Coastal Hazard Mapping and Monitoring For Decision Making

Presenters Jacquelyn Overbeck, CFM Richard Buzard

Alaska Planning Conference February 10, 2020

1 CEC for CFM certification

Mapping, Monitoring, and Modeling Coastal Flooding and Erosion for Alaska Communities

Agenda

Part I: Flood & Erosion Mapping

Coastal Flooding & Erosion in Alaska

Community Needs for Flood & Erosion Mapping

Examples of Mapping Projects

Funding Opportunities

- FEMA Cooperative Technical Partners (Pre-announcement for executive summaries)
- BIA Tribal Resilience Grants (Due March 2, 2020)

Part II: Community-Based Monitoring for Flooding & Erosion

Flood Monitoring Tools

- Low-cost autonomous sensors
- Flood staffs
- Photographs

Erosion Monitoring

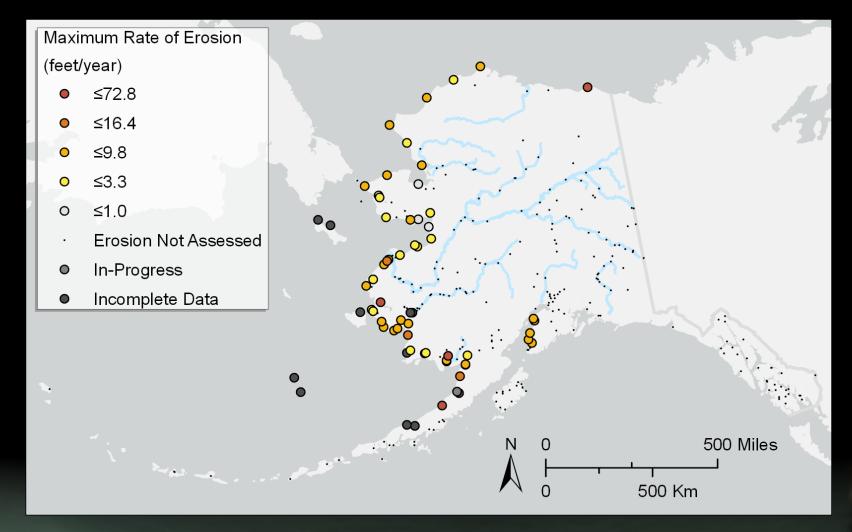
- Time-lapse cameras
- Measuring tapes
- Drones/GPS Surveys

Monitoring products online

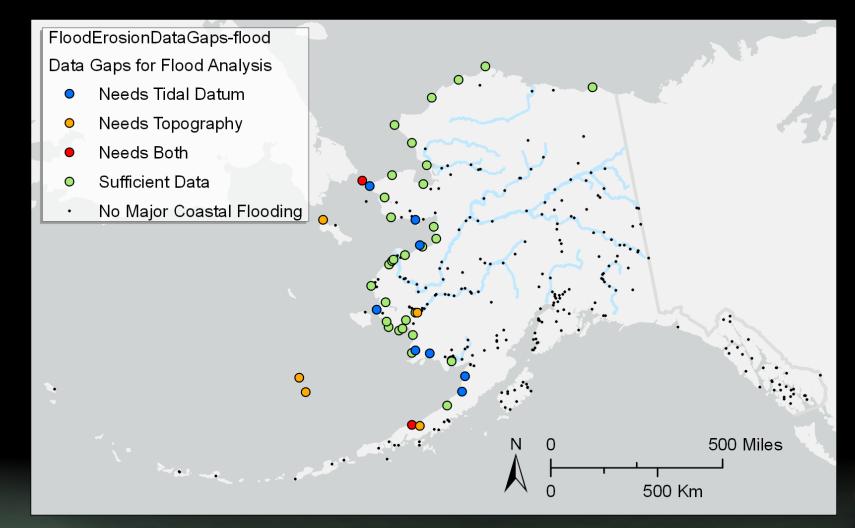
Part I Flood & Erosion Mapping

Mapping, Monitoring, and Modeling Coastal Flooding and Erosion for Alaska Communities

Coastal Flooding & Erosion in Alaska



Coastal Flooding & Erosion in Alaska



Coastal Flooding & Erosion in Alaska

Full Descriptions of Hazards as they relate to Alaska are in the 2018 State Hazard Mitigation Plan:

https://ready.alaska.gov/Plans/Mitigation/SHMP

Erosion Hazard Characteristics

Erosion is the wearing away and transportation of land. Erosion is a natural process at the interface of land and water, however, erosion can also be caused by human activities. Erosion can be both gradual and/or abrupt, for example: as the result of flash flood, coastal storms, or permafrost thaw. Erosion becomes hazardous when it affects immovable infrastructure, cultural, and natural resources.

- Coastal Erosion
- Riverine Erosion
- Wind Erosion

Flood Hazard Characteristics

A flood is the overflow of an expanse of water submerging normally dry land. Flooding occurs when water exceeds natural or artificial barriers such as beaches, stream banks, and levees that protecting adjacent floodplains. Flooding is typically a natural event and considered a hazard only when people and property are at risk. Flooding is Alaska's most common disaster, costing the state in excess of one million dollars annually, major disruptions to society, and occasionally loss of life.

- Coastal Flooding & Sea Level Rise
- Riverine Flooding
- Glacial Outburst
- Groundwater
- Fluctuating Lake Levels

Alaska Department of Military and Veteran Affairs Division of Homeland Security & Emergency Management PLANNING SECTION				Search		Search
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You are here: Division of Homeland Security & Emergency Management / Planning Section / State Hazard Mitigation Plan (SHMP)

The SEOC is currently at level: 1

State Hazard Mitigation Plan (SHMP)

The State Hazard Mitigation Plan is designed to reduce Alaska's vulnerability to disasters. Mitigation before disaster strikes is essential, as hazards in Alaska can not be eliminated. There will always be the potential for an earthquake or flooding. However, the amount of damage and destruction caused by these hazard events can be limited through mitigation. A long-term commitment to hazard mitigation, through the development and adoption of this plan, will make Alaska a safer place for Alaskan's to live and work.

