

Changing Landscapes

Coastal Erosion

High School Guide



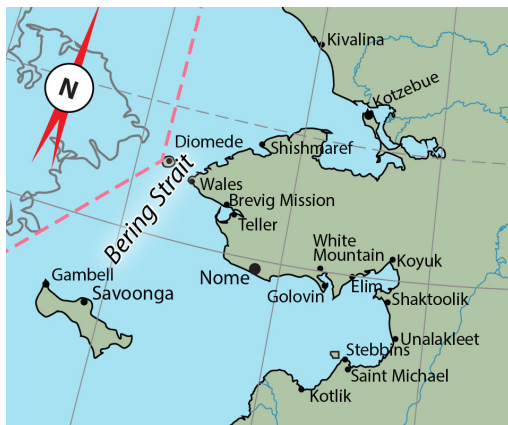
REACH Up

Raising Educational Achievement
through Cultural Heritage Up

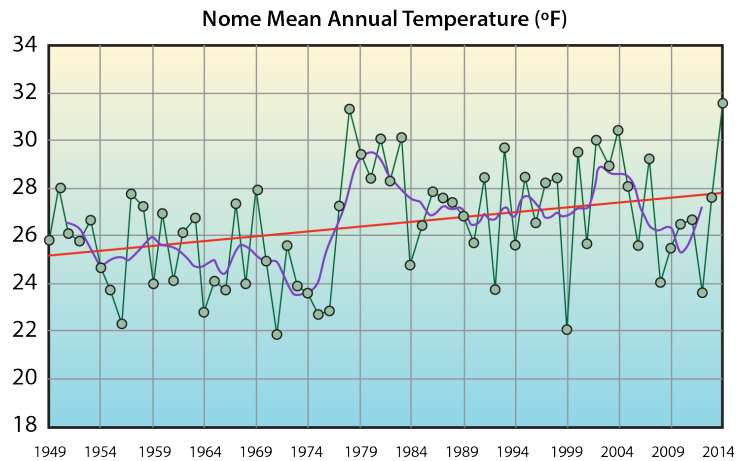
Changing Landscapes

How does climate change impact the landscape?

The climate in the Bering Strait region of western Alaska is warming. Increasing temperatures change the landscape in a variety of ways. Landscape changes impact local ecosystems and ways of life for local residents. What are these changes? What processes cause them? How do these changes impact Bering Strait communities?



Bering Strait, Alaska



How is climate change impacting Alaska's coastline?

The coast of Alaska is changing. Land-fast sea ice is forming later and melting earlier. Fragile shorelines unprotected by this ice are battered by wind, rain and waves from storms. Permafrost-rich soil along the coast is thawing, making it more vulnerable to erosion by ocean waves. In many places, the land is eroding into the sea.



Sand, soil, and vegetation on this beach are being eaten away by coastal erosion. Photo credit: Matthew Whitley



Ask an Expert

1. Watch the REACH Up *Coastal Erosion* video available at www.k12reach.org/videos.php
2. Discuss local coastal erosion with an elder or cultural knowledge bearer.

Some questions you may want to ask:

- Is coastal erosion occurring in our community? If so, which parts of our coast are being impacted and how?
 - How might an eroding coast affect:
 - subsistence activities?
 - local plants and wildlife?
 - transportation and structures in our community?
 - Do you know if our community or other communities in our region have taken any action to reduce or prevent coastal erosion? If so, what has been done? How can people adapt to coastal erosion?
3. If the person you interview speaks an Alaska Native language, ask them what language and dialect(s) they are familiar with. Ask them to please translate the following words:
 - ice
 - sea ice
 - shore ice
 - coast
 - storm
 - waves

Compare your words with the translations on the following page. Are any of the terms the same or similar?



Bessi Sinnok of Shishmaref discusses the changes that she has observed on the island. Photo credit: P. Clark



Activity

Coastal Erosion Vocabulary

Would you like to know Alaska Native language terms related to climate change?

Work with your classmates to practice coastal environment vocabulary words in English and the indigenous language of your community. Your teacher will give you vocabulary cards with the English word and an illustration on one side. Write the corresponding indigenous term on the blank line on the back of each card. Use the words you learned from a local elder or cultural knowledge bearer, or choose the translation below that is closest to your community.



Miriam Toolie
Savoonga, AK
Siberian Yupik
St. Lawrence Island Yupik dialect

ice - siku
sea ice - qelughtaaq
shore ice - uughhun
coast - tapghaa
storm - eslalluuk
waves - nengulghat



Annie Conger
Nome, AK (from Brevig Mission)
Seward Peninsula Iñupiaq
Bering Strait dialect

ice - siku
sea ice - siku
shore ice - siku sinaani
coast - taġium sinaa
storm - piqsiq
waves - qailiq



Luci Washington
St. Michael, AK
Yup'ik
Unaliq dialect

ice - ciku
sea ice - imarpik ciku
shore ice - ceña ciku
coast - ceña
storm - pircir
waves - qaiq



Jolene Nanouk
Unalakleet, AK
Seward Peninsula Iñupiaq
Qawiaraq dialect

ice - siku
sea ice - siku
shore ice - sinaasiku
coast - taġium sinaa
storm - piqsiq
waves - qailiq



What drives coastal erosion?

