Assessing planimetric and volumetric coastal changes on Herschel Island Qikiqtaruk, Yukon, Canada

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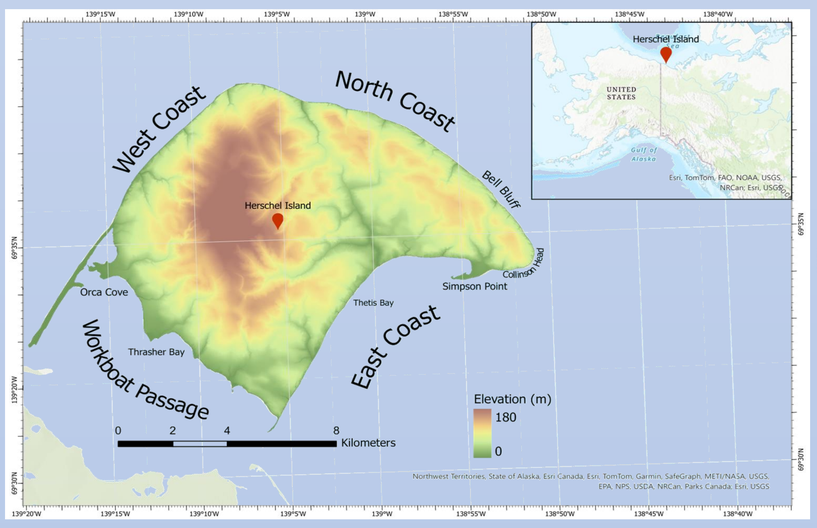
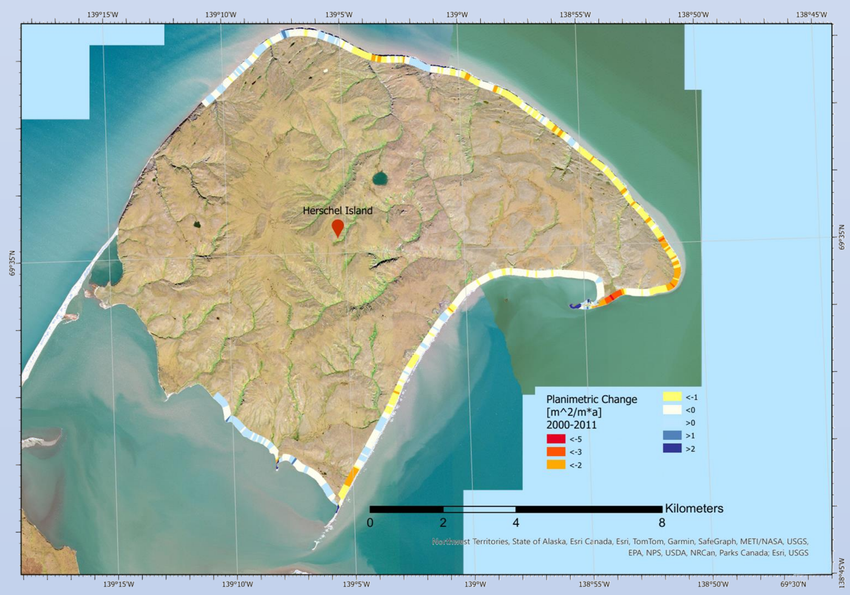
Where are we?