The Alaska State Hazard Mitigation Plan was originally approved by FEMA in March of 2002 meeting the criteria of the Disaster Mitigation Act of 2000 and 44 CFR parts 210 and 206. The Plan is formally updated every five years by DHS&EM through consultation with the State Hazard Mitigation Advisory Committee. The current 2018 Plan is linked below. For more information, please contact Brent Nichols, the State Hazard Mitigation Officer.

State Hazard Mitigation Plan

FORM NAME	FILE TYPE	PUBLISHED
Ch01-Introduction	PDF	November 2018
Ch02-AlaskasBackgroundInformation	PDF	November 2018
Ch03-PlanningProcess	PDF	November 2018
Ch04-StateHazardMitigationPlanAdoption	PDF	November 2018
Ch05-HazardAnalysisProcess	PDF	November 2018
Ch06-NaturalHazards	PDF	November 2018

Alaska Division of Geological & Geophysical Surveys | Coastal

Coastal Hazards Program

Coastal Flooding & Erosion in Alaska: Impacts to Infrastructure

Winter storms flood houses in Nunapitchuk and Kotlik

By Krysti Shallenberger, Alaska's Energy Desk - Bethel - March 4, 2019

Storms battered the southern Bering Sea and the Yukon-Kuskokwim Delta last month. February storms aren't unusual, but the amount of rain and flooding is. The combination caused a lot of damage for two communities in the region.

▶ 0:00 / 4:01 →

"It's like getting April weather out there. Not enough thickness, not enough snow, and already lots of water," said Morris J. Alexie, the tribal administrator for Nunapitchuk. The rain flooded an older house that had already begun sinking into the ground.

ALASKA PUBLIC MEDIA 🞯 PBS 👖 p r



The house pictured had already begun sinking into the ground a while ago, making it more susceptible to flooding. According to a climate scientist, flooding in this area isn't normal in February. (Courtesy of the village of Nunapitchuk)

ENVIRONMENT

For Alaskan Coastal Village, Erosion Hits Home

December 20, 2017 · 5:00 AM ET

RACHEL WALDHOLZ





During a storm, the Alaskan village of Newtok can lose 10 to 20 feet of tundra. Erosion is getting worse because of warming temperatures and record low sea ice. Rachel Waldholz/Alaska's Energy Desk

Coastal Flooding & Erosion in Alaska: Impacts to Infrastructure

City of Homer works with state and Army Corps to battle erosion on the spit

By Aaron Bolton, KBBI - Homer - June 11, 2019



Handmade barriers used to protect against erosion wash up on the Homer Spit (Photo by Aaron Bolton, KBBI - Homer)

The Homer Spit's future as an iconic tourist attraction is in danger of washing away. Erosion along the spit's sea walls is not a new problem. City officials are working with state and federal agencies to find a lasting solution.

Norton Sound communities are facing an extended coastal flood season and it began this weekend

By Davis Hovey, KNOM - Nome - October 9, 2019



The beginning of the Shaktoolik coastal berm. (Photo Anna Rose MacArthur, KYUK



Coastal Flooding & Erosion in Alaska: Responses

Four Phases of Emergency Management:

Mitigation Planning/Preparation Response Recovery

Mitigation Recovery Damage Assessment Hazard Mitigation Plan Continuity of essential services Hazard vulnerability analysis Lessons learned Debris Management **Donations & Volunteers** Local Emergency Planning Assistance Programs Committee (LEPC) Building & Fire Codes Cost Recovery Economic Recovery Floodplain regulations Long Term Recovery Hazard mitigation programs Committee (LTRC) Preparedness Response Communications Countywide EOP Support life safety activities Build relationships with Address basic human needs community partners Restore critical infrastructure Provide training Coordinate with community partners Exercise the EOP Coordinate Disaster Declarations Provide public education Administer Grant Programs Activate the EOC Document disaster related activities

Coastal Flooding & Erosion in Alaska: Responses

Four Phases of Emergency Management:

Mitigation Planning/Preparation Response Recovery

Recovery

 Damage Assessments including mapped flood and erosion extents and magnitudes.

Response

Recovery

Response

- Real-time awareness for emergency responders using interactive flood maps and real-time water level sensors.
- Proactive communications with communities that may have been impacted.

Mitigation

Mitigation

- Historical events accurately and consistently documented in local hazard mitigation plans.
- Local conditions taken into consideration when developing coastal setback policies and floodplain regulations.
- Baseline data and risk assessments are direct inputs for engineering design.

Preparedness

- □ Use maps of past events to prepare for the future.
- Initiate community-based monitoring for local awareness and building relationships.

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Preparedness

Coastal Flooding & Erosion in Alaska: Responses

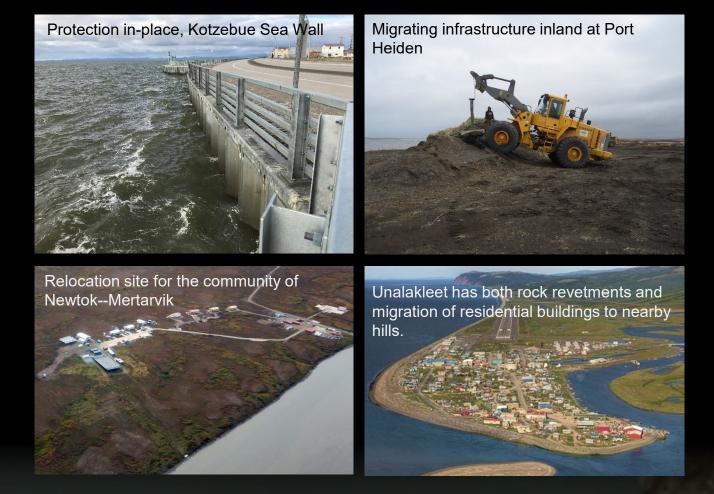
Mitigation Responses for Flooding & Erosion

> Protect In-Place

> > Migrate

Relocate

A Combination of All Three



Coastal Flooding & Erosion in Alaska: Challenges

- No Lead Agency Taking on these Hazards Holistically
- Stafford Act includes flooding alone
- No Coastal Zone Management Program in Alaska
- Many communities do not participate in the national flood insurance program

Community Needs for Flood and Erosion Mapping

Coastal mapping data along with technical guidance are used for a variety of purposes that improve community resilience to flood and erosion hazards and make a better case for projects funded by State and Federal agencies.

