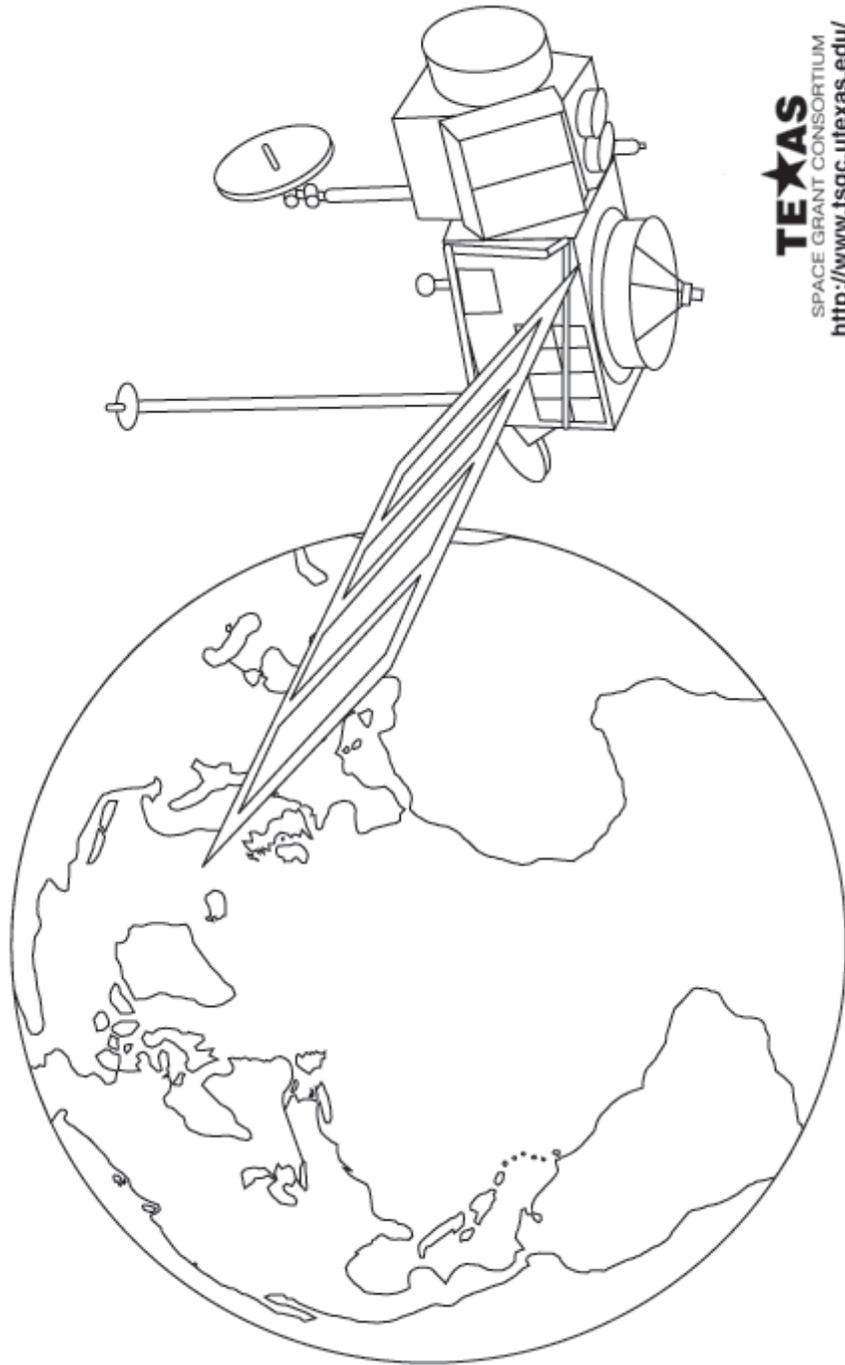
1. Draw a line around the city with a fine black marker.
2. Place a ruler between A and B. Use the scale to figure out the distance from the easternmost edge of the city to the westernmost edge.

_____ kilometers
3. How much did Las Vegas expand along this east-west line between 1972 and 1992?

_____ kilometers
4. Make this image into a map! You have already drawn a line around the city. Now use the marker to outline the highways going into Las Vegas and the streets in the city.

Module 1, Investigation 2: Log 1

Why do we need satellites?

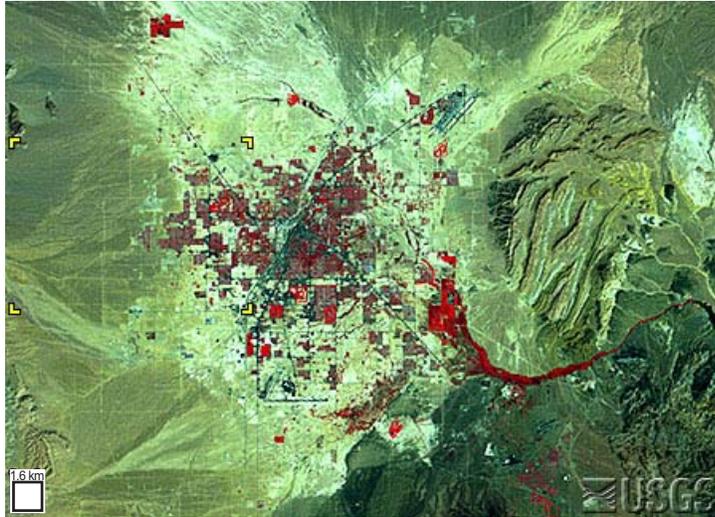


TEXAS
SPACE GRANT CONSORTIUM
<http://www.tsgc.utexas.edu/>



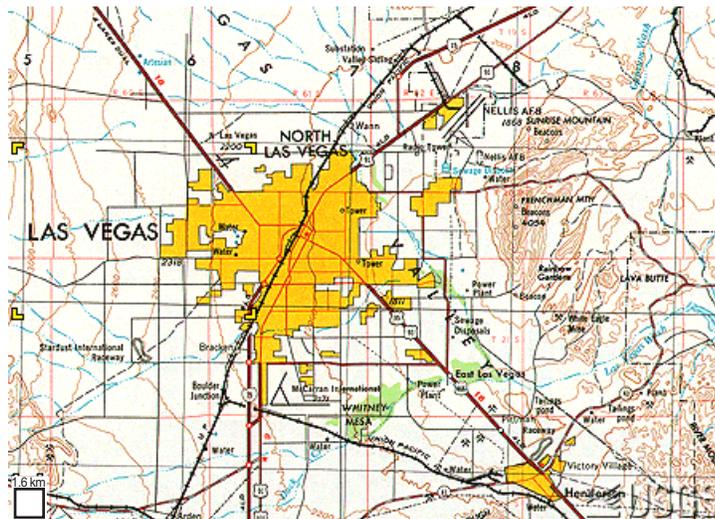
Module 1, Investigation 2: Log 2

It's a map! or It's an image—Boxes



Can show borders of countries

Can show actual water bodies



Can show actual landforms

Can show quick changes to the land

Can show drawings of land and water



Module 1, Investigation 2: Log 3

It's a map! or It's an image!—Poster

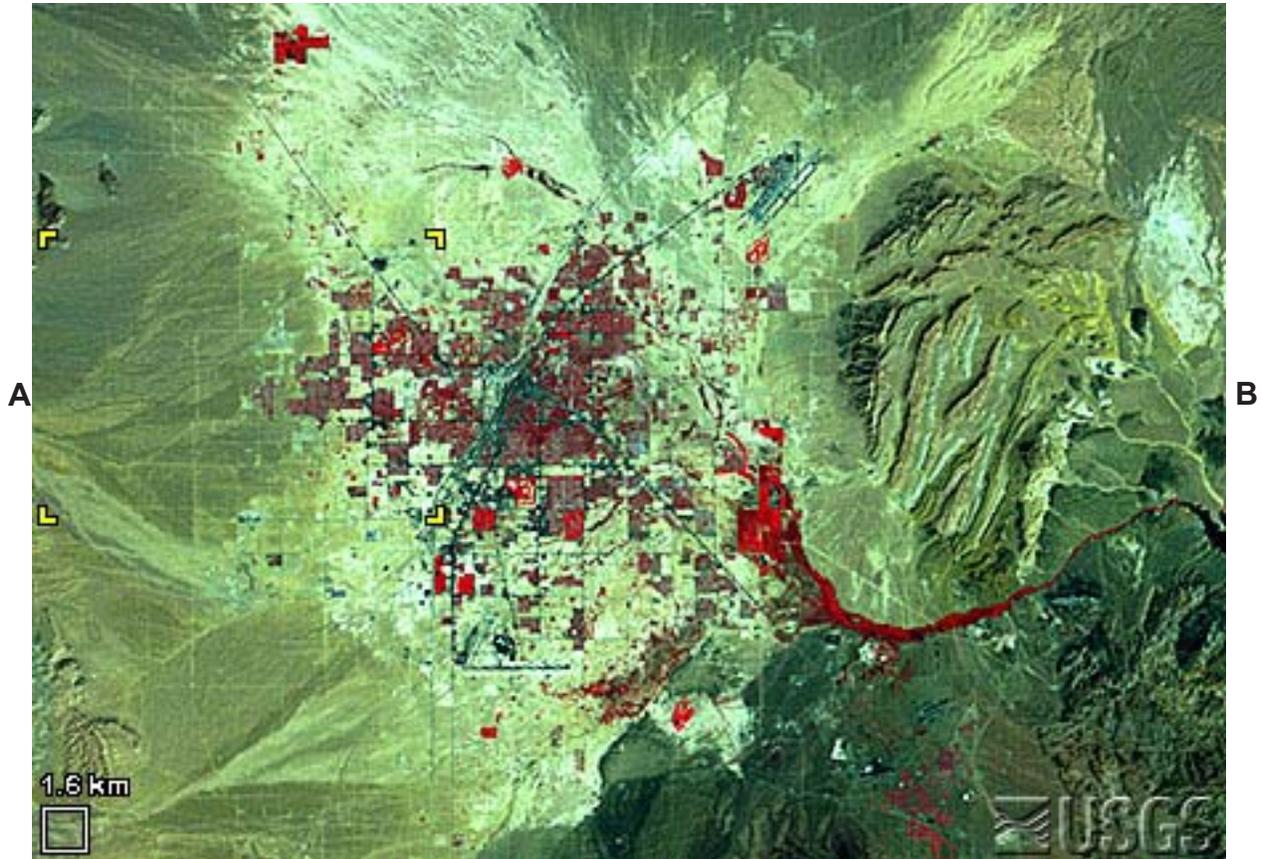
It's a Map!

It's an Image from Space!



Module 1, Investigation 2: Log 4

What do you see in this image?



