

REFORESTATION: IMPACT ON CLIMATE

Subject Area: Science - Carbon Cycle, Deforestation and Reforestation

Grades: 6th – 8th

Time: This lesson is designed to be completed in three 45-minute sessions.

Essential Questions:

- How do deforestation and reforestation affect the carbon cycle?
- What can people all over the world do to preserve and restore forests?

Purpose and Overview:

Students will learn about the importance of large-scale forest landscapes and the impacts of deforestation and reforestation with a focus on global climate change. Focus will be given to the carbon cycle and the ways in which forests decrease carbon dioxide and greenhouse gases in the atmosphere, thereby minimizing climate change, and improving air quality. Consideration will also be given to the ways in which deforestation and forest restoration affect wildlife.

Themes:



Forests provide numerous benefits, including cleaning our air by filtering out dust and pollution and absorbing carbon dioxide and other greenhouse gases. Trees provide natural filtration and storage systems.

Introduction:

In this lesson, students learn the value of forests and their role in the carbon cycle. Students investigate deforestation and its impact on climate and explore local and global reforestation efforts.

Deforestation is clearing Earth's forests on a massive scale, often resulting in damage to the quality of the land. Agriculture is the largest global driver of deforestation. Farmers cut forests to provide more room for planting crops or grazing livestock and many small farmers will each clear a few acres by cutting down trees and burning them in a process known as "slash and burn" agriculture. To provide wood and paper products, loggers cut down a large number of trees

each year. Wildfires and overgrazing also prevent the growth of young trees.

One solution to deforestation is to simply stop cutting down trees or, more realistically, to sustainably manage forest resources. Reforestation efforts are a vital way to undo some of the damage that has already been done.

Reforestation has many positive effects on the environment. One of the most dramatic impacts is an increase of habitat for millions of organisms. Adding trees allows the forest to expand its canopy, which blocks the sun's rays during the day and holds in heat at night. Forest soils are moist, and protection by sun-blocking tree cover keeps them from drying out. Without this coverage plants and animals would experience extreme and potentially harmful temperature swings.

Reforestation also impacts climate change. Trees play an important role in absorbing the greenhouse gases that fuel global warming. Trees also anchor soil with their roots. When they are removed, the soil is transported and deposited in other areas releasing carbon into the air. Adding to forests mean smaller amounts of greenhouse gases entering the atmosphere.

Objectives:

The student will...

- compare and contrast forested and deforested areas.
- identify parts of the carbon cycle where carbon dioxide is produced.
- identify steps to reduce carbon dioxide levels.
- explain how deforestation affects the carbon cycle.
- explore and represent different perspectives on deforestation.
- examine ways that people can help conserve forests and live more sustainably.
- create an infographic that explains the relationship between carbon dioxide, deforestation, and climate change.
- model greenhouse gases using a computer simulation.
- calculate their carbon footprint and compare it to their calculations of the amount of carbon stored in a tree of choice.
- evaluate the role of human activity in the carbon cycle.

Standards:

Next Generation Science Standards

Disciplinary Core Ideas

- LS2.C Ecosystem Dynamics, Functioning, and Resilience
- LS4.D Biodiversity and Humans
- ESS3.D Global Climate Change
- ETS1.A Defining and Delimiting Engineering Problems
- ETS1.B Developing Possible Solutions

Crosscutting Concepts

- Stability and Change
- Systems
- Causation

Science and Engineering Practices

- Asking questions/defining problems

- Using mathematics
- Using models
- Communicating information

Performance Expectation Middle School

- MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
- MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
- MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Common Core English and Language Arts Standards for Writing Grades 6-8

- CCSS.ELA-LITERACY.WHST.6-8.2.A Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
- CCSS.ELA-LITERACY.WHST.6-8.2.B Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
- CCSS.ELA-LITERACY.WHST.6-8.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic.
- CCSS.ELA-LITERACY.WHST.6-8.6 Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.

Vocabulary:

Carbon cycle: The movement of carbon between the living and nonliving environment through natural processes.

Deforestation: the permanent destruction forests to make way for other activities like agriculture, ranching, or housing.

Greenhouse Gases: Gases in the atmosphere, such as carbon dioxide, which absorb energy from the sun.

Reforestation: Planting new trees in areas where they have been removed by cutting or destroyed by fire or disease.

