Revisiting Shoreline and Beach Morphological Changes along South Beach, Haida Gwaii

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Introduction

- Shifting under the pressures of the ocean- and land-interface, coastal landscapes are in constant flux (Siyal et al., 2022).
- Coastal erosion occurs when the balance in the sediment budget is tipped and the beach and dune material is removed more than it can be replaced (Paul et al., 2022).
- Haida Gwaii was identified as one of the most sensitive regions in Canada to climate based impacts, including erosion (Walker et al., 2007).
- South Beach surrounds Masset and Old Massett, two remote coastal communities at risk of erosive hazards.
- This research has investigated the erosion and accretion trends that change shoreline position and beach morphology to update the 2007 Walker et al. report on climate vulnerability in northeastern Haida Gwaii.

Data

- Landsat 7 ETM+ and Landsat 8 OLI panchromatic images acquired bi-annually in approximately April and October between 2007 and 2022.
- LiDAR-derived DEM from 2006 and 2017.

Methods

- Satellite imagery was used to digitize shorelines to monitor shoreline movement using the Digital Shoreline Analysis System (DSAS).
- Transects, spaced at 30 m intervals, were generated from the creation of an onshore baseline to intersect and quantify rate of change statistics over the 15-year temporal scope.
- Uncertainty was considered the propagation of scanning error, georeferencing error, and physical properties leading to user related error.

- DEMs were used to determine morphological and sediment shifts using the Geomorphic Change Detection software.
- The DEMs were differenced to identify regions of deposition and erosion, as well as volumetric changes in sediment were quantified.
- Uncertainty was propagated from the vertical error of each DEM.

Figure 1. DSAS transects showing end point rate (EPR) of erosion and accretion trends between 2007 and 2022.

Table 1. Shoreline erosion and accretion classification based on DSAS EPR results.

Evaluation	Number of transects	Length of section of shoreline	Mean EPR
Very high erosion (EPR > -2m)	163 transects	4.89 km	-4.326 m
High erosion (-2m ≤ EPR < -1m)	96 transects	2.88 km	-1.395 m
Moderate erosion (-1m ≤ EPR < 0m)	176 transects	5.28 km	-0.475 m
Stable (EPR ≈ 0m)	47 transects	1.41 km	0.006 m
Moderate accretion (0m < EPR ≤ 1m)	180 transects	5.40 km	0.454 m
High accretion (1m < EPR ≤ 2m)	34 transects	1.02 km	1.221 m
Very high accretion (EPR > 2m)	5 transects	0.15 km	4.894 m

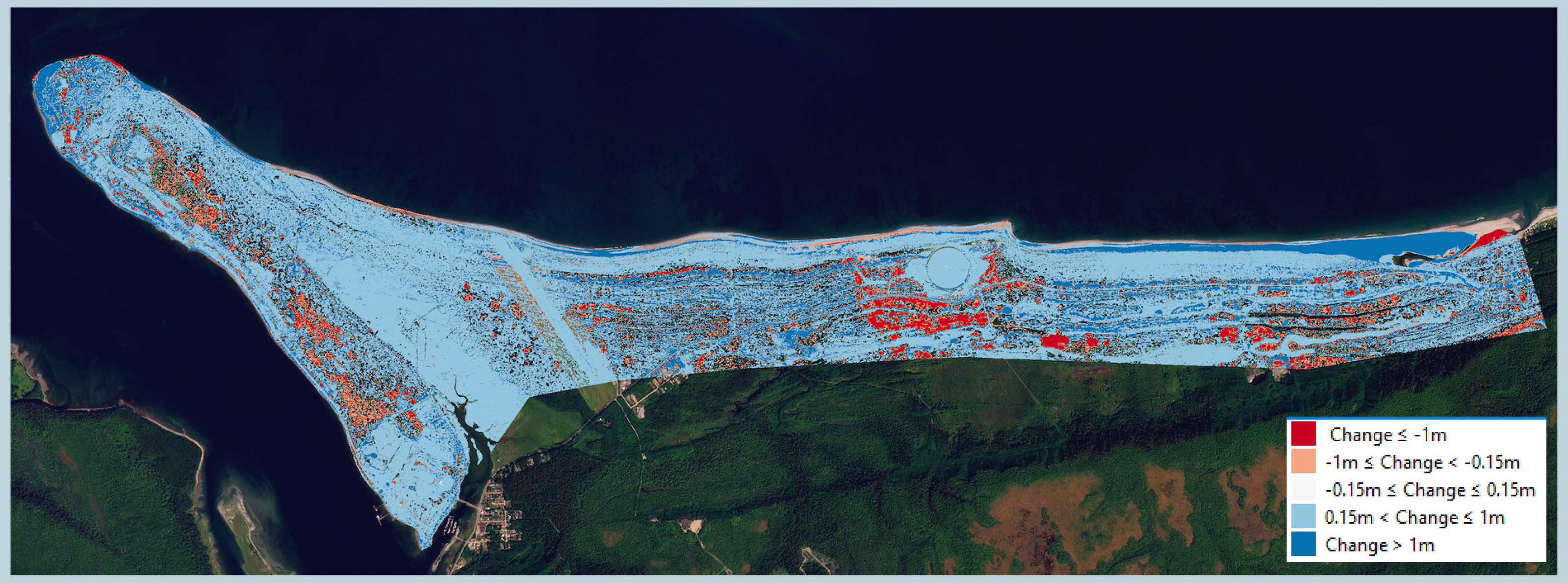

Figure 2. Geomorphic change detection showing regions of that have experienced deposition (blue) and erosion (red).

Preliminary Results

- Erosion and accretion are localized and heterogeneous.
- 62% of the shoreline is experiencing some erosion and 36% of the shoreline is experiencing high or very high erosion, particularly around Entry Point, Elephant Cage, and the Sangan River.
- South Beach experienced much less extreme accretion, with only 31% of the beach experiencing accretion, most of which was only moderate.

- The GCD showed more inland accretion.
- Mean accretion depth was found to be 0.89 m.
- Mean erosion depth was found to be 1.25 m.

Preliminary Discussion

- Severe localized erosion will likely become an increased risk to the Old Massett community as Entry Point is continuously eroded.
- Entry Point is subject to moderate to low sediment abundance, which likely contributes to the severity of erosion, whereas much of the rest of the shoreline has more sediment abundance.
- As well as being sheltered from the severe impacts of wind and waves, the shoreline inside of the Masset inlet is composed of a sand and gravel, resulting in a more resistant shoreline to erosion and better location for deposition.
- As wind has been identified as a predominant method of sediment transportation (Walker & Barrie, 2006), the landward wind may be carrying sediment, causing the build of up landward features.

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