LAMPIRAN A

Dokumentasi

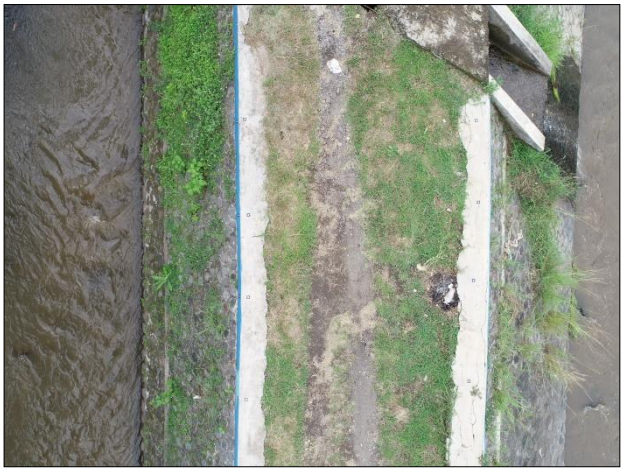
- **Persiapan UAV dan Pemotretan**

- **Pemotretan Kamera DSLR**

- **Pemasangan dan Pengukuran Jarak Langsung Retro**

LAMPIRAN B

Data Foto UAV



LAMPIRAN C

Data Foto DSLR

Agisoft PhotoScan

Processing Report

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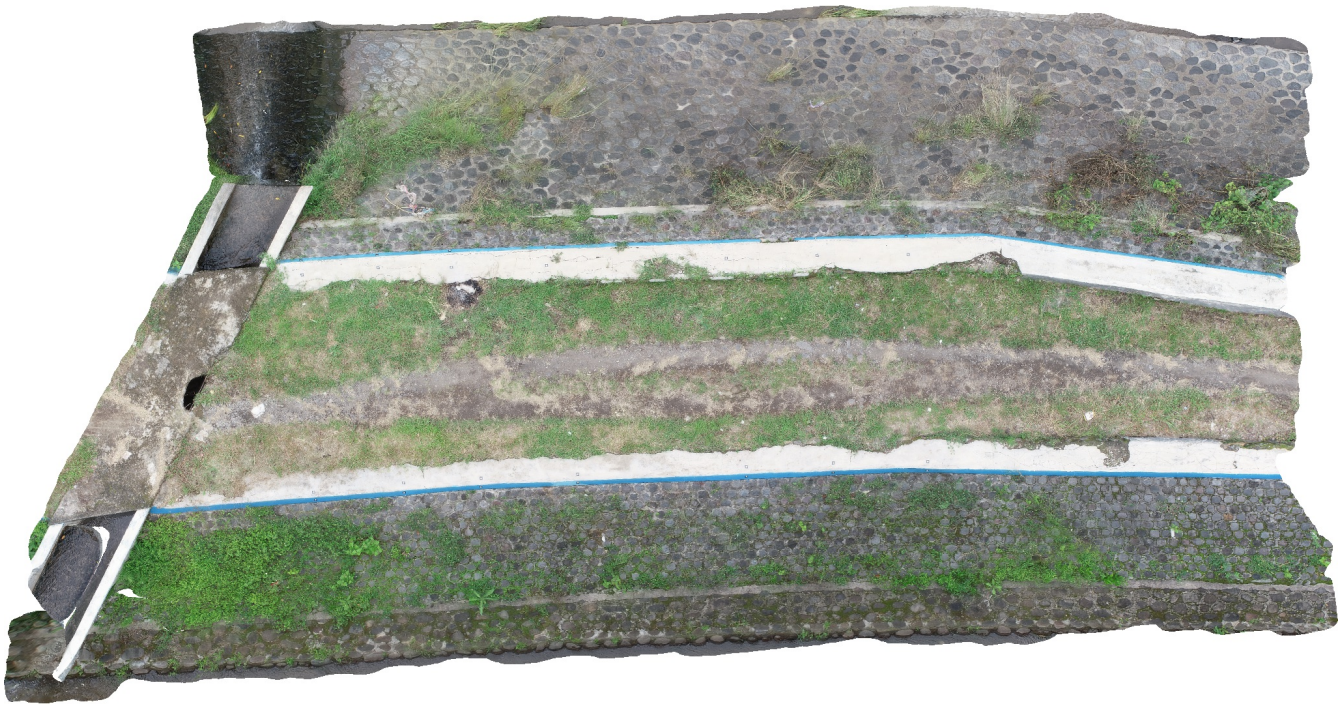

Survey Data

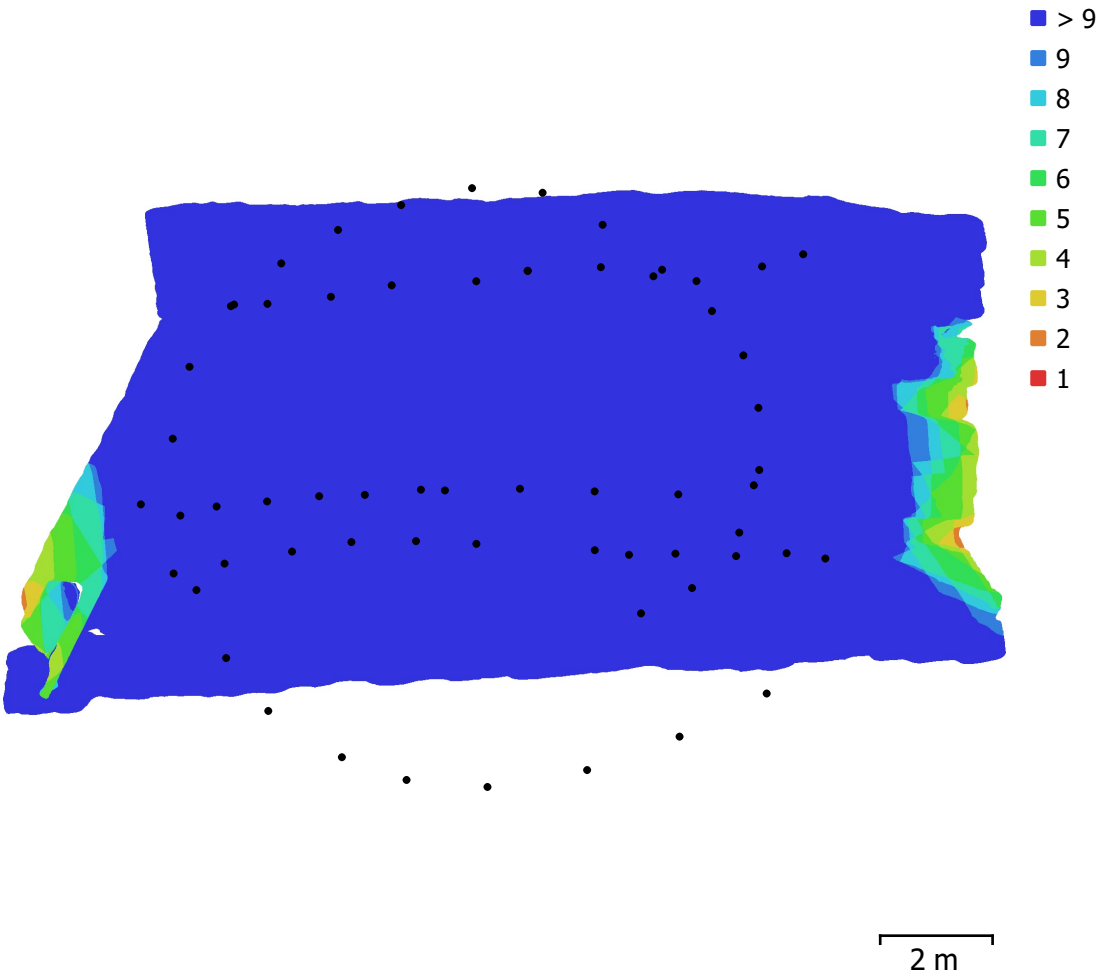

Fig. 1. Camera locations and image overlap.

