GLOBAL CLIMATE CHANGE AND SEA LEVEL RISE

Learning Objectives:

In this lesson, students will

1. learn that ice formations on land will cause a rise in sea level when they melt, whereas ice formations on water will not cause a rise in sea level when they melt.
2. learn that ice is less dense than water.
3. learn that ice displaces water equal to the mass of the ice.
4. practice some of the steps involved in a science investigation.

Materials

- two identical clear food storage boxes (approximately 6 inches square) per group
- 8 sticks of classroom modeling clay per group
- 1 ruler per group
- 1 tray of ice cubes per group (may need to start storing ice cubes ahead of time)
- 1 liter of water per group
- Sea Level Rise Worksheets (1 per student)

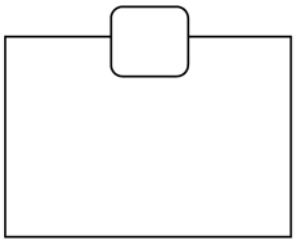
Teacher Background:

Global climate change is becoming a threat to our current way of life on Earth. One consequence of climate change is the melting of ice caps, glaciers, and sea ice, including polar ice in Greenland and Antarctica. Substantial melt of these massive glaciers will cause a rise in sea level along coastlines throughout the globe. This activity will explore how melting ice impacts sea level.

Water is an unusual liquid because it expands when it freezes. In general, liquids do not expand upon freezing, but rather contract and become denser as temperature drops. Like other liquids, as water begins to cool, it becomes more and more dense. But, because of the physical structure of the water molecule, it continues to become denser until just before freezing, when it expands. This expansion occurs at the point that freezing begins (around 4°C). At this temperature water molecules arrange themselves into a crystal lattice structure that is significantly **less dense** than the liquid form. Because of this **decrease in density** at the point of freezing, ice always floats on water.

When objects are totally submerged in water, they displace an amount of water equal to their volume. However, because ice floats on water and is not completely submerged, ice does not displace an amount of water equal to its volume. Instead, it displaces less than its total volume of water. The water that floating ice displaces is equal to the volume that the ice would take up if it melted and became water again. In other words, floating ice **displaces** water equal to the mass of the ice. When ice melts, the mass of the ice is conserved, but the crystal lattice structure of ice disappears and the volume decreases and becomes equal to the volume of water it displaced in its ice form.
Therefore, when floating ice melts, the melted water is equal only to the volume of the ice that was submerged. This means that when floating ice melts, it contributes no additional volume to the body of water. We see this phenomenon when we let ice melt in a glass of water. The water does not overflow because the ice has already displaced water equal to the volume it will take up upon melting.

Ice cube floating in water



Ice cube melts into water, becoming denser. The melted water fills in the space where the ice had previously displaced water. The total volume of water does not change.

Ice already in the oceans does not contribute to sea level rise, but ice covering land will contribute to sea level rise upon melting. Greenland, for example, is covered by vast quantities of continental ice. The melting of this ice will contribute to sea level rise. The sea ice in the area of the North Pole is floating in water and thus the melting of this ice will not contribute to sea level rise.

In this activity, students will learn which masses of ice pose the biggest threat for rising global sea level and why.

Activity:
This activity can be performed as a demonstration or in student groups.

Introduction
Have a discussion about global climate change and its impact on sea level rise. Ask students where there is a lot of ice in the world. Is the ice on land or on water? Does it matter whether the ice is on land or water? Will one or both cause sea level to rise when they melt?

Give each student the Sea Level Rise worksheet.

