Applied Terrestrial Photogrammetry of Soil Slumps on Ashmun Creek, Sault Sainte Marie, MI

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Introduction

The purpose of this study is to monitor and quantify erosion of soil slumps along Ashmun Creek. Soil slumps (**Figure 3**) are a form of mass wasting that can be rapidly activated, causing various levels of destruction and erosion. The major technique applied, Terrestrial Photogrammetry, was successful in collecting highly precise and significant spatial data.

Study Area:

The study area is located on a parcel of city property in Sault Ste. Marie, Michigan. The study area focused on a 1.3 km long tributary of Ashmun Creek, including two major slumping sites, Location #1 and Location #2. The tributary study area runs nearly parallel to the city airport (Sanderson Field Municipal) and is directly upstream from the I-500 snowmobile Racetrack (**Figure 1** and **Figure 2**).

Ashmun Creek:

Ashmun Creek is part of the largest sub-watershed in Sault Ste. Marie (approx. 2,558 acres) and the central thalweg runs through the business spur of town. The major outflow for Ashmun creek is the St. Marys River. Several studies on the creek have focused on local biota and water quality, this study focuses on erosion. Erosion occurring in Ashmun Creek and the surrounding watershed has the potential to have various negative effects downstream. One of the most notable concerns are the fine silt-clay particles from major soil units within the study area. These particles can travel great distances as suspended loads and are problematic for the boat locks (that are often dredged) as wells as aquatic stream biota.

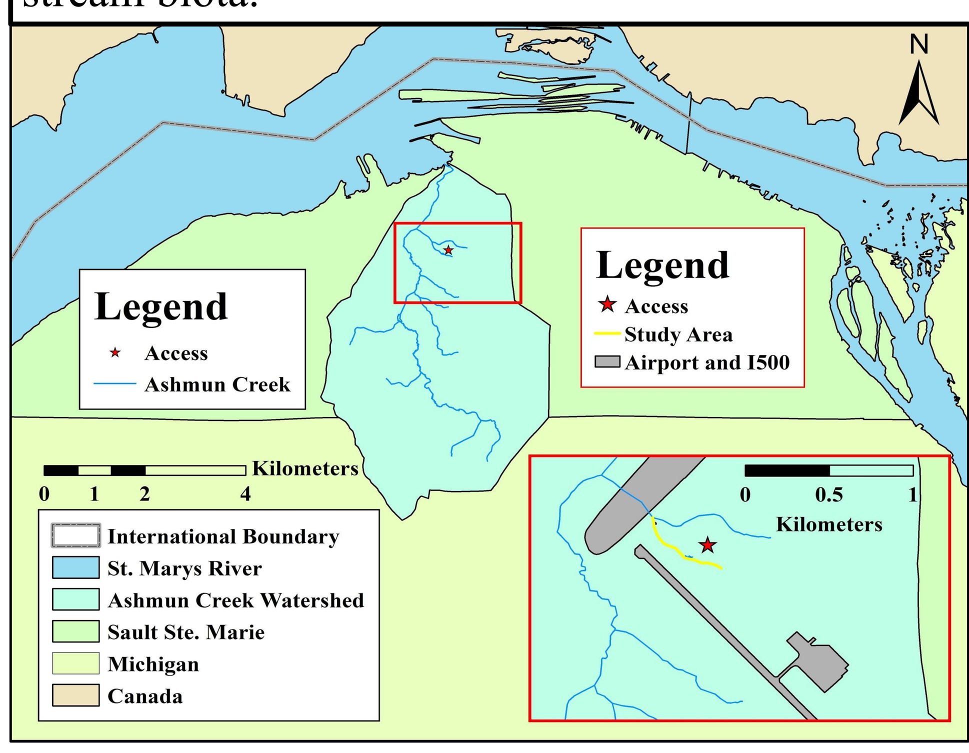


***Figure 1 - General Location Map**

Michigan DNR; Major Watersheds-Subbasins (https://gisago.mcgi.state.mi.us/arcgis/rest/services/OpenData/hydro/MapServer/15)

