

Metadata Report

Project Name

Three surveys on the Dhaulagiri Southwest fault (Western Nepal fault system), Nepal, October 2021

Summary

During investigations of the Western Nepal fault system (NSF award #1827870), we targeted a series of three adjacent glacial cirque valleys that are traversed by the Dhaulagiri Southwest fault for slip rate and paleoseismic studies. We have assigned names to the valleys based on information obtained from local maps and discussion with our Nepali guides. From northwest to southeast, the targeted valleys are named Parmi, Marmi, and Naya Ban. Data for each site was collected and processed individually but we have combined these into a single dataset due to their proximity along a single fault. We use the Parmi, Marmi, and Naya Ban names to distinguish the datasets and corresponding metadata documents and information below.

Personnel

- PI: Sean P Bemis, Virginia Tech
- Collected and processed by: Sean Bemis and Elizabeth Curtiss, Virginia Tech

Site Information

Parmi:

- Site description: Parmi lake is situated at ~4400 m elevation within a southwest-facing glacial cirque. Dextral-normal slip on the Dhaulagiri Southwest fault has created a large scarp that acts as a natural dam across the outlet of the valley.
- Site objective: Mapping glacial landforms to measure cumulative displacement
- Site location: 83.097899°E 28.664404°N
- Site conditions: Clear sky, light to moderate winds
- Date/time spent at each site: Survey occurred between 9 – 10:30 am local time on October 15th, 2021.
- Source photos: DJI_0600.jpg through DJI_0803.jpg

Marmi:

- Site description: Marmi lake is situated at ~4430 m elevation within a southwest-facing glacial cirque. Dextral-normal slip on the Dhaulagiri Southwest fault has created a large scarp that acts as a natural dam across the outlet of the valley.
- Site objective: Mapping glacial landforms to measure cumulative displacement
- Site location: 83.106912°E 28.657439°N
- Site conditions: Low clouds, occasional wisps of fog, moderate to strong winds. The beginnings of an incoming storm.
- Date/time spent at each site: Survey occurred between 2:44 and 3:04 pm local time on October 17th, 2021.
- Source photos: DJI_0888.jpg through DJI_0971.jpg

Naya Ban:

- Site description: The Naya Ban site is situated at ~4200 m elevation within a southwest-facing glacial cirque. Dextral-normal slip on the Dhaulagiri Southwest fault has created a large scarp that acts as a natural dam across the outlet of the valley.
- Site objective: Mapping glacial landforms to measure cumulative displacement and documenting the scarp geometry to support paleoseismic investigations
- Site location: 83.119243°E 28.651792°N
- Site conditions: Partly cloudy, moderate winds.
- Date/time spent at each site: Survey occurred between 2:29 and 2:56 pm local time on October 15th, 2021.
- Source photos: DJI_0804.jpg through DJI_0886.jpg

Survey Results

- Equipment used: DJI Mavic Pro
- GPS solutions: We collected some ground control points within each survey, but due to poor accuracy, very distant base data stations for differential corrections, and inconsistent coverage, we chose to use the embedded geotags in the photos as our georeferencing control.

- Errors:

Parmi: As a simple assessment of potential error, we differenced the WNFS_Parmi_dem with the EarthDEM 2m dataset. The mean vertical difference is 155.12 m (WNFS_Parmi_dem higher) with a standard deviation of 0.98 m. The range of differences is from 149.6 to 169 m, with the ends of this range associated with poorly resolved portions of the WNFS_Parmi_dem, such as the lake and edges of the target area. In map view, the differences appear symmetrical across

landforms, suggesting the horizontal position of the DEM is well-located relative to the EarthDEM topographic data.

Marmi: As a simple assessment of potential error, we differenced the WNFS_Marmi_dem with the EarthDEM 2m dataset. The mean vertical difference is 176.5 m (WNFS_Marmi_dem higher) with a standard deviation of 7.6 m. The range of differences is from 146.6 to 194.2 m, with the ends of this range associated with poorly resolved portions of the WNFS_Marmi_dem, such as the lake and edges of the target area. The larger range and standard deviation are likely a result of this DEM being derived from a smaller set of photos taken in a single grid flight. In map view, the WNFS_Marmi_dem appears to be shifted a few meters northward relative to the EarthDEM data.

Naya Ban: We cannot make similar error assessments for this site as we did for Parmi and Marmi. The EarthDEM data features interpolation artifacts and other errors across this site.

- Collection methods

Parmi: Collected as three overlapping grid flights, with the camera inclined 20° from nadir.

Marmi: Collected as one grid flight, with the camera inclined 20° from nadir

Naya Ban: Collected as one grid flight, with the camera inclined 20° from nadir

Products

The products include: 1) source photos (.jpg), 2) unclassified point clouds (.laz), 3) raster DEMs (_dem.tif), and 4) orthoimagery (_ortho.tif).

We performed all data processing within Agisoft Metashape Pro v2.2. For each survey site, we generated a Metashape processing report to capture processing settings and provide those reports within this metadata document.

In addition to the processing settings described in the metadata reports, we exported the datasets with the following settings:

- 1) Coordinate System: WG84 UTM Zone 44N
- 2) DEM raster resolution:
 - a. WNFS_Parmi_dem.tif: cell size = 0.087 m
 - b. WNFS_Marmi_dem.tif: cell size = 0.07 m
 - c. WNFS_NayaBan_dem.tif: cell size = 0.08 m
- 3) Orthoimagery resolution:
 - a. WNFS_Parmi_ortho.tif: cell size = 0.044 m
 - b. WNFS_Marmi_ortho.tif: cell size = 0.035 m
 - c. WNFS_NayaBan_ortho.tif: cell size = 0.04 m



All exported datasets were clipped to an outer boundary. This boundary was manually mapped around the perimeter of the survey area in Agisoft Metashape Pro to exclude portions of the working dataset that contained low-confidence data, low point density, and/or obvious artifacts

