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Flood Mapping: Bering Sea Storm Impact Assessments Utilizing Indigenous Knowledge

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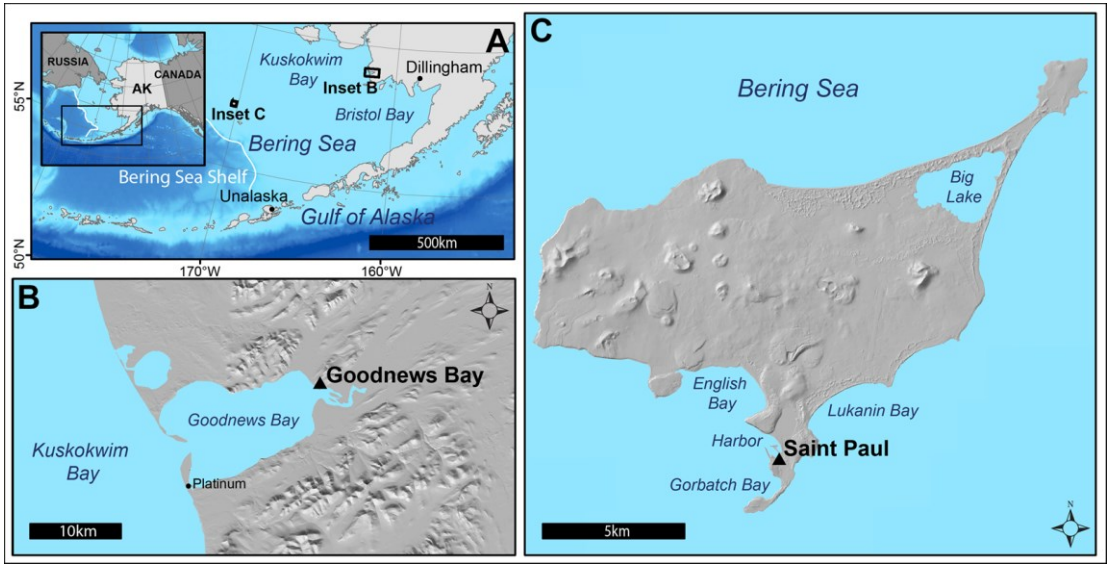
Study Sites



- Goodnews Bay: Yup'ik community in southern Kuskokwim Bay (B)
- St. Paul Island: Unangax̂ community in central Bering Sea (C)

Research Goals

Develop ~70 year storm history

Data sources include: meteorological data, flood heights, infrastructure databases, and local and Indigenous Knowledge

Generate historic flooding and infrastructure maps to support local decision-making & funding proposals

Maps detail: 1) historic flood extent, 2) infrastructure vulnerability, and 3) potential sea-level rise implications

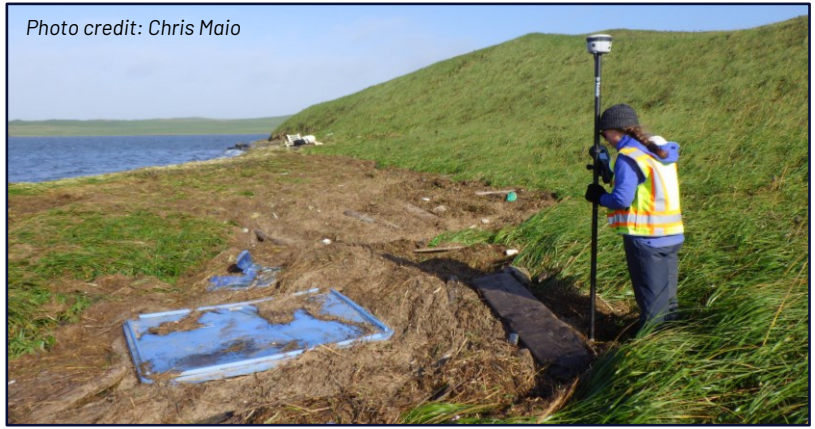
Write storm narratives to document Indigenous Knowledge on storms

Storm narratives incorporate observational and instrumentation data to constitute a unique contribution

