Report of Investigation 2021-3 Shaktoolik

EROSION EXPOSURE ASSESSMENT—SHAKTOOLIK

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Shaktoolik, Alaska, in 2019. Photo: Alaska Division of Geological & Geophysical Surveys.

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EROSION EXPOSURE ASSESSMENT—SHAKTOOLIK

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SHAKTOOLIK EROSION EXPOSURE ASSESSMENT

This is a summary of results from an erosion forecast near infrastructure at Shaktoolik, Alaska. We conduct a shoreline change analysis, forecast 60 years of erosion, and estimate the replacement cost of infrastructure in the forecast area. Buzard and others (2021) describe the method and guidance for interpreting tables and maps.

Source data for this summary include the following:

- Shoreline change assessment ArcGIS shapefiles from Overbeck and others (2020) updated to the vegetation line if appropriate.
- Infrastructure AutoCAD outlines and metadata from Division of Community & Regional Affairs (2004) Community Profile Map series.
- Added infrastructure such as roads, water and sanitation facilities, and outbuildings, delineated if visible in the most up-to-date high resolution (≤ 0.66 ft [20 cm] ground sample distance) aerial orthoimagery (Overbeck and others, 2016).

Shaktoolik is located at the head of Norton Sound. The community is constructed on a long, vegetated, gravel spit. The Tagoomenik River travels along the inland side of the spit to meet with the larger Shaktoolik River before exiting into Norton Sound. From 1950 to 2015, the beach remained relatively stable with accretion up to 3.3 feet per year near the tip of the spit (Overbeck and others, 2020). Despite long-term stability, large storms can erode the vegetated soil above the beach, undercut-

ting infrastructure near the coastline. Shaktoolik constructed a gravel berm in 2014 to buffer soil erosion and undercutting (HDR and RIM First People, 2016). Due to the relatively stable beach erosion trends and the construction and maintenance of the gravel berm, we cannot forecast erosion at Shaktoolik.

U.S. Army Corps of Engineers [USACE] (2009) measure net stability or accretion of the vegetated shoreline from 1980 to 2004, yet forecast erosion assuming erosion rates of 2 feet per year. Given this inconsistency, we do not find the USACE (2009) erosion forecasts reliable for estimating erosion exposure. In addition, the forecasts were made prior to the construction of the erosion protection berm. Erosion forecasts become outdated when erosion protection is built.

The Native Village & City of Shaktoolik and others (2009) express concern that a thin section of the spit may erode and become a new outlet for the Tagoomenik River (making Shaktoolik an island). USACE (2009) estimates this area erodes at 3 feet per year, but this claim is not based on a measurement. Johnson and Gray (2014) estimate "…that it would likely be at least 10 years [2023-2024] before the beach on Norton Sound would

