



## LESSONS FOR UNDERSTANDING CLIMATE CHANGE

### **Pennsylvania Sea Grant/Erie Times-NIE Learn about your environment**

This topic and information offers many opportunities to teach sciences, social studies, language arts, geography, math and art. Incorporate these lessons into your classroom so students will have a better understanding of climate change as they improve their reading, speaking, writing and critical thinking skills.

Students often feel overwhelmed and powerless in the face of environmental problems. The first step is to understand the problems about climate change and its impacts. Then they can be encouraged to take positive action to overcome that sense of helplessness.

Students will learn that climate change is affecting everything from birds to fish to polar bears to people by changing habitat requirements through droughts, wildfires, floods, increased storms, rise in sea level and rise in the temperature of oceans, lakes, rivers and streams.

#### **Goal:**

To help students understand the international and regional scope of climate change impacts, while at the same time encouraging them to think, speak, write critically and take positive actions at school, in their homes, and communities.

### **SCIENCE**

#### **Title: Thermal Expansion and Sea Level Rise**

Summary: Students investigate how thermal expansion of water might affect sea level.

Source: Adapted from Global Climates – Past, Present and Future. EPA Report No. EPA/600/R-93/126 and recommended by Sandra Henderson

#### **Grade level: 5-9**

Time: One class period

Student Learning Outcomes:

- Students will describe the change in water level when water is exposed to heat.
- Differentiate between thermal expansion and melting snow and ice fields as they relate to sea level rise.
- Predict the impact of rising sea level on coastal areas.

Lesson format: Demonstration

National Standards Addressed: 5-8 Content Standard D: Properties of Earth materials

#### **BACKGROUND INFORMATION:**

As global temperature increases, many scientists have indicated that an increase in sea level is one of the most likely effects. Two factors will contribute to this accelerated rise in sea level.

First, although the oceans have an enormous heat storage capacity, as atmospheric temperatures rise, the oceans absorb heat and will expand. This thermal expansion will lead to a greater volume of ocean water which will cause a rise in sea level. Second, rising temperatures will cause the ice and snowfields to melt, thereby increasing the amount of water in the oceans. NOTE: Only the melting of land-based ice and snow will increase sea level. The melting of floating ice will not affect sea level. Demonstrate this to your students by partially filling a glass container with ice and water and marking the water level on the glass. When the ice cubes melt, note that the water level has not changed.

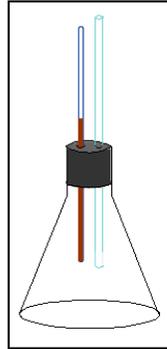
Throughout Earth history there have been periods of glaciation followed by warming trends in which the glaciers retreated towards higher latitudes and higher altitudes. At present, glaciers throughout the world are retreating and the amount of snow and ice at the poles is shrinking. The present interglacial warm period began about 14,000 years ago. At that time sea levels

were about 75 to 100 meters lower than they are today. The sea level rose rapidly (up to 1 meter per century) as massive amounts of snow and ice melted. Today the rate of sea level rise is much lower at 15-17 centimeters per century.

However, the rate of sea level rise is increasing as the rate of global warming increases. An accelerated rate of sea level rise would inundate coastal wetlands and lowlands, increase the rate of shoreline erosion, cause more coastal flooding, raise water tables, threaten coastal structures, and increase the salinity of rivers, bays

#### **MATERIALS:**

- Conical flask
- Two-hole cork for flask
- Thin, glass tube
- Long thermometer
- Portable, clamp-on reflector lamp
- 150 Watt floodlight
- Food coloring
- Water
- Marker



#### **DIRECTIONS:**

1. Completely fill the flask with very cold water (to improve visibility, dye can be added).
2. Place the thermometer and glass tube into the cork as shown in the picture at the right.
3. Place the cork (with tube and thermometer) into the mouth of the flask. The water should rise a short way up the glass tube.
4. Have a student report the temperature of the water and mark the water level in the glass tube with marker.
5. Ask students to predict what will happen to the water level when exposed to heat. Form a hypothesis or multiple hypotheses.
6. Place the flask under the lamp. (Lamp should be aimed towards the water, not the top.)
7. Turn on the lamp and within 5-10 minutes the water level in the glass tube will have risen.
8. Discuss results, hypotheses, and how this example relates to the effect of global warming on sea level (pointing out the dissimilarity between the flask and ocean basins).

The source of Thermal Expansion and sea level rise is *Windows to the Universe*, at <http://www.windows.ucar.edu/> at the [University Corporation for Atmospheric Research \(UCAR\)](http://www.windows.ucar.edu/). © The Regents of the University of Michigan. *Windows to the Universe*® is a registered trademark of UCAR.

