Lesson 8: Quantifying Land Changes Over Time in Areas of Deforestation and Urbanization

PURPOSE/QUESTION
Students will quantify and analyze changes in land cover in areas affected by urbanization and deforestation and research and hypothesize there impacts on the earth system and human populations.

GRADE LEVEL
9-12

TIME TO COMPLETE
2 – 45 minute class periods for Quantifying Changes in Land Over Time in Areas of Deforestation and Urbanization

STANDARDS
See appendix below – page 8

LEARNING OUTCOMES
- Students will quantify changes in land cover over time
- Students will analyze land cover change to help them grasp the extent, significance and consequences of land cover change.

STUDENT OBJECTIVES
- Quantify land cover change over time
- Predict ways and directions that an urban area might grow
- Realize that land cover/use in our country is changing and that it has serious implications

TEACHER BACKGROUND

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.

Deforestation

Rainforest loss around the globe releases as many heat trapping gasses (greenhouse gases, GHG) into the atmosphere as all the world's cars, trucks, ships, and airplanes combined. Accounting for around 12% of global carbon dioxide emissions, tropical deforestation is a major driver of global climate change (global warming), when the carbon stored in our planet's forests is released as forests are cut and burned.

Deforestation also threatens the local biodiversity of a region, reduces and degrades water supply and soil quality and has devastating impacts on local communities – all key factors that perpetuate global poverty. When people think of the causes of deforestation, logging for timber usually comes to mind. In fact, the largest driver of deforestation today is commercial agriculture driven by consumer demand for two key commodities—palm oil (used in many processed foods, cosmetics, household products) from Indonesia and cattle (leather and meat) from Brazil. The expansion of large-scale cattle ranching has driven three quarters of Brazil's forest loss. An area of rainforest the size of the state of Texas has been cleared. In Southeast Asia, primarily Indonesia and Malaysia, between the years 1990-2005, studies suggest that 56% of palm oil expansion occurred at the expense of these tropical rainforests.

TEACHER BACKGROUND CONTINUED…

Tackling global climate change is a daunting challenge that will require wide international cooperation. While shifting to renewable energy and aggressively pursuing low-carbon fuels are essential means of reducing global heat trapping gas (GHG) emissions for energy, the 2006 UK Stern Review reports, protecting tropical forests is "the single largest opportunity for cost-effective and immediate reduction in carbon emissions".

NWF-Forest Justice

Urbanization

Urbanization is the physical growth of urban areas as a result of global change. The United Nations defines urbanization as movement of people from rural to urban areas as a result of global change. More than half the world's populations live in urban areas. More than half of the world's population lives less than 1 hour from a major city, 85% of the developed world and 35% of the developing world; 95% of the population is concentrated on 10% of the world's land; but only 10% of the land is classified as more than 48 hours from a large city.[1]

Urbanization affects many facets of the earth system. Rapid urbanization can affect public health from poor urban planning that can lead to dilapidated living conditions, strains on water and sewage infrastructure, as well as on the availability of food and jobs.

Wild places and wildlife also suffer from the affects of urbanization. Depletion of our natural green spaces deprives our world of carbon sinks, which sequester large amounts of carbon from the atmosphere, much of which is anthropogenic. With loss of large areas of trees comes loss of habitat for a variety of species; changing food chains resulting in a domino effect that could prove catastrophic for the regional food webs.

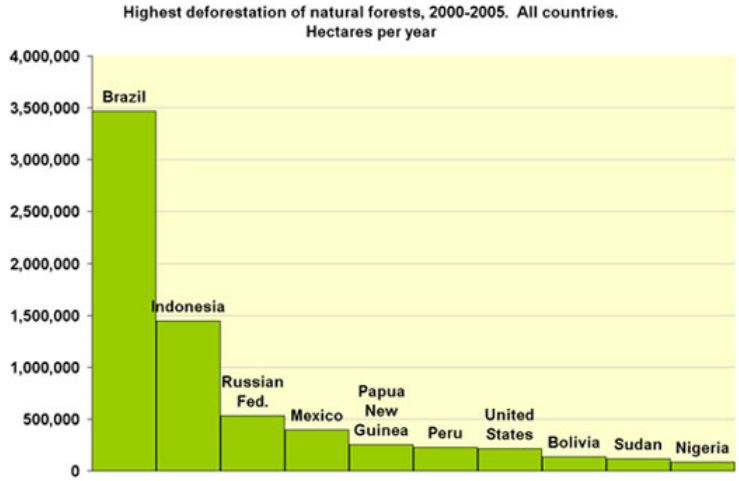


Figure 1. Highest deforestation of natural forests, 2000-2005. All countries. Hectares per year