WNFS_Parmi

Processing Report
03 October 2025



Survey Data

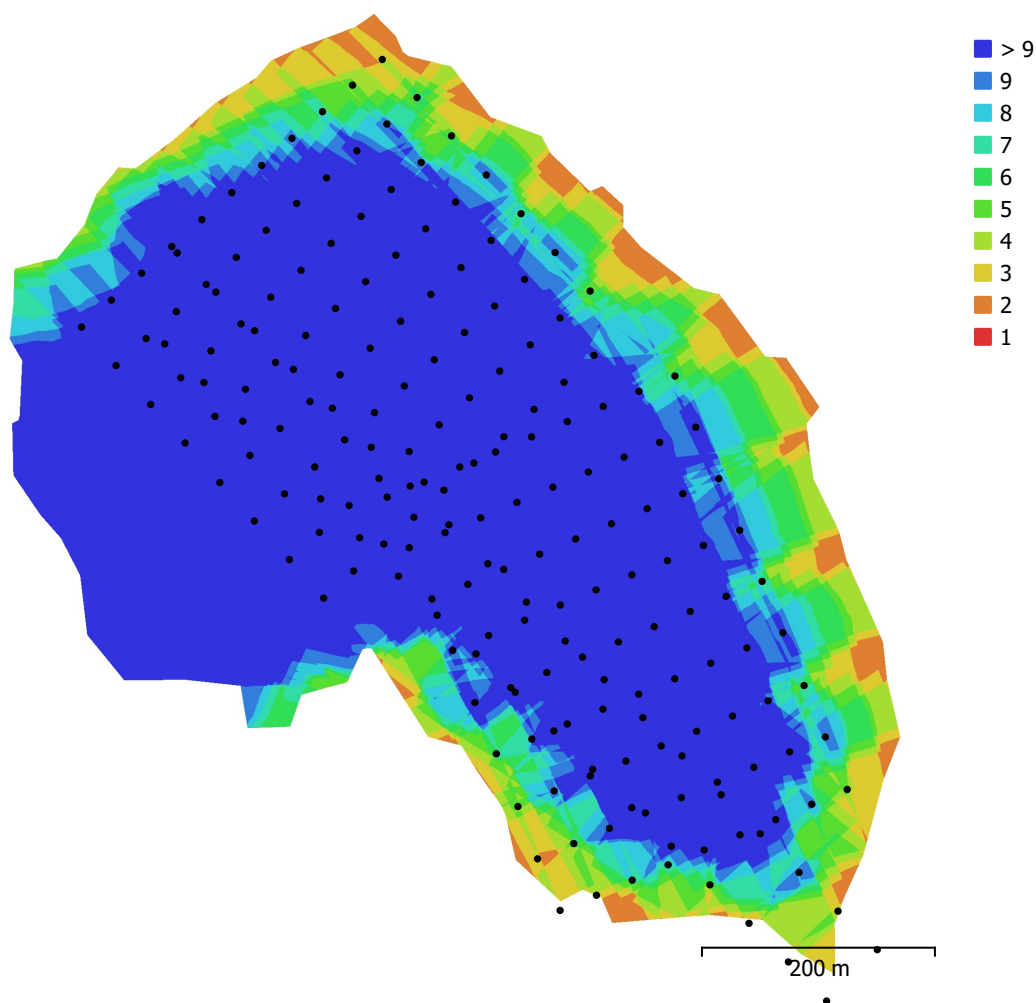


Fig. 1. Camera locations and image overlap.

Number of images:	204	Camera stations:	204
Flying altitude:	129 m	Tie points:	177,727
Ground resolution:	4.35 cm/pix	Projections:	742,879
Coverage area:	0.370 km ²	Reprojection error:	0.964 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC220 (4.7mm)	4000 x 3000	4.7 mm	1.56 x 1.56 μ m	No

Table 1. Cameras.

Camera Calibration

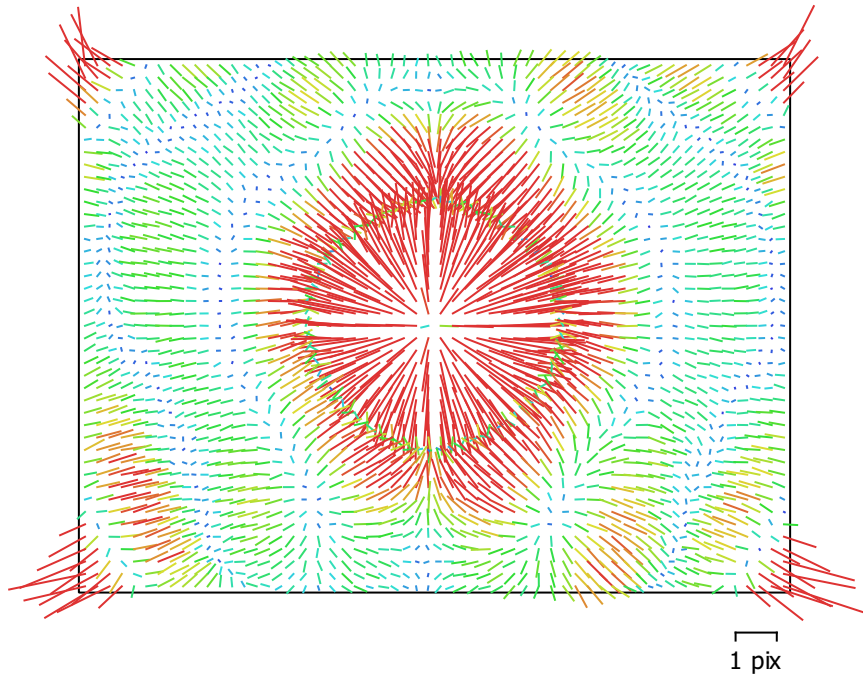


Fig. 2. Image residuals for FC220 (4.7mm).

FC220 (4.7mm)

204 images

Type	Resolution	Focal Length	Pixel Size
Frame	4000 x 3000	4.7 mm	1.56 x 1.56 μm

	Value	Error	F	Cx	Cy	K1	K2	K3	P1	P2
F	3070.42	0.16	1.00	0.06	-0.94	0.17	0.02	0.01	0.04	-0.75
Cx	4.34351	0.042		1.00	-0.10	0.04	-0.02	0.02	0.83	-0.11
Cy	-18.2063	0.13			1.00	-0.29	0.07	-0.09	-0.07	0.87
K1	0.0259819	8e-05				1.00	-0.94	0.90	0.04	-0.30
K2	-0.0765353	0.00028					1.00	-0.99	-0.01	0.08
K3	0.0787237	0.00032						1.00	0.01	-0.10
P1	-0.000494637	4.5e-06							1.00	-0.09
P2	0.000180523	9.5e-06								1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Locations

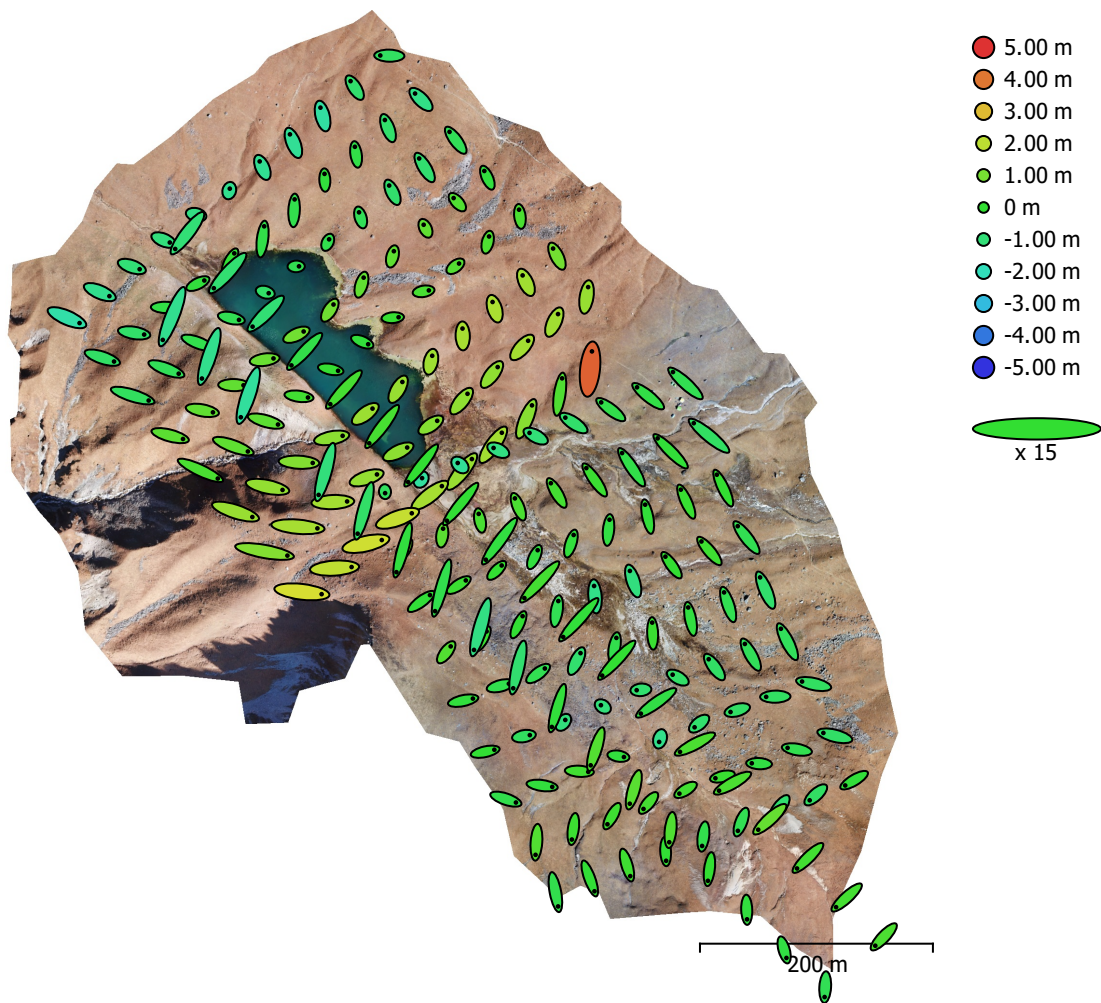


Fig. 3. Camera locations and error estimates.

Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
0.953609	1.08245	0.915213	1.44259	1.70841

Table 3. Average camera location error.
X - Longitude, Y - Latitude, Z - Altitude.

Digital Elevation Model

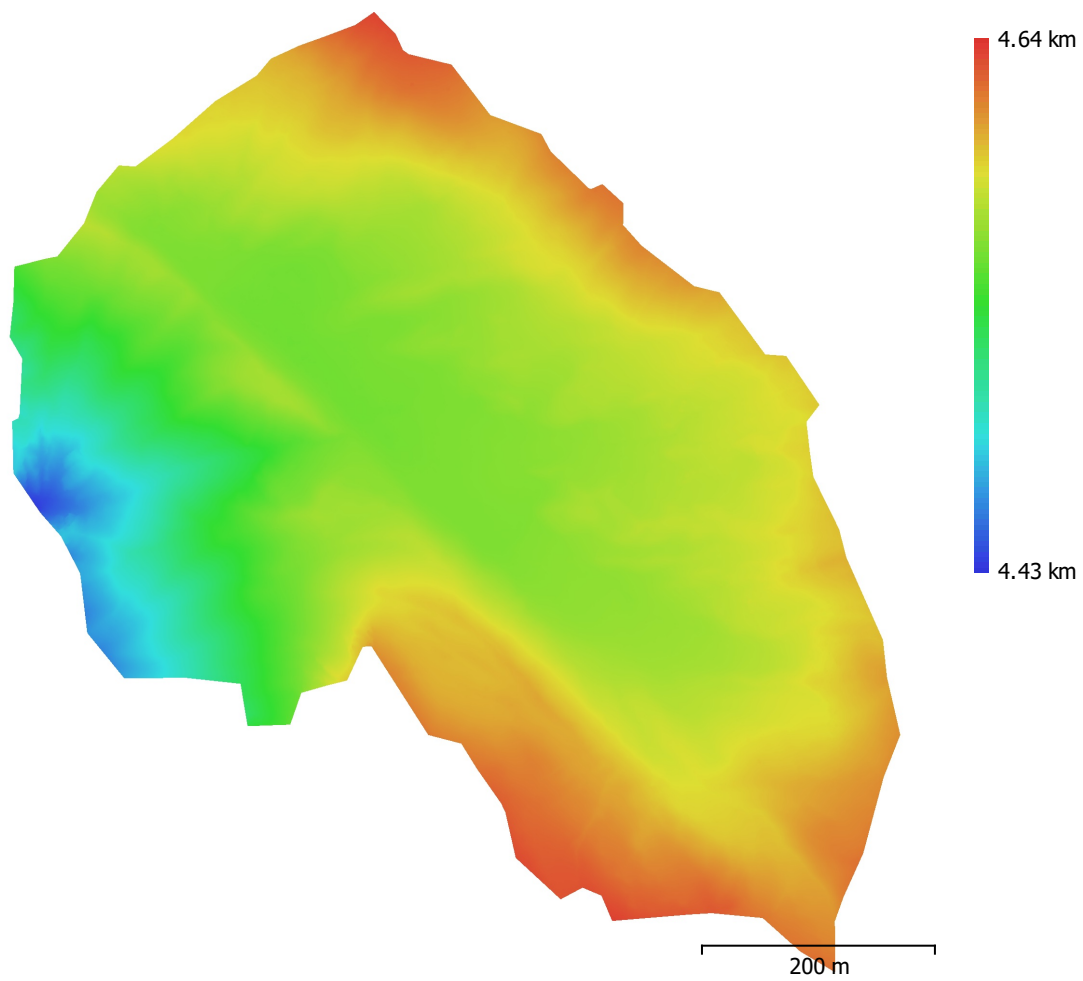


Fig. 4. Reconstructed digital elevation model.

Resolution: 8.70 cm/pix
Point density: 132 points/m²

Processing Parameters

General

Images	204
Aligned images	204
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll

Shapes

Polygon	1
Coordinate system	WGS 84 (EPSG::4326)

Tie Points

Points	177,727 of 193,201
Point colors	3 bands, uint8
RMS reprojection error	0.356043 (0.964121 pix)
Max reprojection error	1.21684 (25.5823 pix)
Mean key point size	2.73233 pix
Key points	No
Average tie point multiplicity	4.53212

Alignment parameters

Accuracy	High
Generic preselection	Yes
Reference preselection	Source
Key point limit	40,000
Key point limit per Mpx	1,000
Tie point limit	4,000
Exclude stationary tie points	Yes
Guided image matching	No
Adaptive camera model fitting	No
Matching time	1 minutes 21 seconds
Matching memory usage	515.01 MB
Alignment time	26 seconds
Alignment memory usage	571.43 MB

Optimization parameters

Parameters	f, cx, cy, k1-k3, p1, p2
Adaptive camera model fitting	No
Exclude corners	No
Optimization time	1 seconds
Date created	2025:09:02 15:58:18
Software version	2.2.2.21069
File size	18.01 MB

Depth Maps

Count	204
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Depth maps generation parameters

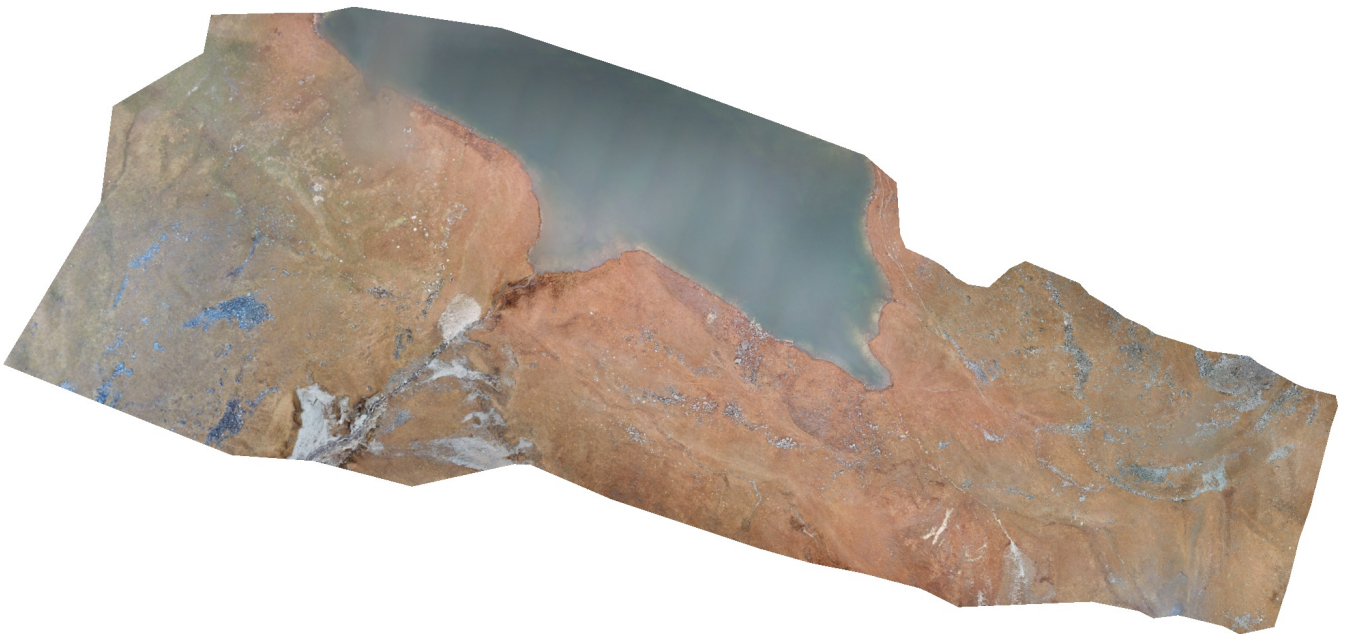
Quality	High
Filtering mode	Aggressive
Max neighbors	16
Processing time	4 minutes 41 seconds
Memory usage	2.72 GB
Date created	2025:09:02 16:11:29
Software version	2.2.2.21069
File size	918.37 MB

