SciGuide Lesson: Climate Change and Ocean Tides

Authors: Zach Smith

Grade Level: 9–12

Subject Area: Earth and Space Science

SciGuide Resources:

NOAA Sea Level on-line
http://tidesandcurrents.noaa.gov/sltrends/sltrends.shtml

NOAA Ocean Service Education
http://www.oceanservice.noaa.gov/education/kits/tides/welcome.html

United States Global Climate Change Research Program
http://globalchange.gov/publications/reports/scientific-assessments/us-impacts

Global Climate Change Impacts in the United States-
FULL REPORT
http://globalchange.gov/publications/reports/scientific-assessments/us-impacts/full-report

KEY FINGINGS
http://globalchange.gov/publications/reports/scientific-assessments/us-impacts/key-findings

NOAA Climate Service
http://www.noaa.gov/climate.html

Standards Addressed:

Earth and Space Science

- **Energy in the earth system**

  Global climate is determined by energy transfer from the sun at and near the earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the earth's rotation, and static conditions such as the position of mountain ranges and oceans.

Science in Personal and Social Perspectives

- **Natural resources**

  The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed.

  Humans use many natural systems as resources. Natural systems have the capacity to reuse waste, but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologicall

- **Natural and human-induced hazards**

  Human activities also can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal.

Such activities can accelerate many natural changes.

Natural and human-induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society, as well as cause risks. Students should understand the costs and trade-offs of various hazards—ranging from those with minor risk to a few people to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations.

- **Environmental Quality**
  Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans.

Life Science

- **Behavior of organisms**
  Organisms have behavioral responses to internal changes and to external stimuli. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses either can be innate or learned. The broad patterns of behavior exhibited by animals have evolved to ensure reproductive success. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change. Plants also respond to stimuli.

Time Required:	3 class periods Period 1: Understand the impact of higher tides based on sea level rise on coastal areas. Period 3: Develop a plan to mitigate the impact of higher tides. Period 4: Discuss how students can apply their plans to coastal communities.
Lesson Goal:	The overall goal for this lesson is for students to evaluate the impact of higher tides, as a result of sea level rise, on coastal communities.
Learning Objectives:	· Students will be able to evaluate a sea level and tidal data · Students will be able to develop a reasonable plan for mitigating coastal impacts. · Students will be able to discuss and evaluate plans with other students.
Prerequisite Knowledge:	Nationwide, about 5000 square miles of dry land are within two feet of high tide. Although the majority of this land is currently undeveloped, many coastal counties are growing rapidly. Land within a few feet above the tides could be inundated by rising sea level, unless additional dikes and bulkheads are constructed. A two foot rise in sea level would eliminate approximately 10,000 square miles of land (PDF) (26 pp, 267K) including current wetlands and newly inundated dry land, an area equal to the combined size of Massachusetts

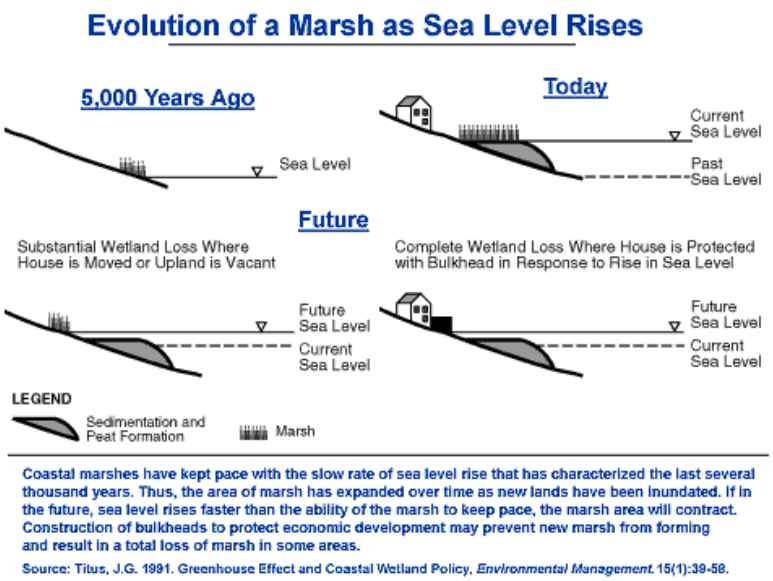
and Delaware (EPA, 1989).

