Metadata Report

Project Name

Zig Zag Landslide, Snow Basin Road (UT-226), Morgan County, Utah – Aerial reconnaissance and landslide monitoring project (June 2019)

Summary

The Zig Zag landslide is located along the side of Snow Basin Road (UT-226) in Morgan County, Utah. The Utah Geological Survey (UGS) began monitoring the movement with high-accuracy GPS in 2005, and currently collect GPS movement data on a yearly basis. Using Structure from Motion (SFM), the landslide was surveyed in June 2019.

Personnel

- PI(s)

Adam I. Hiscock (adamhiscock@utah.gov)

- Field staff

Adam I. Hiscock, Ben E. Erickson, Greg N. McDonald, Nathan Payne

- Additional team members

Site Information

- Site description

Landslide along Snow Basin Road (Utah Highway 226) in Morgan County, Utah.

- Site objective

Collect SFM data for the active landslide to assist in landslide monitoring and movement.

- Site location (GPS cords and/or map)

41.215231°, -111.852547°

- Site conditions

Mid-day, cool temperature, some small clouds

- Date/time spent at each site

Flights conducted on 6/11/2019 at approximately 12:30 PM

Survey Results

- Equipment used

DJI Phantom 4 Pro drone with 20 MP camera and fixed 8.8 mm focal length for image collection. Trimble R8 GNSS unit for Ground Control Point (GCP) survey data collection.

- GPS solutions

6 GCPs were surveyed using the Utah Reference Network (TURN) real-time kinematic network and processed in WGS 84.

- Errors

Overall point cloud error was 18.03 cm using all 6 GCPs. GCP error was 17.96 cm horizontal and 1.59 cm vertical.

- Alignments
- Collection methods

338 images were acquired from 100 ft (30 m) altitude at nadir. Camera positions, overlaps, and orientations were controlled automatically using Pix4D software running on an iPad. Images were processed using Agisoft Metashape Professional (see below for processing details). GCPs were provided by installing orange, black, and white bucket lid targets for visibility in images. GCPs were surveyed and processed in UTM North Zone 12, WGS 84 Datum, g12aus geoid.

Products

- Date of dataset collection

10/30/2018

- Coordinate system of datasets

WGS 84 datum (EPSG::4326)

- Spatial resolution

Ground resolution – 1.16 cm/pix, DEM resolution 4.63 cm/pix, Point density – 466 points/m^2

- Horizontal Accuracy

17.96 cm

- Vertical Accuracy

1.59 cm

- Data formats

Raw point cloud is provided in .LAZ format. DEM and orthomosaic are provided as geotiff.

- Data processing methods

Point cloud, DEM, and orthomosaic data were generated by Agisoft Metashape Professional.

Misc Notes

Please send any questions about this dataset to adamhiscock@utah.gov

Agisoft Metashape

Processing Report
Zig Zag Landslide, June 2019, Snow Basin Road (UT-226), Morgan County, Utah
12 August 2019

