STORM IMPACT SURVEY DATA FOR SELECTED ALASKA COASTAL COMMUNITIES IN RESPONSE TO EXTRA-TROPICAL CYCLONE MERBOK, SEPTEMBER 2022

Keith C. Horen, Autumn C. Poisson, Zachary J. Siemsen, Joseph M. Donohue, Kimra L. Widmer, Josip D. Adams, and Jacquelyn R. Overbeck

Raw Data File 2022-14

Photo from south end of airstrip looking southwest at flooding in Golovin, Alaska, on September 20, 2022, following Extra-Tropical Storm Merbok. Photo: Alaska Division of Geological & Geophysical Surveys.

2022
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

STATE OF ALASKA
Mike Dunleavy, Governor

DEPARTMENT OF NATURAL RESOURCES
Akis Gialopsos, Acting Commissioner

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
David L. LePain, State Geologist & Director

Publications produced by the Division of Geological & Geophysical Surveys are available to download from the DGGS website (dggs.alaska.gov). Publications on hard-copy or digital media can be examined or purchased in the Fairbanks office:

Alaska Division of Geological & Geophysical Surveys (DGGS)
3354 College Road | Fairbanks, Alaska 99709-3707
Phone: 907.451.5010 | Fax 907.451.5050
dggspubs@alaska.gov | dggs.alaska.gov

DGGS publications are also available at:

Alaska State Library, Historical
Collections & Talking Book Center
395 Whittier Street
Juneau, Alaska 99801

Alaska Resource Library and
Information Services (ARLIS)
3150 C Street, Suite 100
Anchorage, Alaska 99503

Suggested citation:
Horen, K.C., Poisson, A.C., Siemsen, Z.J., Donohue, J.M., Widmer, K.L., Adams, J.D., and Overbeck, J.R., 2022, Storm impact survey data for selected Alaska coastal communities in response to Extra-Tropical Cyclone Merbok, September 2022: Alaska Division of Geological & Geophysical Surveys Raw Data File 2022-14, 8 p.
https://doi.org/10.14509/30909

STORM IMPACT SURVEY DATA FOR SELECTED ALASKA COASTAL COMMUNITIES IN RESPONSE TO EXTRA-TROPICAL CYCLONE MERBOK, SEPTEMBER 2022

Keith C. Horen[1], Autumn C. Poisson[1], Zachary J. Siemsen[1], Joseph M. Donohue[2], Kimra L. Widmer[2], Josip D. Adams[3], and Jacquelyn R. Overbeck[4]

INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS), with assistance from the Alaska Division of Mining, Land and Water (DMLW) and the U.S. Geological Survey (USGS), collected Global Navigation Satellite System (GNSS) positional data in Golovin, Hooper Bay, Newtok, Nome, Shaktoolik, Stebbins, and Teller, Alaska, in the wake of Extra-Tropical Storm Merbok between September 19 and September 23, 2022. These data include high-water mark (HWM) locations and elevations, coastal profile transects, observed erosion evidence, and ground elevation points.

The GNSS position data was collected to assess coastal impacts from the storm. We used Trimble GNSS field equipment and Trimble Business Center to process these data. These products are released as a Raw Data File with an open end-user license. All files can be downloaded from https://doi.org/10.14509/30909.

LIST OF DELIVERABLES

- High-water mark point data
- Coastal profile point data
- Ground and erosion point data
- Metadata & Data Dictionaries

These data are further subdivided by community.

METHODS

DGGS, DMLW, and USGS staff were divided into three field teams to collect HWM, coastal profile, ground, and erosion point data. Each team was made up of two crew members and equipped with a GNSS base station and ground rover, as well as a retractable survey rod and a camera. HWM points were collected using methods consistent with USGS (Koenig and others, 2016) and U.S. Army Corps of Engineers (USACE, 2012) guidance. Digital copies of HWM data submitted to USGS can also be found on the USGS Flood Event Viewer application (https://stn.wim.usgs.gov/FEV/#2022SeptemberAKExtratropicalCyclone). Coastal profiles were collected along historical transects that can be viewed on the DGGS Alaska Coastal Profile Tool (ACPT) found at https://maps.dggs.alaska.gov/acpt/.

