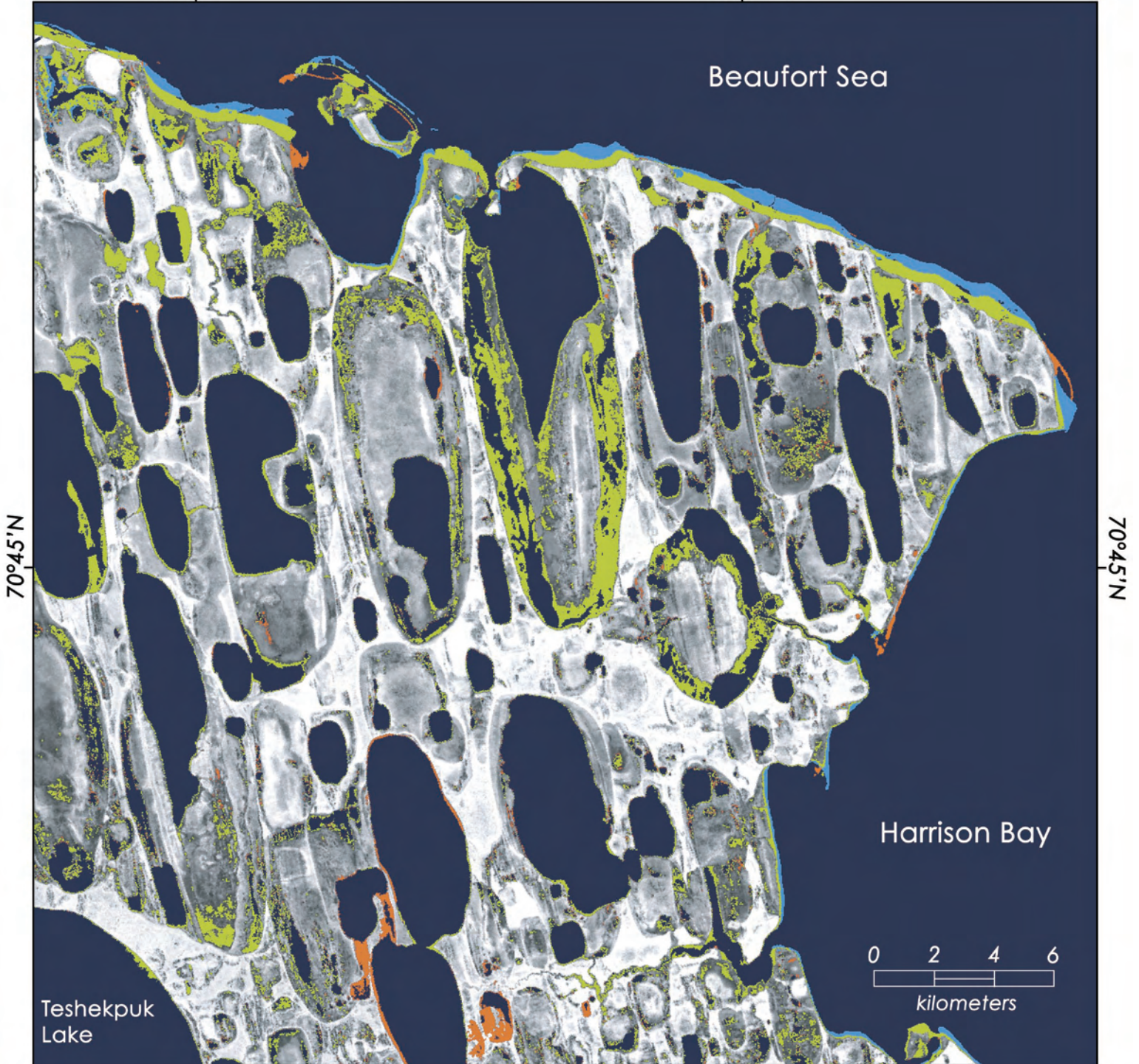


# Alaska's Thawing Permafrost

154°W

152°30'W



■ LAND LOST 1955–1985     
 ■ LAND LOST 1985–2005     
 ■ LAND GAINED 1985–2005

In this Landsat satellite image of Cape Hallett, Alaska, a landscape of thawing permafrost appears like a section of white and grey bone, full of openings. Blue and green indicate where open water has increased from 1955 to 2005. Smaller areas of reddish orange show land gained. Landsat gives us a special vantage point to monitor changes in the landscape over time. Image credit: Mars/Houseknecht, USGS.

