Today I Learned About Planting Trees

Description:

Forests are and can be an important part of a lower-carbon future – but how does that work? Students experience the carbon cycle as a carbon atom, grounding their understanding of the flux of carbon between earth, air, water, and living things. Using data from Global Forest Watch, students investigate regional and global patterns of forest loss, gain, and carbon emissions to answer the questions: should we plant trees as a solution to climate change? Does location matter? How do we know?

Skills & Objectives

SWBAT

- Explain a simple carbon cycle
- Describe global patterns of forest loss and gain.
- Understand that deforestation causes carbon dioxide emissions, and that growing forests remove carbon dioxide from the atmosphere.

Skills

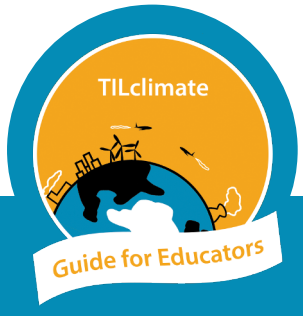
- Graphing
- Map reading
- Critical thinking

Students Should Already Know That

- Trees grow by using sunlight, carbon dioxide from the atmosphere, and water and nutrients from the soil.
- Releasing carbon dioxide, whether from burning fossil fuels or land disturbance, adds to a heat-trapping blanket around Earth. This trapped heat is causing dramatic changes to Earth's climate, including severe weather and other effects.

Standards Alignment:
HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
HS-ESS2-6 Develop a quantitative model to describe the cycling of carbon.
HS-LS2-5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon.
WHST.9-12.1 Write arguments focused on discipline-specific content
WHST.9-12.7 Conduct research project to answer a or solve a problem

Disciplinary Core Ideas:
ESS3.A Natural Resources
ESS3.C Human Impacts on Earth Systems
ESS3.D Global Climate Change
LS2.B Cycles of Matter and Energy Transfer in Ecosystems
LS2.C Ecosystem Dynamics, Functioning, and Resilience



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How To Use These Activities:

Pages with the circular "TILclimate Guide for Educators" logo and dark band across the top are intended for educators. Simpler pages without the dark band across the top are meant for students.

Each of the included activities is designed to be used as a standalone, in sequence, or integrated within other curriculum needs. A detailed table of contents, on the next page, explains what students will do in each activity.

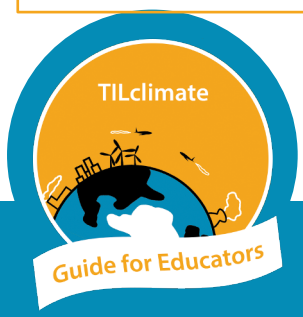
The investigation into forest data could lend itself to a longer assignment making an argument from evidence.

A Note About Printing/Materials

All student pages are designed to be printable in grayscale. The Station Signs do have color and only need to be printed once – they can be reused between classes. However, they can also be printed grayscale.

The worksheets do not leave space for students to answer questions. Students may answer these questions in whatever form is the norm for your classroom – a notebook, online form, or something else. This allows you, the teacher, to define what you consider a complete answer.

Podcasts in the Classroom: Throughout these Guides for Educators, we invite students to think about how they would share their learning with family and friends. One way to do this is to encourage your students to create their own podcasts - they're shareable, creative, and have multiple options for embedded assessment. We would love to hear any podcasts or see any other projects you or your students create! Email us at tilclimate@mit.edu, Tweet us @tilclimate, or tag us on Facebook @climateMIT.



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Detailed Table of Contents

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Trees and Carbon

This Educator Guide includes a game and a data visualization exploration. Educators may pick and choose among the pieces of the Guide, as suits their class needs.

Parts of this Guide may align with the following topics:

- Life/environmental science: Carbon cycle, cycles, deforestation, impacts on biodiversity
- History/social science: Country- or region-specific studies on forest management
- ELA/nonfiction: Argument from evidence
- ELA/fiction: Write the story of a carbon atom going through a system

MIT Resources

We recommend the following as resources for your own better understanding of climate change or as depth for student investigations. Specific sections are listed below:

- Climate Science, Risk & Solutions, an interactive introduction to the basics of climate change. https://climateprimer.mit.edu/
  - Chapter 02 The greenhouse effect and us
  - Chapter 05 How much of the CO_2 increase is natural?
  - Chapter 10 What can we do?
- MIT Climate Portal Explainers are one-page articles describing a variety of climate topics. https://climate.mit.edu/explainers
  - Soil-Based Carbon Sequestration
  - Coastal Ecosystems and Climate Change
  - Forests and Climate Change
  - Greenhouse Gases
  - Wildfires

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Wrap-Up Discussion Questions

- Where are humans changing the carbon cycle? How did the cycle look before industrialization and the burning of fossil fuels?
- What are some methods we could use to slow the addition of carbon dioxide to the atmosphere? To remove carbon dioxide that has accumulated in the atmosphere?
- What are the dominant drivers of forest loss around the world?
- Does it look like most forests are *sinks* (absorb more CO_2 than they emit) or *sources* (emit more CO_2 than they absorb)?
- What regions could absorb the most CO_2 if they were reforested?
- What other questions do you have? How could you use these tools to answer them?

