

Title: Global Climate Change: Exploring the Impacts of Overpopulation

Study Guide Theme: Climate Change

Featured Photos:



Blue Sky Sign



Dry Lake



Fire



Water Well

Overview: Students will explore the “greenhouse effect” and describe causes of global climate change. Groups of students will analyze and interpret evidence for climate change by graphing population demographics, carbon dioxide emission concentrations, temperature anomaly, and sea level data. Students will then use the *OVERBook* photographs to discuss the impacts of climate change on humans and the earth. Finally, students will calculate their ecological footprint and reflect on the relationship they have with the changing climate.

Subject(s): 9th-12th grade science/ Earth and Environmental Science/ Biology/ Physical Science/ Global Studies

Corresponding National Standards:

Next Generation Science Standards	
http://www.nextgenscience.org/search-standards?keys=&tid%5B%5D=107&tid_3%5B%5D=94	
HS-LS2-7.	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-ESS2-2.	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
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-ESS3-1.	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
HS-ESS3-4.	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ESS3-5.	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.
HS-ESS3-6.	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Corresponding Global Competency Skills: List which global competency skills are addressed in the study guide (<https://asiasociety.org/education/what-global-competence>)

- **Investigate the World-** Globally competent students are aware, curious, and interested in learning about the world and how it works.
- **Recognize Perspectives-** Globally competent students recognize that they have a particular perspective, and that others may or may not share it.
- **Communicate Ideas-** Globally competent students can effectively communicate, verbally and non-verbally, with diverse audiences.
- **Take Action-** Globally competent students have the skills and knowledge to not just learn about the world, but also to make a difference in the world.

Essential Question(s):

- What is the basic structure and function of the Earth’s atmosphere and how does its composition influence global climate change?
- How can we evaluate and analyze data to describe the relationships between humans and climate change?
- How has climate change impacted humans around the globe, and how can we remediate the impacts of climate change?

Materials:

Suggested materials include computer(s) for each student/group, Microsoft Excel, projector, printed copies of OVERBook images, and printed copies of handouts.

Materials for Teacher Demonstration: two gallon Ziploc bags, two small cups (Dixie cups) filled halfway with water, three thermometers (high temperature range needed), three Alka-Seltzer tablets, and a Halogen lamp.

Theme	Climate Change	
Time	Two consecutive 1-hour class periods	
Scope and Sequence	Student Prior Knowledge: Students may have a general working knowledge of Earth’s systems and the structure and function of the atmosphere. Students have experience graphing data and have performed data analysis.	
	Lesson Sequence	Time
	Day 1: <ul style="list-style-type: none"> • Greenhouse Effect Demo Setup • What’s is Climate Change? Introduction with guided notes • Evidence for Climate Change <ul style="list-style-type: none"> ○ Explore Climate Time Machine ○ Data Deep Dive: Graphing Climate Data • Greenhouse Effect Demo Discussion • HW: Finish Graphing Climate Data Analysis Day 2: <ul style="list-style-type: none"> • Discuss Climate Data Graphs and Analysis • Impacts of Climate Change: Photograph Analysis • Taking Action Against Climate Change <ul style="list-style-type: none"> ○ Reflection: Ecological Foot Print ○ Action: PSA Flyers • HW: Finish PSA Flyer 	Day 1: 10 minutes 10 minutes 30 minutes 10 minutes Day 2: 10 minutes 30 minutes 20 minutes
Resources	<ul style="list-style-type: none"> • Climate Data_ OVERBook Excel File • Climate Change_ OVERBook PowerPoint Presentation • Printed copies of the OVERBook Photographs (full page, color print) • Climate Time Machine Website <ul style="list-style-type: none"> ○ https://climate.nasa.gov/interactives/climate-time-machine • Ecological Footprint Calculator <ul style="list-style-type: none"> ○ https://www.footprintcalculator.org/ 	
Learning Outcomes	<ul style="list-style-type: none"> • Students will describe the general composition and function of the atmosphere and relate it to how the Greenhouse Effect impacts temperatures. • Students will use key climate indicators (CO₂ emission, sea level, temperature anomalies, etc.) to model historical data and make predictions about future climate patterns. • Students will be able to describe the impacts that humans have on the Earth’s climate and discuss the impacts global climate change is having on populations and environments around the world. • Students will calculate their ecological footprint and begin the process of taking action in their community to reduce the effects of climate change. 	

