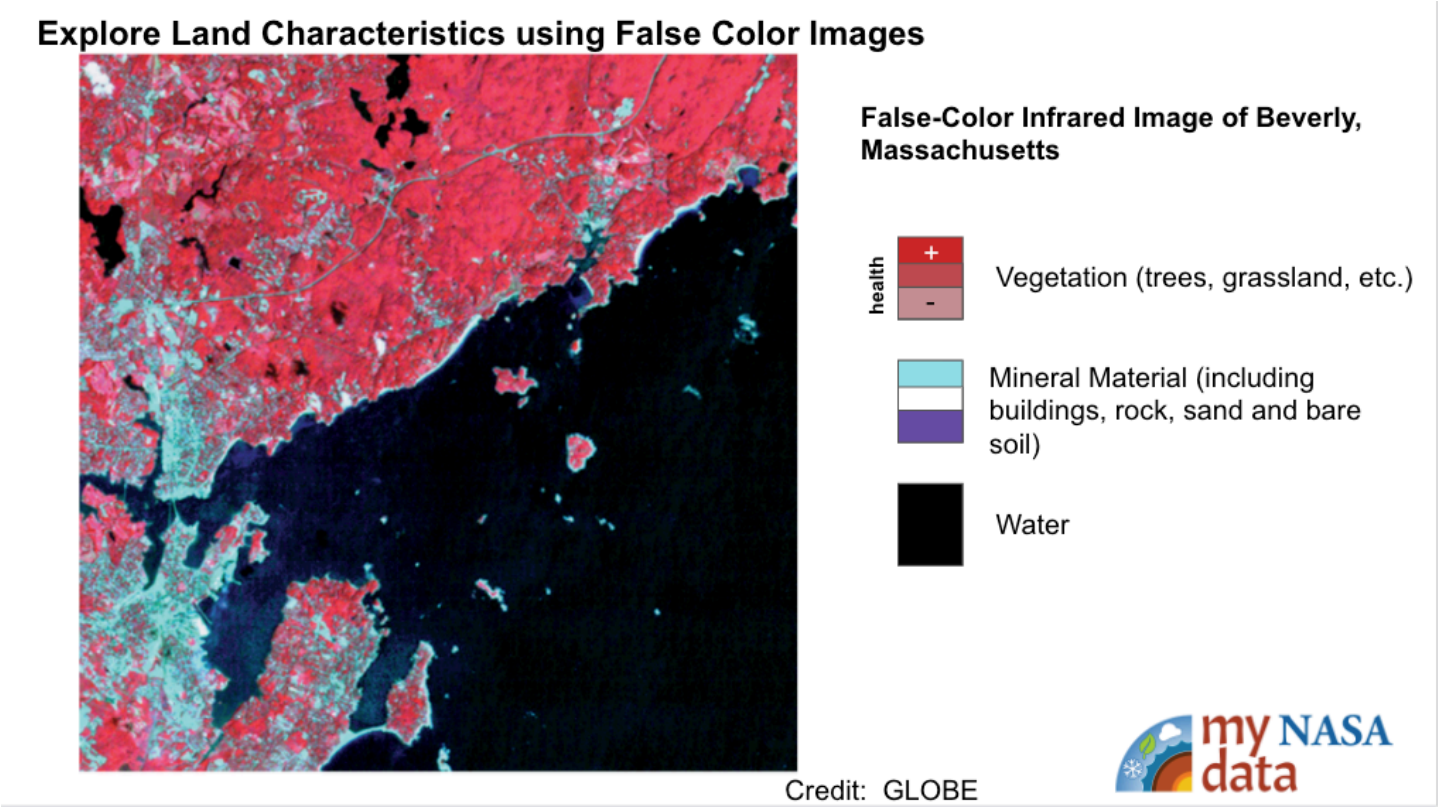
My NASA Data - Lesson Plans

Exploring Satellite Imagery and False Color Images



Overview

This lesson walks students through the use of Landsat false-color imagery and identification of different land cover features using these as models. Building from an original GLOBE lesson, this resource features Google slide and a digital notebook to assist in both face-to-face and virtual learning.

Learning Objectives

The student will:

- Analyze a Landsat image of Beverly, MA
- Identify land cover types
- Explore characteristics of Landsat's false-color images
- Apply understanding to new Landsat images showing change over time.

Why Does NASA Study This Phenomenon?

