



# DGGS Geologic Hazard Research: Coastal Erosion and Flooding

*House & Senate Joint Resources Committee*

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                                 Jacquelyn Overbeck, Coastal Hazards Program Manager

Division of Geological & Geophysical Surveys  
Alaska Department of Natural Resources  
September 10, 2018

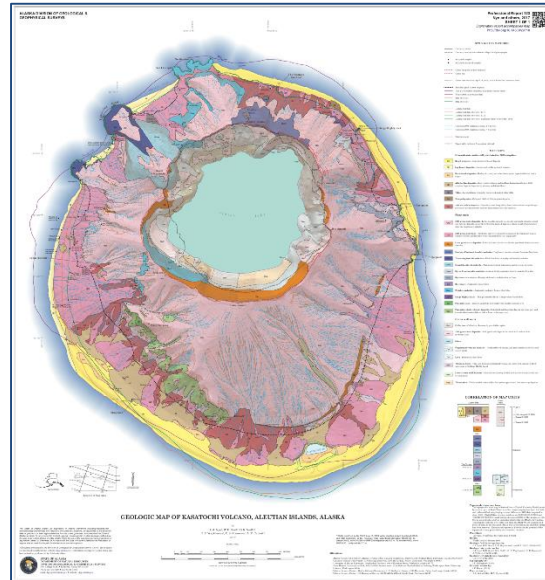




# VOLCANIC HAZARDS



**Ted Stevens Anchorage Airport is the second busiest cargo airport in the U.S. and 90% of Asia's air cargo passes through airspace threatened by Alaska's 54 active volcanoes, about half of which are unmonitored.**



**Geologic Mapping and Research**  
**Chiginagak, Kasatochi, Shishaldin, Makushin,**  
**and Okmok volcanoes**

**Helicopter and Fuel Procurement and Logistics**  
**Support for all AVO field projects**

**AVO Website and Alaska Tephra Database**  
**Photos, volcano history, ash fall extent, ash**  
**deposit thickness and age, and reports**  
**(60M+ page views for [avo.alaska.edu](http://avo.alaska.edu))**







# GEOLOGIC HAZARD PROGRAMS



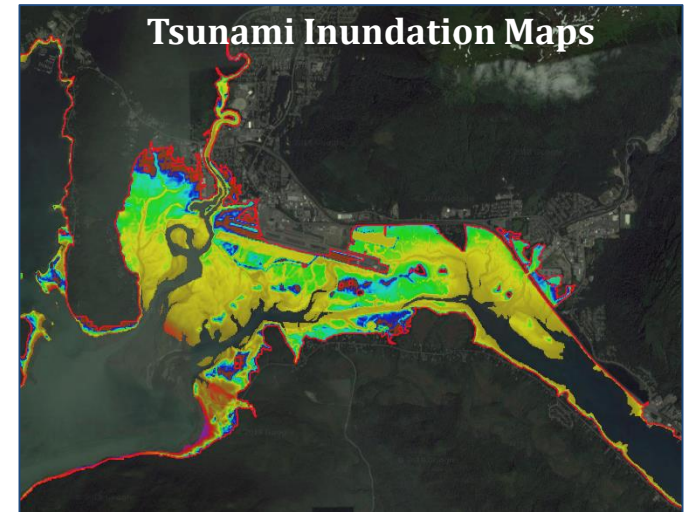
**Active Faulting, Earthquakes, and Tsunami Inundation Mapping (Right)**

**Landslide Mapping and Response (Bottom right)**

**Snow and Ice Hazards**

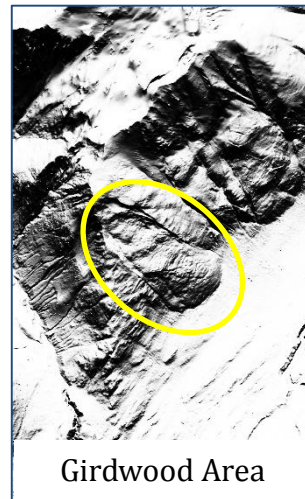
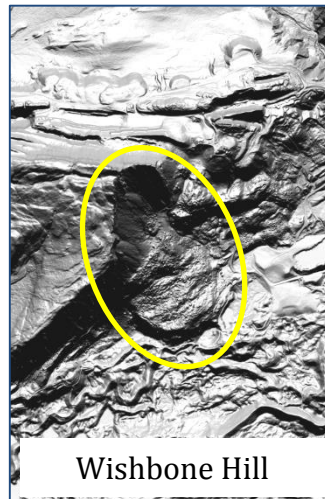
**Permafrost and Groundwater Program**

**Coastal Erosion and Flooding**



**LiDAR Applications:**

**Permafrost  
Landslides  
Lava flows  
Erosion  
Flooding  
Faults**





# 2018 PROGRESS



**Yukon River/Dalton Highway Crossing:**  
Working with the DOT (surface geology, permafrost distribution, and hydrology) supporting planning, development, & maintenance

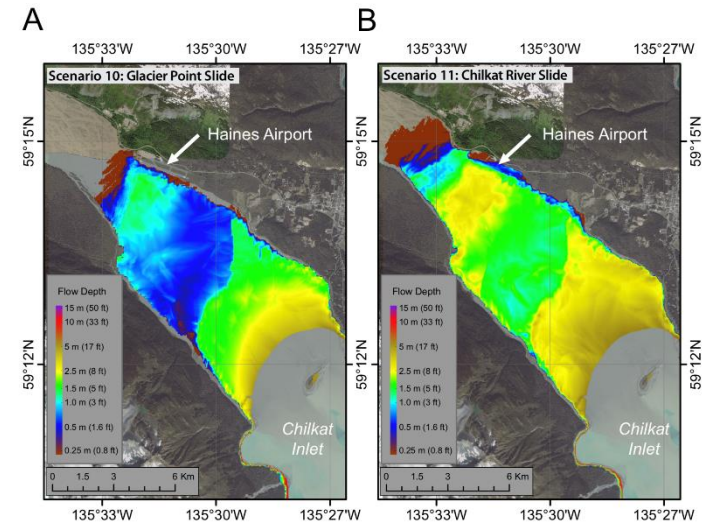
**Sitka Landslides:**  
Processing and analyzing new LiDAR data

Key publications include tsunami inundation maps for Kodiak, Juneau, Skagway, and Haines

Permanent flooding maps for Valdez, Chenega, Chignik, and Chignik Lagoon

In FY18, DGGS published 32 new reports and peer-reviewed publications on geologic hazards (up 50% from FY17)

With the Alaska Seismic Hazards Safety Comm., DGGS also published a seminal report summarizing the state of knowledge of active faults and seismic hazards in Alaska



