

Project Wild – Activity to introduce the GLOBE Observer Land Cover Tool



Learning Activity:

GRADES 6–12

MATERIALS • Computer with Internet access

Picturing a Pixel on Earth with GLOBE Land Cover

Almost every aspect of life is connected to the land on which we live. The homes we live in are built on land. Much of the food we eat is grown on land. Rivers and lakes provide us with water to use. Even the air we breathe is affected by land cover. Places with more trees take in (absorb) more carbon dioxide and release more oxygen into the atmosphere. When land cover changes, our health, well-being, and lifestyle may be affected. Geoscientists monitor and investigate how Earth's landscape changes over time: it is critical to analyze the impacts of floods and fires, map wildlife habitats, and track the impact of climate change. Landsat satellites collect space-based images of Earth's land surface in paths that cover the entire Earth. The resolution of these images is about that of a baseball field. This means that small-scale changes will not show up on these images. By documenting changes in land cover that occur where you live with a simple app on your phone, you help fill in the gaps in this global dataset. Plus, you can analyze those changes over time. Look around you! Earth science is everywhere!

Procedure:

1. What is land cover? [Watch this video](#) and [read about the science](#) behind land cover. Scientists classify what is on the ground into land cover categories, such as forest, shrubland, water, barren, developed, and others. The National Land Cover Database (NLCD) is a public domain set of data created from Landsat satellite imagery and other sources. [Look over the current classification system](#).
2. Launch the [MRLC viewer](#) and zoom into where you live or the place you want to investigate. Refer to the [classification system legend](#) to see how the land is categorized.
3. What is a pixel? When you zoom in on the map, you will see squares called pixels. In this case, these are picture elements that have a resolution or size of 30 by 30 meters (98 X 98 feet) pieces of Earth. The data captured by Landsat satellites cannot detect changes that are at a smaller scale than this level. [Read this article](#) to learn more.
4. [Download](#) the GLOBE Observer app.
5. [Watch this video](#) about how to use the GLOBE Observer Land Cover tool. You will use the GLOBE Observer Land Cover tool to collect data about a "pixel-sized" piece of Earth. These pixels will be 100 X 100 meters or about three times the size of the Landsat pixels. To get a sense of the size of the pixel you will photograph, count your steps as you walk about 10 feet. If it takes five steps, your stride is about 2 feet. If it takes three steps, your stride is 3.3 feet, or the total distance (10 feet) is divided by the number of steps. You

will be standing at the center of your pixel, so you will need to photograph about 50 meters (164 feet) in each direction. When you first begin taking measurements at your site, you may want to pace out the space.

6. Take a Land Cover observation. In the app, you will identify the surface conditions of the land cover you are mapping (e.g., snow/ice, standing water, muddy, dry ground, leaves on trees, raining/snowing.) Next, take pictures up and down at your site and then in all four directions (e.g., North, east, south, and west.) Classify the land cover in your photos and comment on any unique information you want to share. Submit your observation.

7. The images you take are recorded on the [GLOBE Visualization System](#) and analyzed by scientists to document the changes happening at that place on Earth. [View your images](#) and those of others online. By participating in this process, you are making an essential contribution as a “citizen scientist.”

8. Collect land cover data at your site at least four times a year (one for each season) or more frequently, depending upon changes that may be happening there.

Analysis:

1. What questions do you have about this place?
2. How has your site changed during your observations?
3. Consider the factors that might affect the changes you see (e.g., changes in temperature weather). What other data might you be able to collect if you wanted to study factors that influence changes in land cover and/or how changes in land cover affect aspects of our environment?

NGSS CONNECTIONS

SEP: Asking Questions, Planning and Carrying Out Investigations

DCI: ESS3.B: Natural Hazards; ESS3.D: Global Climate Change

CCC: Patterns; Cause and Effect



Caption: The GLOBE Observer Land Cover Tool



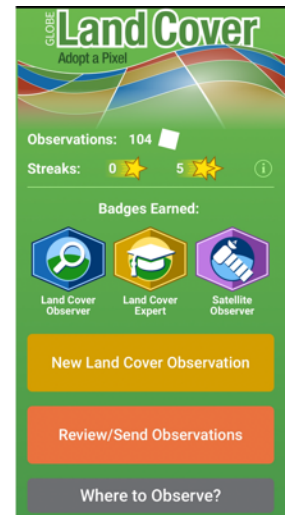
Project Wild – Land Cover

Research Activity Time Lapse



In this field exploration, you will use past and present land cover observations to identify changes in the landscape that have taken place over the past 40 years and guide learners in developing hypotheses about the causes of the change observed and potential impacts on wildlife and human society.

