NATIONAL GEOGRAPHIC

RESOURCE LIBRARY I ACTIVITY : 1 HR 15 MINS

Local Emissions

Students view carbon dioxide emissions data for their local area. Next, they evaluate specific claims about their state's emissions by choosing relevant information, organizing it in a chart, and calculating summary statistics across multiple years. Finally, students write an evidence-based statement in support or denial of the specific claim, and self- and peer-assess their work in this lesson.

GRADES

6, 7, 8

SUBJECTS

Conservation, Earth Science, Climatology

CONTENTS

1 Link, 2 PDFs

OVERVIEW

Students view carbon dioxide emissions data for their local area. Next, they evaluate specific claims about their state's emissions by choosing relevant information, organizing it in a chart, and calculating summary statistics across multiple years. Finally, students write an evidence-based statement in support or denial of the specific claim, and self- and peer-assess their work in this lesson.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/local-emissions/

In collaboration with

educurious
learning that connects

DIRECTIONS

This activity is part of the Climate Change Challenge unit.

1. Model data analysis and response to an argument with evidence-based statements for students.

- Explain to students that today they will be working with a different dataset: one that shows how carbon dioxide emissions (carbon dioxide released into the atmosphere) have changed in each of the United States over time. Connect to knowledge from the *Global Trends* activity by asking students:
    - *Do you predict that our state's carbon dioxide emissions are going up or down over time?* (Student answers may vary, but should reference their understanding of global changes in carbon dioxide seen using the Keeling Curve and associated data).
- Project the EPA's *State CO2 Emissions from Fossil Fuel Combustion, 1990-2017* (XLSX version) from the EPA in a spreadsheet program. Find your state.Orient students to the form of the data by asking the following questions:
    - *What types of data are available here?* (Carbon emissions from commercial (businesses), industrial (manufacturing), residential (homes), transportation (vehicles), and electric power (electricity) sources. If time allows, students can look up the meaning of these terms and work through local examples; for example, the emissions from a pizza restaurant near the school would count as commercial.)
    - *What years is this information for?* (This data is available for every year from 1990 to 2017.)
    - *What are the units for these numbers?* (The units are million metric tons of carbon dioxide. That means a seemingly small number like 2.43 (Alabama's commercial emissions in 1990) actually means 2.43 x 1,000,000 x 2,204 lbs. = 5,355,720,000 lbs. or over 5 billion pounds of carbon dioxide. This is as much as 50 million students who each weigh 100 pounds!)
- Encourage students topractice asking questions about carbon dioxide emissions using data. Record suggestions for questions and corresponding data in a visible location:
    - *What are some questions about our state's emissions we could answer using this dataset?* (Students will likely bring up questions about the relative importance of different emissions types or changes in emissions over time.)

- *What data would we need to address each of these questions?* (Help students move from suggesting single data points to choosing groups of data that could be summarized with mean, median, and/or range to address the question).

- To help prepare students for the coming assessment, model responding to an argument about their state's carbon dioxide emissions with evidence from data.

    - Introduce a hypothetical argument made against your state, writing it in a visible location:
    - *Electricity use in your state is accelerating global warming: electric power carbon dioxide emissions went up from 1990–1994 to 2010–2014.*
    - Choose the data necessary to address this argument. Organize it in a visible location, using a chart that mirrors Part B of the *Local Emissions Analysis* handout (to be distributed to students in the next step).
    - Prompt students to help you calculate mean, median, and range for these data, entering the values in your chart.
    - Elicit help from students to create and record an evidence-based response to the argument in a visible place, such as:
    - *Electricity use in our state is accelerating global warming. The mean and median carbon dioxide emissions were lower from 1990 to 1994 than they were from 2010 to 2014, and the ranges for both periods were small compared to the differences between them.* (Note that all states do not show the same trends; some have shown progress in reducing carbon dioxide emissions in this comparison.)

2. Prompt students to ask questions and analyze arguments regarding local carbon dioxide emissions independently.

- Distribute a copy of the *State CO2 Emissions from Fossil Fuel Combustion, 1990–2017* data for your state and 2–3 neighboring states (see Teacher Tips below) and a copy of the *Local Emissions Analysis* handout to each student in class.
- Explain that their data analysis will be formally assessed and become part of their digital project portfolios and possibly chosen for incorporation to the Climate Challenge final product.
- Assign each student to choose one neighboring state they'd like to compare with their own for Part A of the *Local Emissions Analysis*, and to record this on their handout.
- Assign each student one of the three arguments listed in Part A of the *Local Emissions Analysis*, or allow students to choose an argument to address for themselves.Prompt

students to complete Part B of the *Local Emissions Analysis* handout. They will:

  - Choose data from the *State CO2 Emissions from Fossil Fuel Combustion, 1990–2017* that is relevant to the argument.
  - Add the data to the chart, labeling each column.
  - Calculate summary statistics from the data.