Survey Data

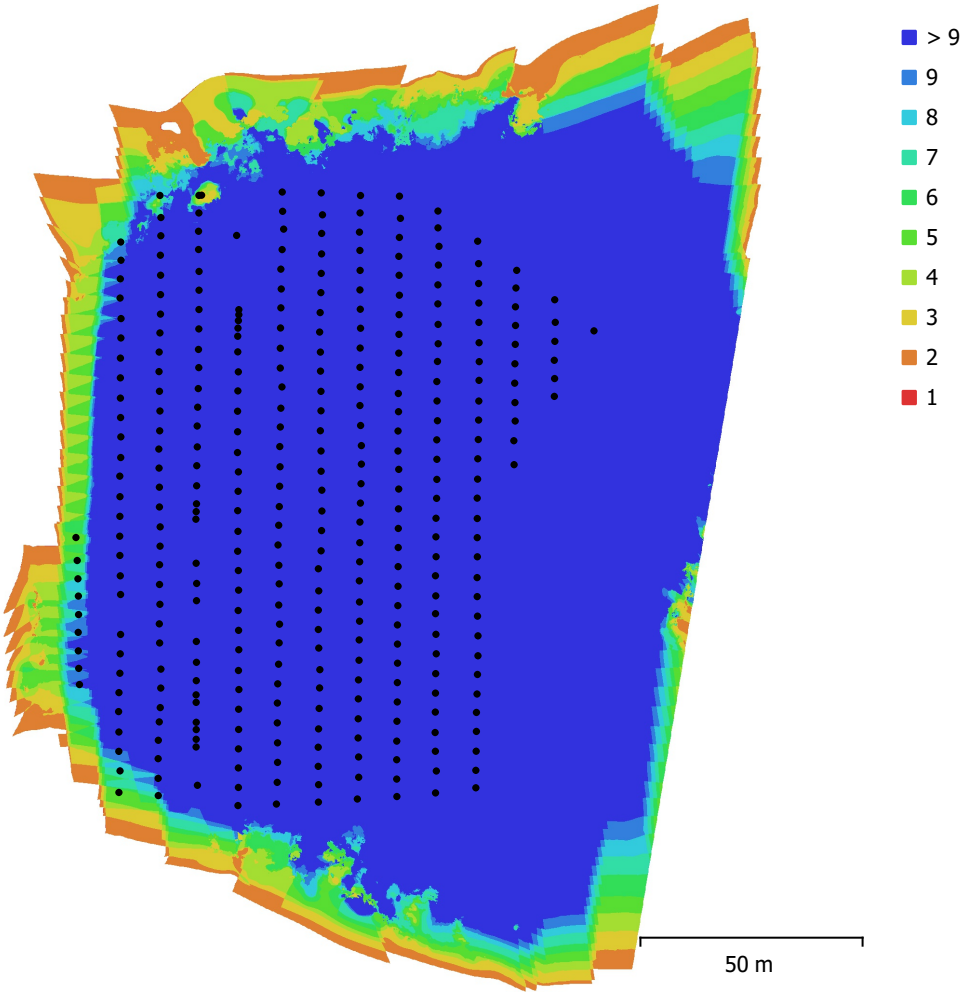

Fig. 1. Camera locations and image overlap.

Number of images:	338	Camera stations:	338
Flying altitude:	43.9 m	Tie points:	29,848
Ground resolution:	1.16 cm/pix	Projections:	333,768
Coverage area:	0.0283 km²	Reprojection error:	0.453 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC6310 (8.8mm)	5472 x 3648	8.8 mm	2.41 x 2.41 µm	No

Table 1. Cameras.

Camera Calibration

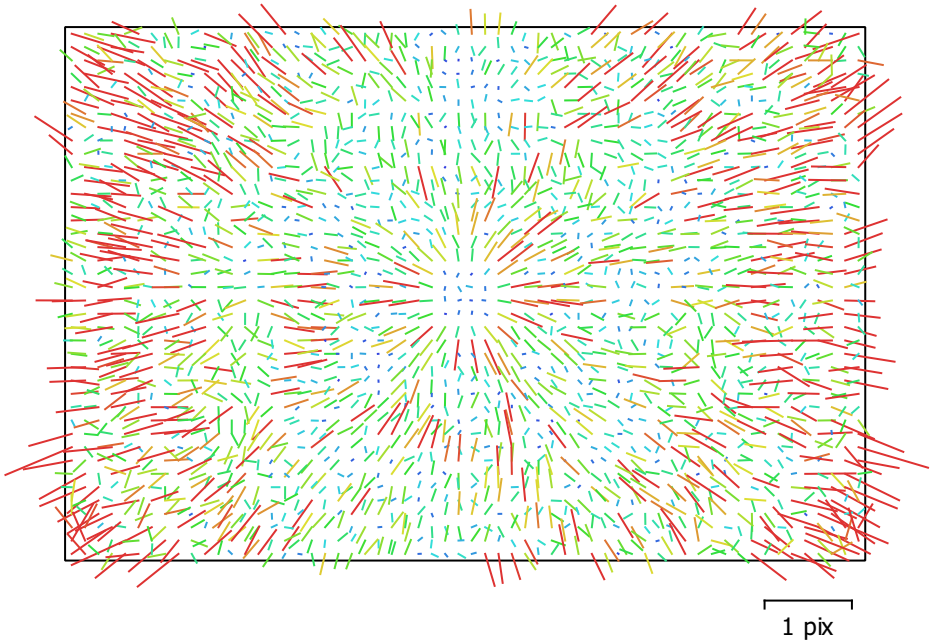

Fig. 2. Image residuals for FC6310 (8.8mm).