A landscape may look quiet and peaceful, but our landscape is dynamic and changing. Sometimes, the change happens slowly, and we need to look at data over a period of years to identify what has happened and predict what might be expected to occur. Documenting changes in land cover is essential for environmental monitoring, climate change mitigation, disaster management, resource management, biodiversity conservation, and gaining a global perspective on land use dynamics. In this research exploration, students will use the GLOBE Observer Land Cover tool to document current land cover conditions. Then, they will compare their observations to past land cover conditions documented by Landsat. Landsat is a program that provides satellite imagery of Earth's surface. It's one of the longest-running satellite missions dedicated to monitoring land cover and land use changes. The program is managed by both the United States Geological Survey (USGS) and NASA. In this activity, students will use freely available Landsat data and examine a time series of imagery spanning several decades, allowing for the analysis of land cover changes over time.



This data exploration supports an understanding of the scientific process. Students make observations about today's land cover using the GLOBE Observer Land Cover tool. After documenting their study site, the same area is examined using a series of satellite images obtained by Landsat from 1984 to the present. Students use their field observations and time series data from the same location to make hypotheses about changes that have taken place on the landscape and how these changes might have impacted the ecosystem.

This activity requires about an hour of preparation by the facilitator, but the prepared materials will tell a story about how the landscape has changed over time and augment discussions of ecosystem dynamics in the study area. Facilitators can connect this data exploration to overarching themes explored in the field session, such as plant succession, biodiversity, biomass, habitat fragmentation, or disturbance. Suppose this is a site that is visited repeatedly by different groups. In that case, the landcover data collected by the GLOBE Observer Landcover tool can be repeated in other locations or at the same location at different times of the year to provide place-based data describing landcover patterns and change on various time scales.

A. Student Fieldwork: Landcover data collection and analysis

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Time: 1 hour

Location: Outdoor study site

Materials:

- One tablet or smartphone per team, with the GLOBE Observer app installed, can be used by a larger group or in smaller teams.
- A 50 m tape (or a rope cut to 50 m long) to help visualize a 50 m view scape using the camera.
- The facilitator created printed satellite images of the study site; see preparation instructions below.
- As a group, travel to the study site selected for this activity.

Introduction

Explain to students that they will contribute to an ongoing scientific investigation of landcover change at the study site, using NASA data from satellites and the GLOBE Observer Land Cover data collection tool. Students will contribute to a long-term project at the study site, where they document changes on the landscape. The data collected by students in the field can also document changes due to succession and the impacts of extreme Earth events such as wildfires or floods.

Present the concept that change is a constant process in landscapes, driven by various natural and human-induced factors such as climate variability, geological processes, ecological dynamics, and human activities. As landscape stewards, it's essential to monitor these changes over time because monitoring provides essential information for informed decision-making, effective management, and sustainable development. It allows us to support ecosystem resilience, protect biodiversity, and safeguard the well-being of present and future organisms in the ecosystem.

Facilitator-led discussion:

Ask students to look at the study site closely:

- Describe the vegetation- what patterns do you notice?
- How far can you see? How would you classify the land cover at the study site? (forest, grassland, wetland, barren, agriculture, buildings, water)?
- What changes do you think have taken place at this site?

Referring to where the group is standing, is the 100 m surrounding the group homogeneous or heterogeneous? If it is homogeneous, the vegetation will be the same in each of the four directions. If it is heterogenous, more than one landcover type will be visible in the four directions.

- What organisms might live in each of the identified habitats?
- How could this land cover community be used economically?
- What valuable resources are found?
- Do you see edges between different land cover types? In ecology, paying attention to edges is crucial because edges represent transitional zones between different habitat types or ecosystems.

Site Observation and Documentation:

Use the GLOBE Observer Landcover tool to document one or more land cover study sites.

Using the GLOBE Observer data collection tool, you will document at 100 m² area.

Looking at each direction, ideally, you will see the type of land cover below in each direction for 50 m (the size of a soccer field).

Steps: Obtain latitude and longitude data. Press the reset button until the accuracy of the geolocation is identified to be between 3-12 meters. Using the app, follow instructions to collect data about surface conditions and then photograph from the center point, up and down, and in 4 cardinal directions, holding the viewfinder so that about 50 m of land is captured- about the length of a soccer field. Students can use a measured rope or tape to help them estimate a 50 m view.

Are there any features you wish to record in the study area, such as unique plants or other organisms that are found? Do you see any threats to the integrity of this land cover? Document interesting features of the study site with the feature photo option using the GLOBE Observer Land Cover app.

The app collects the data and uploads it to a database, where it can be downloaded for visual inspection and analysis later. Repeat the process as many times as you want. Different teams can also document different land cover types found in the study region. Save the data and upload it later when you are back in a building with wireless. The data can be shared with students or visitors when they return home via email.