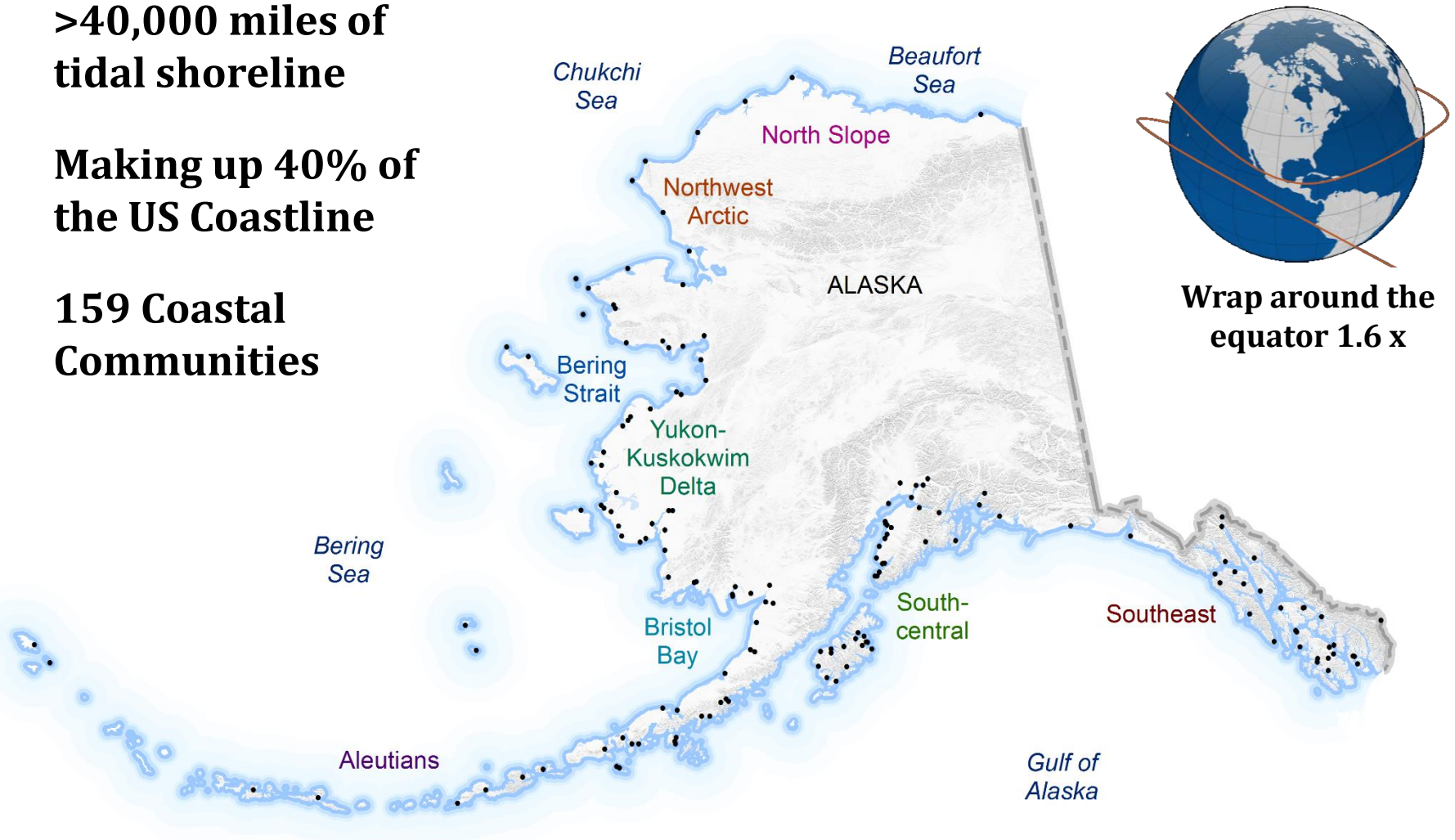


# ALASKA'S COASTLINE

**>40,000 miles of  
tidal shoreline**

**Making up 40% of  
the US Coastline**

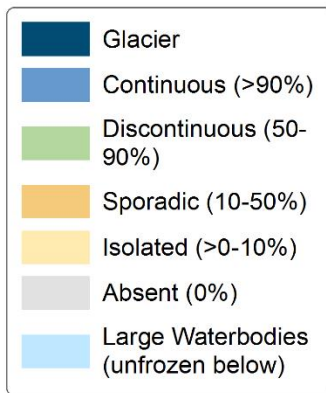
**159 Coastal  
Communities**



# PERMAFROST

**Ground with a temperature that remains below 32°F (the freezing point of water) for two or more consecutive years.**

Permafrost is vulnerable to rising air and sea temperatures that can thaw ice-rich soils. Much of Alaska's rural infrastructure is built directly on permafrost, which is very strong when frozen but becomes unstable and can subside when thawed.

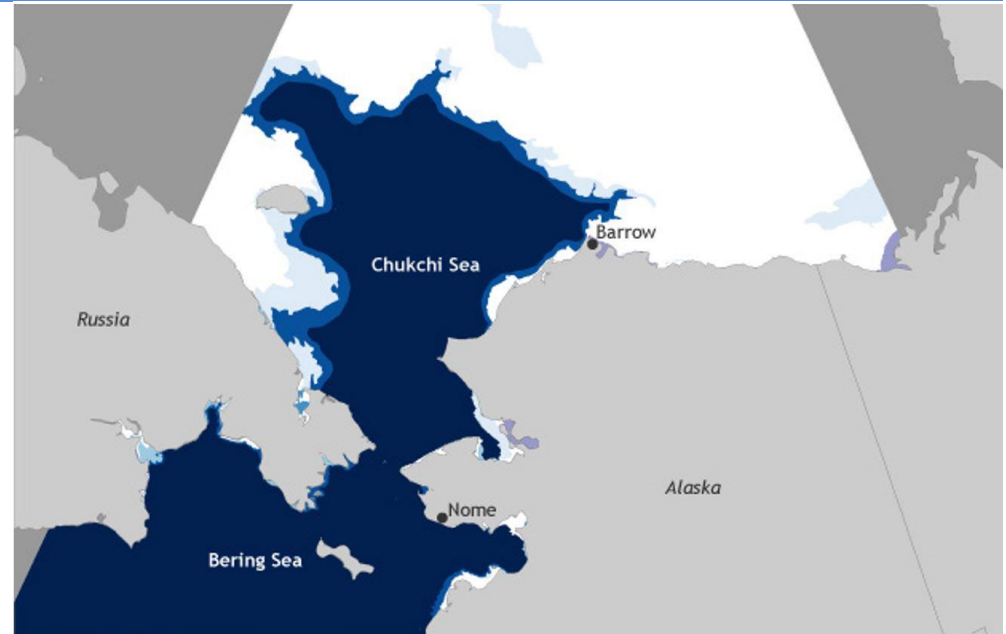
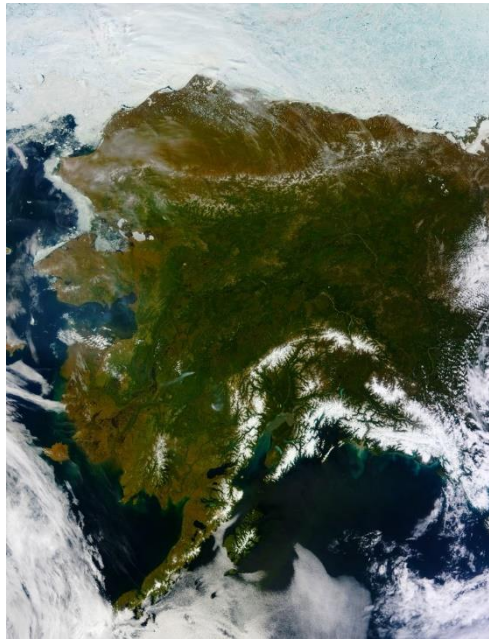


Permafrost zones of Alaska (Jorgenson and others, 2008).