FC6310 (8.8mm)

338 images

Type	Resolution	Focal Length	Pixel Size
Frame	**5472 x 3648**	**8.8 mm**	**2.41 x 2.41 µm**

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	K4	P1	P2
F	**3654.86**	0.32	1.00	0.00	-0.99	0.59	0.08	0.01	-0.03	0.08	-0.11	0.02	-0.21
Cx	**-8.05003**	0.025		1.00	-0.01	0.01	-0.28	-0.01	0.00	-0.00	0.00	0.77	-0.00
Cy	**6.14743**	0.18			1.00	-0.61	-0.08	-0.05	0.07	-0.11	0.14	-0.03	0.24
B1	**1.54325**	0.063				1.00	0.07	0.00	-0.04	0.07	-0.09	0.04	-0.08
B2	**0.932301**	0.051					1.00	0.02	-0.01	0.01	-0.02	0.07	-0.09
K1	**0.00950533**	5.7e-005						1.00	-0.96	0.92	-0.87	-0.01	-0.12
K2	**-0.0662045**	0.00029							1.00	-0.99	0.96	0.01	0.00
K3	**0.124209**	0.00056								1.00	-0.99	-0.01	-0.02
K4	**-0.075675**	0.00037									1.00	0.01	0.03
P1	**-0.000775545**	1.9e-006										1.00	-0.03
P2	**-0.00121133**	2.9e-006											1.00

Table 2. Calibration coefficients and correlation matrix.

