



# DGGS Geologic Hazard Research: Coastal Erosion and Flooding

*House & Senate Joint Resources Committee*

**Presentation by:** Kenneth Papp, DGGS Deputy Director  
Jacquelyn Overbeck, Coastal Hazards Program Manager

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

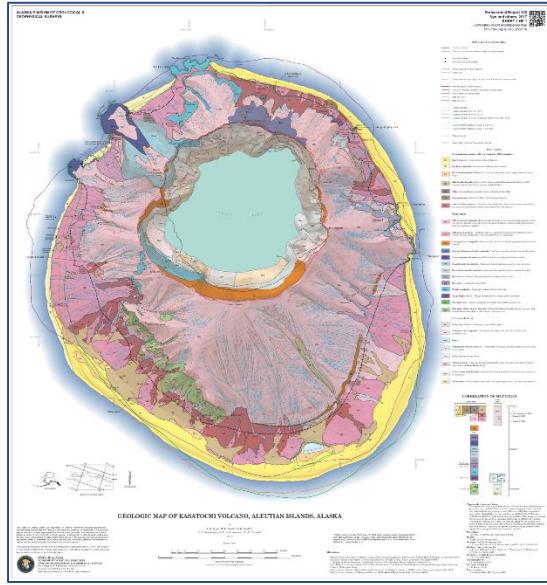




# VOLCANIC HAZARDS



**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)**

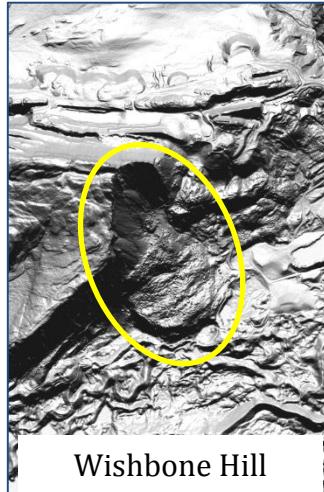
**Snow and Ice Hazards**

**Permafrost and Groundwater Program**

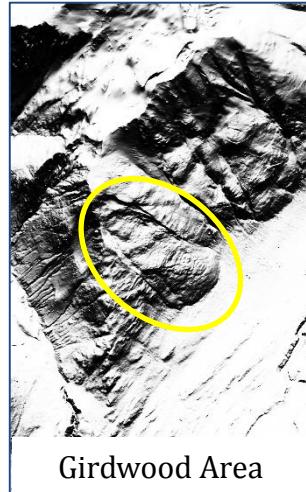
**Coastal Erosion and Flooding**

**LiDAR Applications:**

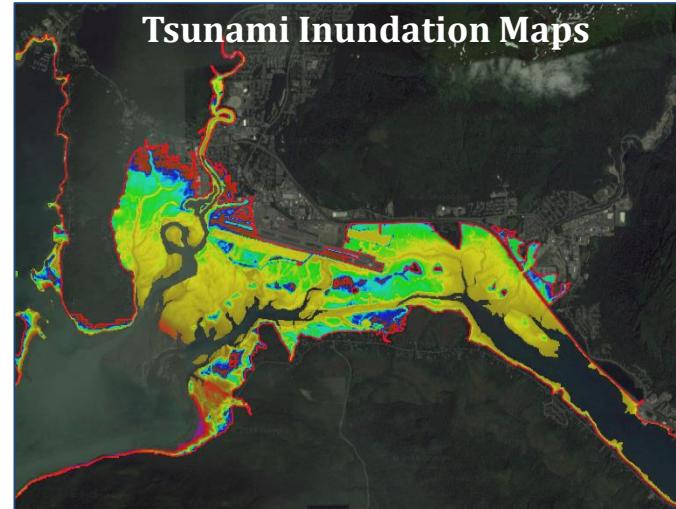
**Permafrost  
Landslides  
Lava flows  
Erosion  
Flooding  
Faults**



Wishbone Hill



Girdwood Area



**Landslide Mapping and Prevention**





# 2018 PROGRESS

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

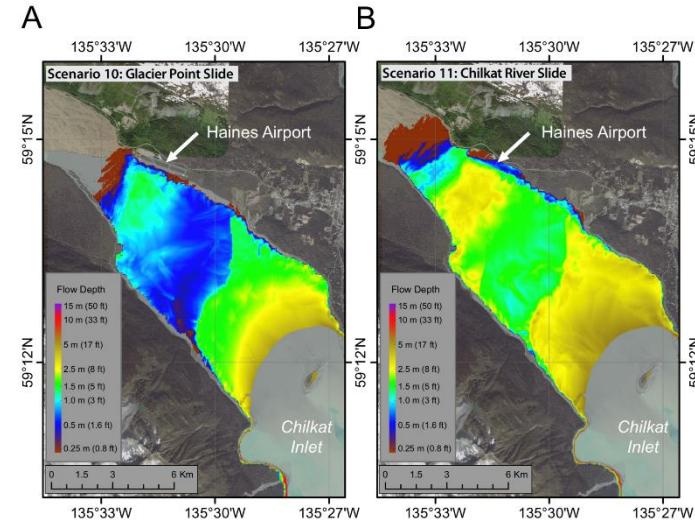
**Sitka Landslides:  
Processing and analyzing new LiDAR data**

