

2017  
EDITION



# *Next Generation Climate*

*Grades 6-8*



# Dear Educator

Dear Educator,

Climate Generation: A Will Steger Legacy is a nationally connected and trusted partner for innovative climate change solutions. We have been a consistent and reliable source of climate change and energy education since 2006.

Climate Generation recognizes the need for quality STEM education materials and educator support focused on climate change. Climate change is the most critical environmental issue of our time and connects across all systems and disciplines. It will need to be understood and addressed throughout all of our lifetimes, yet it is currently not included in most education curriculum. We need our youth to be climate literate so they are able to make informed and responsible decisions with regard to actions about climate change. Climate science literacy (or climate literacy) is an understanding of your influence on climate and climate's influence on you and society. *Next Generation Climate* is a resource to help young people understand and communicate about climate change.

In 2013, the Next Generation Science Standards (NGSS) were released as the most current, research-based way of educating students in STEM and preparing them for STEM careers. Much of the NGSS includes environmental content and human-induced climate change is included as a core idea. NGSS establishes high standards for delivering effective science and climate change education. They also challenge us to provide the professional development and instructional support in our curriculum resources and make NGSS accessible to educators in the classroom. Hands on learning, effective communication, making connections across all domains of science and other disciplines, an emphasis on including “all voices”, and the importance of developing a learning progression are not only integral to the NGSS, but have always guided Climate Generation's development of educational resources.

NGSS offer an excellent framework for a new climate change curriculum because they include climate change, they encourage experiential learning through the practice of science, and because they integrate crosscutting concepts that connect learning across classes and time. Climate Generation's *Next Generation Climate* curriculum was developed to meet a growing need for curricula materials that support the Next Generation Science Standards and that builds in the language and instructional support so that teachers can deliver activities consistent with the NGSS.

Students today will be tomorrow's leaders and we have a responsibility to prepare them to be innovators of climate change solutions, nurturing their creative thinking and problem solving skills using the methods we know are the best. *Next Generation Climate* is an excellent resource to include in any middle school classroom looking to integrate climate change education.

Thank you for the work you do acting as critical messengers of climate literacy!

The Climate Generation Education Team

# Table of Contents

Academic Content Standards	viii-xxviii
Lesson Organizer	xxix
<b>Lesson 1: What evidence is there to show there is a rise in global temperature?</b>	<b>1-26</b>
<ul style="list-style-type: none"><li>• Students will be able to make conclusions about global temperature using various indicators as evidence.</li><li>• Students will be able to ask questions that clarify evidence.</li><li>• Students will be able to distinguish between weather and climate.</li></ul>	
<b>Lesson 2: What factors have caused the rise in global temperature over the last century?</b>	<b>27-52</b>
<ul style="list-style-type: none"><li>• Students will be able to construct an argument, compare and critique multiple arguments, and analyze or interpret the facts presented.</li><li>• Students will be able to investigate how temperature increase impacts and changes the atmospheric conditions.</li><li>• Students will be able to demonstrate the greenhouse effect by showing how carbon dioxide and other greenhouse gases in the atmosphere trap heat and insulate the Earth.</li><li>• Students will be able to determine how human population increase and per capita consumption are contributing to the rise in global temperature and the concentration of greenhouse gases in the atmosphere.</li><li>• Students will be able to distinguish between the greenhouse effect and climate change.</li></ul>	
<b>Lesson 3: What are the repercussions of the rise in global temperature?</b>	<b>53-63</b>
<ul style="list-style-type: none"><li>• Students will be able to explain several repercussions of climate change where they live using the National Climate Assessment, among other resources.</li><li>• Students will be able to explain what makes a good scientific resource.</li></ul>	
<b>Lesson 4: What would you need to monitor the repercussions of the rise in global temperature?</b>	<b>65-82</b>
<ul style="list-style-type: none"><li>• Students will be able to describe how scientists are monitoring the repercussions of climate change.</li><li>• Students will be able to explain what citizen science is and be able to participate in a citizen science project.</li></ul>	
<b>Lesson 5: In what ways can the repercussions of climate change be minimized?</b>	<b>82-90</b>
<ul style="list-style-type: none"><li>• Students will be able to explain the difference between adaptation and mitigation, and provide many examples of each.</li><li>• Students will be able to debate about the positives and negatives of mitigation and adaptation solutions using the CER framework.</li></ul>	
<b>Lesson 6: How can you design a method for monitoring and minimizing climate change?</b>	<b>91-93</b>
<ul style="list-style-type: none"><li>• Students will be able to use the engineering design process to create a way to monitor and minimize human impact on the environment.</li></ul>	



## Lesson Outcomes

## Lesson Materials

### Lesson 1: What evidence is there to show there is a rise in global temperature?

- Students will be able to make conclusions about global temperature using various indicators as evidence.
- Students will be able to ask questions that clarify evidence.
- Students will be able to distinguish between weather and climate.