Pre-Storm Decision Support

Education Tools (Social Media)

Data for Engineering Projects

Local Hazard Mitigation Plans/Community Planning

Post-Storm Impact Assessments

- Disaster Preparation
- Community Awareness
- Structural and Non-Structural Mitigation
- FEMA /Agency Support, Smart Expansion, Policy Development (i.e. coastal setbacks), & Management
- State/FEMA Disaster Declarations

Examples of Mapping Projects and Data Collection that Supports Communities



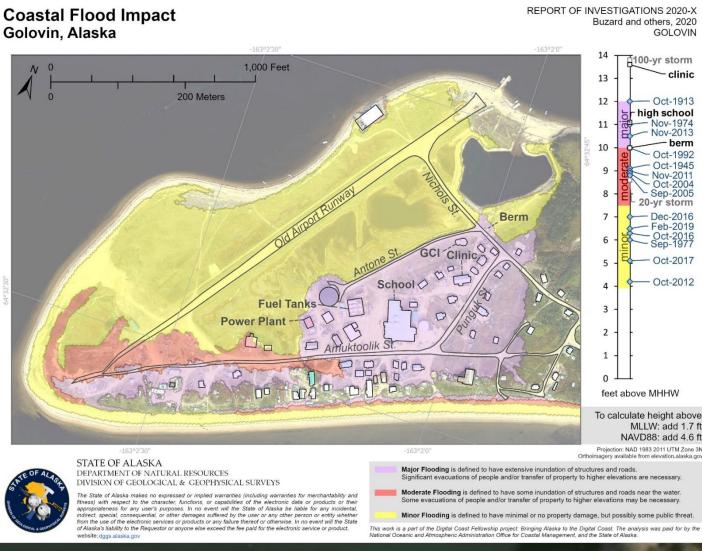
Examples of Mapping Projects: Forecasting

Baseline data and map tools can be very expensive and difficult to fund from a local level. DGGS advocates to state and federal agencies in regard to collecting data that improves our ability to provide flood and erosion map information. Even if your community doesn't engage with us, it may be on the map for data collection.

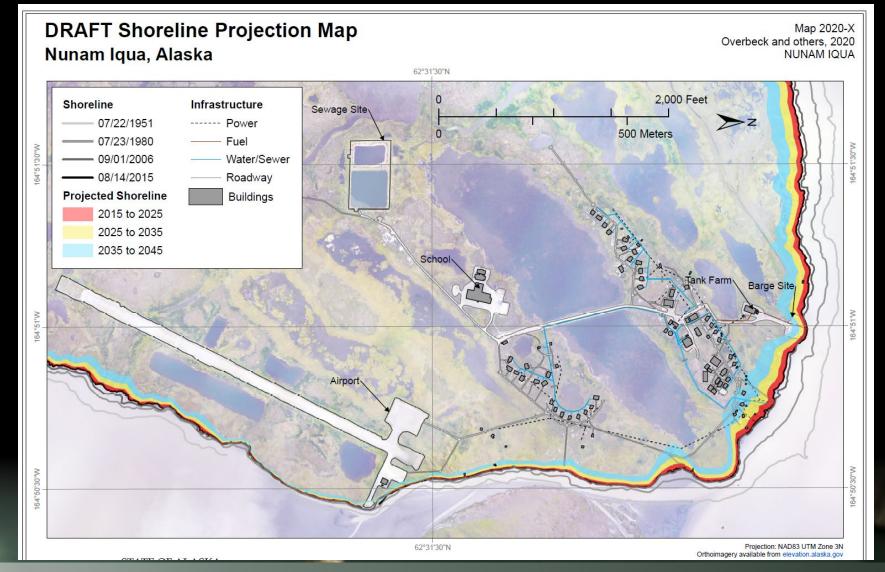


Coastal Flood Mapping, 2020

- Includes Golovin and Hooper Bay.
- By completing maps for these two communities, we will have the methods to create them for others.



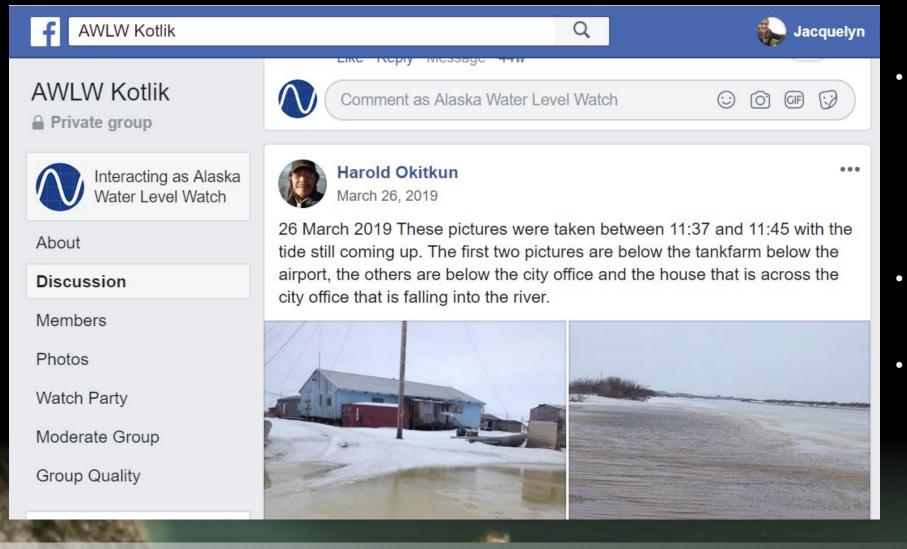
Examples of Mapping Projects: Forecasting



Examples of Mapping Projects: Social Media / Education Tools



Examples of Mapping Projects: Social Media / Education Tools



- Worked with the Native Village of Bill Moore's Slough and Kotlik in 2017 to set up community monitoring and Facebook page.
- 36 members of the Facebook page
- Regular posts about flood events

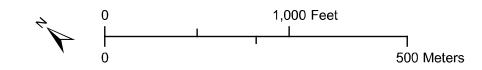
Examples of Mapping Projects: Engineering Projects

Engineering firms often have to start at square one when designing mitigation solutions for communities. DGGS works to improve baseline datasets to reduce the barrier to entry for these design projects.