Number of images:	62	Camera stations:	62
Flying altitude:	7.28 m	Tie points:	43,558
Ground resolution:	1.97 mm/pix	Projections:	198,352
Coverage area:	135 m²	Reprojection error:	0.555 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC6310 (8.8mm)	4864 x 3648	8.8 mm	2.61 x 2.61 µm	No

Table 1. Cameras.

Camera Calibration

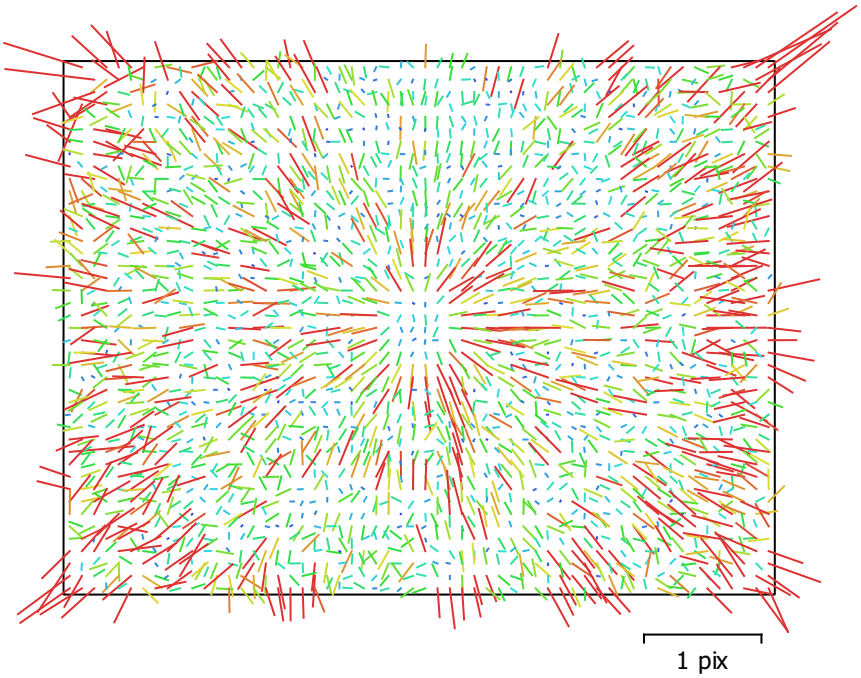

Fig. 2. Image residuals for FC6310 (8.8mm).

FC6310 (8.8mm)

62 images

Type	Resolution	Focal Length	Pixel Size
Frame	**4864 x 3648**	**8.8 mm**	**2.61 x 2.61 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	P1	P2
F	**3664.23**	0.07	1.00	-0.01	-0.48	-0.35	-0.01	-0.05	0.17	-0.14	0.06	-0.42
Cx	**3.1157**	0.041		1.00	-0.10	-0.02	0.14	0.01	-0.02	0.02	0.83	-0.13
Cy	**16.8631**	0.045			1.00	0.14	-0.03	-0.14	0.04	-0.03	-0.10	0.88
B1	**-0.126943**	0.016				1.00	0.05	-0.10	-0.02	0.03	-0.10	0.27
B2	**0.157084**	0.013					1.00	0.03	-0.05	0.06	-0.16	-0.12
K1	**0.00636229**	5.4e-05						1.00	-0.95	0.89	-0.02	-0.15
K2	**-0.0246651**	0.00019							1.00	-0.98	0.02	0.04
K3	**0.0264966**	0.0002								1.00	-0.02	-0.03
P1	**0.000751274**	3.8e-06									1.00	-0.10
P2	**0.000736931**	4.7e-06										1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Locations

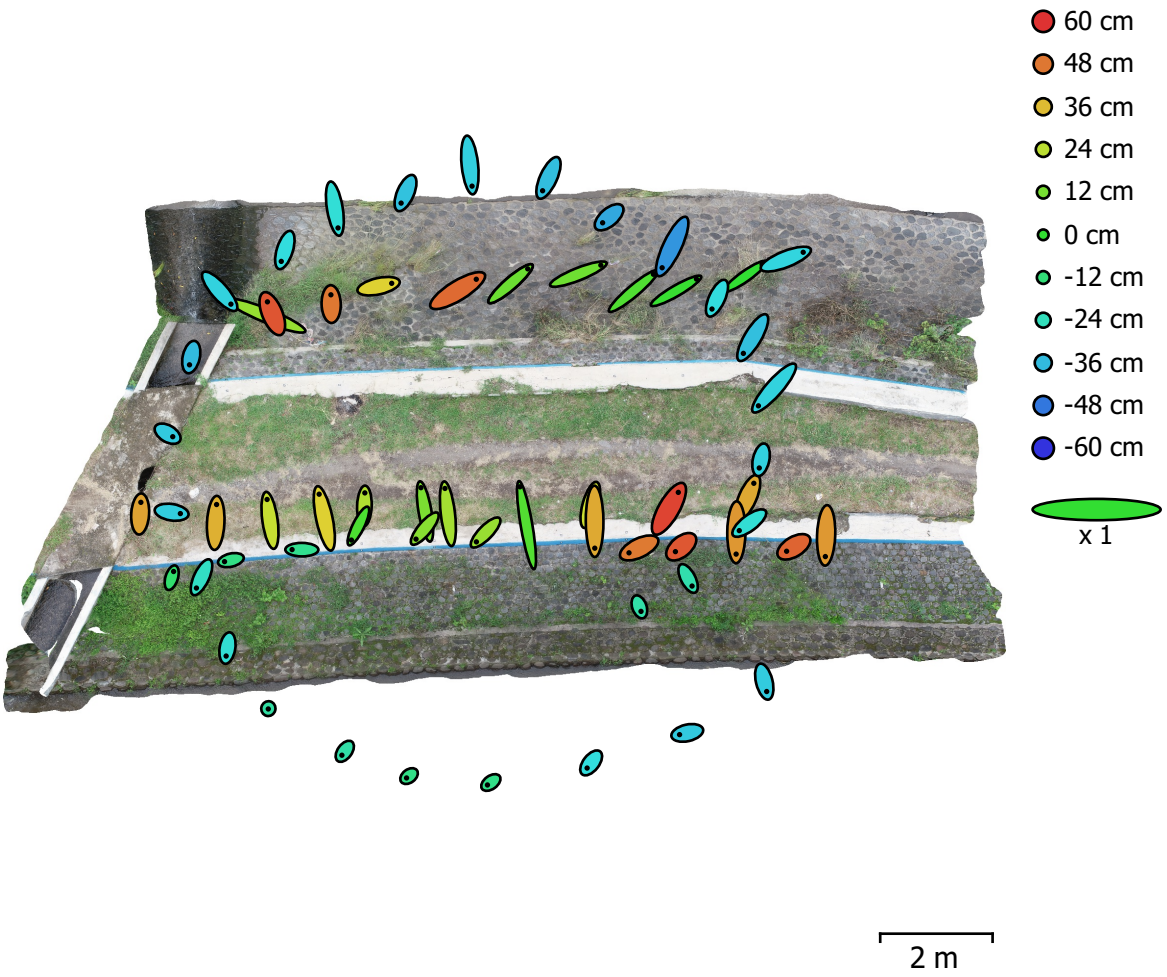

Fig. 3. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total error (cm)
34.8599	49.545	31.2862	60.5799	68.1817

