NATIONAL GEOGRAPHIC

**RESOURCE LIBRARY**
ACTIVITY : 1 HR 15 MINS

# Sea Level: The Evidence

Students watch a video to identify and describe the effects of rising sea levels. Next, they use a graph of sea level data to predict future sea level changes. Finally, they write an evidence-based prediction to help non-scientists understand these changes and read articles to identify adaptation strategies for sea level rise.

**GRADES**

6 - 8

**SUBJECTS**

*Earth Science, Climatology, Oceanography*

**CONTENTS**

1 Resource, 1 Link, 2 PDFs

## OVERVIEW

Students watch a video to identify and describe the effects of rising sea levels. Next, they use a graph of sea level data to predict future sea level changes. Finally, they write an evidence-based prediction to help non-scientists understand these changes and read articles to identify adaptation strategies for sea level rise.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/sea-level-evidence/

## In collaboration with

educurious
learning that connects

## DIRECTIONS

*This activity is part of the Climate Change Challenge unit.*

**1. Show a video and prompt students to identify and describe in detail the effects of sea level rise.**

- Ask students to recall information related to sea level rise, and brainstorm possible effects of this change:
    - *Why is sea level rising in some places around the world?*
    - *In coastal cities or towns, how might the waterfront be affected if the sea level rose two feet?*
    - *How might businesses and homes be affected?* (If your state is inland, it may help to pose this question in terms of rising water levels for a local body of water, then ask students to extrapolate for the ocean.)

- Prompt students to revisit their *Ocean Impacts* handout from the *Oceanic Impacts* activity, identifying the three main effects of climate change on the oceans: ocean acidification, sea temperature rise (covered in *Ocean Acidification: The Evidence* and *Sea Temperature: The Evidence* respectively) and sea level rise (the subject of this activity).
- Explain to students that the *Sea Level Rise and Coastal Cities* video (3:16) will give greater detail on this impact. Assign students to add any new information on the causes and consequences of ocean acidification to Part 1: Causes and Part 2: Consequences of the *Ocean Impacts* handout as they watch.
- Project the video and then solicit volunteers' responses.
- In a Think-Pair-Share, ask students:
    - *Do you think sea level rise in Miami is predicted to be high or low compared to other coastal cities in the United States? Why?*

**2. Prompt students to summarize linear trends in sea level using a digital data set.**

- Distribute the *Sea Level Rise Trends* handout to students. Project the *NOAA Sea Level Trends from U.S. Stations* map. Start by examining the key below the map, which clarifies the meaning of the arrows for each major coastal city. Ask students the following questions, writing volunteers' answers in a visible location:
    - *What does a red up arrow mean in terms of predicted sea level rise?* (A red up arrow means the water is predicted to rise more than 9mm/year or 3 feet/century.)

    - *What does a green up arrow mean?* (A green up arrow means that the water is predicted to rise from just over 0 to 3 mm/year or 0 to 1 feet/century.)
    - *What does a down arrow mean?* (A down arrow means the sea is predicted actually to fall relative to the coastal land in this area. This is true for many cities in the far north, where melting glaciers actually allow the land to move up as their weight decreases. See *Tip* for more information.)

- Zoom in on Miami, the city featured in the video from Step 1. Click on the green arrow to review the precise sea level trend for this city: 2.39mm/year in the period from 1931–1981.

    - Point out to students that this is a measure of slope. For this reason, students do not need to calculate slope, as they did in the previous two activities. Prompt them to simply enter this value in the first row of the chart in Part A of their *Sea Level Rise Trends* handout.

- As students observe, remind students how to calculate the predicted sea level rise in 100 years from this value, by multiplying the slope (2.39 mm/yr) by 100 years, if current rates remain unchanged.

    - City: Miami
    - Slope = m: *2.39 mm/yr*
    - Sea level change in 100 years = 100 (m): 239 mm

- Visualize this by marking, with tape on the wall, the height of water in Miami 100 years from now.
- In pairs, have students look up an additional city to determine its recent sea level rise trend. Calculate the predicted sea level rise in 100 years, if current trends continue, with their partner.

    - Encourage pairs to choose different cities from one another so a wide variety of sea level rise trends are represented.