**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**

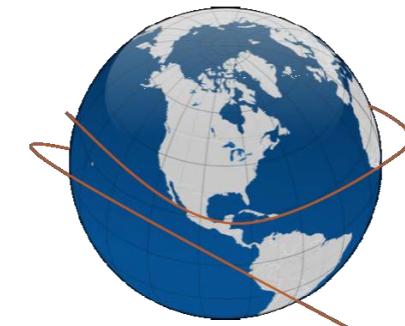


# ALASKA'S COASTLINE

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

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

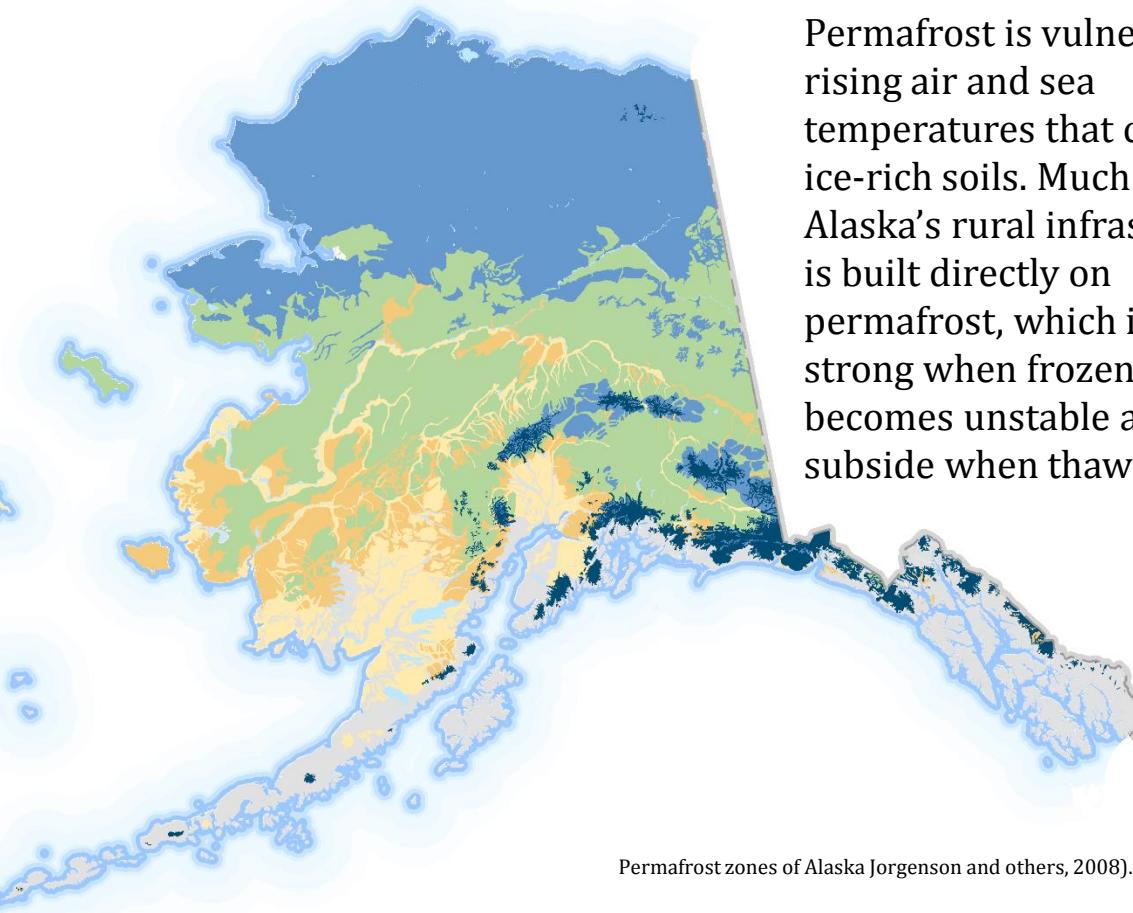
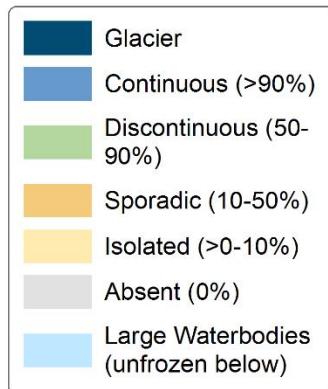
**159 Coastal Communities**



**Wrap around the equator 1.6 x**

# PERMAFROST

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

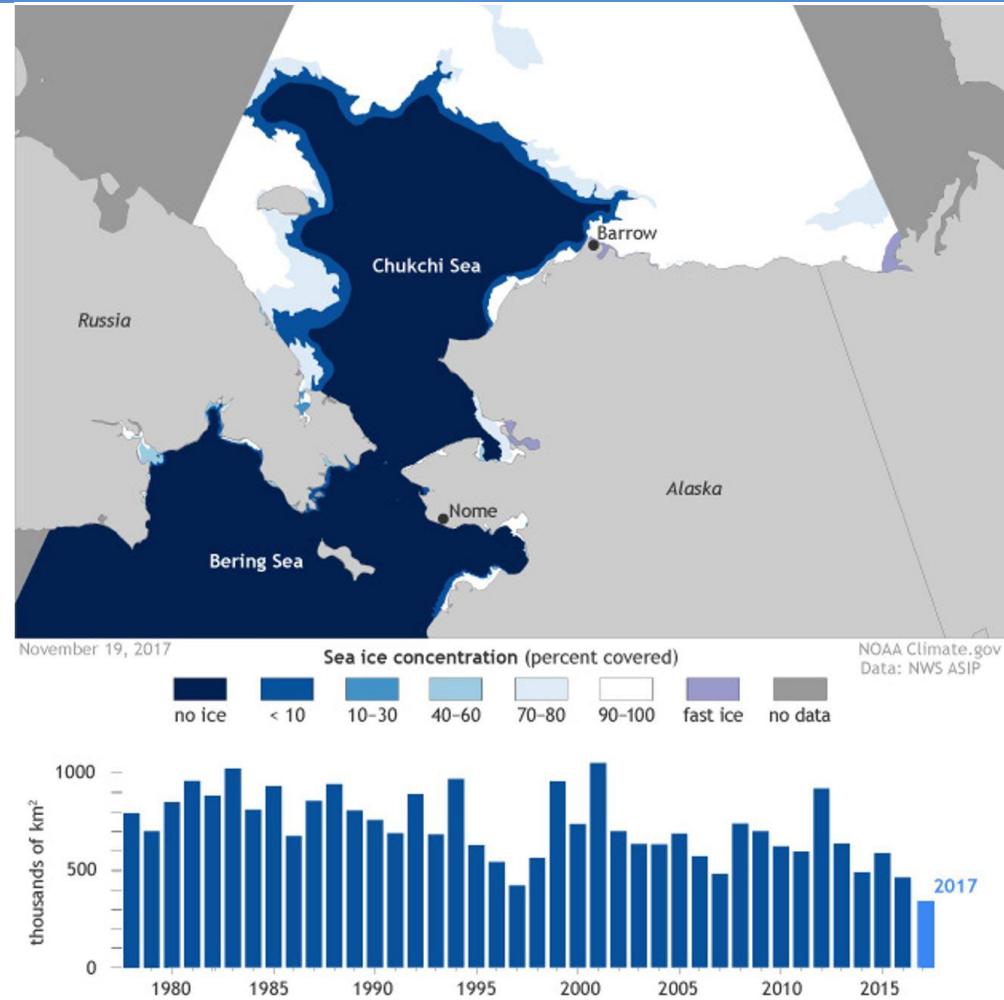
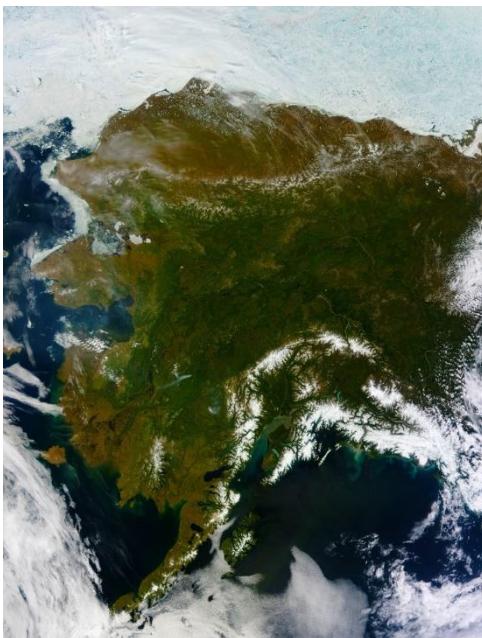