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

Ground Control Points

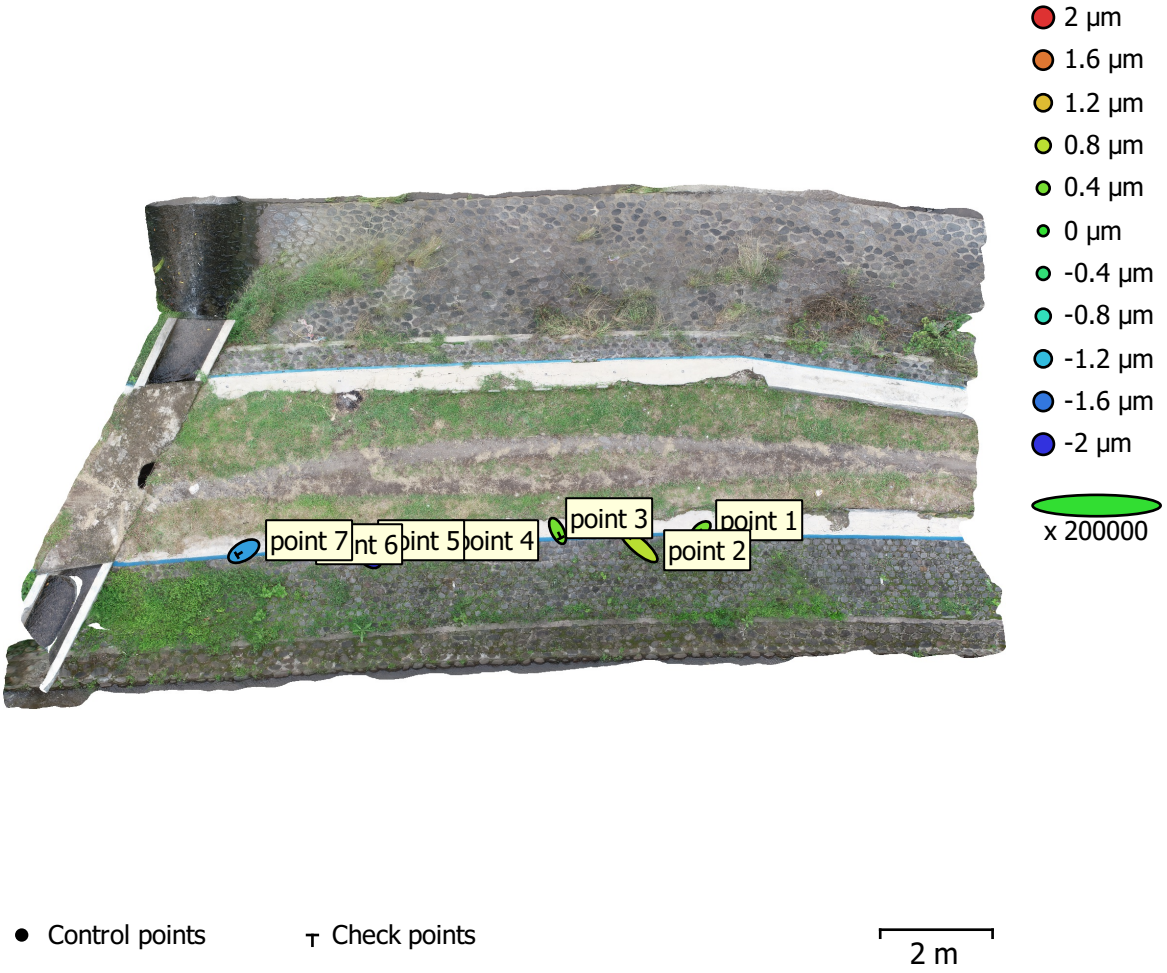

Fig. 4. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (µm)	Y error (µm)	Z error (µm)	XY error (µm)	Total (µm)
7	1.14791	1.07469	0.996315	1.57247	1.86154

Table 4. Check points RMSE.
X - Longitude, Y - Latitude, Z - Altitude.

Label	X error (μm)	Y error (μm)	Z error (μm)	Total (μm)	Image (pix)
point 1	-0.697458	-0.582275	0.399034	0.992331	0.003 (32)
point 2	-2.22192	1.90418	0.778778	3.02809	0.004 (37)
point 3	0.606261	-1.23222	0.378059	1.42438	0.004 (38)
point 4	-0.498526	0.402249	-0.413989	0.762706	0.004 (38)
point 5	-0.955177	1.12862	-1.98077	2.47176	0.004 (39)
point 6	0.86614	-0.791913	0.25899	1.20183	0.003 (37)
point 7	-1.23366	-0.733967	-1.37037	1.98458	0.004 (29)
Total	**1.14791**	**1.07469**	**0.996315**	**1.86154**	**0.004**

Table 5. Check points.

X - Longitude, Y - Latitude, Z - Altitude.

Scale Bars

Label	Distance (m)	Error (m)
point 1_point 2	1.25873	-0.00126969
point 2_point 3	1.16248	0.000482259
point 3_point 4	2.26145	0.00945105
point 4_point 5	1.29605	0.00604762
point 5_point 6	1.02692	-0.00908133
point 6_point 7	1.19389	-0.0101078
Total		**0.00721548**

Table 6. Control scale bars.

