Interactive Maps of Coastal Profiles and Shoreline Positions for Alaska

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Introduction

Historically, access to coastal elevation and shoreline positional data in Alaska has been limited by the lack of a centralized database, making accurate assessment of coastal flooding and erosion hazards difficult. To address this, the Division of Geological & Geophysical Surveys (DGGS) developed two interactive maps that facilitate access to statewide datasets. The Alaska Coastal Profile Tool houses contemporary and historical elevation measurements from around the state. These data can be used to better understand the coastal environments of Alaska and document change. The Alaska Shoreline Tool displays both past and projected shoreline positions. The content in this tool utilizes the Digital Shoreline Assessment System (DSAS) to calculate rates of shoreline change. Both tools facilitate access to coastal data in Alaska and will improve hazard assessments of coastal communities vulnerable to flooding and erosion. Datasets from both of these tools are available for download at the DGGS website.

Alaska Coastal Profile Tool

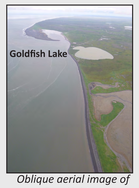
Collect, organize and release beach elevation profile data

Alaska Shoreline Tool

Display historical and projected shoreline positions

Case Study: Port Heiden

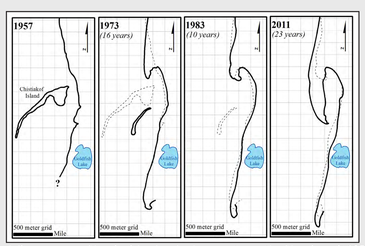
Location of Port Heiden and the Port Heiden Embayment.



Oblique aerial image of Port Heiden.

Background and Coastal Setting

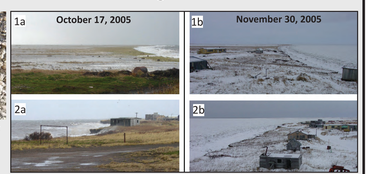
- Port Heiden coastline characterized by barrier spits and coastal bluffs composed of volcanic deposits



Gradual disapearence of barrier island and subsequent growth of barrier spit 1957-2011.

- Village of Meshik threatened by bluff erosion and relocated in 1980s
- Dynamic coast with rapid coastal erosion and geomorphic change
- Critical infrastructure(school and fuel tanks) are still at risk
- Is a delay in sea ice arrival affecting rates of erosion?

Poorly consolidated volcanic deposits that comprise coastal bluffs.



Strong and persistent storm season in summer to late fall.Note arrival of sea ice.

Alaska Coastal Profile Tool

Coastal Profiles

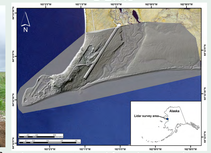
- Coastal Profile – shore-normal elevation transect
- Repeat measurements allow evaluation of changes in coastal environments
- Data useful for many types of studies including storm surge run-up modeling
- Elevation data is collected by a variety of methods and organizations
- In Alaska datasets of this type date back to the 1960's

Methods of Elevation Measurement

DGPS

Differential Global Positioning System - DGGS field measurements in Port Heiden, 2013.

DEMs



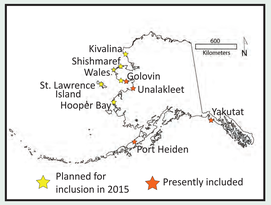
Elevation extracted from high-resolution DEMs with 1 m spacing intervals. Hillshade in Golovin, Alaska.