Materials:

For each group of students/individual student:

- Notebook paper/journal
- Handouts below
- 1 copy of Carbon: Good or Bad
- 1 copy of Carbon Cycle Cards
- 1 copy of Roles and Impacts Placemats
- 1 copy of Balancing People and Nature
- 1 copy of Infographic Project Guide






Nature Lab videos that support this lesson plan:

- *Reforestation: Impact on Climate* Introductory video - <http://vimeo.com/77792711>
- Scientist interview questions:
 - *Reforestation #1: Climate Change* - <https://vimeo.com/78371196>
 - *Reforestation #2: Wildlife Conservation* - <http://vimeo.com/78369345>
 - *Reforestation #3: Preservation and Restoration* - <http://vimeo.com/78369346>
 - *Reforestation #4 Benefits* - <http://vimeo.com/78369342>
 - *Reforestation #5: Local Community* - <http://vimeo.com/78369343>
- Meet the Scientist: Yu Jie - <http://vimeo.com/77788832>

Classroom Activities:

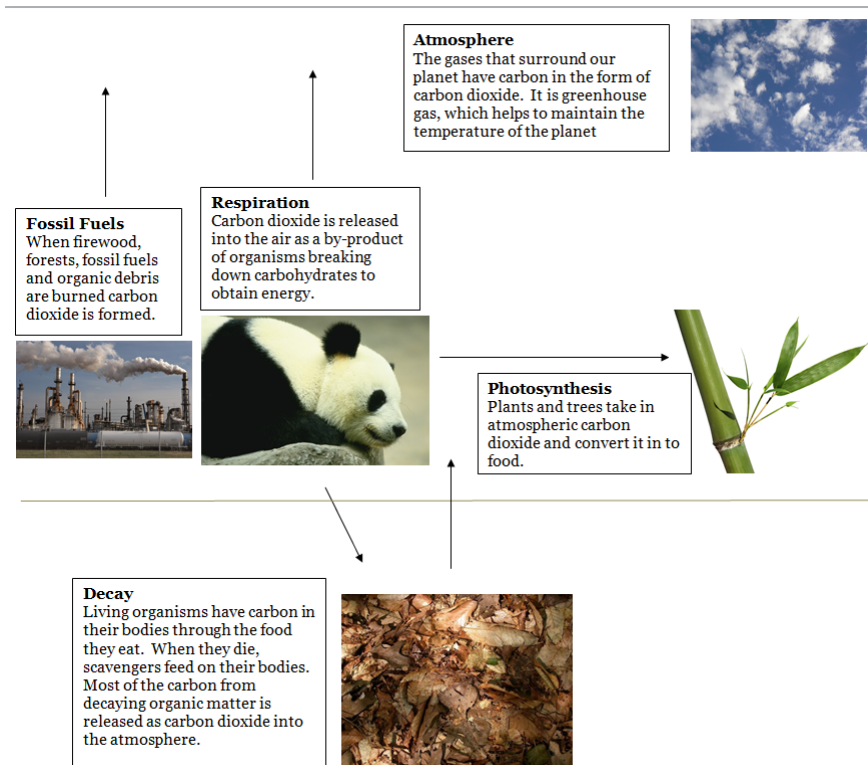
Part 1: Engage - How do trees benefit humans and the environment?

1. Share the slides from NASA displaying a series of before and after images of once forested areas (<http://www.mnn.com/earth-matters/wilderness-resources/photos/7-striking-examples-of-deforestation-from-nasa/deforestat-2>). Ask students to consider what is happening in each pair of images before explaining to students that the images show the same area before and after trees have been removed.
2. Share with students the *Reforestation: Impact on Climate overview video* (<http://vimeo.com/77792711>) and review the guiding questions.
3. Elicit from students a definition for **deforestation**. Deforestation is the permanent destruction forests to make way for other activities like agriculture, ranching, or housing.
4. Explain to students that deforestation drives climate change. Forests are the largest storehouse of carbon after the oceans. When forests are destroyed by activities such as logging and land conversion for agriculture, they release large quantities of carbon dioxide and other greenhouse gases into the atmosphere, which can increase temperatures.
5. Share the *Meet the Scientist: Yu Jie* (<http://vimeo.com/77788832>) video followed by the scientist video *Reforestation #1: Climate Change* (<https://vimeo.com/78371196>) answering the question, “How does deforestation contribute to global climate change?”
6. Provide students with the definition of **Carbon Cycle** (the movement of carbon between the living and nonliving environment through natural processes.). Distribute the **Carbon: Good or Bad?** handout for students to complete as you review this concept. Explain to students that Carbon makes up all organic matter, which is part of all living things. Carbon can be found in gaseous form, carbon dioxide, and in

	Photosynthesis Plants and trees take in atmospheric carbon dioxide and convert it in to food.
	Respiration Carbon dioxide is released into the air as a by-product of organisms breaking down carbohydrates to obtain energy.
	Decay Living organisms have carbon in their bodies through the food they eat. When they die, scavengers feed on their bodies. Most of the carbon from decaying organic matter is released as carbon dioxide into the atmosphere.
	Fossil Fuels When firewood, forests, fossil fuels and organic debris are burned carbon dioxide is formed.
	Atmosphere The gases that surround our planet have carbon in the form of carbon dioxide. It is greenhouse gas, which helps to maintain the temperature of the planet.

water in a dissolved form. Explain that students will investigate the carbon cycle and its relationship with trees.

