Sea Level Rise

Where will the water go?

Grade Level: 9th – 12th

Lesson Summary:

Climate change has a multitude of effects, one being the increase in sea level. This lesson explains why sea levels are rising, explains the impacts on coastal communities, and explores some of the laws that could be making the situation worse. Students perform three tasks related to the topic through a "Tic Tac Toe Choice Board."

Standards:

SC.912.L.17.4 – Describe changes in ecosystems resulting from seasonal variations, climate change and succession.

SC.912.L.17.12 – Discuss the political, social, and environmental consequences of sustainable use of land.

SC.912.L.17.14 – Assess the need for adequate waste management strategies.

SC.912.L.17.16 – Discuss the large-scale environmental impacts resulting from human activity, including waste spills, runoff, greenhouse gases, ozone depletion, and surface and groundwater pollution.

LAFS.1112.WHST.3.8 – Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text.

LAFS.1112.WHST.3.9 – Draw evidence from informational texts to support analysis, reflection, and research.

Project Activity Assessment

Student choice is an excellent way to help your students dive deeper into complex issues such as sea level rise. Giving students the ability to choose their learning path allows for greater buy-in on their part as well as improved final product quality. This Tic Tac Toe activity is developed in a way that learners of various types of abilities and interests have the opportunity to choose what activities they will complete. There are activities that require additional research; some require creative ability while others only require the student to use the information presented in a video or reading. Students drive their own, personal learning experience in learning menus. If done digitally, this format also allows for the creation of a Google folder on sea level rise for a digital gallery walk of student work. This would allow students to see each other's responses and learning related to the topic.

Procedure:

- Students should read the "Sea Level Rise" document prior to class, taking notes and referring to the vocabulary listed at the bottom of the reading.
- Refer to the "Tic Tac Toe" choice board, and explain that each student must complete 2 boxes in addition to box 5. By all students participating in box 5, you have the ability to start here, come back together for a class discussion before moving on or coming together after assignment completion for the discussion.
- Below you will find a brief overview of each block, the purpose of the task as well as additional extension activities if you choose to add them.

Sea Level Rise Lesson Instructions:

Box	Purpose of the task	Extension activities
1 Experiment. In the lab, students fill containers of water to a certain level, and measure the water temperature. They place the water on a burner. As the water heats, the students take the temperature and measure how much higher the water stands in the vessel every two minutes. Teachers explain the atomic dynamics of thermal expansion as the water and water temperatures rise. Students then add measured amounts of ice to the vessel, melt them while increasing the heat, and determine rates of additional rise in the vessel.	This activity demonstrates the idea of thermal expansion, and also demonstrates what happens when ice is present, such as in Arctic ecosystems. This also reinforces the importance of temperature in any system- warmer temperatures make ions move faster, and colder temperatures slow ions down. **Materials necessary:** Glassware, Bunsen burner, thermometer, water, ice, tool for measuring	You could make this into a more formal scientific experiment by having students write up their hypothesis about what they expected to see and why; describe their experimental set up and protocols; and incorporate controls (non-heated water).
2 Write Using the referenced journal article about the "Castles in the Sand" case," students identify the implications of one to three of these rulings for future coastal management. Students write short essays about one, two, or three rulings.	This activity allows students to dive deeper into the laws behind environmental protections, using "Castles in the Sand" as a case study. This may be well suited to students that are more comfortable working by themselves or prefer to read and write, and students who are interested in law.	You may have students work in groups, and have each group present to the class about one of the rulings. Ideally, students would be divided into three groups, where each group would present about one of the three rulings.
3 Research and Write Students visit or research a greenhouse, learn how one works, and write a short essay comparing a greenhouse to the earth's atmosphere. Essays must include at least three vocabulary words provided in this lesson.	This activity allows students to learn about the greenhouse effect and how it works through individual investigation. This activity is ideal for students struggling to understand this concept, as the greenhouse effect is an important part of sea level rise and climate change as a whole.	Students may create a model greenhouse to see the greenhouse effect for themselves. To do this, they can cut the tops off of two 2L soda bottles, put soil and a thermometer in each, and leave one soda bottle uncovered while covering the other soda bottle with plastic wrap and securing it with a rubber band. Alternatively – let the student get creative and make their own model!