Camera Locations

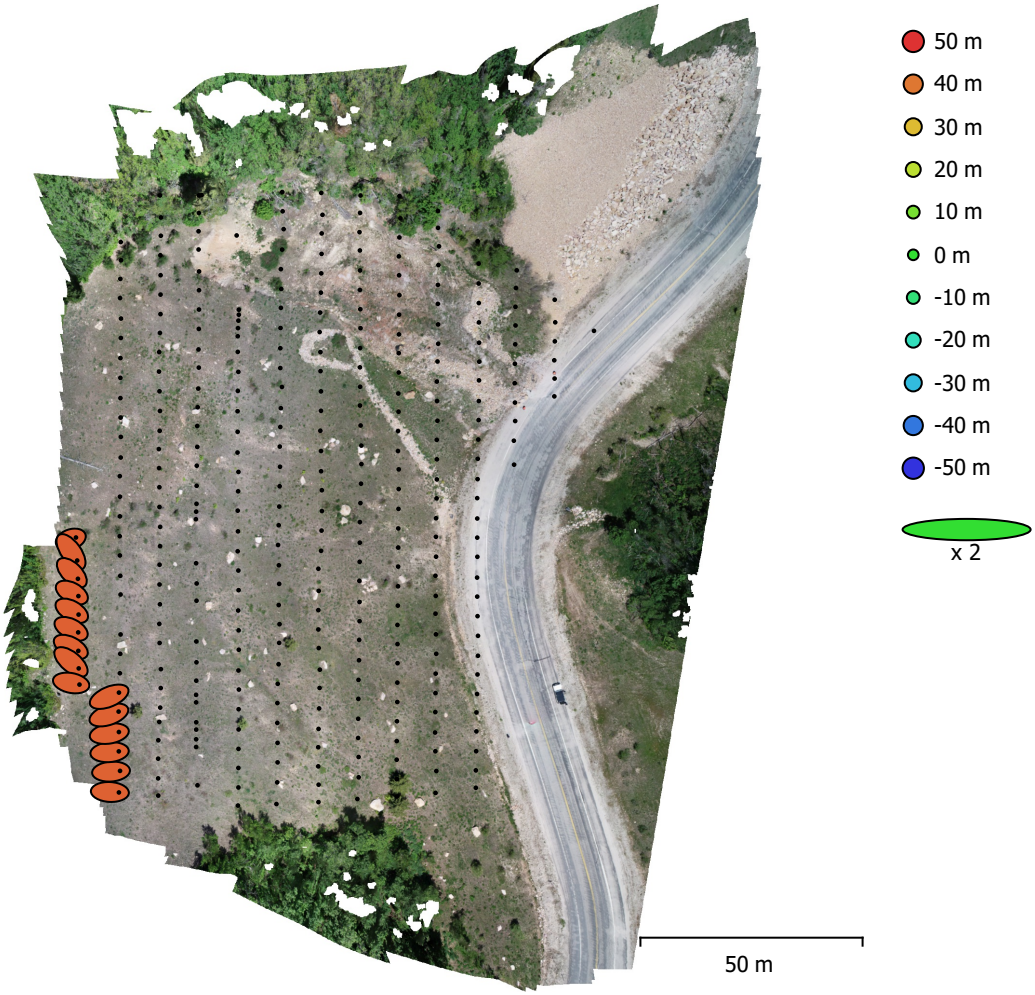

Fig. 3. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	XY error (m)	Total error (m)
1.79918	0.906289	43.2731	2.01455	43.3199