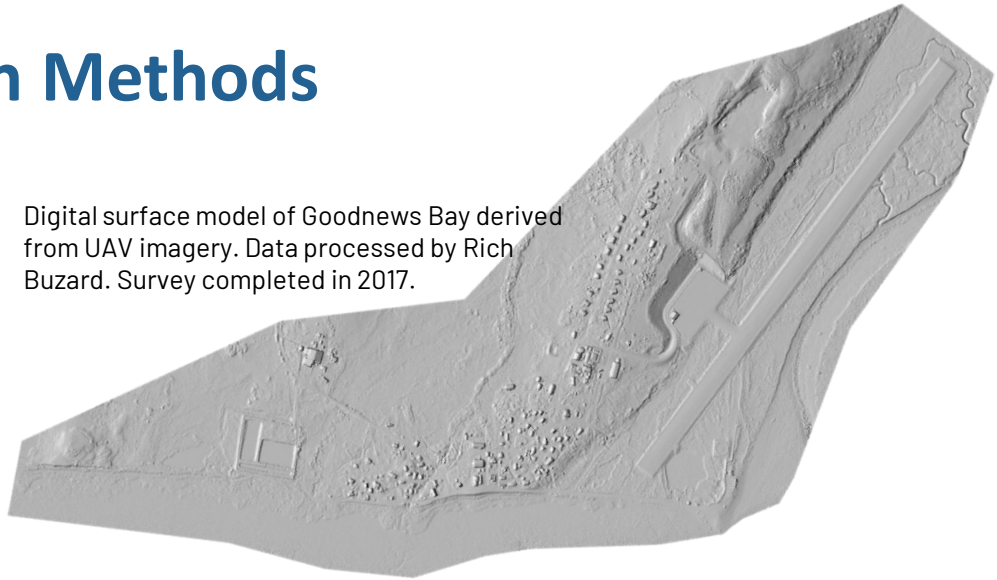
Geospatial Data Collection Methods

GPS Surveys:

- Trimble integrated RTK-GNSS system
- Base station occupations of 18-24hrs
- Accuracy: 0.3cm-3.3cm horizontal, 0.4cm-4.8cm vertical



High-water mark GPS survey after ex-typhoon Merbok on St. Paul Island.



Digital surface model of Goodnews Bay derived from UAV imagery. Data processed by Rich Buzard. Survey completed in 2017.

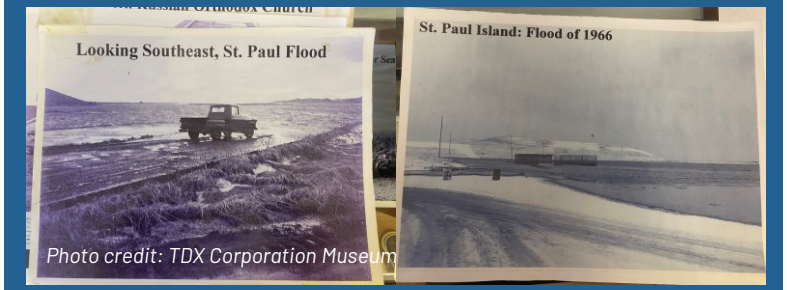
UAV Surveys:

- Phantom DJI drones (various models, including RTK)
- Structure-from-motion techniques used to generate ortho-imagery and surface models

Interview Methods

Storm Event Literature Review:

- Storm reporting database
- Meteorological data
- Scientific literature
- Photos and videos
- High water mark (HWM) field campaigns
- Remote sensing



Photos from 1966 flood event on St. Paul Island.

Interview participant solicitation in Goodnews Bay.

Interview Structure:

- Environmental change questions
- Pre-identified storm events
- Additional storm events
- All observations referenced back to maps

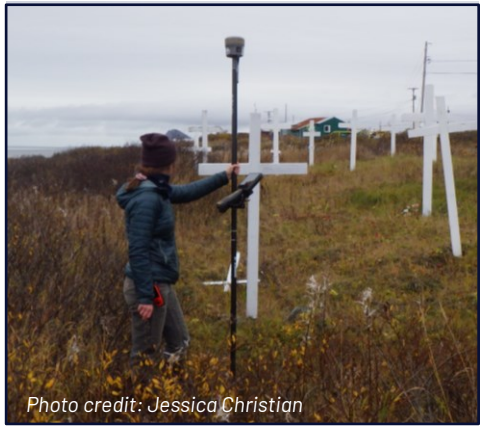
LOCATION	PARTICIPANTS	AVERAGE AGE	AGE RANGE
SAINT PAUL ISLAND	10	60	40-81
GOODNEWS BAY	10	53	34-68

Interview participant characteristics in Goodnews Bay and St. Paul Island.

