PHOTOGRAMMETRY-DERIVED ORTHOIMAGERY AND ELEVATION FOR NAPAKIAK, ALASKA, COLLECTED JUNE 30, 2021

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Raw Data File 2021-20

Location map of survey area with orthoimage.

This report has not been reviewed for technical content or for conformity to the editorial standards of DGGS.

2021
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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Suggested citation:
Buzard, R.M., Christian, J.E., and Overbeck, J.R., 2021, Photogrammetry-derived orthoimagery and elevation for Napakiak, Alaska, collected June 30, 2021: Alaska Division of Geological & Geophysical Surveys Raw Data File 2021-20, 4 p.
https://doi.org/10.14509/30793

PHOTOGRAMMETRY-DERIVED ORTHOIMAGERY AND ELEVATION FOR NAPAKIAK, ALASKA, COLLECTED JUNE 30, 2021

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) collected low-altitude aerial images from an unmanned aerial vehicle (UAV) on June 30, 2021 and used Structure-from-Motion (SfM) photogrammetry to produce a digital surface model (DSM) and orthoimage of Napakiak (fig. 1). The orthoimage and elevation data are for assessing coastal hazards and changes. We used Trimble Business Center to process the Global Navigation Satellite System (GNSS) data used for positional control. We used Agisoft Metashape to process the photogrammetry data. These products are released as a Raw Data File with an open end-user license. All files can be downloaded from doi.org/10.14509/30793 or elevation.alaska.gov.

LIST OF DELIVERABLES

- Orthoimage
- Digital Surface Model (DSM)
- Metadata

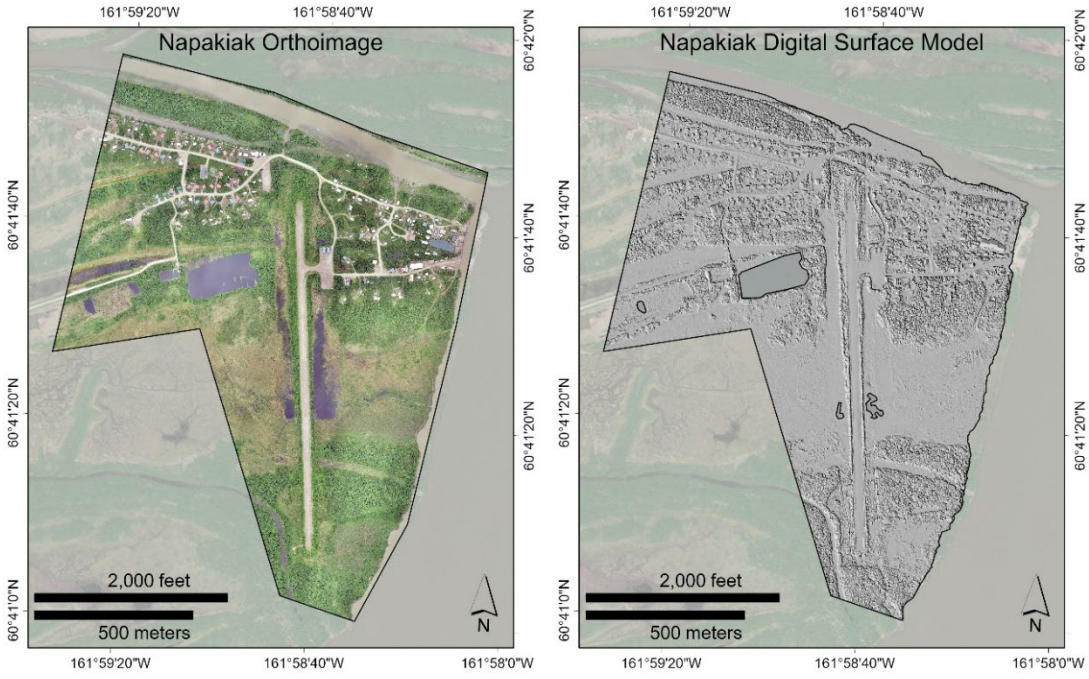

Figure 1. Extent of orthoimage (left) and DSM (right) for Napakiak.

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MISSION PLAN

Aerial Photogrammetric Survey Details

DGGS used a DJI Phantom 4 RTK UAV with a FC6310R camera model (8.8 mm lens) to collect 20-megapixel JPEG photographs (5472 x 3648 pixels per image). We flew the aerial survey with 70 percent sidelap and 80 percent frontlap, 120 m above the ground at 7.9 m/s, with nadir camera orientation stabilized by a 3-axis gimbal. The resulting images cover 1.35 km^2 with ground sampling distance (GSD) of approximately 0.03 m.

Weather and Photo Conditions

DGGS conducted flights on June 30, 2021, from 8:00 to 10:00 PM AKDT. The operator returned the UAV five times to change batteries. The weather was favorable with high overcast clouds, no rain, and light wind. No abnormalities were observed during the flights.

SURVEY AND PROCESSING REPORT

Ground Survey Details

DGGS set up a GNSS base station using a Trimble R10 receiver sampling at 5 Hz. The base was installed over a temporary benchmark of unknown position. This provided real-time kinematic (RTK) corrections to the UAV and Trimble R8s GNSS receiver. DGGS measured 16 photo-identifiable points with the R8s. We derived the corrected base position using the Online Positioning User Service (found at www.ngs.noaa.gov/OPUS/) and post-processed the R8s positions in Trimble Business Center.