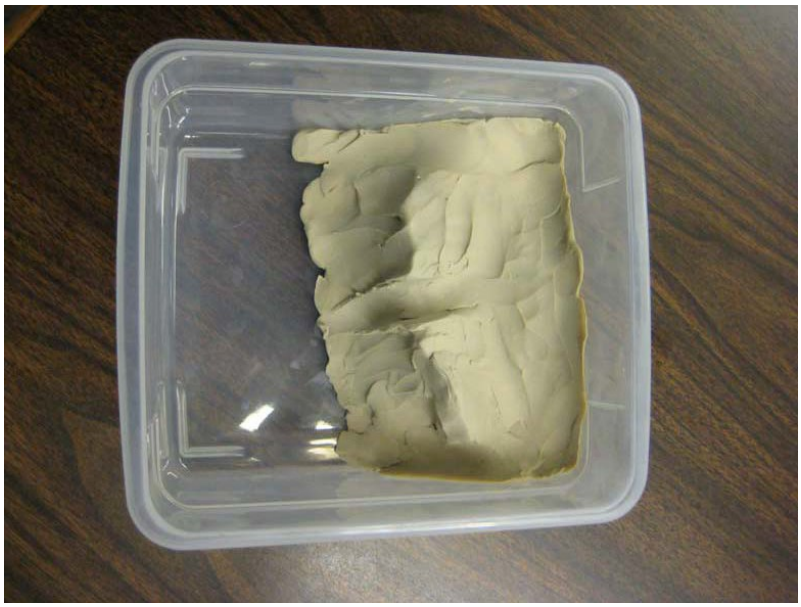
Guide students through the development of a question about the melting of ice and sea level rise. Which type of melting will cause a greater increase in sea level?

Have each student make a prediction.

Explain the steps in the activity and, in the methods section of the worksheet, have each student write down, in their own words, the steps involved in this investigation. Go over the steps slowly and in stages. Tell students they have to write clearly and with enough detail so another student could follow the same steps. Or give students written instructions.

Tell students that they will need to record their measurements and write down their results, so to pay attention as they perform the investigation.

Procedure
1. Place half of the clay into one side of each box. Form the clay to represent land rising out of the ocean. In one box, form a level place at the highest part as shown below. Make rivers on the land if you like.



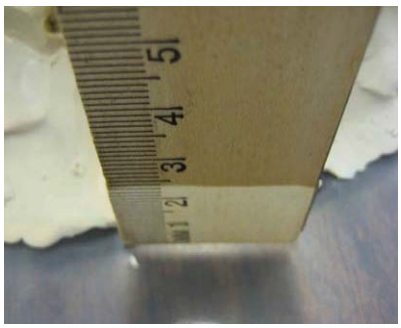
2. Place as many ice cubes as possible on the level place formed with the clay in the first box.

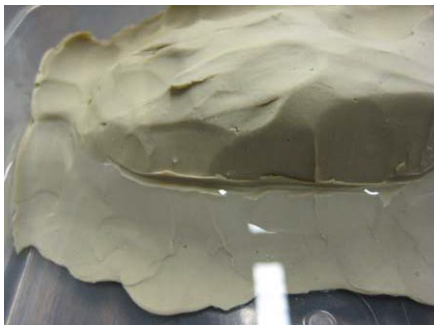
3. Place the same number of ice cubes next to the clay in the second box, so that they are resting on the bottom of the container.

4. Pour water into the container where the ice is resting on the bottom until the ice floats. Be sure the ice is floating, not resting on the bottom. If this occurs, add more water.

5. Pour water into the second container with the ice resting on the clay (be careful not to disturb the ice cubes) until the water levels in the two containers are approximately equal.

6. On their Sea Level Rise Worksheets, have students record initial measurements of water height (in mm) using a ruler. For visual impression you may wish to draw a line in the clay where the water height begins for each container.





7. Leave the setup. If possible, have students take measurements every hour and record the results on their worksheets. You can also leave the setup for several hours or overnight and just record the final measurement after the ice has melted.

9. Have students measure new water heights and make observations about what occurred once the ice melted. Make sure students enter their measurements on their worksheets.

10. Have students include the answers to the following questions in their conclusions on the worksheet.

In which "situation" did the water level rise more?
How do the results compare with your predictions?
Why do you think this happened?

Use the information in the teacher background section to help students understand their results.

Have another discussion about global climate change. Why might we be concerned about sea level rise? (Coastal areas will be flooded. People will lose their homes. Some fresh water resources will become too salty to use. Habitat loss will occur.) What can we do to help slow this process by using less fossil fuel? (Take public transit instead of driving, eat local foods, turn off lights and electrical equipment when not in use, plant a tree, reduce, reuse and recycle.)