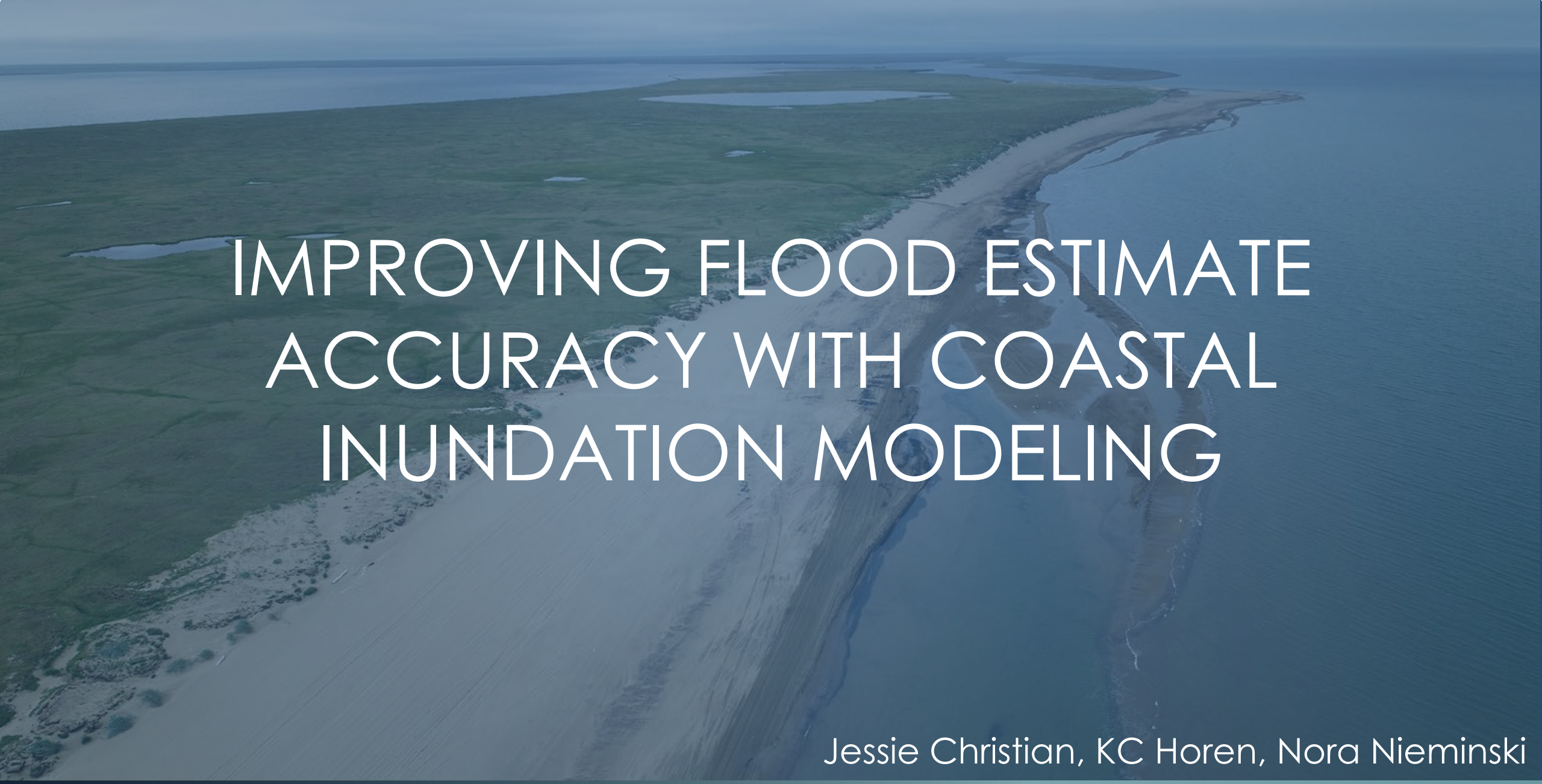


IMPROVING FLOOD ESTIMATE ACCURACY WITH COASTAL INUNDATION MODELING

Jessie Christian, KC Horen, Nora Nieminski

Alaska Division of Geological & Geophysical Surveys | **Coastal Hazards Program**

BACKGROUND

- There is a need for a consistent way to measure and model storm surge and flood heights.
  - Understanding how frequently floods reach certain heights can help communities plan for future flood risks and mitigate damage.
- Commonly used simple bathtub models (sBTM) often overestimate inundation extents.
- Complex hydrodynamic models are often inaccessible to local GIS analysts, especially with many models lacking coverage for Alaska.
- Objective: Create a sustainable proxy dynamic model to promote local flood height modeling while taking into consideration community layout to better understand flood impacts.