Photogrammetric Dataset Processing

The UAV maintained RTK connection throughout the survey. The RTK system automatically applies the lever arm correction when writing camera GNSS coordinates (WGS84 ellipsoid) to the image metadata. Yaw, pitch, and roll information were not written to the image metadata. We update UAV positions using a X, Y, and Z shift from the initial to the corrected base position.

DGGS processed images in Agisoft Metashape Professional software (Version 1.6.3 build 10732). We masked image corners where shadows and image warping were disruptive. Processing steps included aligning images, identifying ground control points (GCPs), manually cleaning the sparse point cloud, optimizing the bundle block adjustment (refining camera positions and lens distortion parameters), constructing the dense point cloud, building the DSM, and creating the orthomosaic image. We used six GCPs to create the model, leaving ten survey check points.

Orthoimagery

The orthoimage is a three-band (red, green, blue), 8-bit unsigned GeoTIFF file with a GSD of 0.033 m per pixel; the "No Data" value is set to 0.

Digital Surface Model

The DSM represents surface elevations such as the height of vegetation and buildings. Water bodies can introduce noise. We manually delineated the river boundaries to restrict the DSM to the land. We selectively removed areas where inland water bodies introduced great noise. The DSM is a single-band, 32-bit floating point GeoTIFF file with a GSD of 0.066 m; the "No Data" value is set to $-3.4028231 \times 10^{38}$.

ACCURACY REPORT

Coordinate System and Datum

All data were processed and are delivered in NAD83 (2011) UTM Zone 4N and vertical datum NAVD88 (GEOID12B).

Horizontal Accuracy

We quantify the horizontal accuracy of the DSM and orthoimage by comparing the known locations of 10 photo-identifiable check points measured with GNSS against their modeled locations in the photogrammetric products (fig. 2). X and Y errors are calculated as the root-mean-square (RMS) error of offsets. The total horizontal error is the root-sum-square error of X and Y RMS errors, 0.081 m (table 1).

Vertical Accuracy

We assess the vertical accuracy of the DSM using the same check points. The RMS error of Z offsets is 0.073 m (table 1). The total error of the DSM (X, Y, and Z) is 0.109 m.

Figure 2. Location of photo-identifiable ground control points (GCP; red) and check points (CHK; blue).

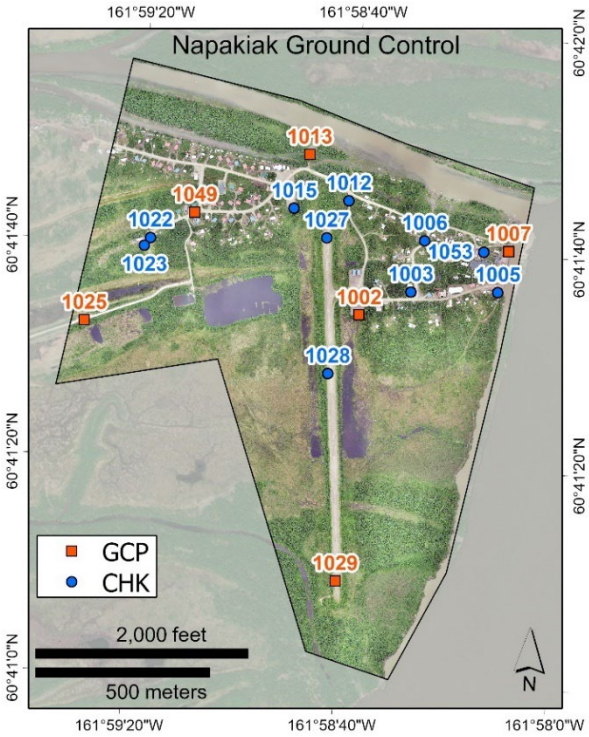

Table 1. Check point coordinates and offsets from orthoimage and DSM.

Check Point	Easting	Northing	Elevation	X Offset (m)	Y Offset (m)	Z Offset (m)
1003	337604.730	6732318.067	3.995	-0.053	-0.073	-0.097
1005	337853.149	6732316.349	3.462	-0.044	-0.041	-0.023
1006	337644.309	6732464.324	3.654	-0.086	-0.086	-0.069
1012	337427.766	6732578.982	3.939	-0.025	0.016	-0.044
1015	337270.983	6732557.574	3.380	-0.044	0.036	-0.089
1022	336860.532	6732473.947	4.941	0.020	-0.062	-0.051
1023	336843.790	6732451.651	4.504	-0.042	0.054	-0.012
1027	337364.422	6732472.918	4.902	-0.065	0.051	-0.117
1028	337367.282	6732084.753	4.670	-0.121	0.053	0.036
1053	337813.735	6732431.545	4.777	-0.019	-0.038	-0.105
			Mean	-0.048	-0.009	-0.057
			Standard Deviation	0.038	0.057	0.048
			Range	0.141	0.140	0.153
			Root Mean Square Error	0.060	0.054	**0.073**
			Total Error	**0.081 (XY)**		**0.109 (XYZ)**

Data Consistency and Completeness

DGGS visually inspected the orthoimage for data errors such as shifts, seamline mismatches, and water noise overlapping land. There were no significantly erroneous areas that required repair. Visual errors common to these SfM photogrammetry products include discontinuous powerlines, blurriness near high-angle features like buildings, and distortion at water boundaries. Bright objects like metal roofs and white paint can cause overexposure, leading to spurious elevation points.

ACKNOWLEDGEMENTS

We thank the Native Village and City of Napakiak for funding and supporting the creation of these data products.