Climate Change in Your Own Backyard

Lesson Set 4 of 5

NCSE National Center for Science Education

Teacher Prep

Age Levels: 9th-12th grade

Time Commitment: 6 days
(if all activities completed)

Key Vocabulary/Concepts:
extreme weather, watch, warning, bushfire, wildfire, hurricane, tornado, heat wave, heat island, probability, ratio, global, national, regional, modeling, metropolitan, rural

Materials:

- Internet access
- Post-It Notes (in-person) or Google Jamboard (remote)
- 3" x 5" Notecards (in-person) or Google Jamboard (remote)
- Dice (2 per student)
- Double-six loaded dice (2 per student)
- For each group of 4 students:
  - Flex Seal Liquid
  - 2 ice cube trays to form the urban grid
  - Asphalt cubes to build streets (or other material to model black asphalt, such as black gravel)
  - Kinetic Sand
  - Turkey baster for making lakes and ponds
  - 3 types of buildings
    - Wood: 1-3 stories (10 wood bldgs total)
    - Glass: 1-4 stories (8 glass bldgs total)
    - Steel: 1-3 stories (4 or 5 steel bldgs total)

Continued on next page.

Introduction

This lesson set explores extreme weather events, and the effect climate change is having on their frequency and intensity. Climate change affects the conditions that lead to extreme weather events. For example, warmer ocean temperatures produce the energy that fuels more intense hurricanes. Students begin by analyzing the global impacts of extreme weather events and then focus on national, regional, and community impacts in order to assess the relationship between climate change and extreme weather as well as potential solutions that can mitigate the impact of extreme weather events.

Teacher Goals

1) Provide structured opportunities for students to ask questions that drive the learning process.
2) Guide students through analysis of global, national, regional, and local climate models in order to understand the consequences of climate change.
3) Use questioning strategies rather than providing easy answers.

   Note: This is especially important when working with students who are resistant to the scientific consensus on climate change.

Student Learning Goals

1) Generate questions in order to clarify the relationship between tree rings, ice cores, and other proxies for historical carbon emissions and global temperature.

Climate Change Lesson Set Series

https://ncse.ngo/supporting-teachers/classroom-resources

CLIMATE CHANGE

Lesson Set 1: Scientific Consensus—A Tsunami of Evidence
Lesson Set 2: Understanding Climate Modeling
Lesson Set 3: Back to the Future—Climate Edition
Lesson Set 4: Climate Change in Your Own Backyard
Lesson Set 5: Climate Super Solutions

Teacher Prep (continued)

- Urban adventure cards
- Infrared thermometer
- 1 liter of water (inside a sturdy container that will not topple)
- Leafy twigs to represent plants
- Heat source – Options include:
  - Hairdryer – Best for the under-eight crowd
  - Space heater – May use too much power if working in an outdoor/ communal space
  - Heat lamp – Probably the best for heating, but can easily cause burns
- Play money

Apps and Software:

- Google Jamboard or Google Drawings
- Google Earth

Student Learning Goals (continued)

2) Obtain and communicate information in order to explain how natural processes affect climate.
3) 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.

Background

Teacher Knowledge

Nature of Science

It's recommended that students work through the NCSE Nature of Science lesson sets before this unit. However, if this is not possible, be sure to introduce students to FLICC, a framework for understanding science denial, prior to presenting this lesson set. Part E: The Characteristics of Science Denial in Nature of Science Lesson Set 1: Science is a Way of Knowing is especially valuable. It takes students through several examples of FLICC in action while dismantling common misconceptions about the COVID-19 pandemic. Learn more about FLICC.

Scientific Concepts:

This lesson set focuses on the study of extreme weather events and the impact climate change has on the frequency and intensity of these events. To that end, teachers will need to understand basic probability math. Understanding trends of extreme weather can help us to prevent and mitigate the impacts these events have on humans and to forecast and prepare for future extreme weather events. If a refresher on climate change's impact on extreme weather is necessary, consider checking out the Paleontological Research Institute's Teacher-Friendly Guide to Climate Change or Jeffrey Bennett's online Global Warming Primer before introducing this curriculum to your students.