Point Cloud

Points	73,968,263
Coordinate precision	2.18 cm
Point attributes	
Color	3 bands, uint8
Normal	
Confidence	1 - 31
Point classes	
Created (never classified)	73,968,263
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Max neighbors	16
Processing time	4 minutes 41 seconds
Memory usage	2.72 GB
Point cloud generation parameters	
Source data	Depth maps
Processing time	9 minutes 31 seconds
Memory usage	6.20 GB
Date created	2025:09:02 16:21:06
Software version	2.2.2.21069
File size	1.05 GB
DEM	
Size	10,563 x 9,789
Resolution	8.70 cm/pix
Coordinate system	WGS 84 (EPSG::4326)
Reconstruction parameters	
Source data	Point cloud
Interpolation	Enabled
Processing time	29 seconds
Memory usage	307.64 MB
Date created	2025:09:02 16:39:10
Software version	2.2.2.21069
File size	188.12 MB
Orthomosaic	
Size	21,126 x 19,578
Resolution	4.35 cm/pix
Coordinate system	WGS 84 (EPSG::4326)
Colors	3 bands, uint8
Orthophotos	1.12 GB
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Enable ghosting filter	No
Processing time	1 minutes 48 seconds
Memory usage	1.30 GB
Date created	2025:09:02 16:46:15
Software version	2.2.2.21069
File size	1.43 GB
System	
Software name	Agisoft Metashape Professional
Software version	2.2.2 build 21069
OS	Windows 64 bit
RAM	127.63 GB
CPU	13th Gen Intel(R) Core(TM) i9-13900
GPU(s)	NVIDIA RTX 4000 Ada Generation

WNFS_Marmi

Processing Report
03 October 2025



Survey Data

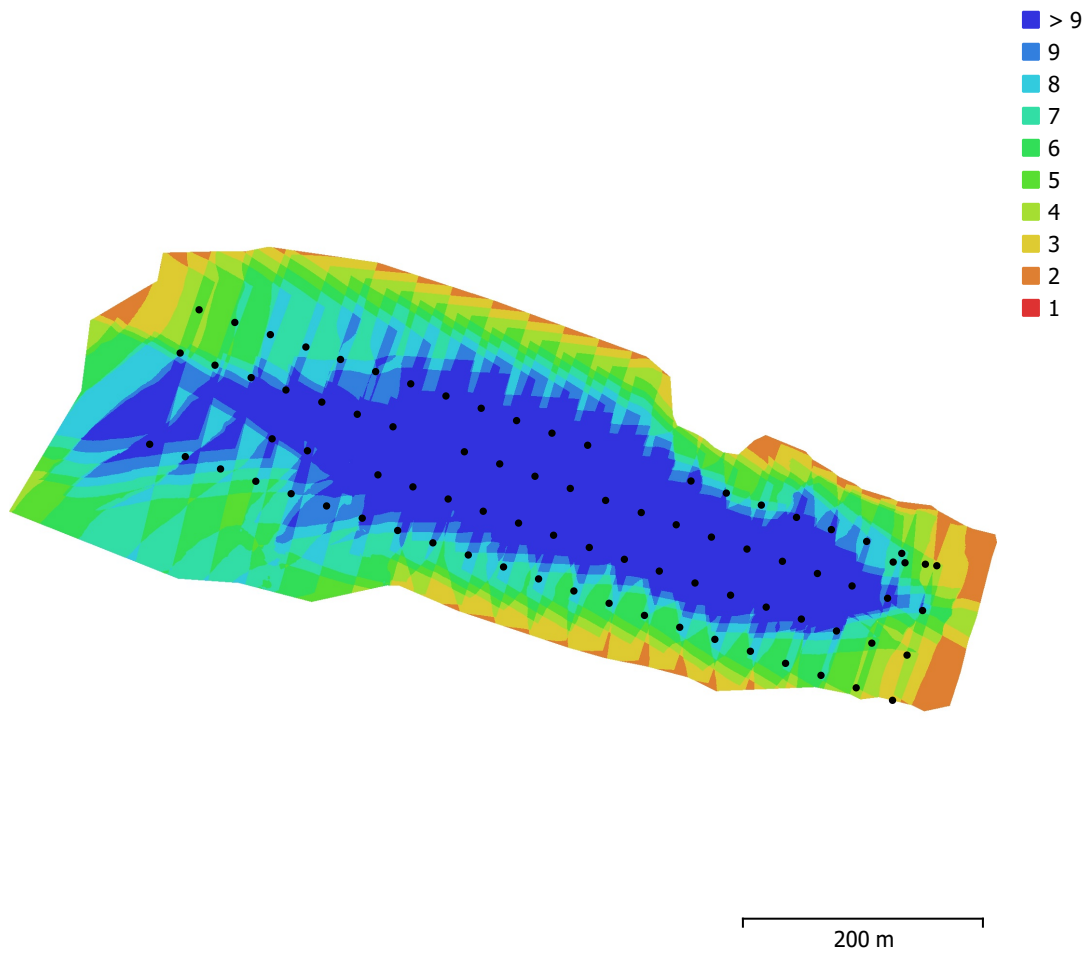


Fig. 1. Camera locations and image overlap.

Number of images:	84	Camera stations:	84
Flying altitude:	104 m	Tie points:	120,371
Ground resolution:	3.47 cm/pix	Projections:	331,484
Coverage area:	0.179 km ²	Reprojection error:	1.12 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC220 (4.7mm)	4000 x 3000	4.7 mm	1.56 x 1.56 μ m	No

Table 1. Cameras.

Camera Calibration

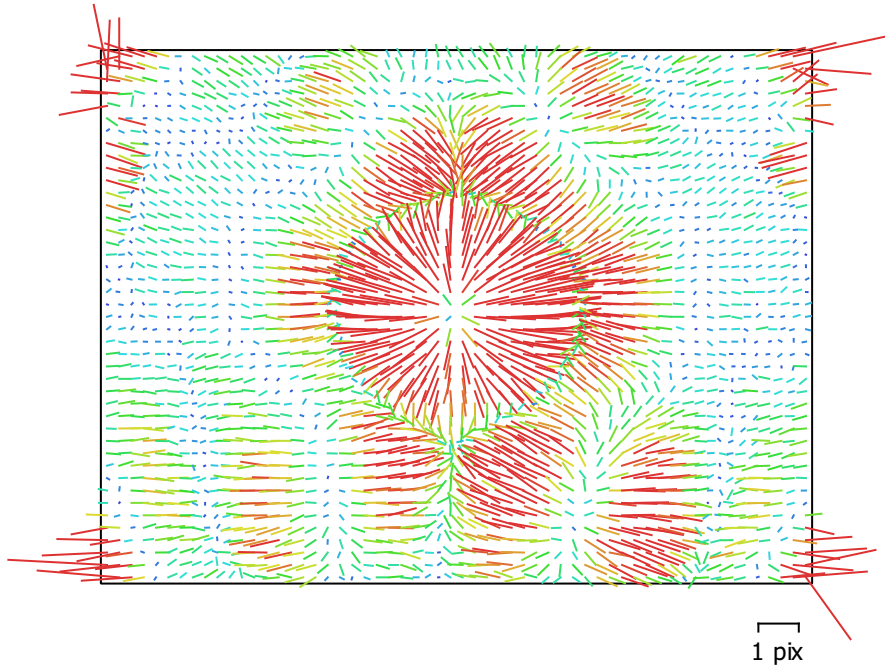


Fig. 2. Image residuals for FC220 (4.7mm).

