

# The extreme erosion of Pelly Island, Northwest Territories: Using UAV's and modelling techniques to evaluate the fate of sediments

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## Overview of Project

The proposed research, which will be conducted in collaboration with Natural Resources Canada (NRCan), plans to investigate the origin, suspension, transport, deposition, and resuspension of sediments in the nearshore region of Pelly Island. Pelly Island, located just 20 km offshore of the Mackenzie Delta front is still well within the Mackenzie Estuary. However, a 20 m high ice-rich cliff on the NW side of the island is currently experiencing both thermal and mechanical erosion processes and is changing at an unprecedented rate. The island has been eroding at an average rate of 16.5 m/yr since 2000, which is almost double the 1950-2000 average of 8.2 m/yr. Since 2014, over 100 m of coastal retreat occurred releasing large amounts of sediment into the nearshore environment.

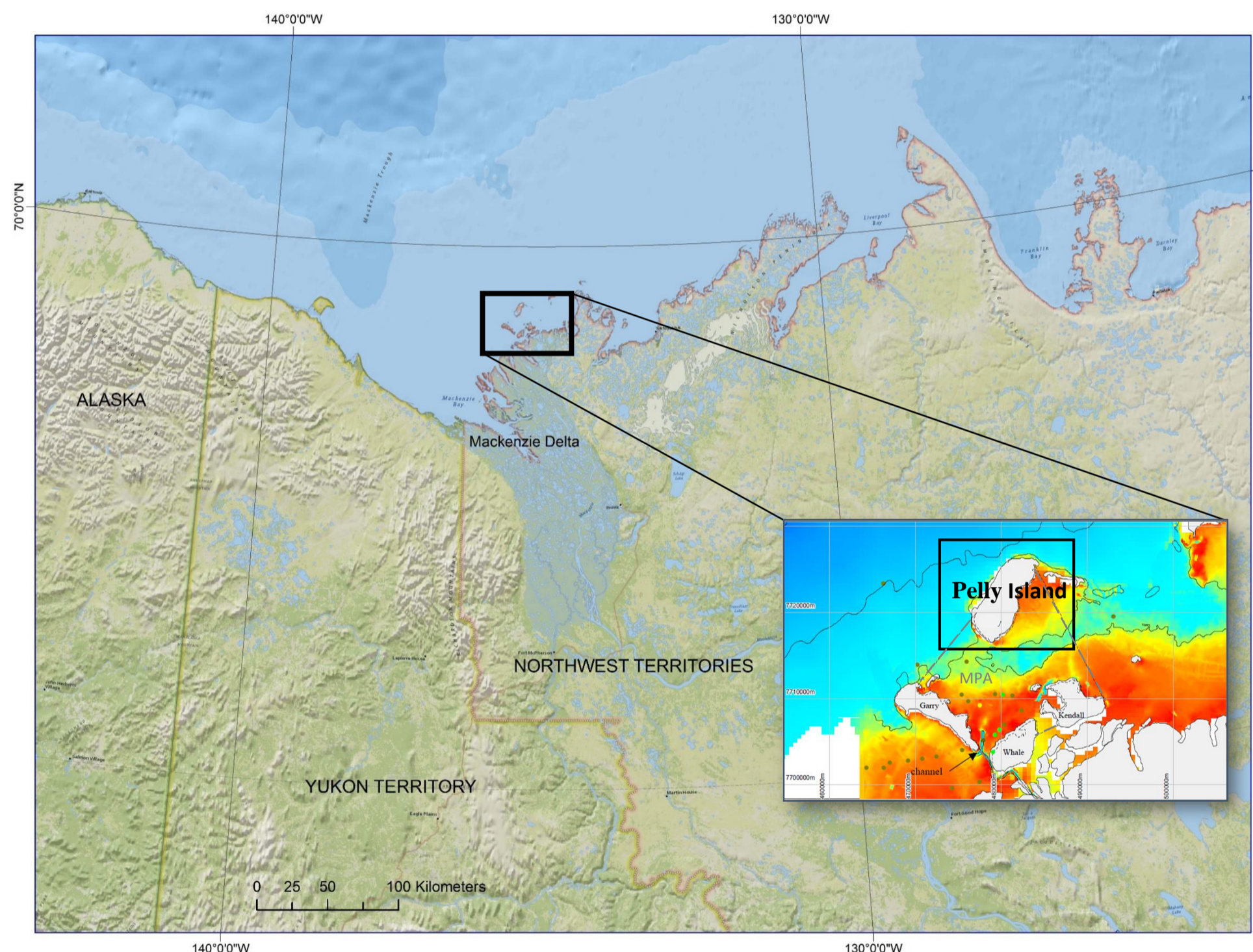


Fig.1) Pelly Island is found at the edge of the Mackenzie Delta in the Northwest Territories, Canada. The inset bathymetric map (Solomon 2003) shows Pelly Island, Garry Island, Whale Island, and Kendall Island which all make the perimeter of one of three individual sections of the Tarium Niryutait Marine Protected Area.