# SEA ICE & STORMS

Sea ice forms offshore of Alaska's northern and western coasts in winter, creating extreme seasonal differences in ocean conditions. Sea ice can dampen ocean conditions—such as wind-driven waves, currents, and storm surge—that cause coastal erosion and flooding.

**In recent years, however, the extent and thickness of sea ice during the fall storm season has been at record lows.**

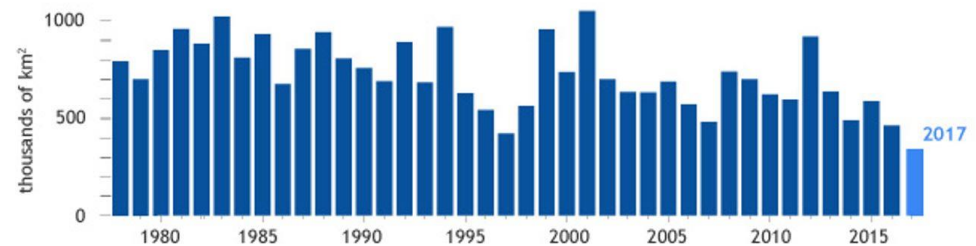


November 19, 2017

Sea ice concentration (percent covered)



NOAA Climate.gov  
Data: NWS ASIP



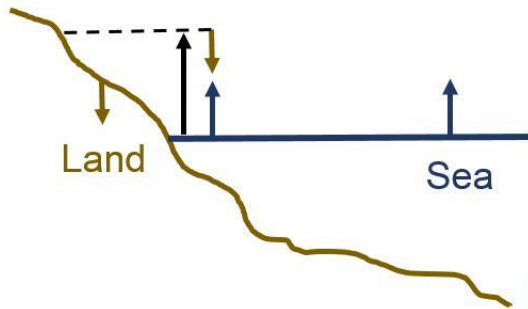
The bar chart demonstrates the 2017 record low Arctic sea ice extent in Alaska's Bering and Chukchi seas. The map shows sea ice extent on November 19, 2017. Figures from Thoman (2017) at [www.climate.gov](http://www.climate.gov).



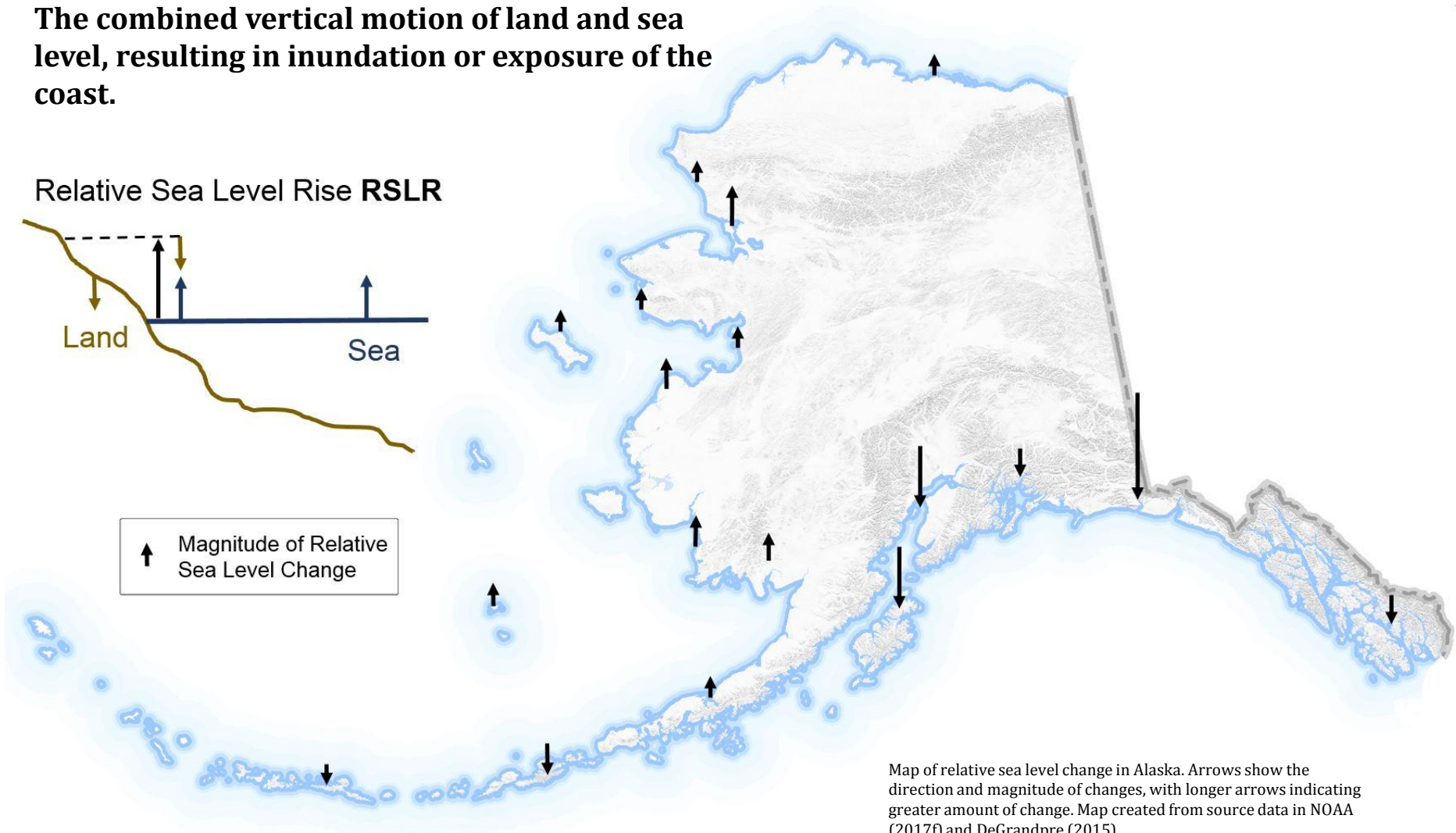
# RELATIVE SEA LEVEL CHANGE

The combined vertical motion of land and sea level, resulting in inundation or exposure of the coast.

