



Thinning of Northeast Greenland Ice and Sea Level Rise

Is there a solution to rising seas?

Grade(s): 9

Lesson Duration: Class 4 class periods; 45 minutes each

Course Name: Honors 1 and Honors Biology

Lesson Author: Audrey Lavertu , Attleboro, MA

Directions for using this template: The red text provides guidance on what to include in the sections with the blue or gray headers. Remove this set of directions as well as the red text and replace the red text with your own text.

BIG IDEAS

Students explore humans and global change. This section of the chapter on Humans and Global Change climate change is discussed and real world examples of human impacts and sustainable solutions are explored. This lesson plan will address the effects of rising sea levels, which students will observe is linked to Global temperatures. They are familiar with the water cycle. This lesson will also address a solution that scientists are exploring. The solution connects this lesson to the Biosphere with the salt marsh data from an experiment along the coast of MA.

EDUCATION STANDARDS

The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a

variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HSESS2-5)

Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HSESS2- 1),(HS-ESS2-2)

- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HSESS3-6)

- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2- 6)

Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)

- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to HS-LS2-7) (secondary to HS-LS4-6) (secondary to HSESS3-2),(secondary HS-ESS3-4) (HS-ETS1-3)

ESS2.E: Biogeology • Plants and animals can change their environment. (KESS2-2) • Living things affect the physical characteristics of their regions. (4-ESS2-1)

The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)

NGSS Performance Expectation(s):

PE:

1. *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 systems. HS-ESS3-5*
2. *Use a computational representation to illustrate the relationships among Earth systems and the changes being modified due to human activity HS-ESS3-6*
3. *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*

Science and Engineering Practices: <i>(SEP elements connected to the PEs)</i>	Disciplinary Core Ideas: <i>(DCI elements connected to the PEs)</i>	Crosscutting Concepts: <i>(CC elements connected to the PEs)</i>
<p>Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.</p> <p>Science investigations generally produce data that must be analyzed in order to derive meaning</p> <p>The goal of science is to explain phenomena in the natural world</p> <p>A major practice of science is to communicate ideas and results of scientific inquiry and to obtain and evaluate findings reported by others</p>		<p><i>Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.</i></p> <p><i>Much of science deals with constructing explanations of how things change and how they remain stable.</i></p> <p><i>Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.</i></p>
<p>Common Core State Standards:</p> <p>Math: HSS.ID.A.1 Represent data with plots on the real number line(dot plots, histograms, and box plots) MP2 Reason abstractly and quantitatively</p> <p>and/or</p> <p>ELA: State Standards: RST.9-10.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions RST.9-10.3 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 text and topics.</p>		

RST.9-10.3 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text

ITEEA Standards: *Our school is required to use only NGSS Standards*

Other Standards:

MEASURABLE STUDENT LEARNING OBJECTIVES

Students will be able to:

Explain how human activities change the atmosphere and climate

Describe how changes in the atmosphere drive climate and other changes in global systems

Explain how human land use cause changes in global systems

Portray the different kinds of pollution that lead to global changes

List some impacts of climate change

Explain the role of science in responding to global change

Science investigations generally produce data that must be analyzed in order to derive meaning

Webb's Level 2: In this level, students may be asked to complete multiple steps in order to find a solution, like collecting and then displaying data in a chart. The key to level 2 is that students are using their knowledge outside of the original context

MATERIALS NEEDED

ipad, pen, pencil

<https://www.earthdata.nasa.gov/>

ENGAGING CONTEXT/PHENOMENON: A Boston Museum of Science Podcast about glaciers and a Nasa short video on glaciers melting.

DATA INTEGRATION Students will be using data integration from the NASA website and

Data Nuggets lab

TEACHER BACKGROUND KNOWLEDGE

General glacier knowledge

Climate change information, such as the causes and effects of global warming

Sea level rise

Salt marsh - as a possible solution

Scientific Method: hypothesis, controls, independent variables, dependent variable, data tables, graphs, and understanding the information in a graph, conclusion

DIFFERENTIATION OF INSTRUCTION

This is a lesson designed for H1 students. For H students I would use the videos, then use the NASA link together with the students. I would project the graphs on the board, ask the questions, and have students answer. We would work on the answers together as a class. For the Data Nuggets, I would use an easier level with the graph already drawn. The students would answer the questions using the graph.

