

Topics

Climate Change, Sea-level Rise

Grades

9-12

Duration

60 minutes

Materials

- Google Sheets
- [Raw Data File](#) (Link to Google Sheet file)
- [Student Handout](#) (Link to Student Handout)
- Projector

Standards

NGSS

Practices

- *Analyzing and Interpreting Data*

Core Ideas

- *LS1D: Information Processing*
- *ESS3D: Global Climate Change*

Crosscutting Concepts

- *Cause and Effect*
- *Independence of Science, Engineering and Technology*

Title: “Climate Change and Sea Level Rise”

Connections

dd

Focus Question

Is sea-level rising and is it because of Climate Change?

Objectives/Outcomes

- Students will learn about Climate Change and its effects on ocean sea-levels through graphing raw data in Google Sheets.
- Students will analyze, share, and draw conclusions about their graphed data.
- Students will be able to graph raw data and add a trendline for analysis..
- Students will be able to analyze global mean sea level (GMSL) data.
- Students will be able to explain how Climate Change affects sea-level rise.

Vocabulary/historical figures

- Climate Change, Sea-level Rise (SLR)

Outline

- Students start by reading **focus question**, “Is sea-level rising and is it because of Climate Change?” Record responses or have students write down the question and responses in their notebook (Interactive Science Notebook or Logbook).
- Read the background information and watch the videos from the California Academy of Sciences about Climate Change ahead of time.
- Familiarize yourself with Google Sheets and practice creating a graph. Students will be required to create a graph in Google Sheets.
- Photocopy the Student Handout or post it in Google Classroom.

Assessment

1. Student engagement and participation.
2. Completion of worksheet “Climate Change and Sea-Level Rise”

EXTENSIONS:

- Compare and Contrast sea level rise data to ice melt data.
- Have students go to the beach and photograph or videotape areas that are (or will be) affected by sea level rise and share this with the class. If students do not have access to the beach, they can use the internet to find examples of locations that will be affected by sea level rise.
- Research information on Polar Bear. Have students create a slideshow about the importance of sea ice for Polar Bears.
- Create an infographic about climate change.
- Watch the documentary "Chasing Ice." Click [here](#) to watch the trailer.
- Discuss ways that humans can reduce gases that add to climate change. Have students take a personal pledge to reducing climate change by changing a behavior, such as turning off lights when they leave the room or reducing their red meat consumption.



SHACC has a variety of lesson plans that you might find fun for you students.

Visit <https://shacc.org>



GUIDED INSTRUCTION:

1. Discuss the **Focus Question**. Record responses or have students write down the question and responses in their notebook (Interactive Science Notebook or Logbook). You will come back to this at the end of the lesson and record their thoughtful answers.
2. Have students discuss with their "elbow partners" what they think climate change is. Call on students to discuss their understanding and correct any misinformation.
3. Show the **video** from the California Academy of Sciences about Climate Change. It is 12.06 minutes long. https://www.youtube.com/watch?time_continue=8&v=XFmovUAWQUQ&feature=emb_title
4. If you have limited time, show this 1.39 minute video about climate change. <https://royalsociety.org/topics-policy/projects/climate-change-evidence-causes/>
5. Explain that you are going to break students up in to groups and each group will analyze a "**data set**" of sea-level data.
6. Before assigning groups, write on the board and/or have students write this information in their notebooks:
 - The first column: contains the **date**
 - The four-digit number is the **year** and the following decimal places represent the **percentage of the year that has passed** in the number of days (about the middle of the month) 1880.0417=January 15,1880 (365 days x .0417= 15.22 days) (This will help with graphing the data points on your chart.)
 - Second column: **GMSL**=Global Mean Sea Level (in millimeters)
7. Students will break into groups of 2 or some can work alone. There are 20 data sets (see the bottom of the Google Sheets document), but it is not necessary to do all data sets.
8. Students will open the Google Sheets document "Sea-level Monthly Data" https://docs.google.com/spreadsheets/d/1kXMjIEGJGQr9DHZ1yo3H9BI79_V0dKTkpcol5FrPbDA/edit?usp=sharing
9. Students will need to create a new **Google Sheets** document and Copy/Paste their data set in to their own Google Sheets document.

You can go “paperless”
by sharing the handout
to your students from
Google Classroom.



Ask your students how
is climate change
affecting the ocean’s
sea levels and how this
could affect them.



10. Once students have their data set, have them highlight their data (including column titles) and click on the chart icon to the right. The Chart Editor will pop on the right. Have students click on Custom so they can play with enhancing their graphs. Students may change colors and line thickness. Let them explore. They can always hit the back arrow if they don’t like what they have done.
11. Once they have a graph, students click on “Series” under the custom tab and select the “trendline” which is a best fit line. Again, they can fix it up to make it look more appealing.
12. Students will need to look at the Full Data Set chart in the original Google Sheets document (see first sheet at the bottom of the document).
13. Have students “Share” their file with you or have them turn it in to Google Classroom if you have that set up within your classroom.
14. Students will then complete their Student Handout Questions. Students will answer **questions 1- 6** on their own.
15. Using the projector, show each student generated graph to the class. Notice the differences in SLR between data sets. Some will show an increase and some will not. Explain why it is important to study SLR over a long period of time in order to get the whole picture. Students should notice that the GMSLR has been increasing over the last 130 years.
16. Students will now answer **questions 7 & 8**.
17. Ask students to discuss with their “elbow partners” how climate change is affecting the oceans sea levels and how this could affect them.
18. Have students answer **questions 9 & 10**.
19. To wrap up the lesson, come back to the Focus Question: **Is sea-level rising and is it because of Climate Change?** The answer is yes and no. Sea level has been rising for thousands of years now, but it is climate change that has caused an acceleration in ice melt and ocean thermal expansion that has then increased sea-level rise even more.