The Native Village of Shaktoolik requested DGGS make measurements to the communities' storm berm after a storm in August. DGGS was able to travel on-site, measure the change using a drone and GPS, and provide an estimate of the total volume of erosion for engineering plans.



Erosion of berm fronting Shaktoolik (red) Area of erosion: 110,000 sq. ft Amount of erosion: 350,000 cubic ft



Examples of Mapping Projects: Engineering Projects



Mertarvik relocation construction planning relied on baseline imagery and elevation data collected by DGGS.

https://www.congress.gov/116/meeting/house/108887/witnesses/HHR G-116-II24-Wstate-JordanJ-20190212-SD001.pdf

Examples of Mapping Projects: Updating Local Hazard Mitigation Plans

Department of Natural Resources GEOLOGICAL & GEOPHYSICAL SURVEYS

Search DGGS...

Monitoring Sites

Chignik Lagoon

Chignik River

Dillingham

Ekuk

Golovin

Kotlik

Kwigillingok

Heider

Quinhagak

Shishmaref

Unalakleet

Togiak

Wales

Levelock

Naknel

Aleknagik

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Kotlik Shoreline & Water Level Monitoring

A time-lapse camera and tide staff were installed in 2017 at Kotlik to monitor both shoreline change and flooding. Installation was funded by Alaska Institute for Justice and Alaska Ocean Observing System, continued monitoring is being completed by the Native Village of Bill Moore's Slough.

Water levels have been reported on the Alaska Water Level Watch Facebook page. Shoreline monitoring has been conducted using a tape measure from stakes installed and surveyed by DGGS. These measurements have been taken at three locations along the river bank, including sites named: ANTHC Yard, Chris's Site, and AC Hardware.



Click for enlarged PDF version of the profile ma



Updates were just made to DGGS website for Kotlik, Kwigillingok, and Quinhagak. Others still to come in 2020.

Erosion Monitoring at Kotlik



Measuring and monitoring flooding and erosion has long been mentioned in local hazard mitigation plans as a first step, however, has not been pursued by any other state or federal agency. DGGS provides data to update these plans which can lead to defining mitigation projects that are fundable by FEMA and other federal agencies.

http://dggs.alaska.gov/hazards/coastal/monitoring.html

Examples of Mapping Projects: Updating Local Hazard Mitigation Plans

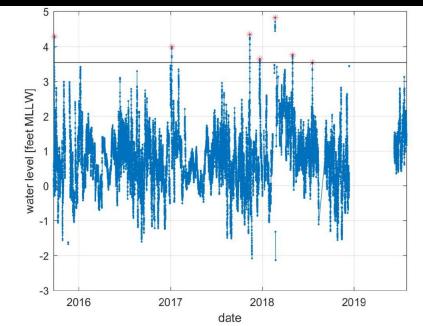


Table 1. Measured high water level events at Kotzebue.

Date	Water Level at Sensor (feet MLLW)	Water Level Other Location (feet MLLW)	Note
Nov-70	-	9.17	Glenn Gray and Associates (2013)
25-Sep-15	4.28	-	
05-Jan-17	3.99	-	
12-Nov-17	4.34	-	Photos in figure 2
21-Dec-17	3.64	-	
20-Feb-18	4.81	-	
01-May-18	3.76	-	
18-Jul-18	3.54	2.73	Photos in figure 3

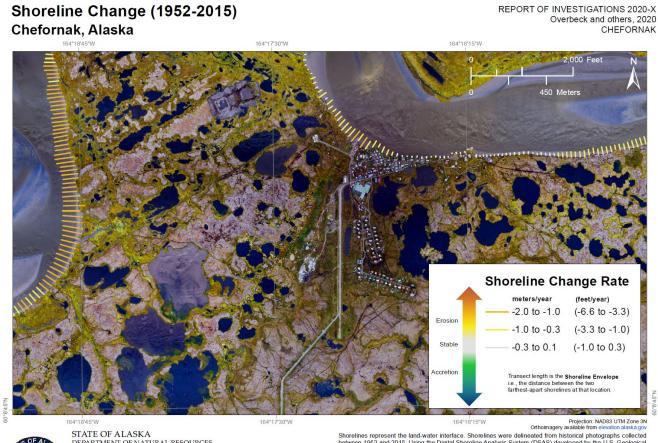


Figure 2. Photos of flooding at Kotzebue from the lagoon side of town, Airport Access Road, boat harbor, and Caribou Drive looking toward Lockhart Point, taken November 12, 2018. Credit: Chris Dankmeyer, Maniilaq Association, <u>leonetwork.org</u>.

Examples of Mapping Projects: Community Planning

Coastal Erosion Mapping, 2020

- Includes most western and northern Alaska communities;
- Available early 2020 in pdf 8.5 x 11 format.
- Funded by the Denali Commission and State of Alaska.