Understanding Change:

1. Present the satellite images for the study site that were prepared earlier (see instructions below). Ask students to describe the changes that they see in the satellite images-patterns and colors. Ask them to generate hypotheses describing the changes that they see taking place over time in the time series of image chips. Facilitators can share any information they have about the history of the site- its use, active conservation, or protection actions, and/or known landscape disturbances that have taken place.

2. Share that Changes can be observed over time in the images, but it is useful to consult the numbers. In remote sensing, "spectra" refers to the measurement and analysis of electromagnetic radiation emitted, reflected, or transmitted by objects on the Earth's surface or within the atmosphere that are used to make up the images. The graph you see summarizes the data and plots changes in the spectral data over time.

Once you have generated the tiles and the NDVI graph for your study site, use these questions for discussion:

What major changes do you see, when viewing the tiles from 1984-present?

Was any vegetation lost? Forests? Agriculture? Why do you think these changes were made?

Do you see changes in roads?

What do you think are the effects of the changes that you observe?

Do you see evidence of land cover changes that have resulted in habitat fragmentation?

These changes may be indicated by the following:

1. Temporal Trends

2. **Seasonal Patterns**
3. **Spatial Variation** (You can create this comparison by selecting a closed forest location as your center point, and decreasing the image chip size for your data return, and comparing with a barren, urban or grassy location)
4. **Anomalies or Disturbances** as seen by sudden changes or anomalies in tiles or NDVI values in the graph. These may indicate disturbances such as wildfires, deforestation, agricultural activities, or land degradation.

B. Facilitator Preparation prior to fieldwork with students:

Identify the general location on your study site where land cover data will be collected and generate geospatially corresponding time series data using the Landsat Time-series Explorer on your computer.

Materials:

Smartphone or tablet with wireless access, to obtain data at the study site.

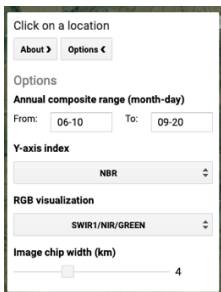
Computer with internet access.

Color printer to print out screenshots of time series of Landsat images.

Instructions on how to use the Landsat Time Series Explorer.

Google Earth Engine is a cloud-based platform developed by Google for planetary-scale environmental data analysis. It combines a vast archive of satellite imagery and geospatial datasets with advanced computational capabilities, allowing researchers, scientists, and developers to analyze and visualize changes on Earth's surface over time. You will use the Landsat Time-series Explorer:

<https://jstnbraaten.users.earthengine.app/view/landsat-timeseries-explorer#run=false;lon=-122.91966;lat=44.24135;from=06-10;to=09-20;index=NBR;rgb=SWIR1%2FNIR%2FGREEN;chipwidth=2;>



Type the address or name of the location into the top line, where it says, "Search places." This will bring up a satellite image of your study site. You can navigate in the image to identify the center point where you expect to do your local landcover investigation.

Under "options on the right menu, select a range of dates. You can access a seasonal average of vegetation by choosing a series of months that coincide with the season you are investigating. For instance, you could select 09-01 to 11-30 for fall. Alternatively, you can choose 01-01 to 12-31 for an annual average.

For the Y=axis index, select NDVI. DVI stands for Normalized Difference Vegetation Index. It's a commonly used vegetation index in remote sensing that quantifies the presence and health of vegetation based on satellite imagery and a measure of greenness as a proxy for productivity and health.

For RGB visualization, set it to the default SWIR1/NIR/GREEN. SWIR1 (Short-Wave Infrared 1), NIR (Near-Infrared), and GREEN typically represent specific electromagnetic spectrum bands captured by sensors. Each band has its own characteristics and is used for different types of analysis in remote sensing. Combining these bands allows for a more comprehensive analysis of various environmental parameters, including vegetation health, land cover classification, and monitoring changes in the landscape over time. Researchers and analysts often use multispectral data like this to derive indices such as NDVI (Normalized Difference Vegetation Index), which provides valuable information about vegetation vigor and density.