Sediment deposition in the Mackenzie Estuary is dominated by the sediment discharge from the Mackenzie River and is relatively well known; however, islands on the outer Mackenzie Delta, such as Pelly Island, are eroding at rates which are much faster compared to the surrounding area. Sediment transport in the region is primarily dominated by fluvial forces from the Mackenzie River extending NE through Kugmallit Bay and NW off of the western delta front and Shallow Bay. Some of the major discharge areas (including Kugmallit Bay) are somewhat sheltered and isolated from prevailing winds that can cause significant resuspension. The exposure of Pelly Island to all prevailing winds and waves is expected to dominate the different processes of sediment transport, deposition, suspension and resuspension. These differences indicate the importance of studying Pelly Island to understand the fate of sediments from a rapidly eroding exposed source of sediment. Information on sediment dynamics in the nearshore region could also be useful for further understanding critical seabed habitats within the Tarium Niryutait Marine Protected Area (Fig.1).



Fig.2) Multiple block failures on Pelly Island in 2016.

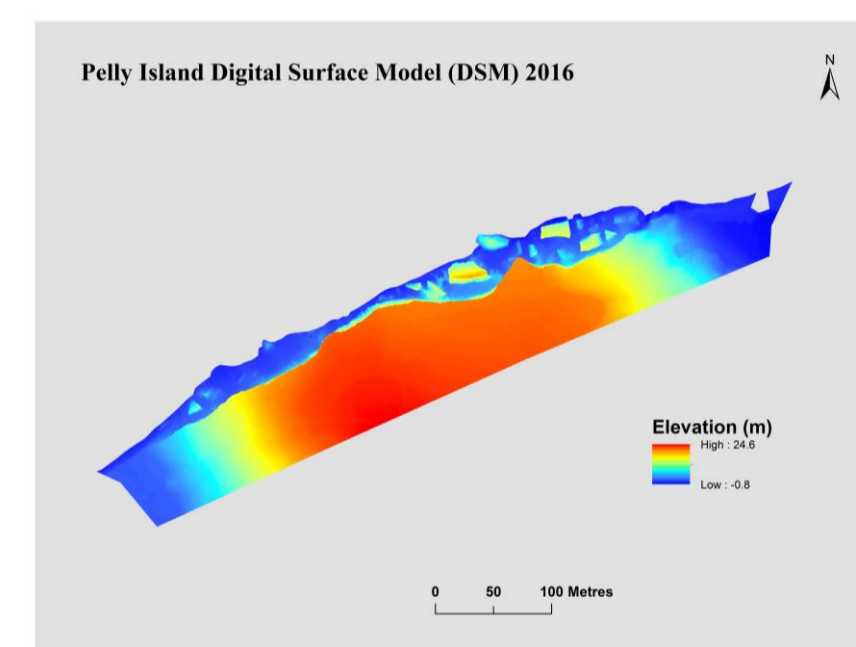


Fig. 4) A digital surface model (DSM) of Pelly Island in 2016 showing elevation in metres. This DSM was created using aerial imagery in structure from motion (SfM) software .

