Permafrost Demonstration

Grades: Grades 7 - 9 (ages 12 – 15)
Time: Approximately 40 minutes (up to 1 hour)
Preparation time: overnight (to freeze the permafrost)

Note: This activity might be best for the summer months, when soil is available outside. If soil is not available, it is possible to use soil from houseplants or clean, unused cat litter.

Objectives:

Students will:

1) Learn about permafrost and how climate change can affect permafrost.
2) Discuss the challenges of building on permafrost, and why permafrost is important in Nunavut.
3) Construct a small structure on a permafrost model and predict what happens to the structure when the permafrost is warmed.

Background:

See Appendix A for a more detailed introduction to climate change and permafrost.

- **Permafrost** is ground that has been frozen for at least two years. In Nunavut, all of the ground consists of continuous permafrost, meaning that the permafrost layer stays frozen all year round.
- With climate change, one of the impacts is that Arctic temperatures are starting to increase. As the temperature increases, permafrost can start to thaw.
- Infrastructure (buildings, roads, bridges, airport runways, etc.) is built on permafrost. Frozen soils are more stable than unfrozen soils. The way we build on permafrost is important for creating stable structures that will last a long time.
- There are a few different ways we can build on permafrost. If permafrost starts to thaw and the buildings are not built properly for the type of ground or building, then buildings can move, shift, or slant. (See the Homeowner's Guide to Permafrost in Nunavut for more information)

For more information on permafrost and climate change, visit www.climatechangenunavut.ca/resources

Materials:

For the permafrost:

- 1 clear container - a plastic shoe box, Tupperware, or large baking dish (approximately 9"x13")
- Ice cubes – 1 tray, approximately 12
- Local soil or sand – enough to fill each container about half-way
- Water – about 2 cups

House-building supplies:

- Toothpicks or wooden skewers
- Modeling clay
- Popsicle sticks
- Cardstock or paper
- Tape
- Glue
- Scissors
- Other supplies in the classroom such as felt, Styrofoam, pipe cleaners, or string

Preparing the Permafrost:

* Prepare the permafrost the day before the activity. Keep the permafrost frozen (in a freezer or outside) until just before the activity begins.

1. Pour 2/3 of the soil into the container
2. Add water until moist. Mix.
3. Freeze overnight (several hours).
4. Place ice cubes on top (to mimic ice wedges).
5. Add the last 1/3 of moist soil.
6. Freeze for minimum 3 hours.

Figure 1 – Permafrost box ready for the houses

Activity:

1. Split the students into groups (of 2-4, depending on class size). Each group is tasked with building the best house/structure they can with the available resources. The structure must fit in the permafrost container, so make sure the size is appropriate.
2. Hand out house-building supplies to each group. Resources can be limited to make the project more challenging for older students.
3. Each group builds a house, taking into consideration structure type, and how they will connect the structure to the permafrost (See Appendix C for foundation examples). It may be useful to set a time limit for the house-building portion of the activity.
4. The houses are then placed on the permafrost. Use a hair dryer to speed the process of “thawing” the permafrost. Alternatively, the permafrost can be left alone for a few hours until the permafrost melts. CAUTION: Using hair dryers to melt the permafrost requires close teacher supervision due to electrical dangers near water.

5. Note what happens as the permafrost thaws.

Figure 2 – Students building their houses to test on the permafrost

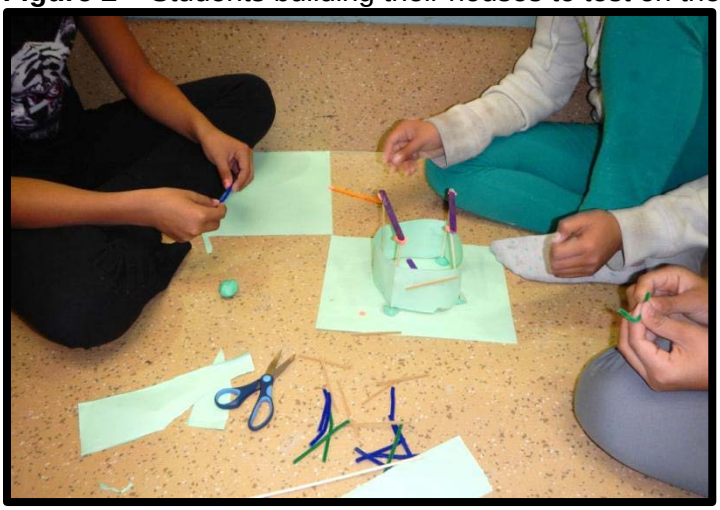

Figure 3 – Removing the house from the melted permafrost. Notice the “swampy” areas, and the depressions in the ground where the ice wedges melted.

