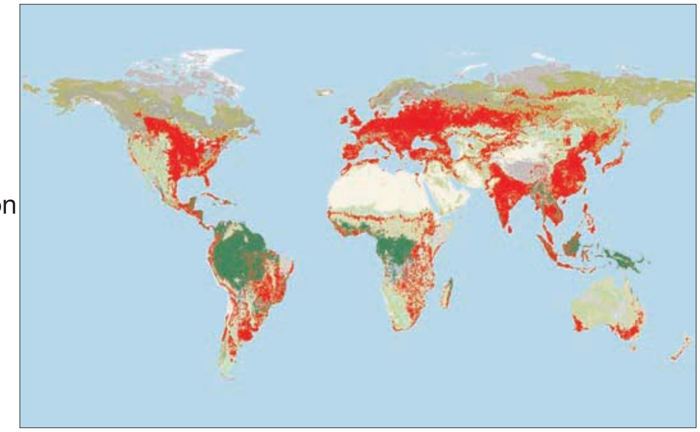
Background on Land Cover Change

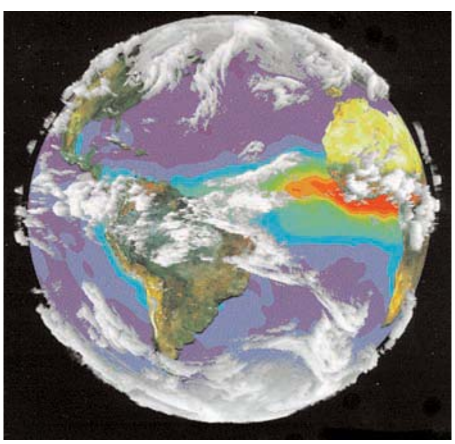
Our land is changing. Forest is changing to farmland, farmland is changing to suburbs; cities are growing. Shorelines are shifting; glaciers are melting; and ecosystem boundaries are moving, As human population numbers have been rising, natural resource consumption has been increasing both in our country 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…”



In approximately 10,000 BCE, the world population was 6-10 million, and the percent of land cover in agriculture was negligible. In the map at right, red indicates areas of the world currently dominated by agriculture. The world population is now about 6.5 billion, and agriculture covers 43 percent of the land area (Marc Imhoff, 2005).

Land cover change has effects and consequences at all geographic scales: local, regional, and global. Human changes to the land are enabling our own populations to grow, but they also are affecting the capacity of ecosystems to produce food, maintain fresh water and forests, regulate climate and air quality, and provide other essential functions necessary for life. It is critical for us to understand the changes we are bringing about to the Earth system, and to understand the effects and consequences of those changes for life on our planet.

The first step in understanding change is monitoring, and the second step is analysis. Doing this activity will equip you to do those two steps at an introductory level.



Composite image of NASA global visualizations from several satellites. NASA’s Earth observing satellites enable us to monitor and explore our planet at the global scale.

Change in land use and land cover can be detected at the local, regional (landscape), continental, and global scales by sensors on Earth-orbiting satellites. Satellite technology enables us to accurately quantify change at the global scale for the first time in human history. Satellites such as Landsat bring us the big picture. And with observations of Earth from space, we can most easily grasp how events in one place are affected by or affect life in other places. For example, we can observe air pollution traveling from one continent to another.