Digital Elevation Model

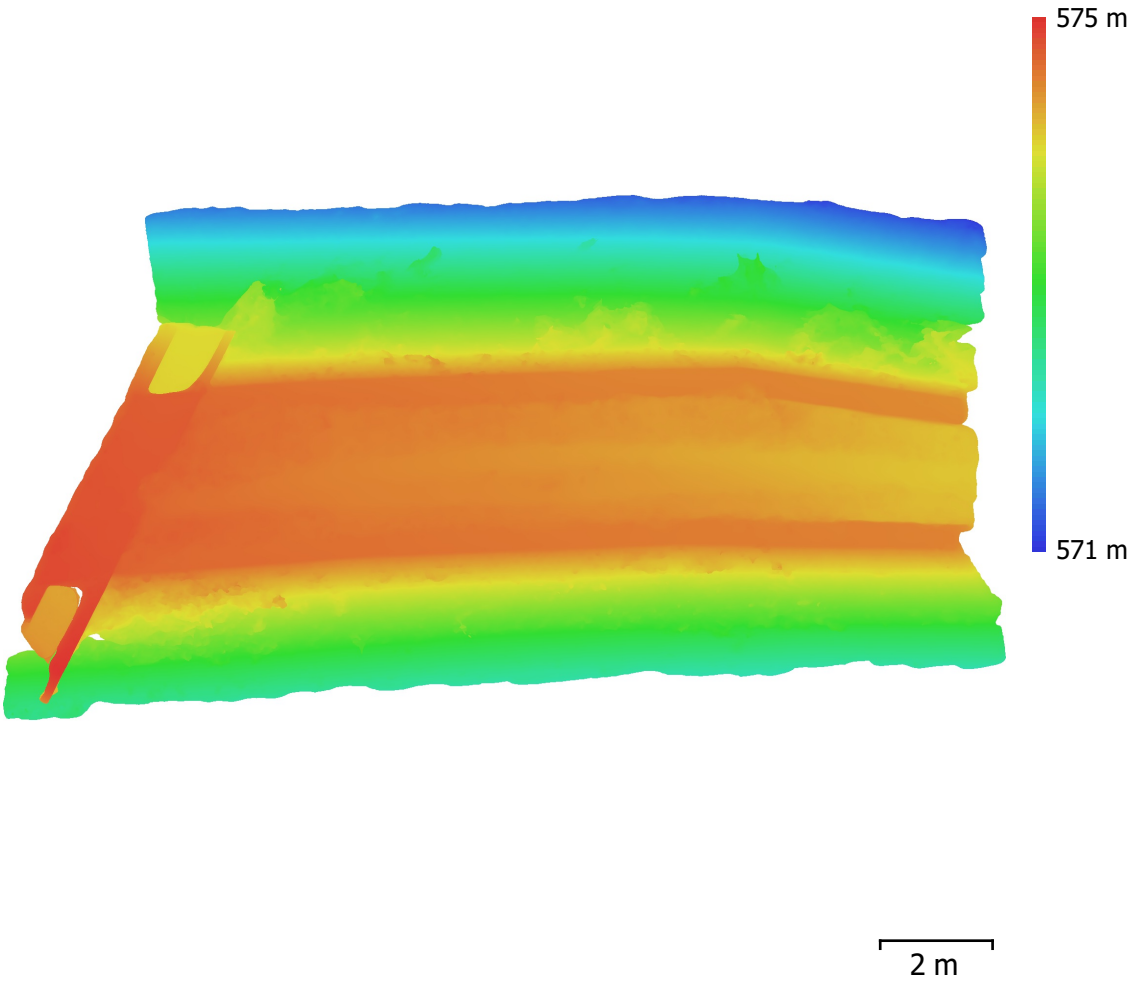

Fig. 5. Reconstructed digital elevation model.

Resolution:	3.94 mm/pix
Point density:	6.43 points/cm²

Processing Parameters

General	
Cameras	62
Aligned cameras	62
Markers	7
Scale bars	6
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	43,558 of 53,613
RMS reprojection error	0.162017 (0.555213 pix)
Max reprojection error	0.486297 (24.4157 pix)
Mean key point size	2.91922 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	4.83595
Alignment parameters	
Accuracy	High
Generic preselection	No
Reference preselection	Yes
Key point limit	40,000
Tie point limit	4,000
Adaptive camera model fitting	Yes
Matching time	26 minutes 15 seconds
Alignment time	42 seconds
Dense Point Cloud	
Points	13,220,875
Point colors	3 bands, uint8
Reconstruction parameters	
Quality	High
Depth filtering	Aggressive
Depth maps generation time	6 hours 11 minutes
Dense cloud generation time	3 hours 40 minutes
Model	
Faces	881,391
Vertices	443,397
Vertex colors	3 bands, uint8
Texture	4,096 x 4,096, 4 bands, uint8
Reconstruction parameters	
Surface type	Arbitrary
Source data	Dense
Interpolation	Enabled
Quality	High
Depth filtering	Aggressive
Face count	881,391
Processing time	1 hours 7 minutes
Texturing parameters	
Blending mode	Mosaic
Texture size	4,096 x 4,096
UV mapping time	8 minutes 30 seconds
Blending time	1 minutes 35 seconds
Software	
Version	1.4.5 build 7354
Platform	Windows 64

Agisoft PhotoScan

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Survey Data

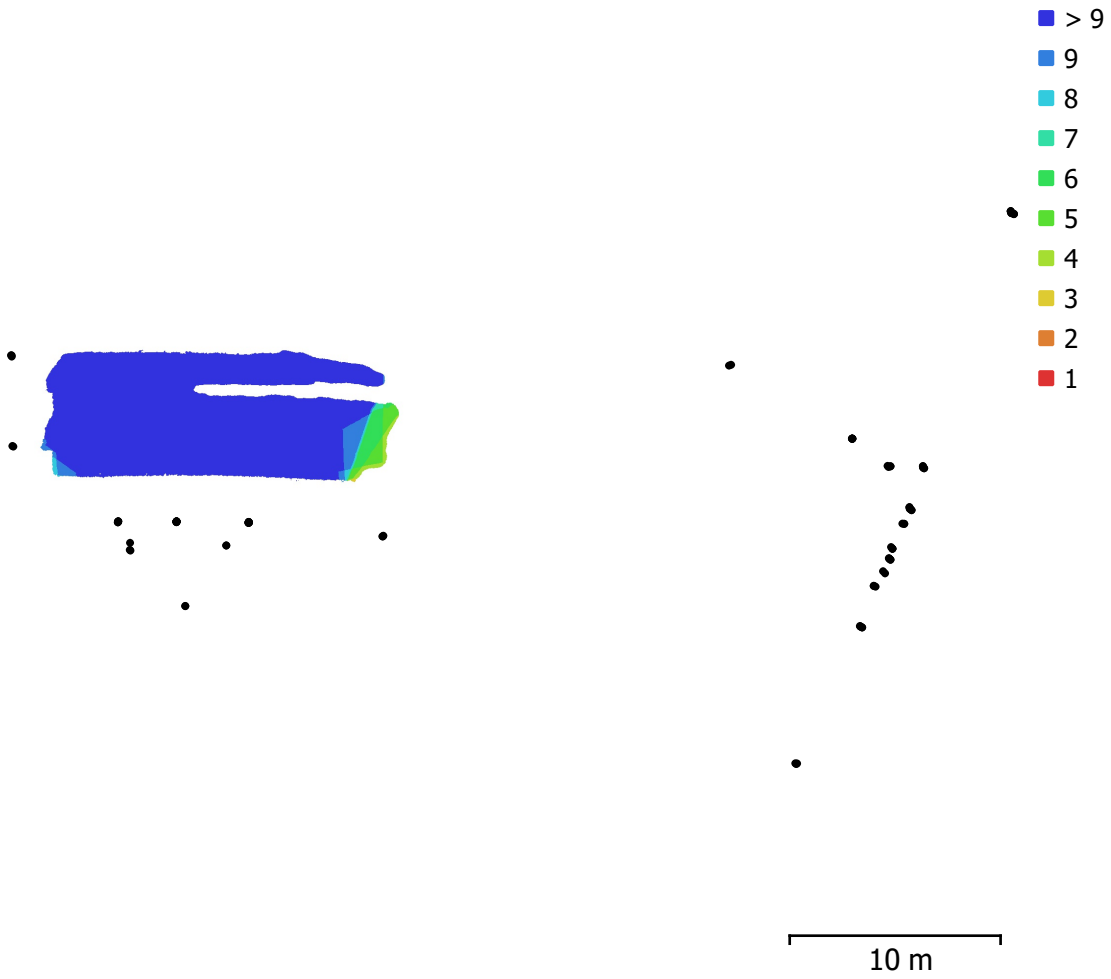

Fig. 1. Camera locations and image overlap.

Number of images:	95	Camera stations:	95
Flying altitude:	8.42 m	Tie points:	10,132
Ground resolution:	1.79 mm/pix	Projections:	71,608
Coverage area:	86.4 m²	Reprojection error:	0.619 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
NIKON D3400 (18mm)	6000 x 4000	18 mm	4 x 4 µm	No

Table 1. Cameras.