Global Land and Ocean Temperature Anomalies graph  
Lesson 1 Worksheet: Temperature Indicators  
Temperature Indicators Figure Set  
Temperature Indicators Figure Set Descriptions

### Lesson 2: What factors have caused the rise in global temperature over the last century?

- Students will be able to construct an argument, compare and critique multiple arguments, and analyze or interpret the facts presented.
- Students will be able to investigate how temperature increase impacts and changes the atmospheric conditions.
- Students will be able to demonstrate the greenhouse effect by showing how carbon dioxide and other greenhouse gases in the atmosphere trap heat and insulate the Earth.
- Students will be able to determine how human population increase and per-capita consumption are contributing to the rise in global temperature and the concentration of greenhouse gases in the atmosphere.
- Students will be able to distinguish between the greenhouse effect and climate change.

Human Impact Cards  
Lesson 2 Worksheet 1: Claim, Evidence, Reasoning Evidence Figure Set  
Evidence Figure Set Descriptions  
Lesson 2 Worksheet 2: Discussion Diamond Separating Human and Natural Influences on Climate figure

### Lesson 3: What are the repercussions of the rise in global temperature?

- Students will be able to explain several repercussions of climate change where they live using the National Climate Assessment, among other resources.
- Students will be able to explain what makes a good scientific resource.

Ten Indicators of a Warming World graphic  
Lesson 3 Worksheet 1: Climate Change Repercussions Research Project  
Lesson 3 Worksheet 2: National Climate Assessment Scavenger Hunt  
National Climate Assessment Scavenger Hunt Answer Key

### Lesson 4: What would you need to monitor the repercussions of the rise in global temperature?

- Students will be able to describe how scientists are monitoring the repercussions of climate change.
- Students will be able to explain what citizen science is and be able to participate in a citizen science project.

Lesson 4 Worksheet: Scientists in Action  
Scientist Stories  
Citizen Science slideshow

### Lesson 5: In what ways can the repercussions of climate change be minimized?

- Students will be able to explain the difference between adaptation and mitigation, and provide many examples of each.
- Students will be able to debate about the positives and negatives of mitigation and adaptation solutions using the CER framework.

Impacts, Mitigation, and Adaptation Prompt Lines  
Mitigation and Adaptation Venn Diagram  
Lesson 5 Worksheet 1: Adaptation and Mitigation Scenarios  
Lesson 5 Worksheet 2: Claim, Evidence, Reasoning (Mitigation and Adaptation)

### Lesson 6: How can you design a method for monitoring and minimizing climate change?

- Students will be able to use the engineering design process to create a way to monitor and minimize human impact on the environment.

# Lesson 1: What evidence is there to show there is a rise in global temperature?

Indicators around the world



<i>Age Level</i>	Grades 6-8
<i>Time Needed</i>	Two 50 minutes class periods
<i>Materials</i>	Global Land and Ocean Temperature Anomalies graph Worksheet: Temperature Indicators Temperature Indicators figure set (1 set of 12 for class) Temperature Indicators figure set Descriptions (if using) Science journal for each student
<i>Vocabulary</i>	<b>indicator:</b> a sign that shows the condition or existence of something (factors). <b>weather:</b> the atmospheric conditions of a specific place at a specific point in time. <b>climate:</b> the weather conditions over a given time interval (years, decades). <b>trend:</b> a general tendency or course of events: a warming trend. <b>climate change:</b> a change in the typical or average weather of a region or city. This could be a change in a region's average annual rainfall, or it could be a change in a city's average temperature for a given month or season. <b>anomaly:</b> something different, abnormal, peculiar, or not easily classified; deviation from the common rule.
<i>Student Learning Outcomes</i>	<ul style="list-style-type: none"> <li>• Students will be able to make conclusions about global temperature using various indicators as evidence.</li> <li>• Students will be able to ask questions that clarify evidence.</li> <li>• Students will be able to distinguish between weather and climate.</li> </ul>
<i>Performance Expectation(s) addressed</i>	MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
<i>Educator Prep</i>	<ul style="list-style-type: none"> <li>• Print each page of the Global Land and Ocean Temperature Anomalies graph.</li> <li>• Print a classroom set of the Temperature Indicators figure set and Temperature Indicators Figure Set Descriptions (if using)</li> <li>• Make copies of Temperature Indicators worksheet for each student.</li> <li>• Students will need a science journal for these lessons. Make journals with students during class or use composition notebooks. Journals will make great summative assessments at the end of the six lessons or to use as formative assessments throughout the unit.</li> <li>• Before beginning this lesson, have students go home and interview an older relative about weather and climate. Students should ask their relative about what they remember about the weather when they were younger. They will share their stories with the class.</li> <li>• Consult the Questioning Guide in the front of this curriculum for detailed structure on questioning and how to elicit good questioning (on page vi).</li> </ul>