Flooding in Teller, AK on September 17, 2022, from Extratropical Typhoon Merbok.

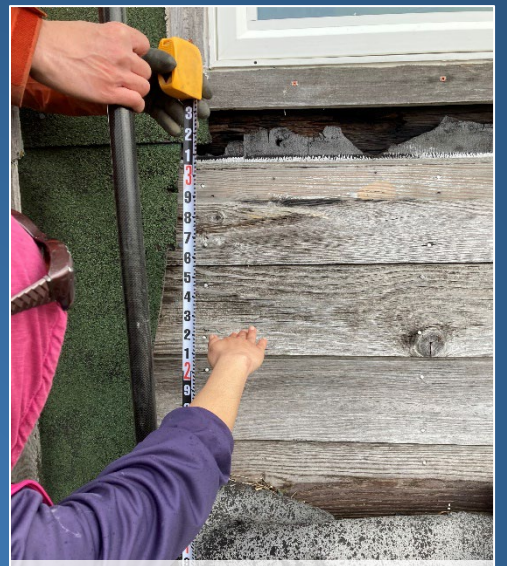
Flooding in Napakiak, AK on September 17, 2022, from Extratropical Typhoon Merbok.

DATA COLLECTION

- High water mark (HWM) data were collected in 17 communities following extra-tropical Typhoon Merbok (September 2022).

- Several different agencies worked together to survey locations indicative of flood water levels after the storm.
  - These data are hosted on the USGS Flood Event Viewer (https://stn.wim.usgs.gov/fev/).

- DGGS is working on Flood Impact Assessments that utilize these and other datasets to document and model historical floods (https://dggs.alaska.gov/pubs/id/30573).
  - HWMs (post-Merbok and previous events, if available)
  - Written observations of flood extents
  - Water level gages



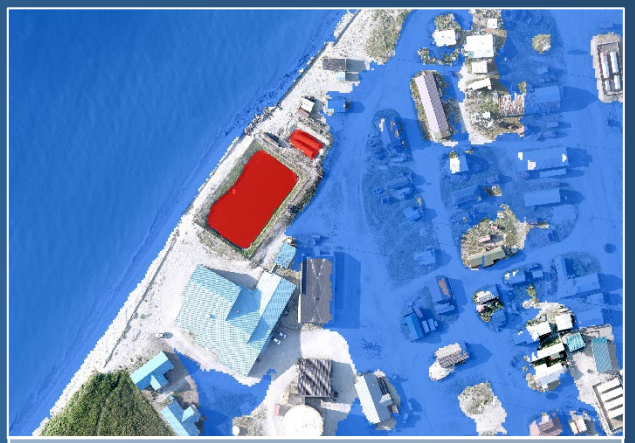
Post-storm verbal HWM collection in Teller, AK.

Surveying HWM debris line in Shaktoolik, AK.

Post-storm HWM from photo collection in Teller, AK.

METHODS

- Enhanced bathtub models (eBTM) have been developed to address hydrological connectivity not accounted for in sBTM.
  - Cost-Distance tool – connectivity with an edited digital elevation model (DEM).
  - Region Group tool – connectivity with visual selection.
- DGGS has leveraged Esri's in-memory raster processing for modeling still water inundation extents.
  - Reduced time and data storage requirements.
  - Allows hydrological connectivity without editing DEMs or visual selection.
- A step-by-step guide of these methods will be published soon. Check the DGGS Coastal Hazards webpage (https://dggs.alaska.gov/hazards/coastal) for more information or reach out if interested in learning more.



Example sBTM inundation model.

Example eBTM inundation model.