FC220 (4.7mm)

84 images

Type	Resolution	Focal Length	Pixel Size
Frame	4000 x 3000	4.7 mm	1.56 x 1.56 μm

	Value	Error	F	Cx	Cy	K1	K2	K3	P1	P2
F	2990.4	1.1	1.00	0.39	-0.99	0.22	-0.26	0.34	-0.02	-0.19
Cx	1.19073	0.14		1.00	-0.39	0.10	-0.12	0.15	0.52	-0.07
Cy	51.277	1.1			1.00	-0.23	0.28	-0.37	0.02	0.18
K1	0.0315053	0.00017				1.00	-0.91	0.86	0.09	-0.41
K2	-0.0871452	0.00056					1.00	-0.98	-0.04	0.13
K3	0.0868405	0.00063						1.00	0.03	-0.14
P1	-0.000792495	9.4e-06							1.00	-0.12
P2	0.000150465	3e-05								1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Locations

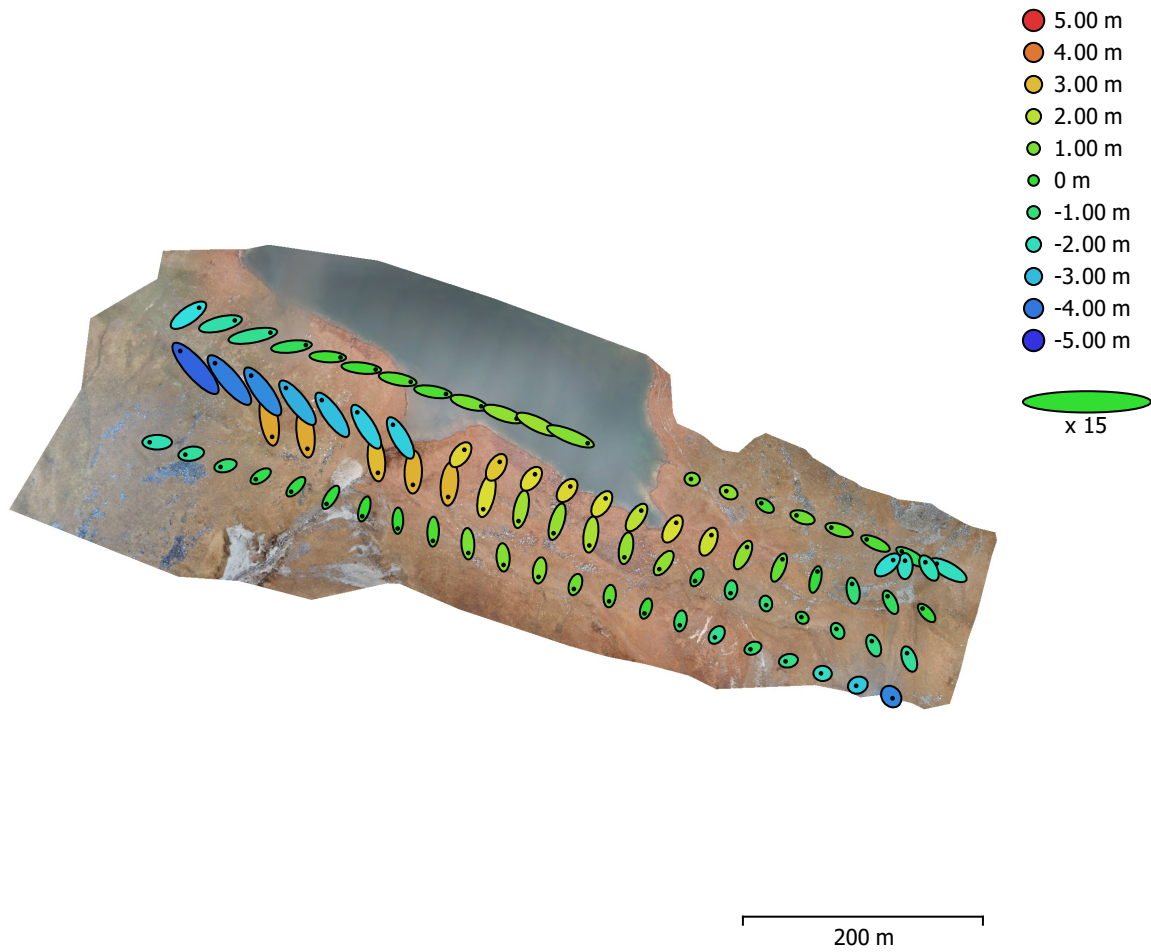


Fig. 3. Camera locations and error estimates.

Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
0.791034	0.857312	1.8647	1.1665	2.1995

Table 3. Average camera location error.
X - Longitude, Y - Latitude, Z - Altitude.

Digital Elevation Model

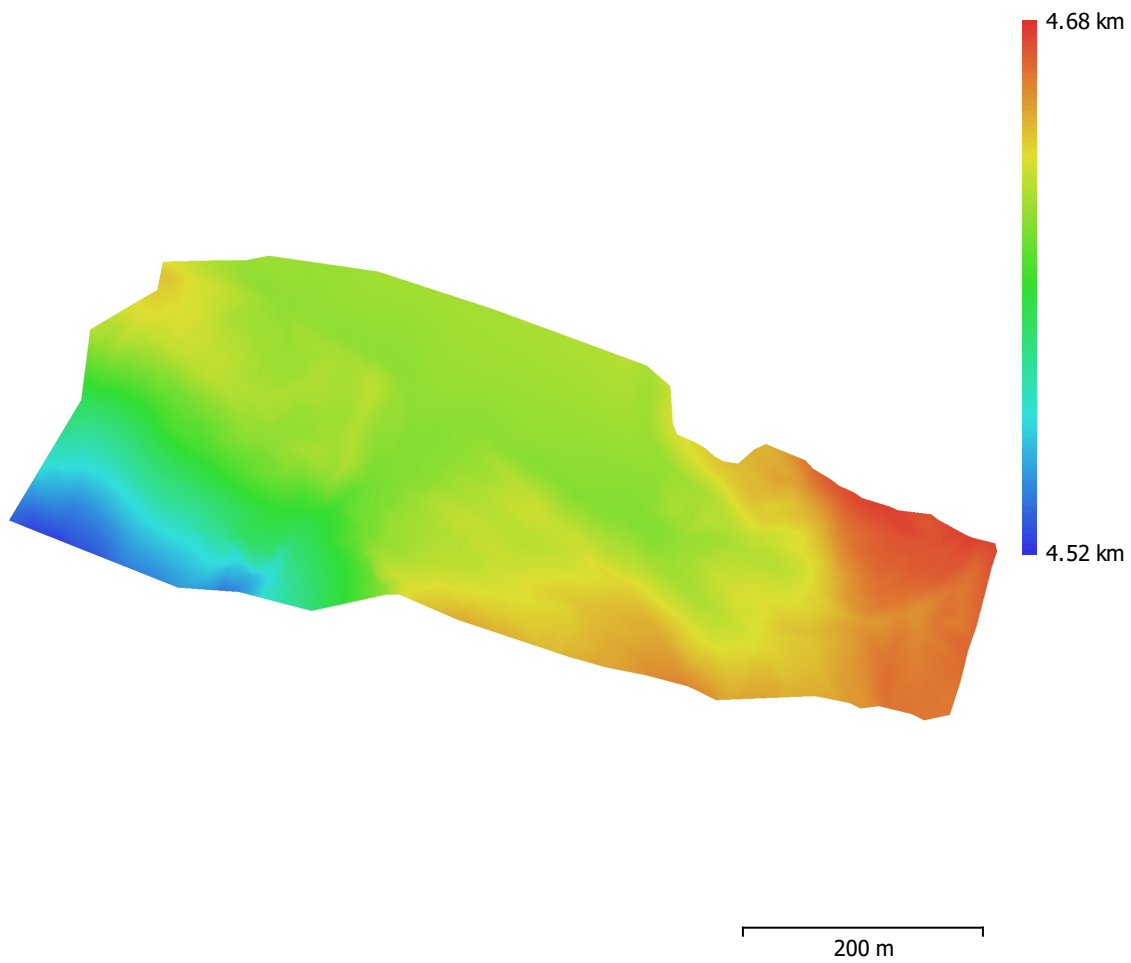


Fig. 4. Reconstructed digital elevation model.