REAL-WORLD CONNECTIONS FOR STUDENTS

Many of my students live near the New England coast, or have summer homes at the Cape or Rhode Island. This would be of interest and concern to them to think that their favorite beach or home could be under water. Students are active in Conservation Groups that are involved in cleaning the beaches from debris and garbage. Some students would be interested in the solution, since they are familiar with salt marshes and might want to participate in a research project that addresses this.

POSSIBLE PRIOR or MISCONCEPTIONS

The students might have misconceptions about the warming of the oceans, that Greenland and Arctic warm faster, the density of warm water compared to cold water, the reasons for global warming, the science behind climate change is not understood

LESSON PROCEDURE

5E	Details of 5E Lesson Implementation (Visit BSCS to learn more about the 5E instructional model)
<u>Engage</u>	<p>Lesson Objective: Describe how changes in the atmosphere drive climate and other changes in global systems</p> <p>Procedure: The students will watch two short videos - one on tracking glaciers. The first video is a cartoon-like video which explains the importance of Greenland glaciers in tracking global warming:</p> <ol style="list-style-type: none">1. https://www.youtube.com/watch?v=yLm7PSsvW8g <p>Students watch the video. At the end of the video we will answer</p>

questions, students will think pair share the answers first, one student will write the answer on the board. (we rotate who goes to the board)

We will also generate questions we might like answered.

2. The second short clip is a podcast:

<https://mosbos.podbean.com/e/glaciers-tortoise-or-hare/>

the Science Museum of Boston will feature an exhibit of Glaciers within the coming months. I will encourage the students to attend. A Field Trip would be an idea, but difficult to actually have approved.

During this phase the students watch the video, answer questions and also ask questions about glaciers. The teacher facilitates the discussion after the students watch the video. Students will also be taking notes on the video

Modifications All students have access to an ipod. The teacher will project the video on the screen and students will take notes.

Standards Addressed:

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HSESS2- 1),(HS-ESS2-2)
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HSESS2-5)

Formative Assessments: A worksheet that students will answer:

https://docs.google.com/document/d/1C2SRGQ3V-ADRIj1fjkn5IJ8kAlxe473Dalpd8d_KQOM/edit

We also will think- pair share our answers, and write them on the board. We will discuss questions that we would like answers to in the explore section

Resources

https://docs.google.com/document/d/1C2SRGQ3V-ADRIj1fjkn5IJ8kAlxe473Dalpd8d_KQOM/edit

Explore

Lesson Objective:

1. Describe how changes in the atmosphere drive climate and other changes in global systems
2. List some impacts of climate change

For this part students will explore a NASA website:

The attached questions will be answered as they observe the Greenland Glacier

Procedure: Students will read an article for homework; Warming Seas are Accelerating Greenland's Retreat, Jan. 24, 2021 There is also a short video which shows how the glacier ice melts, ice breaks off, and the calving is explained

<https://climate.nasa.gov/news/3062/warming-seas-are-accelerating-greenlands-glacier-retreat/>

For this part The students are exploring a NASA website and determining how much ice has melted.

<https://climate.nasa.gov/vital-signs/arctic-sea-ice/>

Vital signs of the planet. The students will observe graphs of data collected for different signs of glacial ice retreat such as global warming, global temperature data, ice sheet, sea level and arctic sea ice minimum

During this class the students will navigate through the above website, read graphs comparing data from 1900 to 2020. They will compare global temperature data, ocean warming data, ice sheet, sea level, and sea ice minimum.

They will answer the attached worksheet questions from the website to compare the data and understand the trends from 1900 until the present.

I will show the students how to use the website, point out the various tools to compare the data easily, show the animation of earth to see the color changes as the years progress.

The link to the attached worksheet:

<https://docs.google.com/document/d/1xQG8-DWY9Vv58Tte6P662OGRZQRDIoCzsQbSv7NEjs0/edit>

Students will be using their ipads to access the data and the tools of this website.

Modifications Each student has access to an ipad or laptop if need be. I walk around the room and help each student and see their progress.

Standards Addressed

Math: HSS.ID.A.1 Represent data with plots on the real number line(dot plots, histograms, and box plots)
MP2 Reason abstractly and quantitatively

Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HSESS2-1),(HS-ESS2-2)

- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HSESS3-6)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2- 6)

Formative/Summative Assessments

Students will complete answering the questions comparing the data about sea level rise, ice sheet, global temperature, and ocean warming. I will grade the worksheet that they complete for completeness and accuracy.

Resources <https://climate.nasa.gov/vital-signs/arctic-sea-ice/>

Explain

Lesson Objective:

1. *Explain how human activities change the atmosphere and climate*
2. *Describe how changes in the atmosphere drive climate and other changes in global systems*
3. *Explain how human land use can cause changes in global systems.*
4. Science investigations generally produce data that must be analyzed in order to derive meaning

The students will read pages 204-209, and 218-221 of their text book.

