Climate Change and Ocean Level Rise

Objective

This lesson helps students understand what climate change is and how it is impacting coral reef ecosystems around the world. They will investigate how thermal expansion of water might affect sea level rise and how that will affect coastal areas.

Time needed

Prep time: 30 minutes

Class time: 1-2 Hours

Materials

Thermal Expansion + Ocean Rise Activity

- Conical Flask (125 or 250 mL)
- Two-hole Cork
- 2 thin, glass tubes
- Long Thermometer
- Heater or Reflector Lamp (to heat the water)
- Food coloring
- Small ruler to measure cm
- 1 permanent marker
- Stopwatch
- 1L of water
- Question sheet

Background Information

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

First, although the oceans have an enormous heat storage capacity, if global atmospheric temperatures rise, the oceans will absorb heat and expand. This is called thermal expansion. A greater volume of ocean water due to thermal expansion will lead to 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. It should be noted that only the melting of land-based ice and snow will increase sea level. The melting of floating ice will not affect sea level. This can be

demonstrated 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.

Today 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 and aquifers.

Engage

Students can help perform the activity by measuring the height of the water as it warms and the time it takes for the water to change levels. This activity is a great demonstration of what is happening in our oceans by showing them precisely the mechanism of thermal expansion. They will understand the concept and use that to link concepts of climate change and ocean warming. As students learn about coastal ecosystems, particularly coral reefs and the organisms that occupy these reefs, they will start to think about the future of these organisms and their ability to adapt into the future.

Explore

Experiment Questions:

1. What happens when water is warmed?
2. How will this affect coastal areas and ocean organisms?
3. What role does climate change have on sea level rise?
4. What is coral bleaching?

Procedure:

1. Place the thermometer and glass tube into the cork as shown in the picture.
2. Fill one flask with cold water (to improve visibility, dye can be added).
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 starting temperature of the water and mark the water level on the glass tubes with the 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 or on the heater. (If using the lamp, it should be aimed towards middle of the flask, not the top.)
7. Turn on the lamp or heater, and record temperature on the data sheet over one minute intervals for the flask.

8. When time is completed and water has cooled, take out tube with marks and use ruler to measure volume increases for each corresponding time interval. Record on data sheet.
9. Once the experiment is completed, graph the results.
10. Answer the questions on the sheet and discuss them as a class.

11. Once students have finished the experiment and answering the questions, talk to them about coral bleaching. Show them pictures (in the PowerPoint provided) that shows a healthy coral and a bleached coral.

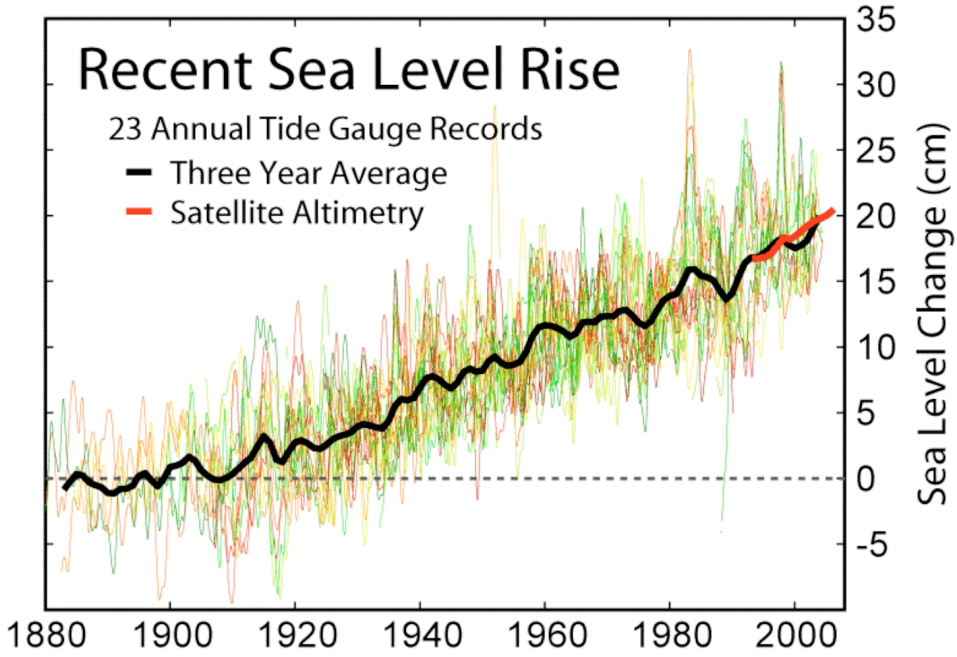
12. Ask students "What do you think is causing the bleaching effect on corals?"
Coral bleaching is when the zooxanthellae are expelled from a coral polyp because they become unhappy in the coral. The zooxanthellae become toxic when the water is warm and they no longer provide the sugars and nutrients that is important for coral growth and survival.