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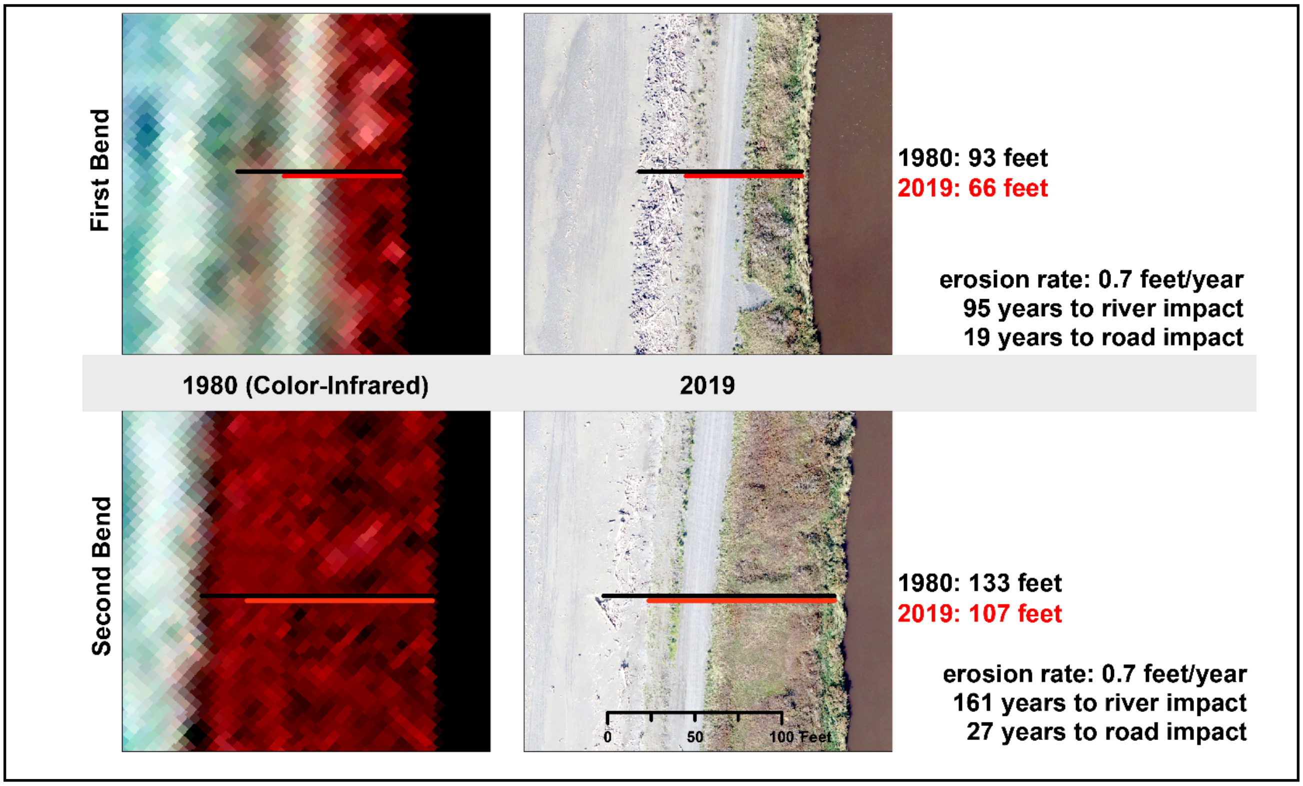

Figure 1. Erosion estimates at the thinnest points of First Bend (top) and Second Bend (bottom). The black line shows the distance from the 1980 coastal vegetation edge to the riverbank. The red line shows the distance as of 2019. At First Bend, the vegetation line eroded 33 feet from 1980 to 2019 (0.7 feet per year), and 66 feet remain. The 1980 image is color-infrared, so vegetation appears red and water black.

erode through to the river," citing the erosion rates assumed by USACE (2009). Measurements from aerial imagery show erosion rates from 1980 to 2019 are 0.7 feet per year at First and Second Bend (fig. 1). This rate predicts the earliest breach occurring in 95 years at First Bend. The long-term rates may be slower than recent observations because few major storms impacted Shaktoolik in the 1980s and 1990s (Native Village & City of Shaktoolik and others, 2009). Many factors can increase erosion rates beyond the historical record (such as reduced sea ice during the storm season or unprecedented storm surge). These findings suggest that a breach is not imminent but is likely to occur within 100 years, depending on the frequency of storms that reach the bluff. Erosion of the road at both First and Second Bend is a more immediate concern.

Beach erosion can be measured from repeated beach elevation surveys using GPS or digital elevation models. For example, Kinsman and DeRaps (2012) collected pre- and post-storm beach elevations at transects along the beach that show erosion from the November 2011 storm surge. The storm caused minor beach erosion and modification from the old village to the current site and deposited a significant amount of ice and debris towards the end of the spit by the airport runway. The community built a gravel berm in 2014 to buffer further soil erosion. After an August 2019 storm, DGGS collected post-storm beach elevation data, finding that 470,000 cubic feet of the berm eroded (fig. 2). Like the 2011 storm, gravel was eroded in front of the community while the north end of the spit accreted (fig. 3). As the community continues to explore erosion solutions, repeat elevation surveys can be used to quantify the ongoing changes, evaluate the effectiveness of the berm, and help identify whether and when infrastructure may become exposed to erosion.

ACKNOWLEDGMENTS

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Figure 2. The eroded berm at Shaktoolik in front of the school and water tower after the August 2019 storm. The storm eroded much of the gravel, leaving the woody debris it was built upon.

Figure 3. This broad gravel sheet on the northwest section of the spit was deposited by storms. The deposit ranges from 1 to 3 feet above the ground elevation (geologist for scale). The August 2019 storm added to the deposit, causing net accretion at the tip of the spit.

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