

Hydrologic Impacts of the Slumgullion Landslide on Lake Delta Formation

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Abstract

The Slumgullion landslide, located in southwestern Colorado near Lake City, has been an area of interest for many scientists for 300 years. Data on the movement of the slide indicates that the younger, active part of the landslide moves over the older, inactive part of the landslide. To further our understanding of the landslide dynamics, we integrated data previously collected from easy-to-access outcrops with our analyses of satellite imagery and hydrologic data. We see that on average the shallow landslide moves 0.755 m/yr (+/- 0.078 m/yr) with faster movement to the south. Aerial data combined with precipitation and lake level data was used to determine if the amount of rainfall and the lake level have any effect on the average rate of movement determined. Based on our analyses of the annual precipitation data, we interpret that precipitation does impact the migration rate. This work demonstrates the necessity for more process-based linkages between surface and subsurface hydrology and mobility of the Slumgullion slide. We recommend future, priority measurements to further our understanding of the slide dynamics include water table levels along the slide, strength of materials in the slide, and higher resolution characterization of the hydrology and deformation.

Motivation and Goals

- To study this landslide through the integration of existing geological data with the aim to design a way to leverage our knowledge and improve our understanding of this landslide
- To find a connection between the deformation of the landslide and the amount of precipitation in this region
- To find the displacement caused by this landslide over time



Figure 1. Overview of the landslide showing sediment has traveled from Northeast towards the Southwest into Lake San Cristobal. The figure in the top right corner shows the location of the landslide in comparison to the state of Colorado [1,2].



Figure 2. Yellow pins represent the fixed location from which displacement measurements were recorded. The blue line corresponds to study Location 1. The orange line represents study Location 2. The green line represents study Location 3 [2]. These measurements can be seen in Figure 4 on the right.

Methodology

- Understand preexisting knowledge of landslide from USGS and others
- Decide what is still unknown about the landslide
- Quantify shoreline displacement and compare to annual precipitation
- Compare change in deformation with change in precipitation data

Existing Knowledge

- USGS articles on geotechnical properties and aerial photography recorded
- Stream gauge data for Lake City, CO during range of deformation [3]
- Discharge velocities recorded in this region
- Constant lake depth of about 27 meters

Conclusions and Next Steps

- Annual precipitation does have an impact on the displacement of the landslide
- Water table levels should be recorded and compared to displacement measurements
- Soil strength and bioturbation should be analyzed as additional controls on deformation

References

- [1] J. Palmer, *Slumgullion: Colorado's natural 'lab' offers insights into landslides worldwide*, 2018. [Online]. Available: <https://www.earthmagazine.org/article/slumgullion-colorados-natural-lab-offers-insights-landslides-worldwide/>. [Accessed: 03-Apr-2022].
- [2] "Earth versions – google earth," *Google*. [Online]. Available: <https://www.google.com/earth/versions/>. [Accessed: 02-Apr-2022].
- [3] N. O. A. A. US Department of Commerce, "Annual Summary 2005 -- Colorado Springs," *National Weather Service*, 16-Mar-2015. [Online]. Available: <https://www.weather.gov/pub/climateCos2005>. [Accessed: 13-Apr-2022].

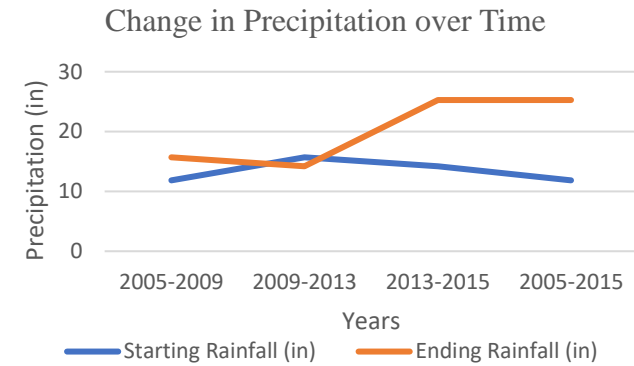


Figure 3. Graph of precipitation at beginning of range in comparison to precipitation at end of range.

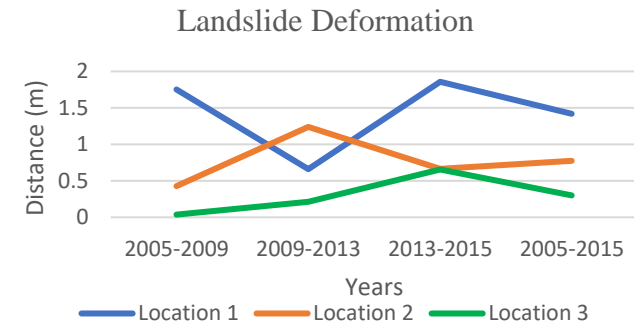


Figure 4. Graph of landslide deformation over time for each study location using Google Earth.

Average Precipitation in Lake City, CO

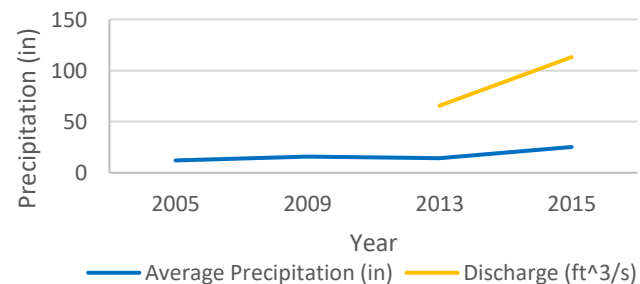


Figure 5. Graph of the average precipitation in Lake City, including discharge velocities at the toe of the landslide.