Camera Calibration

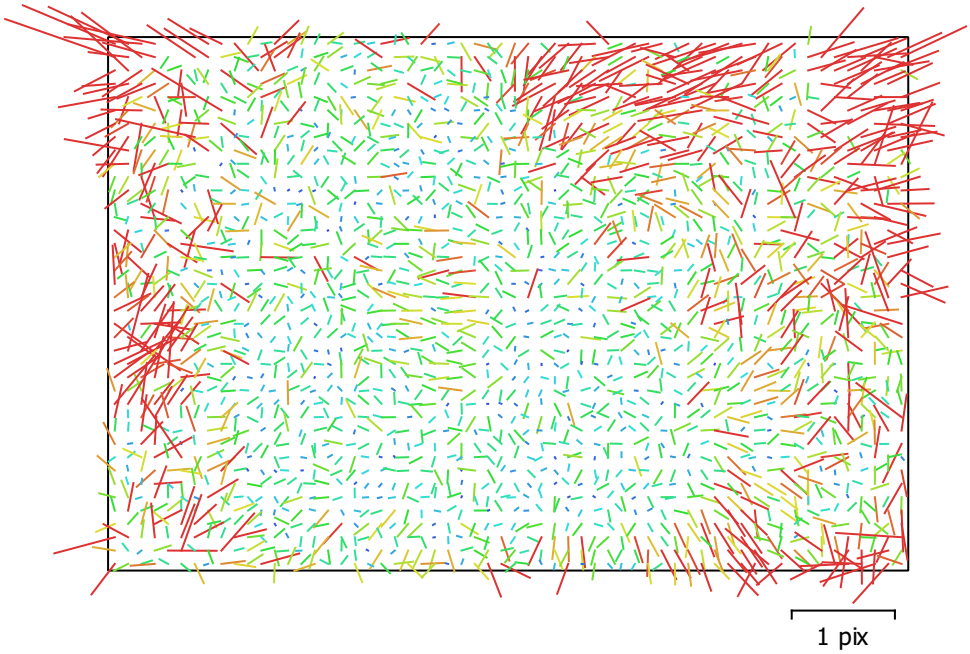

Fig. 2. Image residuals for NIKON D3400 (18mm).

NIKON D3400 (18mm)

95 images

Type	Resolution	Focal Length	Pixel Size
Frame	**6000 x 4000**	**18 mm**	**4 x 4 µm**

F:	4702.5		
Cx:	5.11501	B1:	-0.248882
Cy:	3.61958	B2:	0.736267
K1:	-0.0962934	P1:	0.000361414
K2:	0.0244213	P2:	0.00037287
K3:	0	P3:	0
K4:	0	P4:	0

Scale Bars

Label	Distance (m)	Error (m)
point 1_point 2	1.26044	0.000439801
point 2_point 3	1.15836	-0.00364371
point 3_point 4	2.25879	0.00678579
point 4_point 5	1.29874	0.00873872
point 5_point 6	1.02703	-0.00897236
point 6_point 7	1.19243	-0.011568
Total		**0.00763986**

Table 2. Control scale bars.

Digital Elevation Model

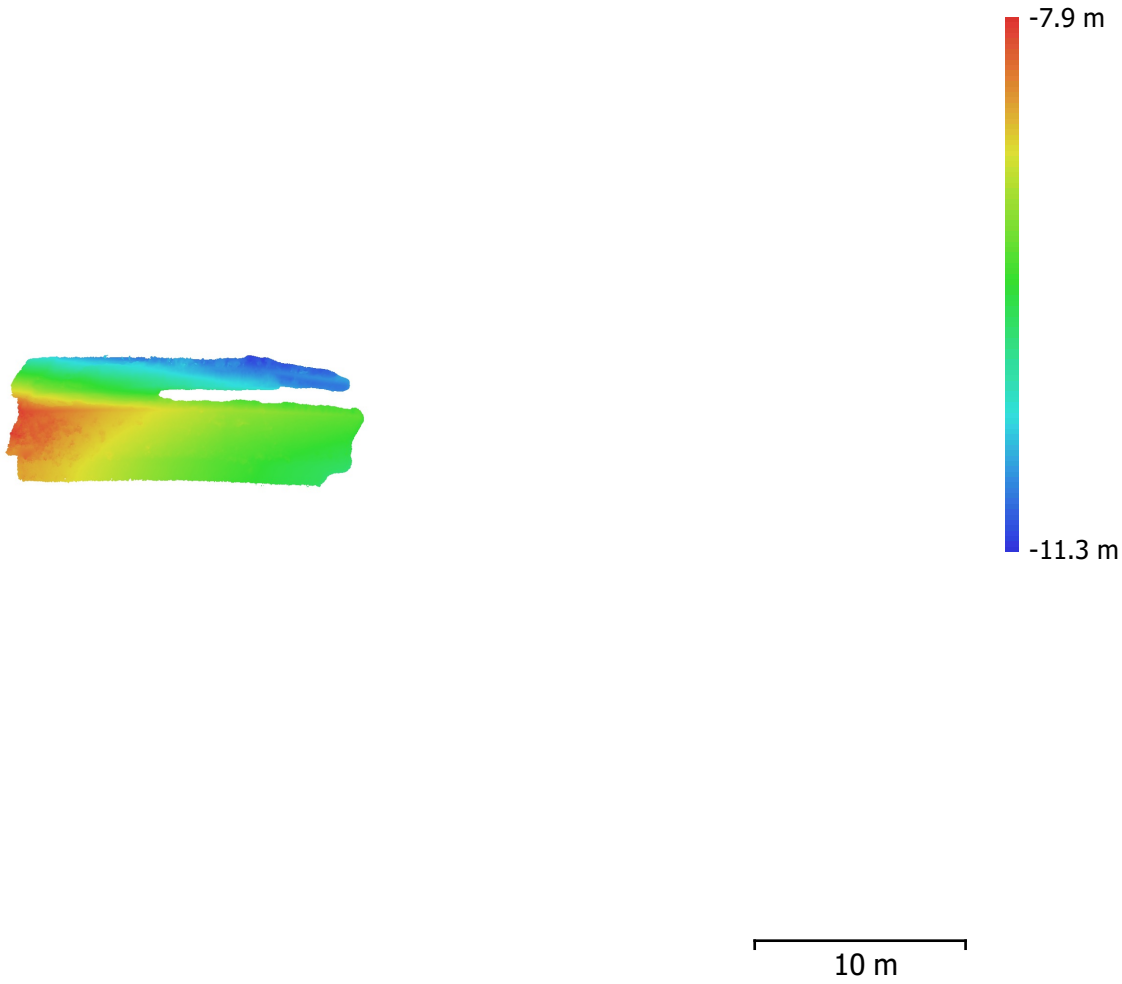

Fig. 3. Reconstructed digital elevation model.

Resolution:	unknown
Point density:	unknown

Processing Parameters

General	
Cameras	95
Aligned cameras	95
Markers	7
Scale bars	6
Coordinate system	Local Coordinates (m)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	10,132 of 73,067
RMS reprojection error	0.106831 (0.618546 pix)
Max reprojection error	0.386704 (13.2558 pix)
Mean key point size	5.42417 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	6.34342
Alignment parameters	
Accuracy	Medium
Generic preselection	Yes
Key point limit	40,000
Tie point limit	4,000
Adaptive camera model fitting	Yes
Matching time	1 hours 2 minutes
Alignment time	10 minutes 50 seconds
Dense Point Cloud	
Points	2,354,107
Point colors	3 bands, uint8
Reconstruction parameters	
Quality	Medium
Depth filtering	Aggressive
Dense cloud generation time	9 minutes 19 seconds
Model	
Faces	132,885
Vertices	67,524
Vertex colors	3 bands, uint8
Texture	4,096 x 4,096, 4 bands, uint8
Reconstruction parameters	
Surface type	Arbitrary
Source data	Dense
Interpolation	Enabled
Quality	Medium
Depth filtering	Aggressive
Face count	156,940
Processing time	3 minutes 17 seconds
Texturing parameters	
Blending mode	Mosaic
Texture size	4,096 x 4,096
UV mapping time	5 minutes 57 seconds
Blending time	1 minutes 28 seconds
Software	
Version	1.4.5 build 7354
Platform	Windows 64