Relative Sea Level Rise **RSLR**



↑ Magnitude of Relative Sea Level Change



Map of relative sea level change in Alaska. Arrows show the direction and magnitude of changes, with longer arrows indicating greater amount of change. Map created from source data in NOAA (2017f) and DeGrandpre (2015).



# ALASKA COMMUNITIES IMPACTED BY COASTAL FLOODING & EROSION

| Vulnerability Type            | Coast Type |           |          |
|-------------------------------|------------|-----------|----------|
|                               | Exposed    | Sheltered | Riverine |
| Possible Erosion              | ●          | ■         | ▲        |
| Erosion                       | ●          |           | ▲        |
| Erosion and Flooding          | ●          | ■         | ▲        |
| Flooding and Possible Erosion | ●          | ■         | ▲        |
| Flooding                      | ●          | ■         | ▲        |

10

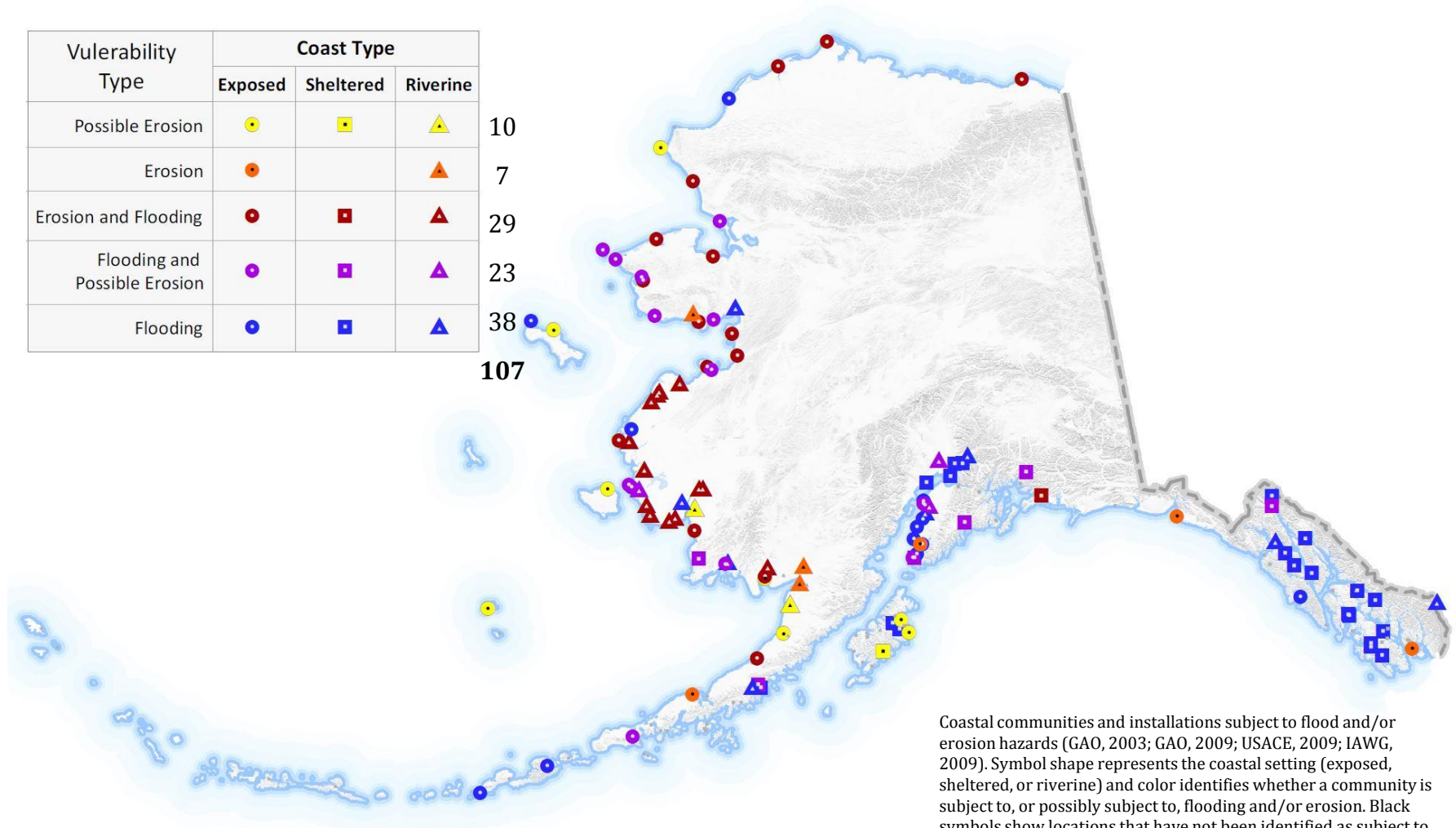
7

29

23

38

107



Coastal communities and installations subject to flood and/or erosion hazards (GAO, 2003; GAO, 2009; USACE, 2009; IAWG, 2009). Symbol shape represents the coastal setting (exposed, sheltered, or riverine) and color identifies whether a community is subject to, or possibly subject to, flooding and/or erosion. Black symbols show locations that have not been identified as subject to flooding and/or erosion.

