

# Guided Inquiry Activity: Impact of Sea Level Rise on a Local Coastal Community

## Teacher Notes

**Grades:** 6-8

**Timeline:** 2 - 3 40-minute class periods

**Issue or Problem:** Global sea level will likely rise 9 - 88 cm within the next 100 years as the anticipated result of thermal expansion of the oceans due to global climate changes and global warming. (IPCC, 2001)

**Core Question:** What will be the impact of sea level rise due to global warming on my coastal town?

### Objectives:

- Students will examine USGS topographic maps and become familiar with the legend of a topographic map.
- Students will practice reading contour lines to interpret the map.
- Students will accurately convert between metric and English measurements.
- Students will use the maps to locate local landmarks.
- Students will apply their knowledge of USGS topographic maps to a larger-scale topographic map of a coastal town.
- Students will be able to accurately map new coastlines based on predicted changes in sea level.
- Students will make assessments and recommendations for residents and town departments based on the new coastlines.

### Background Information for Teachers:

It is expected that students will have familiarity with the concept of global warming and the influencing factors. They should be familiar with the following concepts:

- ocean circulation patterns
- greenhouse gases
- the greenhouse effect
- thermohaline circulation and density currents (experimentation or teacher demo)
- thermal expansion of water (experimentation or teacher demo)
- the effect of melting ice on water level (experimentation or teacher demo)

### Materials:

Background readings on sea level rise and predictions  
USGS Quadrangle topographic maps, scale 1:24 000  
Local topographic map, scale 1"=100'  
Wet/dry markers  
Post-it© notes  
Science Journals (notepads)

Pencils  
Overhead transparencies/ Topographic map legend  
PowerPoint slides: Copy of USGS topographic map  
Copy of local topographic map  
Overhead/LCD projector

### **Assessing Prior Knowledge (one class period):**

1. Working in cooperative groups have students brainstorm answers to the following questions:  
“How has climate in your area changed in the past several years? Has there been more snow or rain? Has there been less precipitation? Has it been noticeably warmer or cooler in the different seasons? Do you recall your parents talking about how climate is different now as compared to when they were young?”  
Students should write their thoughts on Post-it© notes. As you lead a class discussion have students assemble post-its on the board.
2. “How has this impacted your life?” Have students jot down notes in their Science Journal.
3. “What do you know about Global Climate Change? What are the impacts?”  
Again, students should write their thoughts on Post-it© notes, and then assemble them on the board.
4. “What do scientists know or predict about how global climate changes will impact local environments? What will these changes mean to you and your coastal town?” Have several readings available for each group, or allow groups to access information from selected websites. (See **Resources**)

### **Exploration:**

#### **Part 1: USGS Quadrangle Topographic Maps**

1. Have each group check for necessary materials - a USGS topographic map of the Quadrangle covering their town, a set of wet/dry pens.
2. Using overhead transparencies or PowerPoint slides, point out the colors on the map and their significance. (green - vegetation, blue - water, black - buildings, red or gray - densely built-up areas, purple - recently updated information)
3. Show the map legend while students locate it on their map.
  - Have students locate: a primary highway, a secondary highway and a light duty road. Trace a major road with the red marker. Trace a local road with the black marker.
  - Have students locate: a major building, a school, a church, and residential homes. Circle a school with the green marker. Circle a neighborhood of homes with the black marker.
  - Have students locate: a river, a marsh, a beach, a rocky shore, and a breakwater, pier or jetty. Trace a river with the blue marker. Circle a marsh with the green marker. Circle a beach in red. Circle a rocky shoreline in black.
4. Display slide of brown contour lines. Students should examine their maps to locate the contour lines. Each brown line represents a 10 foot change in

elevation. Index contour lines are wider, darker and display the elevation in feet. Have students locate an area along the coastline where the elevation is steep (contour lines very close together) and circle it in red and a place of relatively level ground along the coastline (widely spaced contour lines) and circle it in green.

## Part 2: Local Coastal Town Topographic Maps

Give each group a local topographic map. Have students find the new elevation interval? 2 ft. The comparable elevation in cm: approximately 60 cm.

1. Students should choose an area of the local map that encompasses a coastal area with relatively level ground. It will be more interesting to have an area with natural (marsh, beach, rocky shoreline) as well as man-made (houses, businesses, jetties, piers) features.
2. Looking at their map, have students first determine the current shoreline, as determined by the mean high water line. They should trace an area of the current coastline with the blue marker.
3. Have students examine various scenarios of sea level rise. Begin with 60cm (approx. 2'). They should mark the new shoreline due to this sea level rise in a red marker.
4. Within the groups students should discuss the implications of the shoreline change. For instance:  
What natural and man-made features will be affected?  
How much land will be lost?  
Will buildings, houses, marshes, etc. be inundated?  
What animals/plants will be affected?  
Will there be economic costs due to the coastal change?  
Will the impact be short-term or permanent?
5. Next assume a 90cm (approx. 3') rise. They should trace an this new coastline with the green marker. Students should revisit the questions.
6. Assign each student in the group the role of a community member. Suggestions: a homeowner, the Community Planner, a Town Council member, a member of a Neighborhood Improvement Group, the local Conservation Commission chairperson, a business owner.
7. Assuming their assigned roles, each student should write brief notes in their Science Journal on the effect as well as the remedy for each incremental sea level rise.
8. Compile the Effects and Remedies on the board as each group reports out on their findings.