Resolution: 6.94 cm/pix
Point density: 208 points/m²

Processing Parameters

General

Images	84
Aligned images	84
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll

Shapes

Polygon	2
Coordinate system	WGS 84 / UTM zone 44N (EPSG::32644)

Tie Points

Points	120,371 of 129,538
Point colors	3 bands, uint8
RMS reprojection error	0.263872 (1.11647 pix)
Max reprojection error	0.793438 (14.8004 pix)
Mean key point size	4.23243 pix
Key points	No
Average tie point multiplicity	2.81892

Alignment parameters

Accuracy	High
Generic preselection	Yes
Reference preselection	Source
Key point limit	40,000
Key point limit per Mpx	1,000
Tie point limit	4,000
Exclude stationary tie points	Yes
Guided image matching	No
Adaptive camera model fitting	No
Matching time	42 seconds
Matching memory usage	452.75 MB
Alignment time	14 seconds
Alignment memory usage	82.34 MB
Date created	2025:09:02 13:16:46
Software version	2.2.2.21069
File size	8.71 MB

Depth Maps

Count	84
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Max neighbors	16
Processing time	1 minutes 27 seconds
Memory usage	1.83 GB
Date created	2025:09:02 13:25:47
Software version	2.2.2.21069
File size	266.41 MB

Point Cloud

Points	48,349,816
Coordinate precision	1.73 cm

Point attributes

Color	3 bands, uint8
Normal	

Confidence	1 - 18
Point classes	
Created (never classified)	48,349,816
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Max neighbors	16
Processing time	1 minutes 27 seconds
Memory usage	1.83 GB
Point cloud generation parameters	
Source data	Depth maps
Processing time	2 minutes 38 seconds
Memory usage	2.21 GB
Date created	2025:09:02 13:28:29
Software version	2.2.2.21069
File size	695.71 MB
Model	
Faces	5,091,436
Vertices	3,219,269
Vertex colors	3 bands, uint8
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Max neighbors	16
Processing time	1 minutes 27 seconds
Memory usage	1.83 GB
Point cloud generation parameters	
Source data	Depth maps
Processing time	2 minutes 38 seconds
Memory usage	2.21 GB
Reconstruction parameters	
Surface type	Height field
Source data	Point cloud
Interpolation	Disabled
Strict volumetric masks	No
Processing time	1 minutes 44 seconds
Memory usage	883.45 MB
Date created	2025:09:02 14:21:57
Software version	2.2.2.21069
File size	109.17 MB
DEM	
Size	13,909 x 5,760
Resolution	6.94 cm/pix
Coordinate system	WGS 84 / UTM zone 44N (EPSG::32644)
Reconstruction parameters	
Source data	Point cloud
Interpolation	Enabled
Processing time	25 seconds
Memory usage	318.36 MB
Date created	2025:10:03 10:59:37
Software version	2.2.2.21069
File size	159.47 MB
Orthomosaic	
Size	27,569 x 11,417
Resolution	3.50 cm/pix
Coordinate system	WGS 84 / UTM zone 44N (EPSG::32644)

Colors 3 bands, uint8
Orthophotos 392.36 MB

Reconstruction parameters

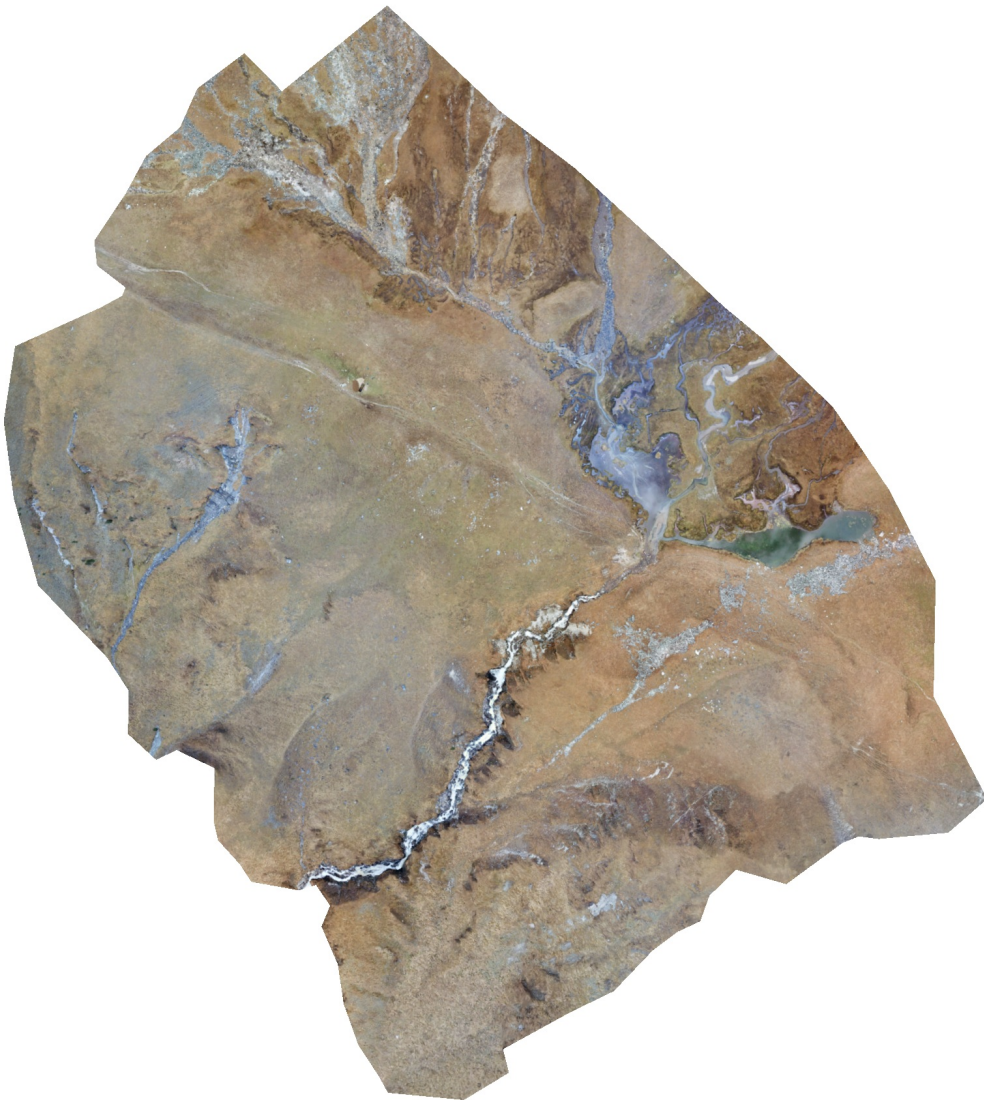
Blending mode Mosaic
Surface DEM
Enable hole filling Yes
Enable ghosting filter No
Processing time 1 minutes 20 seconds
Memory usage 1.60 GB
Date created 2025:10:03 11:01:39
Software version 2.2.2.21069
File size 557.14 MB

System

Software name Agisoft Metashape Professional
Software version 2.2.2 build 21069
OS Windows 64 bit
RAM 127.63 GB
CPU 13th Gen Intel(R) Core(TM) i9-13900
GPU(s) NVIDIA RTX 4000 Ada Generation