Permafrost zones of Alaska Jorgenson and others, 2008).

# 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.**

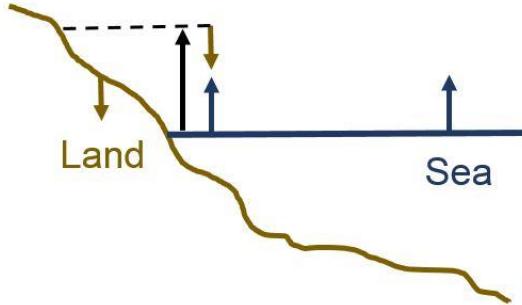


The bar chart demonstrates the 2017 record low Arctic sea ice extent in Alaska's Bering and Chukchi seas. The map shows sea ice extent on November 19, 2017. Figures from Thoman (2017) at [www.climate.gov](http://www.climate.gov).

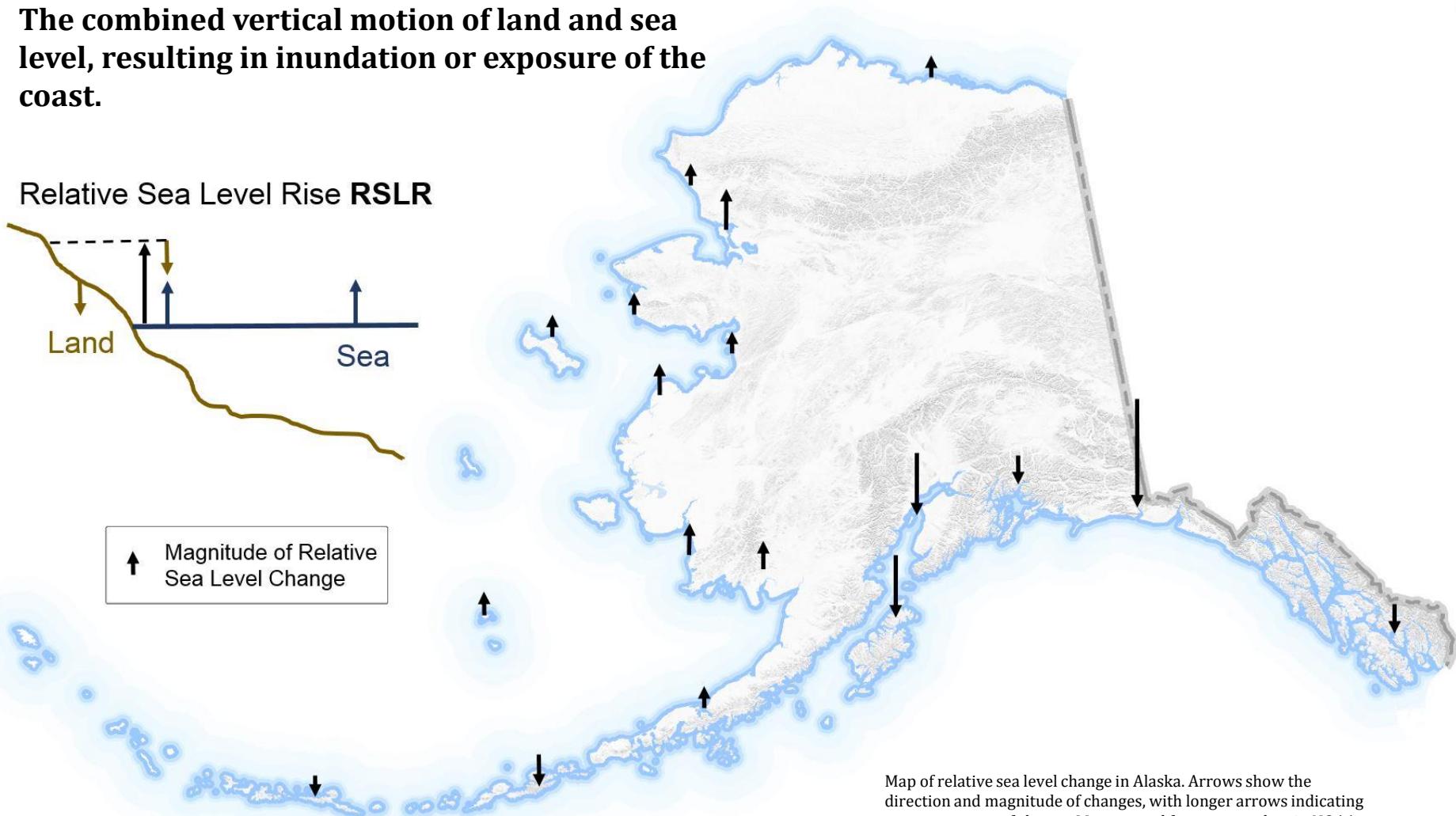
