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New insights into coastal erosion rates along the Yukon coast, Canada

Introduction

Global climate change is appearing in the Arctic among others in the form of rising air, ground and water temperatures, elongating open water seasons and increasing storminess[1,2,3]. As a consequence, coastal erosion along Arctic coasts is expected to accelerate. In order to detect how the western Canadian Arctic is responding to these environmental changes, shoreline detection analyses were carried out. Total station and Real Time Kinematic (RTK) GPS survey data from two Geological Survey of Canada (GSC) monitoring sites and remote sensing data in the form of aerial photographs and a SPOT satellite image were used to quantify rates of change. Additionally, it was investigated, if coastal geomorphological parameters correlate with coastal erosion rates.

Study Area

Extent: 35 km long coastal stretch between the USA-Canada Border (west) and Komakuk DEW line (east) GSC monitoring sites (Fig. 1).
Geomorphology: Yukon Coastal Plain, mainly composed of marine and estuarine deposits, flat tundra with incised stream valleys, continuous permafrost, mainly narrow beaches backed by up to 11 m high gently sloping to overhanging cliffs (Fig. 3).
Climate and sea ice: mean annual temp. is -11 °C, main wind direction is NW, open water season is from late June till early October.

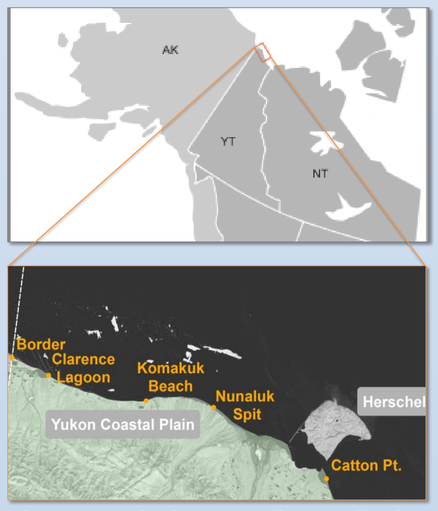

Figure 1: Study site next to the USA border

Key Findings

- Mean annual erosion is **1.2 m (250,000 m³/a)** with **no significant change** within the last 60 years
- A comparison of our results with studies carried out in Alaska[4,5,6] suggests an overall spatial pattern of **decreasing erosion rates from west to east**
- There is a **strong** and **significant correlation** between **beach widths and erosion rates** (↓beach width → ↑ erosion rate)
- There is a **strong** but **insignificant correlation between cliff heights** and **erosion rates** (↓cliff height → ↑ erosion rate)

Results

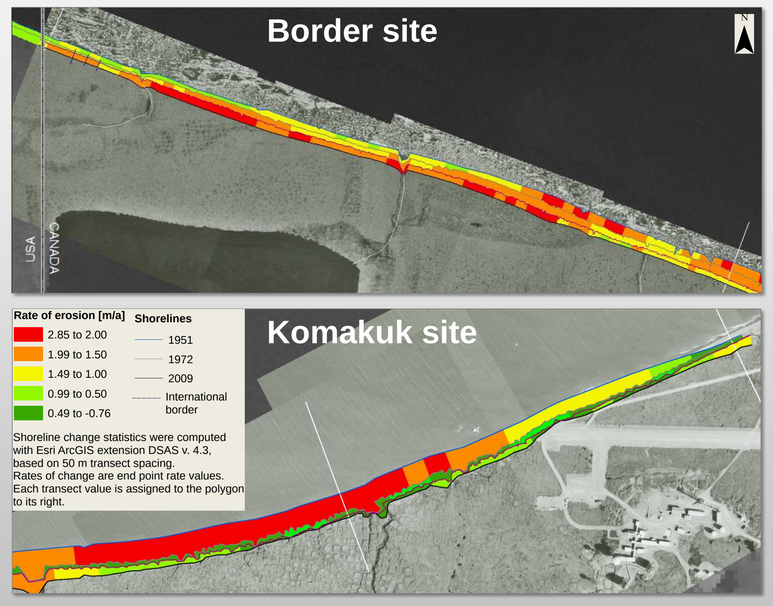

Figure 2: Digital shoreline analysis (DSAS) results for the USA-Canada border site (top) and the Komakuk DEW Line Station (bottom).

Figure 3: RTK-GPS measurements taken along the border site (top) and the Komakuk site (bottom) in 2012.