STATE OF ALASKA DEPARTMENT OF NATURAL RESOURCES DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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Shorelines represent the land-water interface. Shorelines were delineated from historical photographs collected between 1952 and 2015. Using the Digital Shoreline Analysis System (DSAS) developed by the U.S. Geological Survey, the measured distance between shorelines through time determines the linear rate of shoreline change at shore-perpendicular transects. The transects have been cut to the distance of the shoreline envelope. The shoreline envelope is colored by the shoreline change rate (metersystem and feetywan), where hot colors represent erosion and cool colors represent accretion. Linear rates of shoreline change are simplified and do not accurately reflect shoreline erosion and accretion at all locations.

This work is a part of the Coastal Infrastructure Erosion Vulnerability Assessment project funded by the Denali Commission Environmentally Threatened Communities Grant Program. Data used to conduct the analysis were paid for by the State of Alaska and the Federal Emergency Management Agency in the 2018 bytable to the Alaska State Hazard Mitgation Plan.

Examples of Mapping Projects: **Community Planning**

Historical Flood Records and Infrastructure

Elevation Feature	Elevation (ft MHHW)	Vertical Uncertainty (ft)	Subject to wave runup
Airstrip	31	5	
Evacuation center	80	5	
Wastewater facility	60	5	
*Clinic first floor	13.6	0.5	
Dexter Roadhouse beach side	13	1	$\boldsymbol{\triangleq}$
Highest recorded storm (still water)	12	2	
*Recommended building height	12	0.5	
*High school front door sill	11.1	0.5	
Drinking water	10.5	0.7	
Several buildings	10.5	0.7	
Fuel tanks	10.1	0.3	
Major (minimum temporary berm height)	10	1	
Lowest residences	8.8	1.2	
Roads in town	7.5	0.7	
Moderate	7.5	0.7	
Lowest building	7.0	0.3	
Beach property	3.9	0.7	
Minor	3.9	0.7	

Storm	Elevation (ft MHHW)	Vertical Uncertainty (<u>ft</u>)
05-Oct-1913	12	2
10-Nov-1974	11	3
09-Nov-2013	10.5	1.2
05-Oct-1992	10.0	0.9
28-Oct-1945	9.1	1.4
08-Nov-2011	9	2
19-Oct-2004	8.9	1.1
22-Sep-2005	8.8	0.3
30-Dec-2016	7.0	1.2
11-Feb-2019	6.5	1.2
29-Oct-2016	6.3	0.7
12-Sep-1977	6	2
13-Oct-2017	5.1	0.7
05-Oct-2012	4.2	1.3

Examples of Mapping Projects: **Disaster Declarations**

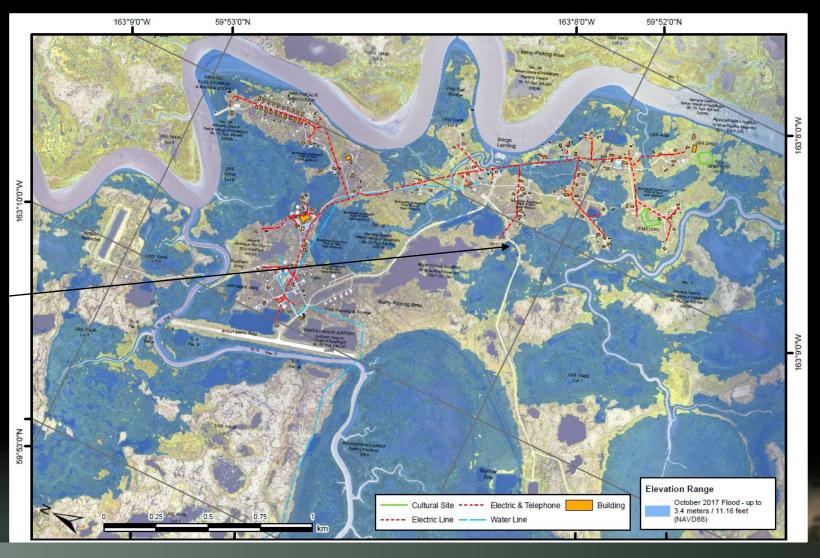
Many flood disasters have not been declared because there was no scientific proof the event occurred and incurred impacts. DGGS maintains coastal monitoring equipment and community monitoring networks that collect data regarding disastrous events, and can provide the data to you to include in a declaration.

Flood documentation at Kotlik through Alaska Water Level Watch Facebook page. Posted by Harold Okitkun