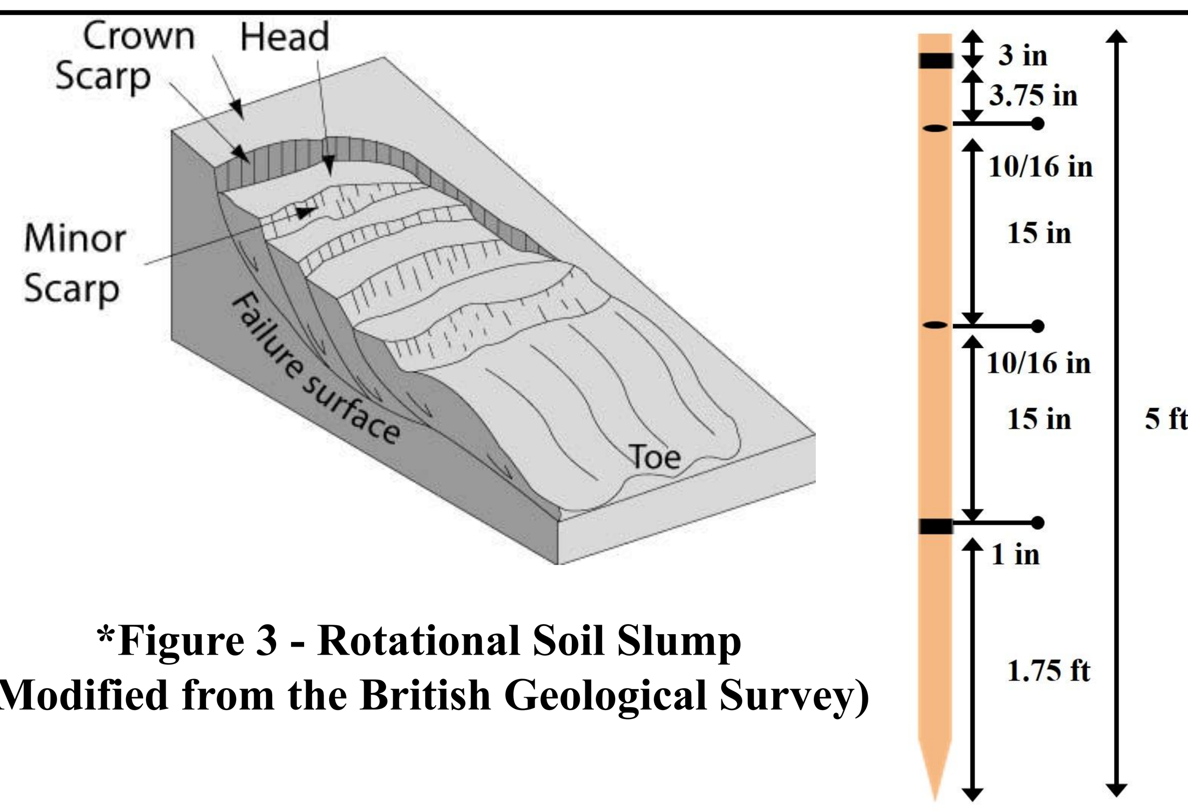


***Figure 3 - Rotational Soil Slump (Modified from the British Geological Survey)**

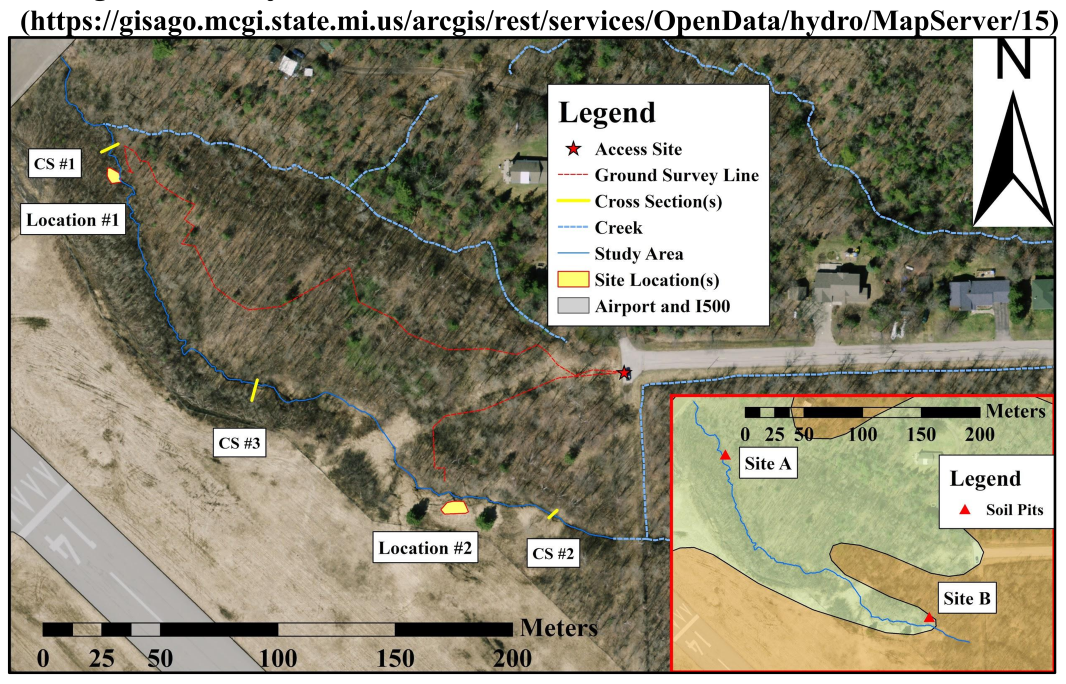


***Figure 2 - Study Area and Soil Map**

U.S. Department of Agriculture, Natural Resources; Soil Survey Geographic (SSURGO) database for Chippewa County, Michigan (https://websoilsurvey.sc.egov.usda.gov/)

Site A	
A - 0 to 16 in	Clay Loam
B - 16 to 35 in	Silty Clay
B - 35 to 45 in	Clay
B - 45 to ? In	Varved Clay

Site B	
A - 0 to 35 in	Fine Sandy Loam
B - 35 to 55 in	Sandy Loam

***Table 1 - Soil Pit Data**

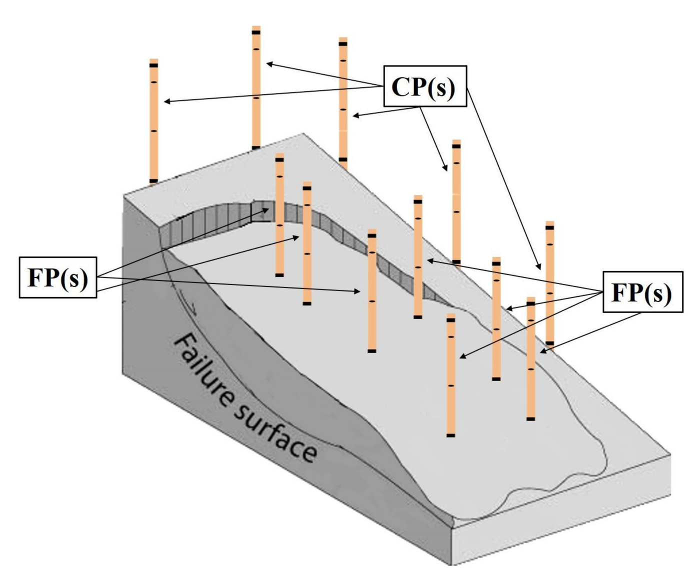


***Figure 4 - Survey Stakes and Diagram of CP(s) and FP(s) Setup**

Methods

The major technique applied in this study was Terrestrial Photogrammetry. Conventional ground-based surveying, with a laser auto level and GPS, was used to create a baseline to transform the photogrammetry data. Terrestrial Photogrammetry was conducted with a Canon EOS Rebel T7i (24 megapixel) camera with an 18mm to 55mm adjustable lens. Major setup for the study is depicted in **Figure 4**. Major processing for this project was conducted within the Photomodeler standard software package.