# Melting Permafrost Causes Coastal Erosion

Goddard Space Flight Center

The low-lying Arctic coastal plain of Alaska north of Teshekpuk Lake on the Beaufort Sea hosts endangered species of waterfowl, provides calving grounds for large herds of caribou, and contains potentially significant petroleum resources. For tens of thousands of years, underlying this special place has been permafrost—defined as permanently frozen ground that remains at or below 0° C (32° F) for at least two years at a time. Not only wildlife, but people too, have built their lives and livelihoods on permafrost in Alaska. Roads, buildings, and pipelines rest and rely on hard permafrost foundations. But permafrost is sensitive to climate change, and powerful warming forces are at work.

Continuous permafrost on the North Slope of Alaska has warmed 2.2–3.9° C (4–7° F) over the last century. Thawing permafrost is more prone to erosion, and erosion means the loss of land. Thawing also produces excessive wetting and plasticity and makes sediments unstable. Thawing of permafrost and cycles of freezing and thawing cause extensive damage to highways, railroads, airstrips, and other facilities. Many native villages are located on low-lying rivers and coasts where they may be susceptible to erosion due to melting permafrost. Combating eroding community infrastructures takes time and labor away from the activities required for survival.

Governments and communities are concerned about these changes. To make the images on the other side of this lithograph, scientists at the U.S. Geological Survey analyzed Landsat data and topographic maps compiled from aerial photographs. They found that land loss in the study area more than doubled from 1985–2005, compared to the 30-year span from 1955–1985. In some areas, coastal erosion has caused the shoreline to recede as much as 0.9 km (0.56 mi) over the last 50 years.

“This area’s increased rate of coastal erosion over these time increments may be the result of greater wave action

caused by earlier seasonal melting and reduced size of the Arctic ice pack, which warrants further study,” said USGS scientist Lyle Mars. “Since beaches are absent or poorly developed along most of the studied coast, there is little, if any, protection against this increased wave energy. As a result, the waves undercut the mud-rich permafrost land, causing it to collapse into the sea.”

Thawing permafrost has another important implication for the welfare of people and ecosystems. Gases trapped in permafrost, such as carbon dioxide and methane, are released when it melts. Those greenhouse gases warm the atmosphere. Methane is 25 times more potent than carbon dioxide as a greenhouse gas. If the high northern latitudes continue warming at current rates, the region’s soils will release more carbon and methane into the atmosphere, which may lead to higher temperatures that fuel a feedback cycle of carbon and methane release and temperature rise. Thawing permafrost may lead to an acceleration in the rate of climate warming.

## About Landsat

Landsat satellites provide an unparalleled record of Earth’s varying landscapes to help us understand how Earth is changing and what those changes mean for life on our planet. The consistency of Landsat’s data from sensor to sensor and year to year makes it possible to trace land cover changes from 1972 to the present. Landsat sensors have captured over two million digital images of Earth’s continents and surrounding coastal regions. These digital images include information from wavelengths of light both visible and invisible to human eyes. NASA designs the Landsat Earth-observing satellites; USGS manages the satellites, archives the imagery, and makes the data available to all interested users.

## Landsat Program

<http://landsat.gsfc.nasa.gov>  
<http://landsat.usgs.gov>



Location of Cape Halkett on Alaska’s northern coast.

## International Permafrost Association

<http://www.ipa-permafrost.org>

## Alaska Coastal Erosion

[http://energy.usgs.gov/alaska/ak\\_coastalerosion.html](http://energy.usgs.gov/alaska/ak_coastalerosion.html)

## Intergovernmental Panel on Climate Change

<http://www.ipcc.ch>

## Monitoring Land Change with Landsat

<http://change.gsfc.nasa.gov>

## Source Reference

*Quantitative Remote Sensing Study Indicates Doubling of Coastal Erosion Rate in Past 50 Years along a Segment of the Arctic Coast of Alaska*

by John Mars and David Houseknecht, both USGS  
<http://energy.usgs.gov/flash/AKcoastalErosion.swf>

*For more products like this one:*

<http://landsat.gsfc.nasa.gov/education/resources.html>  
(Scroll down to “Landsat Lithographs.”)