This learning activity was developed to examine the potential impacts of climate variability and change. Each activity is part of an overall series entitled ***The Potential Consequences of Climate Variability and Change,*** which includes 1–12 teacher resources. Twelve modules (10 printed and 2 online resources) comprise the set and are presented below:

**OVERVIEW**

- Too Many Blankets (Grades 1–4)
- Global Balance (Grades 5–12)

**AGRICULTURE**

- El Niño (Grades 5–8)
  This activity is provided in an online format only and is available at *http://ois.unomaha.edu/casde/casde/lessons/Nino/teacherp.htm.*
- The Great American Desert? (Grades 9–12)
  This activity is provided in an online format only and is available at *http://ois.unomaha.edu/casde/casde/lessons/grass/teacherp.htm.*

**COASTAL AREAS**

- What Could a Hurricane Do to My Home? (Grades 5–8)
- What Is El Niño? (Grades 5–8,9–12)
- Coral Reefs in Hot Water (Grades 9–12)

**FORESTS**

- A Sticky Situation (Grades 5–8)
- Planet Watch 2000 (Grades 9–12)

**HUMAN HEALTH**

- Beyond the Bite: Mosquitoes and Malaria (Grades 5–8,9–12)
- Climate and Disease:A Critical Connection (Grades 9–12)

**WATER**

- Here, There, Everywhere (Grades 7–8,9–12)

The development of the activities was sponsored by the National Aeronautics and Space Administration and the Environmental Protection Agency, in support of the US Global Change Research Program. The Institute for Global Environmental Strategies implemented the effort. For more information,see *http://www.strategies.org.* For additional resources, please visit *http://teach earth.com*—Resources for Teaching and Learning about Earth System Science..

## Climate Variability & Change
# COASTAL AREAS

**Authored by:**
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## ACTIVITY
# What Could A Hurricane Do To My Home?

**CONTENTS**

# What Could A Hurricane Do To My Home?

This activity explores the potential for global climate change to increase the frequency and intensity of hurricanes and storm surges, and the impacts that could result. Designed to teach through scientific inquiry, the activity seeks to stimulate thought about the long-term impact of a warmer planet.

## GRADE LEVELS

Grades 5–8

## TIME REQUIRED

Four to five 45-minute class periods

## OBJECTIVES

Through their participation in the following activity, students will:

- Explain the impact of hurricanes on coastal communities;
- Identify possible trends in economic and human impacts by examining hurricane records;
- Predict impacts on coastal areas if hurricane frequency increases and sea level rises;
- Determine areas that are most vulnerable to hurricane surges by using topographic maps;and
- Make and use scale drawings and maps or three-dimensional models to represent real objects, find locations, and describe relationships.

## DISCIPLINES ENCOMPASSED

- Earth System Science
- Geography
- Language Arts
- Mathematics
- Meteorology
- Social Studies
- Technology

## PREREQUISITE KNOWLEDGE: TEACHER

To effectively teach about the effects of climate variability and change, teachers should have a solid understanding of the following concepts:

- A hurricane is a large low-pressure weather system that has sustained winds of 74 mph or greater. These winds rotate around the calm center of the hurricane, called the eye, where air pressure is the lowest. The storm is driven by the heat released by condensing water vapor and by external mechanical forces. It is fed by warm ocean water. Once it starts to cross land, it usually diminishes because it loses its source of energy and is pulled apart by friction.
- The most dangerous impact of a hurricane is usually not from the winds but from a storm surge, a great dome of water often 50 miles wide that sweeps across the coast near where the eye of a hurricane makes landfall.
- Over 85% of a storm surge is caused by onshore winds that push the ocean surface ahead of a storm. During a hurricane, these winds form due to the pressure difference caused by the hurricane. Therefore, the surface pressure gradient of the hurricane indirectly causes the storm surge. Other factors that affect the strength of a storm surge are coastal topography, angle of incidence and landfall,and the speed of hurricane motion.
- When a storm surge is added to both the normal height of a high tide and the effects of driving winds, it can create a massive storm tide that pushes water well inland.

Nine out of ten tropical storm fatalities are caused by storm surges.