- After students have collected and analyzed data in Part B of the *Local Emissions Analysis*, direct them to complete Part C using the evidence-based statement developed in Step 1 above, as well as their evidence-based claim from the *Global Trends Calculation Tracker* as examples.Now that students are well-oriented to the data, have them complete Part D of the *Local Emissions Analysis*. Here, they must consider what additional questions they could address with this dataset and what data, in particular, would allow them to do so.

3. Facilitate self- and peer-assessments of carbon dioxide emissions analyses.

- Distribute two copies of the *Local Emissions Analysis Rubric* to each student.
- Assign students to complete one of the rubrics by examining their own work, and give time for students to revise their responses and analysis, if necessary.
- Assign students to use a second rubric to assess another student's work, preferably a peer who addressed a different argument. Give time for students to share their assessments with their partners, and to revise their responses and analysis if necessary.
- Collect the *Local Emissions Analysis* handout from all students for assessment.
- Return to the class *Know and Need to Know* chart. Add any new insights or questions associated with local carbon emissions and their connections to global trends, sinks and sources, global warming, or climate change.

Tip

Step 1: It may be helpful to prepare a copy of carbon dioxide emissions data from your state and a few neighboring states to share with students ahead of time. Use the EPA's *State CO2 Emissions from Fossil Fuel Combustion, 1990–2017*. The units in this chart are in Million Metric Tons of CO_2 ($MMTCO_2$). For a given number on the chart, multiply by 1,000,000 and then by 2,204 lbs./metric ton to get the number of pounds of carbon dioxide gas released by this sector in a year.

Rubric

Use the *Local Emissions Analysis Rubric* to formally assess students' progress towards NGSS PE *MS-ESS3-5*: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Extending the Learning

Step 2: If students are already familiar with selecting, charting, and analyzing data digitally, have them perform the calculations for their assessment products in a spreadsheet program. In this case, you may also wish to have them create simple digital bar graphs of the means. If students have less familiarity with digital technology, you may wish to wait until these skills are scaffolded in future lessons within the unit.

OBJECTIVES

Subjects & Disciplines

- Conservation

  Earth Science
  - Climatology

Learning Objectives

Students will:

- Select and chart relevant carbon dioxide emissions data to address a claim about global warming.
- Independently calculate summary statistics from carbon dioxide emissions data.
- Begin to connect particular human activities with carbon dioxide emissions and global warming.

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning

- Modeling
- Reflection

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
  - Life and Career Skills
    - Initiative and Self-Direction
    - Productivity and Accountability
    - Social and Cross-Cultural Skills
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Evaluating
- Science and Engineering Practices
  - Analyzing and interpreting data
  - Engaging in argument from evidence
  - Using mathematics and computational thinking

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

- **CCSS.ELA-LITERACY.WHST.6-8.1.B:**

Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 1:**
Patterns
• **MS. Earth and Human Activity:**
MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
• **Science and Engineering Practice 4:**
Analyzing and interpreting data
• **Science and Engineering Practice 5:**
Using mathematics and computational thinking
• **Science and Engineering Practice 7:**
Engaging in argument from evidence

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Copies of handout[s]

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Monitor/screen, Printer, Projector, Speakers

PHYSICAL SPACE

- Classroom

GROUPING

- Large-group instruction
- Large-group learning
- Small-group learning

- Small-group work

BACKGROUND & VOCABULARY

Background Information

In the United States and across the world, a variety of different sectors contribute to carbon emissions. Burning fossil fuels for electricity, heat, and transportation are some of the biggest carbon sources, with manufacturing and agriculture playing a smaller role. Although many of these sectors are increasing efficiency, demand for energy around the world is growing quickly, often outpacing these gains.

Mean, median, and range are numbers used to summarize information about groups of observations; for this reason, they are called 'descriptive statistics.' To calculate the mean, divide the sum of all observations in a list by the number of observations. To find the median, choose the middle observation in an ordered list, or average the two middle observations if there are an even number of observations. To calculate the range, subtract the smallest observation in a list from the largest. These three descriptive statistics are useful for working with large amounts of data, in particular, to describe and compare the average observation or the spread of observations in two groups.

Prior Knowledge

[]

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
carbon dioxide	*noun*	greenhouse gas produced by animals during respiration and used by plants during photosynthesis. Carbon dioxide is also the byproduct of burning fossil fuels.

Term	Part of Speech	Definition
carbon emission	*noun*	carbon compound (such as carbon dioxide) released into the atmosphere, often through human activity such as the burning of fossil fuels such as coal or gas.
carbon sink	*noun*	area or ecosystem that absorbs more carbon dioxide than it releases.
carbon source	*noun*	process, area, or ecosystem that releases more carbon dioxide than it absorbs.
climate change	*noun*	gradual changes in all the interconnected weather elements on our planet.
global warming	*noun*	increase in the average temperature of the Earth's air and oceans.

For Further Exploration

Instructional Content

- National Geographic: Resource Library: Collection: Climate
- National Geographic: Resource Library: Collection: Climate Change