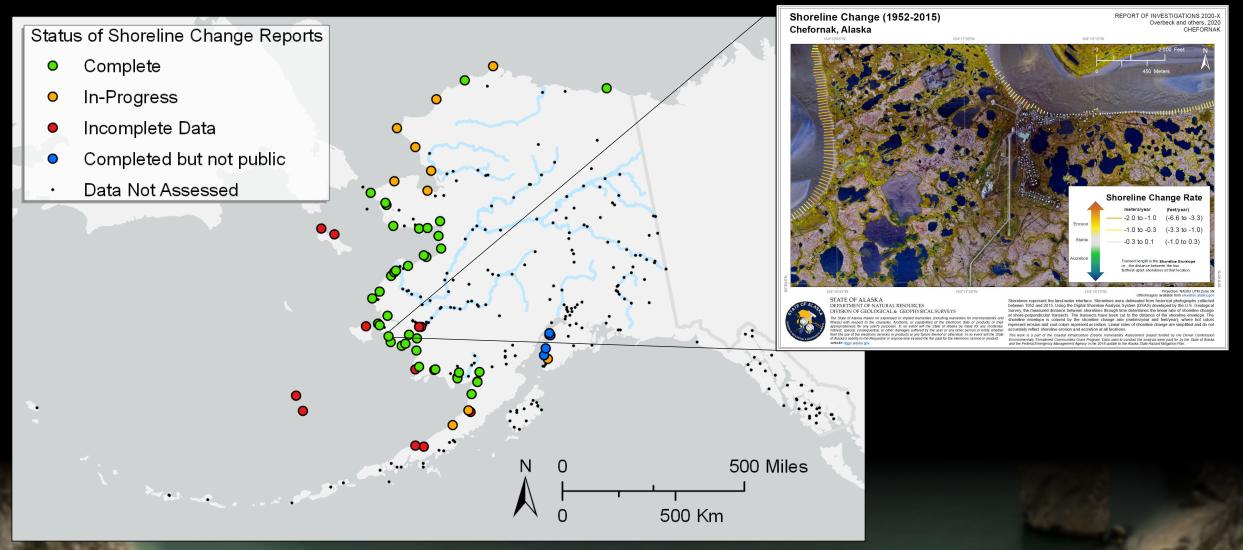


Examples of Mapping Projects: **Disaster Declarations**





Upcoming Mapping Projects: Shoreline Change Report



Baseline Mapping Data: Alaska Nearshore Mapping Strategy

PRESIDENTIAL MEMORANDA

Memorandum on Ocean Mapping

of the United States Exclusive

Economic Zone and the Shoreline

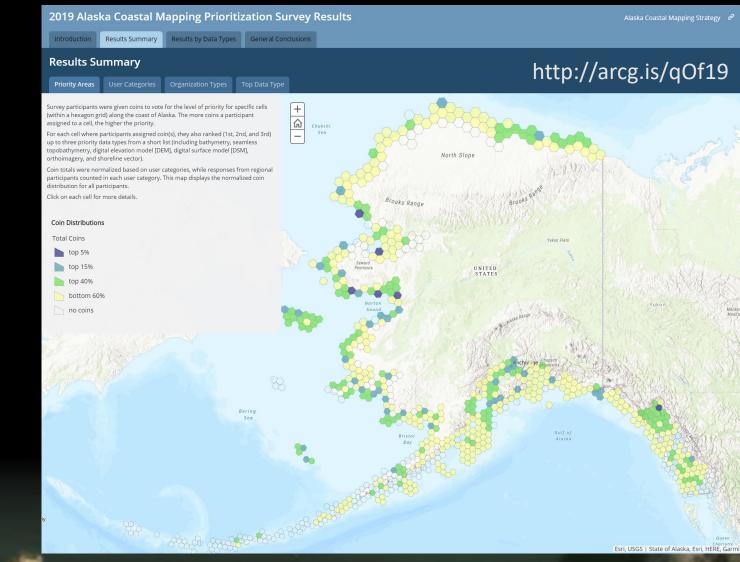
and Nearshore of Alaska

- ENERGY & ENVIRONMENT | Issued on: November 19, 2019

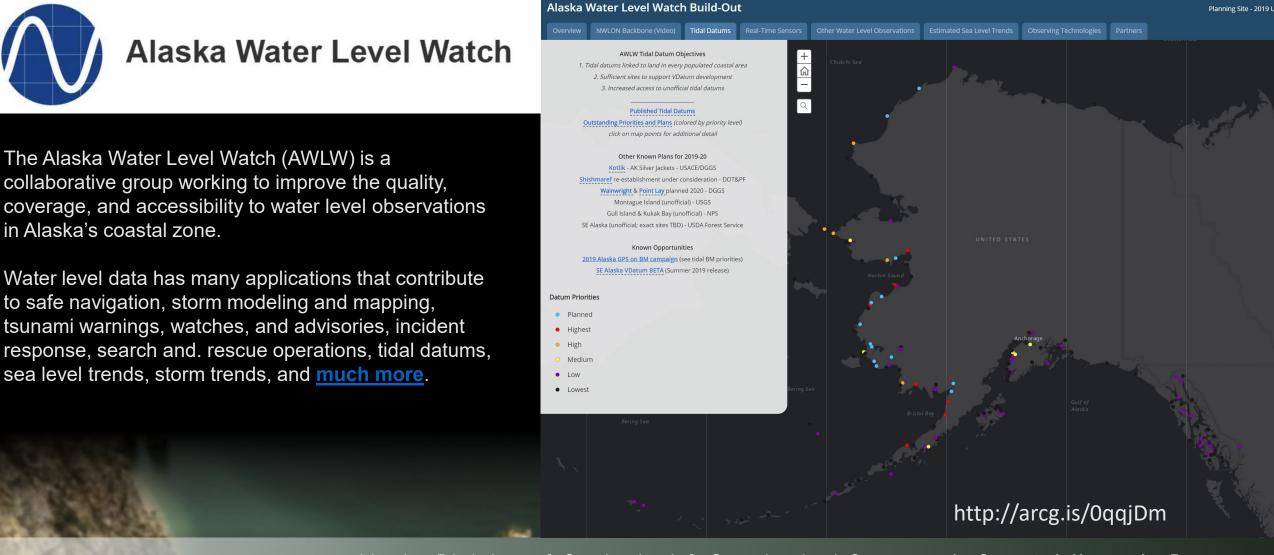
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The White House



Baseline Mapping Data: Alaska Tidal Datums



Funding Opportunities for Mapping: FEMA Cooperative Technical Partners

Available to RiskMAP communities. Previous announcements are listed at: https://www.fema.gov/media-library/assets/documents/21123

If you are interested to engage with DGGS on a collaborative grant application, FEMA is taking executive summaries now. DGGS is an existing Cooperative Technical Partner.

- 1-2 page summaries
- No data collection, (exception is lidar)
- Funding for travel to coordinate
- 18-24 month projects ideal
- Match funding is a plus
- Must have an expected benefit or mitigation action as a result of the project
- Must have community support identifying the need and ability to coordinate
- Due February 14, 2020

Report of Investigation 2018-1

CHANNEL MIGRATION STUDY OF EMMONAK, ALASKA

Jacquelyn R. Overbeck and Katrina S. Kennedy

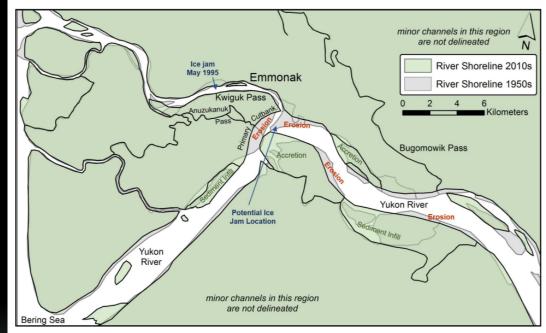


Figure 5. River shorelines interpreted from aerial (ca. 1950) and satellite (ca. 2010) imagery showing regional changes, including sediment infilling, accretion, and erosion, as well as potential locations of ice jams.