- Hurricane season in the western Atlantic is from June through October, with the greatest frequency of hurricanes in September. This correlates to warm ocean water temperatures.
- The Gulf Stream causes warm ocean water temperatures in the Atlantic. This current of warm water, driven by wind patterns, flows north from the Gulf, along the east coast of North America,and then northeast into the Atlantic. The water warms the air above it, which causes mild temperatures over western Europe, milder than would be expected at that latitude. The effect of the differences in the water temperature, water movement, and wind can cause violent storms, increasing hurricane activity.
- During the past 20 years, more and more people have moved to the coast. Now 44 million people live along the East Coast of the United States from Maine to Texas with more people moving closer to the coast all the time.
- Hurricanes seem to occur in stronger or weaker cycles of about 10 to 20 years duration. From 1947 through 1969,only 13 hurricanes with winds of more than 110 miles an hour hit the North American coast. From 1970 to 1987 only one major hurricane struck.In 1995,however, hurricane activity increased dramatically with 19 named storms. Although scientists cannot correlate hurricane activity with global climate change, they have correlated sea level rise to global climate change. They are concerned that these factors, a stronger hurricane cycle added to sea level rise, may impact the growing numbers of people moving to the coast, both in property and lives.
- The Saffir-Simpson Hurricane Scale is a 1–5 rating based on a hurricane's intensity. For more detailed information link to: *http://www.nhc.noaa.gov/aboutsshs.html*

## PREREQUISITE KNOWLEDGE: STUDENTS

Students must have the following skills and knowledge to complete this activity:

- Ability to read and interpret topographic maps and data tables.
- Ability to make and use maps and models to develop arguments and draw conclusions.
- Ability to read tide tables.
- Ability to use Internet browsers to do research for problem-solving.
- Ability to work collaboratively in groups.
- Ability to distinguish between high and low pressure systems and describe how they form.

## KEY TERMS AND CONCEPTS

The following terms and concepts will be presented in the following text and activities:

Climate
Condensation
Friction
Gulf stream
Hurricane
Pressure systems (high and low)
Sea level
Storm surge
Tides
Tropical storm
Weather system

## SUGGESTED READING/RESOURCES

### ■ *WEB PAGES*

Hurricane History from the Florida Sun-Sentinel
*http://www.sun-sentinel.com/storm/history*

Miami Museum of Science's Storm Science Web page
*http://www.miamisci.org/hurricane/insideahurricane.html*

National Hurricane Center Tropical Prediction Center
*http://www.nhc.noaa.gov*

The Saffir-Simpson Hurricane Scale
*http://www.nhc.noaa.gov/aboutsshs.html*

Hurricane Weather Center—from Tampa Bay Online
*http://hurricane.weathercenter.com/*

Hurricane Guide
*http://www.channel10.com/Weather/hurricane.html*

FAQ:Hurricanes, Typhoons, and Tropical Cyclones
*http://www.aoml.noaa.gov/hrd/tcfaq/tcfaqHED.html*

NASA's Observatorium—Hurricanes
*http://observe.ivv.nasa.gov/earth/hurricane/hurricane_links.html*

Tropical Twisters
*http://kids.earth.nasa.gov/archive/hurricane.index.html*

Working With Maps
*http://www.usgs.gov/education/learnweb/wwmaps.html*

**Hurricane Activity**

Gulf of Maine Aquarium Web site
*http://octopus.gma.org/surfing/weather/index.html*

## ACTIVITY

# What Could A Hurricane Do To My Home?

This activity will answer the question: Will global climate change intensify the effects of hurricanes on coastal areas?

### MATERIALS

- Map of the Atlantic and Gulf U.S. coasts that includes the Gulf Stream:
  *http://www.erols.com/gulfstrm/*
  *http://www.erols.com/gulfstrm/allgulf.htm*
- Class map, a topographic map of the fictional coastal community, Seaside (Appendix D)
- Tide chart for Seaside:
  *http://www.catalina.org/goodies/tides.htm*
  Use chart for Portland, Maine.
- Construction paper
- Pencils
- Computers with Internet connection
- Student activity sheets

### PROCEDURE

**Step 1**
Ask students to give their definition of a hurricane. What does a hurricane need to "feed" it? Students can look up answers from the list of Web Sites in the Suggested Reading section. Students can also use the Hurricane Activity listed in the Suggested Reading section as an introduction to this lesson. Guide the students into developing an accurate definition.

