USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

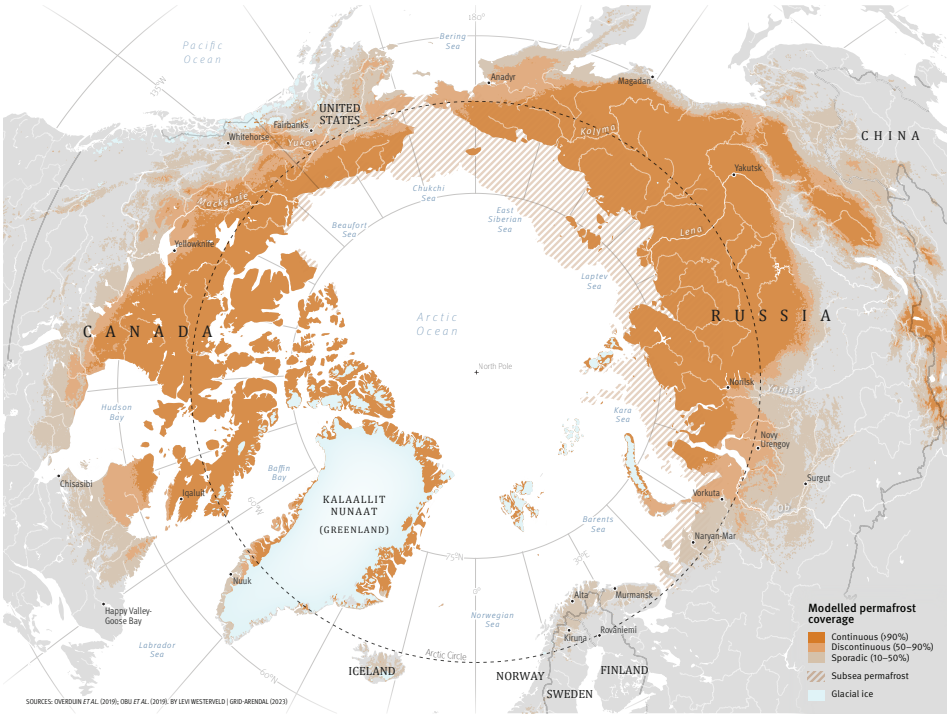
AGI american geosciences institute
connecting earth, science, and people

Earth Science Education Activity

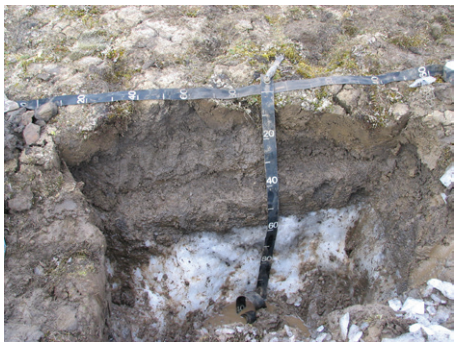
Observing Impacts to Communities Built on Permafrost

Background: Think about what lies underneath the buildings and roads in your community—rocks and soil! There are different types of soil, commonly classified into 12 **soil orders**. One soil order, called **Gelisols**, is located in cold climates and is characterized by permanently frozen ground, called **permafrost**. Permafrost is any soil that has been completely frozen for at least two years—even in the summer! Some permafrost has been frozen for thousands of years. Because our climate is warming, the permafrost in Gelisols is melting. As the Gelisols thaw, previously frozen carbon is released into the atmosphere as carbon dioxide and methane gas that further contribute to a warming climate. Thawing Gelisols also impact ecosystems and landscapes.

Key Question: How are communities that are built on top of soil with permafrost affected by a warming climate?



Most of the world's permafrost is found in the northern hemisphere, as shown in this map of modelled permafrost coverage in the Arctic Permafrost Atlas.
Credit: GRID-Arendal



Credit: Skip Walker, United States Permafrost Association

STANDARDS

NGSS: MS-ESS2-2
SDG 11: Sustainable Cities and Communities
SDG 13: Climate Action

Learn more about the United Nation's Sustainable Development Goals (SDGs) and explore resources for educators from UNESCO: https://en.unesco.org/themes/education/sdgs/material

MATERIALS, FOR EACH GROUP

- 2L bottle with top cut off and holes poked around the bottom*
- aquarium gravel (~ 3 cups)
- crushed or pellet ice (~2 cups)
- scoop or measuring cup
- small container with flat top (e.g., **mini food container**)
- **bubble level**
- roasting pan or similar

*A large cup can also be used as long as the small container with the flat top can fit inside.