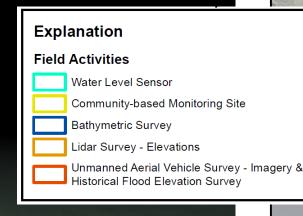
Funding Opportunities for Mapping: BIA Tribal Resilience

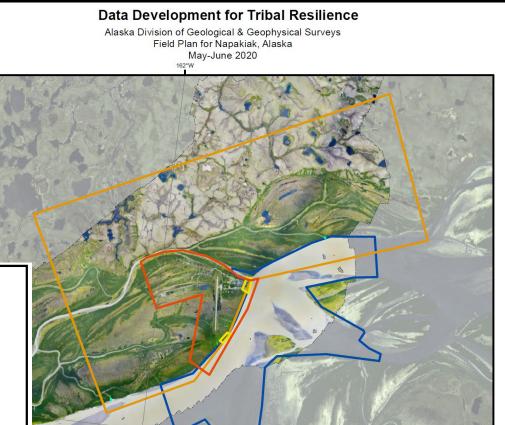
Funding is available to federally recognized tribes to conduct risk mapping and planning work:

https://www.bia.gov/bia/ots/tribal-resilience-program#FY2020

Categories:

- Adaptation Planning (\$150k)
- Ocean and Coastal Management Planning (\$150k)
- Capacity Building (\$65k)
- Relocation, Managed Retreat, or Protect-in-place Planning (\$150k)
- Travel Support for these Activities
- Match funding not needed
- Can fund data collection
- 12 month projects
- Due March 2, 2020





Part II Community-Based Monitoring

Mapping, Monitoring, and Modeling Coastal Flooding and Erosion for Alaska Communities

Community-Based Monitoring

Monitoring: taking periodic measurements to document change

Community-based: Measurements are collected by **local residents**



Better: Data is collected more often **Faster:** Data is collected as quickly as possible after an event **Community-centered:** Data is in the hands of the community first

Community-Base Monitoring: Measuring erosion rates (Port Heiden)

relocated

Old tank farm site

Goldfish Lake

Could Goldfish Lake be used as a safe harbor?







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Community-Based Monitoring

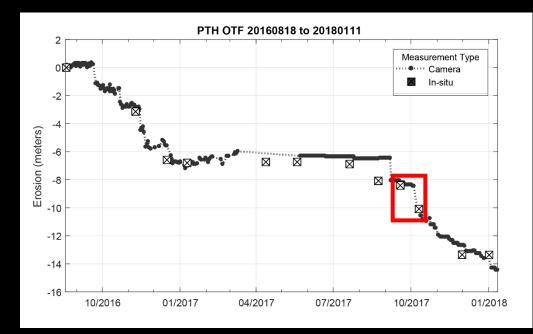


Stake-to-bluff measurements:

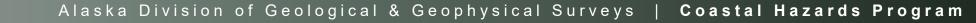
- -Greatest accuracy
- -Cover more ground

Camera measurements: -Great detail over short times -Require CBM

Understand inter-annual erosion



Measure storm damage



Mapping with Drones

- Feasible for CBM, but requires training
- Valuable products



Mapping with Drones

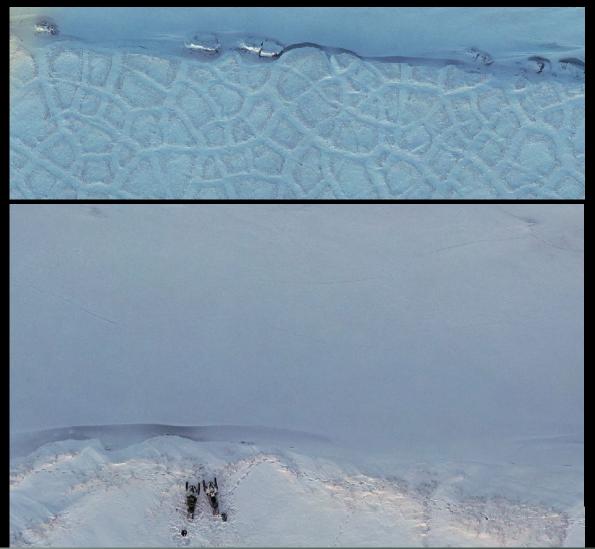
- Feasible for CBM, but requires training
- Valuable products
- Takes more effort: investment should meet the needs of the community



Erosion of berm fronting Shaktoolik (red) Area of erosion: 110,000 sq. ft Amount of erosion: 350,000 cubic ft

Measure storm <u>damage</u>

Mapping with Drones – Repeat flights



Jones, B.M. and Buzard, R.M., (In Prep.), Using repeat UAV surveys to measure block erosion at Drew Point, Alaska.

Community-Based Monitoring: Documenting hazards and changing conditions

Old airstrip at Quinhagak

Flood Monitoring: Autonomous Sensors



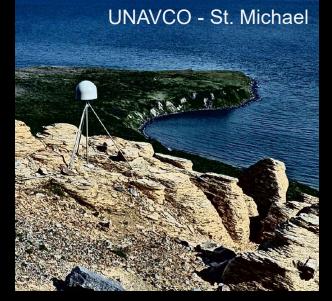
Downward Facing

iGage sensing less than 30 feet ~\$1500-\$1750/sensor ~\$490/year data transfer and warranty Minimal maintenance Stillwater Technologies, LLC

iRadar

sensing greater than 30 feet ~\$5000-6000/sensor ~\$490/year data transfer and warranty Minimal Maintenance

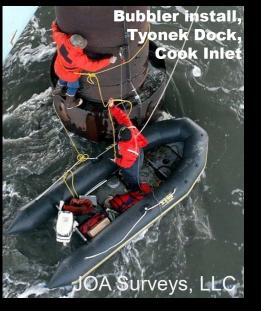
Stillwater Technologies, LLC



Oblique

GNSS Reflectometry

Not on the market, however, research sites have been installed at St. Michael and Seward. Maintenance costs unknown.