### Notes:

- You may wish to assign a specific map area to each group to ensure that a variety of coastal scenarios are represented.
- The benefit of using a local map is that students should be familiar with local businesses (marinas, restaurants, small shops) along a particular coastal road. If

using a map of an unfamiliar area, you might point out these features, or even add them onto a map.

**Standards Addressed:**

**National Science Education Standards - Science Content Standards: 5-8**

- Content Standard A *Science as Inquiry*
  - Abilities necessary to do scientific inquiry
  - Understandings about scientific inquiry
- Content Standard B *Physical Science*
  - Properties and changes of properties in matter
  - Transfer of energy
- Content Standard C *Life Science*
  - Populations and ecosystems
- Content Standard D *Earth and Space Science*
  - Structure of the earth system
  - Earth's history
  - Earth in the solar system
- Content Standard E *Science and Technology*
  - Abilities of technological design
  - Understandings about science and technology
- Content Standard F *Science in Personal and Social Perspectives*
  - Populations, resources and environments
  - Natural Hazards
  - Risks and Benefits

**AAAS Project 2061 Benchmarks**

1B Scientific Inquiry  
3A Technology and Science, 3C Issues in Technology  
4B The Earth, 4C Processes that Shape the Earth, 4D Structure of Matter, 4E Energy Transformations  
5D Interdependence of Life, 5E Flow of Matter and Energy  
7C Social Change, 7D Social Trade-Offs, 7G Global Interdependence  
8C Energy Sources and Use  
11A Systems, 11C Constancy and Change  
12A Values and Attitudes, 12B Computation and Estimation, 12D Communication Skills

**Vocabulary:**

**climate:** the meteorological conditions, including temperature, precipitation, and wind, that characteristically prevail in a particular region.

**global warming:** a rise in the average temperature of the Earth's atmosphere believed by many scientists to be caused by the increase of **greenhouse gases**. Global warming may be capable of causing major changes in weather patterns.

**greenhouse gas:** gas that is transparent to incoming solar radiation and that absorbs some of the longer wavelength infrared radiation (heat) that the Earth

radiates back; any of the atmospheric gases that contribute to the greenhouse effect.

**greenhouse effect:** the phenomenon whereby the earth's atmosphere traps solar radiation, caused by the presence in the atmosphere of gases such as carbon dioxide, water vapor, and methane that allow incoming sunlight to pass through but absorb heat radiated back from the earth's surface.

**inundation:** to cover with water, especially floodwaters.

**thermal expansion of water:** increase in volume of water resulting from an increase in temperature

### **Extensions:**

**K-5** Students will examine the larger scale map, locating houses, jetties, beaches, and businesses with the current and projected shorelines already marked for the lower grades. With assistance they should be able to discuss the impacts.

Older elementary students can mark the shorelines themselves, discuss and report on the impacts.

**6-8** Students prepare a report on the effect and proposed remedies for each incremental sea level rise. This report may take any number of formats: a written report for a Town Meeting, a short oral presentation for a Town Meeting, a letter to the editor, a poster, a PowerPoint presentation.

**9-12** Have students assume their roles and participate in a simulated Town Meeting. All of the students with the same role should meet as a "committee" to write up recommendations. The "Town Meeting" should discuss/decide what if any changes will be made to town property in anticipation of a specific sea level rise.

### **National Science Education Standards - Science Content Standards: K-4**

Content Standard A *Science as Inquiry*

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard B *Physical Science*

- Properties of objects and materials
- Light, heat, electricity and magnetism

Content Standard C *Life Science*

- Organisms and environments

Content Standard D *Earth and Space Science*

- Properties of earth materials
- Changes in earth and sky

Content Standard E *Science and Technology*

- Understanding about science and technology

Content Standard F *Science in Personal and Social Perspectives*

- Characteristics and changes in populations

- Changes in Environments

### **National Science Education Standards - Science Content Standards: 9-12**

- Content Standard A *Science as Inquiry*
  - Abilities necessary to do scientific inquiry
  - Understandings about scientific inquiry
- Content Standard B *Physical Science*
  - Structure of atoms and properties of matter
  - Conservation of energy and increase in disorder
  - Interactions of energy and matter
- Content Standard C *Life Science*
  - Interdependence of organisms
- Content Standard D *Earth and Space Science*
  - Structure of the earth system
  - Earth's history
- Content Standard E *Science and Technology*
  - Abilities of technological design
  - Understanding about science and technology
- Content Standard F *Science in Personal and Social Perspectives*
  - Personal and community health
  - Natural resources

### **Resources:**

#### **Primary Resources for this Activity:**

AAAS Benchmarks for Science Literacy: Benchmarks on-Line

<http://www.project2061.org/tools/benchol/bolintro.htm>

AAAS website with detailed information on the Project 2061 Benchmarks for Science Literacy.