Las Vegas, 1972

Source: <http://edc.usgs.gov/earthshots/slow/LasVegasa/LasVegas>

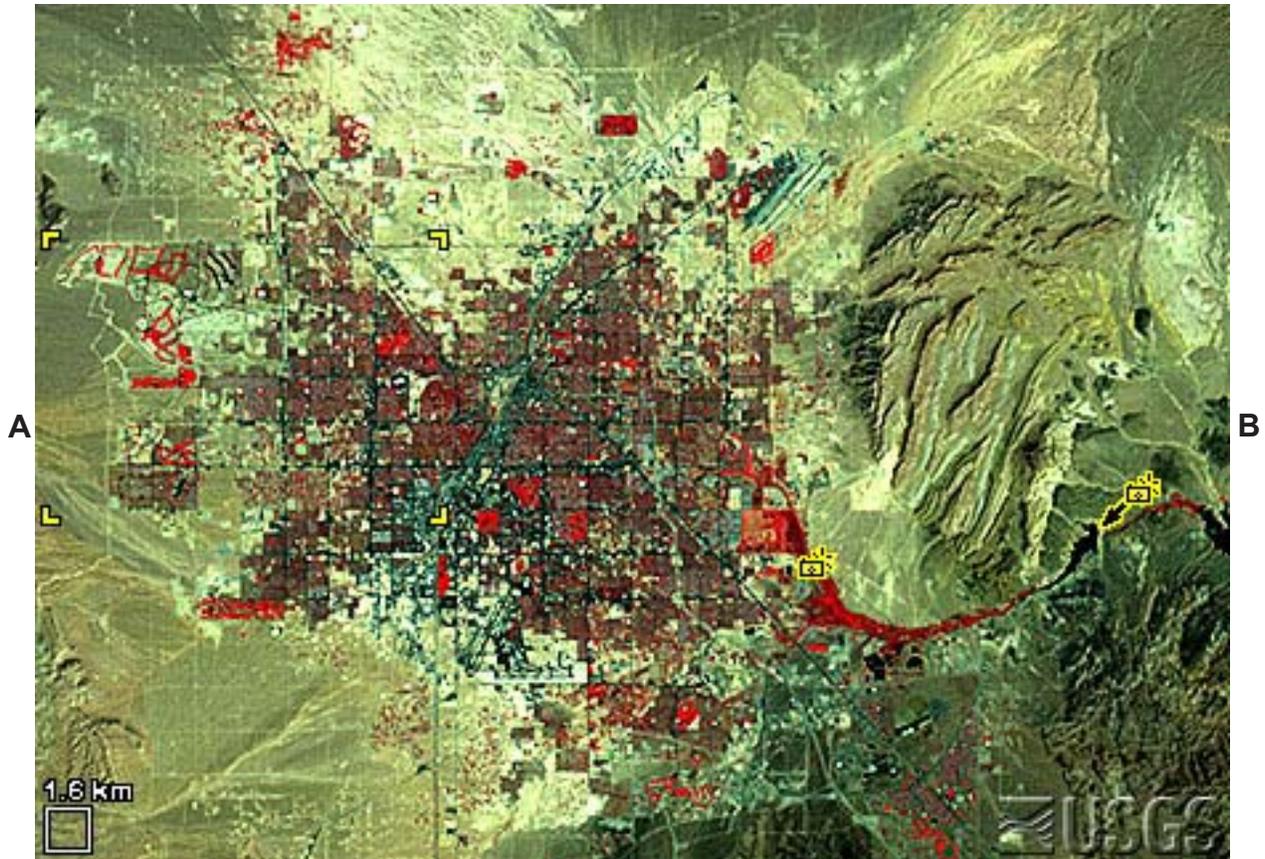
1. Draw a line around the city with a fine black marker.
2. Place a ruler between points A and B. Use the scale to figure out the distance across the city from the easternmost edge to the westernmost edge.

_____ kilometers



Module 1, Investigation 2: Log 5

How has this place changed? How do you know?



Las Vegas, 1992

Source: <http://edc.usgs.gov/earthshots/slow/LasVegas/LasVegas>

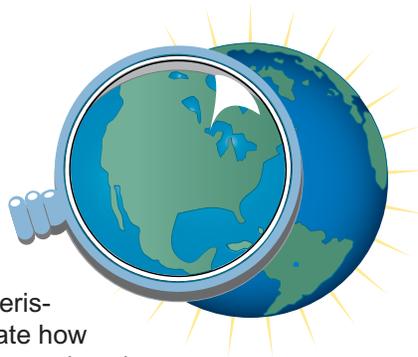
1. Draw a line around the city with a fine black marker.
2. Place a ruler between A and B. Use the scale to figure out the distance from the easternmost edge of the city to the westernmost edge.

_____ kilometers
3. How much did Las Vegas expand along this east-west line between 1972 and 1992?

_____ kilometers
4. Make this image into a map! You have already drawn a line around the city. Now use the marker to outline the highways going into Las Vegas and the streets in the city.



What can satellites tell us about Earth?



Investigation Overview

Students learn to identify basic characteristics of satellite images. They demonstrate how satellite signals are connected to images and explore the ways in which different scientists use such images.

Time required: Two 45-minute sessions

Materials/Resources

Crayons

Log 1: Morro Bay, California: Which is the satellite image? (transparency)

Log 2: What is this satellite doing? (transparency)

Log 3: How do satellites work? (transparency and one copy for each student)

Log 4: How are satellite images like puzzles? (one copy for each pair of students)

Log 5: Who uses satellite images and for what purpose? (one copy for each group of four students)

Log 6: How do satellite images help predict hurricanes? (transparency)

Log 7: How do images of flooding help us learn about Earth? (transparency)

Log 8: How do images of volcanoes help us study Earth? (transparency)

Content Preview

Remote sensing is the science of observing, identifying, and measuring objects and regions without direct contact. An aerial photo and a remotely sensed satellite image are two perspectives “from above.” Sensors are mounted on satellites that orbit Earth. Sensor signals are processed to produce a satellite image. Views of large areas are produced by overlapping remotely sensed images, a technique known as mosaicing (making a mosaic). A pixel is the smallest unit in an aerial photo or remotely sensed image, and refers to the area on the ground from which the satellite acquires a single measurement. A remotely sensed digital image is made up of millions of pixels. Many types of scientists use remote sensing and satellite images in their research.

Classroom Procedures

Beginning the Investigation

1. Show the students a transparency of **Log 1**. Explain that both show Morro Bay, California. Discuss the differences between the two and have them answer the Log questions. Guide the students to discover the difference in scale.

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.

Geography Skills

Skill Set 4: Analyzing Geographic Information

- Use texts, photographs, and documents to observe and interpret geographic trends and relationships.

- The satellite image (**Figure 2**) shows a much larger area since the satellite was at a higher altitude than the airplane from which the photo was taken. The satellite was directly overhead (oblique view), while the airplane view was at an angle (though cameras mounted on airplanes can also take photographs from directly overhead).
 - The satellite image appears to be made of small squares. These are called pixels. Tell the students that they will soon learn why this is so.
 - Explain that during this investigation students will learn how a satellite creates images, and how these satellite images are used to study Earth.
2. On the board write “remote sensing” and ask students if anyone has heard of this term. Ask one student to read a few sentences from a book. Tell the class that this student is using remote sensing. Ask how can this be? Explain that this student is gathering information about something from a distance and that this is a form of remote sensing. Explain that the brain gathers information from a book by analyzing and interpreting reflected light. Explain that remote sensing is a way of gathering information without touching the source of the information, from as close as a book or from as far away as a satellite in orbit.

Developing the Investigation

3. Ask students what they know about satellites. Explain that a satellite is a small body, natural or artificial, that revolves around a larger astronomical object. The Moon is Earth’s natural satellite. There are many kinds of artificial satellites that serve different purposes. Some help communication by transmitting signals from telephones and computers. NASA’s satellites carry sensors that observe Earth to better understand the environment. These satellite sensors gather information about weather, landforms, oceans, vegetation, land use, and other things. The information is transmitted to computers on Earth. Information gathered by satellites is displayed as pictures or “images.”
4. If an Internet connection is available, show the class the animation of how one satellite scans Earth. <http://earthobservatory.nasa.gov/Library/AM1/anim/am_godview.mov> or <http://earthobservatory.nasa.gov/Library/AM1/anim/swath_modis.mov> Have students note that as Earth rotates, the satellite observes a new swath of Earth surface.
5. How do satellites send images from space? Tell students that they are going to draw a picture to simulate how satellites send images from space to computers. Give each student a copy of **Log 3** and display a transparency of **Log 3**.
- Tell students that you are the “sender” in the satellite and each of them is a “receiver” in a computer at a ground station that communicates with the satellite. They will draw a picture by interpreting the signals you send them. This is remote sensing!
- Tell the students that the squares on the Log are called pixels. Each pixel must be completely filled in with their pencils or left completely empty. Tell them that when you say “0,” the pixel is to be left empty and when you say “1” the pixel is to be completely filled in. Read the “digital code” to the receivers, the students. Fill in the first few pixels on the transparency to help them get started.

1A - 1	1B - 0	1C - 0	1D - 0	1E - 0	1F - 0	1G - 0	1H - 1
2A - 0	2B - 1	2C - 0	2D - 0	2E - 0	2F - 0	2G - 1	2H - 0
3A - 0	3B - 0	3C - 1	3D - 0	3E - 0	3F - 1	3G - 0	3H - 0
4A - 0	4B - 0	4C - 1	4D - 0	4E - 0	4F - 1	4G - 0	4H - 0
5A - 0	5B - 0	5C - 0	5D - 1	5E - 1	5F - 0	5G - 0	5H - 0
6A - 0	6B - 0	6C - 0	6D - 1	6E - 1	6F - 0	6G - 0	6H - 0
7A - 0	7B - 0	7C - 0	7D - 1	7E - 1	7F - 0	7G - 0	7H - 0
8A - 0	8B - 0	8C - 0	8D - 1	8E - 1	8F - 0	8G - 0	8H - 0

6. Color the pixels according to the directions. Share the finished products. The pictures should all look the same. Help students figure out that they have made an image of part of a river, where two tributaries meet. It may be difficult for them to interpret the image because the pixels distort the paths of the rivers but this distortion is an important concept. Explain that pixels can be smaller or larger and speculate with the class whether their images would look more like actual river paths if the pixels were much smaller. (*Yes, the smaller the pixels the more realistic the image.*)
7. **Putting the pieces together.** Tell students that computers create very many small images that must be put together into larger images. To make sure there are no gaps, each image shows part of the previous image. Explain that only by overlapping the images can we get a clear picture of a

larger area. This larger image is called a mosaic. Ask students if they know another meaning for the word mosaic and lead them to discover that the connotation of small pieces fitting together makes this an appropriate term for these pieced-together satellite images.

- Divide the students into pairs and give each pair a copy of **Log 4**. Ask them if they can identify one part of each image that also appears in the other image. (*The bottom of the first image and the top of the second image.*) Tell students to cut out each of the boxes and overlap them to make a mosaic. Point out that these images are composed of very small squares (pixels).

Concluding the Investigation

- Who uses satellite images and how do they use them? Divide students into groups of four and ask them to make a list of ways that satellite images can be used to study Earth. Next, give each group **Log 5**. Tell students to cut out the boxes, read and discuss the information, and paste the box in the bubble that matches the drawing. Discuss the answers with students. Geographers do all of these tasks.
- Now show students each of the transparencies listed below, one at a time.
 - Log 6:** How do satellite images help predict hurricanes?
 - Log 7:** How do images of flooding help us learn about Earth?
 - Log 8:** How do images of volcanoes help us study Earth?

Discuss each transparency using the following questions:

- Describe what you see in the image.
- Who might use an image like this one and how could it be used? Identify the person in **Log 5** who would use each image.

Background

Remote sensing involves the detection and measurement of radiation of different wavelengths reflected or emitted from distant objects or materials. The difference in reflection allows objects to be identified and categorized by class, type, substance, and spatial distribution. A pixel represents an area on an image that is a measure of the sensor's ability to see objects of different sizes. For example, for a sensor with a resolution of 15 meters, each pixel represents an area of 15 meters by 15 meters. Satellites are particularly effective remote sensors because they can cover the entire globe every few days. Scientists use computers to analyze the information gathered by satellites for

many purposes, including to make predictions. Satellites orbit Earth, many greater than 480 kilometers above the ground. Such orbits allow satellites to observe all of Earth's features: land, plant life, oceans, lakes, rivers, clouds, and polar ice.