Our land is changing. Land covered by forest is changing to farmland, land covered by farmland is changing to suburbs; cities are growing. Shorelines are shifting; glaciers are melting; and ecosystem boundaries are moving. As human population numbers have been rising, natural resource consumption has been increasing both in our country and elsewhere. We are altering the surface of the Earth on a grand scale. Nobel Prize recipient Paul J. Crutzen has said, “Humans have become a geologic agent comparable to erosion and [volcanic] eruptions…”

Land cover change has effects and consequences at all geographic scales: local, regional, and global. These changes have enabled the human population to grow, but they also affect the capacity of the land to produce food, maintain fresh water and forests, regulate climate and air quality, and provide other essential “services.” (See Foley, et. al,) It is critical for us to understand the changes we are bringing about to Earth’s systems, and to understand the effects and consequences of those changes for life on our planet. Landsat satellites enable studies of change at the regional or landscape scale.

The first step in understanding change is monitoring, and the second step is analysis. Doing this activity will enable your students to take these steps at an introductory level.

Essential Questions

- What is the practical value of remote sensing?
- How can landscapes change regionally and locally?

Cross-Curricular Connections

- National Geography Education Standards: The World in Spatial Terms
    - Standard 1: How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information
    - Standard 3: How to analyze the spatial organization of people, places, and environments on Earth’s surface

Materials Required

- Google Slides
- Pencil and Paper (students can create their own personalized science writing journal)
- If you have technology, students can write the responses in the digital notebooks, or other digital format you have available

Technology Requirements

- Internet Required
- One-to-One (tablet, laptop, or CPU)
- One-to-a-Group

Teacher Background Information

What You Need to Know about Landsat Satellites for This Activity

When NASA’s astronauts began traveling to the moon for the Apollo missions, they took

photographs of our planet and sent them back to Earth. People began to think about what we could learn from this new vantage point of space if we used other kinds of instruments (sensors). The first Landsat satellite with a special sensor was launched in 1972.

Landsat satellites orbit the Earth from pole to pole as the Earth turns under them. This means that each satellite revisits the same geographic area on Earth every 16 days. Sensors onboard the Landsat satellites detect light reflected from the Earth's surface. (They do not use lasers or radar.) They detect both visible light and infrared light. Each Landsat scene covers an area 185 km by 172 km (115 miles by 107 miles). A grid system of "paths" and "rows" is used to provide a reference number for each scene.

The spatial resolution of Landsat data is 30 meters (98.5 feet). This means each pixel in a Landsat image represents an area on Earth's surface that is 30 meters X 30 meters. ("Pixel" is short for picture element). A pixel is a single point in a graphic image. Computer monitors display pictures by dividing the display screen into thousands (or millions) of pixels, arranged in rows and columns. The pixels are so close together that they appear connected—the same is true of a satellite image. If you look at a computer monitor with a magnifying lens, you can see the individual pixels. If you zoom in close enough on a satellite image you can also see the pixels. Counting the number of pixels of one color or another is one way to quantify land cover change using a satellite image.

About Color in Landsat Images

The sensors on Landsat satellites make observations in both visible and infrared (invisible) wavelengths of the electromagnetic spectrum. We cannot see infrared wavelengths of light without special technology that converts it to wavelengths we can see. When measurements of infrared light are converted to visible images, we must assign colors to the data in order to see it. Therefore some Landsat images show false color.

Prerequisites Student Knowledge

Students must:

- ability to understand and interpret visual representations of Earth's surface from above, such as maps and aerial photographs;
- understand the meaning of wavelengths of light;
- be able to define "electromagnetic spectrum," at an introductory level

Student Misconception

Students might think all Landsat images are photographs. Some are actually "false color" images. There is information about "false color" images in the lesson.