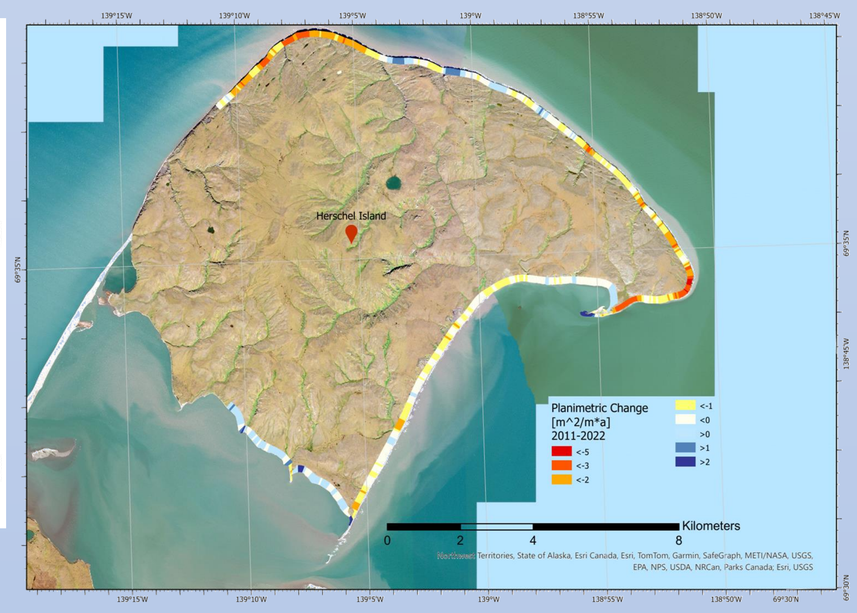
Herschel Island, Qikiqtaruk, is located ca. 3 km off the Yukon Coast in Canada (69°60'N and 139°10'W). Continuous ice-rich permafrost is present all over the island and the entire coastline is experiencing erosion processes such as thermal denudation and thermal abrasion[1]

Study Area



Planimetric Change

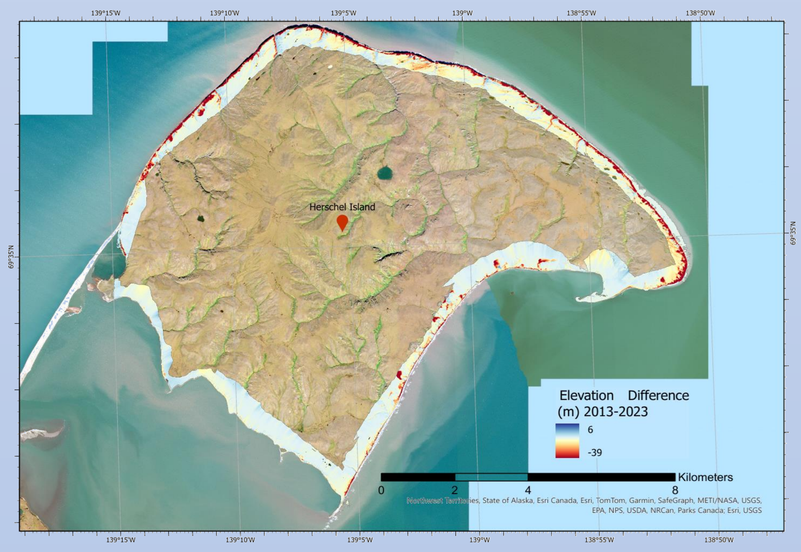




How has it been done?

LiDAR-derived high-resolution digital elevation models (DEMs) were used to compute volumetric data for the years 2013 and 2023. For the planimetric changes we used digitized coastlines derived from satellite imagery in 2000 (IKONOS), 2011 (GeoEye) and 2022 (Pleiades).

Elevation Difference

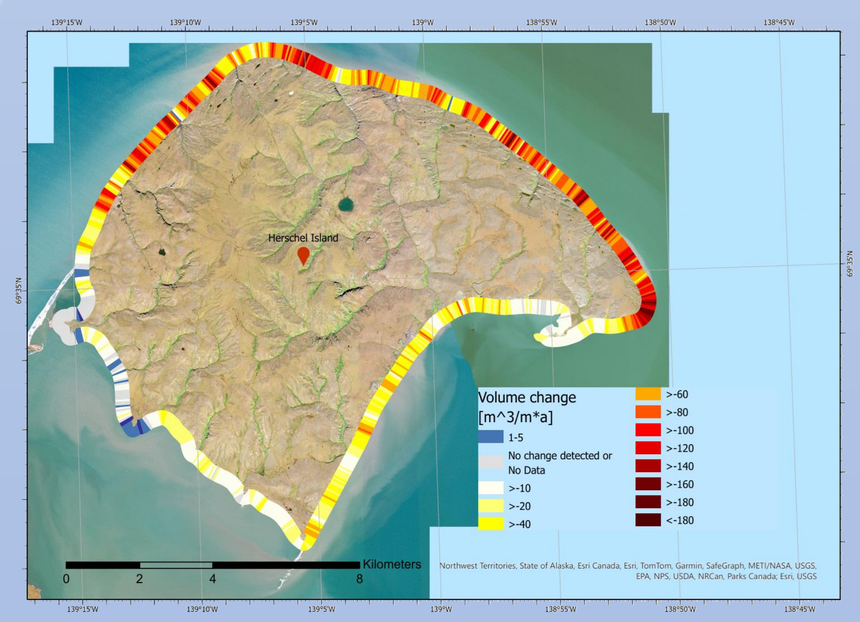


Why did we do this?