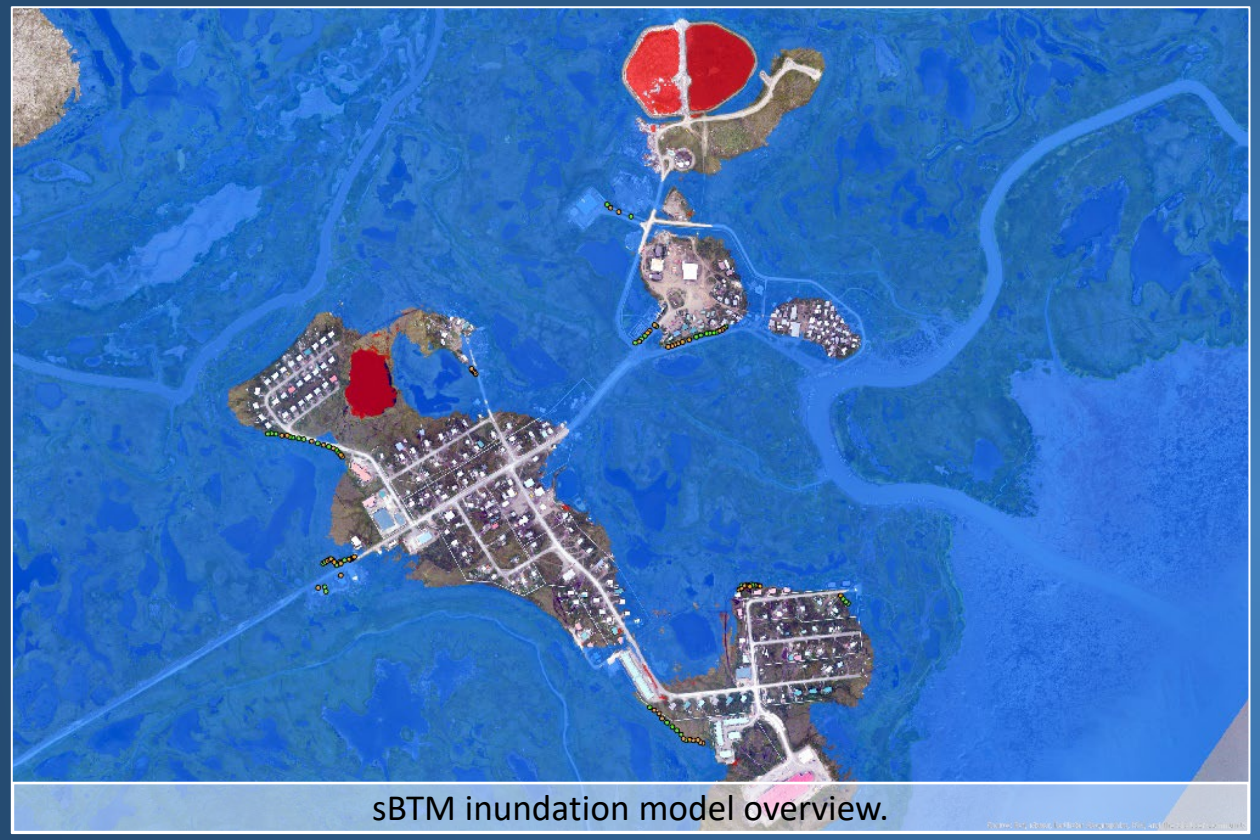
RESULTS

- Approximately 120 post-Merbok HWMs in Hooper Bay were randomly divided into two independent subsets.
- Subset A was used to estimate the still water inundation height. This value was applied to both an sBTM and eBTM.
- sBTM and eBTM extents were tested against subset B to evaluate the accuracy of the estimate and models.
- The average agreement between the eBTM and the HWM data from subset B was +0.015 m with an RMSE of 0.277 m.
- The sBTM and eBTM extents were compared to quantify overestimation.
- The sBTM yielded an 7% overestimation of flooding within uninundated areas.

sBTM inundation model overview in Hooper Bay.

eBTM inundation model overview in Hooper Bay.

