

PHOTOGRAMMETRIC ANALYSIS OF COASTAL EROSION ALONG THE CHUKCHI COAST AT BARROW, ALASKA

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A variety of empirical and modeling approaches are being taken to assess the history and risk of erosion and flooding along the Chukchi Sea coast near Barrow, Alaska. Part of a broad assessment of climate impacts for the North Slope (nome.colorado.edu/HARC), this study utilizes softcopy photogrammetry and GIS to quantify coastal erosion over the last five decades. Barrow was also established as a key site with the Arctic Coastal Dynamics (ACD) program, <http://www.awi-potsdam.de/www-pot/geo/acd.html>.

We conducted a preliminary analysis of aerial photography for 1948 and 1997 (Fig. 1). The scanned photos were orthorectified (1997) and co-registered (1948) with PCI Geomatics to 0.5 m pixel resolution. The 1997 photos were orthorectified using Ground Control Points (GCP's) previously acquired for this project with Differential GPS (instaar.colorado.edu/QGISL/barrow_gcp) and a Digital Elevation Model (DEM) created from 1997 topographic lines. Bluff bottom line (Fig 1a) and shoreline (Fig 1b) positions were then digitized and overlaid. A graph was created showing alongshore-coastal changes between 1948 and 1997. Locational accuracy is about 1.9 m for shorelines and 2.1 m for bluff bottom lines, considering errors due to 1948 co-registration, digitizing, and transient waterline shifts from tides and wave setup. Accuracy for corresponding erosion rates, averaged over the 49-year period, is thus 0.04 m/yr.

Coastal erosion is spatially variable, with virtually no erosion on the bluffs south of the gravel pit (the southern third of the photo in Fig. 1a), and high erosion on the bluffs near Barrow. Over the 49-year period, the bluff bottom has retreated only 0.2 m for the area south of the gravel pit, compared to an average of 17.6 m near Barrow. Immediately southwest of Barrow, bluff-bottom retreat due to erosion reaches a maximum of 34 m. Corresponding time-averaged erosion rates are <0.01 m/yr for the area south of the gravel pit, and 0.36 ± 0.04 m/yr on average for the bluff near Barrow, reaching a maximum rate of 0.69 m/yr southwest of Barrow. It must be noted that time-averaged coastal change rates are not reflective of the true nature of coastal change on the Chukchi coast, where change is primarily determined by extreme storm events (Walker, 1991, Harper, 1978).

Similarly, beach erosion is spatially variable, with substantial retreat near Barrow, and growth of the beaches near Browerville (Fig. 1b). The shoreline at Barrow has retreated on average 22 m (0.45 m/yr) over the intervening five decades, reaching a maximum retreat of 40 m (0.82 m/yr). Net progradation averaged 17 m (0.34 m/yr) for part of the Browerville shoreline, with maximum progradation reaching 40 m (0.82 m/yr). Some Browerville shoreline areas eroded an

average of 4.8 m (0.1 m/yr). The erosion rates are approximately half those calculated for the ice-rich, peaty shorelines along Elson Lagoon, east of Barrow (Brown et al., 2003). They nonetheless are representative of the high rates of coastline erosion threatening many arctic settlements (cf. Hopkins and Hartz, 1978; Reimnitz et al., 1988; Jorgenson et al., 2002; Smith, 2002).

This analysis documents a significant hazard for the Barrow community. We plan to extend the analysis in space and time (SW of Barrow to Point Barrow, with additional photography for 1955, 1962, 1964, 1979, 1984, and 2002) to address such questions as: Which environmental factors control spatial variability in erosion? Is erosion accelerating due to climate change? Is coastal change gradual, or is it controlled by low-frequency, high-magnitude storms? Have mitigation efforts during the 1990's been effective at slowing erosion? Are the low-gradient gravel beaches northeast of Browerville experiencing progradation due to longshore drift of eroded materials? And with continued mitigation efforts, can we expect significant damage to buildings and infrastructure within the coming few decades?

