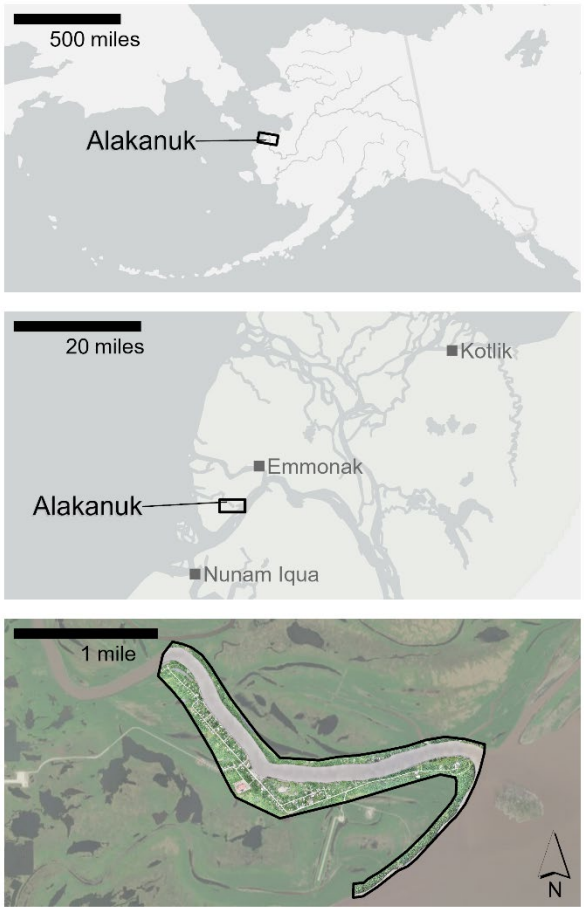
PHOTOGRAMMETRY-DERIVED ORTHOIMAGERY AND ELEVATION FOR ALAKANUK, ALASKA, COLLECTED JULY 11, 2021

Richard M. Buzard, Jessica E. Christian, and Jacquelyn R. Overbeck

Raw Data File 2021-17



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.

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

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PHOTOGRAMMETRY-DERIVED ORTHOIMAGERY AND ELEVATION FOR ALAKANUK, ALASKA, COLLECTED JULY 11, 2021

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INTRODUCTION

The State of Alaska Division of Geological & Geophysical Surveys (DGGS) collected low-altitude aerial images from an unmanned aerial vehicle (UAV) on July 11, 2021 and used Structure-from-Motion (SfM) photogrammetry to produce a digital surface model (DSM) and orthoimage of Alakanuk. 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/10.14509/30790 or elevation.alaska.gov.