# RELATIVE SEA LEVEL CHANGE

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

Relative Sea Level Rise **RSLR**



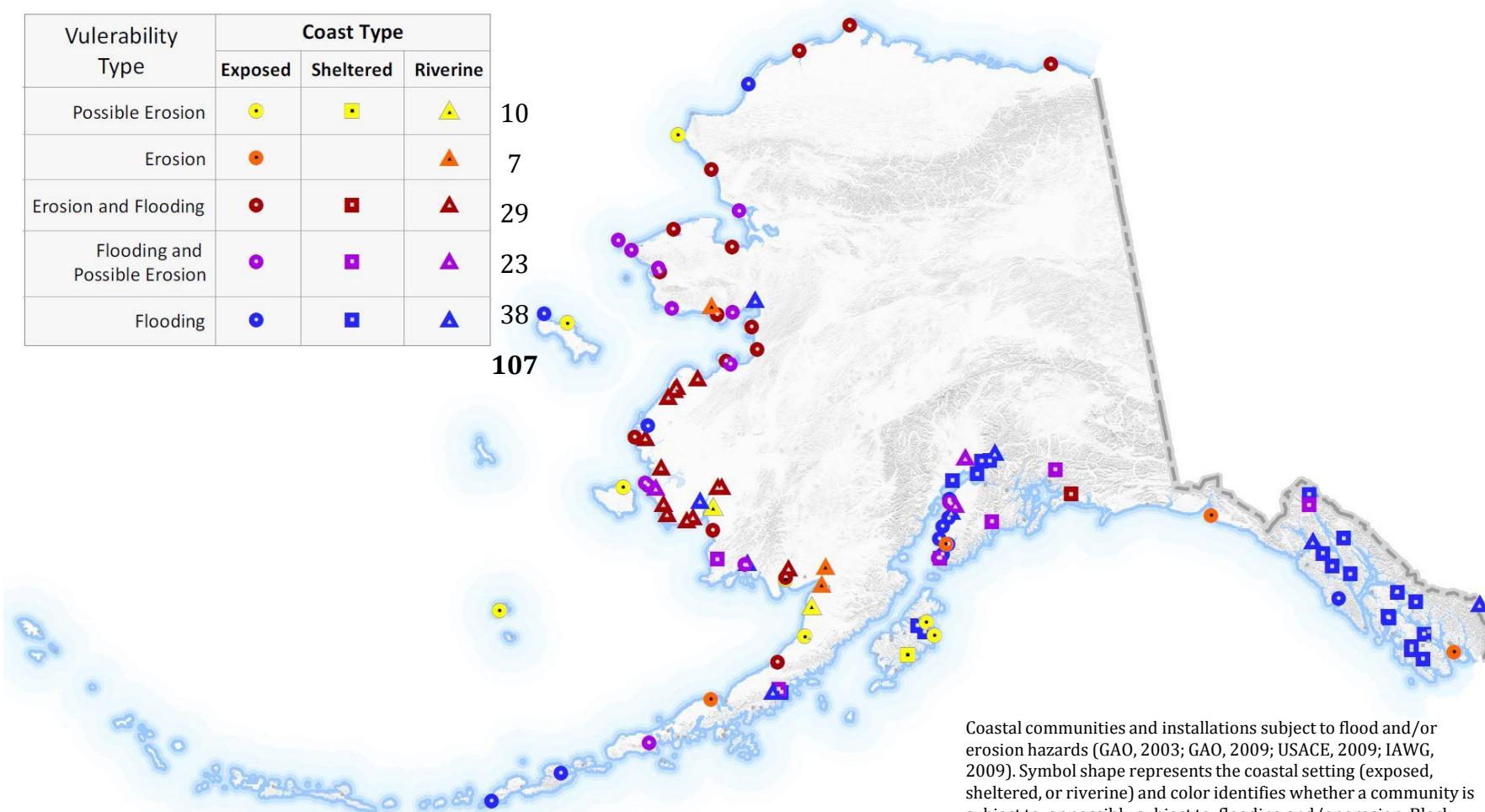
↑ Magnitude of Relative Sea Level Change



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

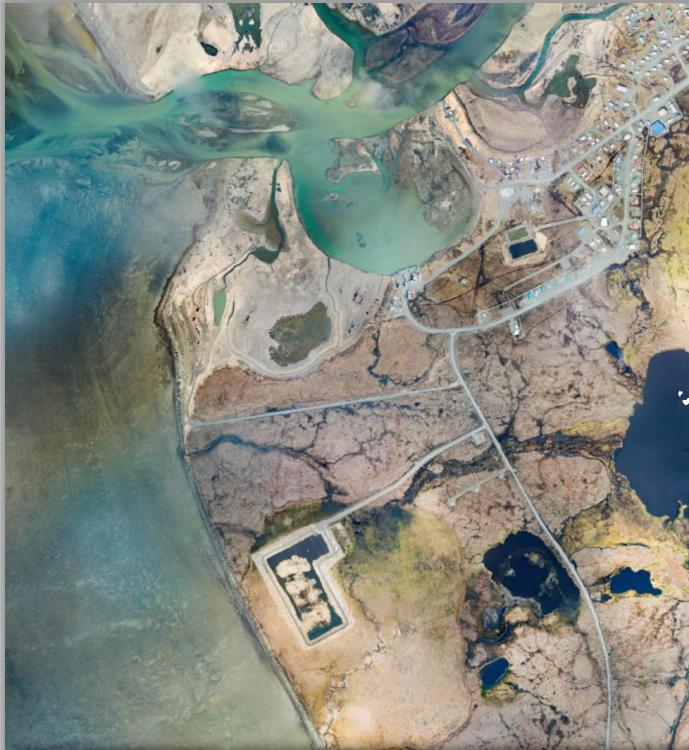
Vulnerability Type	Coast Type		
	Exposed	Sheltered	Riverine
Possible Erosion	●	■	▲
Erosion	●		▲
Erosion and Flooding	●	■	▲
Flooding and Possible Erosion	●	■	▲
Flooding	●	■	▲