RESULTS



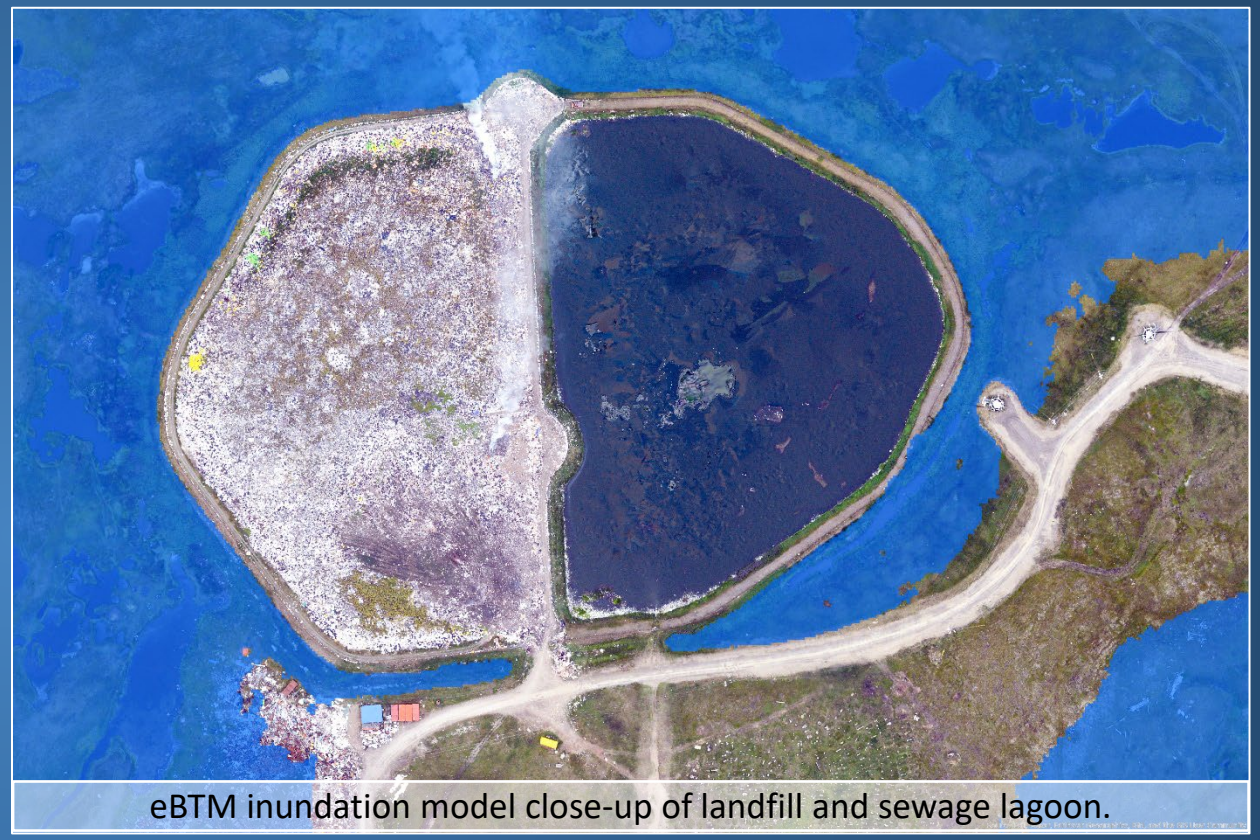
sBTM inundation model overview.

eBTM inundation model overview.

Above is an overview of the sBTM (left) and eBTM (right) results. The sBTM highlights areas where water levels were overestimated in red. The eBTM shows a more accurate representation of flood levels during Ex-Typhoon Merbok.