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

Ground Control Points

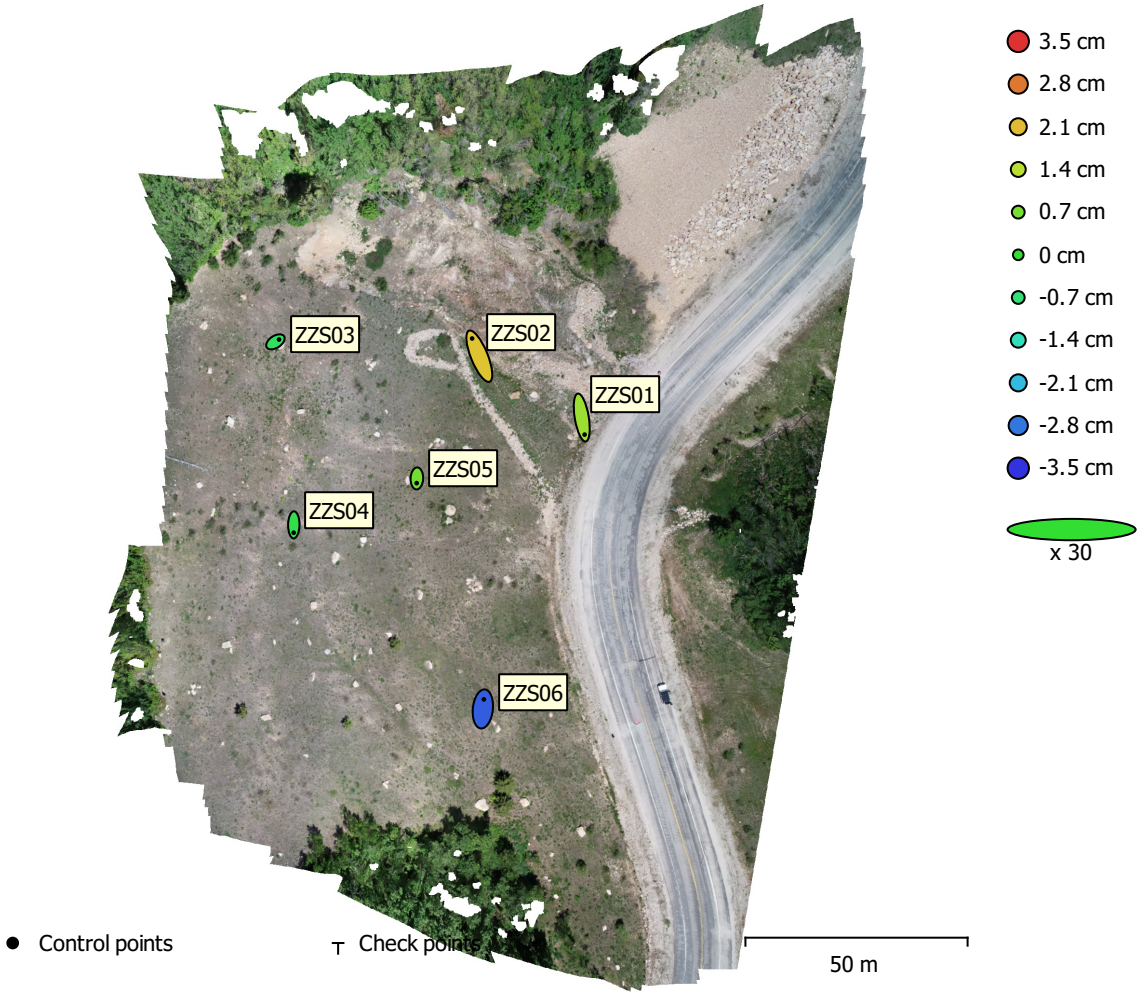

Fig. 4. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
6	5.2623	17.1706	1.5955	17.9589	18.0296

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

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
ZZS01	4.28017	-25.6036	1.0936	25.9819	0.132 (94)
ZZS02	-10.7731	26.5832	2.00709	28.7534	0.268 (81)
ZZS03	5.41629	3.50473	-0.451092	6.46705	0.210 (27)
ZZS05	-0.29171	-7.06686	0.629829	7.10086	0.152 (89)
ZZS04	-0.155017	-11.774	-0.241467	11.7775	0.247 (40)
ZZS06	1.52523	14.3497	-3.06445	14.7523	0.192 (70)
Total	**5.2623**	**17.1706**	**1.5955**	**18.0296**	**0.198**

Table 5. Control points.
X - Longitude, Y - Latitude, Z - Altitude.