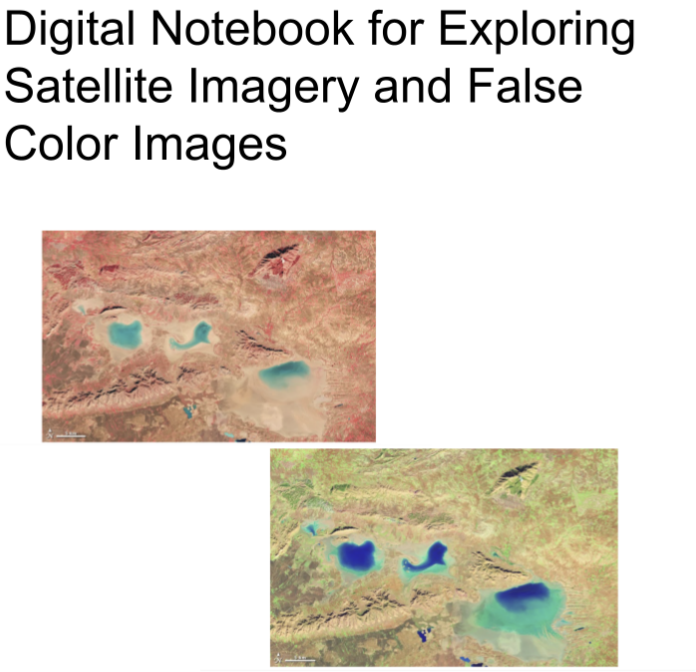
Procedure

A. Engage Prior Knowledge.

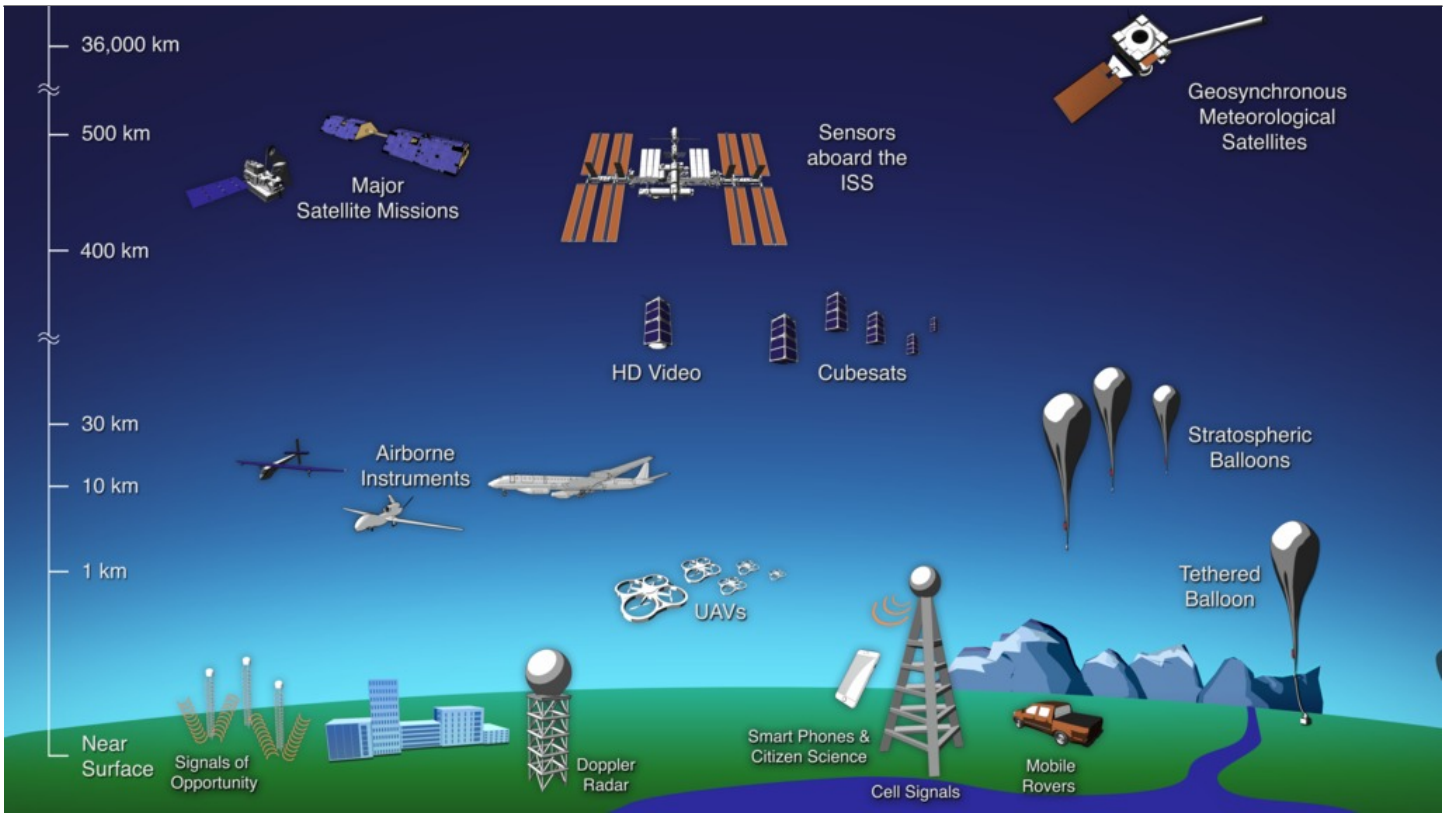
1. Brainstorm with students about why NASA studies Earth's surface.
2. Discuss as a class: What experiences, if any, have you had with changes in the landscapes where you live? For example, has there been any major construction, such as new housing developments, shopping malls, highways, or bridges? Or, in contrast, are any large areas

being allowed to revert to natural land cover?