Field Surveys for Floodmap Generation

Measurement of past flood heights (A)

Critical infrastructure elevation survey (B)



First-floor height measurements (C)

A: Interview participant indicated that 2011 storm reached this step of his porch; Sara Datson surveys flood elevation
B: Sara Datson measures elevation of the cemetery in Goodnews Bay to assess its vulnerability to flooding
C: Goodnews Bay Environmental Coordinator, Wayne Schouten, and Sara Datson collecting first floor height measurements in a frequently flooded area of town

Single-Value Threshold Maps

Key Takeaways:

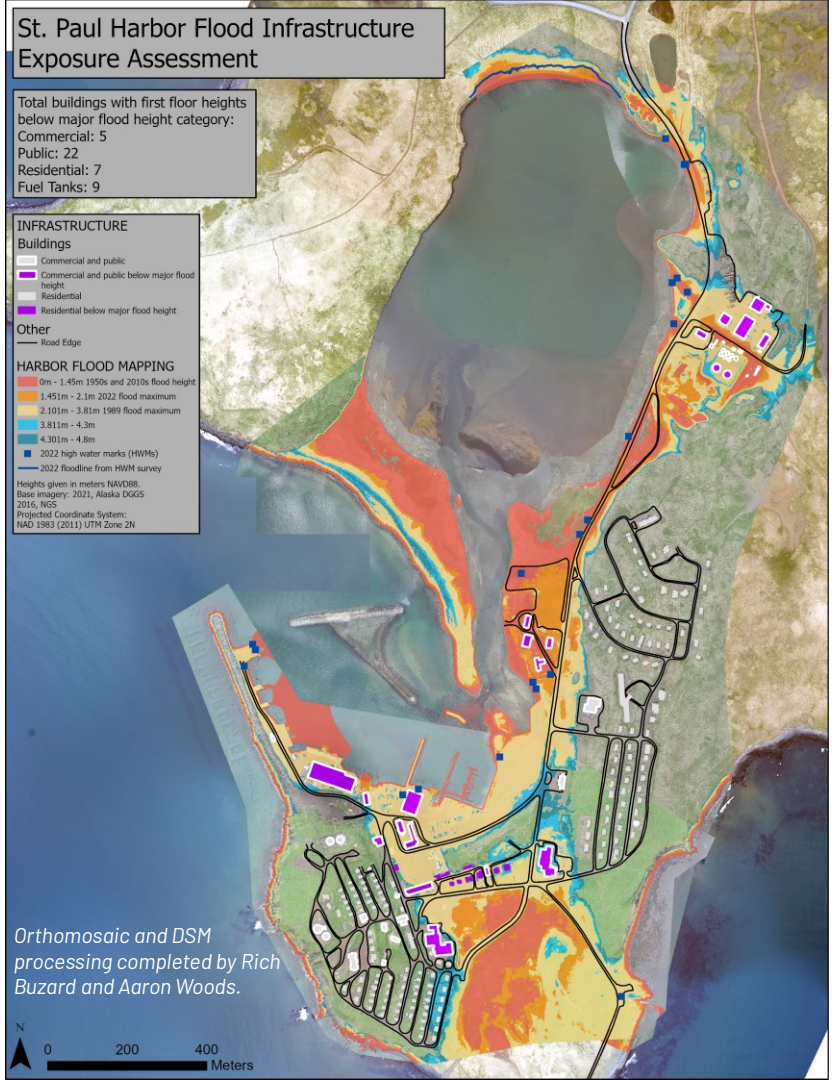
- At-risk infrastructure
- Past flood heights
- Potential future flood heights (based on sea-level rise)

Floods Mapped:

- 1989, 2010s, and 2022
- 2022 event (ex-typhoon Merbok) high water marks shown in blue

At-Risk Infrastructure:

- Fish processing plant
- Harbor warehouses
- Health clinic
- Electric facility
- Fuel tanks
- Gas station
- School
- Alaska Company grocery store
- Local residences