[1] http://www.sciencedaily.com/releases/2008/12/081217192745.htm

PREREQUISITE KNOWLEDGE & SKILLS

- Lesson 7: Quantifying Land Changes Over Time Using Landsat
- Calculating Percent Change
- Basic understanding of the terms deforestation and urbanization

MATERIALS & TOOLS

Computer
Color Printer
Books and/or online atlases and other media resources on population growth, urbanization, and deforestation.

VOCABULARY

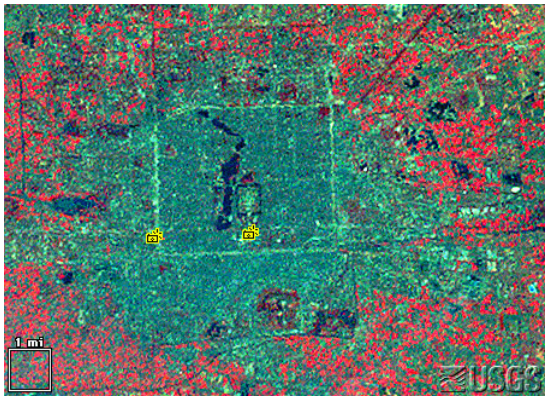
- Rural
- Urban
- Sprawl
- Commercial agriculture
- Palm Oil
- Urban development

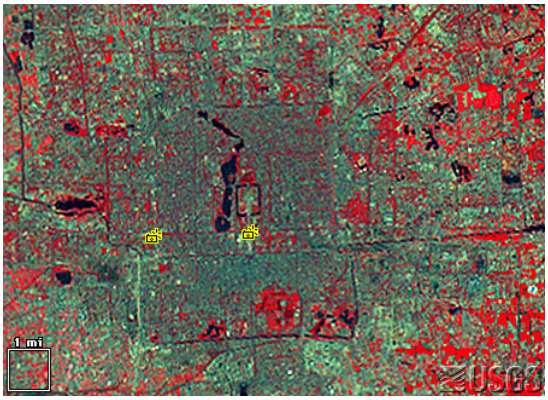
LESSON LINKS

- Classroom set of **COLOR** change pairs for location(s) you choose will work best for your class. (the change pairs are found in this lessons folder)
  - Anchorage, AK
  - Fairbanks, AK
  - Paradise Island, Bahamas
  - Los Angeles, CA
  - Atlanta, GA
  - Dublin, Ireland
  - Raleigh, NC
  - Boston, MA
  - Houston, TX
  - Austin, TX
  - Dallas, TX
  - Quinault Rainforest, WA
  - Seattle. WA

ESSENTIAL QUESTIONS-PART 1

1. What changes in land cover do you see between image 1 and image 2? Utilize the land cover chart.
2. What land cover types seem to have decreased in extent? What could be the reasons behind this change?
3. What land cover types have increased? What could be the reasons behind this change?
4. Indentify specific quadrants of the image where change has occurred, i.e, northeast, southeast, northwest, southwest. Make note of reasons for change in certain quadrants of the map.
5. Make note of any questions or concerns you have, anything you find confusing.





Landsat images depicting Beijing, China in 1976 and 1991. Remember red color denotes natural and agricultural vegetation.
http://earthshots.usgs.gov/Beijing/Beijing

PROCEDURE – PART 1
QUANTITATIVE ANALYSIS

1. May need to review – About the Colors of Landsat Images. Could assign as homework, but would need to supply true and false color images.

2. Working with a partner discuss visually compare the Landsat images you are working with.
   a. Familiarize yourself with the similarities and differences in these images most of which are two decades or more apart. Get a general sense of how much the land cover has changed over time: where, how much, and by how much. **Focus on one part of the geographic area at a time to identify specific areas of change.**
   b. In your science notebook title and date a new page. Record your visual observations via drawings and writings. **Again be sure you are focusing on a small area, not more than a 3cm x 3cm area, and the same area in both images**. Use the ***Essential Questions*** to guide your writing.
   c. You will repeat this process for three other areas on your Landsat images.
   d. Be prepared to discuss in small groups and as a whole class.