Digital Elevation Model

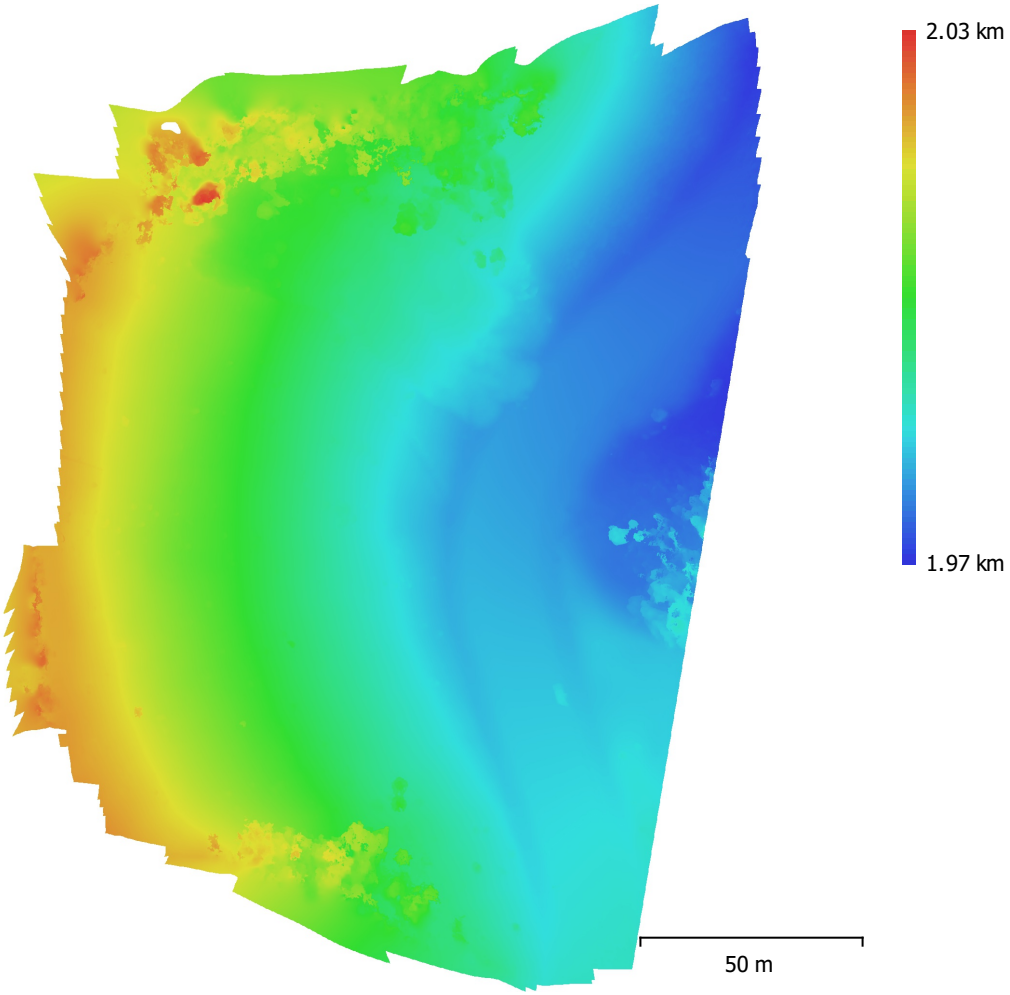

Fig. 5. Reconstructed digital elevation model.

Resolution:	4.63 cm/pix
Point density:	466 points/m²

Processing Parameters

General	
Cameras	338
Aligned cameras	338
Markers	6
Coordinate system	WGS 84 (EPSG::4326)
Rotation angles	Yaw, Pitch, Roll
Point Cloud	
Points	29,848 of 34,089
RMS reprojection error	0.22006 (0.452963 pix)
Max reprojection error	1.48717 (9.92444 pix)
Mean key point size	2.11943 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	13.9586
Alignment parameters	
Accuracy	Highest
Generic preselection	Yes
Reference preselection	Yes
Key point limit	40,000
Tie point limit	1,000
Adaptive camera model fitting	Yes
Matching time	5 minutes 16 seconds
Alignment time	1 minutes 13 seconds
Optimization parameters	
Parameters	f, b1, b2, cx, cy, k1-k4, p1, p2
Adaptive camera model fitting	No
Optimization time	33 seconds
Software version	1.5.2.7838
Dense Point Cloud	
Points	17,812,324
Point colors	3 bands, uint8
Depth maps generation parameters	
Quality	Medium
Filtering mode	Aggressive
Processing time	1 hours 24 minutes
Dense cloud generation parameters	
Max neighbors	All
Processing time	50 minutes 57 seconds
Software version	1.5.2.7838
Model	
Faces	3,562,452
Vertices	1,786,860
Vertex colors	3 bands, uint8
Texture	4,096 x 4,096, 4 bands, uint8
Depth maps generation parameters	
Quality	Medium
Filtering mode	Aggressive
Processing time	1 hours 24 minutes
Reconstruction parameters	
Surface type	Arbitrary

General

Source data	Dense cloud
Interpolation	Enabled
Strict volumetric masks	No
Processing time	23 minutes 10 seconds

Texturing parameters

Blending mode	Mosaic
Texture size	4,096
Enable hole filling	Yes
Enable ghosting filter	Yes
UV mapping time	1 minutes 50 seconds
Blending time	53 minutes 37 seconds
Software version	1.5.2.7838

DEM

Size	4,793 x 5,997
Coordinate system	WGS 84 (EPSG::4326)

Reconstruction parameters

Source data	Dense cloud
Interpolation	Enabled
Processing time	20 seconds
Software version	1.5.2.7838

Orthomosaic

Size	14,760 x 19,188
Coordinate system	WGS 84 (EPSG::4326)
Colors	3 bands, uint8

Reconstruction parameters

Blending mode	Mosaic
Surface	DEM
Enable hole filling	Yes
Processing time	8 minutes 42 seconds
Software version	1.5.2.7838

Software

Version	1.5.3 build 8469
Platform	Windows 64