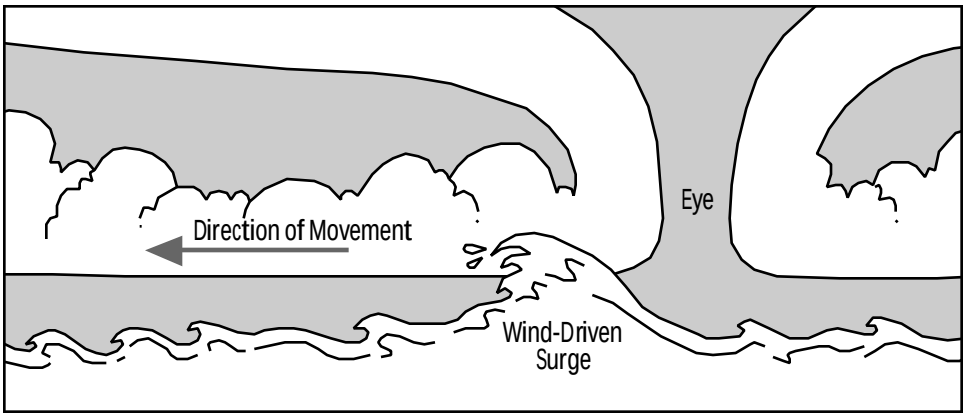
**Step 2**
Show students a map of the East Coast of the United States that includes the Gulf Stream. Using the information in the Prerequisite Knowledge: Teacher section, explain hurricanes, the hurricane season,and how it is affected by the Gulf Stream.

**Step 3**
Explain how a storm surge forms and the damage it can cause (see Figure 1). To further understand the extent of damage caused by a storm surge, use the Hurricane Andrew storm surge activity at:
*http://octopus.gma.org/surfing/weather/index.html.*

For purposes of this activity, imagine that the storm surge from a hurricane is 15 feet above a normal high tide.

**Step 4**
Using historical data from the National Hurricane Center Tropical Prediction Center, *http://www.nhc.noaa.gov,* have students compare the 10 deadliest and the 10 most expensive hurricanes to strike the Gulf and East Coasts of the United States. Students fill in the answers to Questions 1 through 3 on the ***Student Activity Sheets.***

*Figure 1. Storm Surge*



**Step 5**
Scientists have not yet been able to correlate an increase in hurricanes to global climate change. However, sea level rise has been proven to be occurring in many places due to global climate change. Explain how this can affect coastal communities during hurricanes.

**Step 6**
Assume that all members of the class are moving to the coastal community of Seaside (or you may substitute an actual community and obtain a USGS topographic map and tide tables, which are available from the Web or local marine supply stores). Ask students to choose a place for their homes in any part of the community. (Some may want oceanfront property; others may decide to put their homes on the highest part of town.)

Ask each student to mark the location of his or her home on the topographic map. Number each house and make a key, such as:#1, Kevin Smith,15 feet above sea level. Students answer Question 4 on the ***Student Activity Sheets.***

**Step 7**
Tell the students that a hurricane will hit the coastal community of Seaside. Assuming the storm surge causes sea level to rise 15 feet, what would happen to the community at low tide? At high tide? Were any homes hit? Students answer Question 5 on the ***Student Activity Sheets.***

**Step 8**
Discuss the impact an increase in hurricane activity might have on your real community. Have students determine how to prepare themselves and the community for such an occurrence. Students answer Questions 6 and 7 on the ***Student Activity Sheets.***

**Step 9**
Scientists know that warm waters "fuel" tropical storms, which may become hurricanes. As yet, they have not been able to say that hurricanes are increasing as a result of global climate change. Discuss how global climate change might impact hurricane frequency. Students answer Question 8 on the ***Student Activity Sheets.***

## CONCLUSION

- Discuss similarities and differences between student predictions.
- Ask students to explain how their study of the Seaside community relates to the real world.
- Discuss how the effects of climate variability and change combined with hurricane activity can affect coastal populations.
- Ask the students to explain how this information could affect coastal migration.