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



Quinhagak, Alaska



Dillingham, 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



Photo credit: Lewis Amik III Native Village of Kwigillingok

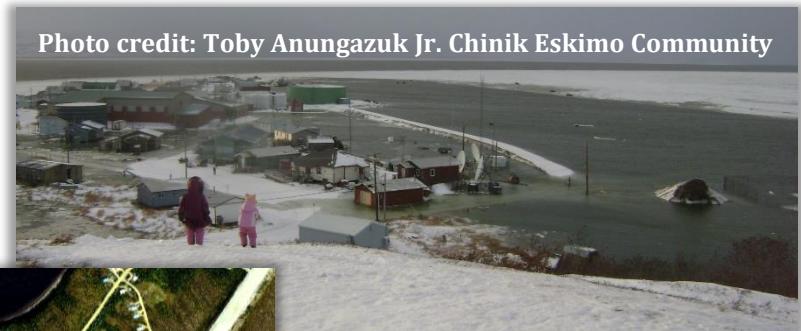


Kwigillingok, Alaska



Photo credit: Toby Anungazuk Jr. Chinik Eskimo Community

Golovin, Alaska



# IMPACTS OF COASTAL FLOODING & EROSION

## Public/Private Infrastructure



Photo credit: Coastal Observers of Barrow

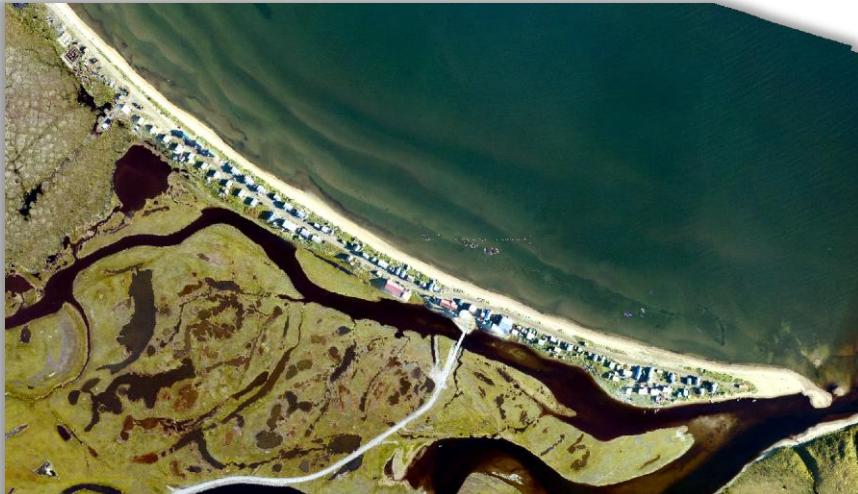
Utqiagvik, Alaska



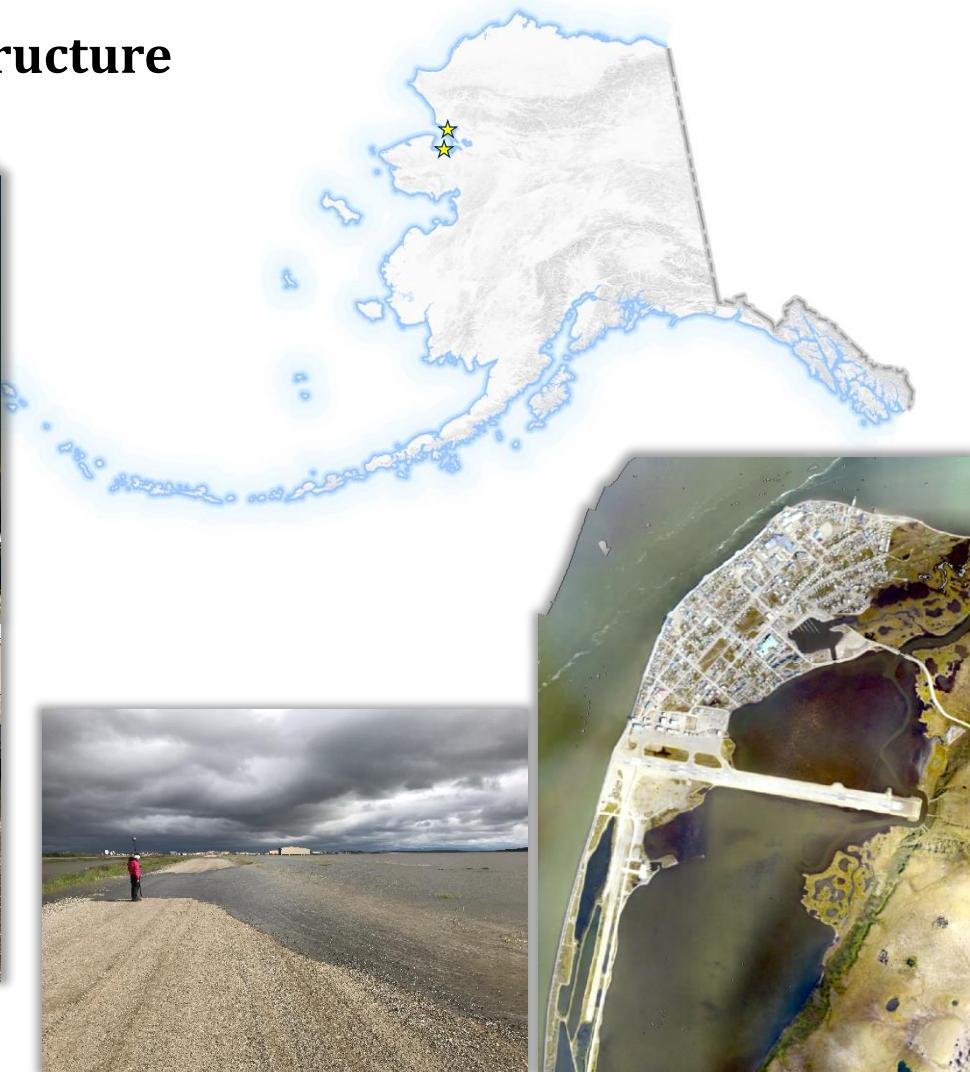
Newtok, Alaska

# IMPACTS OF COASTAL FLOODING & EROSION

## Examples at Public/Private Infrastructure



Deering, Alaska



Kotzebue, Alaska

# IMPACTS OF COASTAL FLOODING & EROSION

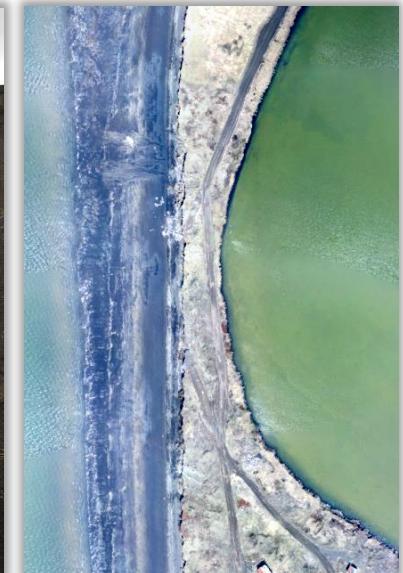
## Examples at Access Corridors



**Shishmaref, Alaska**



**Port Heiden, Alaska**



# WHAT IS THE NEED



**The House**



**The Foundation**

**Effective Engineering**

**Community Planning**

**Disaster Preparation & Mitigation**

**Baseline Coastal Data & Mapping**

# BASELINE COASTAL DATA & MAPPING

**Orthoimagery** (Aerial Imagery)

**Topography** (Elevation Data)

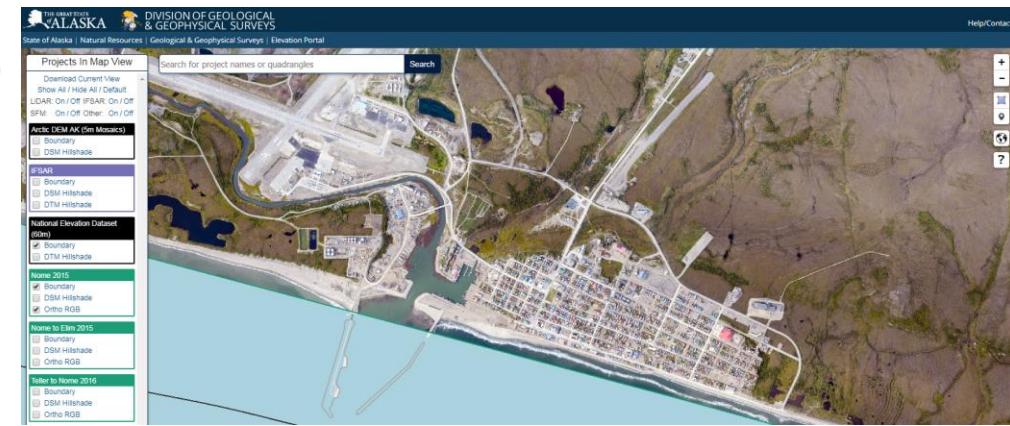