---

[1] Alaska Division of Geological & Geophysical Surveys, 3354 College Road, Fairbanks, AK 99709

[2] Alaska Division of Mining, Land and Water, 550 W. 7th Ave., Suite 1360, Anchorage, AK 99501

[3] U.S. Geological Survey, Geosciences and Environmental Change Science Center, Denver Federal Center, P.O. Box 25046, MS 980, Denver, CO 80225

[4] National Oceanic and Atmospheric Administration, Office for Coastal Management, 3601 C St., Suite 410, Anchorage, AK 99503

Field Collection

The first team, consisting of one DGGS and one DMLW staff member, was deployed to Nome on September 19, 2022, and traveled to Golovin, Teller, and Shaktoolik. This team was equipped with two Trimble R12 receivers, using one as a base station and the other as a ground rover. The second team, consisting of one DGGS and one USGS staff member, was deployed to Bethel on September 19, 2022, and traveled to Hooper Bay and Stebbins. This team was equipped with one Trimble R10 base station receiver and one Trimble R8s ground rover receiver. The third team, consisting of one DGGS and one DMLW staff member, was deployed to Bethel on September 19, 2022, and traveled to Newtok. This team was equipped with one Trimble R10 base station receiver and one R12 ground rover receiver, using one as a base station and the other as a ground rover.

Nome

The field team arrived in Nome on September 19, 2022, and conducted a GNSS survey from approximately 2:00 PM to 6:00 PM AKDT. A base station was set up over known benchmark 946 8756 H with a published solution found at https://www.ngs.noaa.gov/OPUS/getDatasheet.jsp?PID=BBFB37&ts=22075165807. This provided real-time kinematic (RTK) corrections to the ground rover. The team photographed and measured 46 HWM points, recording the GNSS position, type of high water feature, height above ground (if applicable), and description of each mark (fig. 1).

Figure 1. Map of point distribution in Nome, Alaska.

Golovin

The field team arrived in Golovin on September 20, 2022, and conducted a GNSS survey from approximately 10:30 AM to 3:30 PM AKDT. A base station was set up over known benchmark USLM 3651 with a published solution found at https://www.ngs.noaa.gov/OPUS/getDatasheet.jsp?PID=BBDJ67&ts=18215132934. This provided RTK corrections to the ground rover. The team photographed and measured 27 HWM points, recording the GNSS position, type of high water feature, height above ground (if applicable), and description of each mark. They also collected 36 ground elevation and erosion points, as well as nine coastal profile transects (141 points; fig. 2).