Some of the most economically important vulnerable areas are recreational resorts on the coastal barriers of the Atlantic and Gulf coasts. In many cases, the ocean-front block of these islands is 5 to 10 feet above high tide; but the bay sides are often less than two feet above high water and regularly flooded (see USGS's 7.5-minute map series). Erosion threatens the high ocean sides of these densely developed islands and is generally viewed as a more immediate problem than inundation of their low bay sides. Many ocean shores are currently eroding 1 to 4 feet per year (FEMA, 2000).

Coastal Water Supplies

Rising sea level increases the salinity of both surface water and ground water through salt water intrusion. New York City, Philadelphia, and much of California's Central Valley obtain some of their water from portions of rivers that are slightly upstream from the point where water is salty during droughts. If sea level rise pushes salty water upstream, then the existing water intakes might draw on salty water during dry periods. Salinity increases in estuaries also can harm aquatic plants and animals that do not tolerate high salinity.

Shallow coastal aquifers are also at risk (IPCC, 2007). The freshwater Everglades currently recharge Florida's Biscayne aquifer, the primary water supply to the Florida Keys. As rising water levels submerge low-lying portions of the Everglades, portions of the aquifer would become saline. Aquifers in New Jersey east of Philadelphia are recharged by fresh portions of the Delaware River which may become saline in the future.



http://www.epa.gov/climatechange/effects/coastal/index.html

Procedures/Instructional Strategy:

Students will read the report found at http://www.epa.gov/climatechange/effects/downloads/rtc_sealevelrise.pdf and evaluate the impact of higher tides on coastal areas.

1. Effects on organisms
   A. Will the higher tide harm any animals directly?
   B. Will the higher tide harm any animals indirectly by preventing migration, feeding, destroying their habitats and/or food supplies, removal of predators which may affect the carrying capacity and a population's impact on resources?

2. What are the impacts on humans that live close to the coast and those that do not live on the coast but may their wells and septic systems impacted.

3. Will the higher tides increase the erosion potential of the coastlines?

Each team's plan will be recorded and presented.

Report requirements

- The plan must be clearly expressed.
- Multimedia is encouraged to present the plan.

- Points will be given on the following criteria:
  - Engagement: (Does it engage other students? Does it hold their interest?)
  - Content: (Does it cover the required areas — use of real data, mitigation and adaption, realistic expectations/limits)
  - Easy of use: (Are the directions clear?)

- Applicability: To student's school/community.

Outcome/Assessment:	Students will create a report to discuss the merits of a proposal to dam the Mediterranean. They will evaluate other plans and receive feedback on their own plan. The applicability of the student's plan for mitigating coastal impacts should be verifiable based on projects already in place or plans put forth by other groups (public works departments, state agencies, etc) professionals.
Extensions:	Students can explore sea level trends at various stations around the global http://tidesandcurrents.noaa.gov/sltrends/sltrends_global.shtml and or the closest coastline to their homes. They can also compare and contrast areas where sea level is rising and where it might be decreasing. Students might also find where sea level is rising the fastest and using topographic maps or Google Earth, forecast the impacts that might occur in those areas. Example: Areas with steep elevation change will have less impact, whereas areas with relatively flat terrain might experience more dramatic effects, e.g. Most major cities are on coastlines and most of their infrastructure like water and sewer will be flooded by sea level rise thus compromising the health of millions of people. Flat lying areas such as Florida marshes will also be compromised as salt water infiltrates the habitats of inland flora and fauna. Helpful information may come from a variety of sources including news reports such as http://www.sciencedaily.com/releases/2008/11/081122083051.htm
Classroom Resources:	• Computer access for students (group size will determine number of computers)

Other Teaching Resources Lesson Plan List:

Encourage continuation and expansion of EcoZone Green Schools Initiative
http://oceanservice.noaa.gov/news/weeklynews/october08/ecozone.html
http://www.ecozonemedia.com/greenmyschool/

Green Schools Campaign
http://earthday.net/greenschools

Audio/Video Clips:
University of Arizona Lecture series on Global Climate Change, 2006, 7 lectures
Global Climate Change: Disease and Society
http://www.youtube.com/watch?v=P3cXkPZEafI&feature=channel

NOAA Ocean Service
In Our Changing World
http://www.youtube.com/watch?v=x-5T9ePmUL4