Greenhouse Effect Demonstration

Teacher's Guide

Materials:

- 2 1-gallon Ziploc bags
- 2 small cups (Dixie cups) filled halfway with water
- 3 thermometers (high temperature range needed)
- 3 Alka-Seltzer tablets
- Halogen lamp



Procedure:

1. The following demonstration is designed to simulate the greenhouse effect and show temperature changes under three different atmospheric scenarios: normal atmosphere, elevated greenhouse gases, and no atmosphere.
2. This demo works best when placed directly under a heat lamp or halogen lamp.
3. Place three thermometers on a table about five inches apart from each other (lamp off).
4. After about five minutes, record the temperature of each thermometer.
5. Place a cup with water in it into one of the Ziploc bags (do not spill the water into the bag). Place the thermometer in the bag next to the cup. Drop three Alka-Seltzer tablets into the water. As soon as the Alka-Seltzer has been added, seal the bag. (*This bag represents the Greenhouse Effect.*)
6. Place one cup with water into the second Ziploc bag and place the thermometer in the bag next to the cup. Seal the bag. (*This bag represents the Normal Atmosphere.*)
7. The third thermometer will remain uncovered. (*This bag represents No Atmosphere.*)



Greenhouse Effect
(bag with Alka-Seltzer in water)

Normal Atmosphere
(bag with water only)

No Atmosphere
(no covering)

8. Have students predict which setup will warm up the fastest and slowest. Why?
9. Allow the bags to sit for approximately 45 minutes directly under the heat lamp (while you continue the lesson).
10. When enough time has passed for students to see a temperature change, ask the students to compare the three scenarios. Consider the following questions in a class discussion:
 - a. Which was the warmest? Which was the coldest? What was the temperature like for the thermometer that had no atmosphere? Which environment would be the best to live in?

Example results after 45 minutes:

Greenhouse Effect (Alka-Seltzer): 64° C



Normal Atmosphere: 44° C



No Atmosphere: 56° C

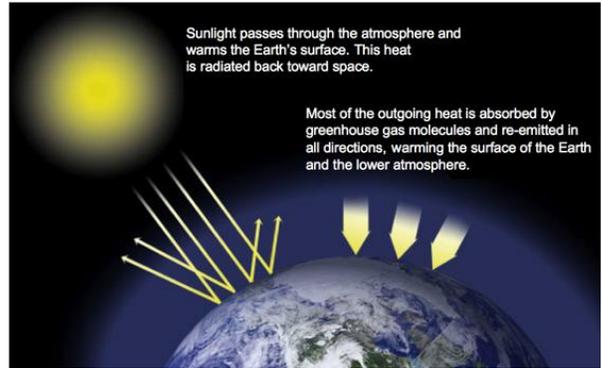


Exploring Earth's Atmosphere and Global Climate Change

Student Handout

Greenhouse Effect Demonstration

Temperature (°C)	Greenhouse Effect	Normal Atmosphere	No Atmosphere
Initial			
Prediction			
Final			



A layer of greenhouse gases – primarily water vapor, and including much smaller amounts of carbon dioxide, methane and nitrous oxide – acts as a thermal blanket for the Earth, absorbing heat and warming the surface to a life-supporting average of 59 degrees Fahrenheit (15 degrees Celsius).

Understanding the Atmosphere and Climate Change

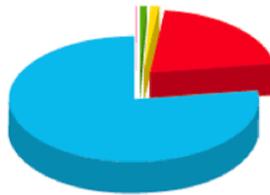
• Earth's atmosphere is defined as:

• Without the protective atmosphere, Earth's temperature would dramatically _____.

• Composition of the Atmosphere:

Nitrogen		%
Oxygen		%
Argon		%
Carbon dioxide		%
Trace gases		%

Atmospheric composition



Water vapor. The most abundant greenhouse gas, but importantly, it acts as a feedback to the climate. Water vapor increases as the Earth's atmosphere warms, but so does the possibility of clouds and precipitation, making these some of the most important feedback mechanisms to the greenhouse effect.

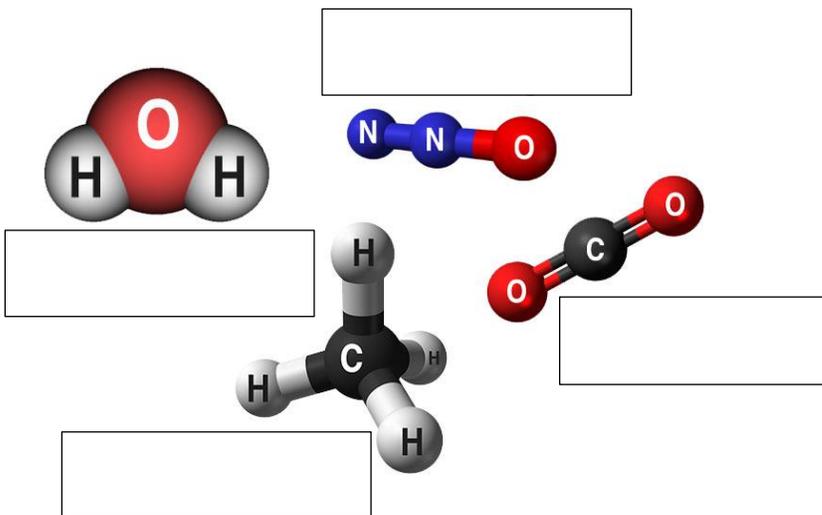
Carbon dioxide (CO₂). A minor but very important component of the atmosphere, carbon dioxide is released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels. Humans have increased atmospheric CO₂ concentration by more than a third since the Industrial Revolution began. This is the most important long-lived "forcing" of climate change.