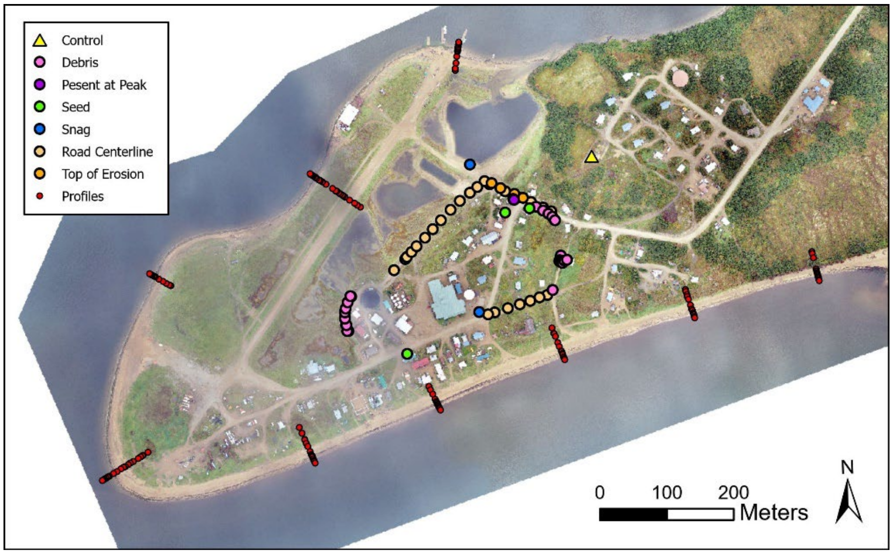

Figure 2. Map of point distribution in Golovin, Alaska.

Hooper Bay

The field team arrived in Hooper Bay on September 20, 2022, and conducted a GNSS survey from approximately 11:45 AM to 5:15 PM AKDT. A base station was set up over known property corner 803 with published horizontal coordinates found on Bethel Recording District Plat 2019-3. The team photographed and measured 121 HWM points, recording the GNSS position, type of high water feature, height above ground (if applicable), and description of each mark. They also collected one coastal profile transect consisting of 35 GNSS positions (fig. 3).

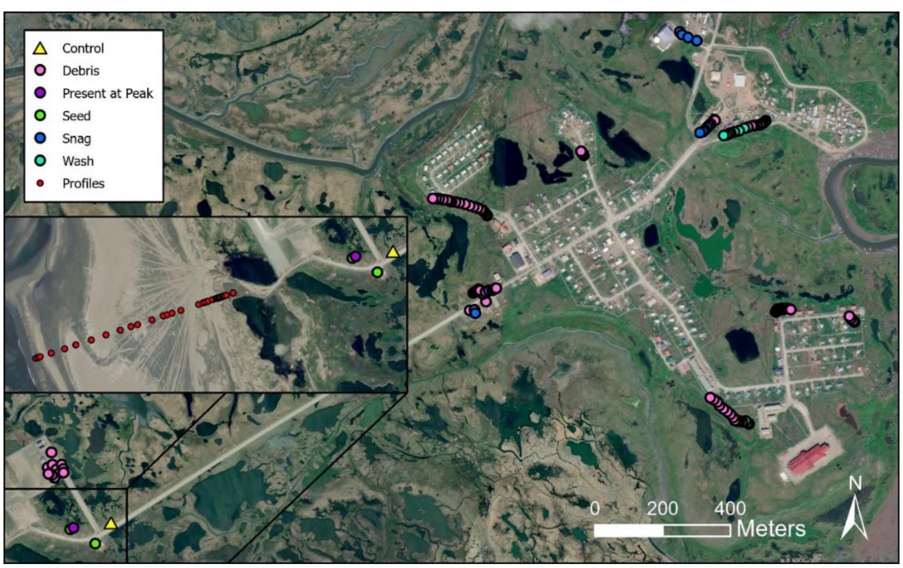

Figure 3. Map of point distribution in Hooper Bay, Alaska.

Newtok

The field team arrived in Newtok on September 20, 2022, and conducted a GNSS survey from approximately 11:30 AM to 3:00 PM AKDT. A base station was set up over known benchmark 946 6563 B with a published solution found at https://www.ngs.noaa.gov/OPUS/getDatasheet.jsp?PID=BBHJ92&ts=21300154141, holding known Mean Lower Low Water (MLLW) elevation found at https://tidesandcurrents.noaa.gov/benchmarks.html?id=9466563. This provided RTK corrections to the ground rover. The team photographed and measured 23 HWM points, recording the GNSS position, type of high water feature, height above ground (if applicable), and description of each mark (fig. 4).