## EXTENSIONS

1. Instead of using a topographic map, have students do this activity by creating a three-dimensional model of Seaside with modeling clay.
2. Have students contact the local historical society, library, or newspaper archives to try to find historical information about the impact of past hurricanes in their community. Students may want to create a timeline, like the Hurricane History from the Florida Sun-Sentinel: *http://www.sun-sentinel.com/storm/history.*
3. Ask students how they would design their homes to have the best chance of withstanding hurricane force winds and storm surges? They should consider how they might design the roof and footings, for instance. What materials would they use? Research building codes of coastal areas, such as barrier islands, to identify strategies that are already in place.
4. Have students design an escape plan in the event a hurricane warning is issued for their area. Look at a road map of the region. Plot an escape route to higher ground. Instruct them to try to avoid bridges and low-lying wetland areas, as these could be washed out or flooded during a hurricane.
5. Have students research the importance of satellites in studying hurricanes.

## Student Activity Sheet: WHAT COULD A HURRICANE DO TO MY HOME?

**Name**

*Answer the following questions in complete sentences, using your own words:*

**1.** Using historical data obtained from the National Hurricane Center Tropical Prediction Center, *http://www.nhc.noaa.gov*, list the ten deadliest and the ten most expensive hurricanes to strike the Gulf and East Coasts of the United States since 1900.

### *Ten Deadliest Hurricanes to Strike the Gulf and East Coasts of the U.S. Since 1900*

| RANK | HURRICANE | YEAR | CATEGORY | DEATHS |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |

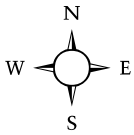
## *Ten Most Expensive Hurricanes to Strike the Gulf and East Coasts of the U.S. Since 1900*

| RANK | HURRICANE | YEAR | CATEGORY | DAMAGE $$$$ |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |

**2.** What conclusions can you draw from this data? Include factors that may have affected this data (for example, as more people now live near the coast, there is more extensive property damage; however, weather forecasts have improved, which has given people more time to escape).

**3.** Can you see a trend in the number (increasing or decreasing) or severity of hurricanes? Do you need more data? If so, what?

**4.** Using longitude and latitude readings, give the location of your home. Be sure to mark it on the class map of Seaside. What is the elevation of your home? Why did you choose this location?




**5.** Assume a hurricane were to hit your coastal community of Seaside, with a storm surge 15 feet above the current sea level at low and high tide (use your tide charts).

a) Will your home be hit at low tide? How many homes in the Seaside community were hit?

b) Will your home be hit at high tide? How many homes in the Seaside community were hit?

**6.** What impact would an increase in hurricane activity have on your real homes? How much of your community would be threatened by storm surges?

**7.** How would you prepare if hurricane activity and storm surges increased in your real community?

**8.** Using the knowledge you have gained from this activity, discuss how you think global climate change might impact hurricane intensity and frequency.

## Appendix A
# Bibliography


Berry, Julia. Science Weekly.

Lauber, Patricia.1996. ***Hurricanes: Earth's Mightiest Storms.*** Scholastic. New York,NY.