1. Using the Google slide, have students document their experiences as they answer the questions in the digital notebook.



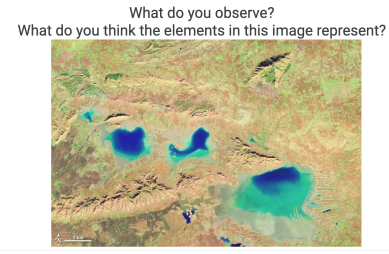
3. Discuss with students how scientists document land change over time. Engage students in thinking about where these data come from. Point out to students that scientists use many different vantage points to collect data with instruments. See image below.

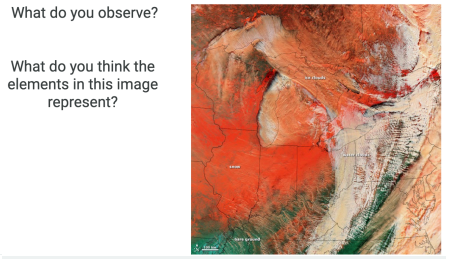


NASA Platforms for collecting data. Credit: NASA

B. Explore False Color Images

1. Use the Google Slide to display the following images to students. Direct students to make observations and document questions that come to mind.





2. Introduce Landsat satellites by queuing the two short video segments in the interactive slides. Students will review the videos and document their findings in the digital notebook. Answer the following questions
    1. Why is Landsat special?
    2. What natural resources do these satellites observe?
    3. How might the data be used?
3. If time and interests allow, review the slides addressing NASA/USGS's Landsat satellite system and false color imagery. See Google Slide for details.

    1. Characteristics of Landsat

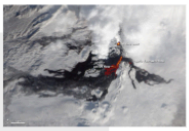
        1. Landsat instruments measure primarily light that is reflected from Earth’s surface.
        2. Landsat instruments are designed to detect data from a range of visible and

infrared (near and mid) wavelengths, including ones that the human eye cannot detect.
3. The data received by these sensors indicate their Electromagnetic Spectral wavelength.
4. Scientists use these data to interpret land cover.

2. Landsat & The Electromagnetic Spectrum
    1. The data received by these sensors indicate Electromagnetic Spectral wavelengths (in nanometers).
    2. Scientists organize these data into wavelength “bands” to interpret land cover. Scientists make true- or false-color images to highlight different features of land cover. They select the wavelength bands most likely to highlight those features.

The four most common false-color band combinations used in analyzing Landsat data are:



1. Near infrared (shown as red), green (shown as blue), red (shown as green). This is a traditional band combination useful in seeing changes in plant health.
2. Shortwave infrared (as red), near infrared (as green), and green (as blue), often used to show floods or newly burned land.
3. Blue (as red), two different shortwave infrared bands (as green and blue). We use this to differentiate between snow, ice, and clouds.
4. Thermal infrared, usually shown in tones of gray to illustrate temperature.

C. Explore Land Characteristics using False Color Images

1. Review the false color image of Beverly, Massachusetts, as well as the accompanying illustrations that show the town's key features. (The false color image of Beverly will serve as the base layer that students will add the other illustrations on top of.)
    - Illustration Layer 1: Water bodies are outlined and labeled.
    - Illustration Layer 2: Elements of the area’s transportation system are outlined and labeled.
    - Illustration Layer 3: Residential and commercially developed areas are outlined and labeled.
    - Illustration Layer 4: Some vegetated areas, a golf course, beaches, and some “unknown” areas are outlined and labeled.
    - Illustration Layer 5: The final land cover type map with all areas outlined and labeled.
2. For each layer added, identify the false color in the image that helps the viewer to distinguish this feature from the others.

D. Extend to New Locations

- Direct students to select one of the following slides in Google Slides and use the sequenced false color images from Landsat to describe how this region changed over time.

E. Closure

1. How do Earth Scientists use physical science properties to help create models of Earth’s surface?
2. How do scientists use false color images to help solve real-world problems?
3. What kinds of human and natural activities can Landsat imagery be used to help monitor?????