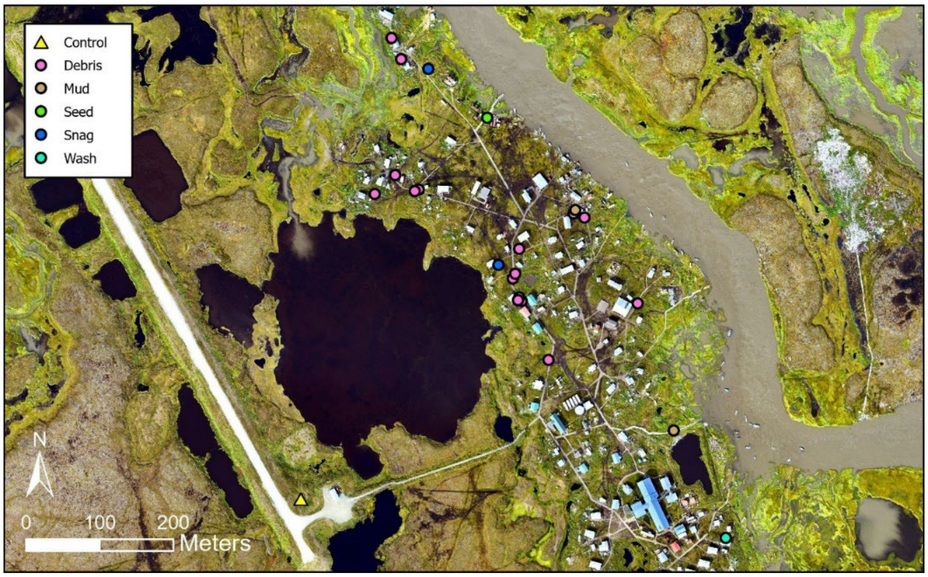

Figure 4. Map of point distribution in Newtok, Alaska.

Teller

The field team arrived in Teller on September 21, 2022, and conducted a GNSS survey from approximately 12:30 PM to 5:30 PM AKDT. A GNSS base station was set up over a temporary benchmark set for this survey. The team photographed and measured 72 HWM points, recording the GNSS position, type of high water feature, height above ground (if applicable), and description of each mark. They also collected 13 ground elevation and erosion points (fig. 5).

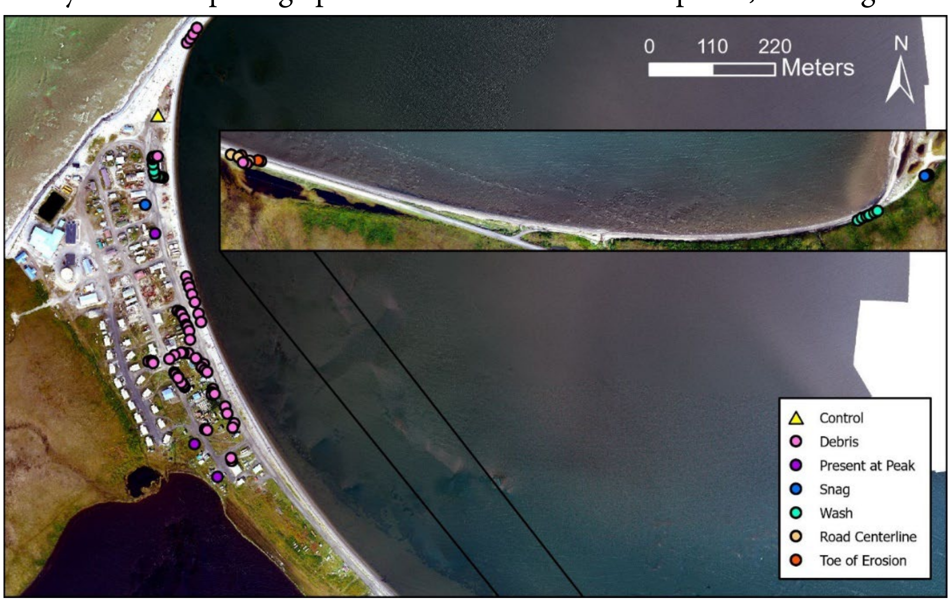

Figure 5. Map of point distribution in Teller, Alaska.