BACKGROUND

California has the fifth longest coastline in the U.S. with 3,427 miles (5,515km) according to the World Atlas (2017). It is known for world renowned beaches and surf breaks, such as Mavrick's in Northern California and Trestles in Southern California. It also contains many unique coastal habitats, such as wetlands, sandy beaches, bays, and rocky intertidal zones. These unique surf spots and habitats are now threatened by sea-level rise. Unfortunately, some of this sea level increase is natural and some is because of our emission of CO₂ that is causing a surge in global warming which is causing massive ice melts. According to the Intergovernmental Panel on Climate Change, otherwise known as IPCC (2013), global mean sea level rise (GMSLR) rose by 0.19 meters between 1901-2010, which is likely to be the largest rate increase over the past 2,000 years. Since the 1970s about 75% of the observed GMSLR has been due to glacier loss and ocean thermal expansion (IPCC, 2013). Thus, a particular increase in GMSLR between 1993-2010 was specifically contributed by changes to the Greenland and the Antarctic ice sheets. If these ice sheets were to melt completely the mean sea levels will rise by 12 meters (Hoegh-Guldberg & Bruno, 2010). Sea ice plays an important role in biodiversity of polar oceans. The annual spring melt plays a major part in the timing of phytoplankton blooms, which ultimately influence polar marine food webs. Due to the loss of food web dynamics, krill, a keystone species, will continue to see a decline in populations. The loss of sea ice will continue to drastically affect seabirds, penguins, seals and polar bears. Polar bears are projected to decline by 68% by 2100 (Hoegh-Guldberg & Bruno, 2010).

It is important that we view sea level rise as a global mean as sea levels may vary from region to region for decades at a time due to fluctuations in ocean circulation, changes in gravitational field, and various geological conditions. These regional changes can have even more of an impact on habitat and coastline conditions as we progress through the 21st century. Under the Kopp et al. (2014) model, California's worst-case scenario for sea level rise is 1.7m (5.6ft) by 2100. This scenario would mean a 48% wetland habitat loss in California (Doughty et al., 2018) and a 10-20% loss of coastal mangroves (Hoegh-Guldberg & Bruno, 2010).

There would also be an untold loss of coastal bluffs and cliffs due to erosion of already unstable sedimentary rock (Caldwell & Segall, 2007). This coastal loss would also contribute to structural losses, such as homes and businesses. In order to plan for such losses it is important that we study sea level rise globally and locally and study the potential effects it will have on plants, animals and even humans.

RESOURCES:

- Caldwell, M., & Segall, C. H. (2007, March). No Day at the Beach: Sea Level Rise, Ecosystem Loss, and Public Access Along the California Coast. Retrieved February 27, 2019, from <https://scholarship.law.berkeley.edu/elq/vol34/iss2/9/>
- Chepkemoi, J. (2017, February 27). US States With the Most Coastline. Retrieved March 19, 2019, from <https://www.worldatlas.com/articles/us-states-by-length-of-coastline.html>
- Curriculum. (n.d.). Retrieved March 18, 2019, from <https://www.montereybayaquarium.org/education/classroom-resources/curriculum>
- Curriculum. (n.d.). Retrieved March 15, 2019, from https://www.montereybayaquarium.org/education/classroom-resources/curriculum?gclid=EAIaIQobChMIxfXjhN6P4QIVSZ7ACh3AywhQEAAAYASAAEgluAfD_BwE
- Doughty, C. L., Cavanaugh, K. C., Ambrose, R. F., & Stein, E. D. (2018). Evaluating regional resiliency of coastal wetlands to sea level rise through hypsometry-based modeling. *Global Change Biology*, 25(1), 78-92. doi:10.1111/gcb.14429
- Evidence & Causes of Climate Change | Royal Society. (n.d.). Retrieved March 18, 2019, from <https://royalsociety.org/topics-policy/projects/climate-change-evidence-causes/>
- Graphing Sea-Level Trends Activity | NASA/JPL Edu. (2018, November 30). Retrieved March 18, 2019, from <https://www.jpl.nasa.gov/edu/teach/activity/graphing-sea-level-trends/>
- Hoegh-Guldberg, O., & Bruno, J. F. (2010). The Impact of Climate Change on the Worlds Marine Ecosystems. *Science*, 328(5985), 1523-1528. doi:10.1126/science.1189930
- IPCC Fifth Assessment Report: CSIROexperts comment. (2013). *Ecos*. doi:10.1071/ec13228
- Kopp, R. E., Horton, R. M., Little, C. M., Mitrovica, J. X., Oppenheimer, M., Rasmussen, D. J., . . . Tebaldi, C. (2014). Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites. *Earths Future*, 2(8), 383-406. doi:10.1002/2014ef000239
- Read the Standards. (n.d.). Retrieved March 18, 2019, from <https://www.nextgenscience.org/search-standards>
- Sciences, C. A. (2014, June 30). How does climate change affect biodiversity? Retrieved March 18, 2019, from https://www.youtube.com/watch?time_continue=725&v=XFmovUAWQUQ

Name: _____ Period: _____ Date: _____

Climate Change and Sea Level Rise

1. Predict what you think your data will show. _____

2. What data set did you graph? _____

3. What Year and Month does your data set begin? _____

4. What is the global mean sea level (GMSL) at the beginning of your data set? _____

5. What is the global mean sea level (GMSL) at the end of your data set? _____

6. What is the difference? _____

7. Is the sea-level rising or falling in your data set? _____

8. After you added your trendline, what did your data tell you about your data set? _____

9. After comparing your data set's graph to the complete 130-year graph, does your graph represent the 130-year trend? _____ Why? _____

10. Draw your **graph** below or on the back of this page. Use a ruler and only illustrate your **trendline**.