Demonstrating the Relationship between Sea Level Rise and Ocean Warming and Flash Flooding

10th-12th

AP Environmental Science/Science Research

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BIG IDEAS

Conceptual Idea in STEM - Environmental impact: analyzing the change in sea level height and ocean warming from 1993 to 2019. Students will also design a way to mitigate the effects of increased flash flooding due to rising sea levels.

EDUCATION STANDARDS

NGSS Performance Expectation(s)

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.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. ● Design or refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations.	**ESS2.D: Weather and Climate** ● 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. **ESS3.B: Natural Hazards** ● Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. **ETS1.B. Developing Possible Solutions** ● 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.	**Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. **Influence of Engineering, Technology, and Science on Society and the Natural World** ● Modern civilization depends on major technological systems. ● Engineers continuously modify these systems to increase benefits while decreasing costs and risks.

Common Core State Standards:

Math:

7.RP - 2. Recognize and represent proportional relationships between quantities. a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.

ELA:

RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g. quantitative data, video, multimedia) in order to address a question or solve a problem

Other Standards

NGSS3-5-ETS1-3 - Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

NGSS3-5-ETS1-1 - Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

NGSS3-5-ETS1-2 - Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

MEASURABLE STUDENT LEARNING OBJECTIVES

Students will be able to:

- ***Analyze*** data for sea level rise and ocean warming to determine a relationship
- ***Explain*** the relationship between sea level rise and ocean warming
- ***Create*** the data in an easy to understand way (create graphs on Google Sheets)
- ***Define*** the relationship between sea level rise and ocean warming
- ***Explain*** the relationship between rising sea levels and ocean warming using line graphs
- ***Identify*** two negative impacts that sea level rise can have on a surrounding area

- ***Propose*** a way to mitigate the effects of sea level rise/flooding
- ***Produce*** a prototype for a proposed mitigation method and test it

STEM INTEGRATION

STEAM subject areas included in lesson - Science, Math, Engineering and Art

Science - The science portion is the natural world phenomenon - flash flooding event along the Guadalupe River in Texas. Students observed images and watched videos of the flood and explained how the flooding impacted humans. This phenomenon was the foundation for the entire lesson. Students then look at data sets that demonstrate that rising sea levels is due to ocean warming (which students already know is due to global warming - prior knowledge). Students then explore how ocean warming causes sea levels to rise through the Thermal Expansion Lab.

Math - The math portion of this lesson is the integration of the skill of graphing. Students will learn explicitly how to graph using Google Sheets to determine what the relationship is between the data points.

Engineering - This lesson including the engineering extension (elaborate portion) allows students to participate in the engineering process. They identify a problem -the hook and intro to the lesson (photos of Guadalupe River flood and NASA High Tide Flood video) indicates that high sea levels cause flash flooding. The data and lab activity further demonstrates that sea levels rise as oceans are warming. The data also demonstrates that this is a current problem (based on the years indicated in the data). Students then propose a solution to mitigate the floods, followed by building and testing their solution. Students will also record their process using the "STEM Challenge" worksheet.

Art - Art is integrated in the PSA (public service announcement) portion of this lesson. After analyzing the data and completing the Thermal Expansion Lab, students are asked to create a PSA about rising sea levels and ocean warming. Students can choose how they want to present this information, which means that students have the ability to incorporate art into their project (whether they want to draw/paint their poster/image, write a song, etc). This allows for students to demonstrate their learning in a way that makes the most sense for them and allows for art to be seamlessly integrated into this science lesson.

NATURE OF STEM

This lesson can integrate different STEM areas. The content of the lesson falls within the "science" pillar, as the data is looking at a "natural world" phenomenon (as cited by Peters-Burton, 2014). The lesson also focuses on the skill of graphing, which falls within the nature of mathematics, which is partially defined as "mathematics explores the possible relationships among abstractions" (American Association for the Advancement of Science, 1990). Graphing takes abstract numbers and organizes them in a way that gives them meaning and demonstrates a relationship between them. The lesson also encompasses engineering. The nature of engineering is defined by Peters-Burton (2014) as "the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind", which is explicitly demonstrated in this lesson. The elaborate portion of this lesson, directly falls under the nature of engineering, where students are taking what they learned from analyzing the data sets and watching the videos and observing the images of the floods to engineer a way to mitigate flood water in order to benefit humankind. The structure of this unit allows for the content and activities to fall within multiple "nature of" branches.