WNFS_Naya_Ban

Processing Report
03 October 2025



Survey Data

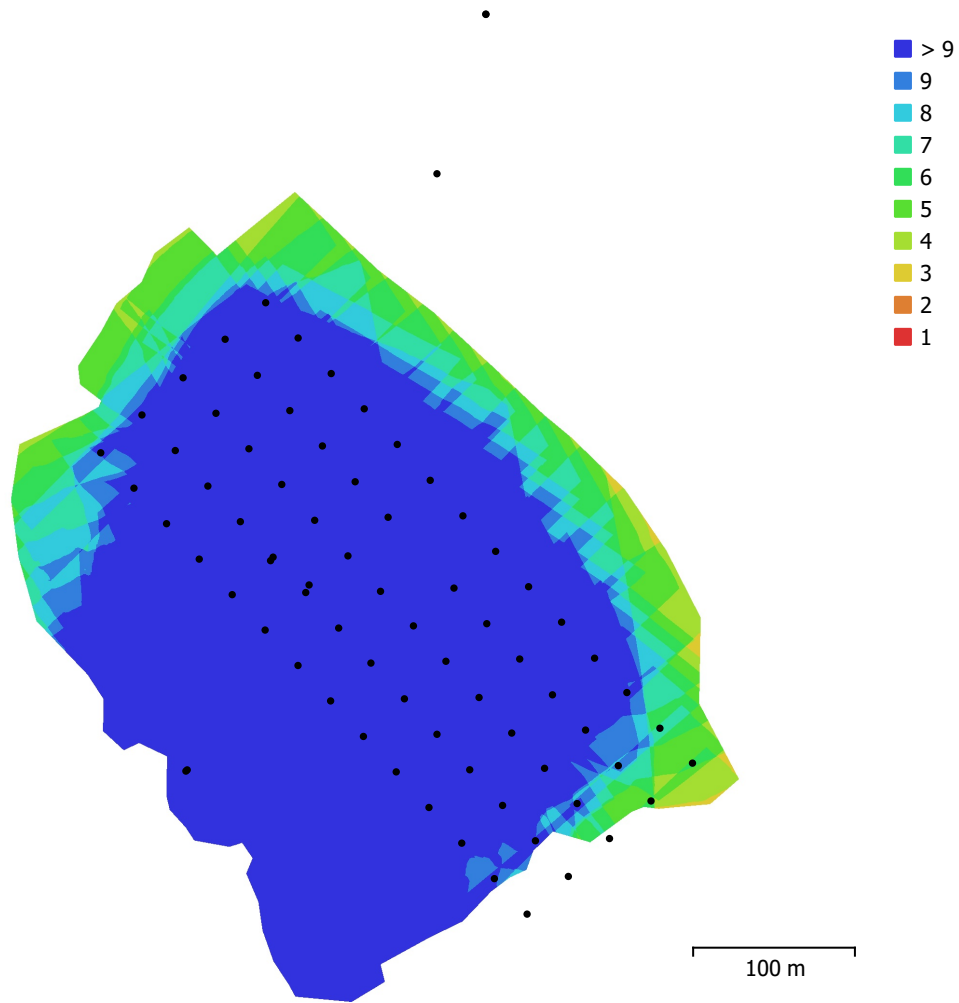


Fig. 1. Camera locations and image overlap.

Number of images:	76	Camera stations:	76
Flying altitude:	108 m	Tie points:	78,766
Ground resolution:	3.91 cm/pix	Projections:	267,067
Coverage area:	0.131 km ²	Reprojection error:	0.797 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC220 (4.7mm)	4000 x 3000	4.7 mm	1.56 x 1.56 μm	No

Table 1. Cameras.

Camera Calibration

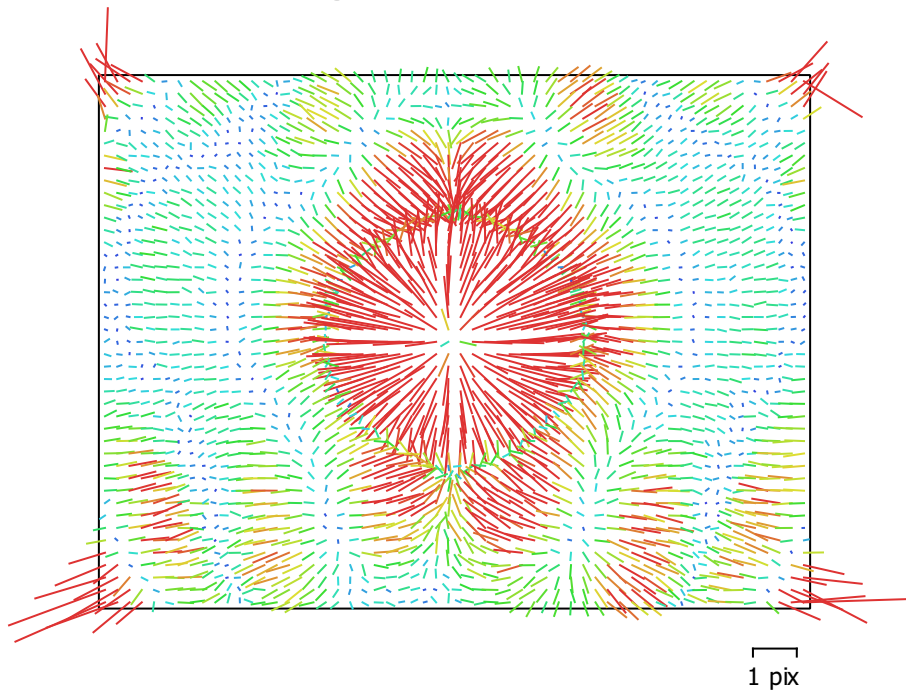


Fig. 2. Image residuals for FC220 (4.7mm).

FC220 (4.7mm)

76 images

Type	Resolution	Focal Length	Pixel Size
Frame	4000 x 3000	4.7 mm	1.56 x 1.56 μm

	Value	Error	F	Cx	Cy	K1	K2	K3	P1	P2
F	3063	0.32	1.00	0.03	-0.96	0.03	0.02	0.01	0.01	-0.37
Cx	1.40289	0.095		1.00	-0.05	0.01	-0.01	0.01	0.65	-0.07
Cy	-9.45462	0.33			1.00	-0.11	0.07	-0.09	-0.01	0.37
K1	0.0202155	0.00013				1.00	-0.95	0.91	0.05	-0.20
K2	-0.0560929	0.00046					1.00	-0.99	-0.02	0.04
K3	0.0571564	0.00051						1.00	0.02	-0.05
P1	-0.000622333	7.5e-06							1.00	-0.11
P2	0.000389084	1.4e-05								1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Locations