Erosion is the movement of sand, soil and rock by natural forces such as wind, water, ice and gravity. In western and northern Alaska, wind-driven waves and flooding caused by storm surges are the key culprits in coastal erosion. The amount of coastal erosion varies from place to place based on sea ice conditions, sea depth near the shore, and the composition of the coast. Many coastal communities in the Bering Strait region have experienced significant erosion over the last 50 years.



Changes to the spit and coastline near Teller, Alaska are clear in these images taken 65 years apart. Photos courtesy of the State of Alaska Division of Geological and Geophysical Surveys



Coastal Erosion

How do waves erode the coastline?

Ocean waves are caused when wind energy transfers to water. Stronger wind means more energy is transferred and this results in higher waves that have a lot of kinetic energy. When a wave meets the shore, the soil and rock of the coast are subjected to great force and this can result in erosion.

How does climate change impact waves?

The distance that waves can travel uninterrupted over the ocean is known as fetch. Long fetches of open water allow for increased wave height. When sea ice blankets the ocean, it reduces the fetch. Waves are disrupted by the ice and do not build as high. As the climate warms, sea ice is forming later and melting earlier, resulting in a longer ice-free season during which forceful waves can build and batter the coast.



*Waves during a storm near Nome, Alaska
Photo Credit: Department of Commerce,
Community and Economic Development;
Division of Community and Regional Affairs'
Community Photo Library*



*Waves meet the rapidly eroding coastline in
Shishmaref, Alaska
Photo credit: Department of Commerce,
Community and Economic Development;
Division of Community and Regional Affairs'
Community Photo Library*





What is a storm surge?

A storm surge is a temporary, localized rise in sea level due to changes in atmospheric pressure and wind associated with a storm. Storm surges can cause flooding in low-lying coastal communities and allow ocean waves to reach further inland along fragile coastlines.

A warming climate can increase the frequency of intense storms that result in storm surges. This is because warmer weather causes more evaporation of Earth's water. The additional water vapor acts as fuel for intense storms to develop.



*A 2011 storm flooded the community of Golovin.
Photo credit: John Peterson, Golovin, Alaska*



Coastal Erosion

What other factors influence coastal erosion?

While waves and storm surges are the key drivers of Alaska's coastal erosion, several other factors influence how successful these drivers are at scooping away coastal soil.

Sea Ice

Sea ice can decrease coastal erosion in two ways. The ice that forms on open water reduces fetch, which has a damping effect on waves. Shore-fast ice, or ice that is frozen to the coastline, decreases erosion by creating a barrier between the sea and the soil of the coast.



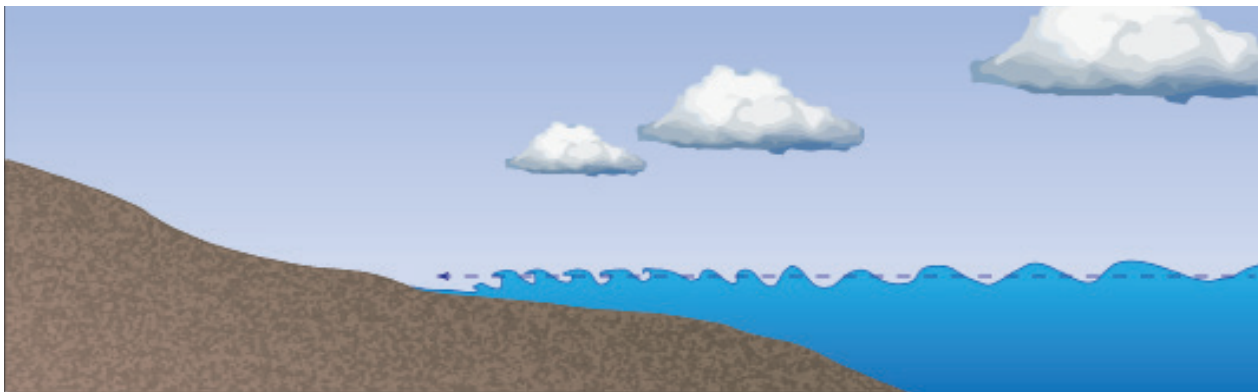
*Shore-fast ice in Kotzebue, Alaska. Note: this photo was taken during an early spring-melt, April 24, 2014.
Photo Credit: P. Clark*





Beach Slope

The slope of the ocean floor as it approaches the coast is known as beach slope. Beach slope impacts erosion. A shallow slope allows wave energy to dissipate as it approaches the shore. This results in weaker waves at the beach and less erosion. A steep slope give waves much less time and distance over which to dissipate, so they meet the shore with more force and have more potential to cause erosion.