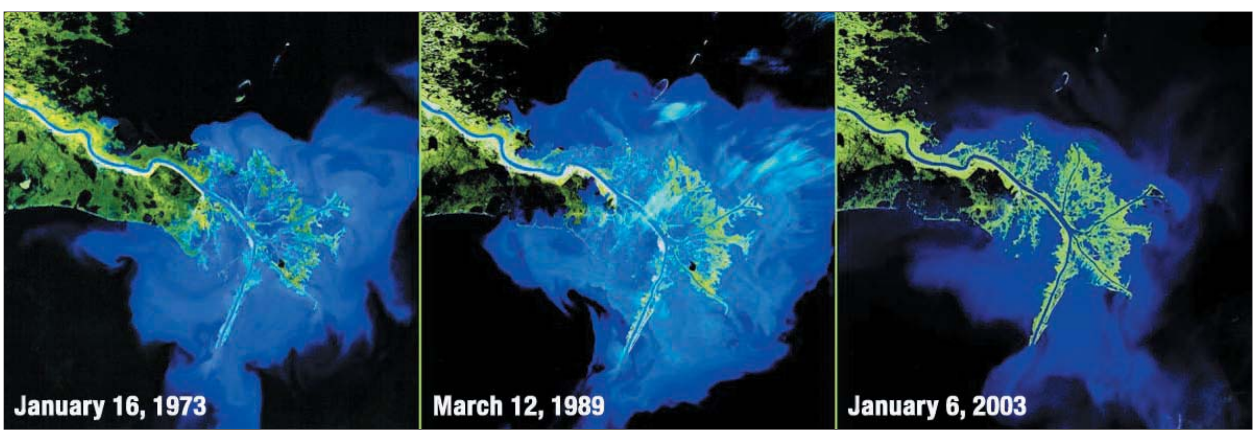
Landsat satellites have been observing the Earth’s land surface since 1972, providing us with an invaluable record of landscape scale change. For more background about NASA’s Earth observing satellite program, visit these Web sites:
NASA Earth Science
Landsat at NASA
Landsat at USGS

Guide for Students

Earth-orbiting satellites are causing a revolution in the ways people find out about the health of our planet and how they solve many practical problems. Working with satellite data involves a great deal of challenge, mystery, risk, and fun, and it is above all creative. **The job market is growing** for people who can integrate data from remote sensing, geographic information systems, sensor networks, and other geospatial technologies, and the market is expected to continue to grow over the next decades. For more about such "geospatial" jobs, go to: http://www.asprs.org/career.

Sensors on satellites give us the regional and global perspectives for where we live and the issues we face, such as the sources of pollution in the air we breathe, how cities are growing, or how coastlines are changing in response to hurricanes and sea level rise. Sensors on NASA satellites collect data about the atmosphere, oceans, ice, biosphere, and land used to make daily global maps of our changing planet. The Landsat series of satellites enables us to see change in the land surface over time.

Information from Earth-orbiting satellites must be checked against observations people make on the ground, in order to be sure we are interpreting the satellite data correctly. Such field campaigns are a critical aspect of NASA research. (Photograph courtesy of Don Deering)



The Landsat series of satellites enables us to see change in the land surface over time. The Mississippi River deposits sediments from the central United States into the Gulf of Mexico and thereby builds the Mississippi Birdfoot Delta in Louisiana. Upon reaching the Gulf, the river's velocity slows, reducing the river's capacity to carry suspended mud and sand. This sediment is deposited in a fan pattern. Clearly, significant change has occurred in just three decades. Compare a specific part of one image to the same part of an image from a later year to discover some details of this remarkable sequence.

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.

As this classroom activity is being finalized, Landsat 5 and 7 are both orbiting the Earth at an altitude of about 705 kilometers (438 miles), and sending data to Earth for us to use. You can find out exactly when they will be over any given location by visiting the NASA Satellite Overpass Predictor Web site.

A new Landsat-type satellite called the Landsat Data Continuity Mission (LDCM) is planned and will be launched sometime after 2010. More information about LDCM is available on the NASA LDCM and USGS LDCM Web sites.

Landsat 5 and 7 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 on board 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 30m X 30m. ("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.**

What we've learned with Landsat is helping us to explore other planets in the solar system as well as our own. If you find yourself enjoying using your "spatial" skills to do the land cover change analysis in this activity, you may consider a career in geospatial technology.

About Color in Landsat Images

The sensors on Landsat 5 and 7 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. You will learn more about color in Landsat images in Step 4, below. For more information about Landsat visit http://landsat.gsfc.nasa.gov and http://landsat.usgs.gov/.