



A World of Change

LESSON DESCRIPTION

These activities will introduce students to Earth's remote sensing tools and changes observed from space over time.

OBJECTIVES

Students will

- Simulate how light collected from a space object converts into binary data and reconverts into an image of the object
- Experience the practical value of remote sensing at an introductory level
- Interpret, assess, and predict changes in the nature and spatial extent of land use at the landscape (regional) scale, using land remote sensing images
- Analyze the extent of urban development and the impacts on natural resources as land cover changes

NASA SUMMER OF INNOVATION

UNIT

Earth and Space Science—Remote sensing

GRADE LEVELS

7–9

CONNECTION TO CURRICULUM

Science, Technology, Mathematics, and Geography

TEACHER PREPARATION TIME

1 hour

LESSON TIME NEEDED

4.0 hours *Complexity: Basic to Moderate*

NATIONAL STANDARDS

National Science Education Standards (NSTA)

- Science as inquiry and the abilities required to do scientific inquiry
- Evidence, models, and explanation
- Change, constancy, and measurement
- Earth in the solar system Processes that shape the Earth
- The nature of technology and science

Principles and Standards for School Mathematics (NCTM)

- Abilities of technological design
- Understanding about Science and Technology
- Number and operation
- Patterns, function, and algebra
- Measurement
- Data analysis, statistics, and probability
- Communication
- Connections
- Representations

National Geography Standards (NCGE)

- The World in Spatial Terms

National Technology Standards (ISTE)

- Understand cultural, social, economic, and political effects of technology
- Ability to use and maintain technological products and systems
- Understand, select, and use
- Medical technologies
- Agricultural technologies and biotechnologies
- Energy and power technologies
- Information and communication technologies
- Transportation technologies
- Manufacturing technologies
- Construction technologies
- Perceive a regional (landscape scale) context for local change
- Develop skills of visual analysis of remote sensing images

MANAGEMENT

Each activity within this unit has materials that will need to be downloaded and printed in advance of the lessons. While the Paint By Numbers activity can be duplicated in black and white, the majority of the Landsat images will need to be reproduced in color. The transparency grids for each activity may be reproduced through the use of appropriate ink jet or laser printer transparency film.

Since working with satellite material is new to many instructors it would be recommended to review the Getting to Know Your Satellite Imagery activity referenced at the end of this lesson plan. This activity may be used as a separate student activity as well.

Students should work in pairs in scrutinizing their images as we see and interpret images differently. This is one of the underlying objectives for Paint By Numbers. This is also helpful with materials management.

CONTENT RESEARCH

Many people do not differentiate between data received by satellites and the “pictures” we see as a result. Some concepts to reinforce might be

- Data is made up of pixels that represent data received by a particular sensor.
- Individual pixels represent generally larger areas than most people understand in looking at remote imagery, i.e., Landsat pixels are 30 by 30 meters. A separate special activity might help students to understand how large a space that is.
- High resolution is not always required for the mission’s tasks, but always affects the ability of the scientists or engineers to “zoom in” on the resulting images. Therefore, high resolution is more significant in remote areas where people cannot go to the site for “Ground Truthing” of the remote data observations.

LESSON ACTIVITIES

Paint by Numbers

Drawn from the Space-Based Astronomy Activity Guide for Science, Mathematics, and Technology Education. This activity is a paper and pencil introduction to the concept of collecting data from spacecraft as binary numbers and converting these numbers into the image they represent.

Working in student pairs, one student interprets the data of the house image based on the observations of the other student on the team. In a second phase of the activity, a finer grid pattern is used to make the same comparisons for the planet Saturn.

Paint by Numbers (page 84):

<http://aesp.psu.edu/files/soi/paint%20by%20the%20numbers.pdf>

Quantifying Changes in the Land Over Time

Students learn to identify kinds of land cover (e.g., roads, fields, urban areas, and lakes) in Landsat satellite images. They decide which land cover types allow the passage of water into the soil (are pervious) and which types do not allow it (are impervious). They consider some effects of increasing impervious surface area on ecosystem health.

Students then make land cover maps using two Landsat satellite images taken about a decade apart. They quantify the change of land cover from pervious to impervious surface during that time period. They make predictive maps of what

MATERIALS

Paint By Numbers:

- Transparent grid
- Paper grid
- Picture of house
- Pencil
- Original activity to download graphics for duplication and specific procedures.

[Down to Earth](#)

Quantifying Changes in the Land Over Time:

Specific activity directions:

[Landsat Activity](#)

•*Phoenix Landsat Movie:*
[Movie](#)

•*Phoenix Landsat Image 1991:*
3,2,1 Bands
[1991 – 3,2,1](#)

•*Phoenix Landsat Image 2000:*
3,2,1 Bands
[2000 – 3,2,1](#)

•*Phoenix Landsat Images 1991:*
7,4,2 Bands
[1991 – 7,4,2](#)

•*Phoenix Landsat Images 2000:*
7,4,2 Bands
[2000 - 7,4,2](#)

•*Transparency Grid:*
[Grid](#)

•*Grid on white paper—1 per team*

•*Washable fine point markers*

•*Any additional images or resources that provide information on the Phoenix area.*

they think the nature and extent of land cover change in the area will be in the year 2025, and speculate about the consequences for the availability of water for people and ecosystems. Students justify their predictive maps and their thoughts about the consequences of change in writing.

This activity uses Landsat images of Phoenix, Arizona. Additional resources are available to permit teachers to download images of their regions through the USGS Web site provided in the resource section.

Quantifying Changes in the Land Over Time:

http://landsat.gsfc.nasa.gov/education/resources/Landsat_QuantifyChanges.pdf

ADDITIONAL RESOURCES

Getting to Know Your Satellite Imagery Introduction Activity:

http://landsat.gsfc.nasa.gov/education/resources/GLOBE_getting2know.pdf

USGS Landsat Gallery of featured Landsat images:

<http://landsat.usgs.gov/gallery.php>

USGS “Earth Shots” showing environmental image change pairs:

<http://earthshots.usgs.gov/tableofcontents>

DISCUSSION QUESTIONS

1. How comfortable are you with the accuracy of your data and the conclusions you drew from this information? Why? *Student answers will vary.*

a. How might you improve the accuracy of your map and your calculations, if at all?

2. Which land cover type changed the most, and which land cover type changed the least? Why do you think this is the case? *There is an increase in human-made structures and impermeable surfaces and a decrease in the permeable natural areas.*

3. Researchers indicate that if 10 percent of the land cover in a given watershed changes, the water cycling through that watershed changes in significant ways. Water quality is affected, and runoff increases.

a. How concerned should people be about the cycling of water in the area you have studied with Landsat? *There has been great change over time to impact how water is treated in this region.*

b. What specific ecological effects of land cover change should be looked into for the geographic area you studied? *Consider air, water, soil, and living things.*

c. What data would we need to investigate some of those ecological effects? *Answers may vary.*

ASSESSMENT ACTIVITIES

Likert Scale designed with rubrics for evaluating the students’ products:

http://landsat.gsfc.nasa.gov/education/resources/Landsat_QuantifyChanges.pdf

ENRICHMENT

Earth+

<http://prime.jsc.nasa.gov/earthplus/background.htm>

Landsat Change Pair images

http://www.ei.lehigh.edu/learners/luc/landuse_change2.html

NASA’s Visible Earth—a catalogue of images and animations of our home planet:

<http://visibleearth.nasa.gov/>

NASA Earth Observatory “World of Change”

<http://earthobservatory.nasa.gov/Features/WorldOfChange/>