Evaluation/Key

***Log 1: Morro Bay, California**

Which one is a satellite image?

1 is an aerial photograph of Morro Bay, California

2 is a satellite image of Morro Bay, California

How can you tell?

- The satellite image shows a vertical view from a greater distance.
- You can see the pixels in the image.

***Log 3: How do satellites work? (River)**

1	0	0	0	0	0	0	1
0	1	0	0	0	0	1	0
0	0	1	0	0	1	0	0
0	0	1	0	0	1	0	0
0	0	0	1	1	0	0	0
0	0	0	1	1	0	0	0
0	0	0	1	1	0	0	0
0	0	0	1	1	0	0	0

***Log 4: How are satellite images like puzzles?**



***Log 5: Who uses satellite images and for what purpose?**

- | | |
|------------------|------------------|
| A. hydrologist | D. volcanologist |
| B. meteorologist | E. planetologist |
| C. oceanographer | F. glaciologist |

***Log 6: How do satellite images help predict hurricanes?**

- Describe what you see in the image. (*South-eastern part of the United States and hurricane clouds.*)
- Who might use an image like this one and how would it be helpful? (*Meteorologists; help forecast hurricanes and give people advance notice so they can prepare for them. Satellite images over time show direction and speed of the hurricane.*)

***Log 7: How do images of flooding help us learn about Earth?**

- Describe what you see in the image. (*Flooding of the Missouri River. Locate the Missouri on a map.*)
- Who might use an image like this one and how would it be helpful? (*Meteorologists; warn people of storms and resulting flooding. Hydrologists; study changes in the river and what happens to vegetation, animals, and fish who inhabit the river during floods.*)

***Log 8: How do images of volcanoes help us study Earth?**

- Describe what you see in the image. (*Mount St. Helens, other volcanoes, craters, vegetation.*)
- Who might use an image like this one and how would it be helpful? (*Volcanologists; see changes to a region over time and to study changes in climate as a result of it.*)

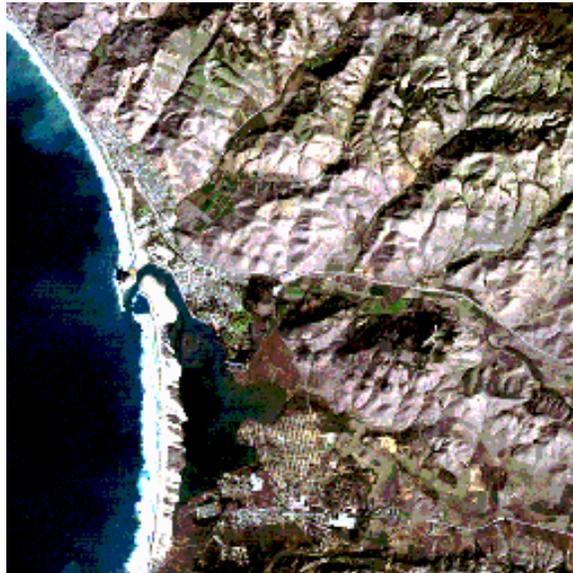
References

"Echo the Bat." Lesson 4—How do satellites work?
<<http://imagers.gsfc.nasa.gov/color/>>



Module 1, Investigation 3: Log 1

Morro Bay, California: Which is the satellite image?



Number _____ is a satellite image.

How can you tell? Give two reasons.

1) _____

2) _____

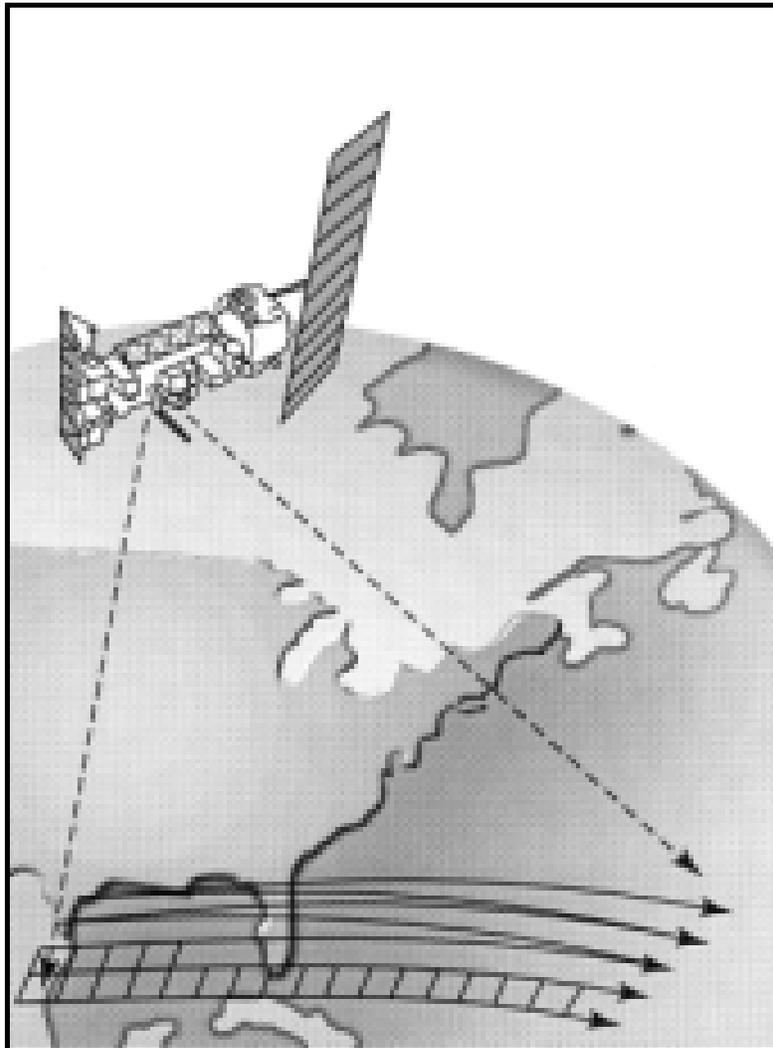


Module 1, Investigation 3: Log 2

What is this satellite doing?

Satellites orbit Earth while Earth rotates. The sensors on the satellite observe and collect information from a strip or swath of Earth's surface.

Color the first swath red and label it 1.
Color the second swath green and label it 2.
Continue for the next two orbits.





Module 1, Investigation 3: Log 3

How do satellites work?

	A	B	C	D	E	F	G	H
1								
2								
3								
4								
5								
6								
7								
8								



Module 1, Investigation 3: Log 4

How are satellite images like puzzles?





Module 1, Investigation 3: Log 5

Who uses satellite images and for what purpose?

Name _____ Date _____

A



B

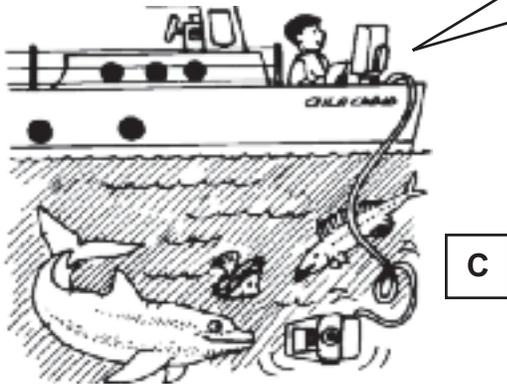




Module 1, Investigation 3: Log 5

Who uses satellite images and for what purpose?

Blank response box for the first question.



Blank response box for the second question.





Module 1, Investigation 3: Log 5

Who uses satellite images and for what purpose?

[Empty rectangular box for student response]



E

[Empty rectangular box for student response]



F



Module 1, Investigation 3: Log 5

Who uses satellite images and for what purpose?

Directions: Cut out the boxes, read and discuss the information in each box, and paste the box in the bubble that matches the drawing.

Volcanologist: I study volcanoes. I use satellite images to find out where winds carry volcanic ash.

Oceanographer: I study oceans and how they change. I make observations from ships, airplanes, and satellites and use images to measure changes in shorelines and ocean currents.

Meteorologist: I predict the weather by gathering information about the atmosphere from satellite images and ground measurements. You can see meteorologists on television news programs.

Hydrologist: I study water. I study where water goes, what elements it contains, and whether its chemistry has changed. I use satellite images to measure flooding.

Glaciologist: I study glaciers in the Arctic and Antarctic as well as those formed in the tallest mountains. I study temperatures, snow accumulation, and deep ice cores to understand what is happening to the glaciers. I can use satellite images to determine how fast glaciers move.

Planetologist: I study planets other than Earth. When I study planets like Mars, which has very little water compared to Earth, I can learn more about what could happen to our planet if it becomes drier. The only way I can study Mars is by observing the planet with large telescopes and using satellite images. The satellites we have sent to orbit around Mars send us detailed information about the planet.



Module 1, Investigation 3: Log 6

How do satellite images help predict hurricanes?

Predicting Hurricane Intensity Far from Land



Source: <http://svs.gsfc.nasa.gov/imagewall/hurricanes/bonnieir.jpg>

Which of the people in Log 5 would use this image? _____



Module 1, Investigation 3: Log 7

How do images of flooding help us learn about Earth?

Flooding in the Missouri River



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

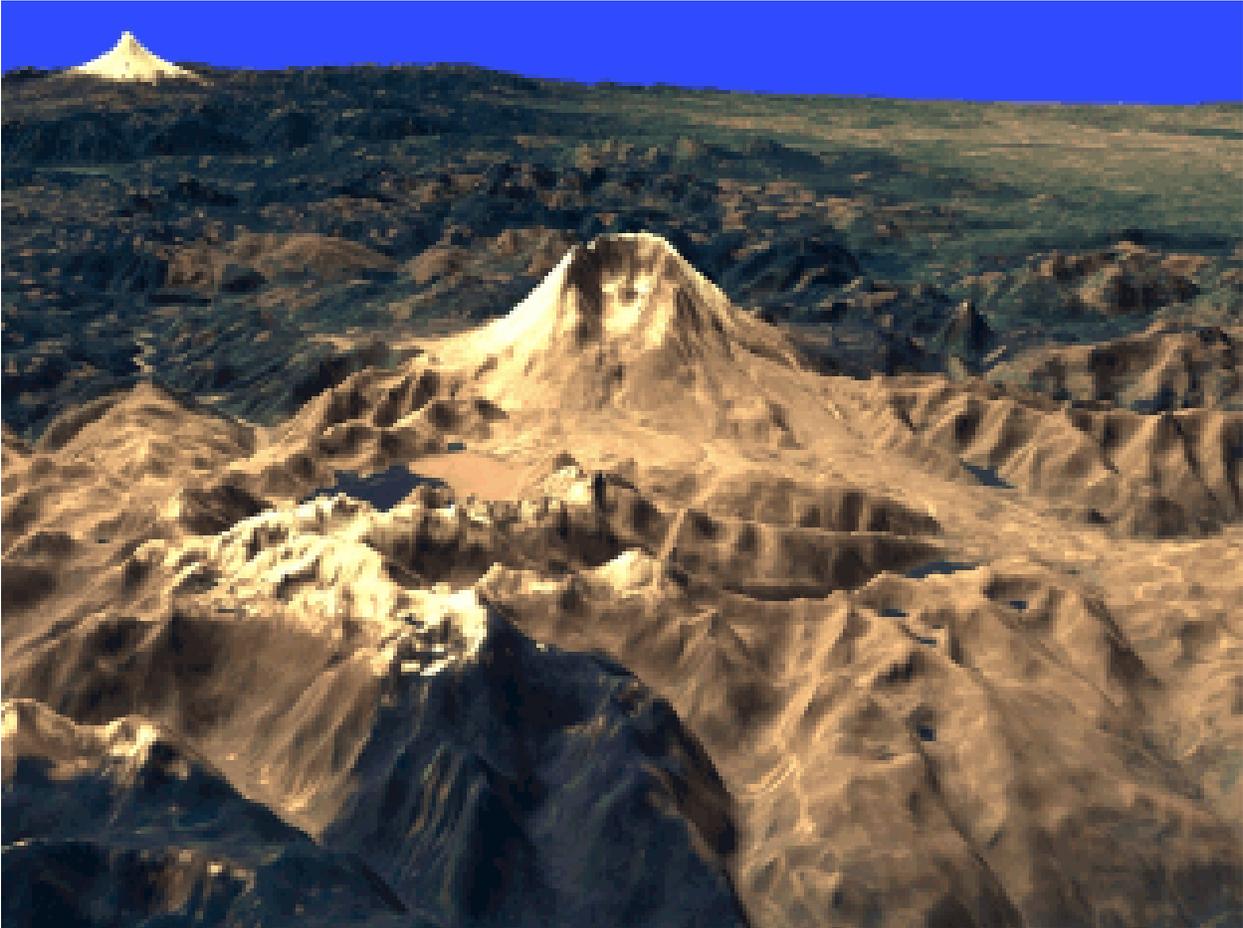
Which of the people in Log 5 would use this image? _____