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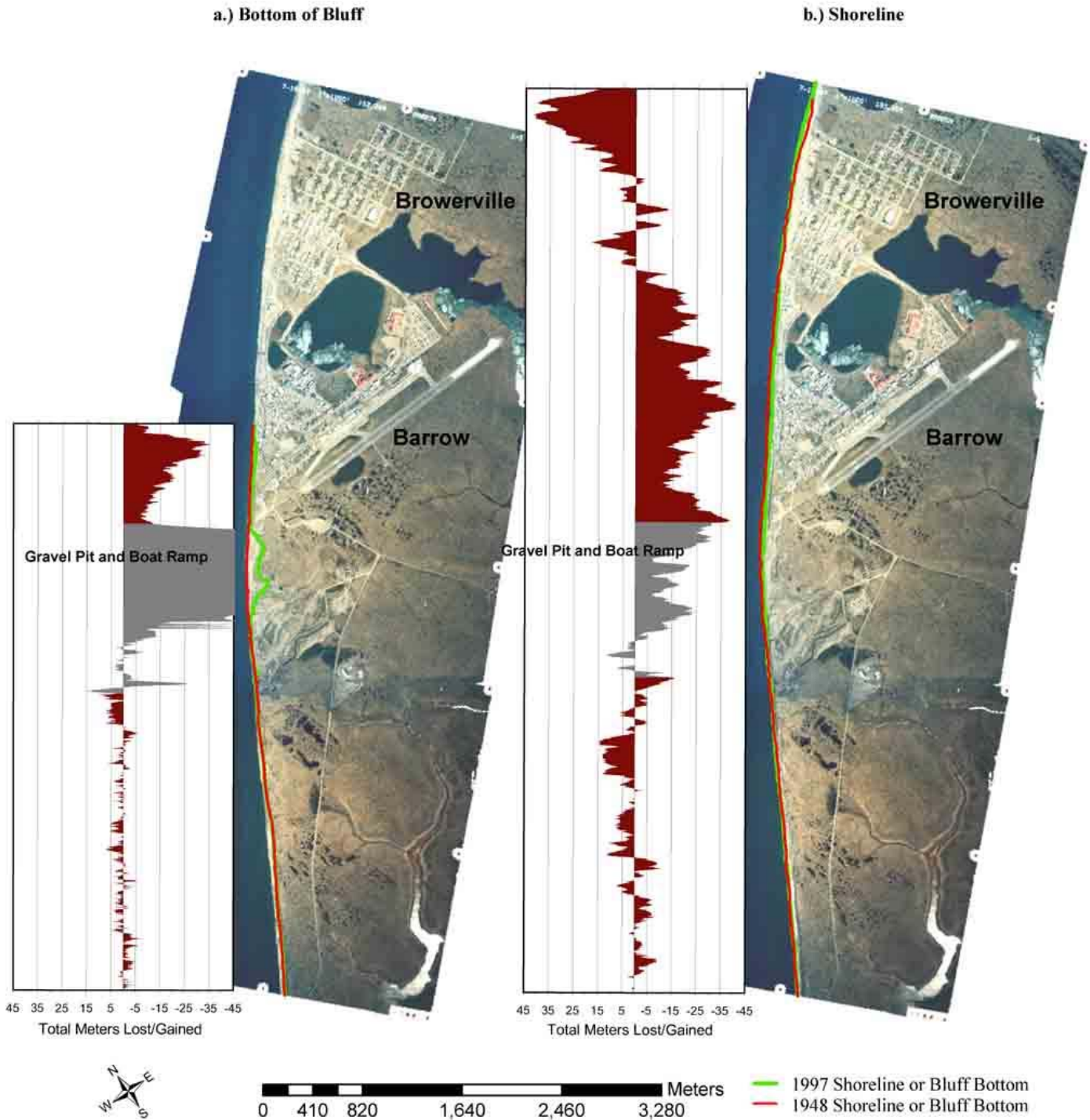


Figure 1. Coastal Retreat (Negative Values) or Aggradation (Positive Values) Between 1948 and 1997, Barrow, Alaska. Orthorectified 1997 aerial photography of Barrow and Browerville, showing the **a.)** bluff bottom positions in 1948 (red) and 1997 (green) and the **b.)** shoreline positions in 1948 (red) and 1997 (green). Portions of the graphs in gray depict the location of the gravel pit and boat ramp. Bluff and beach erosion in the study area is highest immediately southwest of downtown Barrow.