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Survey Data

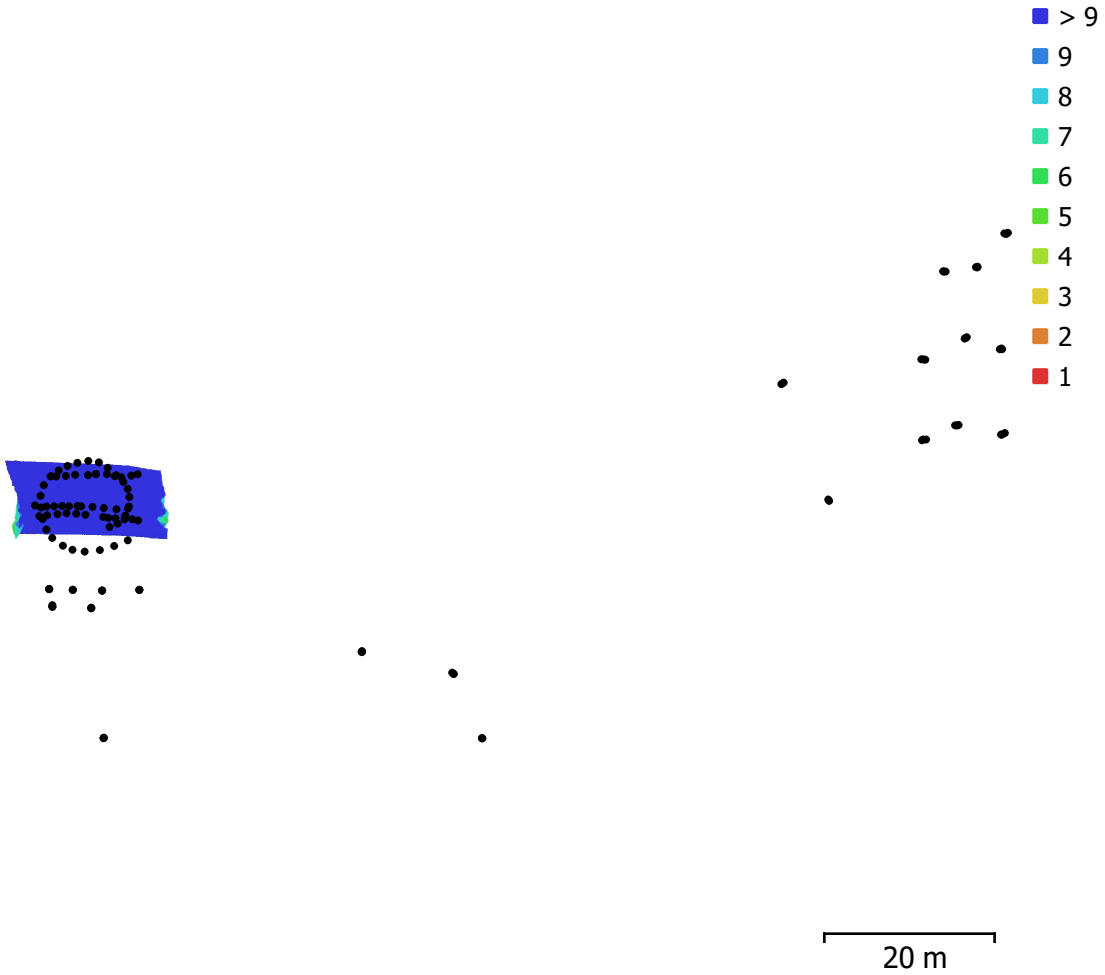

Fig. 1. Camera locations and image overlap.

Number of images:	127	Camera stations:	124
Flying altitude:	7.71 m	Tie points:	47,519
Ground resolution:	2.06 mm/pix	Projections:	218,801
Coverage area:	149 m²	Reprojection error:	0.527 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC6310 (8.8mm)	4864 x 3648	8.8 mm	2.61 x 2.61 µm	No
NIKON D3400 (18mm)	6000 x 4000	18 mm	4 x 4 µm	No

Table 1. Cameras.

Camera Calibration

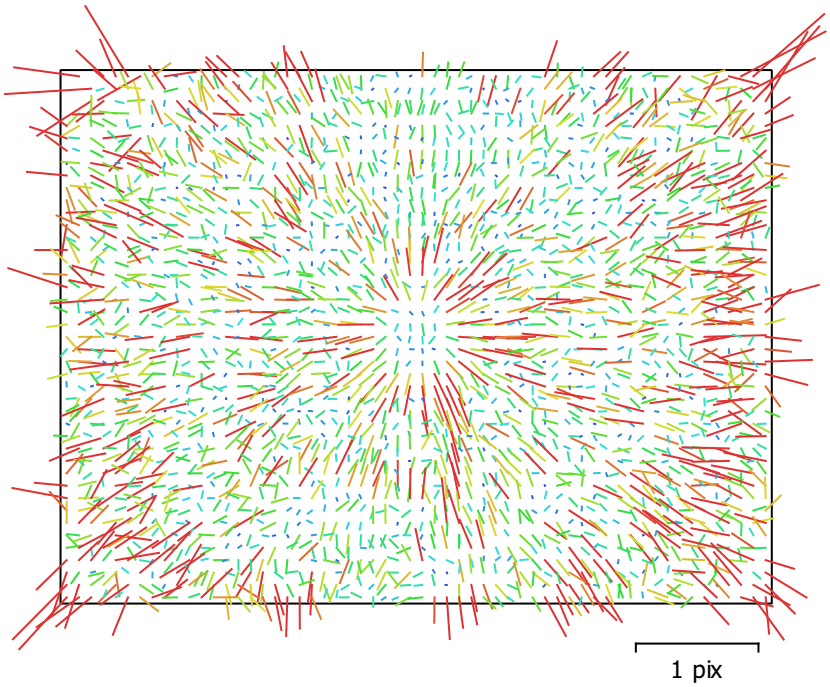

Fig. 2. Image residuals for FC6310 (8.8mm).

FC6310 (8.8mm)

62 images

Type	Resolution	Focal Length	Pixel Size
Frame	**4864 x 3648**	**8.8 mm**	**2.61 x 2.61 µm**

F:	3664.23		
Cx:	3.05016	B1:	-0.15305
Cy:	16.9108	B2:	0.14671
K1:	0.00641748	P1:	0.00074697
K2:	-0.024899	P2:	0.000738726
K3:	0.0267995	P3:	0
K4:	0	P4:	0

Camera Calibration

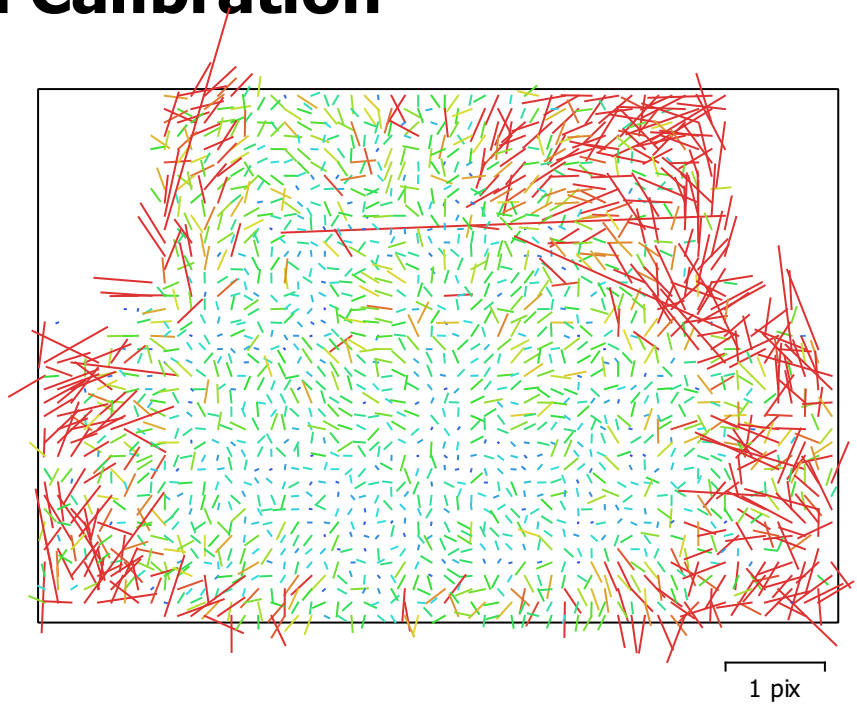

Fig. 3. Image residuals for NIKON D3400 (18mm).