Use this chart from the previous lesson if it will help you with your qualitative assessment of the two images. Each land cover type needs to be represented on the map by a letter or a symbol, such as:

S	Suburban	F	Forest
U	Urban	G	Grassland
H	Highways and Roads	W	Water

ESSENTIAL QUESTIONS – PART 2

1. **What types of land cover changes were most prevalent? Pervious or Impervious? What reasons might explain these changes?**
2. **Estimate the percent change before doing your actual calculations.**
   a. **What is the actual percent change from pervious to impervious land cover?**
   b. **What is the actual percent change from impervious to pervious land cover?**
3. **The images you have analyzed show urbanization, deforestation, or both? Explain the evidence you have to support your claim.**
4. **Researchers indicate that if ten 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 run-off increases.**
   a. **How concerned should people be about the cycling of water in the area you have studied with Landsat? Explain your reasoning.**
   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 these ecological effects?**

PROCEDURE – PART 2
QUALITATIVE ANALYSIS

Students will again work in pairs and gather qualitative data. Take two transparency grids and cover each of the Landsat images. *Note: painter's tape may be used to tape the transparency to the grid without tearing the paper.*

1. Each pair of students needs a paper copy of the grid and a wipe off marker. *Note: if students would prefer to use color instead of symbols each pair of students will need two markers that are different colors.* In the grid you will –
    a. Use one symbol to represent change from pervious to impervious surface, and another symbol to represent change from impervious to pervious surface.
    b. If no change has occurred, leave blank.
    c. Be sure to include a key, total number of pervious to impervious changes, total number of impervious to pervious changes, and the total number of squares that remained unchanged. This information will be critical when calculating percent change.

2. Calculate percent of land cover type changes. Record this information in your science notebook.
    a. Total number of squares =
    b. Number of grid squares that changed from pervious to impervious land cover between image 1 and image 2 =
    c. Number of grid squares that changed from impervious to pervious land cover between image 1 and image 2 =

    Which number is larger, (b) pervious to impervious, or (c) impervious to pervious?
    In most geographic areas where land cover types are changing, (b) will be larger than (c). If (c) is larger than (b), your geographic location is not experiencing urban growth.

    To determine the percent of land cover changed from pervious to impervious, calculate the following:

$$\frac{\text{Value for b X (100)}}{\text{Value for a}}$$

    To determine the percent of land cover changed from impervious to pervious, calculate the following:

$$\frac{\text{Value for c X (100)}}{\text{Value for a}}$$

PROCEDURE – PART 3

1. Choose to learn more about how urbanization or deforestation affects temperatures.
    a. Urbanization – use this link, http://www.epa.gov/heatisld/ .
    b. Deforestation – use this link,
    http://www.nasa.gov/centers/goddard/news/topstory/2004/0603amazondry.html
    http://earthobservatory.nasa.gov/Features/Deforestation/
2. Create a presentation that will be presented and or distributed to other classes or school wide, using a method of your choice, brochure, poster session, multi-media, art, etc. Choose your purpose – who will the audience be?
    a. Focus on
        i. Causes
        ii. Impacts to local cities, are there impacts beyond cities
        iii. What happens to temperatures as a result of urbanization or deforestation
        iv. How do these changes impact ecosystems

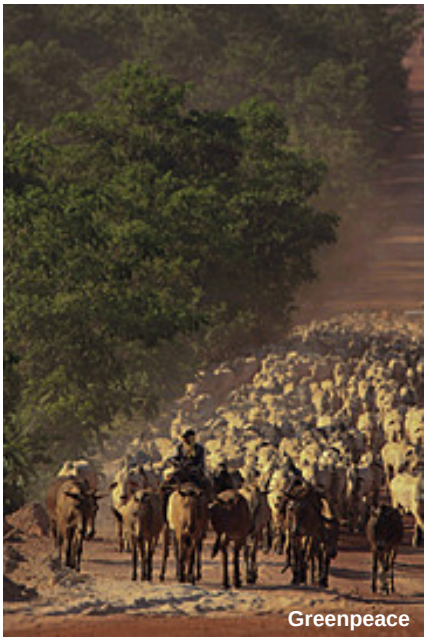
WEBSITES FOR FURTHER LEARNING

- State of Flux
- Aster image shows extent of clear-cutting in the Amazon
- Rainforest Action Network
- Palm Oil
- UN-REDD
- Deforestation in the Amazon

STUDENT READING RESOURCES

- Deforestation for Palm Oil
- How cattle ranches are chewing up the Amazon rainforest
- Urbanizations Aftermath
- The Urbanization of Dubai

Above: Palm oil plantation in Borneo threaten orangutan habitat.



