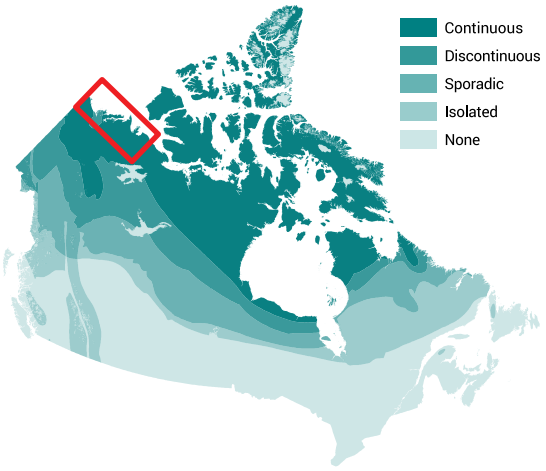
Advancing Arctic coastal erosion measurement and monitoring through UAV-SfM and object-based image analysis



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Study locations: Tuktoyaktuk Peninsula, Darnley Bay, Yukon Coast, Crumbling Point.

Keywords: Arctic coastal erosion, object-based image analysis, multi-proxy analysis, volumetric change, deep learning, UAV-SfM, remote sensing.

This research developed new techniques for measuring Arctic coastal erosion. This is important because Arctic coastal erosion has local, regional, and global implications that are not well understood nor quantified. The increasing availability of high-resolution remote sensing imagery presents new opportunities to improve on traditional measurement techniques furthering the usefulness of coastal erosion studies in the Arctic. For example, multiple object-based derived coastal proxies can be generated in a systematic way that contributes to a broad scale coastal monitoring to understand the impact of climate change on the coastal zone in the Arctic.

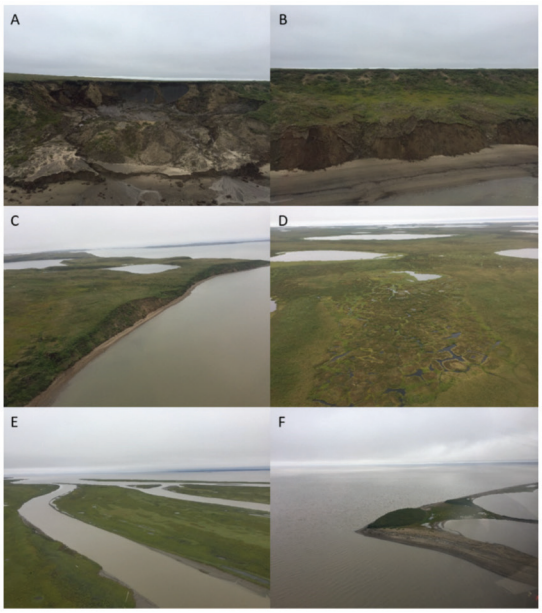

Figure 1. Sample coastal types. A – active retrogressive thaw slump. B - stabilized retrogressive thaw slump. C - coastal cliff. D - ice-wedge polygons. E - low plains. F - sand spit.

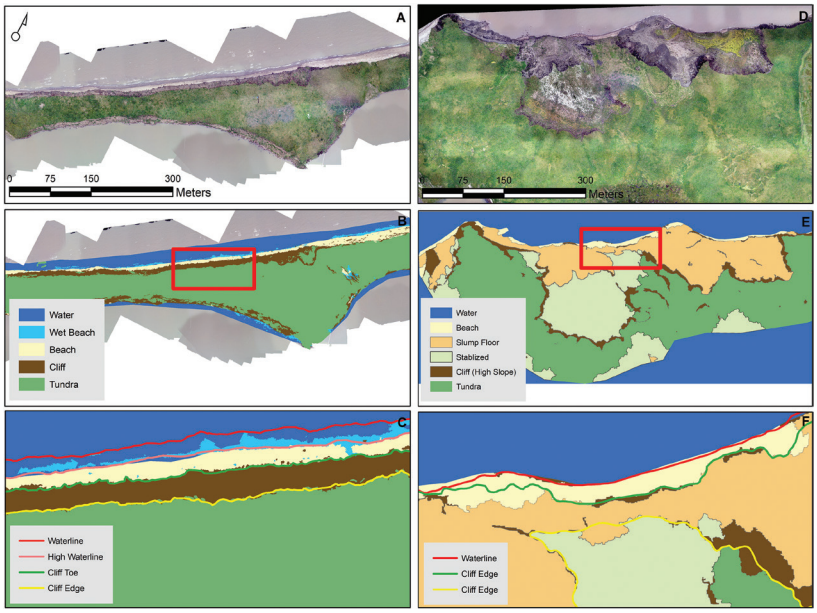

Figure 2. Coastal feature extraction process from aerial imagery. Imagery is classified using object-based image analysis. Boundaries between classes represent linear features which are used as coastal proxy features.

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Research summary

Arctic coasts represent 30–34% of the Earth's coast, exhibit some of the highest rates of erosion in the world, and are expected to erode even faster in a changing climate. Arctic coastal erosion liberates previously frozen organic carbon, releasing greenhouse gases into the nearshore and atmosphere. This research explored new techniques for measuring Arctic coastal change at high temporal and spatial resolution, where object-based image analysis was used to classify aerial imagery and extract multiple coastal proxy features. The choice of coastal proxy feature used was found to vary temporally, highlighting a potential limitation of traditional methods. Object-based features were extracted with high accuracy along coastlines with well-defined features, creating new opportunities for broad-scale erosion monitoring and measurement.

Taking action

The next steps that researchers can take are to conduct broad-scale coastal erosion studies to provide up-to-date information on coastal change. In addition, establishing a broad-scale monitoring program would help reveal the impacts of climate change, other forcing factors, and associated variabilities. Future research should also explore the potential of leveraging ArcticDEM in erosion studies.

Connections to other projects

2 5 This project is part of Theme 4 - *Hazards and impacts associated with permafrost thaw* and links to Theme 2 – *Monitoring of permafrost change* by advancing monitoring techniques to reveal and quantify coastal permafrost change in Canada. This project also aligns with the objectives of Theme 5 - *Adaptation to permafrost thaw* by providing information to support northerners in adapting to changing coastal conditions.

Partners, team members and support

This research benefited from the support of the Tuktoyaktuk Hunters and Trappers Committee and Dustin Whalen and Paul Fraser at the Geological Survey of Canada – Atlantic, who provided logistical, research, and field assistance. Gonçalo Vieira (University of Lisbon) generously provided satellite imagery included in the analysis.

Acknowledgment, thanks and funding

This project recognizes the coastal lands of the Yukon and Northwest Territories as the traditional territory of the Inuvialuit. Special thanks go to the Hamlet of Tuktoyaktuk, Aurora Research Institute, and the Geological Survey of Canada. This work was supported by the Natural Sciences and Engineering Research Council of Canada (NSERC), NSERC PermafrostNet, an NSERC Discovery grant, and an NSERC Northern Supplement. This work was also supported by Polar Knowledge Canada through the Northern Scientific Training Program. This project received funding from the Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) Beaufort Sea Regional Strategic Environmental Assessment (BRSEA) program, supported by the Natural Resources Canada (NRCan) Climate Change Geoscience Program with logistical support provided by the Polar Continental Shelf Program. Pleiades imagery was acquired through the ISIS Pléiades Programme in connection with the WMO Polar Space Task Group.

References

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