Module 1, Investigation 3: Log 8

How do images of volcanoes help us study Earth?

Mt. St. Helens



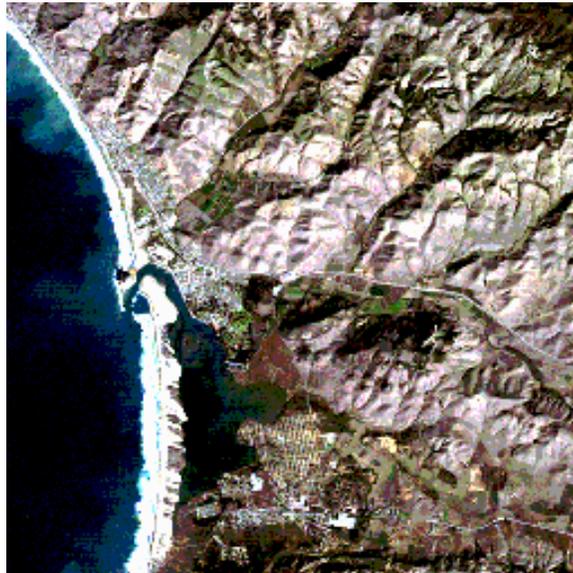
Source: http://svs.gsfc.nasa.gov/imagewall/LandSat/mt_st_helens.html

Which of the people in Log 5 would use this image? _____



Module 1, Investigation 3: Log 1

Morro Bay, California: Which is the satellite image?



Number _____ is a satellite image.

How can you tell? Give two reasons.

1) _____

2) _____

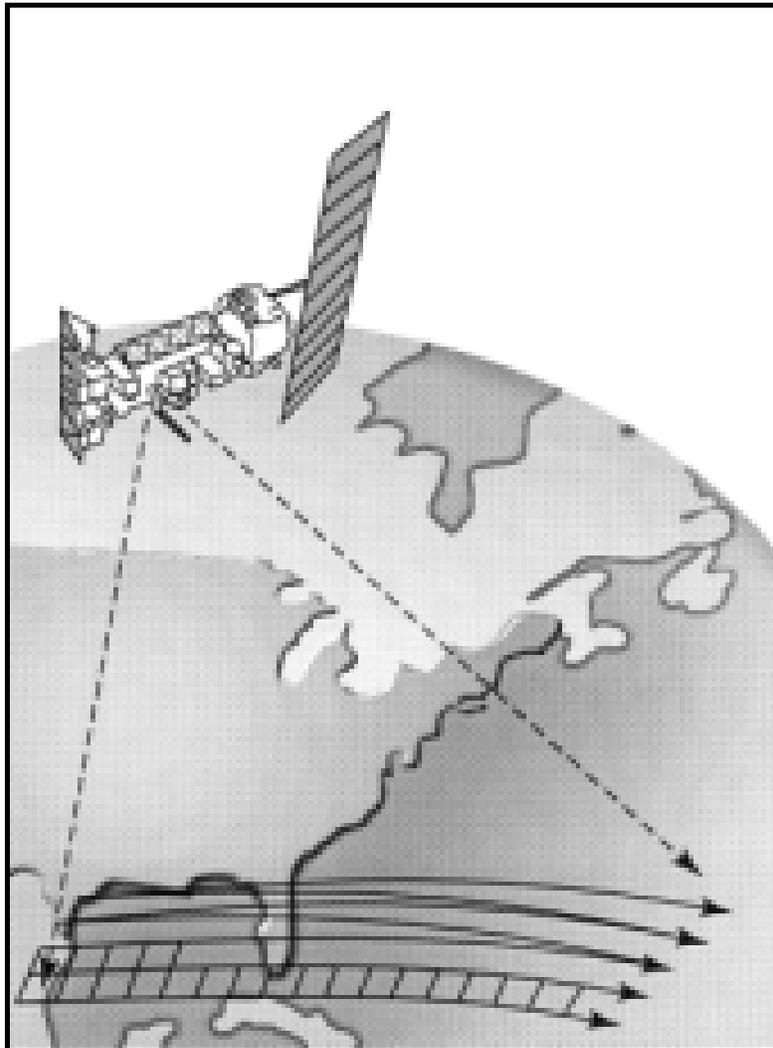


Module 1, Investigation 3: Log 2

What is this satellite doing?

Satellites orbit Earth while Earth rotates. The sensors on the satellite observe and collect information from a strip or swath of Earth's surface.

Color the first swath red and label it 1.
Color the second swath green and label it 2.
Continue for the next two orbits.





Module 1, Investigation 3: Log 3

How do satellites work?

	A	B	C	D	E	F	G	H
1								
2								
3								
4								
5								
6								
7								
8								



Module 1, Investigation 3: Log 4

How are satellite images like puzzles?





Module 1, Investigation 3: Log 5

Who uses satellite images and for what purpose?

Name _____ Date _____

A



B





Module 1, Investigation 3: Log 5

Who uses satellite images and for what purpose?

Blank response box for the first question.



Blank response box for the second question.





Module 1, Investigation 3: Log 5

Who uses satellite images and for what purpose?

[Empty rectangular box for student response]



E

[Empty rectangular box for student response]



F



Module 1, Investigation 3: Log 5

Who uses satellite images and for what purpose?

Directions: Cut out the boxes, read and discuss the information in each box, and paste the box in the bubble that matches the drawing.

Volcanologist: I study volcanoes. I use satellite images to find out where winds carry volcanic ash.

Oceanographer: I study oceans and how they change. I make observations from ships, airplanes, and satellites and use images to measure changes in shorelines and ocean currents.

Meteorologist: I predict the weather by gathering information about the atmosphere from satellite images and ground measurements. You can see meteorologists on television news programs.

Hydrologist: I study water. I study where water goes, what elements it contains, and whether its chemistry has changed. I use satellite images to measure flooding.

Glaciologist: I study glaciers in the Arctic and Antarctic as well as those formed in the tallest mountains. I study temperatures, snow accumulation, and deep ice cores to understand what is happening to the glaciers. I can use satellite images to determine how fast glaciers move.

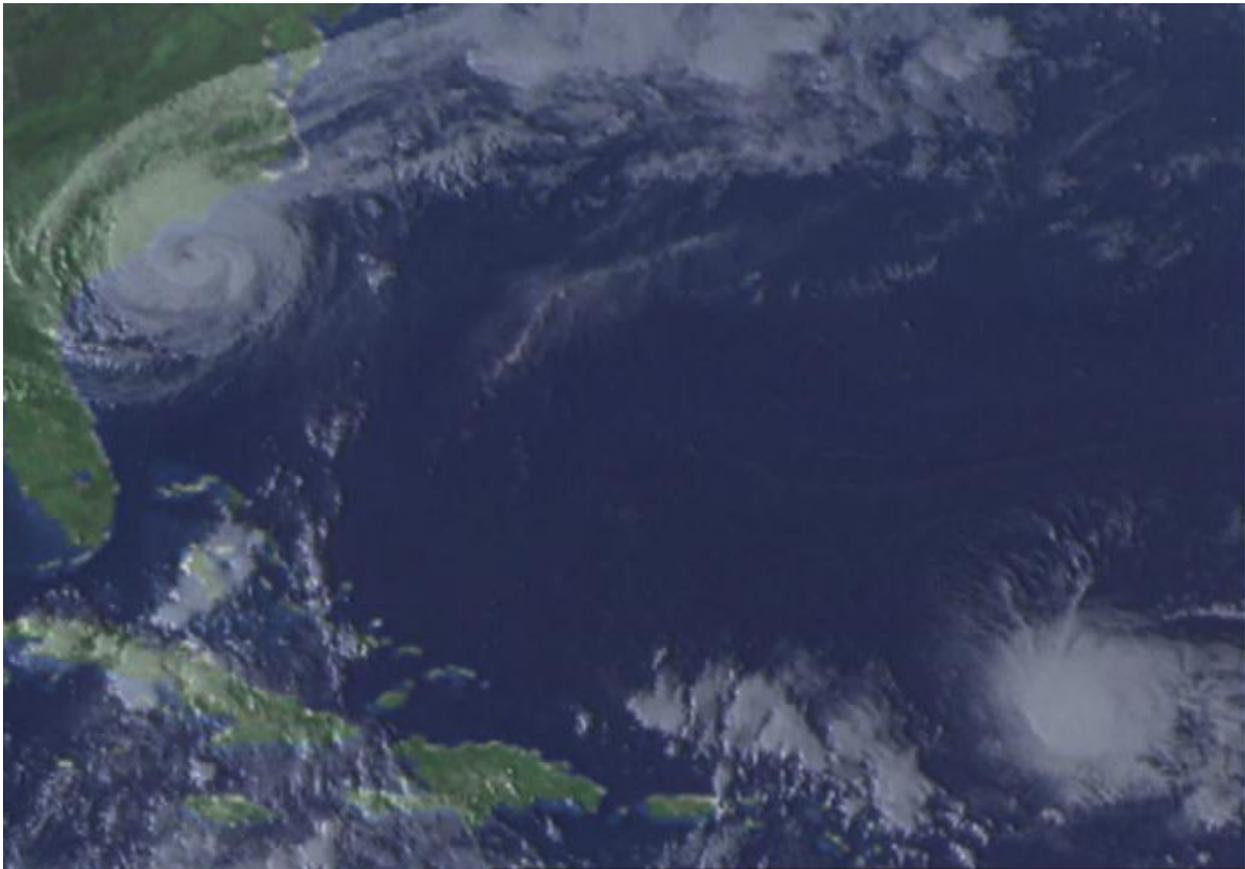
Planetologist: I study planets other than Earth. When I study planets like Mars, which has very little water compared to Earth, I can learn more about what could happen to our planet if it becomes drier. The only way I can study Mars is by observing the planet with large telescopes and using satellite images. The satellites we have sent to orbit around Mars send us detailed information about the planet.