Differential Leveling

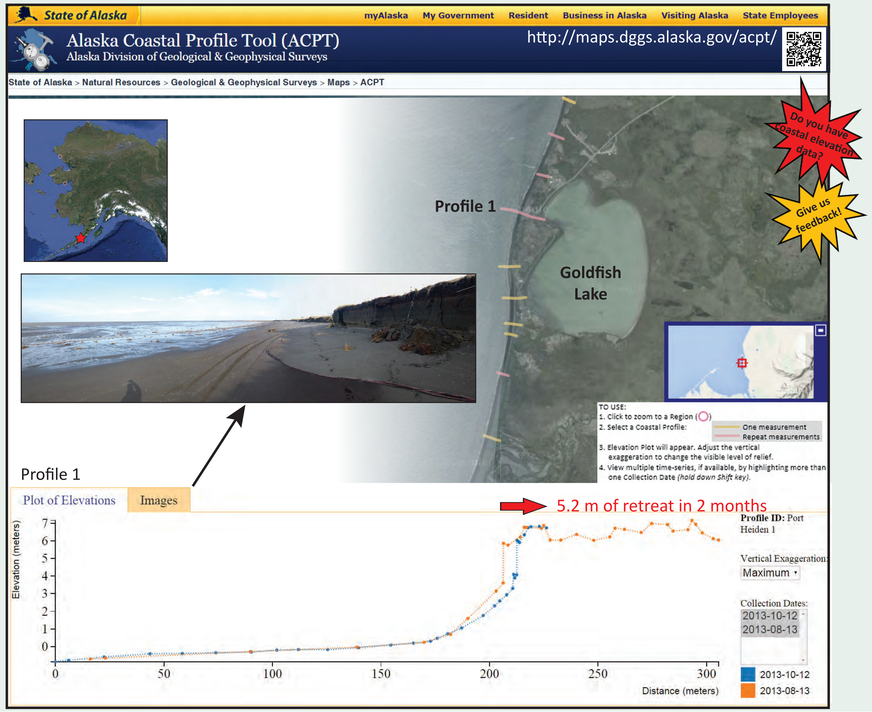
Traditional survey technicques range in sophistication from a total station to Emory board measurements (Yakutat, 2014).

Project Status

- Database is being continually seeded and includes data from the follow locations:



- Data is available for download as a .csv and includes point latitude, longitude, elevation, uncertainties, grain size and field observations



References

Boak, E.H., and Turner, I.L., 2005, Shoreline definition and detection—A review: Journal of Coastal Research, v. 21, no.4, p. 688–703.

Kinsman, N.E.M., and Gould, A.I., 2014, Contemporary shoreline retreat rates at Meshik in Port Heiden, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2014-4, 21 p. doi:10.14509/27321

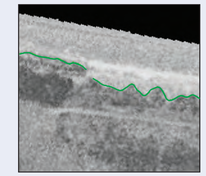
Thieler, E.R., Himmelstoss, E.A., Zichichi, J.L., and Ergul, Ayhan, 2009. Digital Shoreline Analysis System (DSAS) version 4.0 — An ArcGIS extension for calculating shoreline change: U.S. Geological Survey Open-File Report 2008-1278.

Alaska Shoreline Tool

1) Orthorectify Historical Imagery

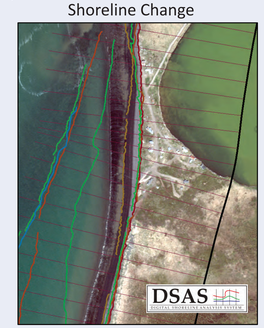
To create a map ready product, the imagery is orthorectified to remove any kind of distortion. Photoscan is used for aerial photographs and Socet GXP is used for satellite imagery.

2) Digitize Shoreline



Shorelines are digitized where a shoreline indicator is identifiable. The shoreline indicators used for most datasets in this tool are the is the seaward dune/bluff edge or vegetation line.

3) Determine Rates of Shoreline Change



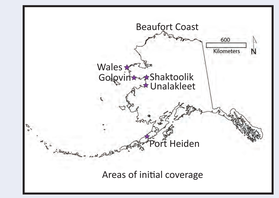
The ArcMap extension, Digital Shoreline Assessment System (DSAS), is used to calculate rates of shoreline change.

4) Project Rates of Shoreline Change

DGGS has developed a tool to automate the process of projecting the rate of change to a certain year and then connecting the points to define a predicted shoreline location.

