Ocean Front Property: An "Immerging" Market

A Classroom Activity for Ocean Gazing Episode #46: An imminent thaw

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Credits: *This activity was developed as part of the MBARI EARTH 2009 Workshop*

Grade Level: 9-12

Lesson Time: 1-2 hrs

Materials Required

Sea Level Graphs (optional), Sea Level Spreadsheet (optional), Fast Delivery Data Instructions (optional), Research Quality Data Instructions (optional)

Summary

This lesson is designed as an introductory activity exploring one facet of global climate change. Students will access real scientific data to investigate and compare long-term changes in sea level from different coastal locations around the United States.

Objectives

- ✓ Locate ocean observing data using computer skills and the Internet.
- ✓ Use spreadsheet software to enter the correct formula and calculate the average sea level change for a given location.
- ✓ Generate a line graph to illustrate sea level trends for a given location.
- ✓ Observe and identify variations in sea level trends across the United States.
- ✓ Communicate results during class discussion.

Vocabulary

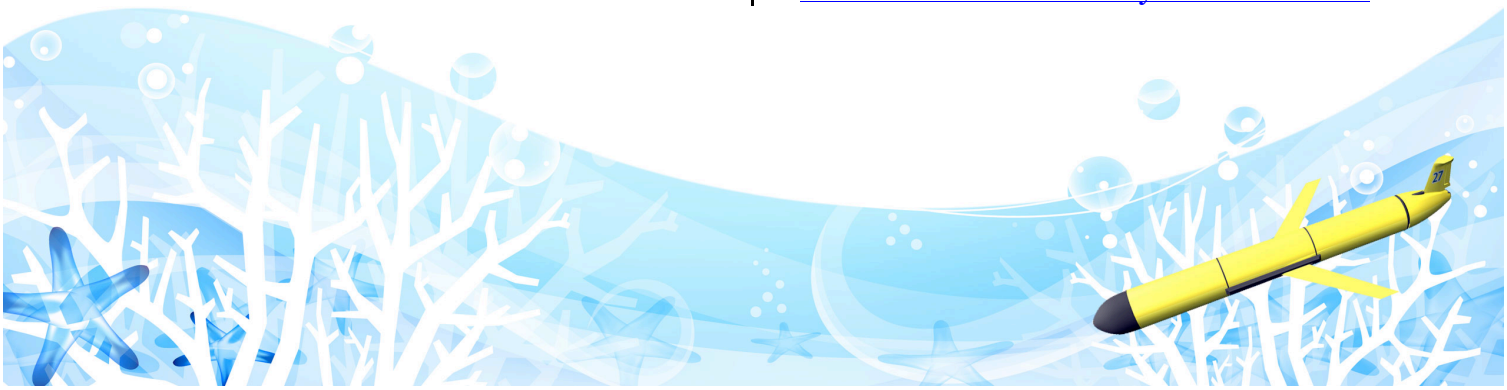
Climate, Fossil fuels, Global climate change, Global warming, Greenhouse gases, Sea level

Introduction

What is climate change? For decades, we've been hearing the terms "global warming" or "global climate change," but what do those terms mean to each of us? How is our world changing and why?

On a piece of paper, have each student brainstorm 1) changes we're seeing as a result of global climate change and 2) causes of global climate change they have heard about. Have the students share and discuss what they wrote down.

Global climate change is the variation of the earth's average climate — in other words, significant changes over decades in the earth's temperature, precipitation, wind, etc. Global warming refers to the increase in the earth's average atmospheric temperature, just one variable of the earth's climate. The earth has always experienced natural changes in climate, however scientific evidence shows that the current change in climate far exceeds what models show would be caused by natural factors



alone. Overwhelming evidence identifies human activities as a significant factor in today's climate change.

How are humans exacerbating, or increasing the severity of, climate change? With the start of the industrial revolution in the late 1700s, fossil fuels were burned to power new machinery. Burning fossil fuels releases carbon dioxide, a major greenhouse gas, into the atmosphere. These gases trap the sun's heat in the earth's atmosphere, causing atmospheric temperatures to rise. Carbon dioxide and other greenhouse gases, such as water vapor and methane, are naturally present in the atmosphere but are increasing in volume due to human activities. Over the past 20 years, U.S. greenhouse gas emissions from human activities have increased by 14%, primarily due to carbon dioxide emissions from the production of electricity. A close second and third source for these gases are transportation and industry, respectively.

The average global increase in atmospheric temperature over the past century is slightly over 1°F, but in the United States, temperatures have increased faster than the global average. Parts of the United States have experienced an increase in average air temperature of 4°F over the past century. With the increase in temperatures, we are also seeing a change in other elements of climate. For instance, as temperatures rise, evaporation increases. What goes up must come down — so precipitation increases as well. But like many of the effects of global climate change, the changes are not equally distributed around the world. While some areas may have an increase in severe storms and flooding, other areas will experience more drought.