Module 1, Investigation 3: Log 6

How do satellite images help predict hurricanes?

Predicting Hurricane Intensity Far from Land



Source: <http://svs.gsfc.nasa.gov/imagewall/hurricanes/bonnieir.jpg>

Which of the people in Log 5 would use this image? _____



Module 1, Investigation 3: Log 7

How do images of flooding help us learn about Earth?

Flooding in the Missouri River



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

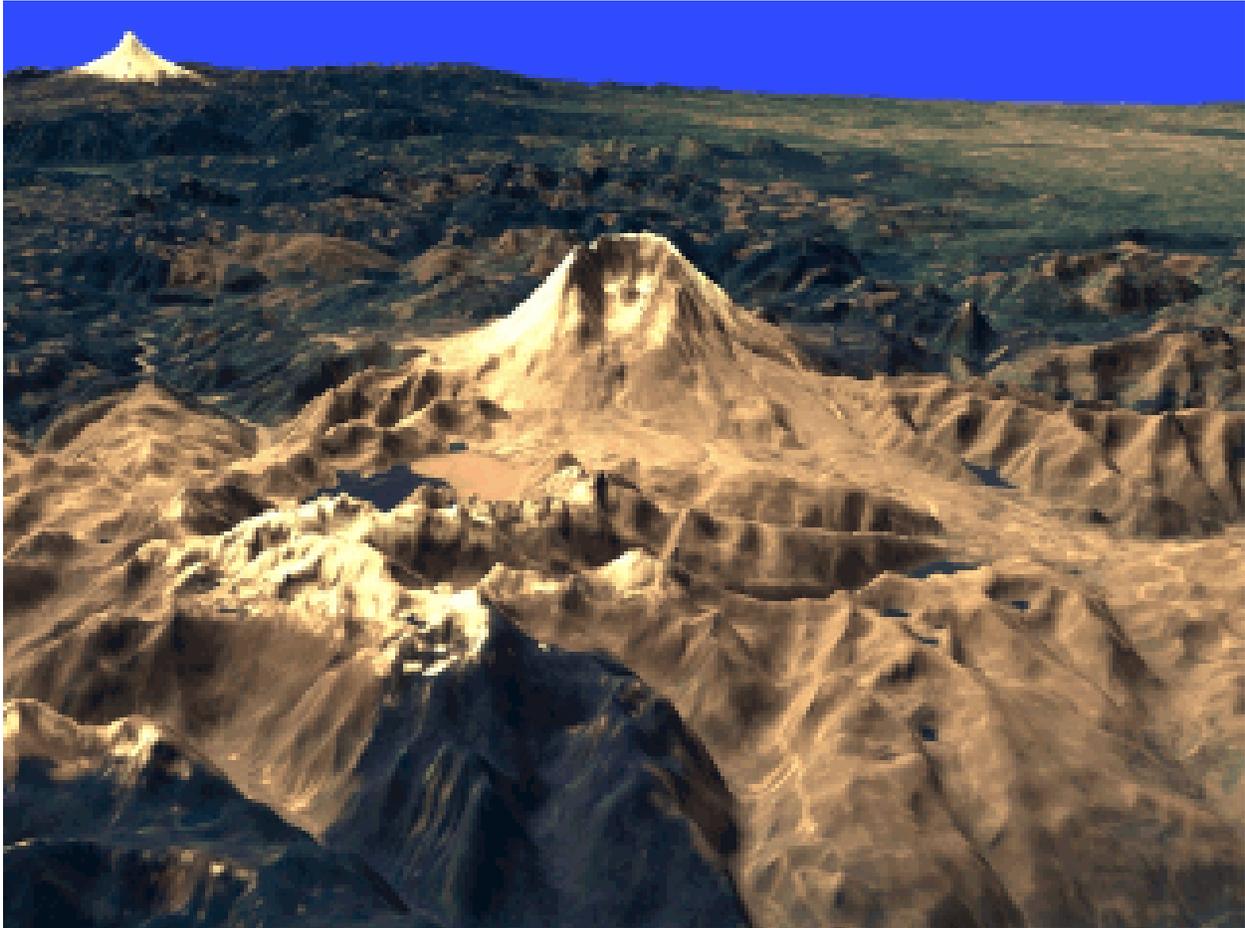
Which of the people in Log 5 would use this image? _____



Module 1, Investigation 3: Log 8

How do images of volcanoes help us study Earth?

Mt. St. Helens



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

Which of the people in Log 5 would use this image? _____



How does color help us understand images from space?



Investigation Overview

Students learn to interpret colors in images from space. A mapping activity helps them to recognize global vegetation patterns from colors seen in satellite images. They also distinguish between true color and false color images, and examine how geographers and scientists use false color images to study the surface of Earth.

Time required: Two 45-minute sessions

Materials/Resources

Monitor image: *Little Red Riding Hood in the Forest* <http://spaceplace.jpl.nasa.gov/eo1_1.htm> (Note: This image should be shown on a monitor.)

Log 1: Mapping the global biosphere—Map (one copy for each student)

Log 2: Mapping the global biosphere—Questions (one copy for each student)

Log 3: Mapping the global biosphere—Chart (one copy for each student)

Color Transparency 1: First image of the global biosphere

Color Transparency 2: Phoenix—True color

Color Transparency 3: Phoenix—False color

Color Transparency 4: Washington, D.C.—False color

Content Preview

The biosphere is the realm of Earth that includes all plant and animal life forms. Geographers divide the biosphere into regions called biomes. A biome is a very large ecological region within which plant and animal communities are adapted to the physical environment (climate and soil). The major biomes are forest, savanna, grassland, and desert. Oceans contain plant life too, including plankton. Satellite images sometimes employ “false” color to make analysis of images easier.

Classroom Procedures

Beginning the Investigation

1. Tell the students that satellites allow us to see images of the entire Earth. Show them **Color Transparency 1**: First image of the global biosphere.
2. Explain that the biosphere is the part of Earth in which living plants and animals exist. This image was created from many smaller images. It was the first global image of plant life.

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 8: Physical Systems

The characteristics and spatial distribution of ecosystems on Earth's surface

- Identify and explain the distribution and patterns of ecosystems.

Geography Skills

Skill Set 1: Analyzing Geographic Information

- Use maps or observe and interpret geographic relationships.

Developing the Investigation

- Ask students if these are the actual colors you would see if you were able to look down at Earth from space. Help them to observe that the colors have been simplified. In reality, continents are not only green and yellow, but these colors have been used in the image to look similar to Earth's colors and also to help us understand what the vegetation is like. Green represents vegetation, and the darker the color, the more intense the growth. In the hot, wet tropics, the green is darkest. Yellow represents little plant life. Point out the locations of the large deserts in the image.
- Ask students what kind of plant life there is in the oceans. Explain that plankton are very small plants that are important sources of food for the animals that live in the oceans. Instruments on the satellites can tell where there are concentrations of plankton and these can be colored in satellite images to make it easier to see them.
- Tell students that they will be making a map of the global biosphere. Give them copies of **Log 1**. Have them use the legend to color the map. Explain that biomes are regions that have similar environments and plants and animals that have adapted to live in these environments. On the map they will identify three basic biomes. When the maps are completed, have the class speculate about how such maps can be useful.
- Then distribute copies of **Log 2** and **Log 3**. Have students work in pairs and use the map to complete **Logs 2** and **3**. Then discuss their answers with the class.

Concluding the Investigation

- Using a computer projector or monitor, show *Little Red Riding Hood in the Forest*. Ask the students to explain what they see in the picture. Explain that there are many different types of trees in the forest and that they are represented by many different shades of green. Ask if they think that scientists can discern different species by their shades of green. (*Sometimes they can but sometimes the shades are too close.*)
- Now move the mouse over the picture and ask the students what happens to the colors of the trees. (*As you move the mouse over the forest, the colors change from different shades of green to pastel colors of pink, purple, yellow, etc.*) Explain that computers can change the different shades of green into other colors that are easier to differenti-

ate. These are called “false” colors because they are not the natural (or “true”) colors of vegetation. Go to the last illustration on this site and show the class the two images of a real forest. How many species can they identify in the false color image?

- Ask the students why it is important to see such details from space. (*Climate changes, pollution, and human activity may all cause changes in the species of trees.*)

Ask students why it is important to monitor such changes. (*The local economy could be affected if the new species are less valuable to the timber industry; wildlife habitats could be affected; if the new species are more disease-prone, they could more easily be destroyed.*) Diseases that affect certain kinds of trees can be controlled better if those species can be picked out by their color on satellite images. The kinds of crops that are grown throughout the country can also easily be monitored if different crops show up as different colors. Color also can be used to indicate the health of trees.

- Looking at images.** Show students **Color Transparency 2: Phoenix—True color image** and **Color Transparency 3: Phoenix—False color image**. Ask them to describe the differences between the true and false color images.

 - Can they guess what is shown in red in the false color image? Hint: It is green in the true color image. (*Vegetation.*)
 - How might this false color image be useful? Could you use it to distinguish the downtown from the suburbs? To locate parks and golf courses? Note that the area around Phoenix is very dry. Most of the vegetation needs irrigation to grow. Notice the square and rectangular pattern of the vegetation, which conforms to property boundaries.
- Now look at **Color Transparency 4: Washington, D.C.—False color**. The brighter the red color, the more intense the growth of the vegetation. Have the students find downtown and identify several parks. In the middle of the downtown area, above the confluence of the Potomac and Anacostia Rivers (to the west and east, respectively), lies the Capitol. You can see the building clearly because it is surrounded by parkland. Extending from the Capitol to the west is the Washington Mall, a grassy area along which several large museums are located. The White House is in a park-like area that extends north from the mall.

Discuss the merits of false color in identifying the parkland. Ask students how false color is used to identify buildings and pavement. (*They are bright green.*)

Discuss the true colors of the buildings (actually rooftops in this perspective) and pavement. Ask why the grey and black true colors would be more difficult to see than the false color. (*They do not stand out and they tend to blend.*)

- In closing, compare this image with the one of Phoenix. What can we tell about the climate of each place? (*Phoenix is much drier. It has less vegetation, and most of it is in smaller areas that show property lines. Washington, D.C., has more large areas of vegetation.*)

Evaluation

***Log 1: Mapping the global biosphere—Map**

Check maps to see if students matched numbers and colors correctly.

***Log 2: Mapping the global biosphere—Questions**

- Explain how the #3 on Africa is different from the #3 on Antarctica.
The #3 on Africa is the Sahara Desert region, and the #3 on Antarctica is the ice desert region.
- Where are the tropical forests and grasslands located?
The tropical forests and grasslands are found near the Equator.
- Identify all the biomes located in the United States.
The United States has temperate forests, temperate grasslands, mountains, deserts, and ice biomes.
- Name the continents that have mountains, deserts, or ice.
North America, South America, Africa, Europe, Asia, Australia, and Antarctica
- How might scientists use your map of the global biosphere to study our planet?
Any reasonable answer such as they can study changes to the environment on the continents over time, see how different biospheres are changing, etc.