What is the coast made of?

The composition of the coastal land mass helps to determine how much erosion takes place. Land made up of rock or solidly frozen permafrost is very resilient and withstands waves and storm surges well. Sand and the muddy soil produced by thawing permafrost are easily scooped away. Warmer temperatures in the Bering Strait region have lead to thawing of coastal permafrost and an increase in erosion as a result.



*Permafrost-rich soil easily erodes into the sea
Photo credit: Matthew Whitley*



Activity

Cape Halkett Coastal Erosion

How does erosion affect the Arctic coast of Alaska? How can we measure coastal erosion? Use Google Earth to compare historical and current coastlines to measure coastal erosion at Cape Halkett on the Arctic Ocean. You will need a computer.

Procedure:

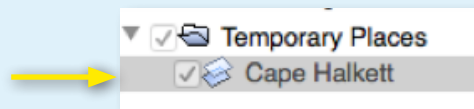
1. Download Cape Halkett.kmz file from: k12reach.org/grade9-12theme2.php

2. Launch Google Earth.



3. File/Open the file

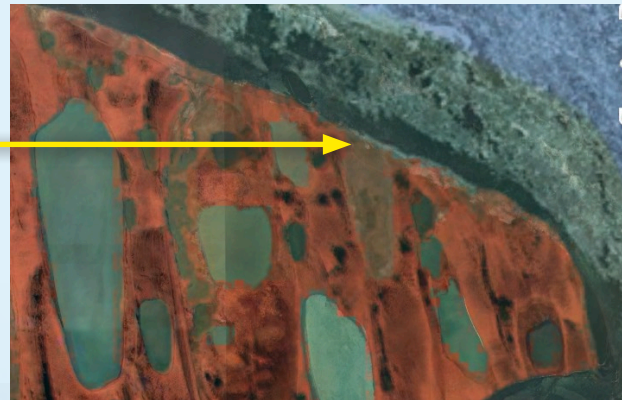
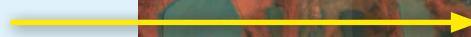
Cape Halkett.kmz. This is a Landsat image of the area taken in 1985. The file will open in the Temporary Places as an image overlay titled *Cape Halkett*.



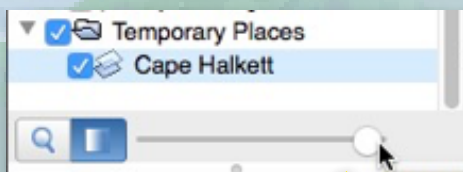
4. Use the navigation tools to zoom to the area of the coastline indicated in the image.



Zoom to this:



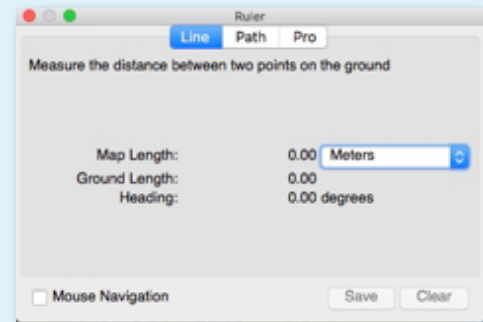
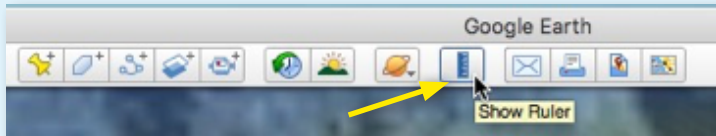
5. Use the Adjust Opacity slider to view the current coastline under the 1985 image so that both the current coastline and the 1985 coastline can be seen. Be sure the Cape Halkett image overlay is checked.



Move the slider back and forth to zoom in.



- Click on the ruler tool and set the units to meters.



- Click on the 1985 coastline then drag a line to the current coastline. You may need to uncheck the box labeled "Mouse Navigation."

How many meters of coastline has been eroded?



- Use the formula distance/time to find average annual rate of erosion in this area.

Meters of coastline lost \div years between 1985 and now = rate of erosion in meters/year. For example:

If it is 2016 and distance measured is 500 meters then:
 $500 \text{ meters} / 31 \text{ years} = 16.1 \text{ meters/year}$

- Move around the image to see how the coast has changed between 1985 and now. Have all areas of the coastline eroded by the same amount?

Discuss!

Discuss your findings with your classmates. Did everyone find the same rate of erosion? If not, what was the mean rate? Where had the coast eroded the most? The least?

Extension!

Follow instructions on the worksheet your teacher provides to help you calculate how much carbon was released by this erosion.





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