# IMPACTS OF COASTAL FLOODING & EROSION

## Examples at Sewage Lagoons



**Dillingham, Alaska**



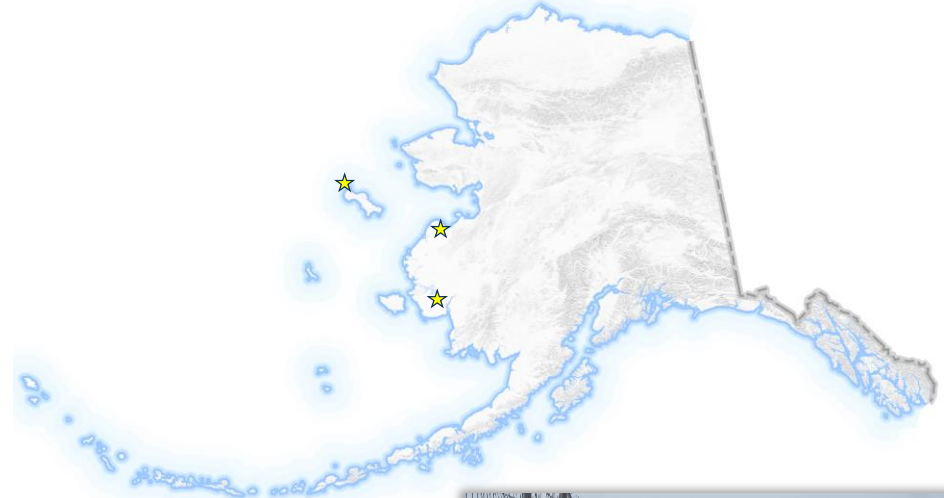
**Quinhagak, Alaska**





# IMPACTS OF COASTAL FLOODING & EROSION

## Examples at Dump Sites



**Kotlik, Alaska**



**Nunapitchuk, Alaska**



**Gambell, Alaska**



# IMPACTS OF COASTAL FLOODING & EROSION

## Examples at Residential Homes



Kwigillingok, Alaska

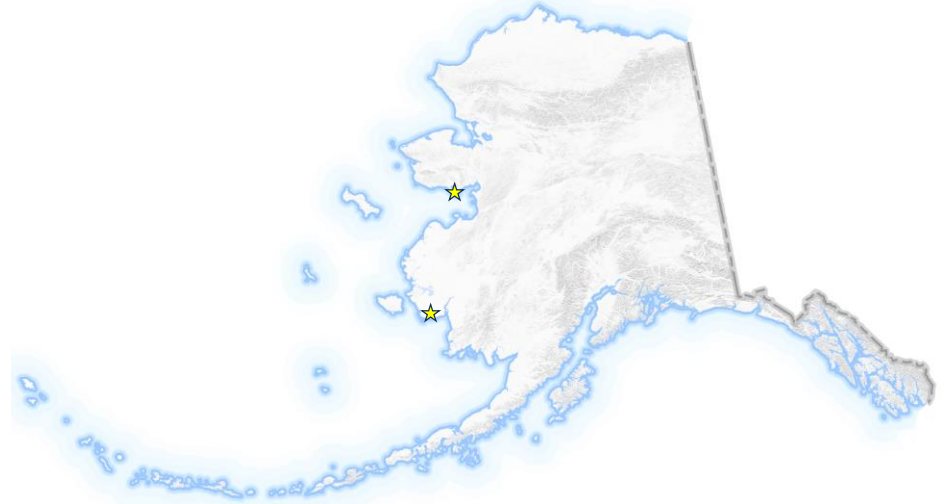


Photo credit: Toby Anungazuk Jr. Chinik Eskimo Community



Golovin, Alaska





# IMPACTS OF COASTAL FLOODING & EROSION

## Public/Private Infrastructure

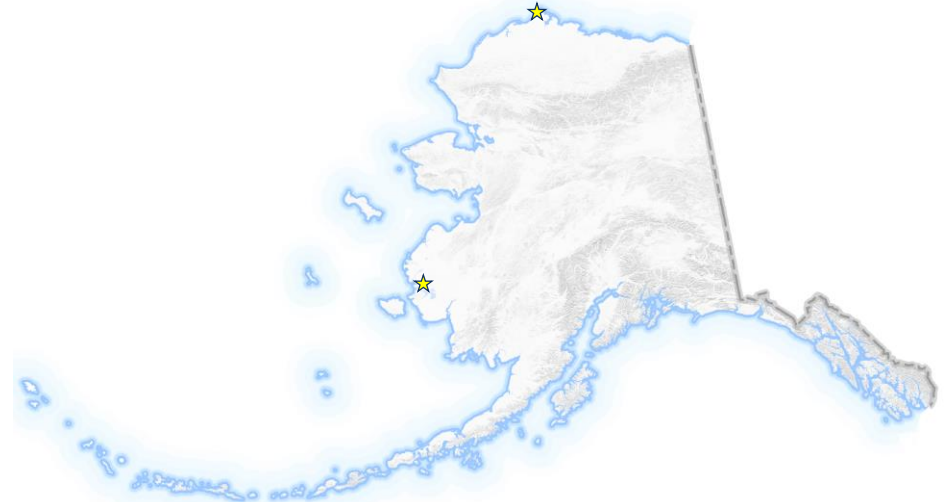


Photo credit: Coastal Observers of Barrow

**Utqiagvik, Alaska**



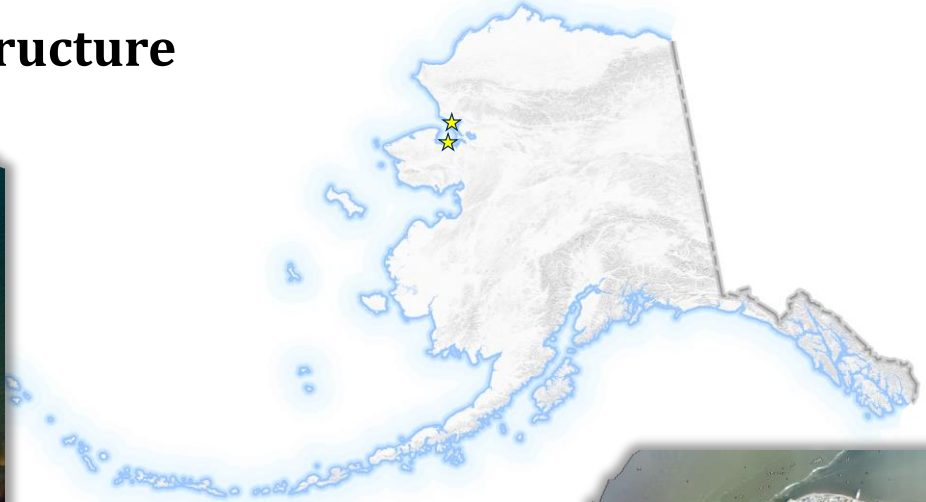
**Newtok, Alaska**

# IMPACTS OF COASTAL FLOODING & EROSION

## Examples at Public/Private Infrastructure



**Deering, Alaska**



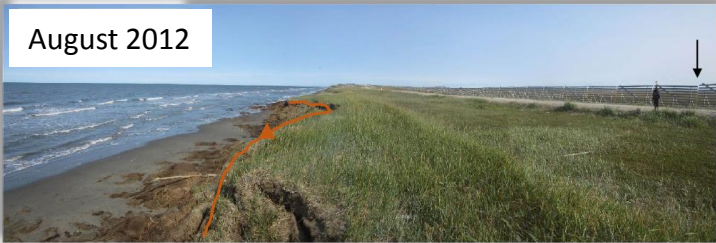
**Kotzebue, Alaska**



# IMPACTS OF COASTAL FLOODING & EROSION

## Examples at Access Corridors

August 2012