- Direct pairs of students to add to the visualization of sea level rise by marking their cities' predicted changes on the classroom wall with tape.
- End by supporting students as they reflect on these trends, asking:

    - *Which cities have the highest predicted sea level rise?* (Any cities with orange or red arrows from the original map will have high predicted sea level rise compared to those with green arrows).

- *How does Miami, which we know from the video will struggle with sea level rise, compare to the other cities represented here?* (Miami has a low predicted sea level rise relative to many other U.S. cities.)

**3. Model and support students as they graph linear trends in sea level and predict future sea level changes.**

- In an I Do, We Do, You Do format, beginning with Miami on the *NOAA Sea Level Trends from U.S. Stations* map, demonstrate and walk students through reading sea level data, creating a scatterplot, and adding a linear trendline (see *Tip*).
- When students have finished creating a scatterplot for one of the cities of their choice (initiating their portfolio product for this lesson), assign them to write an evidence-based statement regarding sea level trends in this city. First, students should draft it using Part B of the *Sea Level Trends* handout. Then add it immediately below their digital graph of sea level rise to help non-scientists interpret the information.
    - For example, an evidence-based statement for Miami would be: *Sea level is increasing in Miami, at a rate of 2.39 mm/year. In 100 years, the ocean there will rise 239 mm.*

**4. Direct students to examine strategies for adapting to the effects of sea level rise.**

- Ask students: *What actions do you think humans can take to adapt to sea level rise?*
- In pairs, assign students to read and annotate one of two articles about adaptation in response to sea level rise:
    - *Sea level rise, explained*
    - *As the climate crisis worsens, cities turn to parks*
- When students have finished reading, assign pairs to create a list in Part C of their *Sea Level Trends* handout. Have students include all the strategies they discovered in the two articles involving the use of technology, specifically, to fight the effects of sea level rise. Emphasize that technology can be as simple as a park and as complicated as an underground structure to hold floodwaters.
- Prompt pairs to choose at least three of these technologies the articles describe as effective and that they think will be particularly helpful to the city they focused on in the

previous step. Direct students to record them below their evidence-based prediction and graph in their portfolio product.

- Distribute the *Changing Seas Rubric* to pairs and assign them to self-assess their portfolio product (graph, evidence-based prediction, and adaptation technologies) using this tool.
- Allow students time to incorporate their findings from the rubric and ensure that each student saves a digital copy of their product, for assessment and for incorporation into their final project portfolio.
- Revisit the class *Know and Need to Know* chart to incorporate any new knowledge of sea level rise or its consequences.

# Modification

**Step 2:** If students are already familiar with the linear equation y = mx + b and how to calculate its elements, all the information necessary to predict the sea level change for a particular year is available in this dataset. Predictions for the year 2100 may be substituted for the more general predictions of sea level change over 100 years made during this step.

# Tip

**Step 2:** It may be challenging for students to understand why sea level is dropping, relative to the local landmasses, in the far northern United States. Although this is due to a variety of forces, one important driver involves melting glacial ice removing mass from on top of the land, allowing it to rise. An *image* of this process may help students to grasp its function.

# Modification

**Step 3:** If time is short, students may simply save the NOAA graph of their city's data and use this rather than creating a digital graph of their own in the portfolio product. The critical aspect of this work is students' ability to interpret and explain the trends they see!

# Tip

**Step 3:** To model the creation of a scatterplot with linear trend line from sea level data, complete the following steps:

- For a given city, click on the *Linear Trend* link under *Choose Plot* to view the data associated with this sea level trend. Then, click the *Export to CSV* button and open the

data in a spreadsheet program.
- Examine the data labels, noting that the first column contains the year, the second column contains the month, and the third column (Monthly_MSL) is the mean surface level for that month.
- Generate a simple scatterplot for the data (year and Monthly_MSL columns only) and add a linear trend line. Show the equation for this trend line on the chart. Note that the slope for this trend line should match the slope reported for each city (for example, 2.39 mm/year for Miami), but the units for the data are in meters, rather than millimeters.
- Add x- and y-axis labels, as well as a title to the chart.