Climate Solutions

Climate solutions can be thought of as falling into four categories outlined below. Across all categories, solutions at the community, state or federal level are generally more impactful than individual actions. For example, policies that increase the nuclear, solar and wind mix in the electric grid are generally more effective at reducing climate pollution than asking homeowners to install solar panels. For more on talking about climate change in the classroom, see "How to Use This Guide".

- **Energy Shift**
  How do decision-makers make the switch from carbon-producing energy to carbon-neutral and carbon-negative energy?
- **Energy Efficiency**
  What products and technologies exist to increase energy efficiency, especially in heating and cooling buildings?
- **Adaptation**
  How can cities and towns adapt to the impacts of climate change?
- **Talk About It**
  Talking about climate change with friends and family can feel overwhelming. What is one thing you have learned that you could share to start a conversation?

TILclimate Guide for Educators

What solutions are the most exciting in your classes? We would love to hear from you or your students! Images, video, or audio of student projects or questions are always welcome. Email us at tilclimate@mit.edu, Tweet us @tilclimate, or tag us on Facebook @climateMIT.

The Carbon Cycle Game

Educator Instructions

This game was originally adapted by Jennifer Ceven from "The Incredible Journey" from Project Wet and further adapted by Rachel Diersen.

In this game, students move through the carbon cycle as carbon atoms. Depending on where they begin and a roll of the dice, they may end up in any one of seven Earth systems. At the end of the game, the whole class graphs their movements and discusses how this model informs our understanding of carbon, fossil fuels, and climate change.

Setup

- Place the seven station signs around the room, with enough room for a group of students to stand near each station. If possible, attach the stations to the wall.
- At each station, leave one (or more) regular 6-sided dice. More dice will allow for students to move more quickly through the stations.
- Give each student one data sheet (two print per page) and a writing utensil.
- At the front of the room, have a large piece of graph chart paper or a quick charting program and projector.

Game Instructions

- Randomly and roughly evenly distribute students to the seven stations as their starting locations. They will write this first station on line 1 on their data sheet.
- Explain to students that they each roll one die. Each person is their own carbon atom – they do not move in groups.
- Depending on the result of the die roll, they may move or stay. If they move, write the name of the station they move to on the next line on their data sheet, and then roll again.
- If they stay, write the name of the station on the next line of their data sheet, and then roll again. For some stations, students may end up staying for multiple dice rolls. They should write the same name of the station each time.
- Once all students have ten station names written on their data sheet, have students return to their seats for graphing and a discussion.

Materials:
One half-sheet data sheet per student
One writing utensil per student
Seven printed station signs
At least one 6-sided die per station
Large graphing paper or graphing program and projector

The Carbon Cycle Game

Once students have written down all ten stations and returned to their seats, it is time for graphing and a discussion.

Graphing

- Using graphing chart paper or a quick charting program and a projector, you will make a bar chart of the frequency of visits to each station.
- Have students count the number of times they visited each station and report them to you (or a class scribe.) With stations as the x axis and number of visits as the y axis, graph the total number of visits to each station.
- If a student stayed at the same station for all ten dice rolls, they would report ten visits to that station.

Discussion

- What forms does carbon take in different parts of the carbon cycle?
- Where are humans changing the carbon cycle? How did the cycle look before industrialization and the burning of fossil fuels?
- Where did most of the carbon end up? Why?
- In the podcast episode, Prof. Harvey says that trees are very efficient at capturing carbon. However, he says that measuring the exact amount of carbon being captured vs being released (carbon flux) is difficult. Why do you think it might be difficult to measure carbon flux?
- Carbon dioxide in the atmosphere acts like a blanket, trapping heat. A regular amount of carbon dioxide is needed to support life on Earth – without it, Earth would be too cold. But today we have rampant carbon dioxide and the Earth is warming more quickly than it ever has before. What are some methods we could use to slow the addition of carbon dioxide to the atmosphere? To remove carbon dioxide that is already in the atmosphere?

Data

Carbon flux, the measurement of carbon into and out of various Earth systems, is a complex and ever-changing science. It cannot be accurately represented by the roll of a six-sided die, but the movements in this activity approximate the measurements reported in the Intergovernmental Panel on Climate Change, AR5, Chapter 6. https://www.ipcc.ch/report/ar5/wg1/carbon-and-other-biogeochemical-cycles/