MATERIALS NEEDED

- Computer
- 1 transparent disposable plastic bottle (500 mL–1 L). *Small bottles made with thicker, sturdier plastic are preferred*
- 1 clear straw (fits securely through bottle cap)
- Food coloring
- Ruler
- Dark felt-tip pen
- Thermometer
- Several low-temperature hot-glue guns, putty or other malleable sealant
- Paper or cloth towels
  Safety goggles
- Heat sources (such as incandescent bulbs, heat lamps, heat pads or the Sun)

ENGAGING CONTEXT/PHENOMENON

To start the lesson, I would show pictures of the most recent flash flooding incident in Texas (Guadalupe River flood, July 2025). Students have probably seen and/or heard about the flood on the news or social media. This would be a way to access students' prior knowledge and demonstrate that this phenomenon is happening right now and could happen to them or their families. This will help the students see the importance of this material and make them feel connected to the content. We will then watch the introduction to the NASA video, High Tide Flooding (NASA Goddard, 2021). I like the introduction to this video because it briefly explains why flash flooding has increased over the last several years, which directly relates to the Guadalupe River flood. Students now have a tangible example of high tide flooding due to sea level rise, which will give context to the data set that they will see.

DATA INTEGRATION

I will provide the students with the following data sets (Sea Level Height Data Spreadsheet and Ocean Warming Monthly Variation Data Spreadsheet) and ask them to determine the relationship between sea level and ocean warming by looking at the data. I chose these two data sets specifically because their time span was similar and they include data points for the same years. Students will easily be able to compare values for sea level and ocean warming for the same time period to support their conclusions. Based on their prior knowledge and skill, they will probably compare sea level and temperature at different years and use this as evidence for their conclusion. This will be a nice segway into talking about how scientists demonstrate data in an easy to understand way, by creating graphs. This is another way that the two data sets can be used in this lesson - by focusing on the skill of creating graphs. I can explicitly teach the students how to create a line graph using Google Sheets and importing the data from the data sets.

TEACHER BACKGROUND KNOWLEDGE

In order to effectively teach this lesson, teachers need to have a solid understanding of how global climate change impacts sea level rising and how rising sea levels can impact the severity of flash flooding. This background is imperative as to ensure the teacher can answer student

questions that are not directly answerable by the data and activities. Teachers should also have an understanding of where the data came from, what the data means and how it was collected. Important information documents for the two data sets are linked below:

Sea Level Height Background NASA Website
Sea Level Height Data Information
Ocean Warming Background NASA Website
Ocean Warming Monthly Variation Data Information

DIFFERENTIATION OF INSTRUCTION

- Students who do not have social media may not have prior knowledge of the flood. Students will gain this knowledge by observing the images and videos shown in the presentation, and will be able to share their own experiences with flash flooding (which happens often in our area).
- Students who have sight issues can access the presentation on their own computers, to make it easier to observe the images.
- Students who have issues writing on paper can access the worksheets digitally to fill out.
- Students who struggle with deeper thinking and analysis will be grouped heterogeneously with higher level students to receive the support they need.
- Students who are ELLs can create their PSA in their home language as well as in English.

For higher level students:

1) Students will have the opportunity to create the Google Sheet graph on their own, without teacher scaffolding
2) Students will be asked to create their own data table, without one being provided for them. Students could also have an extension question where they research where sea level rise is occurring the most and why.
3) Give research extension to see if their groups' proposal has been studied and compare the published methodology to their groups methodology. Use published work to frame next steps

For lower level students:

1) Teacher will assist students in creating the Google Sheet graph for the second, independent data set
2) Students will be provided the data table partially filled out (with the time intervals included) as a scaffold. Teacher will provide students with scaffolds for how to answer conclusion questions.
3) Add scaffolds to the “STEM Challenge” worksheet to aid with filling out information

REAL-WORLD CONNECTIONS FOR STUDENTS

The hook of this lesson is a real-life connection - flash flooding. Flash flooding is a dangerous weather event that can and does happen all over the country and the world. A week or so after the flash flood in Texas, there was a flood in lower Westchester, where many of my students live. The flash flood near home was not as deadly as the floor in Texas, but it was still destructive and impacted many of my students and their families. Part of the hook and intro to this lesson asks students to discuss their own experience with flash flooding. This relates the lesson back to the individual students and drives home why the information they are learning is important and helps keep the students engaged and develop a deeper understanding for the content, because they recognize how it impacts them and their loved ones in the real world.