- Distribute the **Carbon Cycle Cards** handout. These components are photosynthesis, respiration, decay, fossil fuels, and atmosphere. Ask students to cut and position the images to create a cycle, drawing arrows guided by the descriptions.



Above is an image of what students might produce with their card arrangement.

- Ask students to consider which components they identify as producing carbon dioxide gases and share with their 2:00 clock buddy. Information about clock buddies is included under additional resources, below.
- Ask students to pair up with their 7:00 clock buddy and evaluate their cycle to determine which of the components of the carbon cycle can reduce carbon dioxide levels.
- Summarize with students what deforestation is and the effects of deforestation on the carbon cycle by creating a T-chart. Allow students a couple minutes to brainstorm their responses.

Deforestation	Effects of Deforestation

Part 2: Explore - What threats do forests face?

1. Distribute roles for students to participate in a Socratic seminar. A Socratic seminar is a discussion among students in which they are given the opportunity to develop a deeper understanding of the focal point of the discussion through sharing of perspectives, questions, and interpretations. In this seminar, students will be exploring different perspectives on the pros and cons of deforestation.
 - a. Conservationists: Forests are home to many species of plants and animals.
 - b. Logger: My job is to cut down trees and without this job I cannot provide for my family.
 - c. Pharmacist: Many medicines come from our forests and many are yet to be discovered.
 - d. Farmer: I clear away land by burning a few acres of trees to grow crops for my family to eat.
 - e. Environmentalist: Forests help moderate climate change by taking in carbon dioxide during the day. Too much carbon dioxide leads to an increase in greenhouse gases, which causes changes in our climate.
 - f. Restaurant owner: I need paper and meat products to meet my customers' demands.
2. Explain to students that to prepare for their seminar, students will research more information about their role in small groups. Students can organize their research using a Placemat Strategy. The Placemat Strategy provides an opportunity for each student to record individual responses and ideas regarding an issue, topic or question for discussion as a group. The strategy can be used to brainstorm ideas, record researched information, or analyze documents. On one placemat, students should write down supporting evidence for their position for or against deforestation. On the other they should write down ways in which the actions associated with their role impact the carbon cycle. Distribute the **Roles and Impacts Placemats** handouts and either give students class time or assign the research as homework.

Placemat 1	
	What evidence do you have in support of your argument for or against deforestation?

Placemat 2	
	How does the evidence for your role impact the carbon cycle?

- Facilitate the seminar by allowing time for each group to explain their perspective and offer evidence in support of their view as well as how their role impacts the carbon cycle. To ensure that all students are participating, give each student one or two talking chips. These chips can be pieces of paper with their name, Popsicle sticks or game chips. When a student shares, they will place a chip in a central location (a cup or tabletop). You can also use a talking stick to facilitate one student speaking at a time. Students will use their placemats to refer to throughout the seminar.

Suggested guiding questions to keep conversations moving:

- Who has a different perspective?
 - Who has not yet had a chance to speak?
 - Where do you find evidence for that in your research?
 - Can you clarify what you mean by that?
 - How does that relate to what (someone else) said?
 - Has anyone changed his or her mind?
- Students can develop a pro/con chart to organize their thinking during the seminar. Have them draw a chart like the one below in their notebooks.

Reasons for/Pros of Deforestation	Problems with/Cons of Deforestation

- Provide students with an opportunity to self-reflect on their participation in the Socratic seminar and explain how the seminar influenced their thinking about the topic of deforestation and its impact on the carbon cycle. You might ask them the questions below or have them fill out a self-assessment chart like the example below.
 - Why is it important to hear both sides of an argument?
 - Do you think you have to completely agree with one side? Why or why not?

Self-Assessment

Taking a position on a question	5	4	3	2	1
Using evidence to support a position or presenting factual information	5	4	3	2	1
Drawing another person into the discussion	5	4	3	2	1
Asking a clarifying question or moving the discussion along	5	4	3	2	1

Part 3: Explain - What can people do to protect and promote trees in their community?