Discussion Points

- How do we define extreme weather?
- What global consequences do local weather events have?
- How does climate change affect the likelihood or severity of an extreme weather event?
- How do we measure climate change impact?
- What impacts will climate change have on the different regions of the United States?
- What can humans do to mitigate and adapt to the consequences of climate change's impact on extreme weather?
- What inequalities exist in the effects of extreme weather events and the response to them?

Prerequisite Student Knowledge

Before starting the activities below, provide students with an opportunity to write an extreme weather autobiography. Ask students to pick a weather event that they experienced firsthand or witnessed via social media or other sources. Consider reviewing climate factors and climate change causes. Also, ensuring that students have an understanding of the role of energy in weather is recommended.

Core Misconceptions

✗ **MISCONCEPTION:** ***Extreme weather always happens, so global warming can't be making extreme weather worse.***

✓ **FACT: Risk from extreme weather is increasing, although increases in the frequency and intensity of some forms of severe weather can be more confidently linked to global warming than others.**

✗ **MISCONCEPTION:** ***While global average temperature records show a significant increase over the last century, rural areas are relatively unaffected. The global warming trend is due to the increase of urban areas and the heat islands they create.***

✓ **FACT: While urban areas are undoubtedly warmer than surrounding rural areas, this has had little to no impact on global warming trends, which are the same in both urban and rural regions.**

Teacher Instructions

Anchoring Phenomenon

Anchor: Rolling the Dice on Disaster

- Project the video "Global Transport of Smoke from Australian Bushfires" (2:13) and ask students to complete a "See, Think, Wonder." Elicit from students that there is no key, so it is difficult to know what each of the colors represents. It may be beneficial to point out the hurricanes off the coast of Africa or ask students what desert is part of northern Africa in order to determine what the blue and orange signify. After some time, project the key and ask students to identify what the likely source of each color on the map is in each area.
  - Provide students with an opportunity to make a list of extreme weather events and come up with a classroom definition of the phrase "extreme weather." Ask them to identify any extreme weather events from recent memory.

  Show the video "New Normal? Climate Change and the Australian Bushfires." Stop the video at 1:42. As students are watching, ask them to identify:
    - something that surprises them
    - something that worries them
    - something that connects to their own perspective or experience
  - Ask students to share their connections, then ask the following (if they were not addressed by students):
    - Is climate change causing these extreme events?
    - Is everywhere globally affected by climate change?
    - Does everywhere experience the same impact of climate change?
    - The narrator mentioned wildfires in California and Australia; where else have we seen wildfires in recent years?
  - Highlight for students that the narrator said, "Climate change does not cause wildfires, but it does make them more intense and more likely to occur." Tell students that this is what they are going to be exploring today:
    - How does climate change affect the probability of extreme weather events?
  - Hand out the student worksheet *Extreme Weather - Are We Rolling the Dice?* and an equal number of loaded and non-loaded dice. Ask students to roll their dice and identify what number they rolled. Then tally the class. Ask students to calculate the probability of rolling a six with their own die, then to find someone with a different probability and explain why it is different.
  - As a class, work through the three scenarios. Tally the total number of each sum and create a class histogram for each scenario. Ask students to work individually, in pairs, or in small groups for the analysis questions.

Anchoring Phenomenon (continued)

Driving Question Board: Climate Change in Your Backyard

- Once students have worked through the Are We Rolling the Dice? Activity, direct them to open the Google Jamboard Driving Questions Board for this unit.
- *Note: The sample Driving Question Board (DQB) can be found in the Teacher Resource Folder above. Please make a copy of the DQB template provided before beginning the activity.*
- If you're working in-person or without access to digital media, then create a physical version of the Driving Questions Board that can be displayed prominently in the classroom. Provide students with sticky notes so they can add their questions to the board.
- Ask students to write down any questions they have about extreme weather and how climate change influences these events.
- After class, organize the questions students have based on themes. Not all questions will be answered, but this is an important step towards creating an inclusive classroom.
- **Important:** At the end of each part, project the Driving Questions Board and identify any of the questions students asked that have been answered by this activity. Ask students to identify any questions that have been answered over the course of the lesson set and identify any new questions that arise.