# Lesson 2: What factors have caused the rise in the global temperature over the last century?

Looking into the causes



<i>Age Level</i>	Grades 6-8
<i>Time Needed</i>	Three 50 minute class periods
<i>Materials</i>	<p>Human Impact cards (1 set)                      Lesson 2 Worksheet 1: Claim, Evidence, Reasoning (1 for each student)                      Evidence Figure Set (1 set of 10 for each group)                      Evidence Figure Set Descriptions (1 set)                      Lesson 2 Worksheet 2: Discussion Diamond (1 for each student)                      Separating Human and Natural Influences on Climate figure                      A large open area and chalk                      Small bag labeled ‘What do humans do?’</p>
<i>Vocabulary</i>	<p><b>greenhouse effect:</b> A phenomenon in which the atmosphere of a planet traps radiation emitted by its sun, caused by gases such as carbon dioxide, water vapor, and methane that allow incoming sunlight to pass through but retain heat radiated back from the planet’s surface.</p> <p><b>greenhouse gas:</b> gases which allow direct sunlight to reach Earth’s surface, but absorb the infrared energy (heat) that is reradiated to the atmosphere. These gases include: water vapor, carbon dioxide, methane, nitrous oxide, among others. Also referred to as heat-trapping gases.</p> <p><b>cumulative:</b> increasing or increased in quantity</p> <p><b>atmosphere:</b> the mixture of gases that surrounds earth; the air</p> <p><b>carbon dioxide:</b> CO<sub>2</sub>, is the primary greenhouse gas emitted through human activities</p> <p><b>emissions:</b> the act of producing or sending out something (such as energy or gas) from a source</p> <p><b>carbon sink:</b> anything that absorbs more carbon than it releases (trees, ocean)</p>
<i>Student Learning Outcomes</i>	<ul style="list-style-type: none"> <li>• Students will be able to construct an argument, compare and critique multiple arguments, and analyze or interpret the facts presented.</li> <li>• Students will be able to investigate how temperature increase impacts and changes the atmospheric conditions.</li> <li>• Students will be able to demonstrate the greenhouse effect by showing how carbon dioxide and other greenhouse gases in the atmosphere trap heat and insulate the Earth.</li> <li>• Students will be able to determine how human population increase and per-capita consumption are contributing to the rise in the global temperature and the concentration of greenhouse gases in the atmosphere.</li> <li>• Students will be able to distinguish between the greenhouse effect and climate change.</li> </ul>
<i>Performance Expectation(s) addressed</i>	<p>MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s system.</p> <p>MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.</p>
<i>Educator Prep</i>	<p><b>Greenhouse Effect Game:</b></p> <ul style="list-style-type: none"> <li>• Print <i>Human Impacts Cards</i> and create ‘What do humans do?’ bag.</li> <li>• Find a large, open area for game play, preferably outside. Draw two concentric circles on the ground, one about 4 feet in diameter, and a larger one about 30 feet in diameter. The smaller circle represents the Earth and the larger one represents Earth’s atmosphere (for 15-30 students).</li> <li>• Read the information about CER (Claim, Evidence, Reasoning) in the beginning of the curriculum guide. This will provide you will an understanding of how to implement and assess this form of argumentation.</li> <li>• Make copies of the <i>Evidence Figure Set</i> and <i>Descriptions (if using)</i> for each group.</li> <li>• Make copies of the <i>Lesson 2 Activity: Claim, Evidence, Reasoning</i> worksheet for each student.</li> <li>• Make copies of the <i>Discussion Diamond</i> Worksheet for each student.</li> </ul>