NIKON D3400 (18mm)

65 images

Type	Resolution	Focal Length	Pixel Size
Frame	**6000 x 4000**	**18 mm**	**4 x 4 µm**

F:	4702.29		
Cx:	7.44159	B1:	-0.485193
Cy:	4.71948	B2:	0.592079
K1:	-0.0967828	P1:	0.00038783
K2:	0.0243633	P2:	0.000373648
K3:	0	P3:	0
K4:	0	P4:	0

Camera Locations

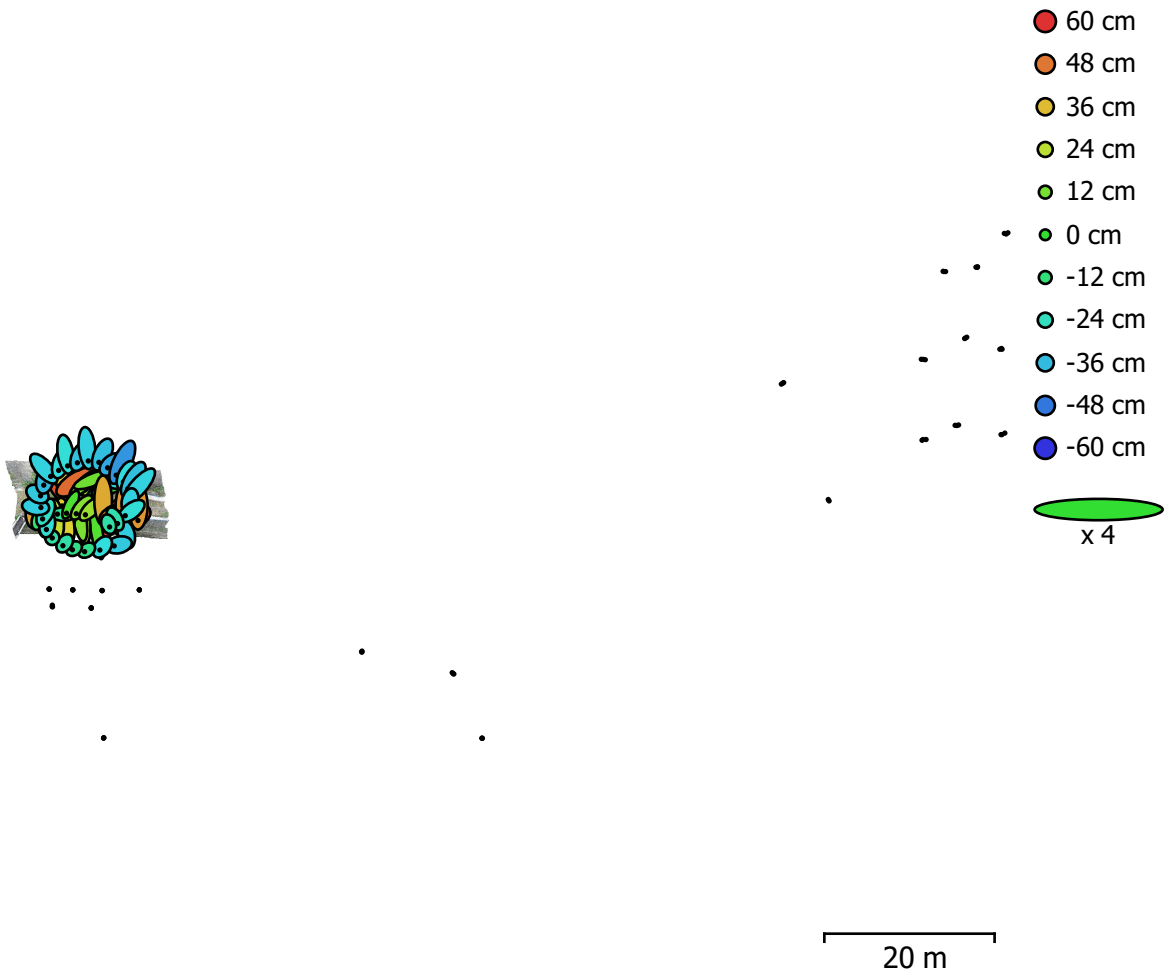

Fig. 4. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total error (cm)
34.8884	49.5666	31.2844	60.614	68.2112

Table 2. Average camera location error.
X - Longitude, Y - Latitude, Z - Altitude.

Ground Control Points

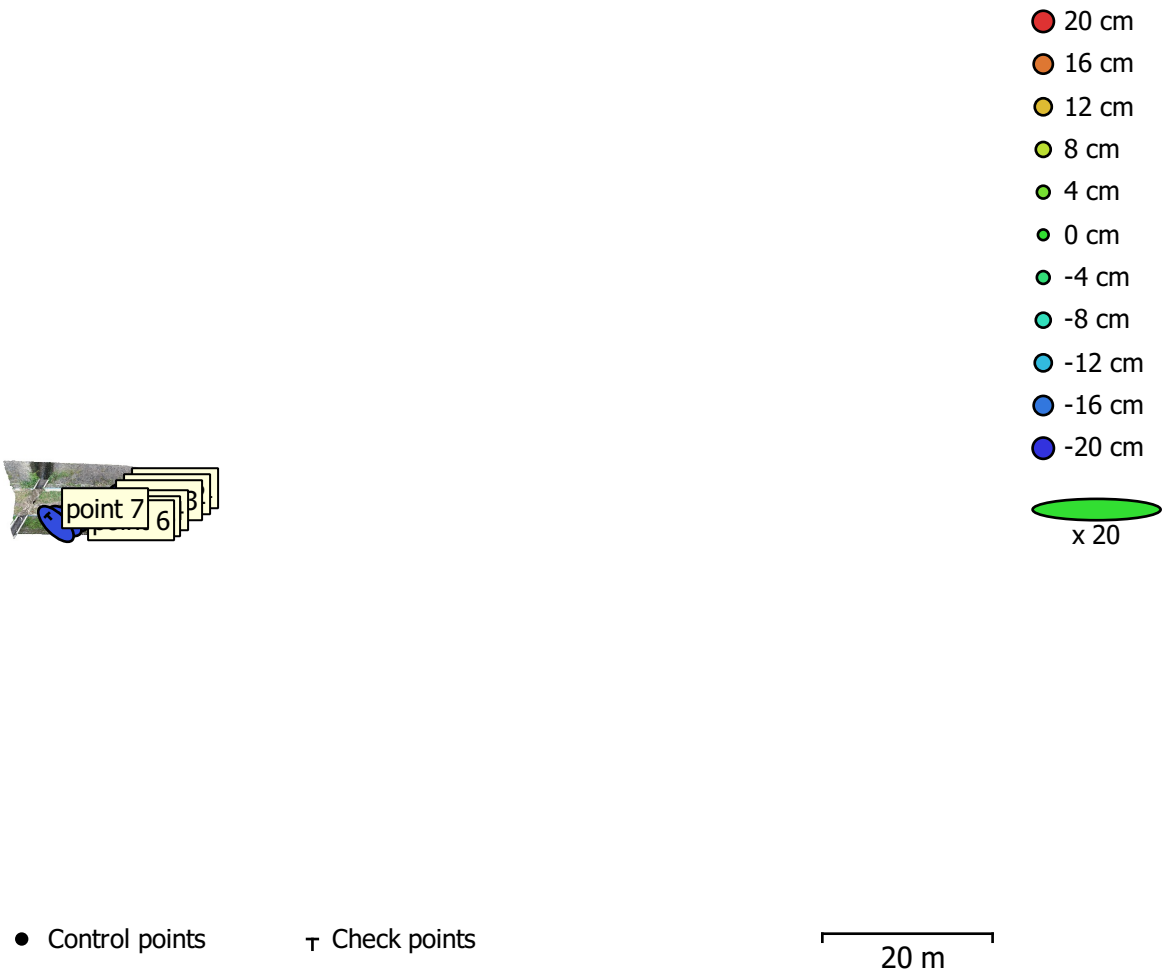

Fig. 5. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
7	6.36455	7.94496	18.6811	10.1799	21.2747