#### **More consequences of CO<sub>2</sub> Increases**

Background: NOAA researchers recently documented how carbon dioxide (CO<sub>2</sub>) in the atmosphere is dramatically altering ocean chemistry and threatening the health of marine organisms, including corals.

Scientists observed measurable increases in ocean acidity in the North Pacific, which may be the result of the ocean's uptake of anthropogenic CO<sub>2</sub>.

Increasing amounts of [carbon dioxide](#) are released into the [atmosphere](#) from burning of fossil fuels. Some of that carbon dioxide makes its way into the world's [oceans](#). This changes the chemistry of seawater, lowering its pH, making it more acidic. The increased acidity lowers the concentration of a building block of the calcium carbonate that many marine organisms use to grow their skeletons and create coral reef structures.

Marine creatures such as [corals](#), [clams](#), [snails](#), and many types of algae and plankton build their skeletons and shells from [calcium carbonate](#). These creatures get the chemical building blocks they need to form the calcium carbonate mineral of their skeletons from seawater. As seawater gets more acidic with more [carbon dioxide](#) dissolved in it, these creatures might have a harder time making their skeletons and shells.

### **Try it out for yourself. Do the following experiment:**

#### **MATERIALS:**

- Vinegar
- Clam shell
- Container to hold clam shell and vinegar

#### **DIRECTIONS:**

1. Put a clam shell (one that you don't want to keep) into a container of vinegar and wait.
2. After a few hours check the clam shell and notice what happened.

Vinegar is an acid. Within a few hours will notice that your clam shell is disappearing. The vinegar is dissolving the calcium carbonate that makes up the shell.

Seawater's pH is not dropping as low as vinegar. Vinegar has a pH of about 3. The pH of seawater varies between 7 and 8, so it is a little more basic than neutral. Since the start of the Industrial Revolution, however, pH of seawater has dropped about 0.1. In the next century it is expected to drop another 0.1-0.35. But scientists suspect that even these small changes can make a big difference to the creatures that need to build their shells.

Because reef corals build massive structures from calcium carbonate, and because those structures become a home to diverse communities of marine life, the impact of increasing acidification on corals is of particular interest to many scientists.

The current research indicated that for a doubling of the partial pressure of carbon dioxide (pCO<sub>2</sub>), rates of calcification decreased in corals an average of 30%. The rate is affected by many other factors besides the concentration of CO<sub>2</sub> dissolved in the water. The temperature, light, and nutrients all affect calcification rates too. Lower rates of calcification will likely impact marine food webs, possibly changing the biodiversity of the ocean.

#### **Science Careers: Learn more about Susan Solomon: Pioneering Atmospheric Scientist**

No one knows for sure how many men and women have filled the rolls of NOAA and its ancestor organizations throughout 200 years of history. But it's safe to say that they number in the hundreds of thousands. Many have distinguished themselves by serving the nation and the world and inspiring their NOAA colleagues with discoveries, innovations, and extraordinary influence and leadership. You can read about Solomon and other scientists who left indelible marks of accomplishment and influence on NOAA's science, service, and stewardship missions and on its people.

<http://celebrating200years.noaa.gov/historymakers/solomon/welcome.html>

For more on NOAA Careers and opportunities:

NOAA Careers: <http://www.careers.noaa.gov>

Hollings Scholarships: <http://www.orau.gov/noaa/HollingsScholarship/>

Knauss Fellowships: <http://www.seagrant.noaa.gov/knauss/>

### **Math**

There are many charts and graphs you can use from the websites listed on the Erie Times-NIE/Sea Grant pages to show students how data is used to measure the conditions that are causing climate change like the one below. You can show your students how scientists measure the changes by using the data over long periods and how climate overall is definitely rising along with sea levels and CO2 levels.

## **LANGUAGE ARTS and SOCIAL STUDIES**

### **Language Arts**

Gathers and uses information for research purposes

Uses reading skills and strategies to understand and interpret a variety of literary texts

Uses reading skills and strategies to understand and interpret a variety of informational texts

Uses viewing skills and strategies to understand and interpret visual media

**Have students do research on the “Dust Bowl Days” and have them compare that time period and how long it lasted to today’s droughts. Students can compare the economic, environmental and social effects of then and now. They can also project into the future how an extended period of droughts will affect us environmentally, economically and socially especially with the economic conditions we now face world-wide.**