August 2017



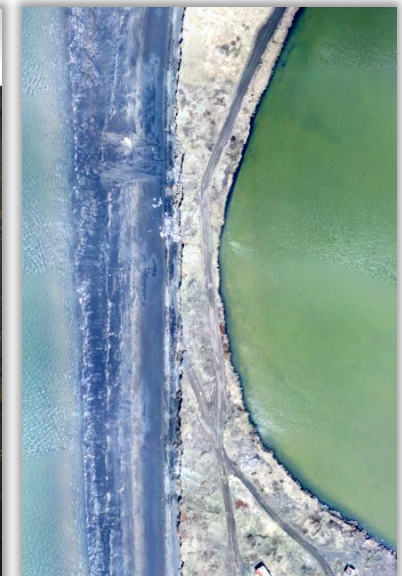
Shishmaref, Alaska



November 2017



Port Heiden, Alaska



# WHAT IS THE NEED



**The House**

**Effective Engineering**

**Community Planning**

**Disaster Preparation & Mitigation**



**The Foundation**

**Baseline Coastal Data & Mapping**



# BASELINE COASTAL DATA & MAPPING

**Orthoimagery (Aerial Imagery)**

**Topography (Elevation Data)**

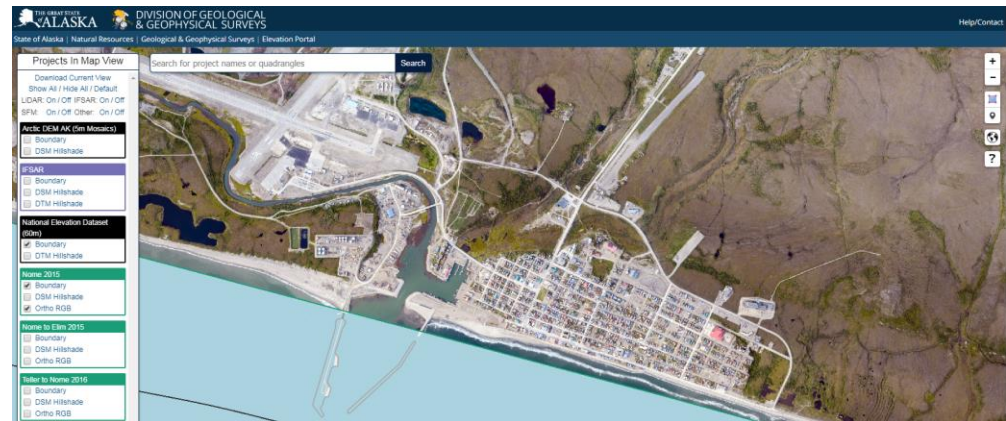
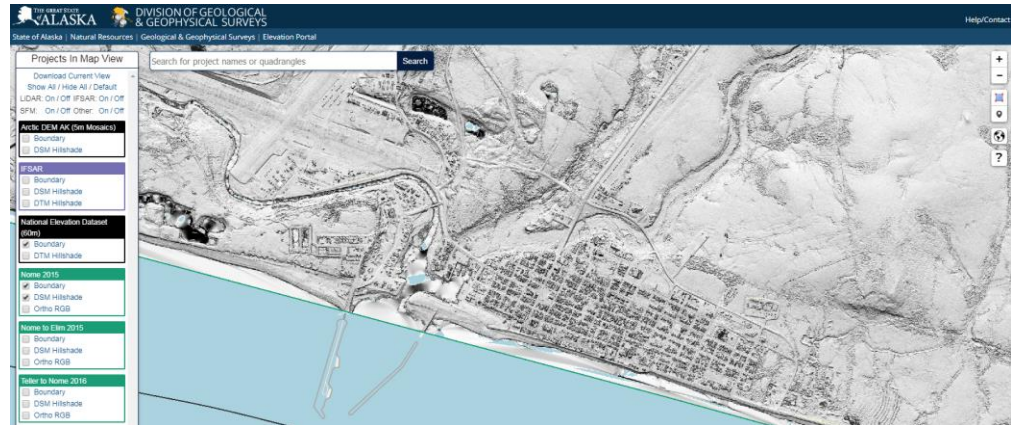
**Bathymetry (Elevations Data  
Below the Water Surface)**

**Water Levels (Continuously  
Collected Water Level Elevations)**

**Sea Ice Data (Satellite and Ground  
Data)**

**Wave Data (Wave Buoys and  
Onshore Wave Cameras)**

**Continually Operating Reference  
Systems (CORS)**



# BASELINE COASTAL DATA & MAPPING

## How Does DGGs Collect Data?

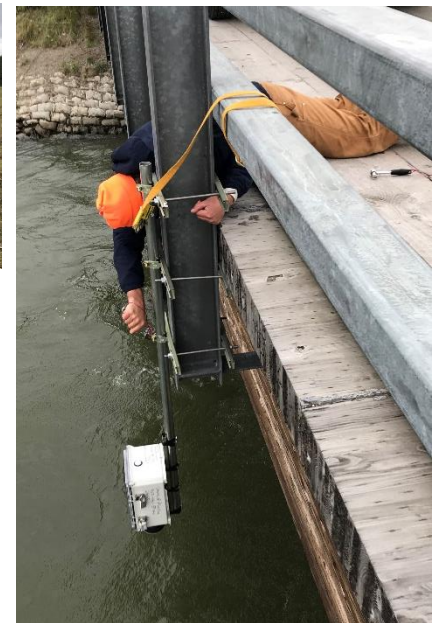
### Remote Sensing



Flight lines and view from plan, Matt Nolan collecting aerial photos to support orthoimagery and topography collection for State of Alaska