Conclusion and Discussion

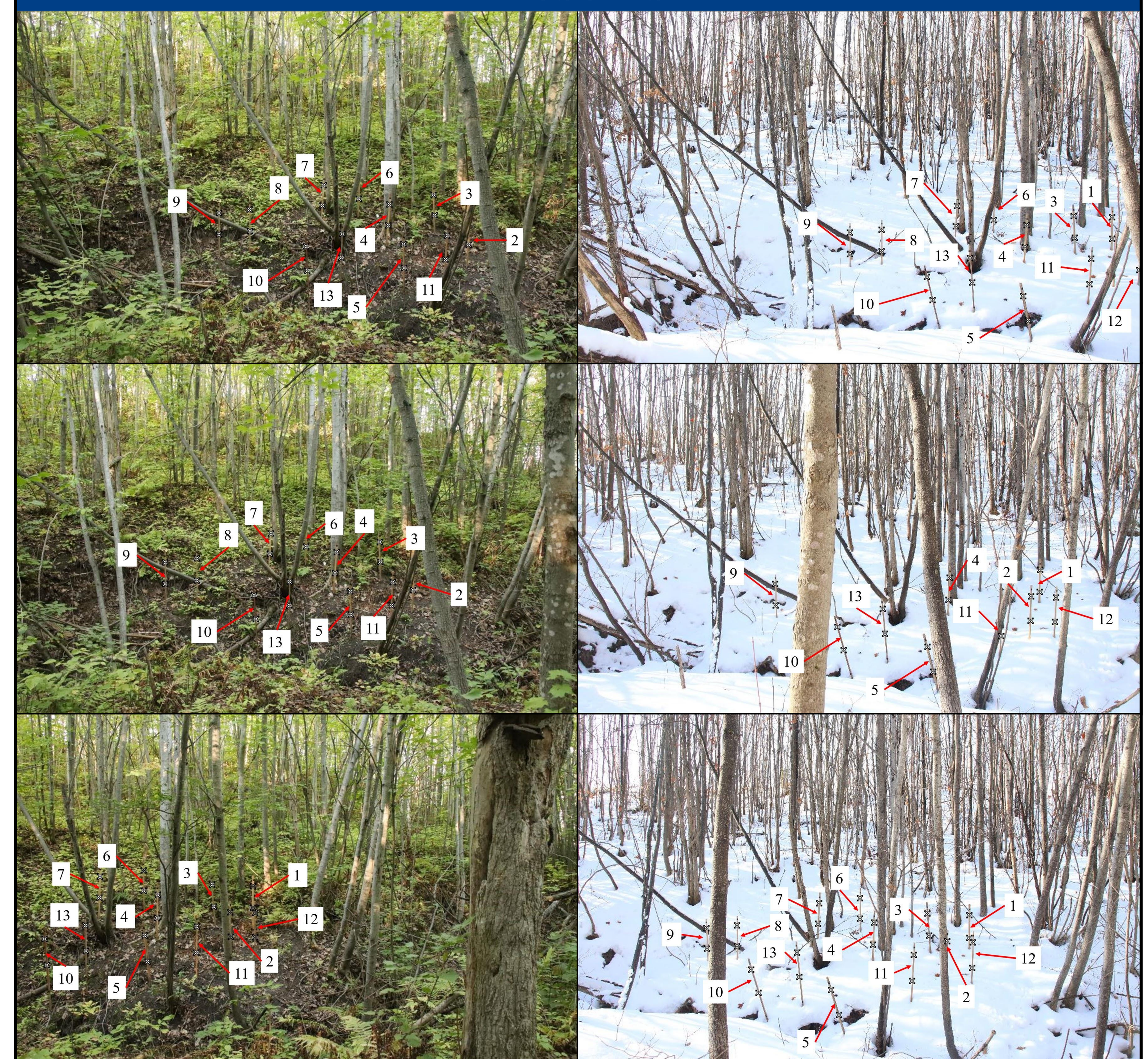
Results show precision significant ground motion at both study locations. Further, non-presented data, shows the major z down motion at Location #1 occurs between October 24th and November 6th. By comparing this data to local weather (**Figure 13**) it becomes clear that frost wedging followed by precipitation is the likely cause of slumping in the study area. This relationship is likely caused by a unique sedimentary deposit in the study area. A thick basal and varved clay deposit is observed more commonly throughout the creek column in the southern reaches of the study area. This paleo-lake deposited clay likely acts as preferential failure surface when wedged and oversaturated. Undercutting in the creek, during periods of high flow, as well as the overburden of snow, may aid this process. Continued observation of the study area will likely aid in supporting this conclusion.

Precision values are determined by a combination of the calibration and modeling process. All The presented data falls under an inch in precision and as processed CP(s) remained highly precise throughout the study it is likely the gross and systematic errors can be assumed to be negligible. Terrestrial Photogrammetry offers several unique issues that must be considered. Including things such as weather, lighting, and camera angles. These errors were accounted for and progressively nullified throughout the study.

References

- Ypsilantis, W.G. 2011. Upland soil erosion monitoring and assessment: An overview. Tech Note 438. Bureau of Land Management, National Operations Center, Denver, CO.
- Barker, R., Dixon, L., & Hooke, J. 1997. Use of Terrestrial Photogrammetry for Monitoring and Measuring Bank Erosion. Earth Surface Processes and Landforms, 22(13), 1217-1227.