INTEGRATION POSSIBLE MISCONCEPTIONS

I anticipate that students will think that only coastal areas will be impacted by flash flooding and that an area like Westchester (because we are not considered a “coastal” area) would not be impacted. I also anticipate that students will think they know how to create a graph but will need step by step directions to create an accurate, easy to read graph using Google Sheets. I also anticipate that students will struggle with the “planning” portion of the engineering design project and will need reminders to be specific about their methods and plan.

LESSON PROCEDURE

5E	Details of 5E Lesson Implementation
Engage	**Procedure:** *Slideshow attached at end of lesson plan*.Teacher will show students slide 1, and ask them if they have heard of the location "Guadalupe River, Texas" before and what happened there this summer. Once students share that there was a flood along this river, the teacher will ask students where they saw this information. Once students share their answers (the news, social media, etc.), teacher will show slides 2-9 (images and video of the recent flash flooding incidents in Texas (Guadalupe River Flood, July 2025)) and ask students to write down 1-3 words that come to mind when they view the image (teacher will provide 15 seconds per image) *Worksheet attached at end of lesson plan*. After viewing all of the images, teacher will provide 2-3 minutes for students to share their words with their groups. Teacher will then ask students to come up with one word per group to describe all of the images. Each group will share and explain why they chose that word. The teacher will facilitate a class discussion about the words chosen and what they mean for a flash flood in a community. The teacher will then ask if students have ever personally experienced a flash flood, and give students an opportunity to discuss and share their experiences. Students will answer the following question on an index card, and turn in to the teacher: "Explain how a flash flood impacts human activity/society/lives. Use evidence from the video and/or images to support your answer." Following the class discussion, the teacher will show the introduction to the NASA video, High Tide Flooding (NASA Goddard, 2021), on slide 10. Prior to watching the video, the teacher will ask students to listen for why flash flooding has increased (answer- due to sea level rise). After the video, students will be asked to brainstorm two reasons why they believe sea levels are rising (this will be prior knowledge from previous AP Environmental Science units), and write those reasons on

	post-it notes. Students then need to put the post-it notes on the board, and create an affinity diagram (as described by Dirksen (2011)) with all of the students' ideas. As a class, students will need to name the different categories they created. Teacher will then facilitate a class discussion about the different ideas of what causes sea level rising. Teacher will discuss all categories, but end focusing on the category that has to do with global warming/increasing temperatures. Teacher will then explain the data integration portion of the lesson, which will take place during the next class. **Modifications:** Students who do not have social media may not have prior knowledge of the flood. Students will gain this knowledge by observing the images shown in the presentation, and will be able to share their own experiences with flash flooding (which happens often in our area). Students who have sight issues can access the presentation on their own computers, to make it easier to observe the images. Students who have issues writing on paper can access the worksheet digitally to fill out. **Formative/Summative Assessments:** Teacher will facilitate multiple class discussions throughout the lesson. Teacher will be able to scaffold questions and change the questions that are being asked based on student understanding. Teacher will walk around while students are brainstorming and sharing with their groups, to get an idea of how well the students are understanding the material. **Resources:** Slideshow (with images and videos), brainstorming worksheet and post-it notes

Explore	**Procedure:** During this phase, students will participate in 1) data analysis and 2) hands-on lab activity. 1) Students will work with a partner to analyze the data provided to them for sea level rise and ocean warming (data will be provided digitally, via Google Classroom post). Data is linked here: Sea Level Height Data Spreadsheet and Ocean Warming Monthly Variation Data Spreadsheet. Students will read the directions and answer questions on a worksheet. *Worksheet attached at the end of lesson plan.* Students will have 15-20 minutes to complete this. Students will then share their answers to questions 3 (the relationship between the data sets) and 4 (steps to determine the relationship). Once all groups share, teacher will facilitate a group discussion surrounding the steps students took in analyzing the data. Teacher will ask students if reading the data in table form was easy and if there would be another way to display this data. Discuss then focuses on how scientists display their data to the audience (in graph form). Teacher will then demonstrate how to create a graph using Google Sheets. *Google Sheets is linked HERE.* Teacher will walk students through how to create a graph using the data for sea level rise (derived data set, date vs. global sea level variance). Students then need to create a graph for ocean warming (derived data set, date vs. ocean heat content) . As an exit ticket for this portion of the lesson, students will be asked to respond on an index card to the following question "WHY does ocean warming and sea level rise both increase over time? Do you think one is causing the other? Explain". Teacher will return exit tickets at the start of the next class. 2) During the next class, teacher will return exit tickets and facilitate class discussion about exit ticket answers. Students will discuss how they believe ocean warming relates to sea level rise and if one causes the other. Teacher will then explain the Thermal Expansion Lab activity. Students will work in groups of 3-4 to participate in this lab. Students will measure the height of water in a water bottle as the water bottle is under a heat source. Students will collect data, analyze that data by creating a graph using