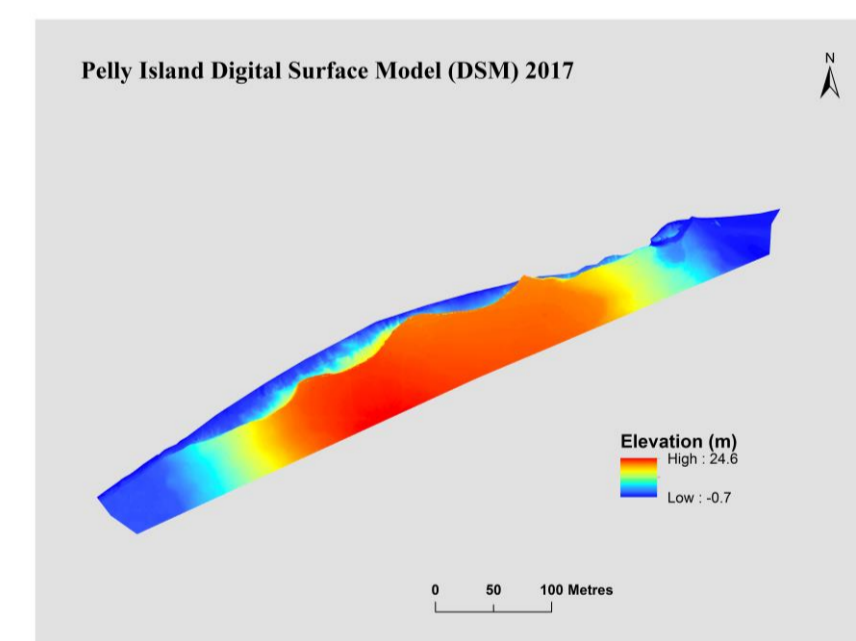


Fig. 5) A digital surface model (DSM) of Pelly Island in 2017 showing elevation in metres. This DSM was created using aerial imagery in structure from motion (SfM) software .

