Why is the sea level rising?

Middle School  •  Discipline: ES  •  Time: One 50-minute class periods

Lesson Level Performance Expectation:
Develop a model to explain the effects of global warming and how it leads to sea level rise.

What Students Will Figure Out
• Gather and synthesize information from multiple sources to develop a model that explains the change in Earth’s shorelines.
• Develop a model to explain the interactions among Earth’s systems and their effects on humans.

Lesson Snapshot:
Students are introduced to sea level rise and its effects on the planet, especially coastal areas. Students research the effects of global warming and how this has led to an increase in ocean temperatures. Students develop a systems model to explain the relationships among increased carbon emissions, global warming, and sea level rise. Finally, students discuss ways global warming and climate change could be mitigated by human action.
Phenomenon: Sea level is rising.

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<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
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<tr>
<td>Developing and Using Models</td>
<td>ESS3.B: Natural Hazards</td>
<td>Cause and Effect</td>
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<tr>
<td>• Develop and/or use a model to predict and/or describe phenomena.</td>
<td>• Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces, can help forecast the locations and likelihoods of future events.</td>
<td>• Phenomena may have more than one cause. and some cause and effect relationships in systems can only be described using probability.</td>
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<td>Constructing Explanations</td>
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<td>System and System Models</td>
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<td>• Construct an explanation using models or representations.</td>
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<td>• Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy, matter, and information flows within systems.</td>
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This lesson could be one in a series of lessons building toward the following:

MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures; atmospheric levels of gases, such as carbon dioxide and methane; and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Materials

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<th>Student Materials</th>
<th>Teacher Materials</th>
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<tr>
<td>Per Student</td>
<td>Whole Group Graphics</td>
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<tr>
<td>• Science notebook</td>
<td>Why is the coastline changing? Slide Deck</td>
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<tr>
<td>• Examining Sea level Rise Exposure for Future Populations Map</td>
<td>Film—OBP Saving Our Shores</td>
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<td>• National Assessment of Coastal Vulnerability of Sea Level Rise: Atlantic, Pacific, and Gulf of Mexico Coasts Map</td>
<td>NASA Climate Kids video—What Causes Sea Level Rise?</td>
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<td>Per Small Group (2 to 4 students)</td>
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<tr>
<td>• Whiteboard or large sheet of paper</td>
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<td>• Markers</td>
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Lesson Preparation

Lesson Sequencing
This lesson could be taught as a stand-alone lesson or as part of a larger instructional sequence that addresses additional student ideas and questions that will likely emerge during the lesson. This lesson could launch into lessons to develop ideas about the following:

• Physical Science—thermal energy, temperature and particle motion
• Earth Science—greenhouse effect, hurricanes (and other severe weather)
• Social Studies—forced migration of people

If this lesson is being used to launch a lesson set, consider showing the film at the end of the set, instead of at the end of this lesson.

Material Preparation

• Have graphics ready to project. Printed copies may also be necessary for students with vision impairments or time needs.
• Have the film queued.
• Have print or digital copies of the student sheets that accompany the readings/video in step 5.
• Assign readings/videos to students, and send out links to students or have them posted on the class platform.
Experience the Phenomenon

What Students are Doing

In this section, students are introduced to the global issue of sea level rise using some infographics. Students notice and wonder about the information they are given and create an initial model to begin to explain sea level rise and how it affects coastal areas.

Teacher Guidance

1. Students experience the phenomenon of sea level rise through a film clip, infographic, and computer simulation data.

   In their science notebooks, students make a T-chart to record observations and questions.
   
   - Share a short film clip from Our Beautiful Planet: Saving Our Shores (00:00–00:25).
   - Project the infographic on slide 1, and ask students to add observations. Suggest that students connect observations from the infographic and observations from the video clip (using words, pictures, symbols, etc.).

   Next, introduce students to the data presented in the Examining Sea Level Rise Exposure for Future Populations Map and the National Assessment of Coastal Vulnerability of Sea Level Rise: Atlantic, Pacific, and Gulf of Mexico Coasts Map (slides 2 and 3). Consider asking students to work with a partner to make and record observations. The following prompts can be used to support students in making observations and identifying patterns:
   
   - What data is represented on the map?
   - What is the scale?
   - What are the lowest and highest values on the scale? How are these values represented on the map?
   - What patterns do you observe on the map?
   - What patterns do you observe between the maps?

2. Students briefly share their observations in small groups and prepare to share these observations with the class.

   Ask students to share their observations with their group members. Tell students that they can add observations and questions to their notebooks. Have each group share what they noticed. Consider asking each group to share one noticing at a time; once all groups have shared, allow groups to also share any observations not yet reported. Capture observations in a public space (on a poster, whiteboard, etc.).

   Sample Student Observations
   
   - Climate change might cause millions of people to be underwater by 2050.
   - A lot of people live near the coast.
   - Not all of the places at risk are right on the coast.
   - Some places located right on the coast are green and not at risk.
   - A lot of people in southern Florida will be affected by sea level rise.
   - The middle of the country is gone from the map. Does sea level rise not affect people living there?
   - At least two feet of sea level rise is predicted to happen by 2100.
   - The map shows people at risk if sea level rises 3 feet.
   - One of the infographics mentioned that reducing emissions could lower the risk for sea level rise.