	Google Sheets and answering conclusion questions. *Lab activity worksheet is attached to the end of this lesson plan*. **Modifications:** Students who struggle with deeper thinking and analysis will be paired heterogeneously with higher level students to receive the support they need. For higher level students: 4) Students will have the opportunity to create the Google Sheet graph on their own, without teacher scaffolding 5) Students will be asked to create their own data table, without one being provided for them. Students could also have an extension question where they research where sea level rise is occurring the most and why. 6) Student will research and find another relevant dataset to graph to support (or refute) their conclusion For lower level students: 4) Teacher will assist students in creating the Google Sheet graph for the second, independent data set 5) Students will be provided the data table partially filled out (with the time intervals included) as a scaffold. Teacher will provide students with scaffolds for how to answer conclusion questions. **Formative/Summative Assessments:** 1) As students are working through their analysis of the data sets, the teacher will walk around the room and meet with each group. This will allow the teacher to ask scaffolding questions and gauge the understanding of all students. Teacher will have a list of premade questions to ask each student, to formatively assess each students understanding. Teacher will look over exit ticket to see how well students understand the relationship between sea level rise and ocean warming 2) As students are working through their lab activities and analysis, the teacher will circulate around the room and meet with each group to ask scaffolding questions and gauge understanding

	of each student. **Resources:** Data sets (Sea Level Height Data Spreadsheet and Ocean Warming Monthly Variation Data Spreadsheet), Part 1 worksheet, Part 2 worksheet
Explain	**Procedure:** As a conclusion to this assignment, students will be asked to create a PSA (public service announcement) poster about sea level rise and ocean warming. Students can choose how they create their PSA (Google Slides, drawing/painting on paper, podcast, commercial, etc). In their PSA, students will need to: 1) **define** the relationship between sea level rise and ocean warming, 2) **explain** and support the relationship using their graphs, 3) **identify** two negative impacts that sea level rise can have on a surrounding area and 4) **propose** a way to mitigate the effects of sea level rise/flooding. Students will be given some class time (following the Thermal Expansion Lab) to complete this assignment, but the rest will be finished for homework. PSA *Instruction document and rubric are attached at the end of the lesson plan.* **Modifications:** Students get to choose how they do their PSA, so all students get to demonstrate their learning in a way that makes the most sense to them. Students who are ELLs can create their PSA in their home language as well as in English. **Formative/Summative Assessments:** As students are completing their PSAs, teacher will circulate around the room and meet with each student and ask scaffolding questions about their PSA. Teacher will have a list of premade questions to ask each student, to formatively assess each students understanding. Teacher can then identify the struggling students and overall topics that most students missed. **Resources:** Worksheet

Elaborate	**Procedure:** As an extension to this project, students will build and test their proposed solutions to combat flooding from their PSA. Students will work in groups of 3-4 students - students will work with those who had the same or similar proposals. Students will first fill out the “STEM Challenge”, which walks the students through a simplified version of the engineering process. *STEM Challenge worksheet attached at the end of the lesson plan.* Students first fill out the “ask” portion, where they would come up with a question having to do with their proposal (ex. How can we change the foundation of a house to withstand a flash flood). Students then fill out the “imagine” section, which is a detailed explanation of their proposal. Students then fill out the “plan”, where they write a methodology for how they will build their proposal. Students can use any materials that they have at home or at school to build their proposal. Students could also choose to create their design digitally using Minecraft EDU (if they have experience from other classes using this site). Students can include a picture of their project for the “create” section. Students then will test their design by seeing if their design could withstand/mitigate a “flash flood”. To demonstrate this, student will place their design in a long, plastic bin. Teacher will place one end of the bin under the faucet. When the faucet turns on, the water will enter the bin and travel towards the design, simulating a flood. Students will observe how their design held up, and write down ways they would change their design in the “improve” section of the worksheet. As a conclusion to this assignment, students need to write a “mini” research paper. They need to explain what they did to build their design, the results of the experiment, what the next steps are and why their project is important. Instructions and rubric will be provided in a document. *Instruction and rubric document included at the end of the lesson plan.* **Modifications:** For struggling students: ● Group heterogeneously with higher level students to give support ● Add scaffolds to the “STEM Challenge” worksheet to aid with filling out information