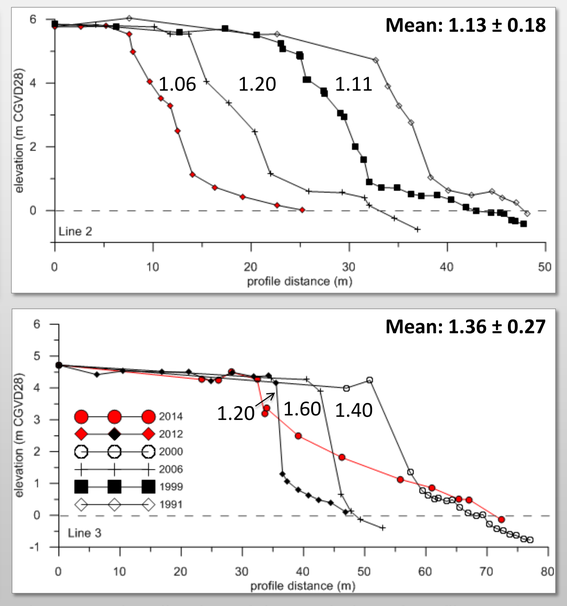

Figure 4: Visualization of the evolution of profile no. 2 at the Border site (top) and profile no. 3 at the Komakuk site (bottom). Note that numbers btw. the profile lines and the listed mean values in the corners of each graph are the respective erosion rates [m/a] for the whole site.

Site	DSAS analyses	
	Time period	Erosion rate [m/a]
Border	1951-1972	1.3
	1972-1994	1.2
	1994-2009	1.8
	Mean	**1.3 ± 0.3**
Komakuk	1951-1964	1.9
	1964-1972	1.5
	1972-1984	1.2
	1984-1992	0.5
	1992-2009	0.5
	Mean	**0.9 ± 0.2**
Whole study site	1951-1972	1.4
	1972-2009	1.2
	Mean	**1.2 ± 0.4**

Table 1: Mean erosion rates for different time spans at the Border site, the Komakuk site and the whole area in between. Erosion rates were calculated on the basis of DSAS analyses (see Fig. 1).

Methods

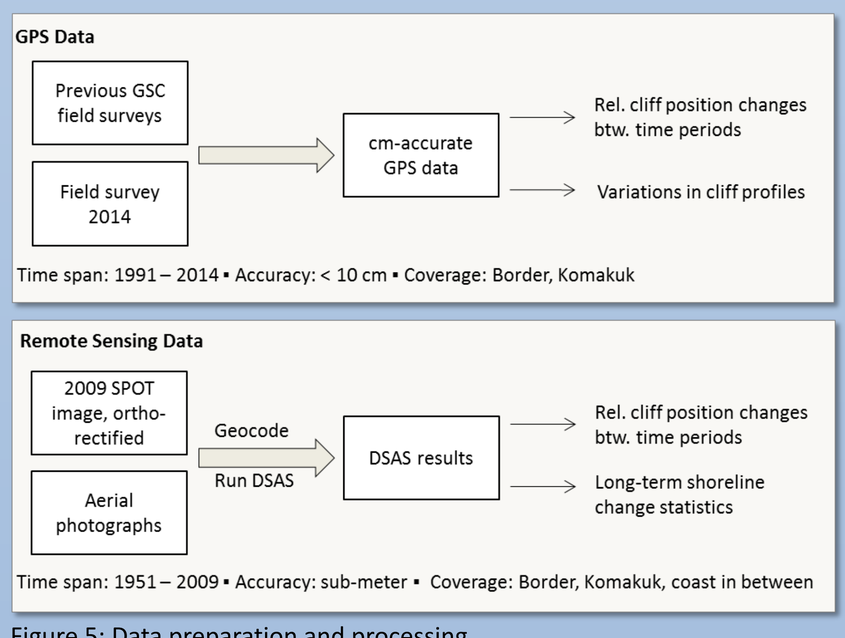

Figure 5: Data preparation and processing

DSAS results (Fig. 2) were obtained from 46 air photos (1951-1994) and a SPOT image (2009) using a transect spacing of 50 m

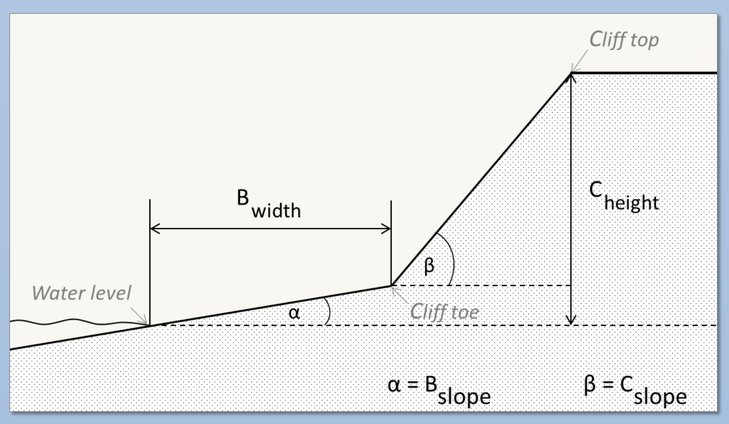

Figure 6: Schematic shoreface profile with the calculated parameters: beach width (B_{width}), beach slope (B_{slope}), cliff height (C_{height}) and cliff slope(C_{slope}).

Outlook

- **Quantification** of coastal erosion along the whole Yukon coast
- **Correlation** of coastal erosion rates with different potential factors (open water season length, temperature, radiation etc.)
- **Estimation** of present and future coastal erosion and its sediment and nutrient fluxes into the Arctic Ocean

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