Results



9-13-2018 ***Figure 6 - Location #1 Marked Orthophoto(s) with Labeled Stakes** *12-16-2018*

***Figure 11 - Observational Slumping (Near Location #2)**

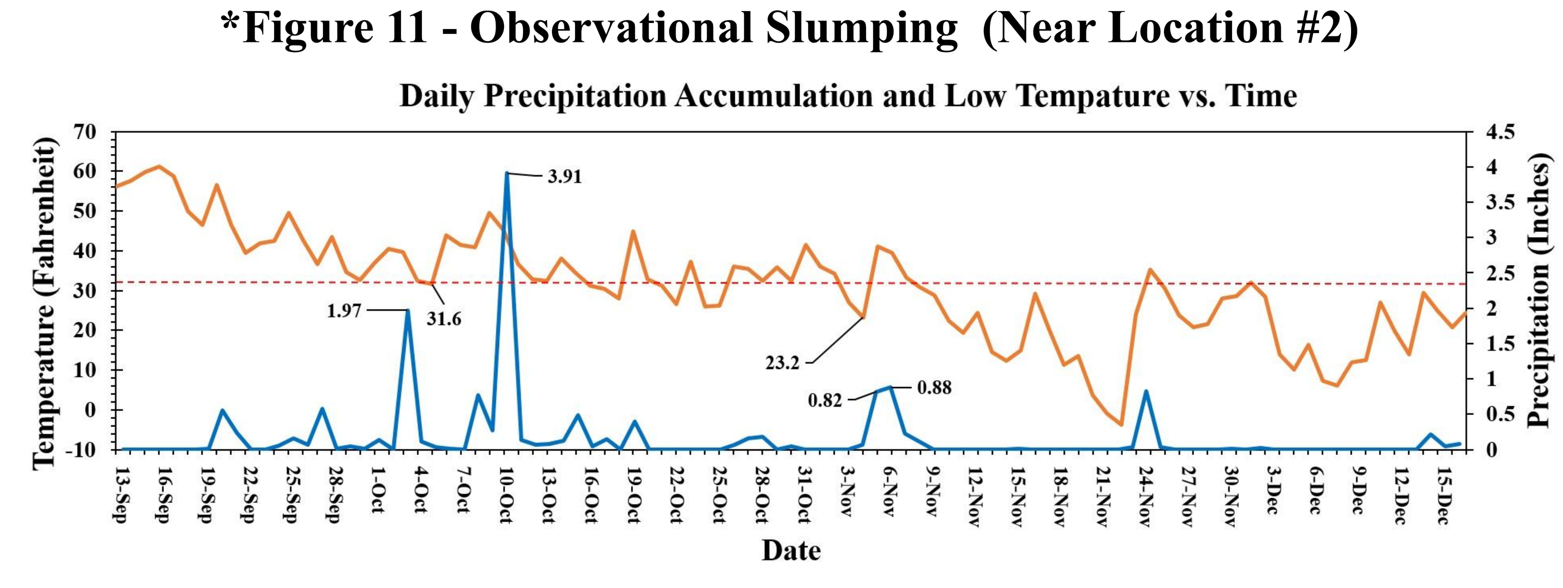


***Figure 13 - Local Weather Data for Study Period**

Location #2 Change						
Name	Cx	Cy	Cz	X Significant	Y Significant	Z Significant
1	0.203	0.012	0.009	No	No	No
3 (CP)	0.02	0.01	0.004	No	No	No
4	0.017	0	0.038	No	No	Yes
5	1.569	1.525	1.49	Yes	Yes	Yes
7 (CP)	0.03	0.01	0.006	No	No	No
8	0.005	0.073	0.066	No	Yes	Yes
9	0.309	0.146	0.041	Yes	Yes	Yes
10	0.283	0.48	0.232	Yes	Yes	Yes
11	0.252	0.01	0.094	Yes	Yes	Yes
12	0.025	0.035	0.084	No	No	Yes
13	0.079	0.231	0.056	No	No	Yes

Location #1 Change						
Name	Cx	Cy	Cz	X Significant	Y Significant	Z Significant
8	0.059	0.05	0.074	Yes	No	Yes
9	0.011	0.072	0.079	No	No	Yes
10	0.001	0.041	0.11	No	No	Yes
11 (CP)	0.005	0.034	0.011	No	No	No
12 (CP)	0.009	0.032	0.003	No	No	No
13	0.054	0.027	0.115	No	No	Yes
14	0.069	0.115	0.091	No	Yes	Yes

***Table 2 - Photogrammetry Data (Blue = Gain in Z and Orange = Loss in Z)**

Acknowledgments

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