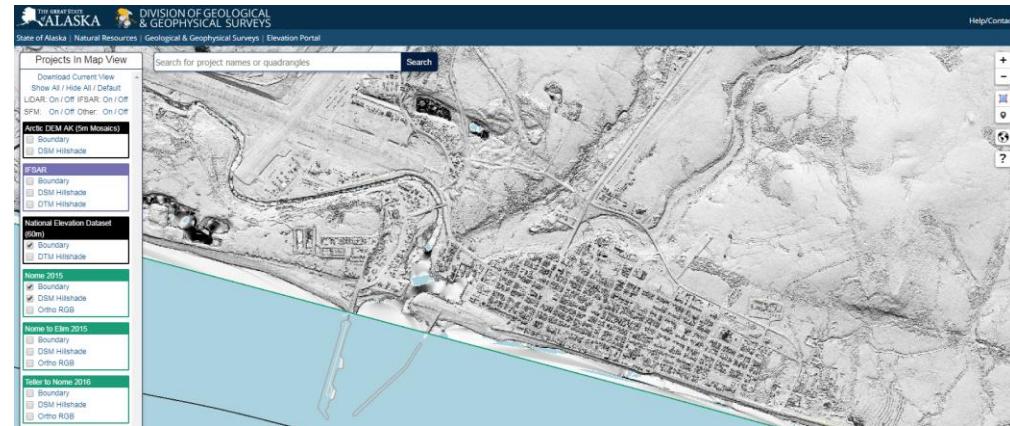
**Bathymetry** (Elevations Data Below the Water Surface)

**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



### Ground Surveys

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



### Equipment Installations



### Community-Based Monitoring



### Collaborative Efforts

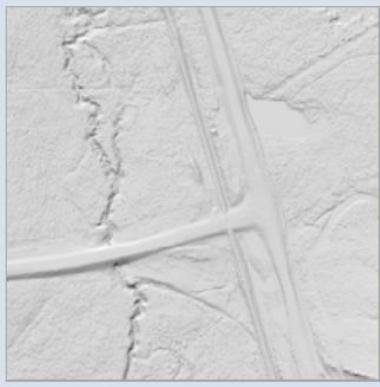
# BASELINE COASTAL DATA & MAPPING

## 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/>

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### PORT HEIDEN EROSION MONITORING

Time-lapse cameras were installed in 2016 to monitor the shorelines fronting Meshik, the old village site for Port Heiden. Funding to install equipment was provided by Alaska Sea Grant and Alaska Ocean Observing System. The install was a collaboration between DGGS, University of Alaska Fairbanks, Bristol Bay Native Association, and Alaska Sea Grant.