RESULTS

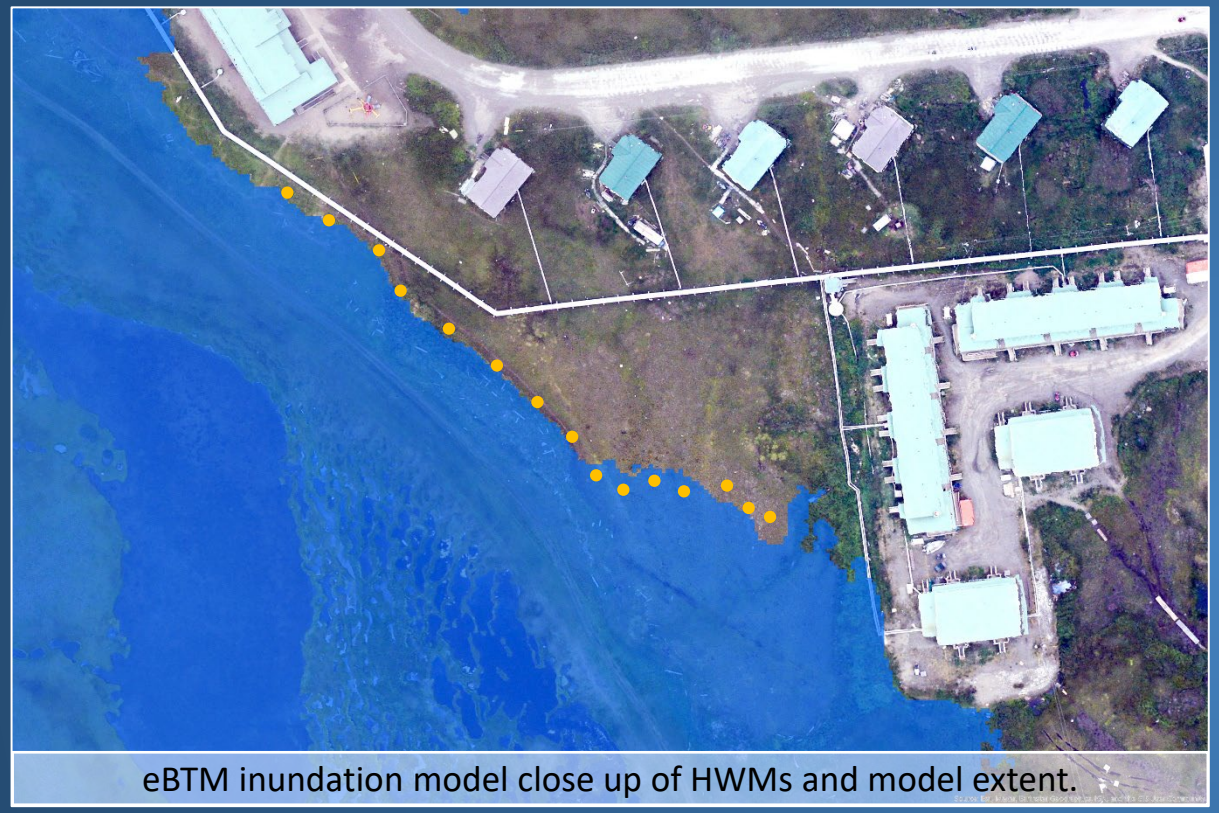
sBTM inundation model close-up of landfill and sewage lagoon.



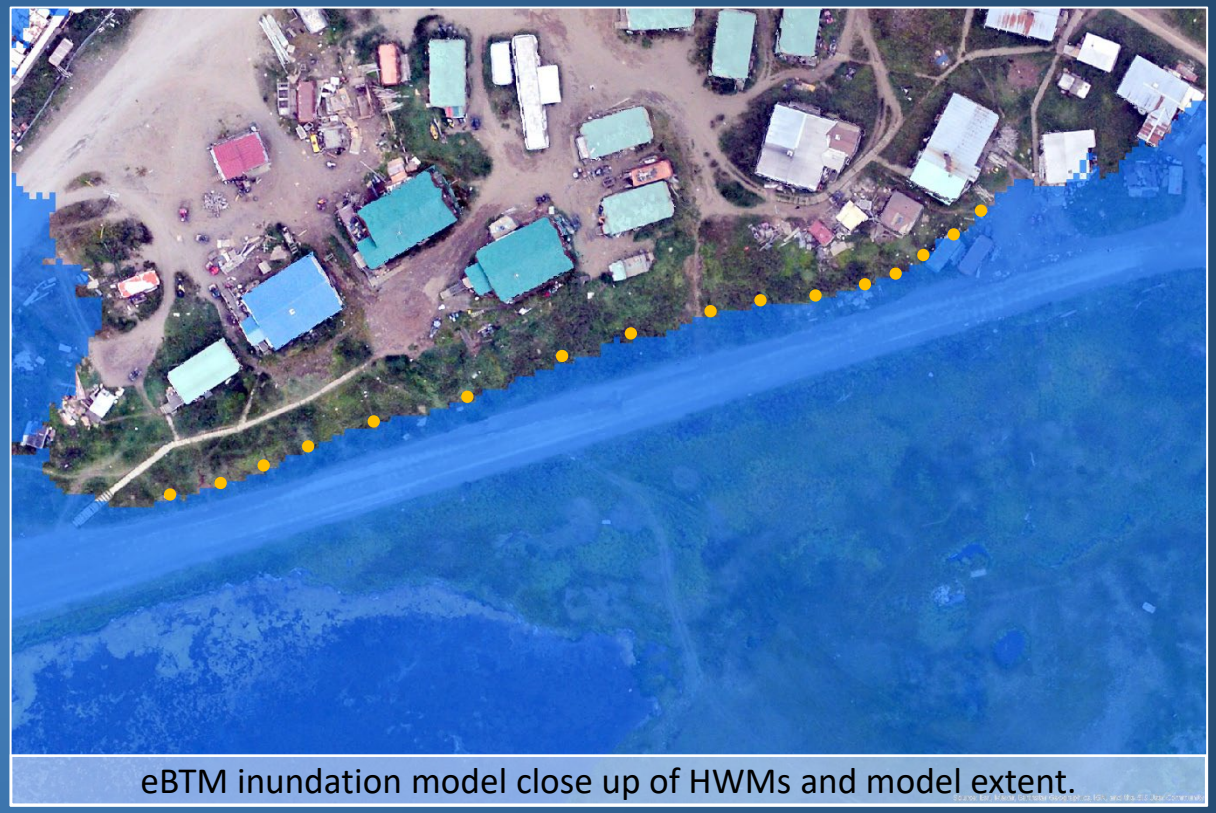
eBTM inundation model close-up of landfill and sewage lagoon.