Storyline Activities

Part A: Mapping the Cost of Extreme Weather

- Provide students with blank copies of a map of the United States. Make sure the map includes the names of the states. Create a class definition for the word "region." Ask students to identify one factor, for example geography or culture, and break the United States into regions by this factor. Provide time for students to do a gallery walk in order to compare and contrast the regions.
- Project NOAA's regions of the United States. Allow students time to complete an "I see, I wonder" activity, then ask them to predict what the NOAA's regions are based on. Students may notice and ask:
  - NOAA's regions do not aim to keep states whole.
  - Why are some of the states split in half?
  - NOAA's regions have a basis in what body of water is closest.
  - What is the importance of the bodies of water?
  - NOAA's regions include the US territories.
  - Should Guam be grouped with Hawaii, considering the distance between them?
- Pass out *The Cost of Extreme Weather Events* worksheet found in the teacher resource folder. Model for students how to complete a notice/wonder for each map. Ask students either to focus on the maps as a whole or to break into small groups to focus on one type of extreme weather and share their group's findings.

Storyline Activities (continued)

Part A: Mapping the Cost of Extreme Weather (continued)

- **Anchor to Activity – Tying it All Together:** To wrap up this activity, bring students back to the anchor. Briefly mention that not only is the frequency of extreme weather events increasing, but so is their intensity and therefore destructiveness. Use these questions to help guide students:
  - Is climate change causing these extreme weather events?
    No. Climate change is indirectly causing these events. Climate change is creating more favorable conditions for extreme weather events to take place. This increases the likelihood and severity of these weather events.
  - This lesson measures the extreme weather using dollars. Why might we choose to use another metric and what metric could we use?
    Students may point out that items are more expensive today than they were in decades past, and therefore the cost of the damage is greater.
    Extreme weather can also be measured in temperature extreme, precipitation amounts, and wind velocity, which students will do in the next lesson.

Part B: Focusing on Your Region

- Ask students to tap into their previous knowledge by presenting the following question:
  - Often, when it comes to extreme weather, we hear about "warnings" and "watches": flash flood warning/watch, hurricane warning/watch, tornado warning/watch. Which do you think reflects a more dangerous situation? Explain.
- Provide students with opportunities to share their personal experiences with extreme weather and allow them to discuss the difference between extreme weather warnings and watches. Then project the image of a cupcake watch versus a cupcake warning. Using this image as a metaphor, ask students to describe the difference between a watch and a warning. With this new information, have them identify which one they consider to be more dangerous in regard to extreme weather. Ask for examples of their own metaphors.
- **Teacher Tip:** This is a good opportunity to use the FLICC model to determine if the meteorologist who created the cupcake metaphor should be considered an expert. If possible, provide students with an opportunity to determine if the owner of this tweet is qualified. A quick internet search will show that he is!
- During this lesson, students will be exploring the impact that climate change is having on extreme weather in different parts of the United States. A variety of options are provided in the teacher resource folder. One option is to choose which activity is most applicable to your location. For example, if you are in a place susceptible to drought, then have students complete the drought activity. Or you can choose based on your region of the United States. However, it is also possible to allow students to self-select from a curated list or options or assign students to activities based on their individual needs.

Storyline Activities (continued)

Part B: Focusing on Your Region (continued)

- **Important:** This collection of activities exploring extreme weather and climate change will continue to grow. As it grows, there will be an ever-increasing amount of region-specific resources available for use.
- Ask students to present their findings to the class. Use the provided jamboard in order to create a class Billion Dollar Weather Event forecast for the next year. Questions to consider:
  - How many extreme weather events do they think there will be?
  - Where do they think they will happen?
  - Are there any extreme weather events that carry over from year to year?
    A good example of an extreme weather event that carries over from year to year is drought.
- **Teacher Tip:** It is important to provide students with the opportunity to justify their Billion Dollar Weather Event forecast. All predictions should have a piece of evidence and reasoning to support it.
- **Anchor to Activity – Tying it All Together:** Ask students to identify other places in the world that are experiencing extreme weather patterns similar to the ones they've been considering. Questions to consider:
  - Are all places experiencing extreme weather?
    Yes, all places are experiencing extreme weather.
  - Are all places experiencing the same type of extreme weather?
    No. All places are not experiencing the same type of extreme weather.