- Share the scientist video [Reforestation #2: Wildlife Conservation](http://vimeo.com/78369345) (<http://vimeo.com/78369345>) answering the question, “How is wildlife conservation closely related to forest conservation?”
- Explain that new conservation techniques are being introduced all over the world in an attempt to achieve a sustainable balance between nature and people. Examples:

- Connecting existing nature reserves to create buffer land that can be guarded to keep out poachers. This will provide refuge for many important species, including giant pandas, and help create new livelihood opportunities for local people.
 - Paying former poachers to patrol forests. Instead of hunting the endangered Yunnan Golden Monkey, they are paid to protect them.
 - Paying residents in Tengchong to look after acres of forest.
3. Distribute the **Balancing People and Nature** handout. Challenge students to explain how each conservation technique is helping balance the needs of nature and people and how each of these techniques impact the carbon cycle.
 4. Reforestation was one of the techniques students explored when investigating the relationship between wildlife conservation and forest conservation. Ask students to reflect on how that technique was used and the benefits and to add their ideas to the handout.
 5. Share the scientist video [Reforestation #3: Preservation and Restoration](http://vimeo.com/78369346) (<http://vimeo.com/78369346>), answering the question, “How are preservation and restoration efforts of forests established?” Ask students to pair up with their 3:00 clock buddy and discuss the main idea of the video: That the forests are valued both internationally for the large amount of carbon they store and locally for their ecological and economic value.
 6. Share the scientist video [Reforestation #4 Benefits](http://vimeo.com/78369342) (<http://vimeo.com/78369342>), which answers the question “What are the major benefits of this large-scale restoration project?” Ask students to compare their summaries with the information in the video.
 7. Share the scientist video [Reforestation #5: Local Community](http://vimeo.com/78369343) (<http://vimeo.com/78369343>), which answers the question “How does this project benefit the local community?” Provide students with the following data around the 277 Tengchong households that receive funding to protect forests:
 - The Sichuan Province is 187,000 square miles.
 - 277 households will be protecting 1.8 square miles.
 - There are 87,250,000 people living in this province.
 -
 8. Ask students to consider the following questions:
 - a. How many hectares of newly planted forests are being protected and how does that compare to the entire region?
 - b. What impact will this reforestation effort have on the carbon cycle?
 9. Explain to students that effectively displaying information and data is a critical part of communicating science. Infographics are used to help explain everything from the economy to ecology. Distribute copies of the **Infographic Project Guide** to each student. This includes a project timeline to help them organize their work.
 10. Ask students to create an infographic that helps the viewer understand the relationship between carbon dioxide, deforestation/reforestation, and global climate change. Information from the scientist videos and articles can be summarized to support their infographic. There are many free, online infographic generators including:

- <http://www.easel.ly/>
- <http://piktochart.com/>
- <https://infogr.am/>
- <https://venngage.com/>
- <https://www.canva.com/>

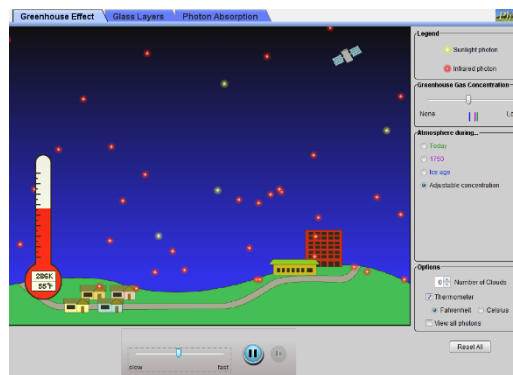
These types of graphics can also be created by many different software packages, such as PowerPoint or the free OpenOffice equivalent. Vector graphics programs exist that can make this process easier too, such as Inkscape (free) and Adobe Photoshop, InDesign, or Illustrator. For the especially computer savvy, flash animations could be created.

Examples of infographics:



11. Students should be encouraged to share their projects with others at various stages of project development, including planning, development, and after completion of the final product.
 - a. Planning: Ask students to sketch out their infographic and include statements about data and information they will include. Students will place their sketches on their desk with blank sticky notes. Direct students to rotate around the room to at least three other projects and write down a compliment and make a specific suggestion for improving the design on the provided sticky notes.

- b. **Development:** Ask students to pair up with a partner and share their designs in the development stage. As their partner is providing feedback, the students will record their recommendations. Specifically, ask students to evaluate how effectively the infographic is communicating the relationship between carbon dioxide, deforestation/reforestation, and global climate change.
- c. **Completion:** After students have developed their final infographic, ask students to display them on their desk next to a carousel feedback form. In teams of two ask students to carousel around the room and write down their feedback for eight of the projects. Feedback should include commenting on the effectiveness of communicating the information, the accuracy of information included, visual design, and any additional comments or considerations.
- d. **Reflection:** Guide students to reflect on their project by responding to the following questions:
 1. What is the most important thing you learned from this project?
 2. How did your project communicate the relationship between carbon dioxide, deforestation and global climate change? Use evidence from your peer feedback.
 3. What would you do differently if you did this project again? Include any projects you reviewed that may have inspired your changes.