# Lesson 3: What are the repercussions of the rise in global temperature?

Rising temperatures are seen around the world



<i>Age Level</i>	Grades 6-8
<i>Time Needed</i>	Three 50 minute class periods (2 days if presentations are skipped)
<i>Materials</i>	Ten Indicators of A Warming World graphic Climate Change Repercussions Research Project (1 for each student) National Climate Assessment Scavenger Hunt (1 for each student) Student computers or access to tablets
<i>Vocabulary</i>	repercussion: an unintended consequence occurring some time after an event or action, especially an unwelcome one (i.e. impacts)
<i>Student Learning Outcomes</i>	<ul style="list-style-type: none"><li>• Students will be able to explain several repercussions of climate change where they live using the National Climate Assessment, among other resources.</li><li>• Students will be able to explain what makes a good scientific resource.</li></ul>
<i>Performance Expectation(s) addressed</i>	<b>MS-ESS3-5.</b> Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
<i>Educator Prep</i>	<ul style="list-style-type: none"><li>• Become familiar with the National Climate Assessment site before introducing it to your students.</li><li>• Make copies of the Climate Change Repercussions Research Project worksheet for each student.</li><li>• Make 1 sign for each of the Ten Indicators of A Warming World graphic and post around the room.</li></ul>

## Background Information

Lesson 2 showed students that scientists are highly confident that many of these observed changes can be linked to the climbing levels of carbon dioxide and other greenhouse gases in our atmosphere, which are caused by human activities.

The National Climate Assessment (NCA) is an informational resource describing the impacts of climate change. It is a report that summarizes the impacts of climate change for the United States, now and in the future. Hundreds of experts, guided by members of the Federal Advisory Committee, produced the report, which was extensively reviewed by the public and experts, including the National Academy of Sciences. The report was turned into a website that will be used extensively in this lesson and in Lesson 5.

For educators that would like suggestions about how to use the National Climate Assessment in the classroom, visit this site: <https://www.climate.gov/teaching/2014-national-climate-assessment-resources-educators>. This site features a list of all key messages and guiding questions for every region in the US, as well as links to other resources outside of the NCA.

In Lesson 2, students explored the many factors that are causing global temperatures to rise. Population increase, more agriculture activity, and the production of cement are just a few pieces of the puzzle. With all of these factors causing global temperatures to rise, it is just a matter of time before we start seeing the repercussions of those actions, indeed some of the repercussions are already being felt around the world.

# Lesson 4: What would you need to monitor the repercussions of the rise in global temperature?

## Monitoring the repercussions



<i>Age Level</i>	Grades 6-8
<i>Time Needed</i>	Two 50 minute class periods
<i>Materials</i>	Scientists in Action worksheet (1 for each student) Scientist Stories (1 classroom set) Citizen Science slideshow Citizen Science equipment (if needed)
<i>Vocabulary</i>	<b>citizen science:</b> The involvement of public volunteers of all ages assisting scientists in their research <b>resilience:</b> Capacity to recover quickly from difficulties, toughness (Resilience comes from having the capacity to respond to change.)
<i>Student Learning Outcomes</i>	<ul style="list-style-type: none"> <li>• Students will be able to describe how scientists are monitoring the repercussions of climate change.</li> <li>• Students will be able to explain what citizen science is and be able to participate in a citizen science project.</li> </ul>
<i>Performance Expectation(s) addressed</i>	<p><b>MS-ESS3-3.</b> Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.</p> <p><b>MS-ESS3-5.</b> Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.</p>
<i>Educator Prep</i>	<ul style="list-style-type: none"> <li>• Make copies of the Scientists in Action worksheet for each student.</li> <li>• Make a classroom set of the Scientist Stories. Make 6 ‘scientist stations’ around the classroom. Students will visit each station to learn about the scientist and answer questions on their worksheet.</li> <li>• Before doing the Citizen Science Activity, familiarize yourself with several citizen science examples (see slideshow in this lesson). Choose one that your students could participate in, or let your students decide which one they would like to participate in. Sign up before the start of the lesson, and if possible, obtain the necessary tools to allow your students to begin collection data right away.</li> </ul>

### Background Information

At this point students have learned that there is an ongoing rise of the global temperature and about the repercussions that are happening because of that rise. In this lesson, students will learn how scientists monitor the repercussions of climate change and how they can also participate in monitoring.

It is important to monitor the repercussions of climate change, because only if we know the impacts will we be able to plan for the future and develop methods to minimize them. For example, monitoring the population of certain trees is crucial because their health impacts many species including other trees, insects, and animals. In Minnesota, aspen and tamarack trees are dying from changes in precipitation patterns, temperature fluctuations, and insect defoliation. Being able to monitor these changes is crucial to understanding what needs to be done to help save these species.

Emphasize to students that in order to monitor these repercussions, it takes time. Point out that while monitoring, scientists are looking for trends. As we discussed in earlier lessons, long term trends cannot be determined from just a few years, more time is needed to fully understand what and how things are happening in nature.