3. Ask students to share with a partner what they think they know about what is causing sea level rise.

   Student background knowledge will vary, but many will share what they know about ice melting, carbon emissions, changes in weather, and experiences with storms and/or flooding.

   Ask students to share their ideas about sea level rise. Record the sharings, and ask students to signal if they had the same or similar idea (hands up, thumbs up, etc.). Continue in this manner until all ideas have been acknowledged.

   Capture any questions that arise on chart paper or a board, and make sure they are easily visible to all students.
4. Students create an initial model in small groups.

Ask students, “Can we use science ideas and evidence to explain why sea level is rising?”

Tell students to individually create a must-have list of components (parts) and relationships among components they think should be represented on the model.

Next, assign students to small groups. Ask students to share their must-have lists and reach consensus on the components and relationships they think are needed to explain why sea level is rising. Invite students to use words, pictures, symbols, color, etc., to communicate their thinking.

5. Identify areas of disagreement among group models.

Instruct students to share their model with at least one other group and record similarities and differences. Bring the class back together, and ask groups to share areas of disagreement. Record these areas and use them to navigate to the next part of the lesson.

Sample Prompt for Navigation

Some groups included climate change in their models, but did not represent the relationship between climate change and sea level rise (or if groups represented different relationships, point that out). Does it make sense to investigate this relationship first?

Additional Guidance

Class discussion and/or initial consensus models may reveal partial conceptions (incomplete ideas) or misconceptions held by students. These partial conceptions and misconceptions should not be directly addressed at this point. Students will have the opportunity to use evidence and scientific information presented in the lesson to change their minds and/or build on science ideas throughout the lesson.

Investigate the Phenomenon

What Students are Doing

In this section, students watch a short video and revise their models based on their new understanding.

Teacher Guidance

6. Share a video that provides more information about the relationship between sea level rise and climate change. Provide an opportunity for students to revise their models.

Play the NASA Climate Kids video What Causes Sea Level Rise? After watching the video, give students the opportunity to return to their group models and make additions or changes based on the information provided. Support students in revising their models using one or more of the following prompts.

• What additional components are necessary to explain why sea level is rising?
• Does your model contain components that are not needed to explain why sea level is rising?
• What additional relationships among components do you need to explain why sea level is rising?

Listen and Look For

• Local Sea Level is the average height of the ocean at a specific place.
• Ocean water is getting warmer, causing the water to expand. This raises sea level.
• Earth is getting warmer, which is causing land ice to melt into the ocean. More water in the ocean makes sea level rise.
Sample New Student Questions

- Why does water expand when it is hot?
- How do satellites measure global sea level?
- Why is Earth getting warmer?

7. **Return to the class record of “what we think we know” about sea level rise to determine what ideas are supported by evidence and/or scientific information.**

   Ask students which ideas about sea level rise—shared at the beginning of the lesson—they can support with evidence and/or scientific information.

**Additional Guidance**

In some of the clips, thermal energy is referred to as heat energy. In the NGSS, it is stated,

**PS3.A: Definitions of Energy**—The term heat as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.

You will need to be explicit with students that when explaining science ideas in this class, you will use the term thermal energy.

**Explain the Phenomenon**

**What Students Are Doing**

In this section, students use their models to write an sea level rise explanation. They watch the Our Beautiful Planet film *Saving Our Shores* and consider additional questions they could investigate to further develop their model of sea level rise.

**Teacher Guidance**

8. **Direct students to use their group model to write an individual explanation that answers this question: Why is sea level rising?**

   **Sample Student Explanation**

   Two reasons why sea level is rising are melting ice on land and water expanding. Both of these causes are connected to climate change. Temperatures are increasing, which is causing ice on land to melt into the oceans and increase the amount of water in the oceans. The increase in temperature is also causing the water to get hotter, which causes it to expand and take up more space.

9. **Play the film Our Beautiful Planet Saving Our Shores.**

   Return to the questions captured in Step 3 and ask students which questions they can answer using gathered evidence and/or scientific information presented in the film or the NASA video.

   **Note:** New questions that arise from the film could be used to navigate to the next lesson(s) in an instructional sequence.

   Ask students if the film confirmed their explanation of the phenomenon of sea level rise.

   Tell students, “It looks like we’ve got a handle on how the sea level rises, but do we know why the global temperatures are rising? After watching the film, does it seem like sea level rise is the only thing affecting people who are living on the coast? Do you think all of these issues are related? What would we need to do to figure this out?”

   Tell students, “We have some of the pieces of the model,” and ask, “What other things do we still need to investigate?” Ask students to work together as a class to create a list of things that they still need to figure out.

   **Sample Student Responses**

   - Why are global temperatures increasing?
   - Why does water expand when it gets warm?
   - How do increased global temperatures affect the number and severity of hurricanes?
• Does sea level rise affect places that aren’t close to the coast?
• Where will people who live on the coasts go?

**Additional Guidance: Using Sea-Level Rise as an Anchoring Phenomenon**

After watching the film, students will likely have many new questions that they would like to investigate. This lesson could be a springboard for several different lines of questions. If using this as an anchoring phenomenon lesson for a larger unit, instead of listing questions, have students co-construct a Driving Questions Board to motivate future investigations. Which questions you choose to pursue with your students will depend on the science ideas you are using this anchoring phenomenon to target.