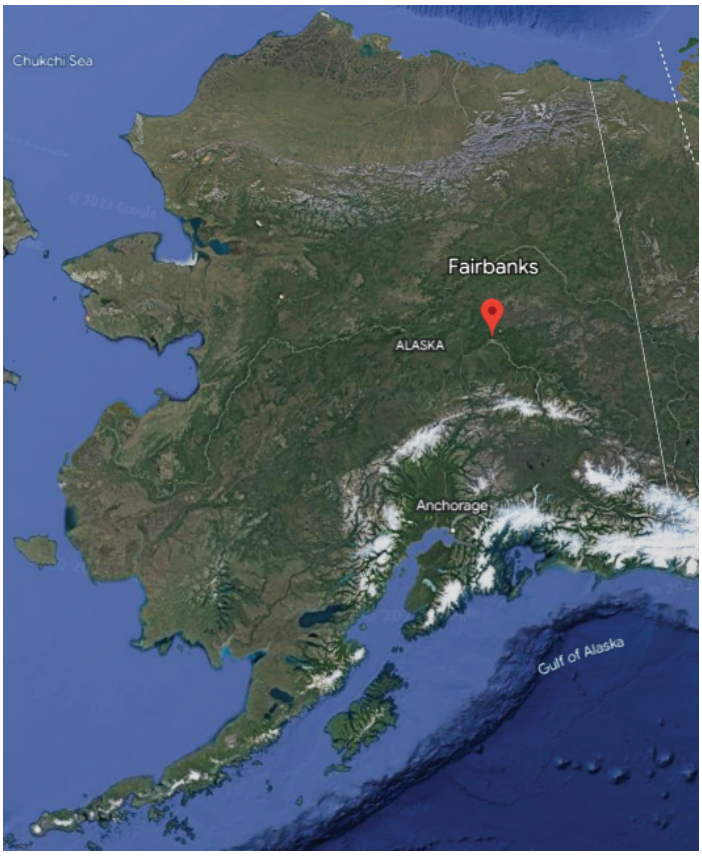
Credit: L. Brase, AGI

HANDS-ON INVESTIGATION

1. Place the bottle in a roasting pan or on a tray.
2. To model soil with a layer of permafrost, fill the bottle with half of the gravel, all the ice, and then the remaining gravel.
3. Place the small container on top of the gravel to act as a model house. Place a bubble level on top of the container to ensure it is flat.
4. Predict what will happen when hot water is poured into the bottle around the model house.
5. Pour the hot water slowly around the model house to represent a warming climate.

ANALYSIS

1. What did you observe as you poured water around the house?
2. How might thawing permafrost impact communities built on Gelisol soils?
3. What steps might you take to help mitigate the effects of thawing permafrost on communities?
4. How does thawing permafrost affect the Earth systems (hydrosphere, atmosphere, geosphere, and biosphere)?



Credit: ©GoogleEarth

SYNTHESIS

Fairbanks is Alaska's second largest city and had a population of over 32,000 people as of 2021. The city is located in the interior of the state at latitude of 64.8˚N. Using the maps provided and your results from the hands-on investigation, describe how you think a warming climate may impact the people of Fairbanks, AK. What evidence might confirm your predictions?

EXTENSION

Imagine you are an urban planner in Fairbanks designing a new residential area. How would knowledge of soil properties and conditions influence design decisions related to building locations, landscaping, drainage, and sustainable development practices?

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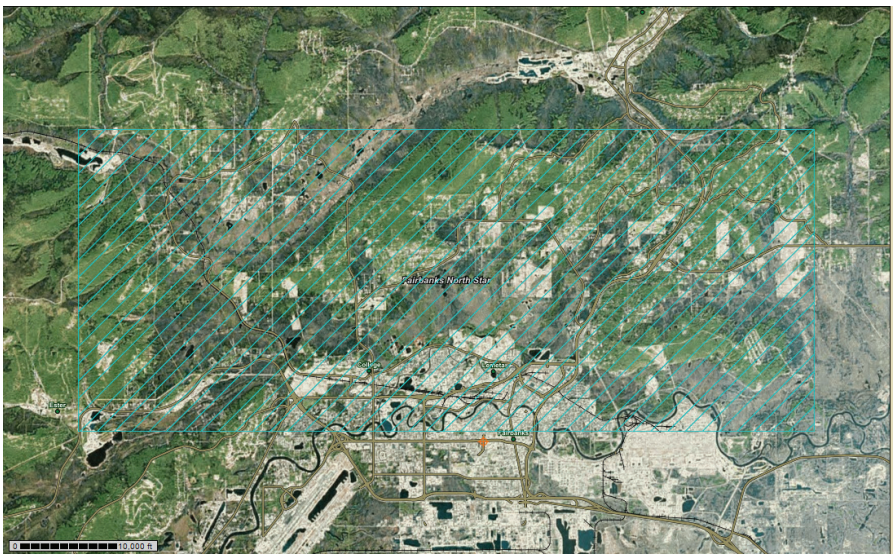
Fairbanks, AK—Area of Interest