Monitoring Sites

- Aleknagik
- Chignik Lagoon
- Chignik River
- Dillingham
- Ekuk
- Golovin
- Kotlik
- Kwigillingok
- Levelock
- Naknek
- Port Heiden
- Shishmaref
- Togiak
- Unalakleet
- Wales

Port Heiden Stake for Stakeholders Profile Map

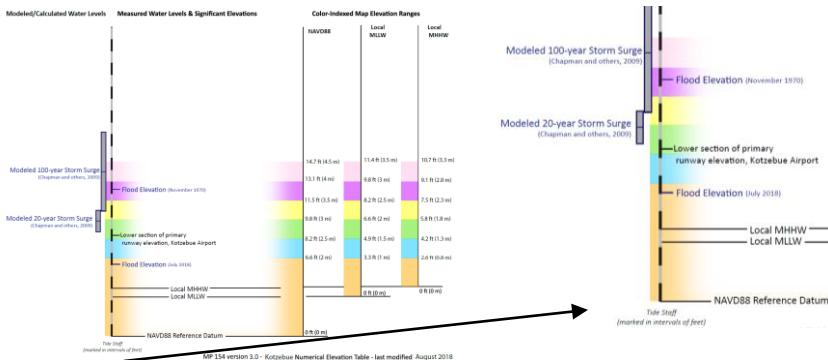
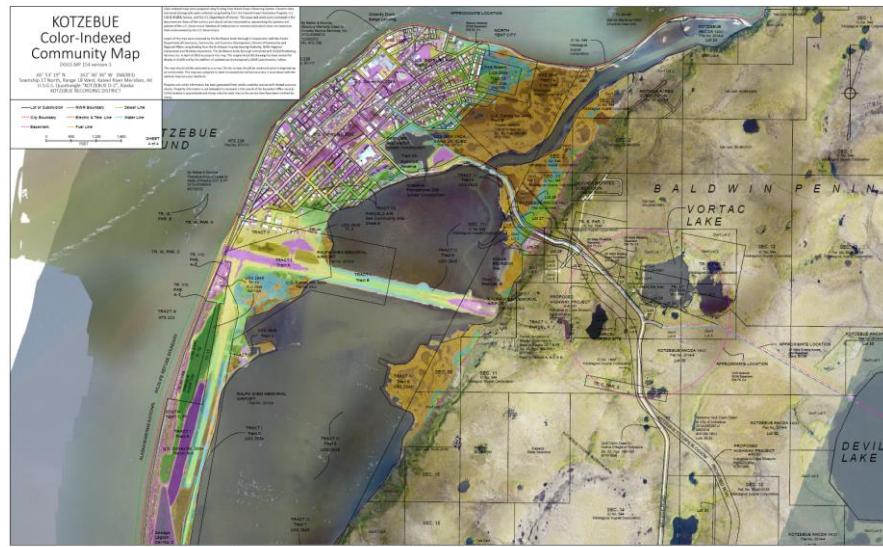
Powered by Richard Bedford  
The map is the result of research sponsored by the Alaska Sea Grant College Program, the National Oceanic and Atmospheric Administration, and the Bristol Bay Native Association. The project is a collaboration between the National Oceanic and Atmospheric Administration, the Bristol Bay Native Association, and the Alaska Sea Grant College Program.

Click for enlarged PDF version of the profile map

PTH P1 23-May-2017 to 14-Apr-2018

# DISASTER PREPARATION & MITIGATION

## Pre-storm Forecast Communicated to Local Individuals



## Post storm assessments and proof of disastrous events



Reported Flood Events at Kwigillingok, Alaska 2017  
Created by: Roberta Glenn,  
Alaska Division of Geological  
& Geophysical Surveys  
Created: August 7, 2018

This map shows a projection of the elevation of two flood events at Kwigillingok, Alaska which occurred in October 2017 and January 2018. The flood elevations were measured on a stationary flood staff. The stationary flood elevations are shown as the blue regions on a digital surface model (available at: <https://elevation.alaska.gov/>; raw data file with data description available at: <http://ddgs.alaska.gov/pubs/id/29548>). Flooding does not occur regularly across the landscape, so the map may not reflect actual flooding at all locations. The data presented here, however, are the best representation of possible flooding during these events.



# COMMUNITY PLANNING

## State Hazard Mitigation Plan Update

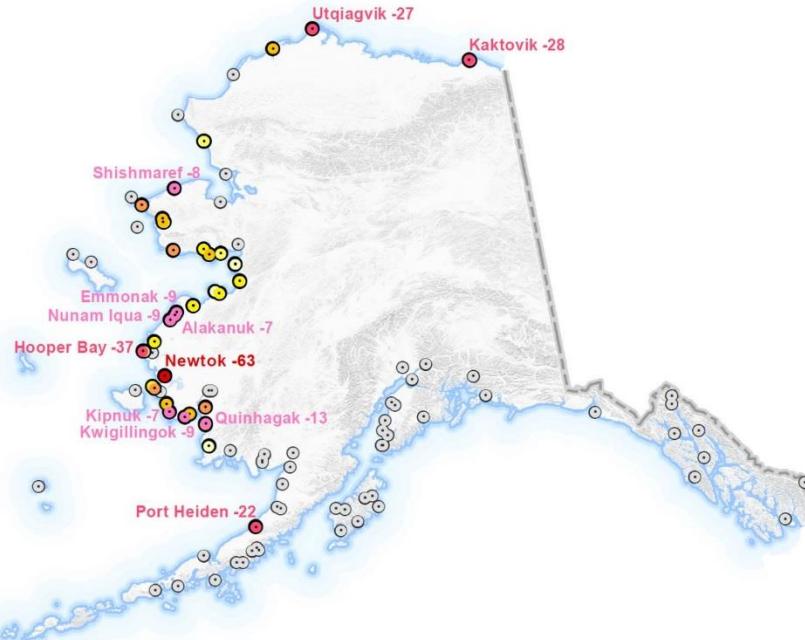
### Coastal Communities Experiencing Erosion

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.