Shaktoolik

The field team arrived in Shaktoolik on September 22, 2022, and conducted a GNSS survey from approximately 10:30 AM to 2:15 PM AKDT. A GNSS base station was set up over known benchmark SKK 1 with a published solution found at https://www.ngs.noaa.gov/OPUS/getDatasheet.jsp?PID=BBFD37&ts=16097131714. This provided RTK corrections to the ground rover. The team photographed and measured 59 HWM points, recording the GNSS position, type of high water feature, height above ground (if applicable), and description of each mark. They also collected 12 ground elevation and erosion points (fig. 6).

Figure 6. Map of point distribution in Shaktoolik, Alaska.

Stebbins

The field team arrived in Stebbins on September 23, 2022, and conducted a GNSS survey from approximately 2:30 PM to 5:45 PM AKDT. A base station was set up over a recovered temporary benchmark established during DGGS field work on July 10, 2022. This provided RTK corrections to the ground rover. The team photographed and measured 36 HWM points, recording the GNSS position, type of high water feature, height above ground (if applicable), and description of each mark. They also collected 64 ground elevation and erosion points, as well as two coastal profile transects (37 points; fig. 7).

Figure 7. Map of point distribution in Stebbins, Alaska.

Data Processing

Base positions were corrected using Online Positioning User Service (OPUS) solutions, which were used to update the ground rover positions using post-processed kinematic base-line adjustments in Trimble Business Center. Finalized GNSS position data were exported and formatted in accordance with the data dictionary metadata files associated with each of these data products.

Data Formatting

All data are delivered in comma delimited (CSV) format with column headers and are accompanied by a data dictionary detailing the header names, definitions, and applicable units. All data include field point identification numbers; UTM zone designations in two-digit number and hemisphere format (e.g., 03N); northing and easting coordinates reported to the ten-thousandth of a meter; heights (where applicable) and elevations reported to the thousandth of a meter; horizontal and vertical precision reported to the ten-thousandth of a meter; the date of collection in two-digit month, two-digit day, and four-digit year format; and long-form notes. HWM and erosion data also include feature codes (table 1).

Profile data are populated with additional headers to more closely match historical ACPT formatting. These include profile name based on location (community) and profile number (e.g., Golovin_003); unique line identification incorporating location, profile number, and date (four-digit year, two-digit month, and two-digit day) (e.g., Golovin_003_20220920); location identification (community); line number; point number along profile line, beginning with 1, in ascending order from seaward extent to landward extent; vertical datum; collector(s) in first initial and last name format (e.g., Z. Siemsen); and field collection method (all points were collected using differential Global Positioning System and coded as DGPS).

Table 1. HWM and erosion feature codes.

Code	Description	Type
AC	Aluminum cap monument	Control
BC	Brass cap monument	Control
CHK	Check shot on monument	Control
CL	Centerline of road or trail	Feature
DEBRIS	Debris line on ground	HWM
GND	Ground shot	Feature
MUD	Mud line on ground or vertical structure	HWM
PAP	Present at peak reported water height	HWM
SEED	Seed line on ground or vertical structure	HWM
SNAG	Debris snag on vertical structure or vegetation	HWM
SSROD	Stainless steel rod monument	Control
TBM	Temporary benchmark	Control
TOE	Toe of erosion feature	Feature
TOP	Top of erosion feature	Feature
WASH	Wash line (depressed vegetation or minor erosion)	HWM