Another effect of climate change is a change in sea level. Sea level (the average height of the ocean's surface relative to land) experiences natural fluctuations from small scale seasonal changes like springtime runoff to long term decadal changes due to ocean circulation and El Niño. In addition to these natural changes, sea level around most of the world is rising due to the effects of global warming. Why does this cause sea level to rise? As air temperatures increase, ice in glaciers melts and runs off into the oceans increasing the amount of water in the oceans and thus causing sea level to rise. And, as air temperatures rise water temperatures rise. When water temperatures rise, water molecules expand also causing sea level to rise. But as with many of the effects of climate change, sea level change is not consistent around the globe. In the following activity, we will look at sea level data from different US coastal cities to investigate if/how sea level is changing in that region.

Data Activity

Using data from the University of Hawaii Sea Level Center we will determine if sea level is changing in different coastal cities of the United States. For this activity, you can use data for select cities already downloaded, graphed and ready for analysis, or have students download and/or graph data themselves for cities they select (instructions provided).

Before accessing the graphs or data, have students develop hypotheses that address their prediction on sea level changes for their location.

Option 1. Ready to Go Graphs

To use the sea level data already downloaded and graphed by the Bridge, click on the city name to download the graph in pdf format for analysis.

- ✓ Portland, ME
- ✓ Charleston, SC
- ✓ Key West, FL

- ✓ Galveston, TX
- ✓ San Francisco, CA
- ✓ Seward, AK
- ✓ Hilo, HI

Option 2. Downloaded Data, Ready to Graph

To have students graph (using Excel) already downloaded data for the above cities, download the following Excel spreadsheet and refer to the graphing section in the Fast Delivery Data Instructions below.

- ✓ Sea Level Spreadsheet (Microsoft Excel)
- ✓ Fast Delivery Data Instructions (pdf) – Begin with step #9.

Option 3. Download and Graph Sea Level Data

The following instructions will walk you through, step-by-step, downloading and graphing sea level data using Microsoft Excel.

Go to the University of Hawaii Sea Level Center website. Click on the map to zoom into your location of choice. Click on your station of choice. Stations with a blue dot offer **Fast Delivery Data** (recommended). Stations in white offer only **Research Quality Data**. Once you have selected your station, use one of the following sets of instructions to download and graph your data.

- ✓ Fast Delivery Data Instructions (pdf)
- ✓ Research Quality Data Instructions (pdf)

Analyzing Graphs

Once students have completed or downloaded the graphs, have them estimate the average annual sea level change by:

1. Approximating the sea level value at the start of the trend line (Start Value).
2. Approximating the sea level value at the end of the trend line (End Value).
3. Subtract the Start Value from the End Value then divide by the number of years. This gives you the average annual sea level change in millimeters.

Discussion Questions

- ✓ Did your city experience a change in sea level? If so, was it increasing or decreasing? By how much?
- ✓ Did your findings support or refute your hypothesis about sea level change for your location?
- ✓ Of the cities examined, how many experienced rising sea level? How many experienced falling sea level?
- ✓ What was the greatest average annual sea level change? What part of the country did this occur?
- ✓ What was the smallest average annual sea level change? What part of the country did this occur?
- ✓ Compare your estimates with the trends found at the NOAA Tides & Currents: Sea Level Trends. Did your calculations match NOAA's?
- ✓ How might the change in sea level affect the people living in these areas? If the trend continues, how much will sea level rise/fall in the next 20 years? 50 years? 100 years?
- ✓ What can be done to stave off further sea level rise? How sill this affect the ecosystem?

Additional Resources

- ✓ EPA's Climate Change Report Powerpoint
- ✓ Understanding Sea Level Change
- ✓ VIMS White Paper: Planning for Sea Level Rise and Coastal Flooding

Related Resources

Physical oceanography, Climate, Technology, Ocean Observing Systems

References

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"FAQ: How do we know humans are the primary cause of the warming?" NOAA National Climatic Data Center. http://www.ncdc.noaa.gov/faqs/climfaq15.html

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"Weather and Climate." US Environmental Protection Agency. http://www.epa.gov/climatechange/indicators/pdfs/CI-greenhouse-gases.pdf

"FAQ: What is Sea Level?" NOAA Center for Operational Oceanographic Products and Services. http://co-ops.nos.noaa.gov/sltrends/faq.shtml#q1

University of Hawaii Sea Level Center. http://ilikai.soest.hawaii.edu/uhslc/datai.html

"Sea Levels Online." NOAA Tides & Currents. http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml

"Climate Change Indicators in the United States." US Environmental Protection Agency. http://www.epa.gov/climatechange/indicators/slideshow.html?placeValuesBefore

"Understanding Sea Level Change." American Congress on Surveying and Mapping (ACSM) Bulletin. http://masgc.org/climate/cop/Documents/SeaLevelChange.pdf

"Planning for Sea Level Rise and Coastal Flooding." Virginia Institute of Marine Science. http://www.vims.edu/research/units/programs/icccr/_docs/coastal_sea_level.pdf

Sources

The related podcast episode for this activity can be found by going to the podcast section of www.oceangazing.org