### Ground Surveys

### Equipment Installations



### Community-Based Monitoring

### Collaborative Efforts





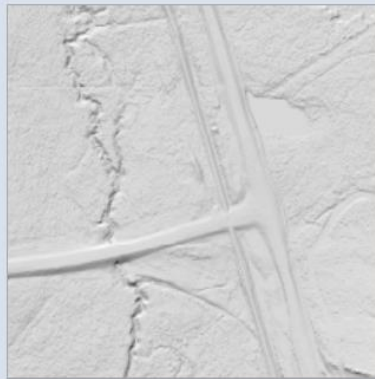
# BASELINE COASTAL DATA & MAPPING

## Providing Data to the Public

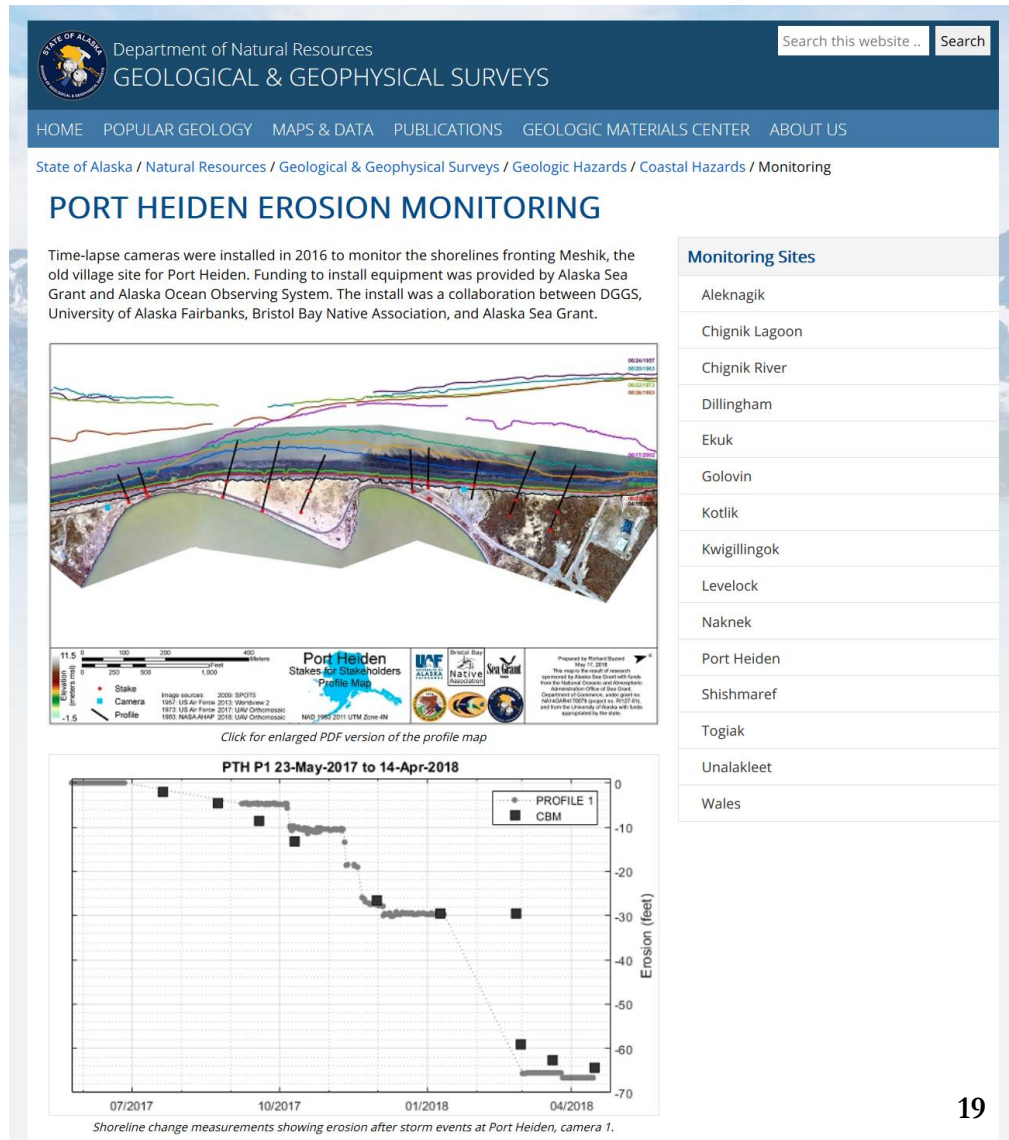
### Elevation Datasets in Alaska

This interactive map displays known public-domain elevation datasets in Alaska.

[See citation details for Elevation Datasets in Alaska](http://maps.dggs.alaska.gov/)



<http://maps.dggs.alaska.gov/>







# COMMUNITY PLANNING

## State Hazard Mitigation Plan Update

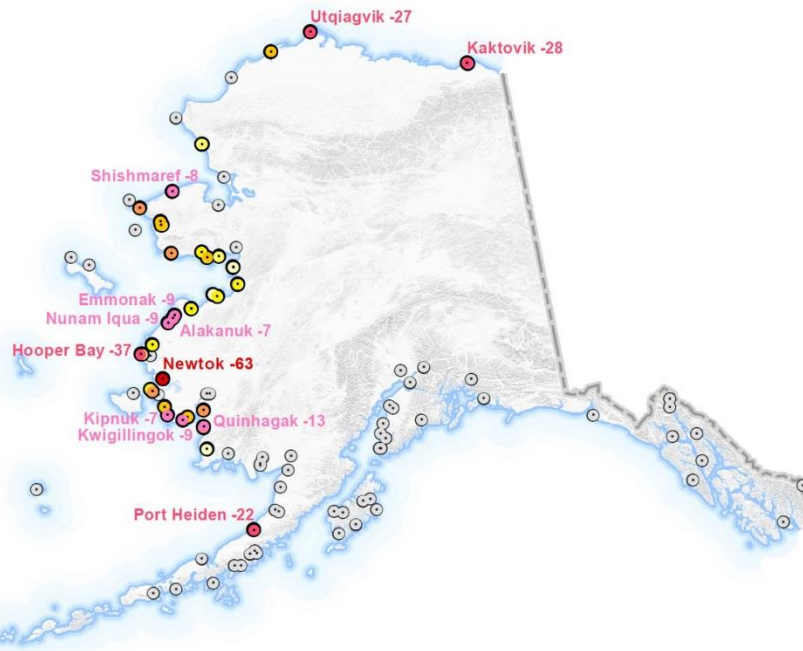
### Coastal Communities Experiencing Erosion

Maximum Rate of Erosion near Community (feet/year)

- -63.12
- -63.11 to -22.18
- -22.17 to -7.32
- -7.31 to -4.27
- -4.26 to -2.92
- -2.91 to -1.77
- -1.76 to -1.05
- -1.04 to -0.46

○ Community experiencing erosion but with no measurements

Communities experiencing the most erosion are labeled with their name followed by the amount of documented total erosion.

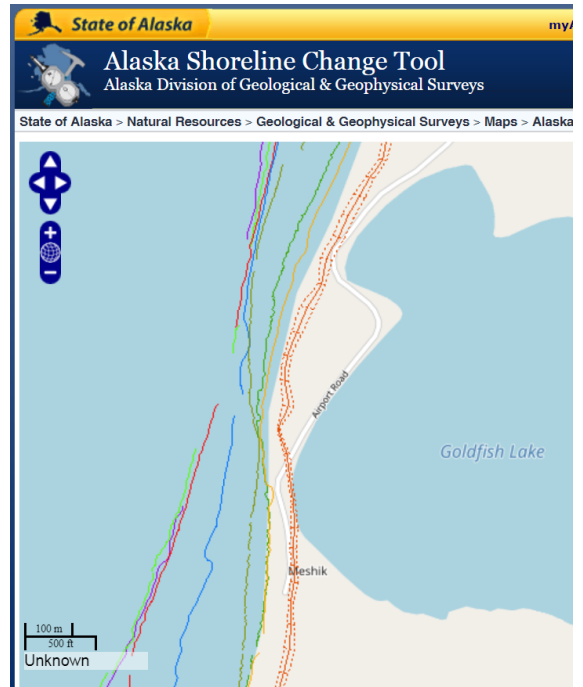
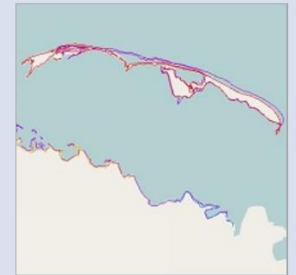