Project Status

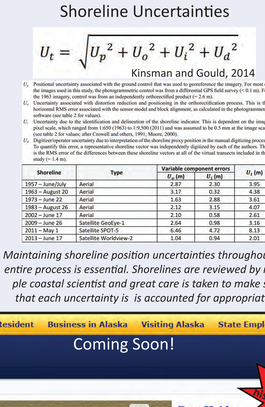
- This interactive map is still being developed and will be released in early 2015
- The database will grow as more imagery and shoreline data is obtained



Shoreline Uncertainties

$$U_t = \sqrt{U_p^2 + U_o^2 + U_i^2 + U_d^2}$$

Kinsman and Gould, 2014



U_p Positional uncertainty associated with the ground control that was used to georeference the imagery. For most of the images used in this study, the photogrammetric control was from a differential GPS field survey (~0.1 m). For the 1963 imagery, control was from an independently orthorectified product (~2.8 m).

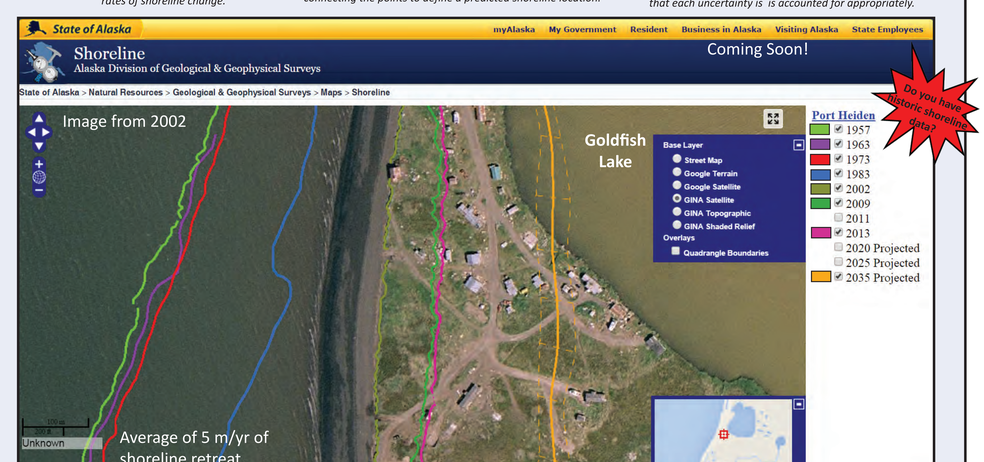
U_o Uncertainty associated with distortion reduction and positioning in the orthorectification process. This is the horizontal RMS error associated with the sensor model and block alignment, as calculated in the photogrammetry software (see table 2 for values).

U_i Uncertainty due to the identification and delineation of the shoreline indicator. This is dependent on the image pixel scale, which ranged from 1.658 (1963) to 1.8,500 (2011) and was assumed to be 0.5 mm at the image scale (see table 2 for values; after Crowell and others, 1991; Moore, 2000).

U_d Digitizer/operator uncertainty due to interpretation of the shoreline proxy position in the manual digitizing process. To quantify this error, a representative shoreline vector was independently digitized by each of the authors. This is the RMS error of the differences between these shoreline vectors at all of the virtual transects included in this study (~1.4 m).

Shoreline	Type	Variable component errors		
		U_p (m)	U_i (m)	U_t (m)
1957 – June/July	Aerial	2.87	2.30	3.95
1963 – August 20	Aerial	3.17	0.32	4.38
1973 – June 22	Aerial	1.63	2.88	3.61
1983 – August 26	Aerial	2.12	3.15	4.07
2002 – June 17	Aerial	2.10	0.58	2.61
2009 – June 26	Satellite GeoEye-1	2.64	0.98	3.16
2011 – May 1	Satellite SPOT-5	6.46	4.72	8.13
2013 – June 17	Satellite WorldView-2	1.04	0.94	2.01

Maintaining shoreline position uncertainties throughout this entire process is essential. Shorelines are reviewed by multiple coastal scientist and great care is taken to make sure that each uncertainty is is accounted for appropriately.



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