### **Historical Understanding**

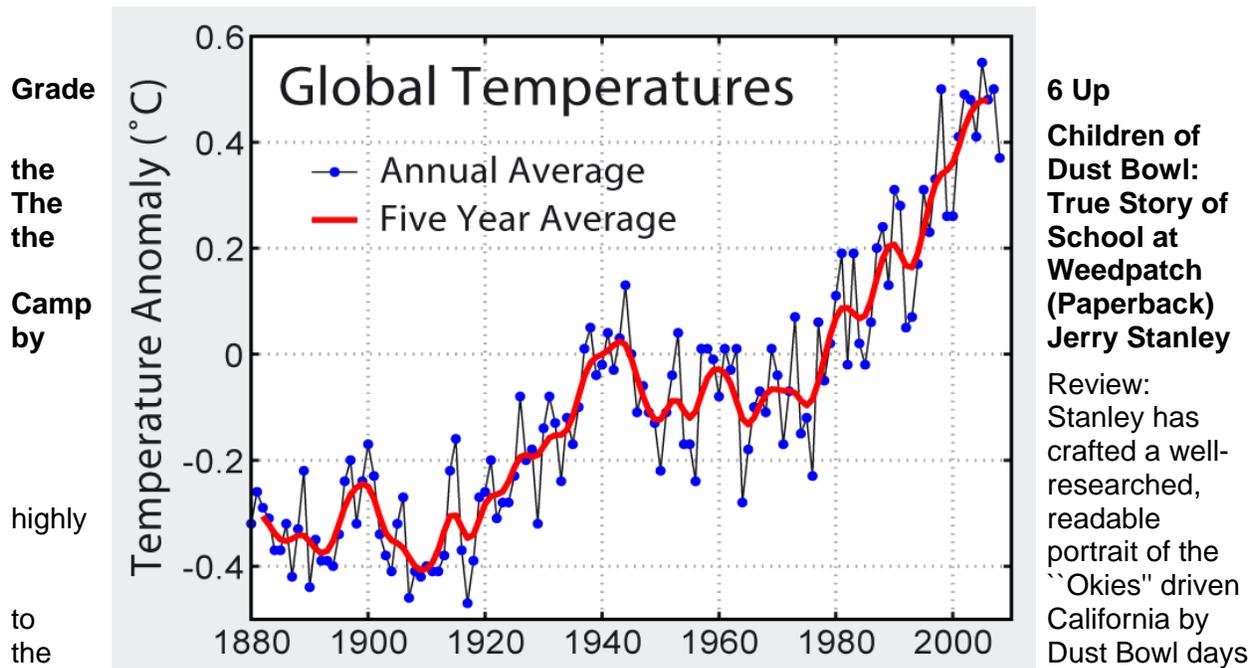
Understands the historical perspective

### **US History**

Understands the causes of the Great Depression and how it affected American society

Understands how the New Deal addressed the Great Depression, transformed American federalism and initiated the welfare state

**Read more books**



of the 1930s and the formidable hardships they faced. After first detailing the desperation of their lives in the Midwest, he follows them on their trek across the western United States to the promise of work in California, where their hopes were dashed. After providing this thorough, sympathetic context of their plight, he zeroes in on the residents of Weedpatch Camp, one of several farm-labor camps built by the federal government. The remainder of the book is devoted to educator Leo Hart and the role he played in creating a ``federal emergency school." Interviews with Hart and the school's former teachers and pupils make Children of the Dust Bowl useful to students of oral history, as well as of the Depression. A thorough index enhances the research value of the book, although it is interesting enough to enjoy on its own. The book is lavishly illustrated with period black-and-white photographs.

**Dust Bowl: The Southern Plains in the 1930s (Paperback) by Donald Worster**

**Review:** "Worster's book is the first to pinpoint the results of the mechanization and defiance of nature, and the sources of such practices. Definitely the best introduction to understanding the cultural sources of modern environmental crises."--A.R. Vasavi, Tufts University  
 "Over ten years old, in a field that is rapidly growing and changing and still the best environmental history of 20th century agriculture!"--Mart Stuart, Oregon State Univ.  
 "An exciting, provocative, and stimulating study....It has much to say to historians, environmentalists, and public policy makers."-- American Historical Review  
 "Superb social history....A gracefully written and fascinating book."--History: Reviews of New Books  
 "Well-written and students respond to it well."--Gilbert W. Gillespie, Cornell University

**The Grapes of Wrath by John Steinbeck**

Students can journey with the Joads in this Steinbeck classic. Controversial, even shocking, when it was written, the work continues to be so even today. It poses fundamental questions about justice, the ownership and stewardship of the land, the role of government, power, and the very foundations of capitalist society. As history, this brings the Dust Bowl years to life in a most memorable way. Steinbeck is a master storyteller and manages to engage the listener's sympathy with this epic story. He won the Pulitzer Prize for this book.

When John Steinbeck's novel The Grapes of Wrath was published in 1939, it caused an uproar in this nation. The Kern County Board of Supervisors banned the book in the county's public schools and libraries on August 22, 1939.