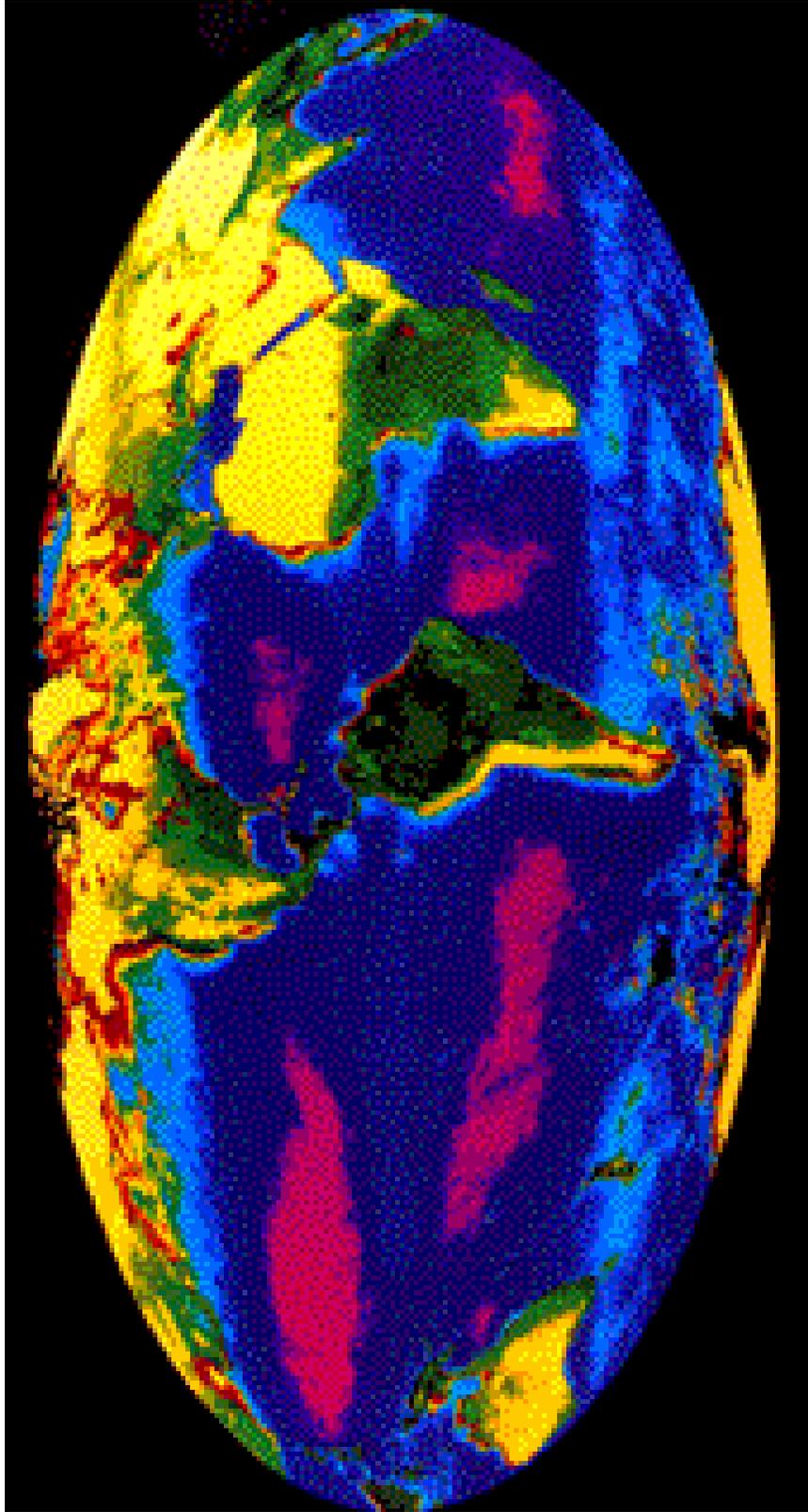
***Log 3: Mapping the global biosphere—Chart**

North America	South America
Temperate Forests Temperate Grasslands Mountains Deserts Ice	Tropical Forests Tropical Grasslands Temperate Forests Temperate Grasslands Mountains Deserts Ice
Africa	Europe
Tropical Forests Tropical Grasslands Mountains Deserts Ice	Temperate Forests Temperate Grasslands Mountains Deserts Ice
Asia	Australia
Tropical Forests Tropical Grasslands Temperate Forests Temperate Grasslands Mountains Deserts Ice	Tropical Forests Tropical Grasslands Temperate Forests Temperate Grasslands Mountains Deserts Ice
Antarctica	
Mountains Deserts Ice	

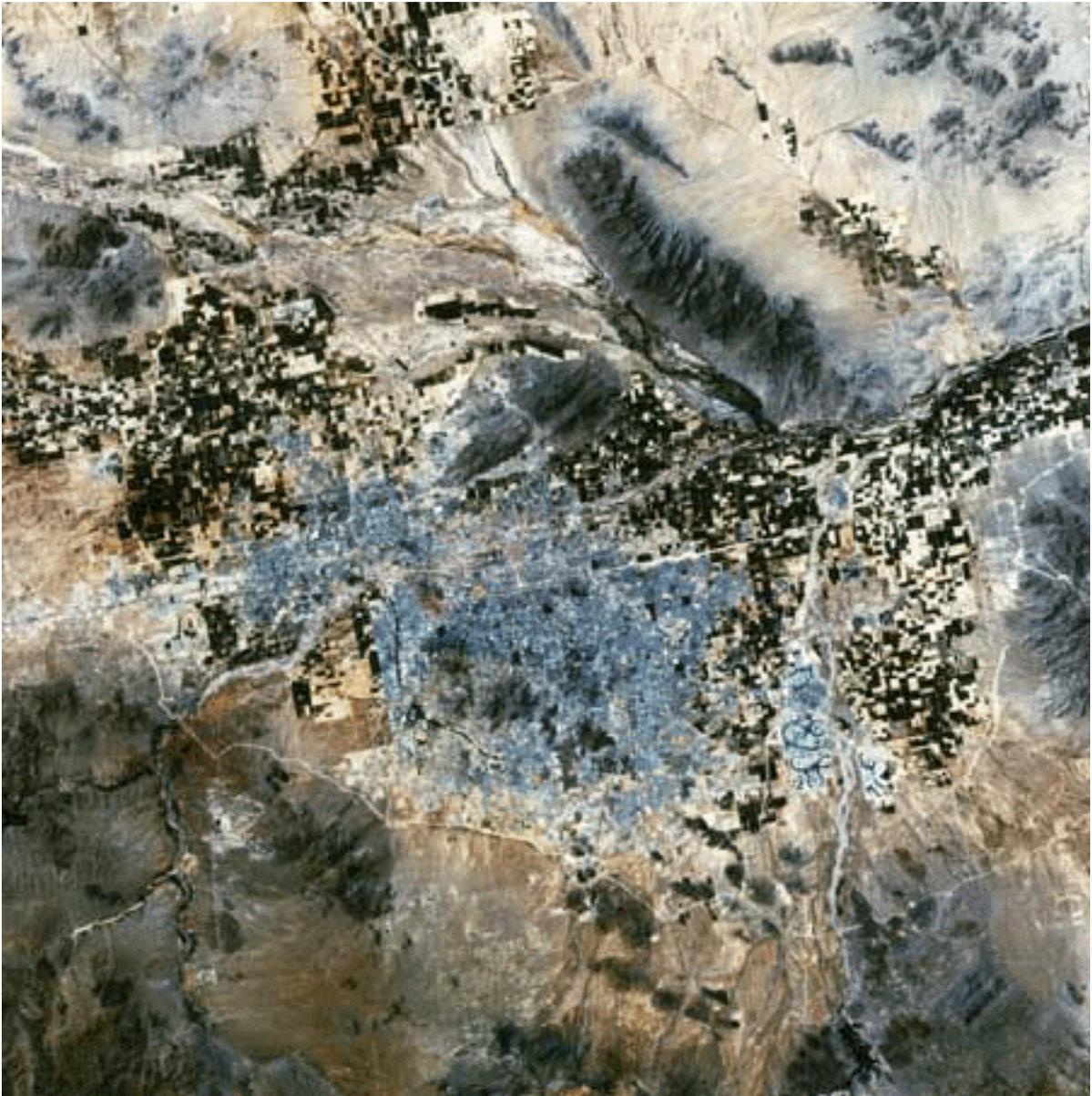
References

<http://kids.earth.nasa.gov/archive/coloring/4/index.html> Image of global biosphere
http://spaceplace.jpl.nasa.gov/eo1_1.htm Little Red Riding Hood in the Forest
<http://imagers.gsfc.nasa.gov/teachersite/Rsimage2.html> Phoenix—True color image
<http://imagers.gsfc.nasa.gov/teachersite/Rsimage3.html> Phoenix—False color image
<http://earth.jsc.nasa.gov/lores.cgi?PHOTO=STS068-209-067> Mackinaw, Michigan—False color
<http://pao.gsfc.nasa.gov/gsfcc/EARTH/PICTURES/Landsat/washlith.jpg> Washington, D.C.—False color