***Storm Surge and Hurricane Safety*** (NOAA brochure).

*http://coolspace.gsfc.nasa.gov/outreach/activity/gulf.html*

*http://www.hameenkyronkoulut.sci.fi/gulfeng.htm*

*http://www.optonline.com/comptons/ceo/03472.016_L.html*

## Appendix B

# Assessment Rubric & Answer Key

### Assessment Rubric

| SKILL | Excellent (4) | Good (3) | Satisfactory (2) | Needs Improvement (1) |
|---|---|---|---|---|
| **Demonstrates ability to access relevant information at appropriate Internet sites.** | Able to access relevant information from appropriate Internet sites. | Accesses some relevant information from appropriate Internet sites. | Accesses very little relevant information at a few appropriate Internet sites. | Is not able to access relevant information at appropriate Internet sites. |
| **Collects and organizes data.** | Able to collect a lot of data that is well organized. | Able to collect some data with good organization. | Able to collect some data with poor organization. | Not able to collect and organize data. |
| **Able to accurately interpret and use a topographic map.** | Able to accurately interpret and use a topographic map. | Able to accurately interpret, but needs help using a topographic map. | Needs help interpreting and using a topographic map. | Not able to interpret or use a topographic map. |
| **Represents findings clearly on map/graph or model (such as a map key).** | Findings are clearly represented. | Findings are represented somewhat clearly. | Findings are not represented clearly. | Not able to represent findings. |
| **Participates in class discussions/ presentations.** | All answers are logical. | Provides many answers, most are logical. | Provides few or illogical answers. | Not able to provide answers. |
| **Provides logical answers to questions.** | Always participates. | Participates frequently. | Rarely participates. | Does not participate. |
| **Infers links between coastal development and global climate change.** | Able to infer many links. | Able to infer some links. | Able to infer links with guidance. | Not able to infer any links. |

## ANSWER KEY Student Activity Sheets:WHAT COULD A HURRICANE DO TO MY HOME?

***Answer the following questions:***

**1.** Ten Deadliest Hurricanes to Strike the Gulf and East Coasts of the U.S. Since 1900

| RANK | HURRICANE | YEAR | CATEGORY | DEATHS |
|---|---|---|---|---|
| **1** | TX (Galveston) | 1900 | 4 | 8000+ |
| **2** | FL (Lake Okeechobee) | 1928 | 4 | 1836 |
| **3** | FL (Keys)/S. TX | 1919 | 4 | 600 |
| **4** | NEW ENGLAND | 1938 | 3 | 600 |
| **5** | FL (Keys) | 1935 | 5 | 408 |
| **6** | AUDREY (SW LA/N TX) | 1957 | 4 | 390 |
| **7** | NE U.S. | 1944 | 3 | 390 |
| **8** | LA (Grand Isle) | 1909 | 4 | 350 |
| **9** | LA (New Orleans) | 1915 | 4 | 275 |
| **10** | TX (Galveston) | 1915 | 4 | 275 |

**1.** (cont.) Ten Most Expensive Hurricanes to Strike the Gulf and East Coasts of the U.S. Since 1900

| RANK | HURRICANE | YEAR | CATEGORY | DAMAGE |
|---|---|---|---|---|
| **1** | ANDREW (SE FL/SE LA) | 1992 | 4 | $26,500,000,000 |
| **2** | HUGO (SC) | 1989 | 4 | $ 7,000,000,000 |
| **3** | FRAN (NC) | 1996 | 3 | $ 3,200,000,000 |
| **4** | OPAL (NW FL/AL) | 1995 | 3 | $ 3,000,000,000 |
| **5** | FREDERIC (AL/MS) | 1979 | 3 | $ 2,300,000,000 |
| **6** | AGNES (NE U.S.) | 1972 | 1 | $ 2,100,000,000 |
| **7** | ALICIA (N TX) | 1983 | 3 | $ 2,000,000,000 |
| **8** | BOB (NC and NE U.S.) | 1991 | 2 | $ 1,500,000,000 |
| **9** | JUAN (LA) | 1985 | 1 | $ 1,500,000,000 |
| **10** | CAMILLE (MS/AL) | 1969 | 5 | $ 1,420,700,000 |

**2. Deaths**—The 10 listed all occurred before 1960. Possible factors could include:

- Technological advances;
- Meteorologists ability to predict and track storms gave people advanced warning and time to evacuate;
- Improved and increased communication ability allowed warnings to reach more people;
- Better road systems provided more people means to evacuate;
- Deaths could have been prevented by improvements in building design;
- Better rescue efforts and technology allowed rescue workers to save more lives.

**Damage**—Overall,the damage caused by hurricanes has been increasing since the 1960s. Possible factors could include:

- More people live in coastal communities, causing an increase in property damage;
- More expensive homes are being built at the coasts;
- Storms occurring more often or with more force.

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**3.** Although general observances can be made, more data is needed. Students would have to review a listing of all hurricanes on record by year and category to make an accurate hypothesis.