13. Ask students "Can corals survive without the zooxanthellae?"
Students should answer no. Based on previous activities, they should know that the zooxanthellae provides the coral with sugars and nutrients for growth and survival and without them, the coral animal cannot live because that's how it gets most of its food.

So if oceans continue to warm, then the corals will eventually all die because they cant survive without the zooxanthallae.

Explain

Presenting the graph provided below will help students understand the relationship between climate change and ocean level rise. As the global temperatures continue to rise, the ocean sea surface temperatures do as well. This ocean warming will cause sea level to rise and the impacts of this effect are already being seen throughout the world.



Once the students have completed the experiment, they will see the relationship between heat and water expansion, or sea level rise. They should create a graph dictating this relationship. On the x-axis, or horizontal axis, the temperature of the water should be recorded. On the y-axis, or vertical axis, the level of the water in the tube should be recorded. They should see a positive relationship between temperature and height of the water. Students should then be able to write a one to two sentence description of these results. Also, with their knowledge of coastal ecosystems and coral organisms from pervious activities, they should be able to make predictions of what might happen in the future if ocean levels continue to rise.

Elaborate

This concept is an important one, as it helps students understand the link between climate change and ocean warming and how it will affect all the organisms that currently live in coastal ecosystems. They will be able to investigate the principle of thermal expansion and relate it to the survival and the ability of organisms to adapt into the future.

Students can extend their learning by thinking about the future of the oceans and what will happen if this phenomenon continues. They can think about ocean organisms such as fish and corals, but also think about coastal communities – human communities as well as land based ecosystems. Human communities that are built on coasts may be affected by the increasing water level. Flooding may be an issue, flooding homes and streets, therefore impacting everyday life. Land based ecosystems, such as forests or deserts may no longer thrive if water invades their homes. Students can extend their knowledge of thermal expansion to also think about the impacts it will have on these communities and ecosystems.

Resources

Additional Resources

http://ocean.nationalgeographic.com/ocean/critical-issues-sea-level-rise/
http://www.climate.org/topics/sea-level/
http://www.ipcc.ch/ipccreports/tar/wg1/411.htm
http://en.wikipedia.org/wiki/Thermal_expansion

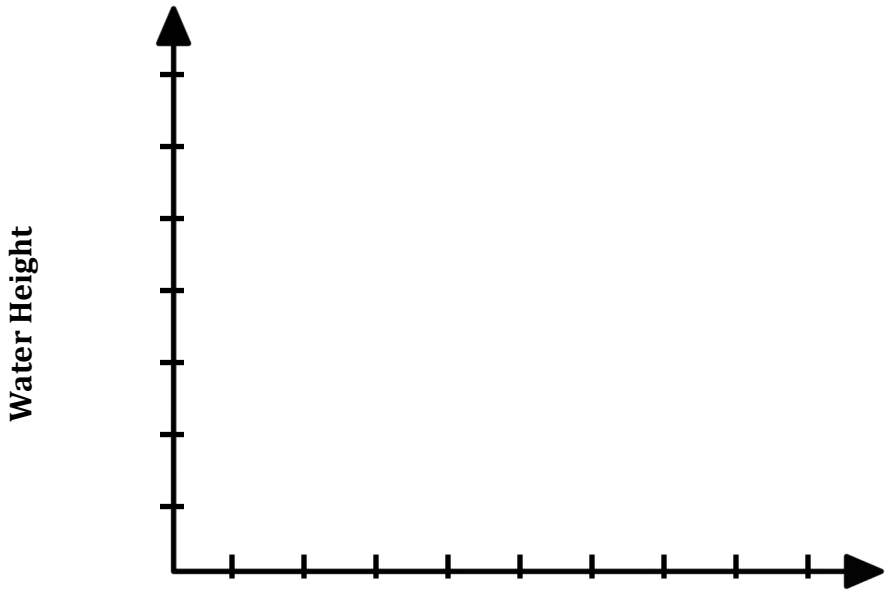
Resources Used:

http://www.windows2universe.org/teacher_resources/teach_thermalexpand.html

SMILE Thermal Expansion Post-Experiment Question Sheet

1. Record your data in the chart and then graph your results!

Temperature	Water Height



Write one sentence that describes the results of the experiment:

2. As the water warmed, what happened to the amount of space it occupied?
It increased as seen by the rising level of water in the small tube. Tell them that a volume increase caused by heat is called thermal expansion.

3. If the water in the oceans becomes warmer, what will happen to the volume of the oceans?
The amount of space occupied by the oceans will increase and cover up some of what is now dry land. In other words, the level of the sea or ocean will rise.

4. How will the change in ocean volume affect coastal areas?
Some areas will be under water. Coastal cities, wetlands, beaches, and roads may be damaged.

5. How will the change in ocean volume affect corals and other organisms?
Corals need sunlight in order to photosynthesize and create nutrients to grow and survive. If the ocean level keeps rising, then the light will not reach the corals and they won't get the proper nutrients they need to continue to survive.