Color Transparency 1: First image of the global biosphere

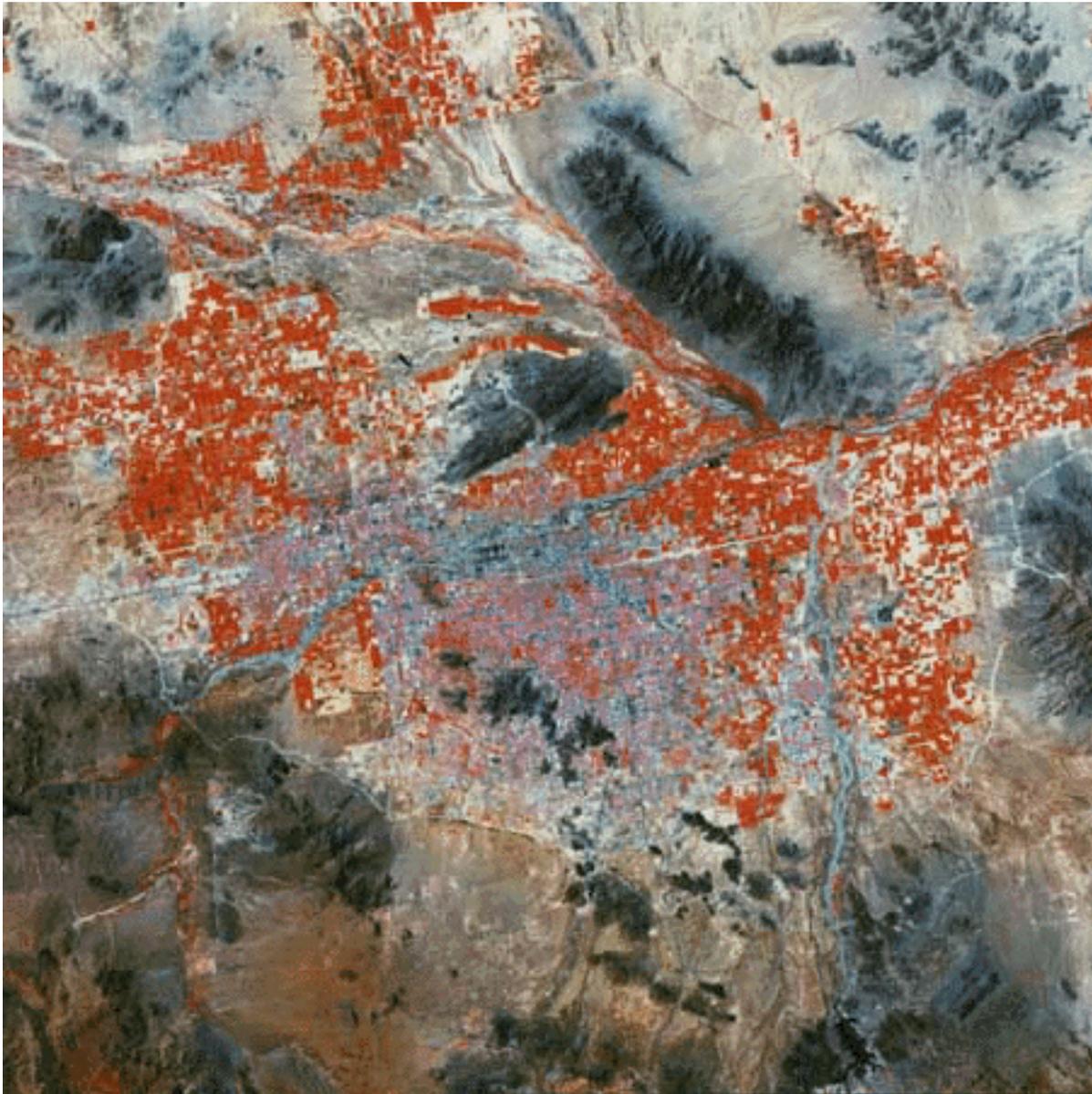


Color Transparency 2: Phoenix—True color

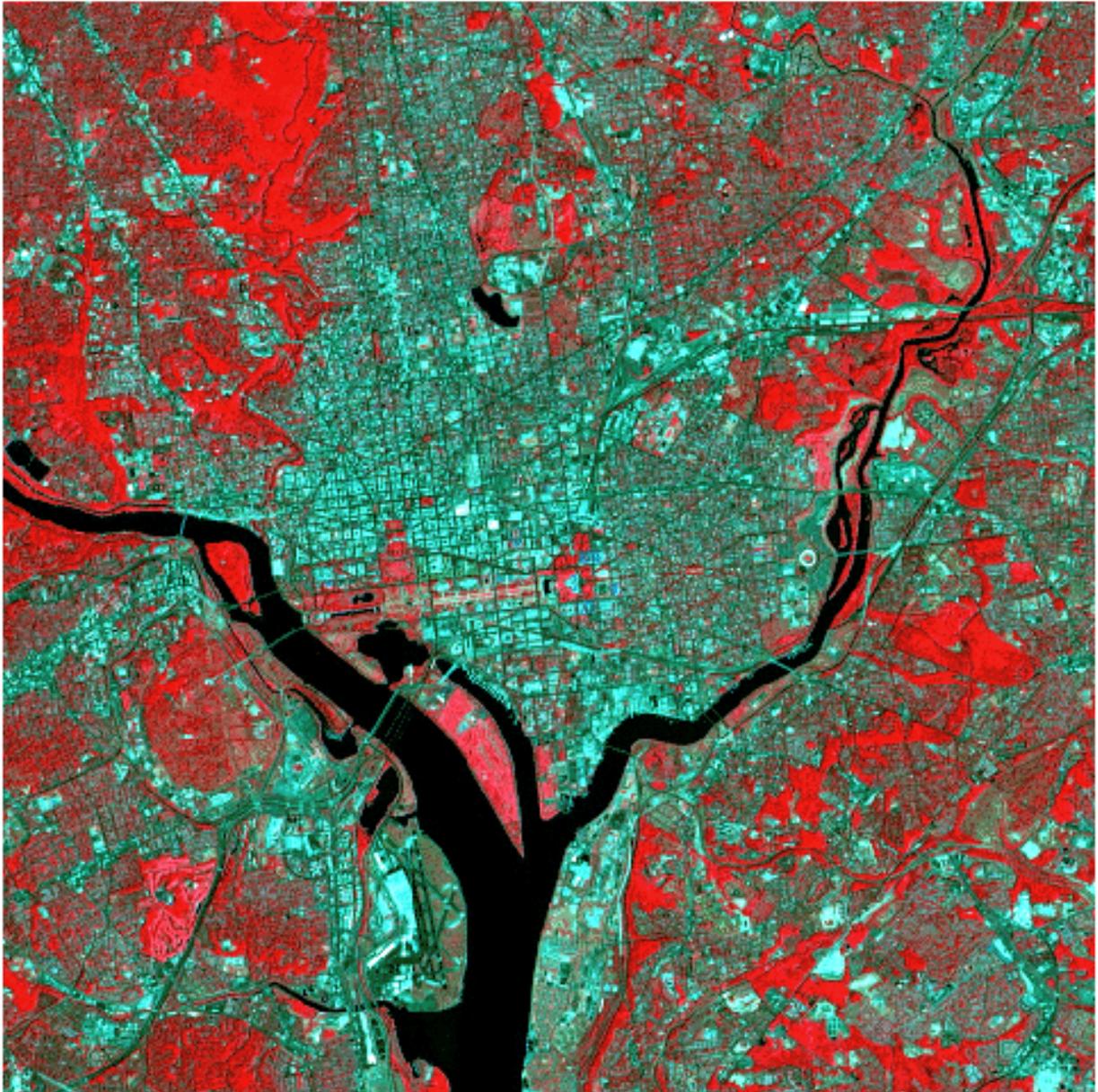


Source: <http://imagers.gsfc.nasa.gov/teachersite/RSimage2.html>

Color Transparency 3: Phoenix—False color



Source: <http://imagers.gsfc.nasa.gov/teachersite/RSimage3.html>

Color Transparency 4: Washington D.C.—False color

Source: <http://pao.gsfc.nasa.gov/gsfcc/EARTH/PICTURES/Landsat/washlith.jpg>

Module 1, Investigation 4: Log 1

Mapping the global biosphere—Map



Directions:

- Use the key/legend to color the land
- Label the oceans
- Color oceans light blue

Biomes

- 1 - Dark Green - Tropical Forests and Tropical Grasslands
- 2 - Light Green - Temperate Forests and Temperate Grasslands
- 3 - Yellow - Mountains, Deserts, and Ice



Module 1, Investigation 4: Log 2

Mapping the global biosphere—Questions

Name _____ Date _____

Use your map of the global biosphere to answer the following questions.