# Rubric

Formally assess students' ability to graph linear trends from large datasets, to interpret trends in the data, and to explain adaptation technologies using the *Changing Seas Rubric*, to meet PE *MS-ESS3-2*: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

# Extending the Learning

Collaboration with students' math educators may help to support and extend their learning as you work with linear trends and their equations in this lesson.

## OBJECTIVES

# Subjects & Disciplines

**Earth Science**

- Climatology
- Oceanography

# Learning Objectives

Students will:

- Describe the effects of sea level rise in detail.
- Use the slope of sea level trends to make an evidence-based statement predicting future sea level change.
- Identify technologies used to adapt to sea level rise.

# Teaching Approach

- Project-based learning

# Teaching Methods

- Lab procedures
- Modeling
- Multimedia instruction

# Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
  - Life and Career Skills
    - Flexibility and Adaptability
- 21st Century Themes
  - Environmental Literacy
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Remembering
  - Understanding
- Science and Engineering Practices
  - Analyzing and interpreting data
  - Using mathematics and computational thinking

# National Standards, Principles, and Practices

### COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.W.7.1:**
Write arguments to support claims with clear reasons and relevant evidence.

## NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2: Cause and Effect:**
Cause and effect relationships may be used to predict phenomena in natural or designed systems.
• **Crosscutting Concept 4:**
Systems and system models
• **MS-ESS3-2:**
Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
• **Science and Engineering Practice 4:**
Analyzing and interpreting data
• **Science and Engineering Practice 5:**
Using mathematics and computational thinking

### Preparation

### What You'll Need

## REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per pair, Monitor/screen, Projector, Speakers

## PHYSICAL SPACE

- Classroom
- Computer lab

## SETUP

You may wish to prepare a digital copy of the data for Miami from the *NOAA Sea Level Trends from U.S. Stations* map ahead of time. It may be helpful to list the particular steps essential to completing Step 3 of this activity. This way, you can more easily model and walk students through these steps, as well as help scaffold their independent ability to graph sea level change data.

**GROUPING**

- Large-group instruction
- Large-group learning
- Small-group learning
- Small-group work

## BACKGROUND & VOCABULARY

# Background Information

Sea level rise occurs in response to global warming for two main reasons. First, heat causes the water already within oceans to expand. Second, when glaciers and other ice melts, the resulting water joins the world's oceans. Global sea level has risen already, and the rate of rise is increasing as well. However, different locations will experience different degrees of local sea level rise. In addition to causing persistent flooding in coastal areas, sea level rise can also cause greater storm surges, which can be damaging and even deadly.

Graphical representations help communicate the messages of data in visual form. Different types of graphical representations, such as bar and line graphs, are suited for use with different types of data. Labels help an audience interpret graphs. Typically, a graph should have a title, and each axis (x and y) should have a brief text description of the variable being measured.

# Prior Knowledge

[]

# Recommended Prior Activities

- Carbon All Around
- Circulation of the Seas
- Global Trends
- Heating Up
- Local Emissions
- Meteorological Models
- Now and Then

- Ocean Acidification: The Evidence
- Oceanic Impacts
- Our Greenhouse
- Plot It!
- Sea Temperature: The Evidence
- Weather Interconnections
- Weather, Meet Climate

# Vocabulary

| Term | Part of Speech | Definition |
|---|---|---|
| **carbon dioxide** | *noun* | greenhouse gas produced by animals during respiration and used by plants during photosynthesis. Carbon dioxide is also the byproduct of burning fossil fuels. |
| **climate change** | *noun* | gradual changes in all the interconnected weather elements on our planet. |
| **global warming** | *noun* | increase in the average temperature of the Earth's air and oceans. |
| **sea level rise** | *noun* | increase in the average reach of the ocean. The current sea level rise is 1.8 millimeters (.07 inch) per year. |
| **slope** | *noun* | slant, either upward or downward, from a straight or flat path. |

---

### For Further Exploration

### Instructional Content

- National Geographic: Resource Library: Collection: Climate Change
- National Geographic: Resource Library: Collection: Climate
- National Geographic: Resource Library: Collection: Catastrophic Weather Events
- National Geographic: Resource Library: Collection: Weather