Methane. A hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes in landfills, agriculture, and especially rice cultivation, as well as ruminant digestion and manure management associated with domestic livestock. On a molecule-for-molecule basis, methane is a far more active greenhouse gas than carbon dioxide, but also one which is much less abundant in the atmosphere.

Nitrous oxide. A powerful greenhouse gas produced by soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Chlorofluorocarbons (CFCs). Synthetic compounds entirely of industrial origin used in a number of applications, but now largely regulated in production and release to the atmosphere by international agreement for their ability to contribute to destruction of the ozone layer. They are also greenhouse gases.

• Gases that contribute to the "Greenhouse Effect:"



- Main causes of increased amounts of greenhouse gases in the atmosphere:

Evidence for Climate Change

Data Activity: Examining the Vital Signs Travel through Earth's recent climate history with the "[Climate Time Machine](#)" interactive tool. Carefully examine the changes over time in sea ice, sea level, carbon emissions, and average global temperature.

Reflect on the key changes in the four variables shown in the interactive by thinking about the following questions:



- Where dates are indicated, when did the key changes occur for each variable?
- Can you hypothesize as to why these key changes occurred when they did?
- How does this information compare with what you have heard in the media?
- Is any of this data surprising or new to you?
- Hypothesize the relationship between each of the following variables:

Variables	Hypothesis
Time and Population Size	
Time and CO ₂ Emissions	
Time and Global Temperature Anomalies	
Time and Sea Level	

Data Deep Dive

**See attached Excel File

- Each group should examine the data in the attached Excel File. Each tab (at the bottom) represents data for:
 - Human Population
 - CO₂ Emissions
 - Temperature Anomalies
 - Sea Level
- Select ONE data set to graph: _____
 - Independent variable (x-axis): _____
 - Dependent variable (y-axis): _____
- Create a graph in Excel for the data you selected. (**Remember to include all important components of a graph including a title, axes labels, and units*)
- Print your graph and be prepared to share with your class.

Impacts of Climate Change

- THINK: Observe and analyze the image given to you by your instructor. Reflect on the prompts below individually.
- PAIR: Share your reactions/ responses within your small group.
- SHARE: Groups should write their reactions/ responses on a large poster or dry-erase board to share with the rest of the students during a whole class discussion.

Discussion Prompts:

- Describe the event in the photograph.
- When do you think this photo was taken?
- Where do you think this photo was taken?
- Describe the same scene one year in the past, then one year into the future.
- What is outside of the photograph?
- Choose one person in the photo, tell their story.

Taking Action Against Global Climate Change

Reflection

- Define Ecological Footprint:
- Calculate your Ecological Footprint with the online calculator:
(For each question, select “Add details to improve accuracy”)
<https://www.footprintcalculator.org/>
- If everyone on our planet had a similar lifestyle as you, how many Earth’s would we need to survive?
- What role do you play in contributing to the increase of greenhouse gas emissions and global climate change?
- What changes could you make to your daily lifestyle and habits to reduce your Ecological Footprint?



Taking Action

Connecting to your Community:

- Climate Stories NC <https://climatestoriesnc.org/documentaries/>
 - Select a video from the “Climate Stories” series to share with students
 - Discuss in your groups that impacts of climate change in our own neighborhoods
- Students as Photographers (Example: [Robert Adams, Art 21 Season 4, Ecology](#))
- Students photograph examples of how the landscape/environment has been impacted by human beings in their own communities.

Climate Change Evidence:

- Students compile evidence and data to inform their community about the existence and impacts of climate change.
- Facts can come from class notes and discussions, along with details from their research about their community.

PSA Announcement Flyers:

- Have students create PSA (Public Service Announcement) Flyers to post around their community. (see example)
- Empower students to inform and empower their peers to take action against climate change.

PSA: Impacts of Global Climate Change

EXAMPLE



Interstate-95 in South Carolina after Hurricane Florence

The United States has witnessed increasing numbers of intense rainfall and extreme weather events in the last century.

SOURCE: USGCRP, 2017: *Climate Science Special Report: Fourth National Climate Assessment, Volume I* [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp, doi: [10.7930/J0J964J6](https://doi.org/10.7930/J0J964J6)

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For more information about the program, please visit <http://worldview.unc.edu/>

Impacts of Climate Change

Teacher Guide

- Divide the class into four (4) groups.
- Provide each group with one image (for most impact, print as a full page image in color) and a discussion prompt sheet.
- Allow the students to discuss the image and answer the prompting questions within their group.
- Groups should write their reactions/ responses on a large poster or dry-erase board to share with the rest of the students during a whole class discussion.



Group Discussion Prompts:

- Describe the event in the photograph.
- When do you think this photo was taken?
- Where do you think this photo was taken?
- Describe the same scene one year in the past, then one year into the future.
- What is outside of the photograph?
- Choose one person in the photo, tell their story.

Climate Change

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