The Grapes of Wrath was mostly set in Kern County, California and illustrated the "corporate landowners" cruelty towards the "exploited agricultural workers. These agricultural workers were usually derogatorily called "Okies," because most of them had migrated from Oklahoma. Others came from Arkansas, Kansas, and New Mexico. After the years of drought in the area that became known as the Dust Bowl and after they were thrown off their land, these farmers moved to California to start a new life, hoping to own their land. However, their luck was not as large as their hope and many were left homeless and unemployed.

Have students conduct interviews to see what people know about climate change. They can ask friends and family members if they believe climate change is a serious issue and find out what evidence they have to support their position.

**ART: Have students draw posters that show the impacts of climate change.**

### **Newspaper Activities:** Sciences, Social Studies, Language Arts **Grades 4–12**

Students will write a letter to the newspaper or to a politician that will reflect their learning and articulate their views and concerns about climate change. This activity will help empower students and give them a voice on climate change and particularly how it impacts their community. Letters will be published on "your space."

**Topic:** Writing letters on climate change

1. Read the NIE pages on climate change. Collect articles about climate change with an international, national, state and local focus. Compare what you read about climate change with what you hear about climate change. What do you think? Do Web Activity below for further research and information before doing number 2.
2. Is climate change a serious problem we should address? Do you want to convince others to stop producing CO<sub>2</sub> and other greenhouse gases? Send your thoughts to [nie@timesnews.com](mailto:nie@timesnews.com). See key points for writing powerful letters below.

**Web Activity:** Compare and contrast how different countries cover climate change. Visit these websites:

#### **Canada**

- **Government of Canada Climate Change Website (How will it affect us?):**  
<http://www.climatechange.gc.ca/english/affect/>
- **Climate Change in Canada Poster Site:** <http://adaptation.nrcan.gc.ca/posters/>

#### **United States**

- **Environmental Protection Agency**  
<http://www.epa.gov/climatechange/US>
- **EPA Global Warming Kids' Site (So What's the Big Deal?):**  
<http://www.epa.gov/globalwarming/kids/bigdeal.html>
- <http://topics.nytimes.com/topics/news/science/topics/globalwarming/index.html>

#### **Australia**

<http://www.climatechangematters.net.au/index.htm>

#### **England**

- British Broadcasting Company

<http://www.bbc.co.uk/climate/> BBC

### **OTHER RESOURCES: See NIE PAGES FOR Other WEBSITES**

#### **To Learn More, Visit These Sites:**

NOAA Research (OAR): <http://www.oar.noaa.gov/>

NOAA's Climate Program Office, <http://www.cpo.noaa.gov/>

Geophysical Fluid Dynamics Laboratory <http://www.gfdl.noaa.gov>

Arctic Research Office, <http://www.arctic.noaa.gov/aro/>

U.S. Climate Change Science Program, <http://www.climatechange.gov/>

Intergovernmental Panel on Climate Change: <http://www.ipcc.ch/>

<http://www.glerl.noaa.gov>

<http://droughtreporter.unl.edu/>

<http://www.research.noaa.gov/research/2007/climatechange.shtml>

Great Lakes Water Levels

<http://www.glerl.noaa.gov/pubs/brochures/lakelevels/lakelevels.pdf>

<http://celebrating200years.noaa.gov/historymakers/solomon/welcome.html>

- **Polar Bear Tracker:-** <http://www.panda.org/polarbears/>

## **Key Points for Writing Powerful Letters:**

### **When writing a letter for Erie Times-NIE “your space”**

(Note: consider bringing in a well-written sample letter from the editorial page for students to use as a guideline or have students read the letters to the editor page and have them critique which letters do the best job of making their thoughts clear while including supporting facts and evidence.)

- Keep the letter short (maximum 250-300 words).
- Deal with one topic and have one major message.
- Use a straightforward, factual approach.
- Back up your opinions with evidence.
- Put the main point at the beginning and progressively less important details towards the end.
- Make sure the letter is concise, grammatically correct, and has no spelling mistakes.
- Have someone edit the letter – everyone who reads the newspaper will see this letter so make sure it is clear and easy to understand.

Letters should include a return address that includes the student's name, teacher, and the school's address.

### **When writing a letter to a politician:**

- Keep your tone polite.
- Do not make the letter too long - approximately one page typed or two pages of large handwriting.
- State your case clearly.

- If a student or the class is aware of anything positive that the politician has done in regard to climate change, state it. For example, if the politician supports the Kyoto accord, acknowledge that.
- If a student is planning to criticize, encourage them to start with a couple of positive comments first.
- Express your concerns and support them with facts and comments from others in your community.

**Lessons compiled and edited by Anna McCartney, Pennsylvania Sea Grant communications and education specialist**