

Drowning Island: How does Climate Change Affect Sea Level?

Background and Key Concepts

Global climate change refers to an increase in the average temperature of the Earth's atmosphere and oceans. Scientists agree that the warming observed during the past century is due to an increase in greenhouse gases in the atmosphere as a result of human activity. For example, levels of carbon dioxide (CO₂), which is released primarily by burning fossil fuels such as coal, oil, and natural gas, have dramatically increased since pre-industrial times. Greenhouse gases such as CO₂ act like the glass in a greenhouse or in your car windows: they allow sunlight in, but prevent some heat from escaping back into space. Thus, increased greenhouse gases cause Earth's average temperature to rise, which in turn causes changes in precipitation frequency and intensity. Warming of the ocean and the melting of glacial ice is also causing a global rise in sea level. Significant sea level rise can eliminate beaches and cause flooding, which is particularly problematic for low-lying islands and coastal areas.

Sea level rise is causing major problems in Hawai'i. We're losing our beaches, experiencing severe coastal erosion, and some towns are even getting flooded with seawater during high tide (see the photo from Mapunapuna, O'ahu, below). Coastal marine ecosystems are also being affected by a combination of sea level rise and warmer temperatures, and these effects will only become more severe as temperature and sea level continue to rise in the future.



Photo credits: Top and bottom left photographs were provided by the Hawai'i Coastal Geology Group. Right: C. Kojima, Star Bulletin.

What causes sea level rise?

While global warming is causing the melting of both sea ice and glaciers, the melting of glaciers has a much larger effect on sea level rise. This is because sea ice is already floating in the ocean, and will not add significant volume to the ocean after melting. However, the melting of mountain glaciers and continental ice sheets at the poles can add large volumes of water to the ocean and greatly affect global sea level. Many glaciers have receded dramatically during the last few decades, and recent NASA observations show that the ice sheets found on Greenland and Antarctica are thinning (http://www.giss.nasa.gov/research/briefs/gornitz_09/). If Arctic ice continues to melt at its present rate, in a few decades it could be absent during summer months. The Arctic would then become a huge

heat collector, absorbing the sunlight that reaches it, rather than reflecting it back into space. Major ocean currents that exchange energy from the tropics to the poles would be altered, as would world weather patterns. If future climate change and sea level rise occur at this magnitude, the Earth would experience the fastest warming and the warmest temperatures in the history of civilization.

Although many of the glaciers and ice sheets that will melt as a result of climate change are far away from Hawai‘i, the change in sea level caused by this melting would submerge parts of our islands and have devastating effects on our lifestyles and economy (<http://www.soest.hawaii.edu/coasts/>). In this activity, students will practice the steps involved in a scientific investigation as they learn how melting ice affects sea level and impacts coastal zones (<http://calacademy.org/teachers/resources/lessons/global-climate-change-and-sea-level-rise/>).

Hawai‘i Content & Performance Standards (HCPS III)

The following standards and benchmarks can be addressed using this lesson:

Science Standard 1: The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process.

Grade 3 Benchmarks for Science:

Benchmark SC.3.1.1 Pose a question and develop a hypothesis based on observations.

Benchmark SC.3.1.2 Safely collect and analyze data to answer a question.

Science Standard 2: The Scientific Process: NATURE OF SCIENCE: Understand that science, technology, and society are interrelated.

Grade 5 Benchmarks for Science:

Benchmark SC.5.2.1 Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.

Social Studies Standard 7: Geography: WORLD IN SPATIAL TERMS-Use geographic representations to organize, analyze, and present information on people, places, and environments and understand the nature and interaction of geographic regions and societies around the world.

Grade 3 Benchmarks for Social Studies:

Benchmark SS.3.7.4 Examine the ways in which people modify the physical environment and the effects of these changes.

Materials (per student)

- Disposable plate (preferably with a dip in it), to represent the Earth
- A small ball of modeling clay, to make the island
- 10 ice cubes
- A few small plastic objects (such as beads or houses), to represent houses
- Blue crayons, to color the ocean portion of the Earth's surface
- Brown or green crayons, to color the land portion of the Earth's surface

Procedure

- 1) Discuss global climate change and its impact on sea level rise. Ask students questions such as:
 - What is causing global climate change? (an increase in greenhouse gases in the atmosphere due to human activities)

- What might happen if the Earth gets warmer? (Ice will melt, among other things.)
 - Where is there a lot of ice? (Arctic, Antarctica)
 - What will happen here in Hawai‘i if the ice melts? (Sea level rise will happen everywhere.)
 - Which locations will be most affected by an increase in sea level? (low-lying islands or coastal areas)
- 2) Pass out the materials, and explain to students that they will be creating a model of Earth to test how the melting of glaciers and ice sheets could affect sea level, to see if the predictions made during the class discussion are correct.
 - 3) Have students color most (about 70%) of the plate blue, to represent the ocean. The remaining part (~30%) of the plate should be colored green or brown, to represent land.
 - 4) Have students mold a ball of clay into a low-lying island and place it on the blue part of the plate. They should then place their plastic houses (or beads) in varying places on the island.
 - 5) Have students place ice cubes on the brown or green part of the plate, to represent ice on land.
 - 6) Set aside the plates until the ice melts.
 - 7) After the ice has melted, have students look at their plates, and consider the following questions: (likely answers are given in parentheses)
 - What happened to the island? (It has flooded.)
 - Where are the houses in relation to the water? (Underwater, or partially submerged)
 - Has there been a loss of dry land? (Yes)
 - How would sea level rise affect coastal areas? (Flooding, coastal erosion, property loss)

References Cited

Information about changes in sea level in the past and present:

http://www.giss.nasa.gov/research/briefs/gornitz_09/

Information about the effects of sea level rise on Hawai‘i’s shores:

<http://www.soest.hawaii.edu/coasts/>

For a more detailed lesson plan and further extensions:

<http://calacademy.org/teachers/resources/lessons/global-climate-change-and-sea-level-rise/>

Additional References

U.S. Global Change Research Program educational resources:

<http://usgcrp.gov/usgcrp/education/default.htm>

Information on global climate change:

<http://climate.nasa.gov/>