Earth Science Everywhere

Exploring Amazonian Deforestation

A Lesson for High School STEM

Developed by AmericaView
www.americaview.org

Table of Contents

AmericaView℠
Empowering Earth Observation Education
americaview.org

Introduction: This lesson seeks to engage students in an examination of how human activities modify the physical environment. This content provides opportunities for students to meet NCGE National Geography Standards 1, 3, and 14 (see next page for details). This lesson is best suited for a STEM enrichment class or as an enrichment activity included as part of a larger science curriculum. It was written with a high school audience in mind but could be adapted for middle school students.

This lesson refers to electromagnetic spectrum and remote sensing topics. It is recommended that the "Exploring the Electromagnetic Spectrum" lesson is completed first.

Keywords: **Deforestation**, **natural land cover, ecosystems, environmental impacts, human-induced changes, aerial photographs, satellite images.**

Background Information:

Scientists have been using satellite imagery to track the deforestation of the Amazon rainforest for several decades. The clearing of the rainforest has changed over time, both in its pace and its location. For two decades, beginning in the 1990s, agriculture, forestry and mining development proceeded rapidly. Satellite-based forest monitoring has enabled successful enforcement of forestry management practices, where such practices are applied. The Landsat image pair on the front of the Earth Observation Day poster shows the change in land use that occurred between 2001 and 2019, when palm oil plantations replaced rainforest in Peru. Illegal forest clearing is constantly adapting to new monitoring practices, and is still occurring across the region. Satellite imagery helps scientists and governments to monitor shifts in deforestation and develop new deterrence strategies.

Time Frame: Two 45 minutes sessions

Materials: In order to complete the activities in this Lesson, the following materials/resources are essential:

- Internet access

- One computer per pair of students (one-to-one is preferred)

- ESRI Landsat App

    o Landsat App (arcgis.com)

- Smartboard or other projection system

National Council for Geographic Education (NCGE) Standard addressed:

Standard Number	Standard	Theme	Knowledge statement	Performance statement
1.	How to use maps and other geographic representation, geospatial technologies, and spatial thinking to understand and communicate information	Properties and Functions of Geographic Representation	1. The advantage of coordinating multiple geographic representations – such as maps, globes, graphs, diagrams, aerial photographs, remotely sensed images, and geographic visualizations to answer geographic questions	A. Explain the advantages of using multiple geographic representations to answer geographic questions, as exemplified by being able to explain how multiple geospatial technologies can be used to solve land-use problems.
3.	How to analyze the spatial organization of people, places, and environments on Earth's surface.	Spatial Patterns and Processes	2. Complex processes change over time and shape patterns in the distribution of human and physical phenomena	A. Analyze and explain changes in spatial patterns as a result of the interactions among human and physical processes through time, as exemplified by being able to analyze vegetation maps for an area over different time periods and explain how changing patterns reflect changes in physical processes and human activities (e.g., desertification, deforestation, natural land cover, agricultural land use.
4.	How human activities modify the physical environment	Modification of the physical environment	1. Human modifications of the physical environment can have significant global impacts	B. Explain the global impacts of human changes in the physical environment, as exemplified by being able to explain the implications of modifying the physical environment in Brazil to grow soybeans for global export (e.g. siltation, desertification, deforestation, global climate change).

Day One
Warm-Up: 10 minutes
Display page 5 on a screen for the entire class and pose the question of, "What's going on in this picture?" Have students turn to their neighbor and give them a few minutes to discuss their ideas. Then have the students discuss their ideas as a class.

Notable features in the image:
- Top picture
  - Meandering river
  - Densely-forested area with a few clearings
  - Clearings increase closer to river.
  - One Road
- Bottom picture
  - The same river
  - Clearings extend farther from river
  - Many more roads in a large area once covered by undisturbed forest

Landsat App Exploration: 25 minutes
Once the warm-up discussion has ended, have the students enter "Ariquemes" (a city in the Amazonian rainforest in Brazil) into the search bar of the Landsat App: [Landsat App (arcgis.com)](#).

The App will open to the latest available date, which may not have coverage over Ariquemes. Follow these instructions:

- Select the "clock" button on the lower left and the Time Line Feature will open. Press the "-" button in the timeline box until you reach May 29, 2024. The dark green areas indicate rainforest land cover. The lighter green or brownish areas are deforested areas – now agricultural land cover.
- Place your cursor on the far left of the Time Line – date June 23, 1984 – to open another image. What was the dominant landcover on that date? What are the geometric features where the dark green rainforest vegetation is missing? What is the approximate percentage of rainforest landcover?
- Click on the "+" button on the Time Line three times – date September 18, 2001. How has the land cover changed? What is the approximate percentage of rainforest landcover?
- Click "+" to reach the date June 28, 2006. Has there been significant change?
- Click "+" to reach the date July 26, 2013. Has the trend continued?
- Click "+" to reach the date July 27, 2019. Has the trend continued?
- Return to May 29th, 2024. What percentage of the original forest cover exists, approximately, on this date?
- Zoom out once, and then close the Time Line. Do you see other areas that look like the Ariquemes area did in 1984? Is the deforestation still ongoing?