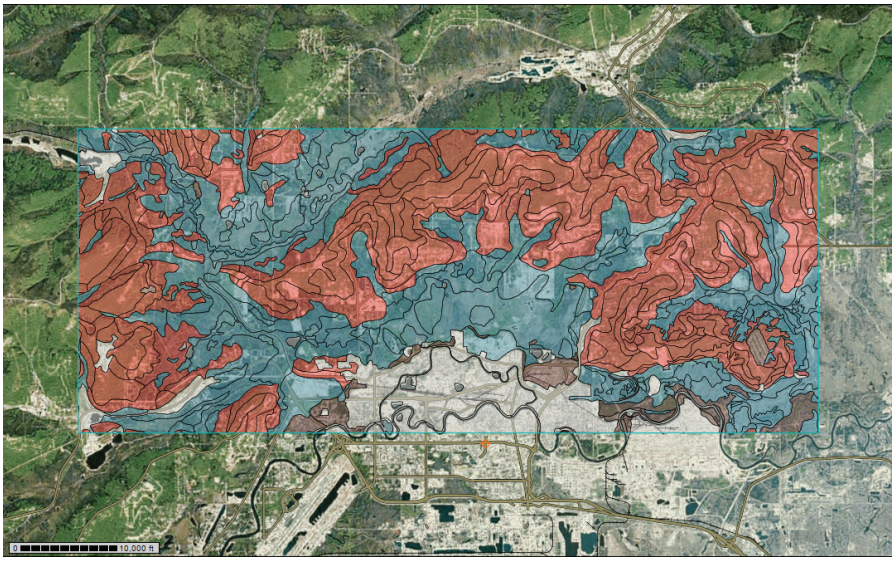


Credit, all: selections by L. Brase using USDA NRCS Web Soil Survey

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Fairbanks, AK—Soil Order



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

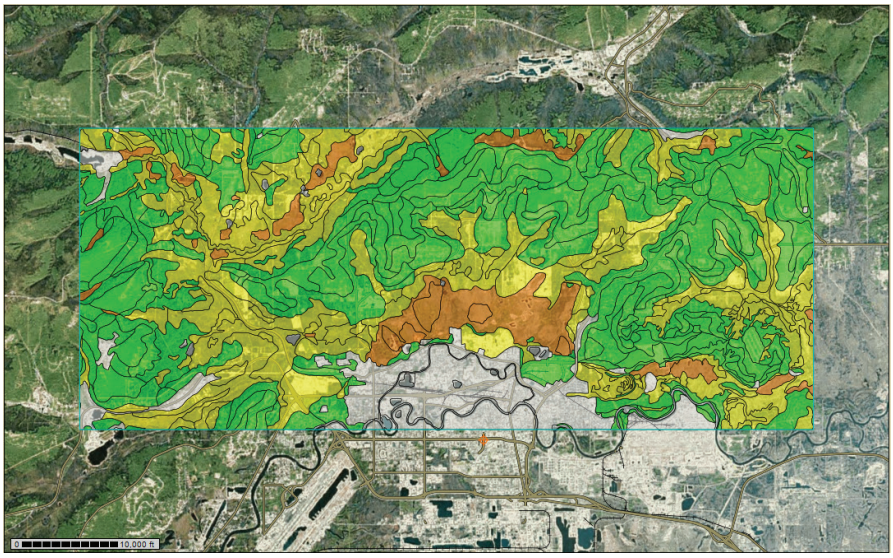
Soil Rating Polygons
- Alfisols
- Andisols
- Aridisols
- Entisols
- Gelisols
- Histosols
- Inceptisols
- Mollisols
- Oxisols
- Spodosols
- Ultisols
- Vertisols
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

Fairbanks, AK—Permafrost Sensitivity



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- Very high
- High
- Moderate
- Low
- None, no permafrost
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography