Arapaho NWR South Area

This report outlines procedures used in Agisoft Metashape Pro to process data captured with a MicSense Rededge-M multispectral sensor and provides error assessments associated with collection and processing.

02 August 2019

Survey Data

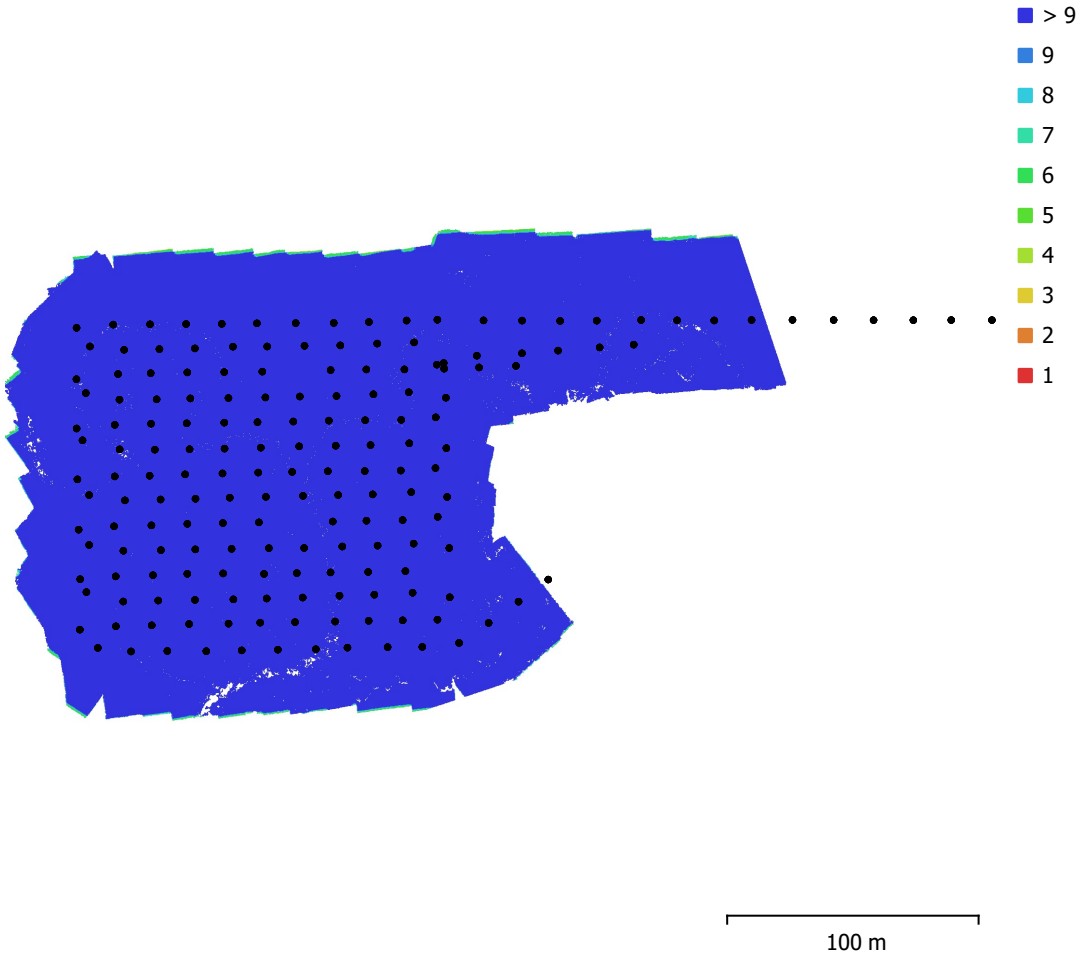

Fig. 1. Camera locations and image overlap.

Number of images:	900	Camera stations:	880
Flying altitude:	61.7 m	Tie points:	689,108
Ground resolution:	4.08 cm/pix	Projections:	2,313,569
Coverage area:	0.0416 km²	Reprojection error:	0.612 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
RedEdge-M, Blue (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes
RedEdge-M, Green (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes
RedEdge-M, Red (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes
RedEdge-M, Red edge (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes
RedEdge-M, NIR (5.5mm)	1280 x 960	5.5 mm	3.75 x 3.75 µm	Yes

Table 1. Cameras.

Camera Calibration

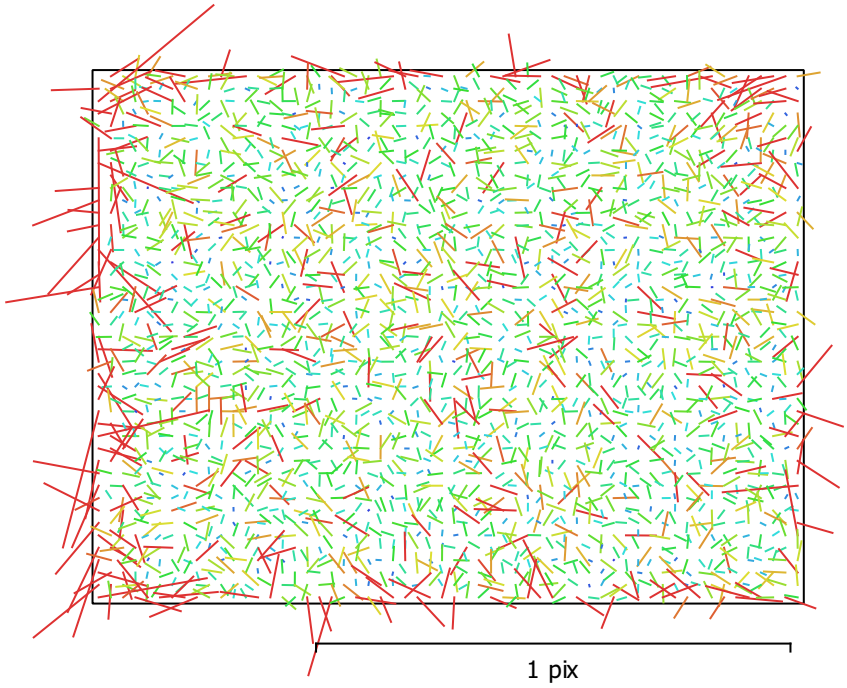

Fig. 2. Image residuals for RedEdge-M, Blue (5.5mm).

RedEdge-M, Blue (5.5mm)

180 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	P1	P2
F	**1452.47**	0.32	1.00	-0.06	-0.78	0.16	-0.04	0.01	0.28	0.01	-0.16
Cx	**7.32642**	0.064		1.00	0.04	0.04	0.27	0.00	-0.01	0.60	0.03
Cy	**8.81199**	0.079			1.00	-0.23	0.06	-0.06	-0.19	0.00	0.33
B1	**-0.203943**	0.01				1.00	0.00	-0.19	0.08	-0.04	0.18
B2	**-0.0774382**	0.0095					1.00	0.01	0.00	-0.02	-0.04
K1	**-0.0957548**	0.00016						1.00	-0.72	-0.05	-0.51
K2	**0.132879**	0.00045							1.00	-0.01	-0.01
P1	**0.000139934**	1.1e-005								1.00	0.08
P2	**4.43257e-005**	1.3e-005									1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Calibration

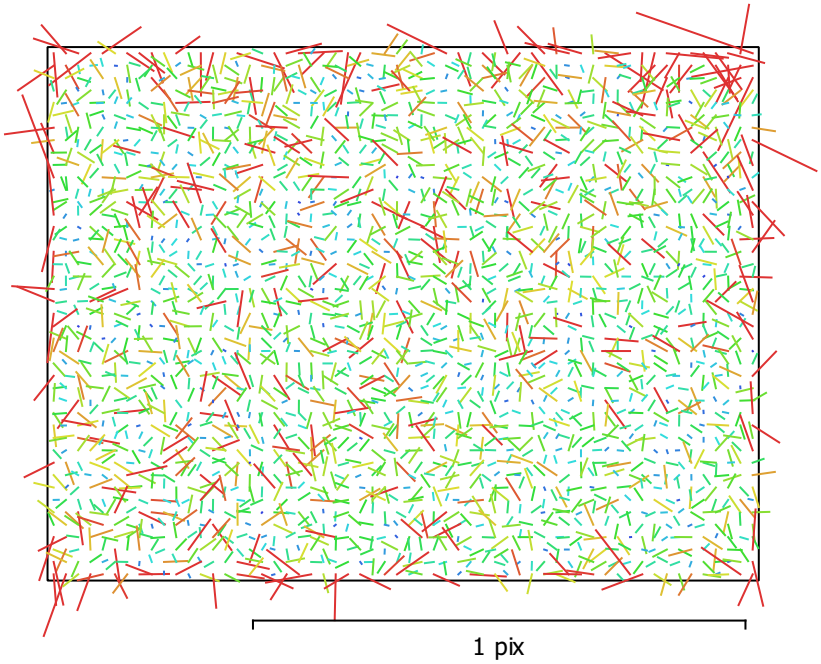

Fig. 3. Image residuals for RedEdge-M, Green (5.5mm).

RedEdge-M, Green (5.5mm)

180 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	P1	P2
F	**1451.24**	0.32	1.00	0.01	-0.80	0.18	-0.02	0.02	0.30	0.04	-0.17
Cx	**-8.65159**	0.061		1.00	-0.01	0.04	0.28	0.00	0.02	0.57	0.02
Cy	**4.41074**	0.079			1.00	-0.25	0.05	-0.06	-0.21	-0.02	0.30
B1	**0.130718**	0.01				1.00	0.01	-0.20	0.09	-0.05	0.20
B2	**0.091875**	0.0093					1.00	-0.01	0.01	-0.03	-0.01
K1	**-0.09635**	0.00015						1.00	-0.69	-0.01	-0.55
K2	**0.134035**	0.00041							1.00	-0.00	-0.02
P1	**0.000688882**	9.8e-006								1.00	0.02
P2	**-7.7865e-005**	1.3e-005									1.00

Table 3. Calibration coefficients and correlation matrix.

Camera Calibration

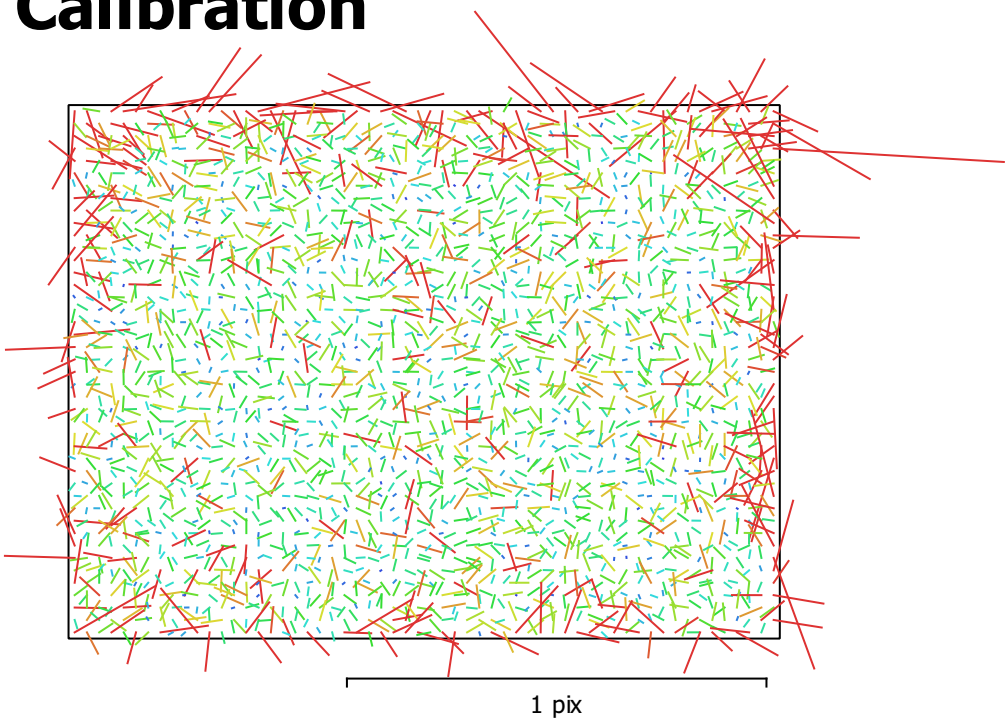

Fig. 4. Image residuals for RedEdge-M, Red (5.5mm).

RedEdge-M, Red (5.5mm)

180 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	P1	P2
F	**1448.72**	0.32	1.00	0.01	-0.78	0.17	-0.00	-0.01	0.27	0.03	-0.14
Cx	**-17.4272**	0.065		1.00	-0.02	0.03	0.28	0.00	0.01	0.61	0.01
Cy	**17.2644**	0.081			1.00	-0.24	0.02	-0.04	-0.19	-0.02	0.31
B1	**0.0178239**	0.011				1.00	0.02	-0.20	0.08	-0.05	0.19
B2	**0.0751685**	0.0097					1.00	-0.01	0.01	-0.01	-0.02
K1	**-0.101569**	0.00016						1.00	-0.74	0.00	-0.49
K2	**0.132318**	0.00046							1.00	-0.01	-0.01
P1	**0.000138988**	1.1e-005								1.00	0.01
P2	**1.87625e-005**	1.3e-005									1.00

Table 4. Calibration coefficients and correlation matrix.

Camera Calibration

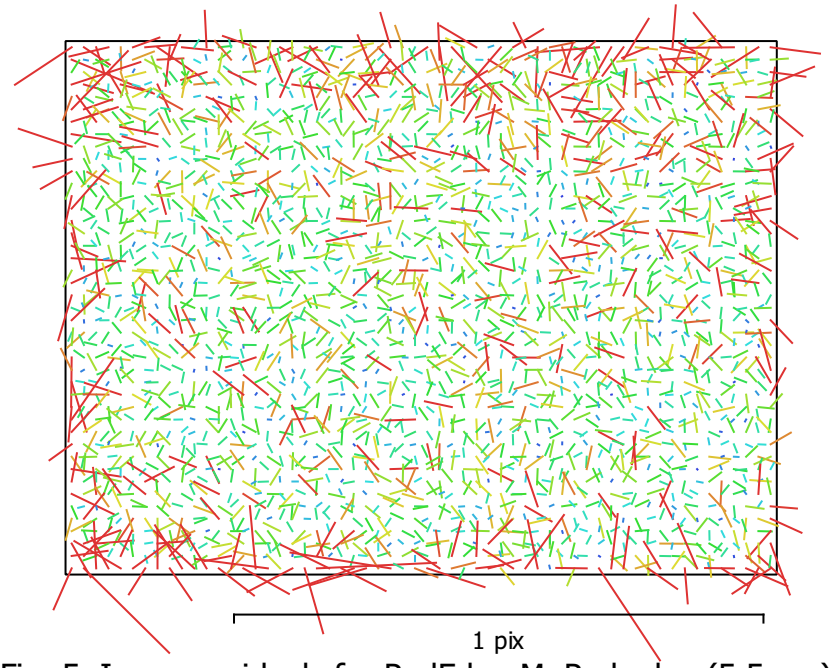

Fig. 5. Image residuals for RedEdge-M, Red edge (5.5mm).

RedEdge-M, Red edge (5.5mm)

180 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	P1	P2
F	**1451.16**	0.32	1.00	-0.05	-0.79	0.17	-0.02	0.01	0.31	0.01	-0.15
Cx	**-15.873**	0.06		1.00	0.03	0.02	0.28	-0.00	0.01	0.53	0.03
Cy	**2.94522**	0.077			1.00	-0.24	0.04	-0.05	-0.21	0.00	0.27
B1	**0.0315716**	0.01				1.00	0.01	-0.19	0.08	-0.07	0.19
B2	**-0.0651932**	0.0091					1.00	0.01	0.01	-0.04	-0.06
K1	**-0.101483**	0.00014						1.00	-0.68	-0.04	-0.56
K2	**0.133532**	0.00039							1.00	-0.02	-0.01
P1	**-0.00028169**	9.4e-006								1.00	0.08
P2	**6.54645e-005**	1.2e-005									1.00

Table 5. Calibration coefficients and correlation matrix.

Camera Calibration

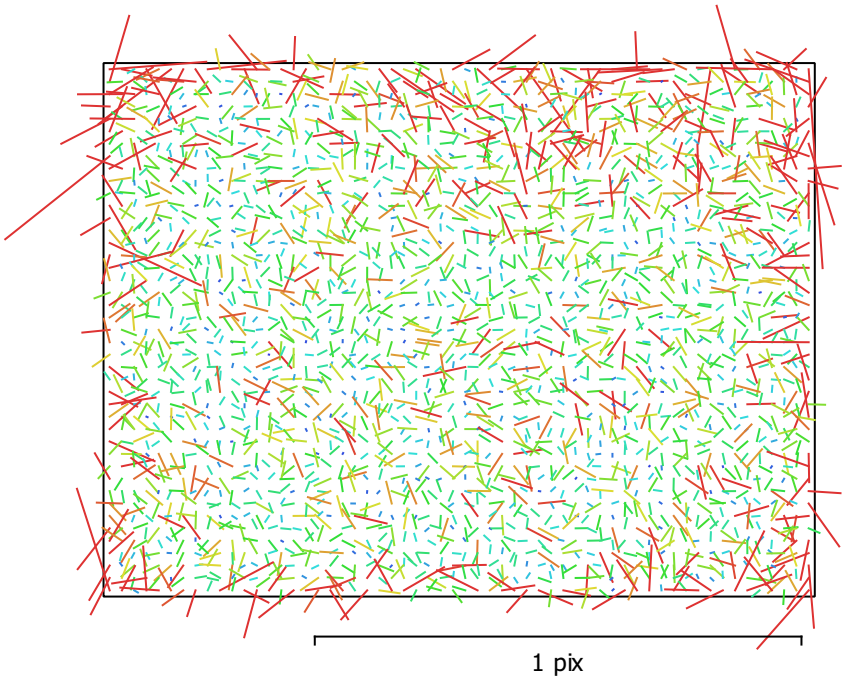

Fig. 6. Image residuals for RedEdge-M, NIR (5.5mm).

RedEdge-M, NIR (5.5mm)

180 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	**1280 x 960**	**5.5 mm**	**3.75 x 3.75 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	P1	P2
F	**1454.39**	0.32	1.00	-0.02	-0.79	0.18	-0.03	-0.01	0.31	0.03	-0.14
Cx	**-17.3125**	0.061		1.00	0.01	0.04	0.30	0.00	0.01	0.53	0.01
Cy	**25.4732**	0.079			1.00	-0.25	0.04	-0.03	-0.23	-0.02	0.28
B1	**0.21752**	0.01				1.00	0.01	-0.20	0.09	-0.05	0.18
B2	**0.150564**	0.0093					1.00	-0.00	0.01	-0.01	-0.04
K1	**-0.102599**	0.00015						1.00	-0.69	-0.02	-0.54
K2	**0.132564**	0.00041							1.00	-0.02	-0.02
P1	**0.000640687**	9.5e-006								1.00	0.04
P2	**0.000250886**	1.2e-005									1.00

Table 6. Calibration coefficients and correlation matrix.

Camera Locations

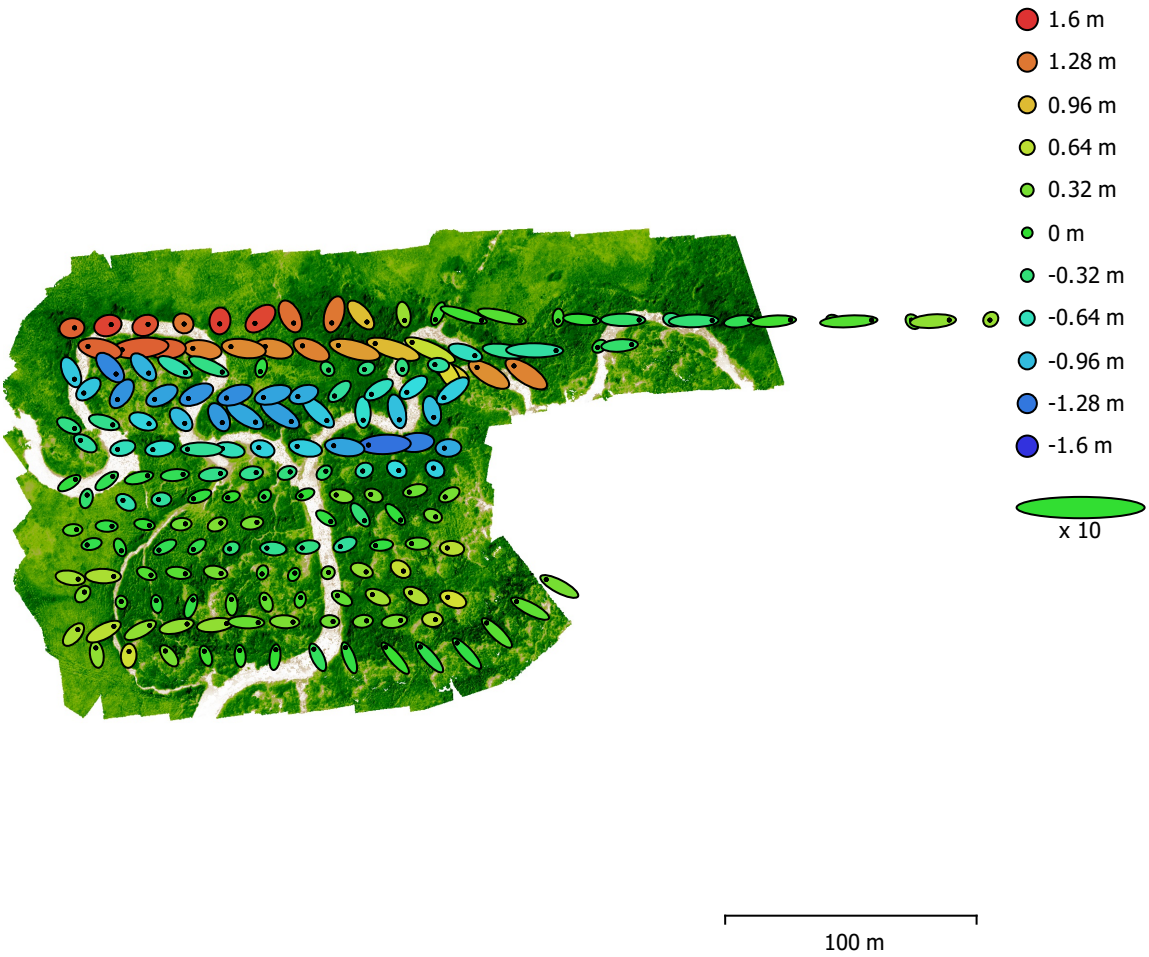

Fig. 7. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total error (cm)
63.4146	32.5601	67.8712	71.2852	98.428

Table 7. Average camera location error.
X - Longitude, Y - Latitude, Z - Altitude.

Digital Elevation Model

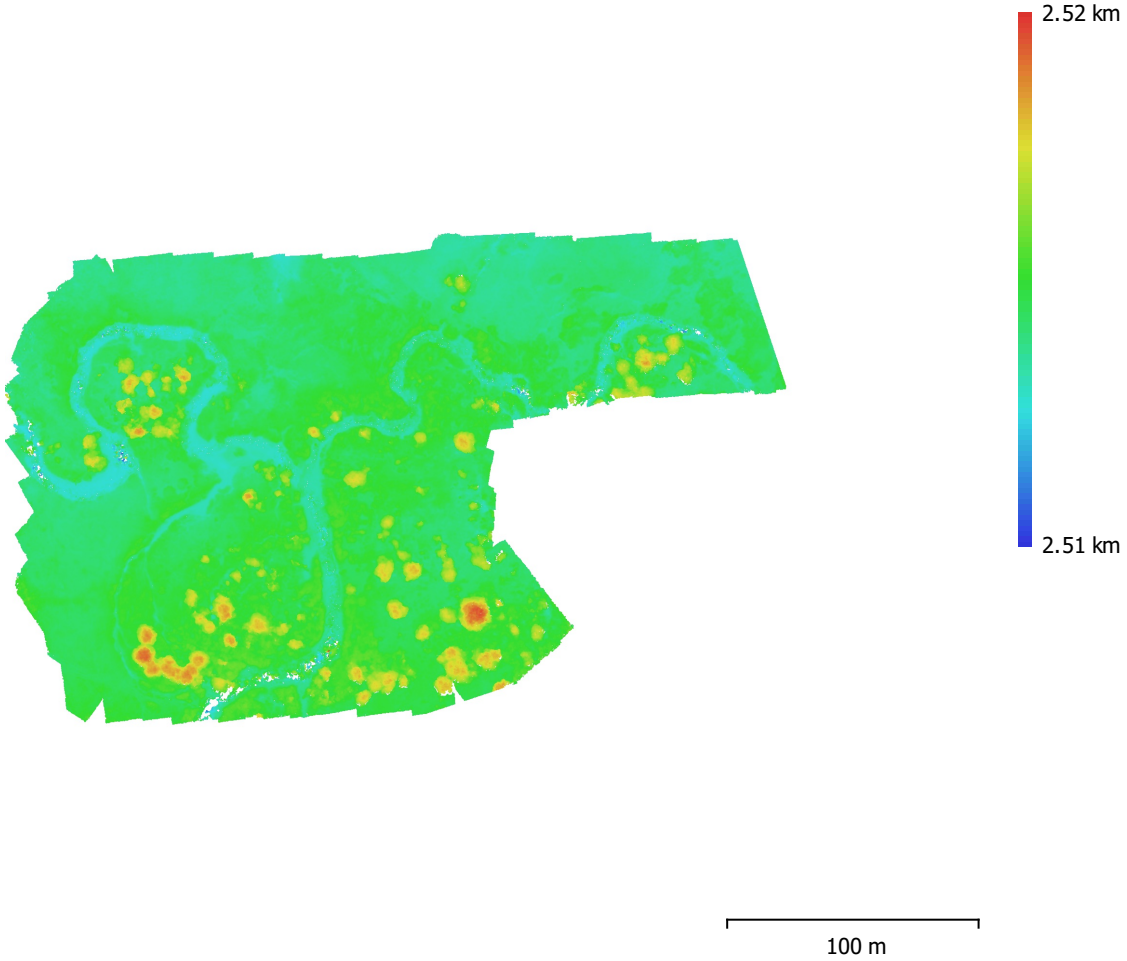

Fig. 8. Reconstructed digital elevation model.

Resolution:	8.16 cm/pix
Point density:	150 points/m²

Processing Parameters

General	
Cameras	900
Aligned cameras	880
Shapes	
Polylines	2288
Polygons	1758
Coordinate system	WGS 84 / UTM zone 13N (EPSG::32613)
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	689,108 of 742,975
RMS reprojection error	0.156171 (0.612329 pix)
Max reprojection error	0.592458 (17.5306 pix)
Mean key point size	3.38997 pix
Point colors	1 bands, uint16
Key points	No
Average tie point multiplicity	4.00654
Alignment parameters	
Accuracy	High
Generic preselection	Yes
Reference preselection	Yes
Key point limit	40,000
Tie point limit	4,000
Filter points by mask	No
Mask tie points	No
Adaptive camera model fitting	Yes
Matching time	3 minutes 14 seconds
Alignment time	9 minutes 29 seconds
Optimization parameters	
Parameters	f, b1, b2, cx, cy, k1-k3, p1, p2
Adaptive camera model fitting	Yes
Optimization time	21 seconds
Software version	1.5.2.7838
Depth Maps	
Count	171
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Processing time	3 minutes 35 seconds
Software version	1.5.2.7838
Dense Point Cloud	
Points	8,094,261
Point colors	5 bands, uint16
Depth maps generation parameters	
Quality	High
Filtering mode	Aggressive
Processing time	3 minutes 35 seconds
Dense cloud generation parameters	
Processing time	2 minutes 39 seconds
Software version	1.5.2.7838

General	
DEM	
Size	4,943 x 3,878
Coordinate system	WGS 84 / UTM zone 13N (EPSG::32613)
Reconstruction parameters	
Source data	Dense cloud
Interpolation	Enabled
Processing time	32 seconds
Software version	1.5.2.7838
Orthomosaic	
Size	7,661 x 4,739
Coordinate system	WGS 84 / UTM zone 13N (EPSG::32613)
Colors	5 bands, uint16
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Processing time	1 minutes 52 seconds
Software version	1.5.2.7838
Raster Transform	
Expression	B1 / 32768; B2 / 32768; B3 / 32768; B4 / 32768; B5 / 32768
Software	
Version	1.5.2 build 7838
Platform	Windows 64