Part 4: Extend

Option 1

Students can explore an interactive Greenhouse simulation from the PhET™ project at the University of Colorado (<http://phet.colorado.edu/en/simulation/greenhouse>). Through this simulation students will observe patterns to explain why greenhouse gases affect the temperature.

Option 2

1. Students can calculate their carbon footprint using a carbon footprint calculator. A few examples are below:
 - <http://www.nature.org/greenliving/carboncalculator/>
 - <http://calc.zerofootprint.net/>
 - <http://footprint.wwf.org.uk/>
2. Lead students outside to select a tree that is at least 5 feet tall and identify the species by using a dichotomous key or tree ID application. If there are several trees on your school grounds you may want to encourage students to select different species to compare.

3. Measure the circumference at chest height in cm. Chest height is the circumference of the tree at 4.5 feet from the base. Guide students to record their measurements.
4. Lead students back to the classroom and use the equation below to measure the biomass of their tree. Information about the species coefficient can be found at: <http://www.yale.edu/fes519b/saltonstall/biomass2.html#estimate>

Calculate the biomass of your tree in kg _____

Formula: $M = aD^b$

M= biomass

a= species coefficient a

D= diameter at breast height

b= species coefficient b

5. After calculating the biomass, students can determine the amount of carbon stored in their tree.

Is the species hardwood or softwood? _____

Calculate the amount of carbon in your tree in kg: _____

Hardwood trees: Multiply biomass (M) by 0.521

Softwood trees: Multiply biomass (M) by 0.498

Covert kg to tons to make it easier to compare your measurement and the carbon counter's measurement of greenhouse gases in the air: _____
(1 metric ton = 1000 kg)

6. Using their final amount of carbon stored in their tree students can compare their figure to how much carbon is emitted each day globally by viewing the carbon counter: <http://www.globalcarbonatlas.org/?q=en/emissions> (make sure to select Mt CO₂ as the unit on this map for metric tons of CO₂).
7. Ask students to consider the following questions;
 - a. How many trees/acres would they need to plant to offset their carbon emissions?
How about the whole class' carbon emissions?
 - b. Is this number of trees/amount of land needed to plant the trees practical?
Why or why not?

Part 5: Evaluate

Have students self-evaluate for:

- Their understanding of the carbon cycle demonstrated by accurately organizing provided components of the carbon cycle within a cycle.
- How well their Socratic seminar role was developed on their placemat graphic organizer, their participation during the seminar, and their reflection of the Socratic seminar.
- Their infographic and its effectiveness in communicating the intended message.

Specific questions:

1. Describe the role of trees in the carbon cycle.
2. Explain the relationship between carbon dioxide, deforestation/reforestation, and global climate change.
3. List two effects that human activity has on the carbon cycle.

Additional Resources and Further Reading:

- **Reforestation America's Forests** (The Nature Conservancy)
<https://www.nature.org/ourinitiatives/urgentissues/land-conservation/forests/restoring-americas-forests.xml>
- **Clock Buddies**
http://www.newtoncsd.org/Downloads/Clock_Buddies.pdf
This is a learning partner strategy. Students are given the graphic of a clock and at each slot two students will record each other's names. Whenever the teacher announces a time for students to process learning a partnership is identified and students meet with their partners.
- **Carousel Feedback Form**
<https://nbinstructionalresources.wikispaces.com/file/view/Carousel+Feedback+Form.doc>
This is a cooperative learning strategy. This form is included with a student project for their peers to capture their feedback on.
- To learn more about Socratic Seminars, check out the following resources:
 - National Paideia Center website: <http://www.paideia.org/>
 - NSTA article on Socratic Seminars by Jeanne Ting Chowning:
http://learningcenter.nsta.org/product_detail.aspx?id=10.2505/4/tst09_076_07_36
 - **Socratic Seminars: Patience and Practice** by the Teaching Channel
<https://www.teachingchannel.org/videos/bring-socratic-seminars-to-the-classroom>
 - Socratic Seminar in Science by Northwest Association for Biomedical Research (NWABR) <https://www.youtube.com/watch?v=9TckVI4e3Y0>
- **Poll Everywhere**
<http://www.polleverywhere.com/>
This tool is an audience response system that uses mobile phones, twitter, and the web.