---

**4.–6.** All answers will be different. The teacher will have to check each student's responses for accuracy.

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**7.** Answers may be general or specific, and could include:

- Move to a different location;
- Build stronger structures;
- Develop an evacuation plan for your family or community;
- Put together an emergency supply kit.

---

**8.** Although global climate change does not affect hurricanes directly, it could increase their intensity and frequency. If global temperatures increase and sea levels rise, this could intensify the effect of storm surges. Also, frequency and strength of hurricanes has also been on the rise recently, which may be an indicator of a changing climate.

## Appendix C
# National Education Standards

***This activity responds to the following National Education Standards:***

### STANDARDS FOR THE ENGLISH LANGUAGE ARTS

**Standard 3:** Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g.,sound- letter correspondence, sentence structure, context, graphics).

**Standard 4:** Students adjust their use of spoken,written,and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

**Standard 5:** Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

**Standard 6:** Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation),media techniques, figurative language and genre to create, critique, and discuss different print and nonprint texts.

**Standard 7:** Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g.,print and nonprint texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

**Standard 8:** Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

**Standard 12:** Students use spoken,written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion,and the exchange of information).

*National Council of Teachers of English and International Reading Association.1996.* ***Standards for the English Language Arts*** *p.24–46.Urbana,Illinois and Newark, Delaware: National Council of Teachers of English and International Reading Association.*

### NATIONAL GEOGRAPHY STANDARDS GEOGRAPHY FOR LIFE (5–8)

**Geography Standard 1:** *The World in Spatial Terms.* How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

**Geography Standard 4:** *Places and Regions.* The physical and human characteristic of places.

**Geography Standard 7:** *Physical Systems.* The physical processes that shape the patterns of the Earth's surface.

**Geography Standard 15:** *Environment and Society.* How physical systems affect human systems.

*American Geographical Society, Association of American Geographers, National Council for Geographic Education,and National Geographic Society. 1994.* ***Geography for Life National Geography Standards*** *p. 143–182. Washington,DC: National Geographic Research and Exploration.*

### CURRICULUM AND EVALUATION STANDARDS FOR SCHOOL MATHEMATICS (5–8)

**Standard 1:** Mathematics as problem solving.

**Standard 2:** Mathematics as communication.

**Standard 3:** Mathematics as reasoning.

**Standard 4:** Mathematical connections.

*National Council of Teachers of Mathematics. 1989.* ***Curriculum and Evaluation Standards for School Mathematics*** *p. 63–119. Reston, VA: The National Council of Teachers of Mathematics, Inc.*

## NATIONAL SCIENCE EDUCATION STANDARDS (5–8)

### CONTENT STANDARD: K–12

**Unifying Concepts and Processes**

***Standard:*** As a result of activities in grades K–12,all students should develop understanding and abilities aligned with the following concepts and processes:

- Systems, orders, and organization
- Evidence, models, and explanation
- Consistency, change, and measure

*National Research Council.1996.* ***National Science Education Standards*** *p. 115–119. Washington,DC: National Academy Press.*

### CONTENT STANDARDS: 5–8

**Science as Inquiry**

***Content Standard A:*** As a result of activities in grades 5–8,all students should develop:

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

**Physical Science**

***Content Standard B:*** As a result of activities in grades 5–8,all students should develop understanding of:

- Motion and forces
- Transfer of energy

**Earth and Space Science**

***Content Standard D:*** As a result of activities in grades 5–8,all students should develop understanding of:

- Structures of the earth system

**Science and Technology**

***Content Standard E:*** As a result of activities in grades 5–8,all students should develop:

- Abilities of technological design
- Understandings about science and technology

**Science in Personal and Social Perspective**

***Content Standard F:*** As a result of activities in grades 5–8,all students should develop understanding of:

- Natural hazards
- Risks and benefits
- Science and technology in society

*National Research Council.1996.* ***National Science Education Standards*** *p. 143–171. Washington,DC: National Academy Press.*