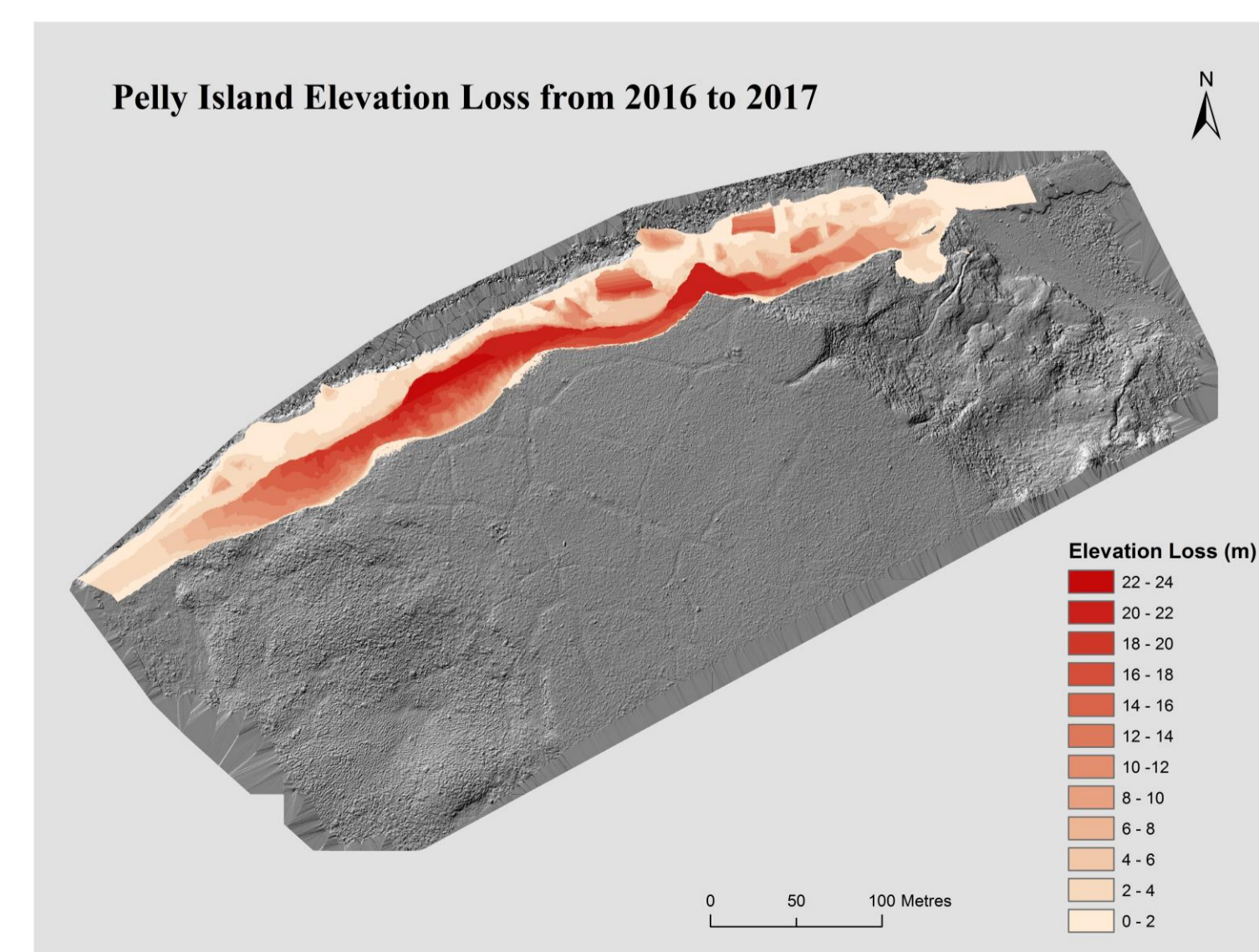


Fig. 6) A digital surface model (DSM) of Pelly Island symbolizing the amount of elevation loss from 2016 to 2017.