Right: Amazon rainforest and cattle compete for space.

LESSON 8-APPENDIX

WEB ADDRESSES FOR HYPERLINKS

PREREQUISITE KNOWLEDGE AND SKILLS

- **Percent change**
  http://www.buzzle.com/articles/calculate-percent-change.html
- **Deforestation**
  http://earthobservatory.nasa.gov/Glossary/?xref=deforestation
- **Urbanization**
  http://en.wikipedia.org/wiki/Urbanization

VOCABULARY

- **Rural**
  http://www.merriam-webster.com/dictionary/rural
- **Urban**
  http://www.thefreedictionary.com/urban
- **Sprawl**
  http://dictionary.reference.com/browse/urban+sprawl
- **Commercial agriculture**
  http://wiki.answers.com/Q/What_is_the_definition_of_Commercial_agriculture
- **Palm oil**
  http://www.answers.com/topic/palm-oil
- **Urban development**
  https://www.google.com/search?hl=en&rls=com.microsoft:*&q=urban+development&tbs=dfn:1&tbo=u&sa=X&ei=6M8mTpikJqjY0QGcm8W9Cg&ved=0CBUQkQ4&biw=1259&bih=858

WEBSITES FOR FURTHER LEARNING

- **State of Flux –** This NASA websites shows before and after and change over time photos of significant events.
  http://climate.nasa.gov/sof/#Flooding_SouthDakota.jpg
- **Aster Image Shows Extent of Clearing in the Amazon –** A page within NASA's Global Climate Change – Vital Signs of the Planet that focuses on clear-cutting the Amazon.
  http://climate.nasa.gov/news/index.cfm?FuseAction=ShowNews&NewsID=29
- **Rainforest Action Network –** This website campaigns for forests, their inhabitants and the natural systems that sustain life by transforming the global marketplace through education, grassroots organizing and non-violent direct action.
  http://ran.org/
- **Palm Oil –** This is a page within the Rainforest Action Network that informs students about the negative impacts of palm oil use.
  http://ran.org/palm-oil
- **UN – REDD –** This website is a United Nations Collaborative Program on reducing emissions from deforestation and forest degradation in developing countries.
  http://www.un-redd.org/AboutREDD/tabid/582/Default.aspx
- **Deforestation in the Amazon**
  http://www.mongabay.com/brazil.html

STUDENT READING RESOURCES

- **Deforestation for Palm Oil**
  http://www.greenpeace.org/usa/en/campaigns/forests/forests-worldwide/paradise-forests/palm-oil/
- **How Cattles Ranches are chewing up the Amazon Rain Forest**
  http://www.greenpeace.org.uk/blog/forests/how-cattle-ranching-chewing-amazon-rainforest-20090129
- **Urbanizations Aftermath**
  http://earthobservatory.nasa.gov/Features/Lights3/
- **The Urbanization of Dubai**
  http://earthobservatory.nasa.gov/Features/WorldOfChange/dubai.php

LESSON 8-STANDARDS

National Science Education Standards

Unifying Concepts and Processes

- Systems, order, and organization
- Evidence, models, and explanation
- Change, constancy, and measurement

Standard A – Science as Inquiry

- Abilities necessary to do inquiry
- Understandings about scientific inquiry

Standard C – Life Science

- Interdependence of organisms

Standard E – Science and Technology

- Understandings about science and technology

Standard F – Science in Personal and Social Perspectives

- Personal and community health
- Population growth
- Natural resources
- Natural and human-made hazards
- Science and technology in local, national, and global challenges

National Education Technology Standards

Standard 1: Creativity and Innovation

- Use models and simulations to explore complex systems and issues
- Identify trends and forecast possibilities

Standard 3: Research and Information Fluency

- Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- Process data and report results

Standard 4: Critical Thinking, Problem Solving, and Decision Making

- Collect and analyze data to identify solutions and/or make informed decisions.