4 Create Students create an infographic for the general public about the causes and effects of SLR. This should include a "hook" title, should briefly describe one or two causes of SLR (there are many causes, but keep it simple!) in simple terms, and focus on ONE major effect of SLR. The infographic should also include a "call to action" that tells the audience what THEY can do to help.	This activity is well suited to creative students interested in public outreach, education, and marketing. This is a fun way for students to learn about SLR in more depth, and also become familiar with tools such as PowerPoint. Infographics such as this can be made easily as a single slide in PowerPoint, and it is recommended that the students look at other infographics to get an idea of what theirs might look like.	This can be expanded into a "lightning talk," where students have 3-5 minutes to explain their infographic to the class. Their talk should explain why SLR occurs, how it affects their chosen system, and what the public can do to help. Questions by the audience are encouraged!
5 Create and Experiment Students in groups build a beach with sand in a paint pan or plastic tub, leaving a few inches for the "beach" to migrate backwards. Fill the pan with water so that it overlaps the beach. Create waves using a fan or other instrument, and observe how the beach behaves. Next, rebuild the beach in its original position. Then, using blocks or any hard material, build a "seawall" on the beach face. Turn the fan back on and report on the differences in how the beach responded.	This is a fun way to see how coastal erosion works, and help them understand that erosion is natural. The unnatural structures will provide a great visual of how humans interfere with nature, and the consequences of well-intentioned actions when it comes to our environment. **Materials necessary:** Water-tight container, sand, water, fan, hard materials to simulate seawall.	Students can glue toothpicks to the bottom of the pan around the area where the "beach" is, or further up on land. These will represent mangroves and other rooting plants. They can create different sections of beach where mangroves are very abundant and where mangroves are sparse or absent. Students should explain (orally or in a short essay) how mangroves prevent erosion based on what they observed.
6 Research and Write Students research and write five-paragraph essays that explore how sea-level rise and two other stressors discussed in this lesson work together to damage essential fish habitats.	This item is ideal for students who prefer to work by themselves, and still provides a great opportunity to learn more about the topic.	The student could take the information researched and create a short news story, blog post or other written product which could be shared in a school newspaper, a class newsletter or similar outlet.
7 Investigate Students visit a site with essential fish habitat including seagrass, mangroves, and nearshore reefs, and then visit a sea wall or other hard structure. They then team up to create a short public outreach presentation on the relative benefits they observed as provided by natural resources vs. manmade structures. This may be in the form of a video or in-class presentation, but should include 1 suggestion of how the public can help.	This item is geared towards students with an interest in relationship building, public speaking or conservation. This is an opportunity to see the effects of coastal development firsthand, and build a direct connection between the lesson and the students' own community.	This task may be expanded into a mini campaign that includes fliers, a video posted on YouTube or the school website, or other public outreach activities that involve sharing information from the lesson in a creative form to people other than classmates. This is recommended as a group project.
8 Write Letters Students write letters to their members of Congress articulating their concerns about sea-level rise and other climate-related stressors.	This is an opportunity for students to participate in making change in their community. Students must gain a firm understanding of the topic and write a well-crafted letter to convince the Congress member to support their cause. More information, contact information for government officials, and a recommended outline can be found here: https://citizensclimatelobby.org/write-congress-about-climate-change/#/7/	Students can research ways to get involved with local government, and in groups or as a class field trip attend a public event. This is an excellent way to encourage students to get to know their community and their local politicians, as well as understand local legislature relating to climate change and SLR.

9 Create Create a visualization of the impacts of SRL on a geographic location of your choice. This may be a map in GIS, an image created with an editing software, a drawing, a piece of art, or anything else you can think of that someone can look at to see the effects of SLR on a community.	This task is specific to a student who enjoys being creative, and is very open-ended. This gives the student an opportunity to use a tool they enjoy to teach others about this lesson.	Combine with topics from other lesson plans and have students participate in an art show for parents and friends to attend. Topics could include climate change as a whole or anthropogenic effects on the earth.

Project Activity Rubric

AREA	1 Does Not Meet Expectations	2 Partially Meets Expectations	3 Meets Expectations	4 Exceeds Expectations
Science Content	NONE. Student does not exhibit or express the concepts of SLR with clear and defined examples.	SOME. Student exhibits a basic understanding of SLR but does not convey its problems.	MOST. Student grasps the concepts SLR but lacks mastery of the subject.	ALL. Student grasps the principles of SLR. Student can draw comparisons.
Use of Scientific Vocabulary	NONE. Student does not use any introduced concept or use scientific vocabulary to form thoughts and narrative.	SOME. Student attempts to use scientific jargon, but fails to use it properly or in context. Shows some mastery of science language, but fails to use effectively.	MOST. Student uses significant scientific jargon, but fails to identify all principles and concepts. Student exhibits some mastery of scientific concepts and vocabulary.	ALL. Student effectively communicates using scientific jargon and vocabulary to convey narrative. Student has achieved mastery of vocabulary and concepts.
Project completeness	Project was missing more than one major component OR prompts were not answered.	Project was missing one major component OR prompts were not fully answered.	Project contained all components but they were not as complete as they should have been, OR answers to prompts were missing a few key details.	Project or answer to prompt was fully completed, and all important information was present.
Conventions	Spelling, capitalization, and punctuation issues are significant and distract from clear communication and narrative.	Spelling, capitalization, and punctuation errors are present and distract from the story's narrative.	Few spelling, capitalization, and punctuation errors.	No spelling, capitalization, or punctuation errors.