Environmental Education for Kids website "Global Warming is Hot Stuff"

<http://www.dnr.state.wi.us/org/caer/ce/ee/earth/air/global.htm>

From the Wisconsin Department of Natural Resources, this kid-friendly website offers information on the greenhouse effect, the reasons behind global warming as well as possible affects.

Global Sea-Level Rise. 2001. Commonwealth Scientific and Industrial Research Organisation, Australia. Information sheet No. 45.

Available from: <http://www.marine.csiro.au/LeafletsFolder/45slevel/45.html>

Impacts of a Warming Arctic: Arctic Climate Impact Assessment. Highlights [2004]

18 page color brochure produced by the Arctic Climate Impact Assessment (ACIA).

Copies available on-line at no charge from: <http://www.gcric.org/orders/>

A nice color brochure to introduce middle and high school students to the impacts of global warming on the Arctic.

The full book (144 pages) is available from Cambridge University Press:  
<http://www.cambridge.org/uk/catalogue/catalogue.asp?isbn=0521617782>

Lovgren S. 2004. Warming to Cause Catastrophic Rise in Sea Level? National Geographic News. Available from:  
[http://news.nationalgeographic.com/news/2004/04/0420\\_040420\\_earthday.html](http://news.nationalgeographic.com/news/2004/04/0420_040420_earthday.html)

National Ocean Service, NOAA. 2004. Population Trends Along the Coastal United States: 1980-2008 [electronic resource]. Available from:  
[http://oceanservice.noaa.gov/programs/mb/pdfs/coastal\\_pop\\_trends\\_complete.pdf](http://oceanservice.noaa.gov/programs/mb/pdfs/coastal_pop_trends_complete.pdf)  
(accessed March 5, 2005)

National Safety Council, Environmental Health Center. Sea Level Rise, Climate Change Update. Washington: National Safety Council. 2001. Available from: <http://www.nsc.org/ehc/climate/ccucla13.htm>

National Science Education Standards [NRC] National Resource Council, National Committee on Science Education Standards and Assessment. 1996. National Science Education Standards. Washington: National Academy Press. Available from: <http://www.nap.edu/catalog/4962.html>

USGS Topographic Maps Home Page  
<http://topomaps.usgs.gov/>

A website with information on understanding, utilizing and ordering topographic maps of the United States. The 7.5 minute maps with a scale of 1:24000 are recommended for this activity.

### **Additional Resources:**

All Topo Maps by iGage  
<http://www.igage.com/>

This website offers a CD-ROM software package of topographic maps for each state.

EPA Website on Global Warming  
<http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html>

This EPA site has sections on climate, greenhouse gases and related topics. Also includes a “visitor section” with an Educators link – this has more websites listed.

EPA Website: Global Warming for Kids  
<http://www.epa.gov/globalwarming/kids/index.html>

A kid-friendly site from the EPA with clear explanations, definitions, and animations about climate change and global warming.

Literature Connections to Global Warming and the Greenhouse Effect  
<http://www.lhsgems.org/GlobalWarmingConx.html>

An annotated list of trade books related to Global Warming that spans K-12 grade levels. These are recommended for use with the GEMS Kit on Global Warming.

Nicholls R., Hoozemans F., Marchand, M. The Impacts of Sea-Level Rise on Coastal Areas. Available from:

<http://www.metoffice.com/research/hadleycentre/pubs/brochures/B1997/sealevel.html>

NOAA's National Climatic Data Center: US Climate at a Glance page

<http://www.ncdc.noaa.gov/oa/climate/research/cag3/cag3.html>

This site offers data on temperature and precipitation organized by US region state or city.

Salt D. Getting into hot water – global warming and rising sea levels. 2004. Nova:

Science in the news. Available from: <http://www.science.org.au/nova/082/082print.htm>

Science News for Kids: "A Change in Climate"

<http://www.sciencenewsforkids.org/articles/20041208/Feature1.asp>

This article from December 2004 deals with climate change and global warming and the effect on habitats. Includes a reference page with related web links and books.

US Global Change Research Information Office (GCRIO)

<http://gcrio.custhelp.com/cgi-bin/gcrio.cfg/php/enduser/home.php>

This website has an extensive library of global warming literature for browsing as well as ordering as well as a bibliographic database. The "Ask Dr. Global Change" page has an archive of previously asked questions related to climate change.

Wyss, B. 2002. Covering the Coasts and Population Pressures. Environment Writer Newsletter. Available from:

[http://environmentwriter.org/resources/articles/1202\\_coasts.htm](http://environmentwriter.org/resources/articles/1202_coasts.htm)