	For higher level students: ● Give research extension to see if their groups' proposal has been studied and compare the published methodology to their groups methodology. Use published work to frame next steps Students who do not have access to material at home can use material that is available at school and teacher can get material that student does not have access to on their own. **Standards Addressed:** **NGSS3-5-ETS1-3** - Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. **NGSS3-5-ETS1-1** - Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **NGSS3-5-ETS1-2** - Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. **Formative/Summative Assessments:** Teacher will circulate between groups as groups are working on their projects to ask scaffolding questions and gauge student understanding. **Resources:** "STEM Challenge" worksheet (published by Meredith Anderson)

Evaluate	**Procedure:**Students will be given grades for the following: • Relationship Between Sea Level Rise and Ocean Warming PSA - rubric • Designing and Building a Flood Mitigation Prototype - rubric ** *all rubrics are attached at the end of the lesson plan* **Resources:** Rubrics

REFERENCES

American Association for the Advancement of Science. "Chapter 2: The Nature of Mathematics." *Science for All Americans Online*, 1990, https://www.project2061.org/publications/sfaa/online/chap2.htm. Accessed 9 July 2025.

Dirksen, D. J. (2011). Hitting the Reset Button: Using Formative Assessment to Guide Instruction. Phi Delta Kappan, 92(7), 26-31.

NASA Goddard, director. *High Tide Flooding*. 2021. *Youtube*, https://www.youtube.com/watch?v=G-ZodfZ-mdU&t=367s. Accessed 9 July 2025.

Tavernier, Lyle. "Thermal Expansion Model - Science Lesson." *NASA*, 5 November 2024, https://www.jpl.nasa.gov/edu/resources/lesson-plan/t

https://www.gettyimages.com/photos/july-2025-central-texas-floods

Links to Materials for Lesson:
Hook/Intro Presentation
Data Set Google Sheets (for creating graphs)
STEM Challenge (adopted from Meredith Anderson)

Guadalupe River Flood Brainstorming Document

Image Number	**Brainstorm** ***List 1-3 words that come to mind when you view each image***
1	
2	
3	
4	
5	
6	
7	
8	

Determining the Relationship Between Sea Level Rising and Ocean Warming: Data Analysis

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Purpose: Flash flooding is a dangerous weather event that is becoming more common. Experts believe that flash flooding is happening more often due to rising sea levels. In this activity, students will:

- *Analyze* data for sea level rise and ocean warming to determine a relationship
- *Explain* the relationship between sea level rise and ocean warming
- *Demonstrate* the data in an easy to understand way

Directions: Look at the data for Sea Level Height and Ocean Warming Monthly Variation Data (spreadsheets are linked above and posted on Google Classroom). Use the data to answer the following questions.
Important information regarding the data sets can be found linked below (and on Google Classroom):

Sea Level Height Data Information
Ocean Warming Monthly Variation Data Information

Questions:

1. What is the relationship between time (years) and sea level height?

2. What is the relationship between time (years) and ocean warming?

3. Based on the data sets provided, what is the relationship between sea level rise and ocean warming? Use evidence from the data set to support your answer.

4. How did you come up with your answer to the question above? Describe the steps your group took to determine the relationship between the two data sets. *Be as specific in the description of your steps as possible.*

Thermal Expansion Lab

Objective:

Students will simulate ocean warming by building a simple model that demonstrates how water expands when heated—and discuss its implications for sea-level rise.

Materials:

- 1 transparent disposable plastic bottle (500 mL–1 L). *Small bottles made with thicker, sturdier plastic are preferred*
- 1 clear straw (fits securely through bottle cap)
- Food coloring
- Ruler
- Dark felt-tip pen
- Thermometer
- Several low-temperature hot-glue guns, putty or other malleable sealant
- Paper or cloth towels
- Safety goggles
- Heat sources (such as incandescent bulbs, heat lamps, heat pads or the Sun)

Procedure:

1. **Assemble model:**
    - Insert the straw through a hole in the cap (straw should extend down approximately 2-3 inches into the bottle when the cap is on). Seal with clay so only water can rise in the straw.
    - Fill the bottle with water completely to the rim and add food coloring. Top with the straw and cap assembly and tighten (the water in the straw should be above slightly above the cap).