Insitu

Traditional NOAA NWLON - type

Depending on accuracy needs, can range from \$15-150k for installation and as much as \$10k/year for maintenance.

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Flood Monitoring: Autonomous Sensors

Autonomous sensors need infrastructure

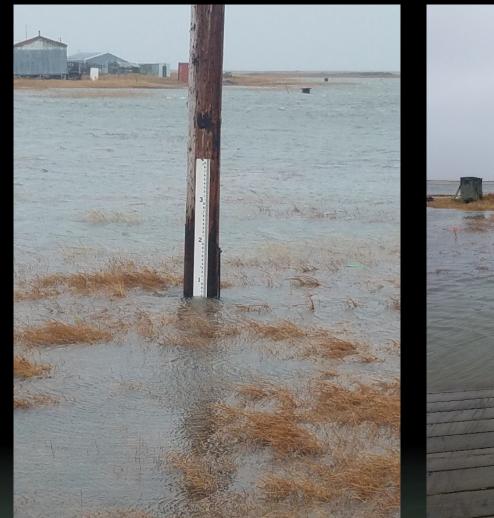
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Tununak

Flood Monitoring: Flood Staffs



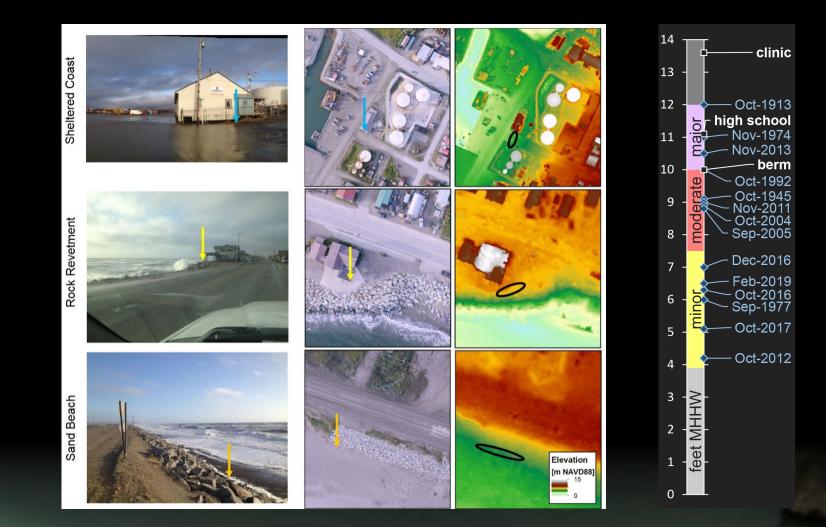
Photos of flood staff installation at Kwigillingok, Alaska. Flood photos provided by Lewis Amik III, Native Village of Kwigillingok via email.





Flood Monitoring: Facebook

http://dggs.alaska.gov/webpubs/dggs/ri/text/ri2017_006.pdf



Monitoring Data Online

Monitoring products online

http://dggs.alaska.gov/hazards/coastal/monitoring.html



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Coastal Monitoring

DGGS helps facilitate local efforts by collecting and providing access to reliable data through the development of community-based monitoring for erosion and flooding. We update and archive data in supported databases, translate information into useable products, and provide data to the public in multiple online formats.

In 2015, a collaborative project to facilitate community-based monitoring of erosion was established between DGGS, Bristol Bay Native Association, University of Alaska Fairbanks, and Alaska Sea Grant with funding from the Bureau of Indian Affairs and Alaska Sea Grant. The pilot project, focused on Bristol Bay, developed procedures for staff at the local tribe or city to monitor erosion, have the resulting data processed using scientific methods, and made accessible in a usable format. Additional communities have shown interest in participating in their own erosion monitoring and, through either funding the work themselves or working with the Alaska Institute for Justice, successfully worked with DGGS to install and maintain sites. The results of recent monitoring efforts are shown below

Erosion & Flood Monitoring Sites

Alaska Peninsula Chignik Bay

Chignik Lagoon **Chignik River**

Bering Strait





Coastal Hazards Program Manager Phone: 907-451-5026 Email: jacquelyn.overbeck@alaska.gov

Search



Online Tools Alaska Shoreline Change Tool Alaska Coastal Profile Tool Alaska Tidal Datum Calculator

Unalakleet Shoreline & Water Level Monitoring





Monito

Alekr

Chigr

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Dillin

Ekuk

Golov

Kotlik

Kwigi

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ice. Warming trends in the Arctic have resulted in reduced ice coverage and increased occurrence of wave events impacting coasts. This camera system was installed by the USGS in collaboration with DGGS, the Native Village of Unalakleet, and the City of Unalakleet to better understand wave and water-level dynamics in Norton Sound. View real-time photographs of waves.



Department of Natural Resources Division of Geological & Geophysical Surveys Coastal Hazards Program



Jacquelyn Overbeck, CFM Geologist IV, Program Manager Jacquelyn.overbeck@Alaska.gov 907-451-5026



http://dggs.alaska.gov/hazards/coastal/ http://dggs.alaska.gov/hazards/coastal/monitoring.html



https://aoos.org/alaska-water-level-watch/ https://www.facebook.com/AlaskaWaterLevelWatch/ http://arcg.is/0qqjDm - Build Out Plan https://portal.aoos.org/?portal_id=111 – Prototype Data Portal

Richard Buzard

Geologist II <u>Richard.buzard@Alaska.gov</u> 907-754-3595



http://agc.dnr.alaska.gov/coastal.html - Coastal Mapping Strategic Plan

1 CEC for CFM certification—see Jaci after the session for signature.