LIST OF DELIVERABLES

- Orthoimage
- Digital Surface Model (DSM)
- Metadata

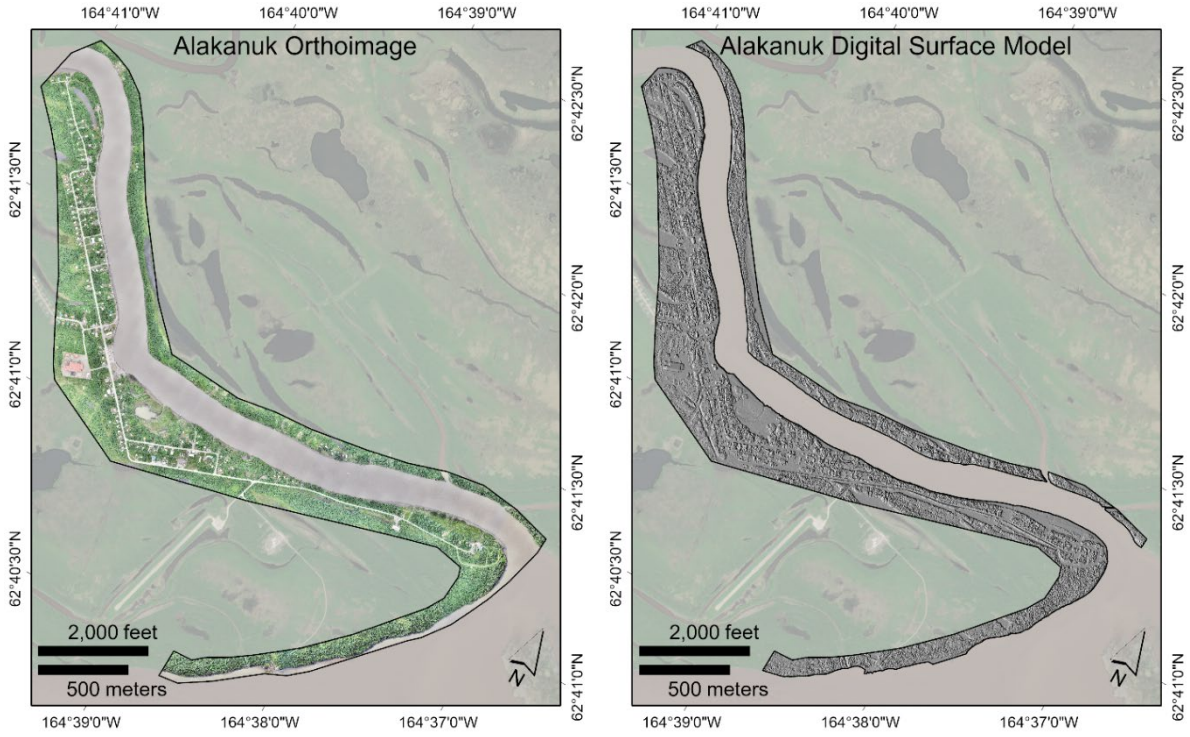

Figure 1. Extent of orthoimage (left) and DSM (right) for Alakanuk.

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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 2.42 km^2 with ground sampling distance (GSD) of approximately 0.03 m.

Weather and Photo Conditions

DGGS conducted flights on July 11, 2021, from 5:30 to 8:45 PM AKDT. The operator returned the UAV eight times to change batteries. The weather was favorable with 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 21 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 five GCPs to create the model, leaving sixteen survey check points.

Orthoimagery

The orthoimage is a three-band (red, green, blue) 8-bit unsigned GeoTIFF file with a GSD of 0.034 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. The DSM is a single-band, 32-bit floating point GeoTIFF file with a GSD of 0.068 m, the “No Data” value is set to $-3.4028231 \times 10^{38}$.

ACCURACY REPORT

Coordinate System and Datum

All data are processed and delivered in NAD83 (2011) UTM Zone 3N and vertical datum NAVD88 (GEOID12B).

Horizontal Accuracy

We quantify the horizontal accuracy of the DSM and orthoimage by comparing the known locations of 16 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, 0.048 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 0.041 m (table 1). The total error of the DSM (X, Y, and Z) is 0.063 m.

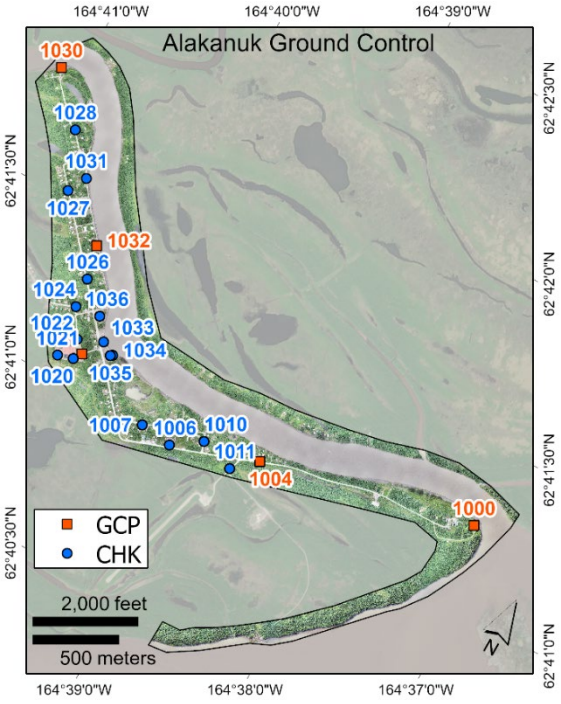

Figure 2. Location of photo-identifiable ground control points (GCPs; red) and check points (CHK; blue).

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)
1006	517720.826	6950350.620	4.240	-0.040	-0.038	0.028
1007	517527.339	6950372.858	4.342	-0.024	0.029	0.061
1010	517882.874	6950467.831	5.054	-0.035	-0.047	0.035
1011	518089.041	6950406.298	4.079	0.041	0.083	0.056
1020	516994.505	6950505.649	4.735	-0.010	-0.008	-0.017
1021	516905.491	6950476.694	4.412	0.037	-0.005	-0.024
1022	516958.313	6950611.627	4.672	0.017	-0.022	-0.011
1024	516857.455	6950770.234	4.084	-0.008	0.000	-0.045
1026	516836.229	6950940.622	4.218	-0.019	0.008	-0.039
1027	516485.543	6951325.417	4.212	-0.072	0.057	-0.043
1028	516346.823	6951648.546	3.617	0.001	0.055	-0.088
1031	516542.290	6951439.275	3.908	-0.005	-0.011	0.012
1033	517097.334	6950675.765	4.019	0.022	-0.062	0.035
1034	517180.438	6950634.212	3.928	-0.004	-0.008	0.039
1035	517169.077	6950625.553	3.957	-0.032	0.011	0.035
1036	517004.842	6950791.695	3.941	0.001	0.008	0.000
			Mean	-0.008	0.003	0.002
			Standard Deviation	0.029	0.039	0.042
			Range	0.113	0.145	0.149
			Root Mean Square Error	0.030	0.038	0.041
			Total Error	**0.048 (XY)**		**0.063 (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

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