Permafrost coasts in the Arctic are extremely vulnerable to the effects of global climate change. The increase in sea temperature, the decrease in sea ice extent and longer open-water seasons lead to higher coastal erosion. These erosion rates are among the highest worldwide. This results in significant land loss, both planimetric and volumetric, and leads to a notable reshaping of the coastline.

Only few studies have attempted to compute the volumes eroded by coastal retreat. The goal of this study is to connect planimetric and volumetric coastal erosion measurements and to serve as an update of coastal erosion rates in the most recent years on Herschel Island Qikiqtaruk (HIQ) in the Western Canadian Beaufort Sea.

Volumetric Change



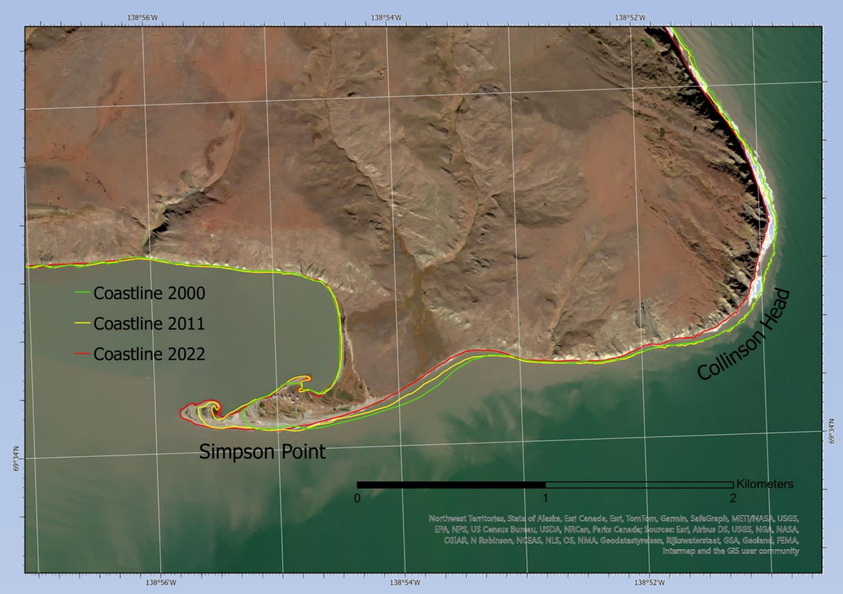
What can we take home?

The increase can have large implications on the near-shore ecosystems of the island and extensive impacts for the settlement on Herschel Island Qikiqtaruk in the future. The planimetric and volumetric change increased by ~74% and ~15%, respectively, over the observed time periods.

Parameter \ Time Period	Planimetric Change in [m²/(m*a)] 2000-2011[2]	2011-2022
Mean	**-0.68**	**-1.18**
Minimum	/	-6.07
Maximum	/	19.06
Standard Deviation	2.48	1.50

Parameter \ Time Period	Volumetric Change in [m³/(m*a)] 2004-2013[2]	2013-2023
Mean	**-29.00**	**-33.18**
Minimum	/	-186.71
Maximum	/	7.70
Standard Deviation	37.20	34.18

View on Simpson Point from the West. Picture by Michael Fritz



View on Thetis Bay and Simpson Point from the Southeast. Picture by Pia Petzold

Acknowledgements

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References

[1] Günther (2012) Thermo-erosion along the Yedoma Coast of the Buor Khaya Peninsula, Laptev Sea, East Siberia: 137.

[2] Obu et al. (2016) Relation between planimetric and volumetric measurements of permafrost coast erosion: a case study from Herschel Island, western Canadian Arctic; Values from Table 1