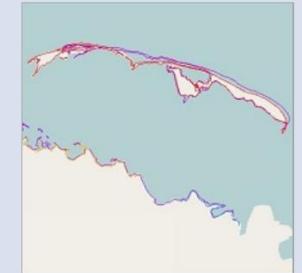
## Shoreline Projections

### [Alaska Shoreline Change](#)

#### [Tool](#)

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

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



 [State of Alaska](#)

### Alaska Shoreline Change Tool

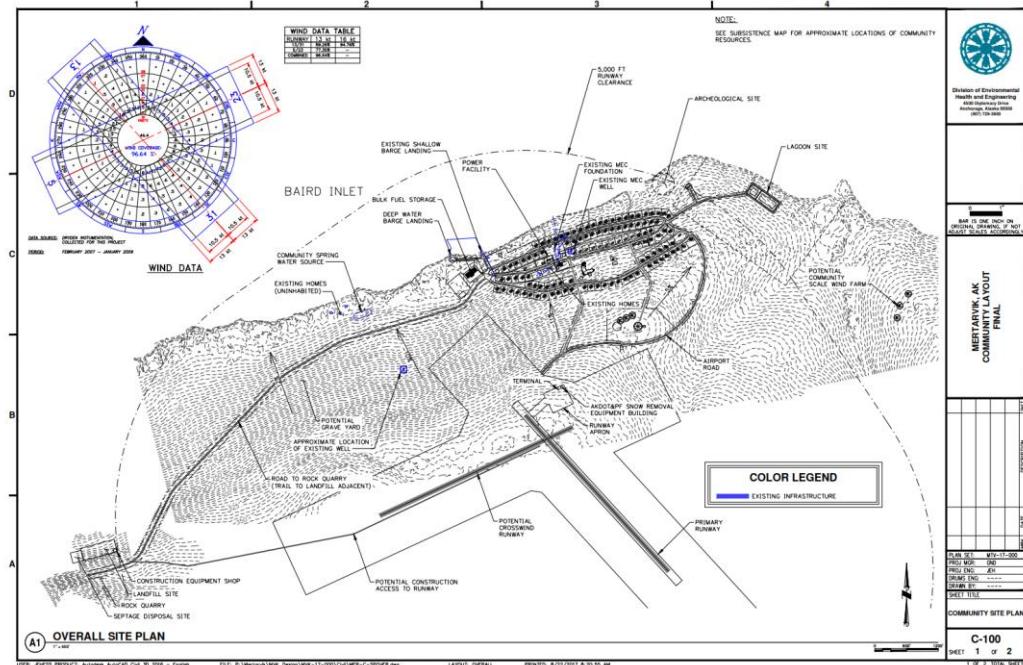
Alaska Division of Geological & Geophysical Surveys

[State of Alaska](#) > [Natural Resources](#) > [Geological & Geophysical Surveys](#) > [Maps](#) > [Alaska](#)



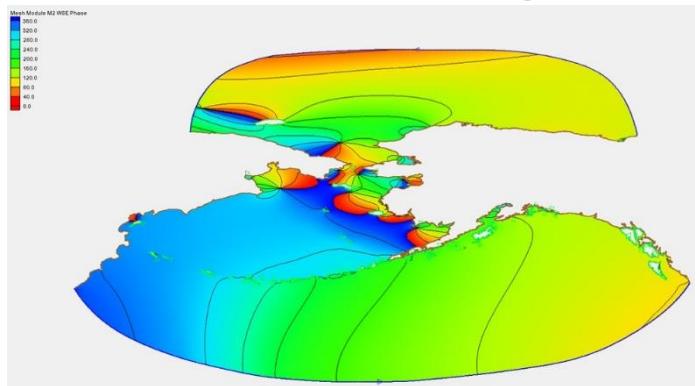
# EFFECTIVE ENGINEERING

## Site Design for Relocation of Facilities

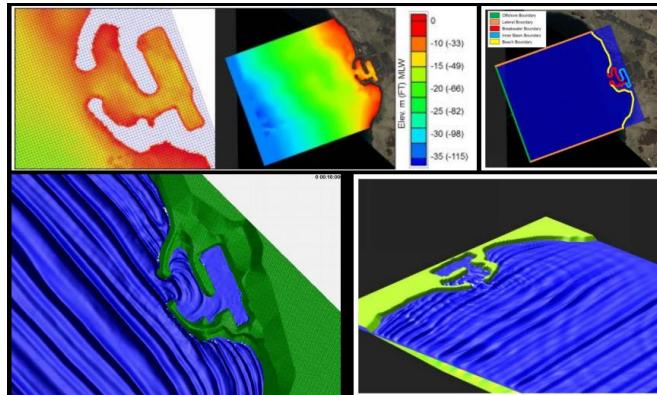


Community layout plan for Mertarvik (Newtok Planning Group)

## Coastal Modelling



Tide and surge model in progress at University of Notre Dame



Example from HDR

<https://www.aoos.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



#### Re-installation of the Tununak iGage

Alaska Division of Geological & Geophysical Surveys and Anchorage National Weather Service (NWS) staff travelled to Tununak to re-install a water level sensor that was damaged in winter of 2015.

1 | 2 | 3 | 4

[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.

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



# CONTACT INFORMATION



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

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Division of Geological & Geophysical Surveys**

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