Above is a close-up of the sewage lagoon and landfill. The sBTM (left) highlights areas where water levels were overestimated in red. The eBTM (right) shows that the lagoon and landfill did not flood, as they were guarded by a higher elevation berm.

RESULTS



eBTM inundation model close up of HWMs and model extent.



eBTM inundation model close up of HWMs and model extent.

Above are two examples demonstrating the accuracy of eBTM results with independent HWM data (yellow points) not used during flood inundation modeling.

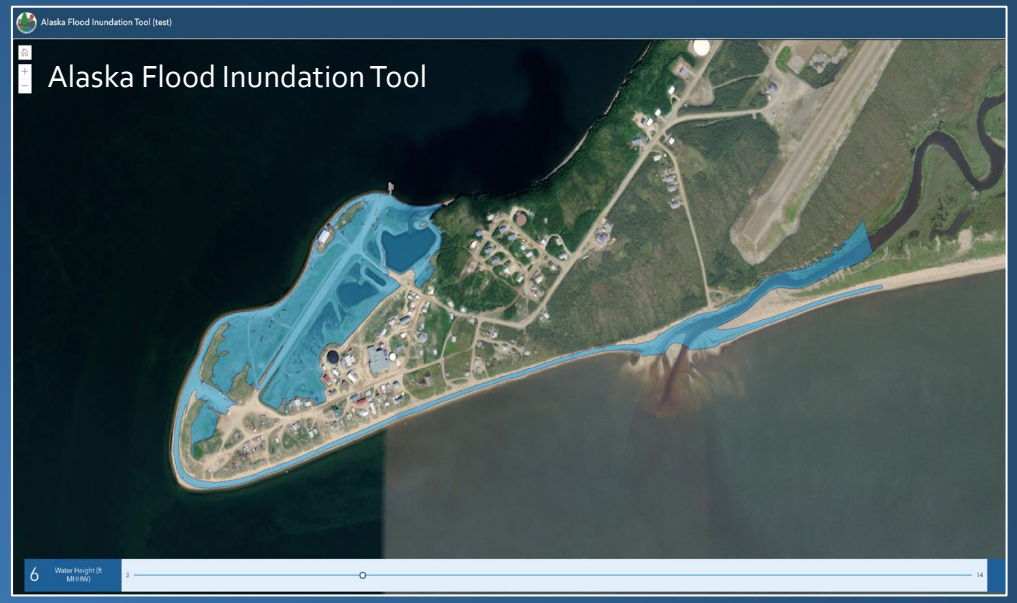
DISCUSSION

- The eBTM is an efficient, user-friendly method for accurate still water inundation extent modeling.
  - This method does not rely on expert knowledge of hydrodynamics, nor does it require access to complex modeling software.
  - Users do not need to edit DEMs or manually select hydrologically connected areas.
- Limited to estimating still water inundation extents.
  - Tidally influenced zones are subject to dynamic flooding, which includes wave set-up, run-up, and overtopping.
  - Dynamic flooding can reach greater extents than those that can be estimated with an eBTM.

eBTM showing flooding over road.