Standard 5: Digital Citizenship

- Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.

Standard 6: Technology Operations and Concepts

- Understand and use technology concepts
- Select and use applications effectively and productively
- Troubleshoot systems and applications
- Transfer current knowledge to learning of new technologies

National Council of Teachers of Mathematics Standards

Algebra

- Understand patterns, relations, and functions
- Use mathematical models to represent and understand quantitative relationships
- Analyze change in various contexts

Measurement

- Understand measurable attributes

Data Analysis and Probability

- Develop and evaluate inferences and predictions that are based on data

Process

- Connections
  - Recognize and apply mathematics in contexts outside of mathematics

Climate Literacy Principles

Principle 2: Climate is regulated by complex interactions among components of the Earth system.
Principle 3: Life on Earth depends on, is shaped by, and affects climate.
Principle 5: Our understanding of the climate system is improved through observations, theoretical studies, and modeling
Principle 6: Human activities are impacting the climate system.
Principle 7: Climate change will have consequences for the earth system and human lives.

Energy Literacy Principles

Principle 1: Energy is a measurable quantity that follows physical laws.
Principle 3: Biological Earth processes depend on energy flow through the earth system.
Principle 7: The energy choices made by individuals and societies affect quality of life.

LESSON 8-ESSENTIAL QUESTIONS ANSWER KEY

The following is information that is applicable to the type of information students are expected to have in regards to both lessons 7 and 8.

When students are looking at changes in any of the NASA images available, whether Phoenix for lesson 7 or one of the many Landsat images from lesson 8 students will see changes from natural landscapes to more man-made landscapes and/or having urban areas grow beyond its initial boundaries. It's important for students to identify what types of land cover are visible and how they are changing – the document, *About Colors of Landsat Images*, is a critical tool to have available as students are making observations.

Equally important for students to comprehend about the images they are analyzing are changes from pervious to impervious and impervious to pervious surfaces. These surfaces have a significant effect on weather and climate and can have significant consequences to cities and outlying areas.
Students will need to identify ecological consequences to areas of urbanization and deforestation.

Having students consider the detrimental effects placed on water ways, air, soils, food and water availability, housing, and wildlife is a critical connection. These ecological areas, these pieces of the city or forest system will have an impact on their lives and therefore you will be able to answer the "why it matters" or "why are we learning this".

Name: _____ Date: _____

Science Concept Quiz

Lesson 8: Quantifying Land Changes Over Time in Areas of Deforestation and Urbanization

Coastal Urbanization, USGS

Tropical Deforestation, AFP

Deforestation and urbanization have created problems that affect many of earth's systems. Select from the choices below, a reason why impacts from urbanization and deforestation are increasing.

A. Population growth and migration
B. Poorly planned urban development
C. Demand for products such as beef and the millions of products that include palm oil
D. All of the above

_____ points out of 20

I. Answer

A.○ B.○ C.○ D.○

_____ points out of 15

II. What is the main concept behind the question?

1. Impacts of urbanization and deforestation
2. Reasons for urbanization and deforestation
3. Urban sprawl
4. Analyzing images

_____ points out of 25

III. Provide the reasoning for choosing your answer in part II.

_____points out of 40

IV. Why are the other responses in part I not the best answer choice?

1.

2.

3.

4.

Use the rest of this page if more room is needed to fully communicate your thoughts.

Teacher Answer Key

1. D

2. 2

3. Answers will vary. The statement asks for reason for urbanization and deforestation, not impacts.

4. Answers will vary.

   A) Population growth and migration are only one of the reasons for an increase in urbanization and deforestation.

   B) Poor urban planning is not the only reason listed that is a contributing reason to urbanization and deforestation.

   C) The demand for products that require space to raise or grow contributes to urbanization and deforestation.

   D) Population growth and migration, poor urban planning, and product demand all contribute to increases in urbanization and deforestation.

Student Name
Teacher/Class
Date

Lesson 8: Quantifying Land Changes over Time Using Landsat Urbanization and Deforestation

Explain how these three people could work together to create the least impact on the environment, cattle rancher or palm plantation owner (choose one), a city planner along with its governing body, and an environmental organization concerned with the impacts of urbanization and deforestation.

What Is the Expectation?

Use new lesson knowledge and student readings to support your position

Visual representations if applicable

Key vocabulary

Evidence of on grade level spelling and grammar usage