- **Wrap-up: 5 minutes**
- Have the students construct the [Deforestation timeline - Rank order (wordwall.net)](#) to test their comprehension of the main topics of the lesson.

Day Two

Reading Activity: 20- 25 minutes

Direct the students to the NASA Earth Observatory website and have them read the "[Tracking Amazon Deforestation from Above](#)" article and view any animations associated with the article. There is an online quiz to monitor their understanding of the main content of the lesson.

Career Exploration: 10 minutes

Have the students navigate to the links below to explore careers within the U.S. Department of Interior related to these activities. This page gives details about job qualifications and if they scroll towards the bottom of the page, they can explore more specific jobs within that category.

- [Ecology | U.S. Department of the Interior (doi.gov)](#)
- [Environmental Protection Specialist | U.S. Department of the Interior (doi.gov)](#)
- [Forestry | U.S. Department of the Interior (doi.gov)](#)
- [Natural Resources Management and Biological Sciences | U.S. Department of the Interior (doi.gov)](#)

If there is additional time or if you want to make this a longer activity in the future, begin at the below link. Students can click on "Find Your Path" then "Get Started" to search careers based on their personal interests.

https://careers.doi.gov/

Wrap-up: 5 -10 minutes

Have the students take the short-answer version of the Amazon Deforestation quiz or the [Amazon Deforestation - Quiz (wordwall.net)](#) to test their comprehension of the main topics of the lesson. The printable versions of a short answer quiz and the multiple-choice quiz are provided on pages 6 and 7.

What's going on in these pictures?

What do you notice?

"Tracking Amazonian Deforestation from Above" Printable Reading Quiz

Open the link [Earth Observatory Tracking Amazon Deforestation from Above](#) .

Short answer quiz:

1. Following the rapid deforestation during the 1990s and 2000s in Brazil, what changes were made*? The Brazilian people and the international community applied pressure to slow the rate. The Brazilian government adopted a plan that involved created a large network of national and state parks, established protected territories for indigenous groups, strengthened environmental enforcement agencies, made it more difficult to export goods produced on illegally deforested land, and strengthened satellite monitoring systems.*

2. Was it effective? *By 2012, forest clearing was down by nearly 80%.*

3. How did the trend in deforestation rate in the Amazon change between 2001 and 2019? *It increased rapidly between 2001 and 2004. It dropped sharply from 2004 to 2012, then began to increase slowly but steadily.*

4. How did satellite imagery impact the situation? *Brazil's national space agency, INPE, began releasing satellite- derived deforestation maps to the public. The system could send alerts to enforcement officers when deforestation showed up on the imagery. Scientists are developing methods to integrate satellite radar data, which can image through cloud cover, into their observations.*

5. How have deforesters reacted to this enforcement activity? *They have switched to deforesting smaller areas that are beyond the resolution scale of the satellites. They have switched their operations to the rainier seasons when clouds block satellite image acquisition.*

Multiple choice quiz (printable and on Wordwall)

1. Following the rapid deforestation during the 1990s and 2000s in Brazil, what changes were made*?*

    a. The Brazilian government adopted a plan that involved created a large network of national and state parks, and established protected territories for indigenous groups

    b. The Brazilian government weakened environmental enforcement agencies,

    c. The Brazilian government made it easier to export goods produced on illegally deforested land

    d. The Brazilian government strengthened satellite monitoring systems

    e. Both a and d

2. Was it effective?

    a. By 2012, forest clearing was down by nearly 10%.

    b. By 2012, forest clearing was down by nearly 30%.

    c. By 2012, forest clearing was down by nearly 80%.

    d. By 2012, forest clearing was down by nearly 50%.

3. How did the trend in deforestation rate in the Amazon change between 2001 and 2019?

    a. It increased rapidly between 2001 and 2004

    b. It decreased rapidly between 2001 and 2004

    c. It dropped sharply from 2004 to 2012

    d. It continued to decrease, but more slowly, in 2012

    e. Both a and c

4. How did satellite imagery impact the situation?

    a. Brazil's national space agency stopped releasing satellite- derived deforestation maps to the public.

    b. The DETER satellite-based system can send deforestation alerts to enforcement officers when deforestation larger than 25 hectares shows up on the imagery.

    c. Scientists are successfully developing methods to integrate satellite radar data, which can image through cloud cover, into their observations.

    d. Satellite imagery can only detect deforestation larger than 500 hectares.

    e. Both b and c

5. How did deforesters react to this enforcement activity?

    a. They switched to deforesting smaller areas that are beyond the resolution scale of the satellites.

    b. They switched their operations to the rainier seasons when clouds block satellite image acquisition.

    c. They began rapid reforestation efforts over areas they had deforested

    d. They switched from raising cattle on deforest acres converted to pasture to raising cattle that will eat rainforest plants.

    e. Both a and b