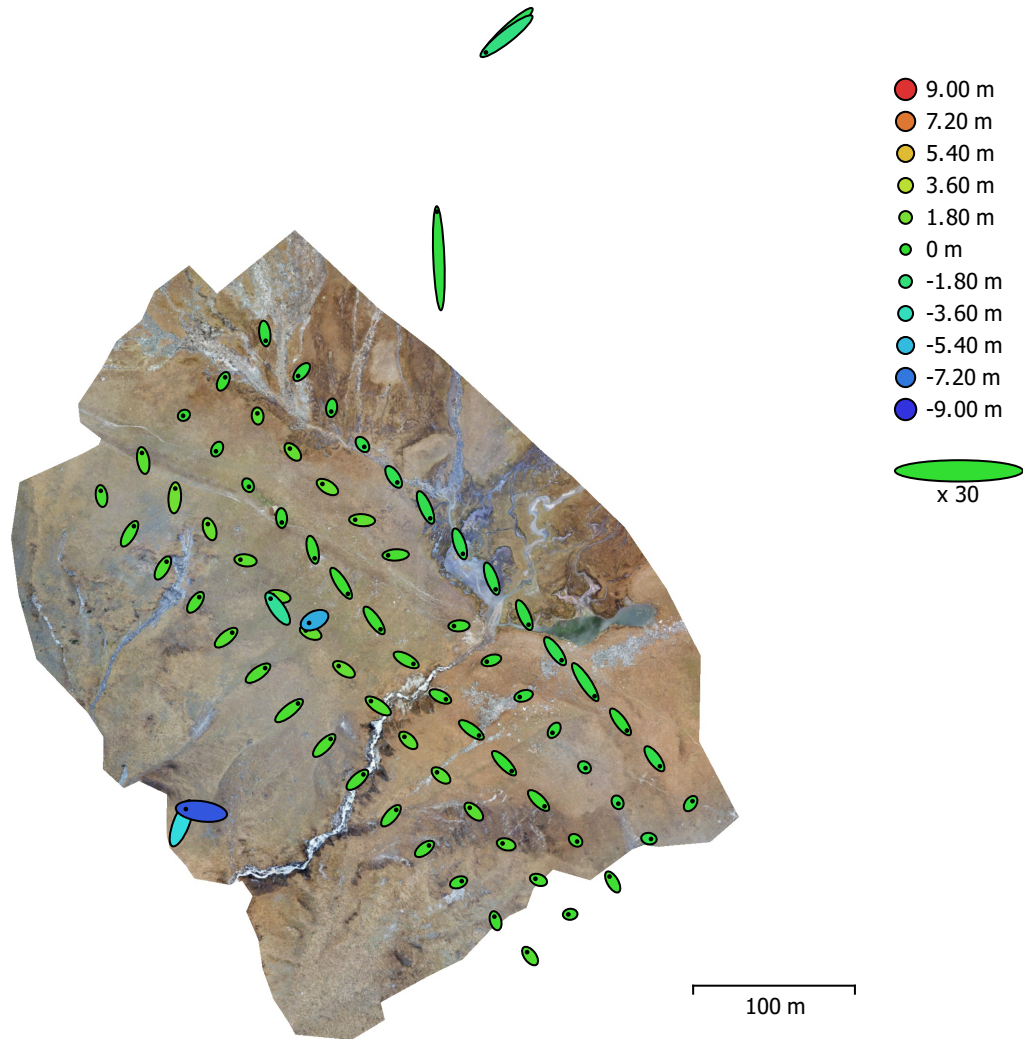


Fig. 3. Camera locations and error estimates.

Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
0.245218	0.344409	1.48698	0.422788	1.54592

Table 3. Average camera location error.
X - Longitude, Y - Latitude, Z - Altitude.

Digital Elevation Model

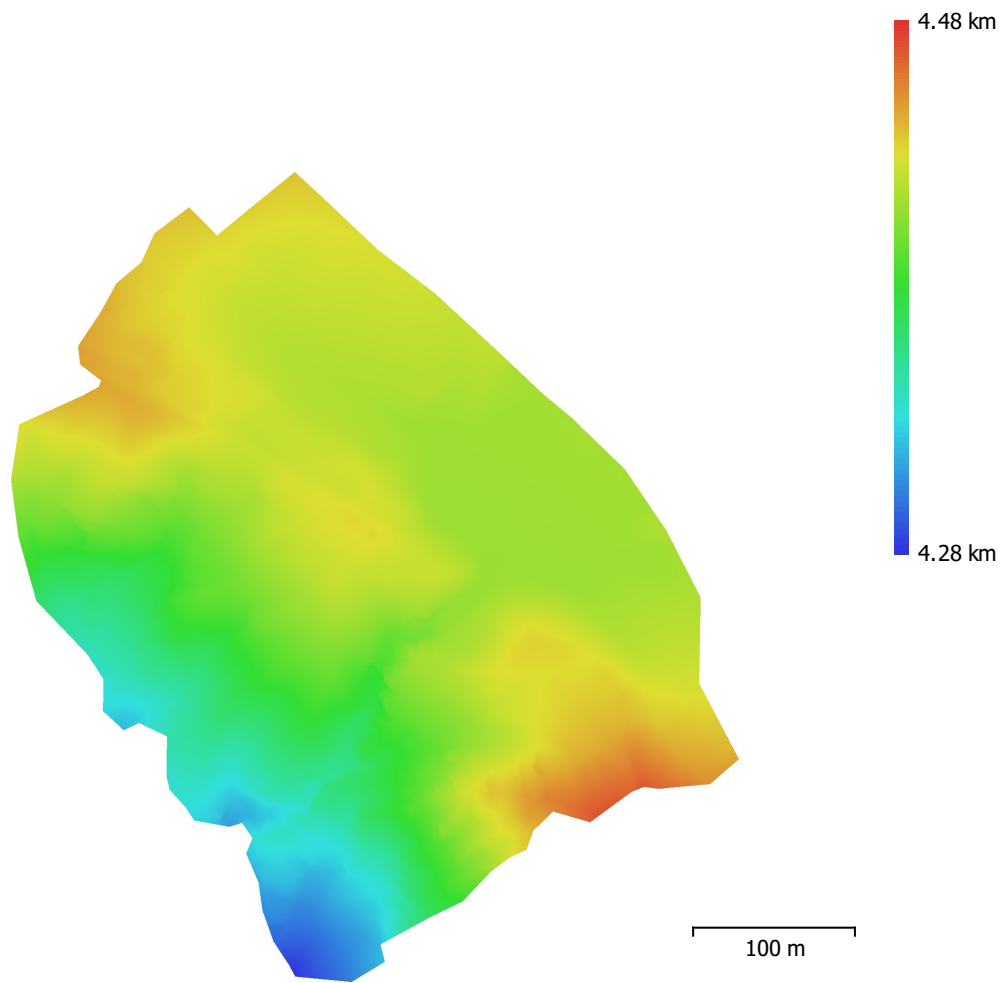


Fig. 4. Reconstructed digital elevation model.

Resolution: 7.82 cm/pix
Point density: 164 points/m²

Processing Parameters

General

Images	76
Aligned images	76
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll

Shapes

Polygon	1
Coordinate system	WGS 84 (EPSG::4326)

Tie Points

Points	78,766 of 90,754
Point colors	3 bands, uint8
RMS reprojection error	0.29898 (0.796662 pix)
Max reprojection error	0.913378 (15.7597 pix)
Mean key point size	2.71258 pix
Key points	No
Average tie point multiplicity	3.57045

Alignment parameters

Accuracy	High
Generic preselection	Yes
Reference preselection	Source
Key point limit	40,000
Key point limit per Mpx	1,000
Tie point limit	4,000
Exclude stationary tie points	Yes
Guided image matching	No
Adaptive camera model fitting	No
Matching time	27 seconds
Matching memory usage	423.36 MB
Alignment time	8 seconds
Alignment memory usage	49.60 MB
Date created	2025:09:02 15:03:18
Software version	2.2.2.21069
File size	7.02 MB

Depth Maps

Count	76
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Max neighbors	16
Processing time	1 minutes 38 seconds
Memory usage	2.06 GB
Date created	2025:09:02 15:12:31
Software version	2.2.2.21069
File size	346.87 MB

Point Cloud

Points	46,195,536
Coordinate precision	1.95 cm

Point attributes

Color	3 bands, uint8
Normal	

Confidence	1 - 21
Point classes	
Created (never classified)	46,195,536
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Max neighbors	16
Processing time	1 minutes 38 seconds
Memory usage	2.06 GB
Point cloud generation parameters	
Source data	Depth maps
Processing time	2 minutes 47 seconds
Memory usage	3.75 GB
Date created	2025:09:02 15:15:21
Software version	2.2.2.21069
File size	658.97 MB
DEM	
Size	7,598 x 8,275
Resolution	7.82 cm/pix
Coordinate system	WGS 84 / UTM zone 44N (EPSG::32644)
Reconstruction parameters	
Source data	Point cloud
Interpolation	Enabled
Processing time	15 seconds
Memory usage	310.32 MB
Date created	2025:10:03 10:26:41
Software version	2.2.2.21069
File size	139.47 MB
Orthomosaic	
Size	14,854 x 16,178
Resolution	4.00 cm/pix
Coordinate system	WGS 84 / UTM zone 44N (EPSG::32644)
Colors	3 bands, uint8
Orthophotos	420.78 MB
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Enable ghosting filter	No
Processing time	1 minutes 14 seconds
Memory usage	1.71 GB
Date created	2025:10:03 10:31:09
Software version	2.2.2.21069
File size	586.34 MB
System	
Software name	Agisoft Metashape Professional
Software version	2.2.2 build 21069
OS	Windows 64 bit
RAM	127.63 GB
CPU	13th Gen Intel(R) Core(TM) i9-13900
GPU(s)	NVIDIA RTX 4000 Ada Generation