	<p><i>They will complete 1. Interactivity: The Great Acceleration and demonstrate their understanding by answering the questions. They will also complete Interactivity 2 Human Impact on Ecosystems and Understanding Global Change are Interactives that will synthesize their new knowledge of glaciers as indicators of global warming. The Interactivity Identifying the Impact of Climate Change explore the various impacts resulting from climate change Interactivities are built into the online text, which take the student around 10 minutes or less to complete.</i></p> <p>Procedure: Students will be assigned the textbook pages 204-209 to read. In class they complete the Interactives on their own with their ipads. They will read pages 218-221 in class and complete an Interactivity.</p> <p>Modifications: Each student has an ipad and can complete the Interacitve on their own.</p> <p>Standards Addressed :</p> <p>Formative/Summative Assessments: the Interactives are graded, these are used as a formative assessment</p> <p>Resources: Biology Miller and Levine</p>
<p><u>Elaborate</u></p>	<p>Lesson Objective:</p> <p>Explain the role of science in responding to global change</p> <p>Procedure: For this part of the lesson students will access data nugget lab. This lab addresses a solution to the sea level rise problem.</p> <p>https://datanuggets.org/wp-content/uploads/2016/03/Salt-Marsh-Keeing-Up_Student-B.pdf</p> <p>Students read the lab, use the data table to graph the data, answer questions about the data and the graph, and come to a conclusion about cord grass and salt marsh grass.</p> <p>I will circulate and answer any questions the students have. Each student has access to an ipad to complete the assignment. If they have any questions, I will answer or the students in the class willingly help their classmates. It is always a pleasure to see the students help each other while performing in the lab. After the lab they will write a formal lab report.</p> <p>Modifications <i>Each student has an ipad and will work alone to read the lab and complete the graph. I will answer questions as I circulate around the room. Each student is busy plotting the graphs. Students are also very helpful if someone needs help.</i></p>

	<p>Standards Addressed:</p> <p>Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)</p> <p>ESS2.E: Biogeology • Plants and animals can change their environment. (KESS2-2) • Living things affect the physical characteristics of their regions. (4-ESS2-1)</p> <p>The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it. (HS-ESS2-7)</p> <p>Formative/Summative Assessments: Formative assessment - They will complete the lab, answer questions in the lab and submit on Google Classroom. We will discuss the complete lab in class. Question: which method (cord grass or seagrass) was most effective for rising sea level solution?</p> <p>Resources: https://datanuggets.org/2016/03/keeping-up-with-the-sea-level/ The data nugget lab that will be used for the Elaborate section of the lesson</p>
<p><u>Evaluate</u></p>	<p>Lesson Objective:</p> <p>Explain the role of science in responding to global change.</p> <p>Procedure: Students will write a formal lab report. The rubric is included here.</p> <p>The students are writing their lab report for homework. I will collect the report, review and return the next day. The student will have the opportunity to rewrite the lab report if there were mistakes.</p> <p>For many students this is the first formal lab report and they are not familiar with the format and expectation. Once the lab report is graded, they are given time to make corrections and submit the revised lab report. The teacher's role is to answer questions and help the students who are experiencing difficulty.</p> <p>By doing this their conclusion should be an explanation of scientist’s ability to respond to global change by trying to solve problems.</p>

Modifications *The teacher answers questions and helps clarify any problems they have in writing a lab report. As a Freshman writing a formal lab report is a Science goal.*

Standards Addressed

Math: HSS.ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots)
MP2 Reason abstractly and quantitatively

The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)

Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HSESS2-1),(HS-ESS2-2)

Summative Assessments: Formal Lab Report

At the end of this unit we will read an article: "The Key to Weathering Rapid Sea Level Rise May Be in a MA Salt Marsh"
It is a one page article that wraps up the lessons. The link is:

<https://necasc.umass.edu/news/key-weathering-rapid-sea-level-rise-may-lie-massachusetts-salt-marsh>

After the lab report the students will evaluate this scientist's claim. We will discuss this as a class.

Resources: The rubric is the revised science lab rubric for 9th grade.

REFERENCES:

Miller,K;Levine,J, (2019) Biology Miller and Levine, Pearson

Earth Science Data Systems

<https://www.earthdata.nasa.gov/>

<https://datanuggets.org/search-current-data-nuggets/>, February 14, 2019