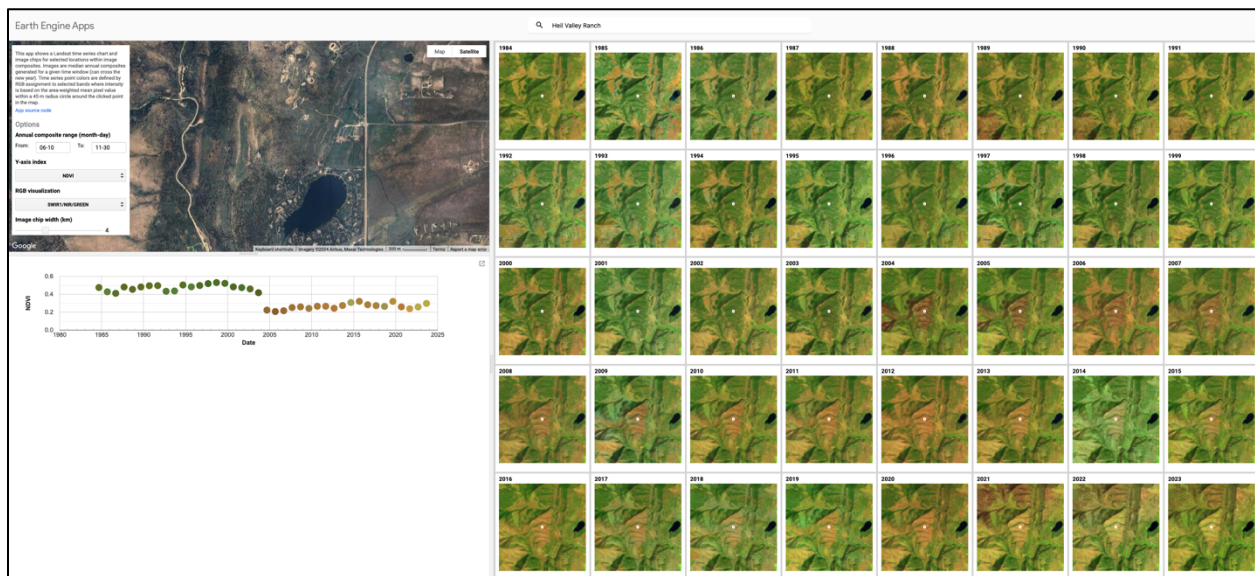
Choose any scale that is meaningful to your landscape for image chip width. You can start with 5 km and repeat the analysis to see if you get useful results at higher or lower levels of resolution.

When you have selected your parameters, submit changes, and you will be returned with a series of image chips from 1984-recent that display changes observed at this location over time, either annually or for a particular season.

When you are satisfied with what you see, take a screenshot of the data from your study area for use in the field with students. You can make several copies for group work or full-page, full-color prints of selected tiles that you can lay out on the ground for group discussion.

Appendix:

Here is an example of a data return from the Landsat Time-series Explorer from a wilderness area near Boulder, CO.



Referring to the graph above, changes can be observed over time in the images, but it is useful to consult the numbers. In remote sensing, "spectra" refers to the measurement and analysis of electromagnetic radiation emitted, reflected, or transmitted by objects on the Earth's surface or within the atmosphere that are used to make up the images. The graph above summarizes the data and plots changes in the spectral data over time. The graph clearly shows a big change in the vegetation index after 2004 and in 2021: these changes represent significant changes resulting from local wildfires.

Once you have generated the tiles and the NDVI graph for your study site, see if you can identify the following:

5. **Temporal Trends:** If the graph represents NDVI values over time, you might see fluctuations in NDVI throughout different seasons. For example, in temperate regions, NDVI typically increases during the spring and summer as vegetation becomes greener and denser due to increased photosynthetic activity. Conversely, NDVI may decrease during autumn and winter as vegetation senesces or loses leaves. When you examine peak growth season data, can you identify drought years in the data series?
6. **Seasonal Patterns:** Seasonal patterns in NDVI can reflect natural vegetation growth and dormancy cycles. For instance, in regions with distinct wet and dry seasons, NDVI may peak during the wet season when vegetation is actively growing and decline during the dry season when vegetation becomes stressed due to water scarcity. (To examine this, use the Landsat Timeseries Explorer twice, comparing data from two different seasons).
7. **Spatial Variation:** If the graph represents NDVI values across different locations or land cover types, you may observe spatial variation in vegetation density. For example, areas with dense forests or lush vegetation may exhibit higher NDVI values than bare soil or urban areas with little vegetation cover. (You can create this comparison by selecting a closed forest location as your center point and decreasing the image chip size for your data return, and comparing it with a barren, urban, or grassy location)
8. **Anomalies or Disturbances:** Sudden changes or anomalies in NDVI values may indicate disturbances such as wildfires, deforestation, agricultural activities, or land degradation. These disturbances can cause abrupt decreases or increases in NDVI depending on their impact on vegetation health and density. If you know the dates of historic disturbances that have taken place at your location, see if you can identify them in the data.

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CCC: Patterns; Cause and Effect

Initial draft of activity for Project Wild, using GLOBE Observer. Seeking community input to improve and complete this activity- contact us- rusty_low@strategies.org