Photographic evidence of flood debris across the road, matching what was modeled by the eBTM.

FUTURE WORK

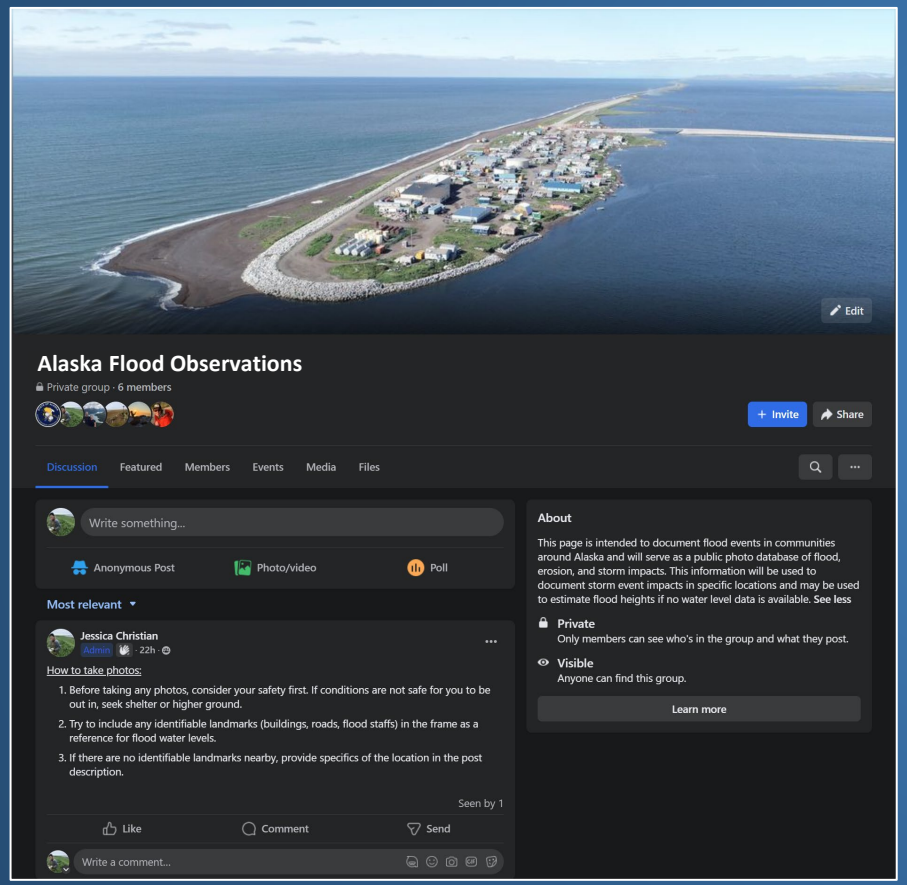


- DGGS plans to continue investigating further enhancements to inundation extent modeling.
  - Seeking a method to generate inundation estimates that do not rely on complex, computationally-intensive modeling.
  - Additional work is planned to incorporate slope and roughness into future models.

- DGGS is partnering with the U.S. Geological Survey and National Weather Service to apply these modeling methods for DGGS' Alaska Flood Inundation Tool (AK-FIT).
  - AK-FIT is in development and will be a web application for communities and planners to visually display forecasted flood inundation extents.

Have a flood photo?

Share it on our Facebook page to help create a public database of high-water levels around Alaska!



https://www.facebook.com/groups/1583030649124051

Reach out

Coastal Hazards Program email:
dnr.dggs.coastal.hazards@alaska.gov

Individual:

Nora Nieminski nora.nieminski@alaska.gov

Jessie Christian jessie.christian@alaska.gov

KC Horen keith.horen@alaska.gov

Upcoming Publication:

Horen, K.C., *In Press,* Still water inundation modeling with hydrological connectivity: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication XXX, 10 p.