- Mark the initial straw water level with the ruler.

2. **Collect baseline readings:**
    - Record the starting water level and temperature in the bottle.
3. **Apply heat:**
    - Heat water bottle by placing it near a hair dryer or direct sunlight.
    - Observe and record the new water level and temperature every 20 seconds for 5 minutes. Record data in data table below.

Data Table:

Time	Temperature	Water Height

Data Analysis:

Create a graph with Google Sheets using the data collected above. Insert graph below and link spreadsheet.

Conclusion Questions:

1. How did the water level in the straw change while heating the bottle?
2. Explain why the water level in the straw changed over time. What caused this?
3. How does this model relate to real-world ocean warming and sea-level rise?
4. Discuss how ocean thermal expansion, combined with melting ice, affects coastal ecosystems and communities.
5. Suggest two ways to improve the accuracy of this lab?

Adopted from: https://www.jpl.nasa.gov/edu/resources/lesson-plan/thermal-expansion-model/

Relationship Between Sea Level Rise and Ocean Warming Activity Conclusion

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Purpose: After analyzing the data sets for Sea Level Rise and Ocean Warming, and completing the Thermal Expansion Lab, you are now considerably more knowledgeable about how ocean warming can impact sea level rise. Your job is now to relay the information you learned to the public. **You must create a PSA (public service announcement) about the relationship between sea level rise and ocean warming and how this can affect flash flooding.**

You may choose any mode for your PSA (example: Google Slides, painting/drawing, newspaper article, letter to a local politician, commercial, podcast, etc.) Be creative - I don't just want to read a paragraph!

Your PSA must include the following:

1) **Define** the relationship between sea level rise and ocean warming
2) **Explain** and support the relationship using graphs
3) **Identify** two negative impacts that sea level rise can have on a surrounding area
4) **Propose** a way to mitigate the effects of sea level rise/flooding
5) **Creativity** - your work should be creative and engaging

Please refer to the rubric on the next page for grading.

Category	Exemplary	Proficient	Developing	Points
1. Scientific Explanation Defines the relationship between sea level rise and ocean warming *(10 points)*	Clearly and accurately defines how ocean warming causes sea level rise (e.g., thermal expansion, melting glaciers); shows deep understanding.	Provides a mostly accurate explanation; may miss one scientific detail or use vague terminology.	Explanation is unclear, inaccurate, or overly simplistic.	___ / 10
2. Real-World Impacts Identifies two negative effects of sea level rise on communities or ecosystems *(20 points)*	Two well-explained, relevant, and specific impacts with scientific or geographic detail.	Two impacts are listed with limited explanation or detail.	One or both impacts are vague, inaccurate, or missing.	___ / 20
3. Mitigation Strategy Proposes at least one realistic, science-based method to reduce or adapt to sea level rise or flooding *(20 points)*	Clear, feasible solution that reflects real-world practices (e.g., green infrastructure, seawalls, policy change); well explained.	Solution is somewhat realistic but may lack full explanation or detail.	Solution is vague, unrealistic, or not explained.	___ / 20
4. Creativity & Presentation Format is engaging and thoughtfully chosen *(10 points)*	Format is original, well-executed, and engaging; effort and thoughtfulness are clearly evident.	Format is appropriate but may lack strong creative elements or polish.	Format is plain or poorly executed; minimal effort or engagement.	___ / 10

Final Score: ___ / 50

Designing & Building a Flood Mitigation Prototype: Project Instructions

Objective:

Design, build, and test a prototype that addresses a real-world flooding problem using environmental science and engineering principles. Your solution should aim to reduce/mitigate the impact of flash flooding. You will use the proposal from your PSA and the “STEM Challenge” worksheet to accomplish this assignment.

Step 1: Identify the Problem

- On your “STEM Challenge” worksheet, fill in the “ask” box with the question/problem you are trying to solve.
    - Your question/problem should relate to mitigating flash flooding.
    - Make sure your question is specific!

Step 2: Design Your Solution

- On your “STEM Challenge” worksheet, fill in the “Imagine” bubble with your proposal. This proposal can be the same as the one you included in your PSA, or it can be tweaked or completely different.
    - Make sure your proposal is detailed and BUILDABLE!