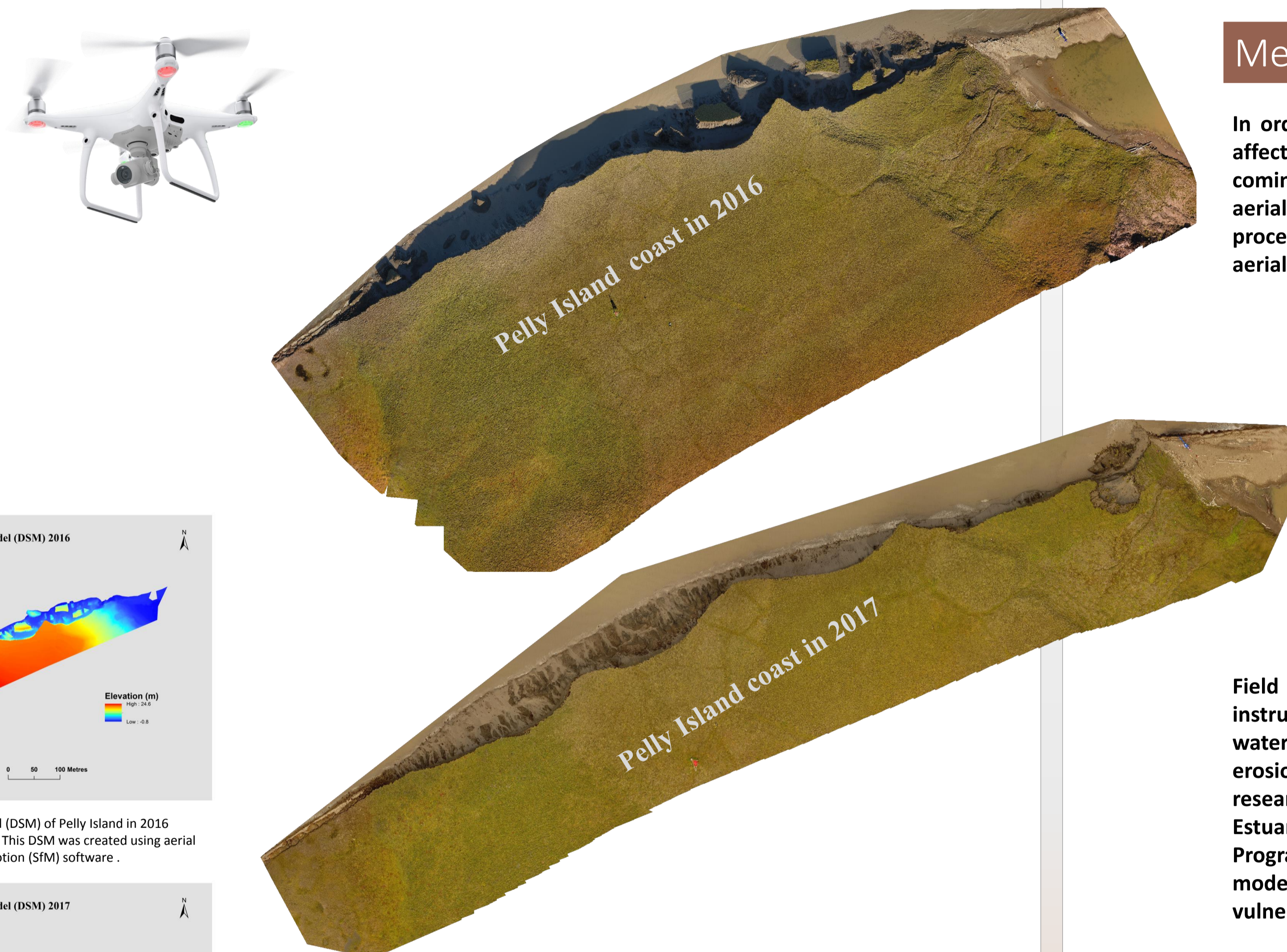


Fig.7) A large block failure on Pelly Island in 2016.

## Methods

In order to better understand how the rapid changes occurring on Pelly Island are affecting the nearshore region, we are conducting volumetric analysis of sediment coming from cliff erosion annually using digital elevation models (DEMs) created from aerial photogrammetry (UAVs). Software that uses the structure from motion (SfM) processing technique are being used to create 3D models of the coastline from 2D aerial photos.



Fig. 8) Massive ice found on a coastal exposure at Pelly Island in 2016

Field work planned for the summer of 2018, will allow for the deployment of instrumented seabed landers which will collect data such as waves, currents, and water depths and time-lapse cameras onshore will record daily observations of erosion which will contribute to validating the models. The model developed in this research will be integrated with other models being developed within the Mackenzie Estuary as part of coastal research within NRCan's Climate Change Geoscience Program. The integration of nearshore and onshore field measurements with modelling is expected to provide information on the fate of sediments in this vulnerable Arctic ecosystem.

## Planned Research

Field work planned for the summer of 2018, will allow for the deployment of instrumented seabed landers which will collect data such as waves, currents, and water depths and time-lapse cameras onshore will record daily observations of erosion. The concentration for ground ice and massive ice within the cliffs will be estimated from exposed ice in cliff faces along with mapping from UAV imagery in order to account for sediment concentration delivered to the nearshore.

The field data will provide input for validating hydrodynamic and sediment transport models. Specifically nested Delft3D will be used to simulate models waves, currents, and sediment transport (both as bed load and suspended load) in the nearshore region of Pelly Island. The integration of nearshore and onshore field measurements with modelling is expected to provide information on the fate of sediments in this vulnerable Arctic ecosystem.

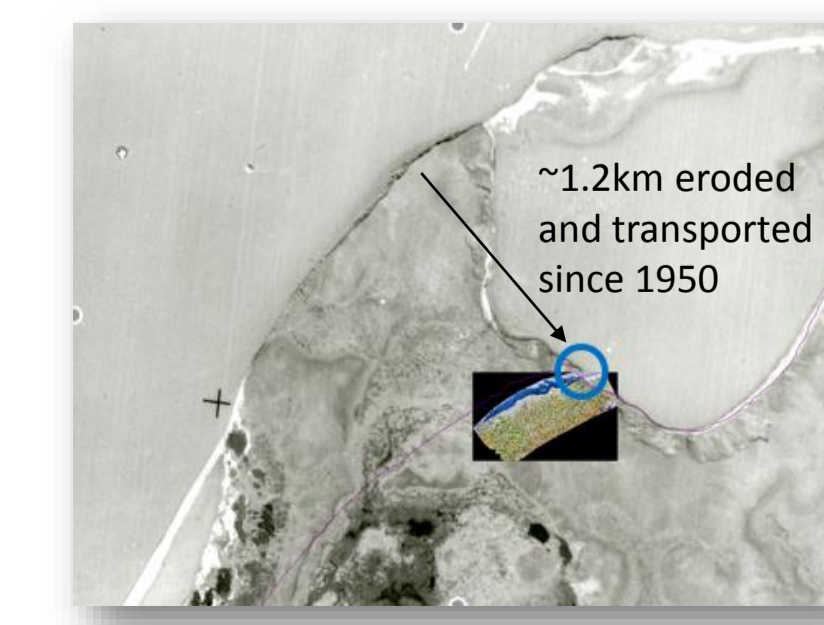


Fig. 9) An air photo of Pelly Island from 1950 which is superimposed with the shoreline in 2017.