# Lesson 5: In what ways can the repercussions of climate change be minimized?

Minimize your impact



<i>Age Level</i>	Grades 6-8
<i>Time Needed</i>	Three 50 minute class periods
<i>Materials</i>	Impacts, Mitigation, Adaptation Prompt Lines (1 for class) Mitigation and Adaptation Venn Diagram (drawn on board) Worksheet: Adaptation & Mitigation Scenarios (1 for each student) Worksheet: Claim, Evidence, Reasoning (Mitigation and Adaptation) (1 for each student)
<i>Vocabulary</i>	<b>mitigation:</b> Technology changes that reduce emissions, reduces or prevents greenhouse gas emissions. <b>adaptation:</b> Adjustment in natural or human systems to a new or changing environment that moderates negative effects, reduces harm to the environment. <b>resilience:</b> The capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from a disruption.
<i>Student Learning Outcomes</i>	<ul style="list-style-type: none"> <li>• Students will be able to explain the difference between adaptation and mitigation, and provide many examples of each.</li> <li>• Students will be able to debate about the positives and negatives of mitigation and adaptation solutions using the CER framework.</li> </ul>
<i>Performance Expectation(s) addressed</i>	<b>MS-ESS3-4.</b> Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s system. <b>MS-ESS3-5.</b> Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
<i>Educator Prep</i>	<ul style="list-style-type: none"> <li>• Make one copy of <i>Impacts, Mitigation, Adaptation Prompt Lines</i>.</li> <li>• Make copies of <i>Adaptation &amp; Mitigation Scenarios</i> worksheet for each student.</li> <li>• Make copies of <i>Claim, Evidence, Reasoning (Mitigation and Adaptation)</i> worksheet for each student.</li> <li>• Create and post two signs on opposite walls in your classroom. Signs will say “Impacts of Climate Change” and “Actions to Combat Climate Change” and will be used for the Impacts, Mitigation, and Adaptation Activity.</li> </ul>

## Background Information

Students will apply the information they learned in Lesson 2 about making claims in this lesson. They will research and discuss/debate the many ways of minimizing the effects of climate change. Refer to the CER discussion in the front of this curriculum for more information (page vi and vii).

There are many terms that are used when discussing climate change solutions. Making students aware of the terms and differences between them is important to their understanding of solutions. Mitigation is often used when discussing possible solutions. *Mitigation* involves reducing the severity or seriousness of a problem. We can mitigate the effects of climate change by creating more fuel efficient vehicles or using renewable energy. *Adaptation* means adjusting to new conditions. This means that the effects are already occurring. While mitigation is concerned with reducing future effects, adaptation is taking action on the current issues at hand, recognizing that they are already occurring. We can adapt to a changing climate by making upgrades to sewer systems for increased rainfall during storms. These actions will lead to more resilient communities therefore allowing those communities to recover quicker from the repercussions of climate change.

# Lesson 6: How can you design a method for monitoring and minimizing climate change?

Your solution to minimize a climate change impact



<i>Age Level</i>	Grades 6-8
<i>Time Needed</i>	Two 50 minute class periods (plus more time outside class for data collection)
<i>Vocabulary</i>	<b>engineering:</b> The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.
<i>Student Learning Outcomes</i>	<ul style="list-style-type: none"><li>• Students will be able to use the engineering design process to create a way to monitor and minimize climate change.</li></ul>
<i>Performance Expectation(s) addressed</i>	<b>MS-ESS3-3.</b> Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
<i>Educator Prep</i>	<ul style="list-style-type: none"><li>• Some student ideas may need approval from your principal or superintendent. Be prepared to ask for permission or limit the actions that your students can take in this lesson.</li></ul>

## Background Information

In this lesson students will use the process of engineering design to create a way to minimize and monitor climate change. For this activity we consider a simple outline of the engineering process (there are many):

- Define the problem and resources available
- Brainstorm solutions
- Develop a plan
- Test your plan
- Improve the plan
- Analyze the plan and use it

As the educator, you have the choice to limit this creation to something the students create in the classroom, regarding just themselves, or extend their reach out into the world. They could create a plan to monitor and minimize something in their house, at their school, or across their state. It could be a real project or one that is so big that it can only be conceptualized.

### Here are a few examples:

- Monitor idling cars at the end of the school day. Make a plan to help minimize the number of cars/buses that are waiting to pick kids by creating no-idling zones.
- Monitor the amount of rain water runoff around school. Create a plan to minimize rainwater runoff and wasted water by installing a rain garden.
- Monitor the amount of food waste at lunch. Make a plan to minimize that waste by implementing a compost system.

*We can reduce the risks we will face from climate change. By making choices that reduce greenhouse gas pollution, and preparing for the changes that are already underway, we can reduce risks from climate change. Our decisions today will shape the world our children and grandchildren will live in.*

*- Environmental Protection Agency*