## Shoreline Projections

### Alaska Shoreline Change Tool

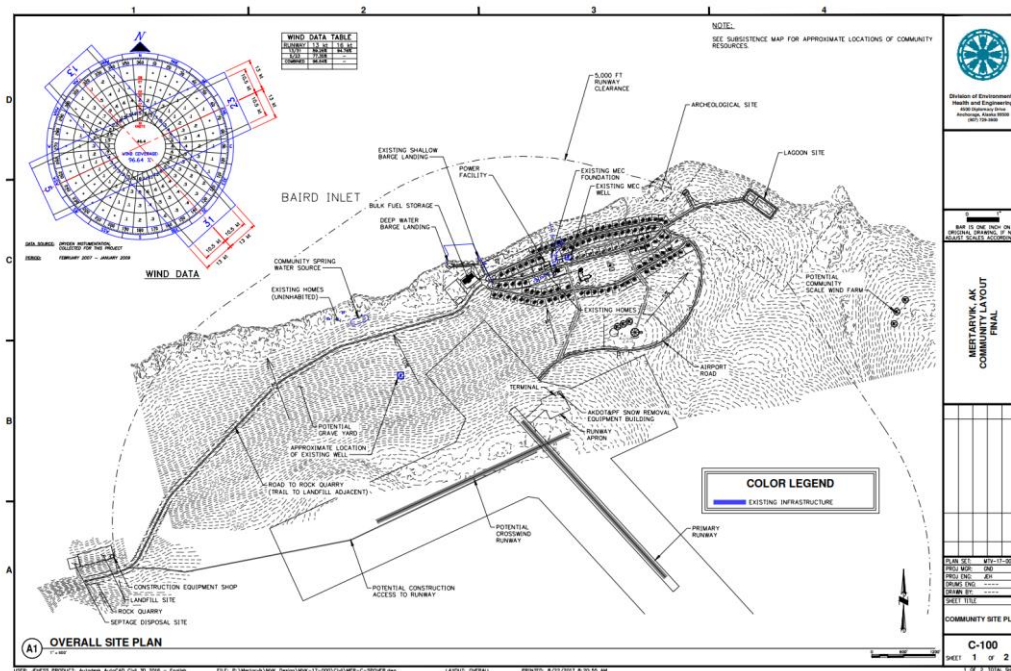
This interactive tool displays historic and predicted shoreline position throughout Alaska.

[See citation details for Alaska Shoreline Change Tool](#)



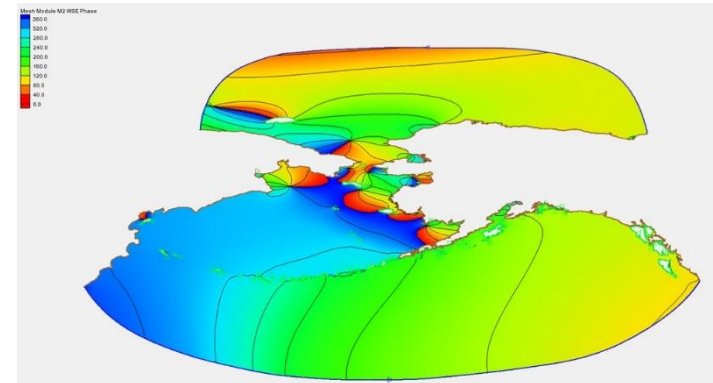
# EFFECTIVE ENGINEERING

## Site Design for Relocation of Facilities

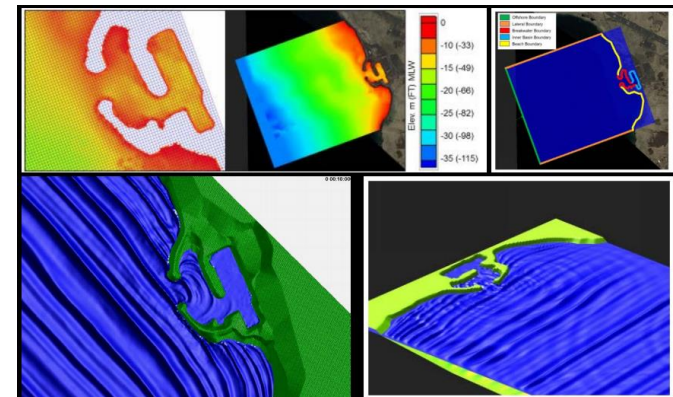


Community layout plan for Mertarvik (Newtok Planning Group)

## Coastal Modelling



Tide and surge model in progress at University of Notre Dame



Example from HDR

<https://www.aos.org/alaska-water-level-watch/alaska-water-level-meeting-2018/>



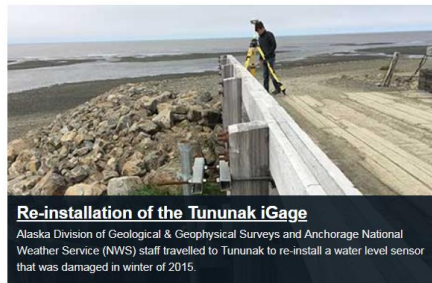
# COMING TOGETHER THROUGH COLLABORATIONS

The Coastal Hazards Program is dedicated to fostering partnerships that improve the quality and quantity of critical coastal baseline data that are necessary to inform decision making throughout the state.



## Alaska Water Level Watch

### Alaska Water Level Watch



[Alaska Water Level Watch Features archive](#)

#### Welcome

The Alaska Water Level Watch (AWLW) is a collaborative group working to improve the quality, coverage, and accessibility to water level observations in Alaska's coastal zone.

#### Resources

##### Observations

- [NWLON Tide Gauges](#)
- [GPS Reflectometry](#)
- [Community-Based Observation Data Sheets](#)
- [Rapid Deploy Sensors](#)

##### Real-Time Data

- [Real-Time Data Portal](#)
- [IOOS QARDOD Manual for Real-Time Quality Control of Water Level Data](#)

##### Tidal Datums

- [About Tidal Datums](#)
- [Convert Between Datums](#)
- [Compute Tidal Datums from Water Level Time Series](#)

##### Published Resources

- [Coastal & Nearshore Water Level Observations in Alaska: Challenges, Assets, Gaps, and Next Steps](#)
- [2011 DGGSS Bering Sea Storm Report](#)
- [Storm water level feature extraction from digital elevation models using intra-storm photographs](#)

<https://www.aoots.org/alaska-water-level-watch/>



## Coastal Strategy

Remote and rugged terrain, unpredictable weather and short field seasons make mapping Alaska's expansive coastal areas uniquely challenging, but data on coastal dynamics and nearshore bathymetry are urgently needed. Coastal erosion and flooding threaten coastal communities while marine traffic including passenger cruise ships and oil tankers is increasing in Alaska's waters.

## Alaska Coastal Mapping Summit

<http://agc.dnr.alaska.gov/coastal.html>

# CONTACT INFORMATION



**Beach north of Unalakleet, Alaska historic reindeer processing facility  
in background**

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