1. Explain how the #3 on Africa is different from the #3 on Antarctica.

2. Where are the tropical forests and tropical grasslands located?

3. Identify all the biomes located in the United States.

4. Name the continents that have mountains, deserts, or ice.

5. How might scientists use your map of the global biosphere to study our planet?



Module 1, Investigation 4: Log 3

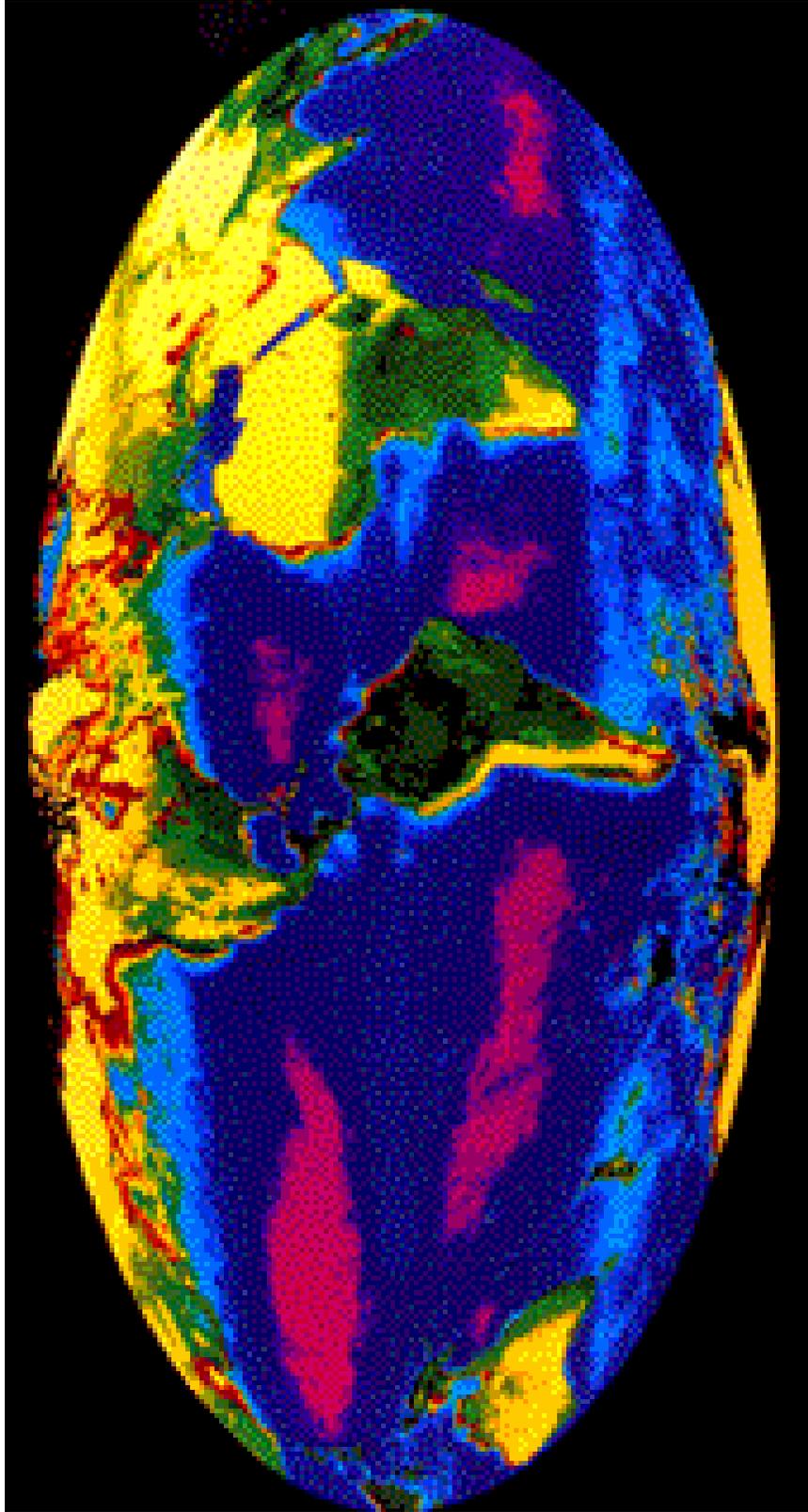
Mapping the global biosphere—Chart

Name _____ Date _____

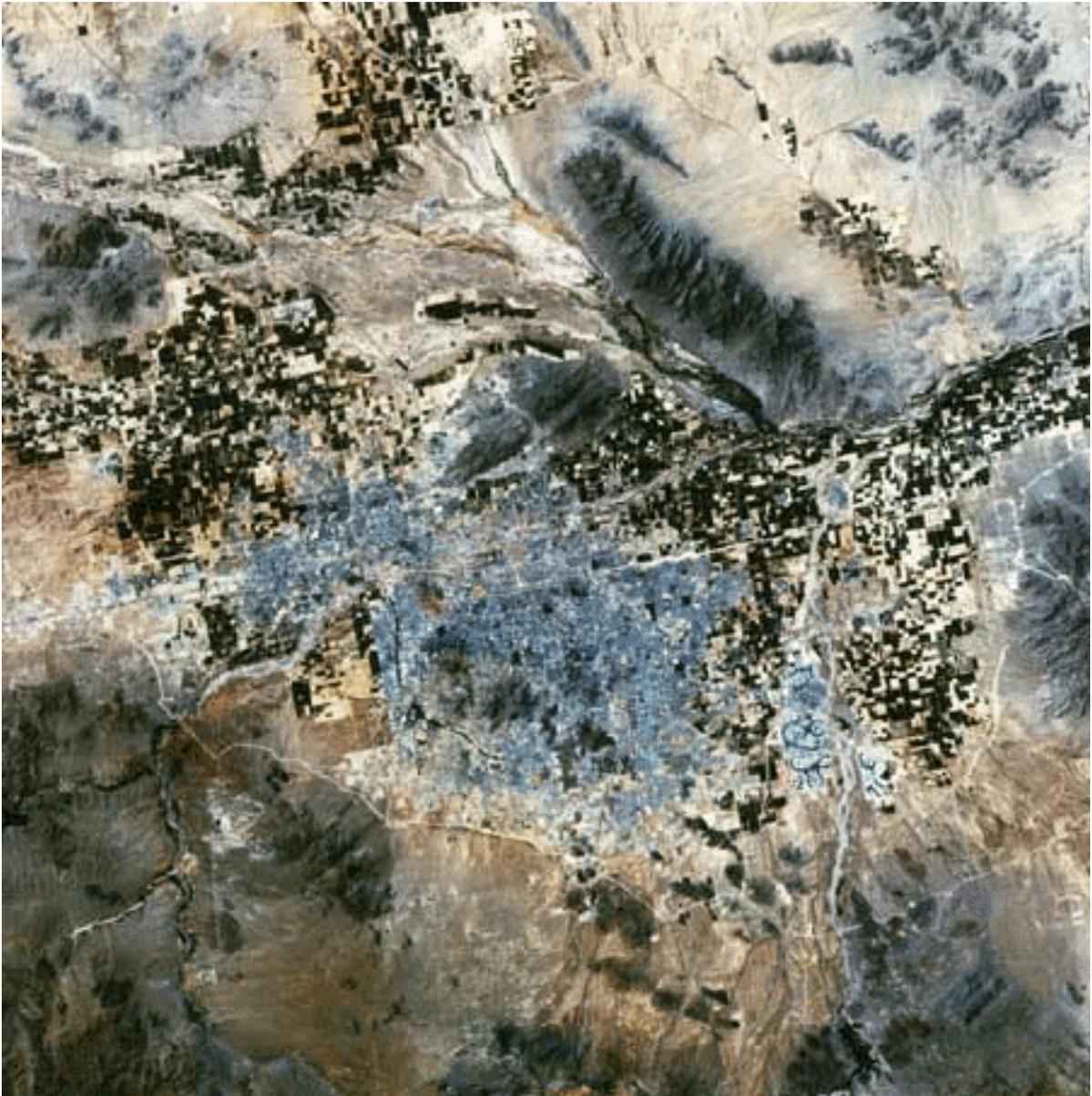
Directions: Use the map to complete the chart. Look carefully at each of the continents and on the chart list the biomes located on each of them.

North America		South America	
Africa		Europe	
Asia	Australia		Antarctica

Color Transparency 1: First image of the global biosphere

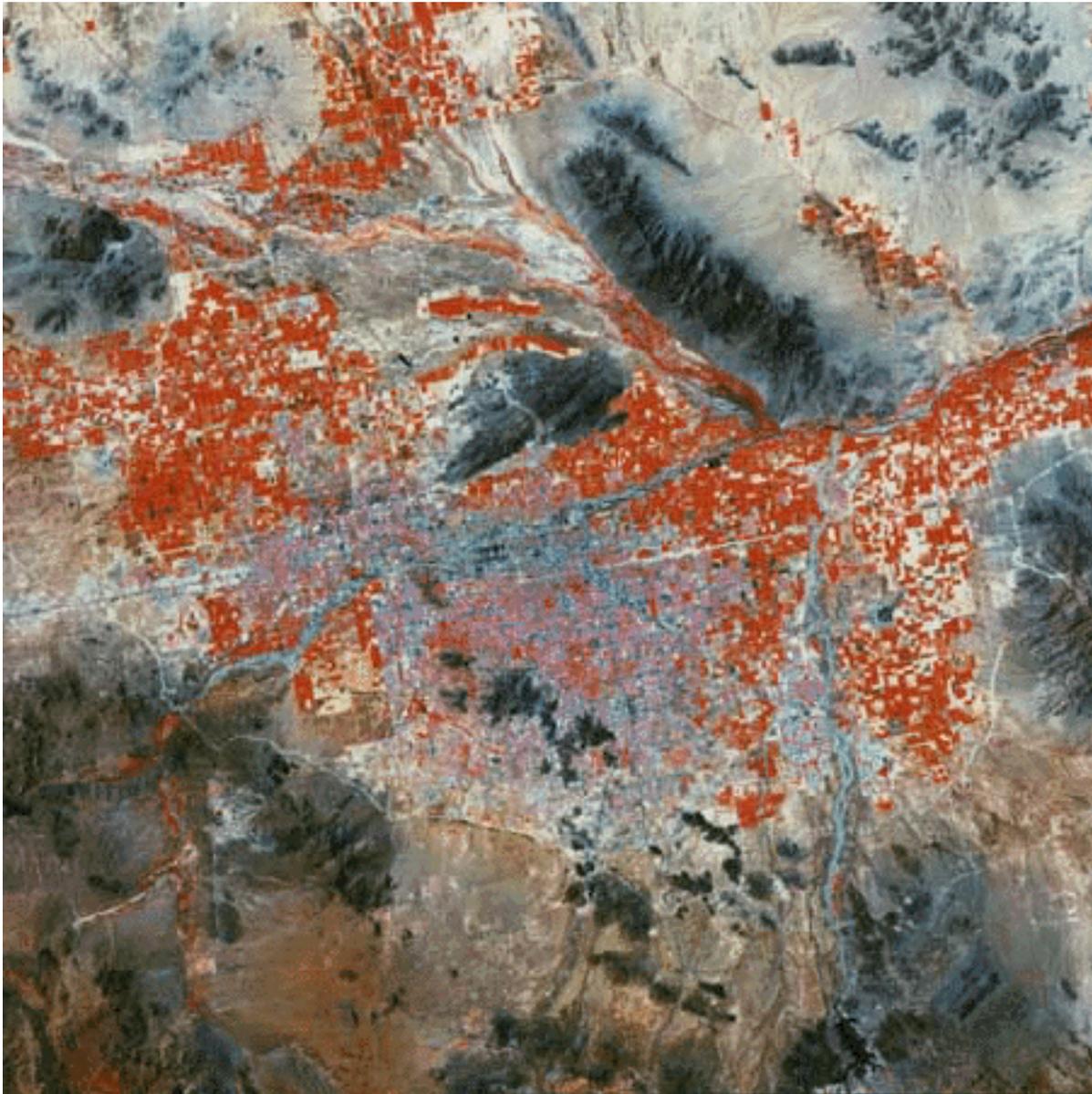


Color Transparency 2: Phoenix—True color

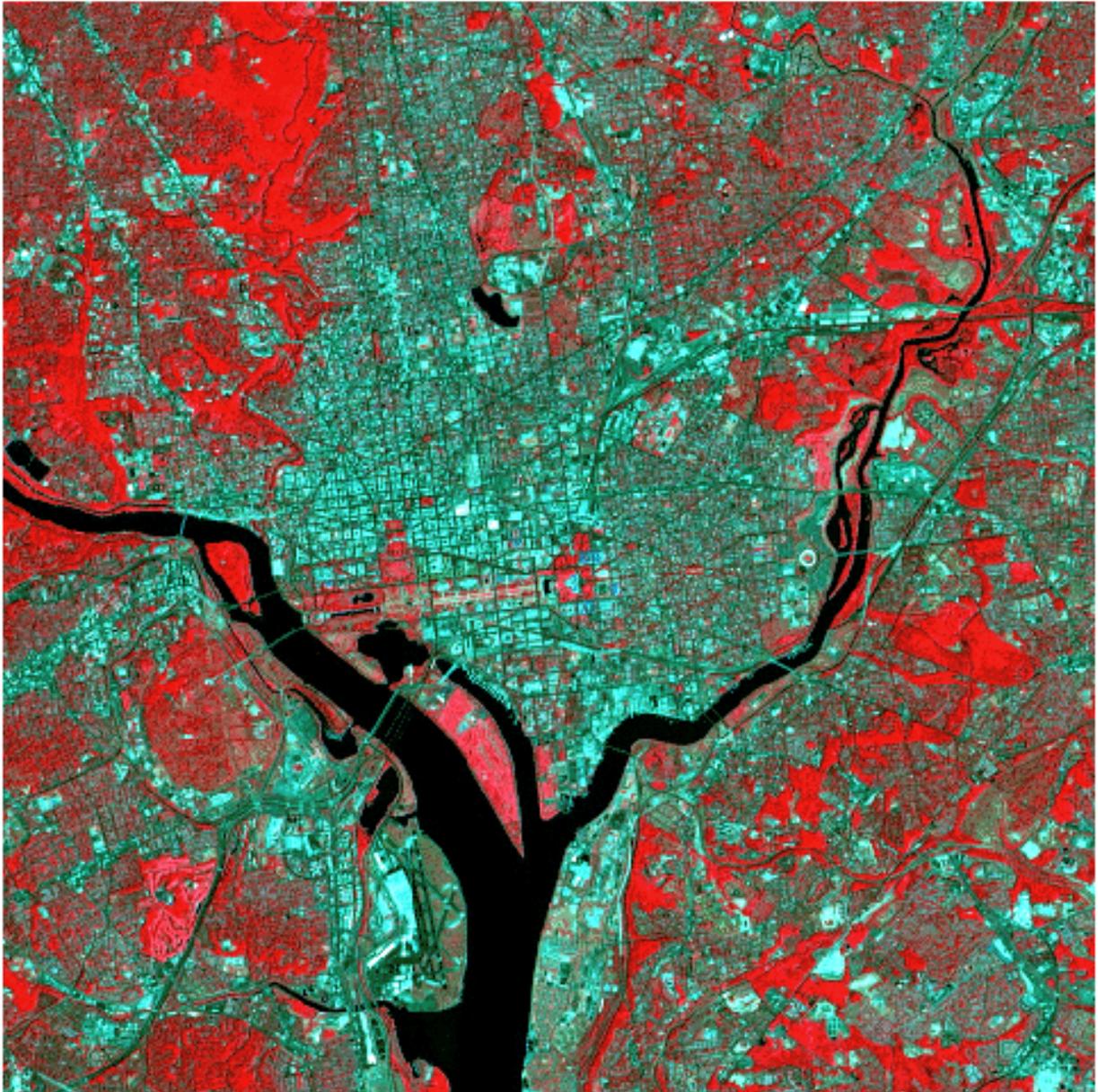


Source: <http://imagers.gsfc.nasa.gov/teachersite/RSimage2.html>

Color Transparency 3: Phoenix—False color



Source: <http://imagers.gsfc.nasa.gov/teachersite/RSimage3.html>

Color Transparency 4: Washington D.C.—False color

Source: <http://pao.gsfc.nasa.gov/gsfcc/EARTH/PICTURES/Landsat/washlith.jpg>

Module 1, Investigation 4: Log 1

Mapping the global biosphere—Map



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Module 1, Investigation 4: Log 2

Mapping the global biosphere—Questions

Name _____ Date _____

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Module 1, Investigation 4: Log 3

Mapping the global biosphere—Chart

Name _____ Date _____

Directions: Use the map to complete the chart. Look carefully at each of the continents and on the chart list the biomes located on each of them.

North America		South America	
Africa		Europe	
Asia	Australia	Antarctica	