Step 3: Build the Prototype

- On your “STEM Challenge” worksheet, write a detailed methodology in your “plan” box for how you are going to build your prototype. Make sure your plan is specific: list the materials you need (and how much the materials cost), how you are going to build the prototype, steps you are going to take, etc.

- Once your teacher approves your plan, you may:
    - Gather materials (use recyclable or low-cost items where possible).
    - Build a **small-scale model** that reflects your proposed solution.
    - Make sure the model is stable and safe to test with water.
- Take a photo of your prototype (or draw it) and paste it in the “create” box of your worksheet

Examples of materials you can use:

- Plastic trays, sponges, cardboard, sand, soil, gravel, mesh, straws, bottles, cups, etc.

Step 4: Test Your Prototype

- Simulate flooding (place prototype in a long, plastic bin. Teacher will place one end of the bin under the faucet. When the faucet turns on, the water will enter the bin and travel towards the design, simulating a flood)
- Observe how your design manages or redirects the water.
- Measure and record the following:
    - How long the prototype is able to withstand the water
    - Any weak points or failures in the model (record this in the “improvement” section of the “STEM Challenge” worksheet

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Step 6: “Mini” Research Paper

Your final product should include:

- A clear explanation of the problem you chose
- Your design plan (diagram + written description)
- Photos or evidence of your prototype
- Testing data and what it shows
- Any improvements you would like to make/next steps and your reflections
- A conclusion: Why is solving this problem important?

Engineering Project Rubric: Flood Mitigation Proposal **Total ____ / 32**

Criteria	Exemplary (4)	Proficient (3)	Developing (2)	Beginning (1)
Problem Definition & Research	Clearly identifies a local or global flooding issue, backed by strong research and environmental relevance; explains causes and consequences.	Identifies a relevant flooding issue with basic research and context.	Problem is loosely defined; minimal or unclear research.	Problem is unclear, unrelated, or lacks any research.
Solution Design & Planning	Innovative, well-reasoned plan with detailed diagrams and clear rationale; includes materials list and cost and explanation of how it mitigates flooding.	Design addresses the flooding issue and includes most relevant planning components.	Design is incomplete or lacks clear explanation of purpose.	Design lacks feasibility, clarity, or planning details.
Prototype Construction	High-quality, well-constructed prototype that accurately represents the proposed solution and is durable for testing.	Prototype is functional and mostly well-built with minor issues.	Prototype is built but has major issues that affect its function.	Prototype is incomplete, unsafe, or nonfunctional.
Testing & Data Collection	Testing method is well-designed and repeated; data collection is clear, accurate, and relevant to assessing flood mitigation performance.	Testing is conducted with mostly relevant data collection.	Testing is minimal or data is incomplete or inconsistent.	No clear testing or data collection conducted.

Scientific and Environmental Understanding	Demonstrates deep understanding of flood dynamics, water flow, and mitigation strategies (e.g., permeability, runoff, infrastructure).	Shows understanding of key environmental science concepts related to flooding.	Basic or partial understanding; may include misconceptions.	Lacks understanding of relevant environmental science concepts.
Iteration & Next Steps	Meaningful improvements brainstormed based on test results; clearly documents changes and explains reasoning.	Some changes brainstormed to improve the design; limited documentation.	Few or ineffective changes brainstormed; reasoning not clear.	No redesign or improvements brainstormed.
Effectiveness of Solution	Prototype demonstrates strong potential to reduce or redirect flooding; clearly aligns with stated goals.	Prototype shows moderate effectiveness in mitigating flooding.	Prototype has limited impact or unclear effectiveness.	Prototype does not demonstrate impact or does not relate to problem.
Presentation & Communication	Final report or presentation is well-organized, visually clear, and includes visuals, data, analysis, and reflections; demonstrates professional effort.	Includes most required elements with clear communication.	Some missing or unclear elements in the final presentation.	Incomplete, disorganized, or unclear presentation.

Scoring Guide:

- **28–32:** Advanced – Exceptional solution and scientific reasoning; strong testing and presentation.
- **22–27:** Proficient – Solid, functional project with thoughtful construction and good understanding.
- **16–21:** Developing – Partially complete with limited testing or application.
- **Below 16:** Beginning – Incomplete project or little evidence of learning and problem-solving.