Discussion Questions

- What happened to the surface of the ground when the permafrost thawed? How would this affect the tundra, plants, and animals?
- How could you make sure that houses aren’t affected when permafrost thaws?
- How would you build your house differently next time?
- Permafrost contains large amounts of stored organic carbon, and also methane deposits. What might happen to these greenhouse gases if permafrost thaws?

Links

For more information and additional resources on climate change visit:
www.climatechangenunavut.ca/resources

Alternative resources for different permafrost demonstrations:

1) **Permafrost in a Box activity**. This is a multi-day activity that is explained well, but may require additional supplies. Would be good for high school students, in grades 11-12. Students review permafrost as the foundation of the Arctic then build a model representing permafrost conditions and record changes over time.
http://www.uniteusforclimate.org/pdf/UniteUs_910_PermafrostInABox.pdf

2) **Permafrost Activity – "Heaving and Thawing."** This activity examines permafrost changes, such as heaving and thawing, and explains how water drainage is affected by these changes. It would be good for younger students, as it is a classroom demonstration.
http://www.blm.gov/ak/st/en/res/education/akcold_desert/akcolddesert_classroom.html

APPENDIX A

Climate Change Primer

The Greenhouse Effect

What happens when a car is sitting in the sun? It will get hot inside. This is like a greenhouse. What do you know about greenhouses and how they work?

The greenhouse is a great example of how the **greenhouse effect** works. The sun's rays enter the greenhouse through the clear glass. Most of the sun's energy is trapped in the greenhouse. This makes the greenhouse warmer than the air outside, so plants can grow. Some heat does escape through the glass, but most of it is trapped.

Similarly, the **earth's atmosphere** works like a greenhouse. Can someone explain how the greenhouse effect on earth?

1) The sun's rays reach the earth – sunlight passes through the earth's atmosphere and warms the earth.
2) Some sunlight (solar radiation) is reflected by the earth and the atmosphere
3) Most of the sun's energy (radiation) is absorbed by the Earth's surface.
4) Next, some of the energy will pass back through the atmosphere, into space.
5) But, the atmosphere also traps some of the heat, which helps to keep the earth warm (warm enough for life on Earth).

What happens when more heat is trapped around the Earth?

→ *The overall surface temperature of the Earth increases.*

Greenhouse Gases

The greenhouse effect on earth is caused by the atmosphere and **greenhouse gases**. Greenhouse gases are things like carbon dioxide or CO2, or methane. We need some greenhouse gases to keep the earth warm enough to live on, but if there are too many greenhouse gases in the atmosphere, we will start to see climate change.

What are some sources of greenhouse gases?
There are natural and human sources:

- Natural → forest fires, volcanoes, cows (produce methane)
- Human → using fossil fuels – driving a car, taking an airplane, charging your phone, deforestation

Climate Change Impacts

How will climate change affect you? Think about:

- Hunting seasons
- Changing ice conditions
- Increased shipping season
- Different plants and animals in the area – seeing plants that normally don't grow here

Adaptation

What are some things that we can do to adapt to the changing environment? What can we do in our everyday lives to live with the changes from climate change? Think about our houses, activities in winter, what happens when sea ice changes, etc.

- Building communities to handle permafrost thaw
- Hunters to find safer, alternate hunting routes
- Being prepared for quick changes in the weather, especially when out on the land
- New building techniques and building stable structures

Mitigation

What are some things that we can do to reduce the amount of greenhouse gases that go into the environment?

- Use less fossil fuels
- Drive less
- Idle less
- Use alternative energy sources, like solar power
- Using energy efficient light bulbs