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Variability of Arctic coastal erosion along the western Yukon coast

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 RTK-GPS survey data from two 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 Border (west) and Komakuk DEW line (east) GSC monitoring sites (see Map 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 (see pictures *1, *2, *3, *4 below).
Climate and sea ice: mean annual temperature is -11 °C, main wind direction is north-west, open water season is from late June till early October.

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)

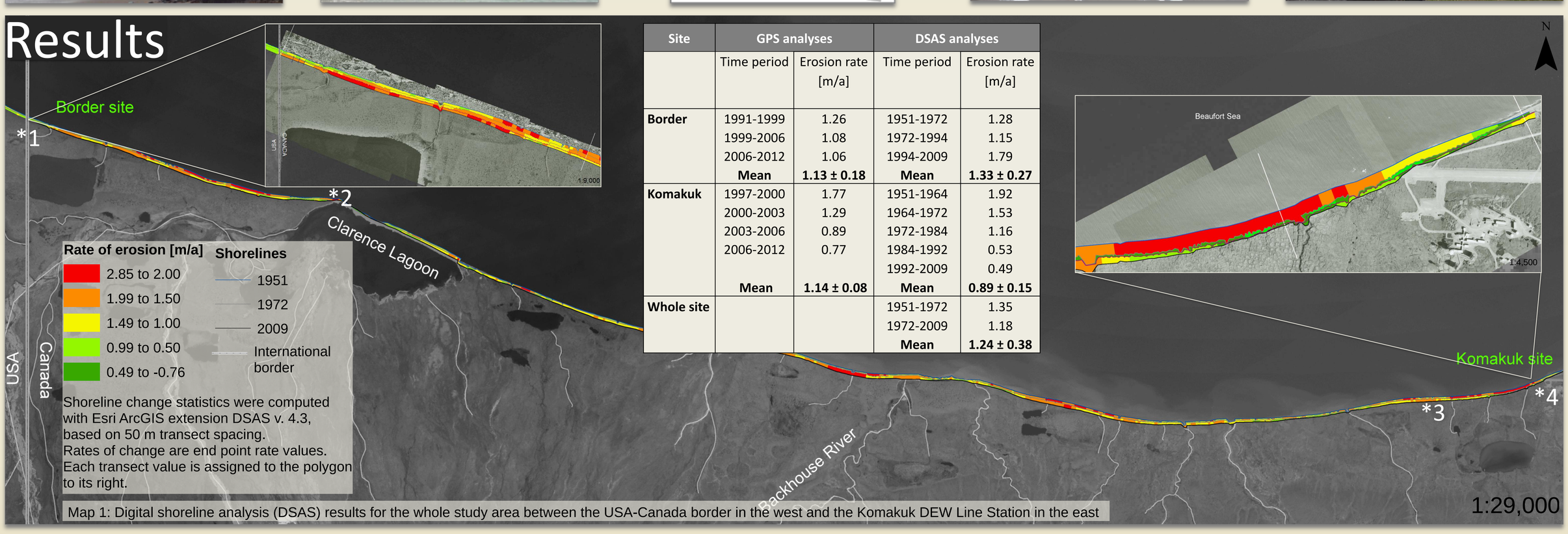
*1

*2

*3

*4

Results



Site	GPS analyses		DSAS analyses	
	Time period	Erosion rate [m/a]	Time period	Erosion rate [m/a]
Border	1991-1999	1.26	1951-1972	1.28
	1999-2006	1.08	1972-1994	1.15
	2006-2012	1.06	1994-2009	1.79
	Mean	**1.13 ± 0.18**	**Mean**	**1.33 ± 0.27**
Komakuk	1997-2000	1.77	1951-1964	1.92
	2000-2003	1.29	1964-1972	1.53
	2003-2006	0.89	1972-1984	1.16
	2006-2012	0.77	1984-1992	0.53
			1992-2009	0.49
	Mean	**1.14 ± 0.08**	**Mean**	**0.89 ± 0.15**
Whole site			1951-1972	1.35
			1972-2009	1.18
			Mean	**1.24 ± 0.38**

Map 1: Digital shoreline analysis (DSAS) results for the whole study area between the USA-Canada border in the west and the Komakuk DEW Line Station in the east

Methods

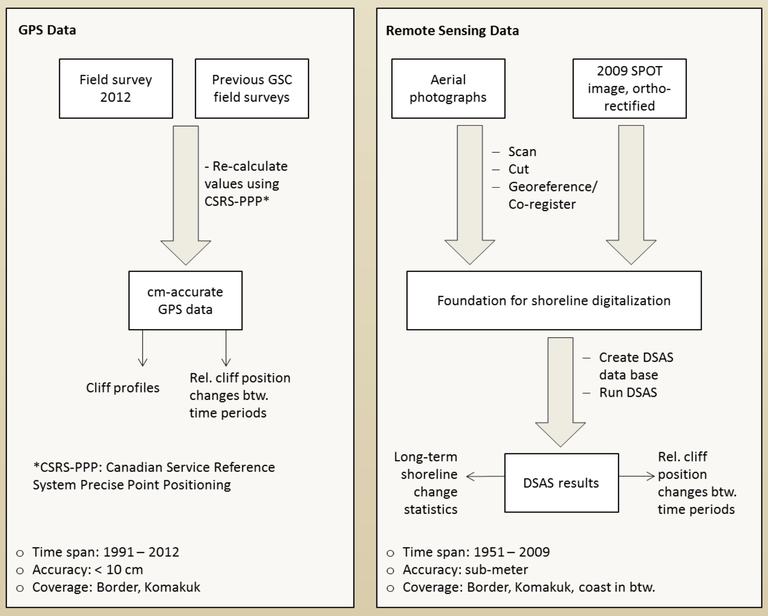


Figure 2: Data preparation and processing

Results in Map 1 were obtained from 46 air photos (1951-1994) and a SPOT image (2009) using DSAS with a transect spacing of 50 m

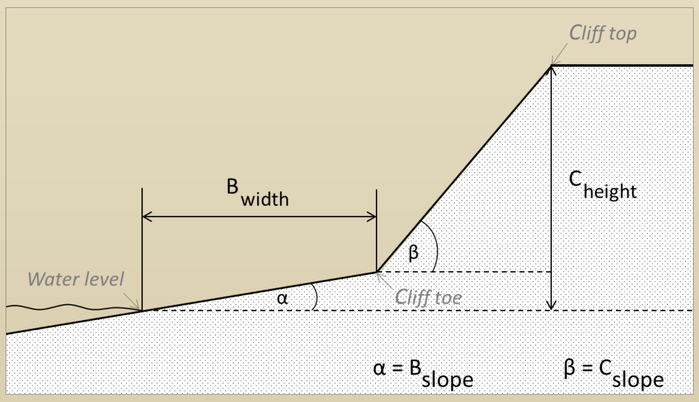


Figure 3: Schematic shoreface profile with the calculated parameters: beach width (B_{width}), beach slope (B_{slope}), cliff height (C_{height}) and cliff slope(C_{slope}). 00

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.)
- Modelling present and future coastal erosion in order to estimate sediment and nutrient fluxes into the Arctic Ocean

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