Table 3. Check points RMSE.
X - Longitude, Y - Latitude, Z - Altitude.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
point 1	0.250593	-12.2874	-18.8648	22.515	0.003 (45)
point 2	-1.3061	-8.73999	-18.8044	20.7774	0.004 (52)
point 3	-2.81368	-5.49773	-18.7589	19.7493	0.004 (54)
point 4	-5.69572	0.822732	-18.6628	19.5299	0.004 (56)
point 5	-7.3772	4.44361	-18.6127	20.5086	0.004 (55)
point 6	-8.80246	7.27135	-18.5469	21.7794	0.004 (50)
point 7	-10.4652	10.5341	-18.5144	23.7333	0.004 (39)
Total	**6.36455**	**7.94496**	**18.6811**	**21.2747**	**0.004**

Table 4. Check points.

X - Longitude, Y - Latitude, Z - Altitude.

Scale Bars

Label	Distance (m)	Error (m)
point 1_point 2	1.25935	-0.000651192
point 2_point 3	1.16222	0.000222733
point 3_point 4	2.25802	0.00602388
point 4_point 5	1.29768	0.00767815
point 5_point 6	1.02945	-0.00655388
point 6_point 7	1.19033	-0.0136698
Total		**0.00736581**

Table 5. Control scale bars.

Digital Elevation Model

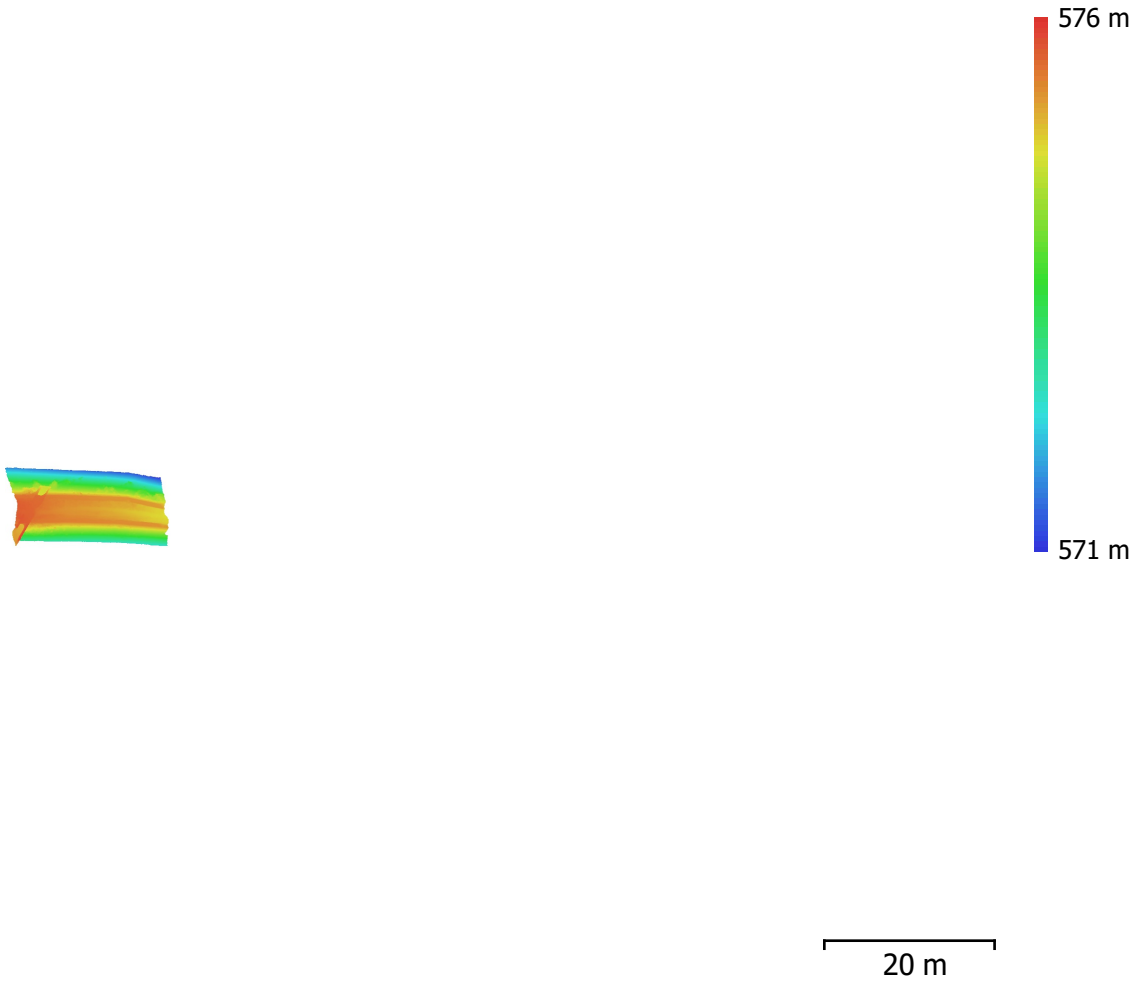

Fig. 6. Reconstructed digital elevation model.

Resolution:	8.22 mm/pix
Point density:	1.48 points/cm²

Processing Parameters

General	
Cameras	127
Aligned cameras	124
Markers	7
Scale bars	6
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	47,519 of 123,682
RMS reprojection error	0.151071 (0.526788 pix)
Max reprojection error	0.428989 (25.5113 pix)
Mean key point size	3.0193 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	4.3657
Alignment parameters	
Accuracy	High
Generic preselection	Yes
Reference preselection	Yes
Key point limit	40,000
Tie point limit	4,000
Adaptive camera model fitting	Yes
Matching time	42 minutes 17 seconds
Alignment time	5 minutes 30 seconds
Dense Point Cloud	
Points	3,550,695
Point colors	None
Reconstruction parameters	
Quality	Medium
Depth filtering	Aggressive
Depth maps generation time	1 hours 47 minutes
Dense cloud generation time	34 minutes 38 seconds
Model	
Faces	205,835
Vertices	103,723
Vertex colors	3 bands, uint8
Texture	4,096 x 4,096, 4 bands, uint8
Reconstruction parameters	
Surface type	Arbitrary
Source data	Dense
Interpolation	Enabled
Quality	Medium
Depth filtering	Aggressive
Face count	236,725
Processing time	5 minutes 9 seconds
Texturing parameters	
Mapping mode	Generic
Blending mode	Mosaic
Texture size	4,096 x 4,096
Enable hole filling	No
Enable ghosting filter	No
UV mapping time	36 seconds
Blending time	3 minutes 27 seconds
Software	
Version	1.4.5 build 7354

Platform	Windows 64