ACCURACY REPORT

Coordinate System and Datum

Data in Nome and Teller were collected in horizontal coordinate system NAD83 (2011) Alaska State Plane Zone 8 in U.S. Survey Feet. Data in Shaktoolik, as well as HWM data in Golovin, were collected in horizontal coordinate system NAD83 (2011) Alaska State Plane Zone 7 in U.S. Survey Feet. Golovin HWM data and all data in Nome, Teller, and Shaktoolik were collected in vertical datum NAVD88 (GEOID12B) in U.S. Survey feet. Data in Newtok, Hooper Bay, and Stebbins, as well as coastal profile data in Golovin, were collected in horizontal coordinate system NAD83 (2011) UTM 3 North in meters. Data in Newtok were collected in vertical datum MLLW in meters. Golovin coastal profile data and all data in Hooper Bay and Stebbins were collected in vertical datum NAVD88 (GEOID12B) in meters. All data were processed and delivered in horizontal coordinate system NAD83 (2011) UTM in meters and vertical datum NAVD88 (GEOID12B) in meters; UTM Zone is indicated as an attribute in each data product.

Horizontal Accuracy

We quantified the horizontal accuracy of the GNSS position data using the latitudinal and longitudinal peak-to-peak errors provided by OPUS.

Vertical Accuracy

We quantified the vertical accuracy of the GNSS elevation data using the combined error of the ellipsoid height peak-to-peak error provided by OPUS and the vertical uncertainty provided by the National Oceanic and Atmospheric Administration's (NOAA) Vertical Datum Transformation software during conversion from ellipsoid height to ortho height.

Data Consistency and Completeness

Base station data was processed using NOAA's OPUS static processing service, which derives GNSS coordinates from the average of three independent, single-baseline solutions, each computed by double-differenced carrier-phase measurements from three nearby National Continuously Operating Reference Stations (CORS; table 2). OPUS provides the range of the three individual single baselines, known as the peak-to-peak error. These ranges include any errors from the Continuously Operating Reference Stations (CORS) used during processing.

OPUS ortho height ranges are estimated to 95 percent confidence, typically resulting in a much larger potential error compared to the peak-to-peak error of the ellipsoid height. For a more accurate ortho height, we used NOAA's Vertical Datum Transformation software for final elevation conversions. This software employs accurate, multi-parameter mathematical equations and location specific grid models to perform vertical transformations and report the total root-mean-square error.

Table 2. Base station coordinates and GNSS errors.

Location	UTM Zone	Easting	Northing	Elevation	GNSS X Error (m)	GNSS Y Error (m)	GNSS Z Error (m)
Golovin	3N	594446.082	7159185.739	27.651	0.007	0.009	0.071
Hooper Bay	3N	439631.578	6821217.448	3.179	0.017	0.014	0.063
Newtok	3N	519612.329	6755816.942	5.928	0.011	0.006	0.064
Nome	3N	479339.451	7153538.041	4.492	0.007	0.009	0.061
Shaktoolik	4N	392707.971	7139872.949	6.590	0.006	0.003	0.021
Stebbins	3N	635146.731	7046747.037	16.898	0.007	0.022	0.064
Teller	3N	436379.538	7238753.199	2.274	0.015	0.002	0.066

ACKNOWLEDGMENTS

These data products were funded by the Alaska State Emergency Operations Center at the Alaska Division of Homeland Security and Emergency Management. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the Alaska Division of Geological & Geophysical Surveys, the Alaska Division of Mining, Land and Water, or the U.S. Geological Survey. Mention of trade names or commercial products does not constitute their endorsement by the Alaska Division of Geological & Geophysical Surveys, the Alaska Division of Mining, Land and Water, or the U.S. Geological Survey.

REFERENCES

Koenig, T.A., Bruce, J.L., O'Connor, J.E., McGee, B.D., Holmes, R.R., Jr., Hollins, Ryan, Forbes, B.T., Kohn, M.S., Schellekens, M.F., Martin, Z.W., and Peppler, M.C., 2016, Identifying and preserving high-water mark data: U.S. Geological Survey Techniques and Methods, book 3, chap. A24, 47 p. http://dx.doi.org/10.3133/tm3A24

U.S. Army Corps of Engineers Alaska District, 2012, Flood and erosion data gathering procedures, 24 p. https://agc-geodetic-soa-dnr.hub.arcgis.com/documents/6a0e72900a2941de97a4767f433debb0/explore