Part C: Heating Up, Cooling Down

- To start Activity C, show students the video titled "Rapid Earth Fault Current Limiter Test Demonstration" (2:09)." Ask students to consider the following questions as they watch:
  - The scientists are not testing this technology in the field; what does the model they are using look like?
    Scientists use a smaller version of a real-life scenario. They have a container with dirt and dry grass, meant to represent the kind of environment found in that area.
  - What are the advantages of using this model?
    The model allows scientists to study the technology in a safe and controlled environment. It accurately models the environment in which this technology will be used.
  - What are the limitations?
    The technology will not be used in such a controlled environment as the laboratory. The model does not take into account larger amounts of grass or the movement of the wire as drops to the ground.
  - How does this technology reduce the impact of human activities on natural systems?
    The technology prevents electrical lines, a human technology, from starting a fire. The fire can have negative impacts on the natural system, such as degrading the ecosystem.

Storyline Activities (continued)

Part C: Heating Up, Cooling Down (continued)

- How might climate change have influenced this research?
  Climate change creates conditions in which bushfires are more likely to occur. It is possible that scientists, understanding that the frequency and intensity of such events may increase owing to climate change, sought solutions to prevent bushfires.

- Pass out the *Metropolitan and Rural Climate Change* worksheet and guide students through the computational thinking involved. Students will also work through the misconception that urban heat islands are artificially increasing the annual global land-sea average temperature.
- As students complete the worksheet, ask them to brainstorm technologies that might reduce the impact heat waves have on people and how these technologies might be developed and/or tested.
- Provide students with the *Cool Cities* worksheet and present the materials to the students and explain to them that they will be building a city that can withstand heat. Allow them to handle the materials and prompt them to predict which materials will create a hotter city and which will create a cooler city. Ask them to explain their reasoning using their background knowledge. Students may describe certain colors as "making it hotter"; it is important to remind students that this is because of absorption/reflection of energy.
- Complete the Cool Cities engineering task found in the teacher resource folder with students and ask them to reflect on their designs using the same questions that students used to evaluate the model Rapid Earth Fault Current Limiter.
  - We, the scientists, are not testing this technology in the field; what does the model they are using look like?
  - What are the advantages of using this model?
  - What are the limitations?
  - How does this technology reduce the impact of human activities on natural systems?
  - How might climate change have influenced this research?
- Variations
  - If time is available, ask students to compare and contrast urban heat maps and canopy maps. Ask students to choose another factor, such as income level, average age, or racial demographics, in order to explore other inequities in regards to the impact of climate change. Research potential solutions to these inequities and ask students to take action.
  - Ask students to research a block in their city that they can recreate using the Cool Cities materials. Students can utilize Google Earth to find a suitable block in their neighborhood.

Extension Activities

Deeper Dive

- Watch the Nova documentary Decoding the Weather Machine
- Use the U.S. Climate Resilience Toolkit Climate Explorer to show students how changes in weather patterns will impact their communities.
- Investigate extreme weather using National Geographic's Extreme Weather on Earth resource.
- Test students' preexisting knowledge using the NASA Extreme Weather Quiz.

Formative Assessment

- TBA

Online Resources

» Video: Global Transport of Smoke from Australian Bushfires (2:13)

» Video: New Normal? Climate Change and the Australian Bushfires (2:18)

» Reading: NOAA Regions

» Tweet: Cupcake Watch/Cupcake Warning

» Video: Rapid Earth Fault Current Limiter Test Demonstration (2:09)

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