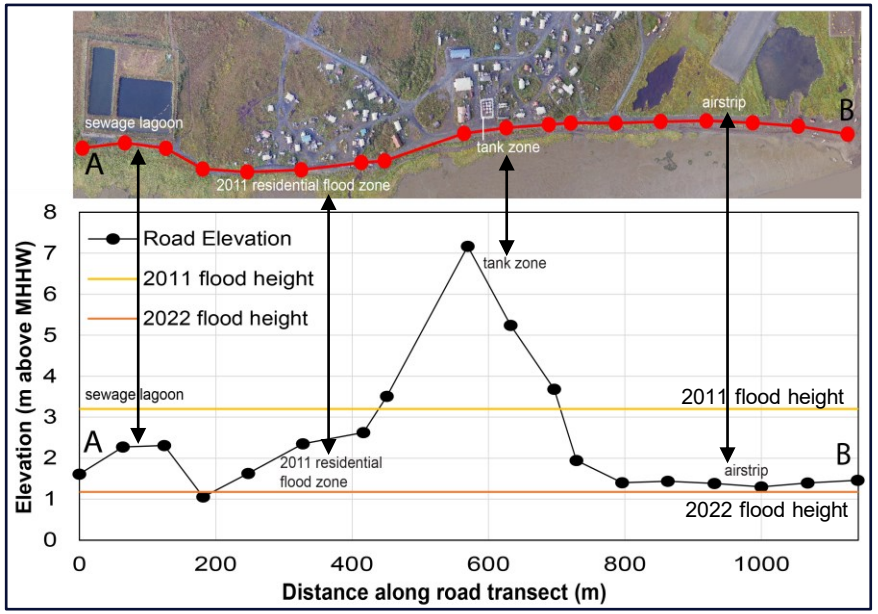
Infrastructure Impacts

Key Takeaways:

- Critical infrastructure in both communities is below historic flood heights
- Sea level rise could increase impact severity

INFRASTRUCTURE	MINIMUM FIRST FLOOR HEIGHT (MHHW)	AVERAGE FIRST FLOOR HEIGHT (MHHW)
BEACH ROAD	1.30	2.43
AIRSTRIP	2.58	2.64
PUMP STATION	3.02	3.05
SEWAGE LAGOON	3.37	3.55
WAREHOUSE	4.03	4.11
BURIAL GROUND	5.21	5.31
FUEL TANKS	6.27	6.44
STORE	11.85	11.86

Critical infrastructure heights in Goodnews Bay based on elevation, with heights below 2022 flood height depicted in orange, heights below 2011 flood height depicted in yellow, and heights within 0.5m and 1.0m of 2011 flood height depicted in light blue and dark blue, respectively.



Comparison of beach road elevation and select historic flood heights in Goodnews Bay.

Utility of Data Products:

- Indicate vulnerable infrastructure to inform decision-makers
- Improve community-preparedness and are directly applicable to funding sources

Storm History and Narratives

Storm History:

- Contents: 1) flood timing and height, 2) tide and wave data, 3) meteorological data, 4) literature and interview sources, 5) uncertainty regarding estimates, and 6) prose description of event
- Developed from work by Buzard et al., 2021

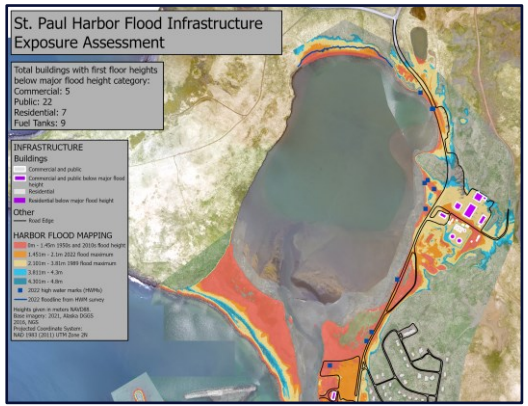
Storm Narratives:

- Focus on two case study storms
- Document local and Indigenous Knowledge
- Information is uniquely applicable to understand changing storm regimes and potential climate change implications

Outreach event on St. Paul Island in July, 2023. Presentation described this project and community discussion of data products ensued. *Photo credit(s): Ethan Candyfire.*

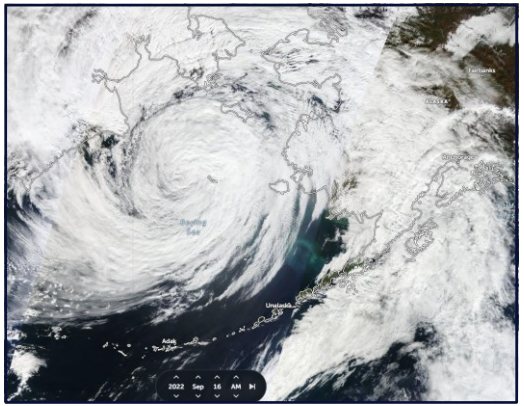
Broader Impacts

Provide localized data products to support flood mitigation funding proposals



New model for integration of Western and Indigenous epistemologies

Improve understanding of potential climate change impacts in the Bering Sea



Conclusions

Key Takeaways:

- Comprehensive understanding of storm impacts requires **localized integration of Western and Indigenous epistemologies**
- **Data sovereignty**: Tribes own data and will determine future use
- **Past flood heights** detailed at map level to improve forecasting and local interpretation
- **Coordination** between St. Paul ECO, Goodnews Bay Tribal Council, DGGS, and UAF Arctic Coastal Geoscience Lab allows for innovation in data collection and visualization techniques

Acknowledgements

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