## CURRICULUM STANDARDS FOR SOCIAL STUDIES

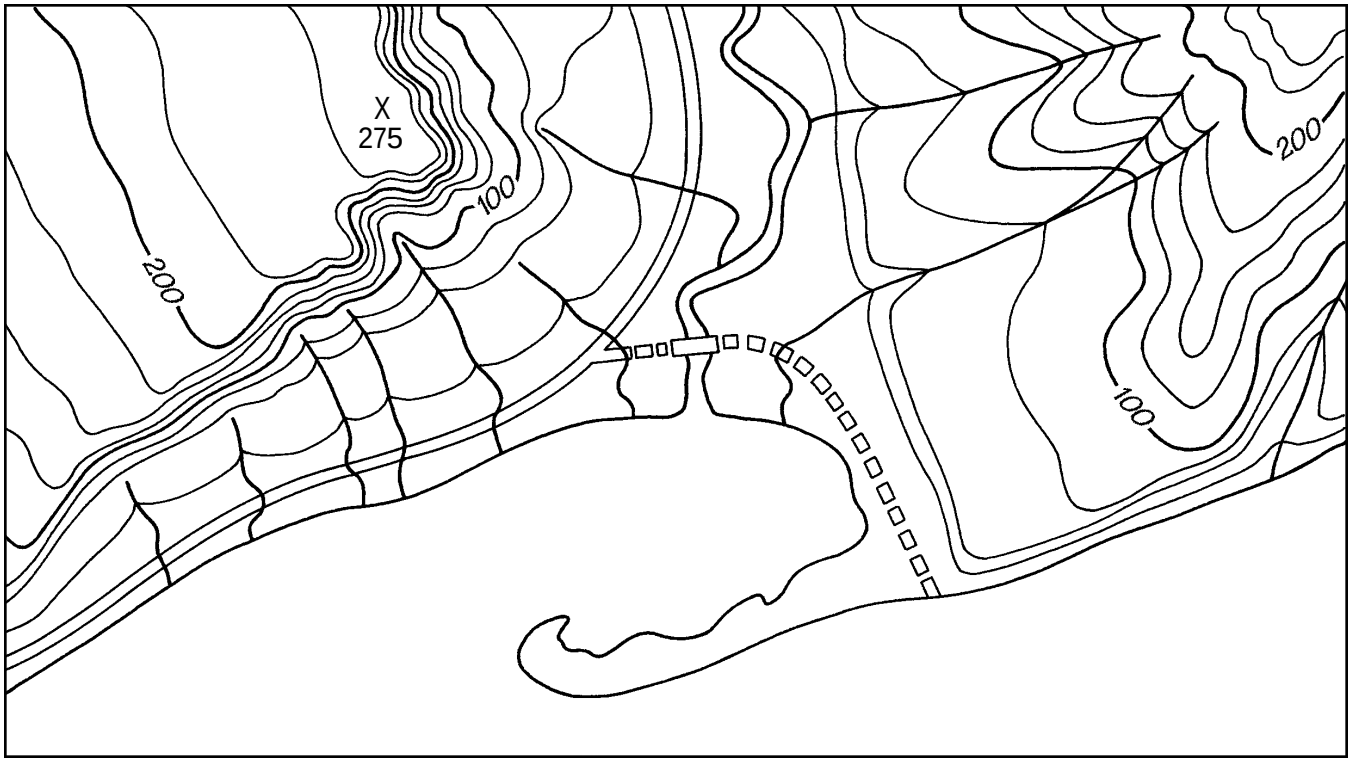
**Strand 3:** *People, Places, & Environments.* Social Studies programs should include experiences that provide for the study of people, places, and environments.

**Strand 8:** *Science, Technology, & Society.* Social Studies programs should include experiences that provide for the study of relationships among science, technology, and society.

**Strand 9:** *Global Connections.* Social Studies programs should include experiences that provide for the study of global connections and interdependence.

*National Council for the Social Studies. 1994.* ***Expectations of Excellence Curriculum Standards for the Social Studies*** *p. 21–30. Washington,DC: National Council for the Social Studies.*

## Appendix D
# SEASIDE




***Topographic Map***

INSTITUTE
*for* GLOBAL
ENVIRONMENTAL
STRATEGIES

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Suite 700
Arlington, VA 22201

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