Terrestrial Laser Scanning Study of Gully Erosion at West Bijou Creek Escarpment, Arapahoe County, Colorado: An Investigation on Field Acquisition and Data Processing

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Abstract

Terrestrial laser scanning (TLS) or ground based LiDAR (light detection and ranging) is a relatively new technology that digitally maps geological outcrops at mm to cm resolution. We report here the results of a trial TLS project that had two main aims: collecting scans for monitoring gully erosion and conducting a survey to connect field methods of TLS with geomorphology. The site of the TLS survey was located at West Bijou Creek, Arapahoe County, Colorado. It consisted of a three-day data collection campaign followed by several weeks of data analysis.

Figure 1. Scanned area of West Bijou Creek gully network.

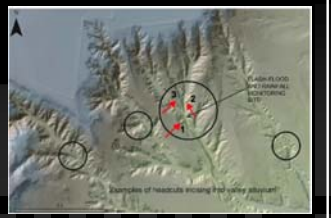

Figure 2. Airborne LiDAR image showing the three TLS scan sites in West Bijou Creek campaign.

Introduction

•The Terrestrial Laser Scanning (TLS) method is based on sending and receiving laser pulses for the construction of a point file of 3D coordinates on almost any surface.

•The data processing and analysis workflow of this almost new system is not well known for Earth Sciences purposes, and this project involves the discovery of new ways to manage the TLS in the area of this study.

•TLS measurements can be used to complement Synthetic Aperture Radar (SAR), Airborne LiDAR, and Spaceborne LiDAR techniques in providing smaller-scale, higher-resolution plots of important areas and in filling in areas inaccessible by these other techniques.

•Site exhibits highly active gullying and good road access.

•Gullies are commonly caused by fluvial erosion due to convective summer thunderstorms, changes in tectonics or base level drop.

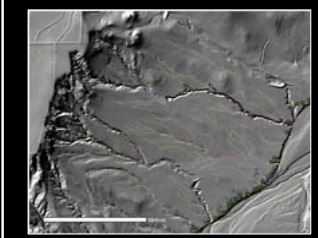

Figure 3. West Bijou Creek Airborne LiDAR image, gullies are represented by green circles and were measured in ArcGis. Gullying in the side of the valley started after the 1965 flood.

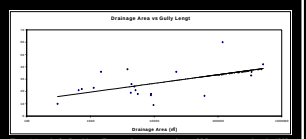

Figure 4. Length of valley sides gullies, reveals average growth rate of 0.5 meters a year since the 1965 flood. Gully length in this area range from 10 to 60 meters. These rates should be detectable with TLS.

Objectives

• To measure and keep track of the changes in the morphology of the gullies located at the West Bijou Creek using Terrestrial laser Scanning (TLS) complemented by Real Time Kinematic GPS (RTK-GPS).

•To explore rates and controlling factors of gully erosion in a landscape.

•To look for different approaches in field acquisition methods using TLS.

•To provide the scientific community with a summary of current practices together with a website including a forum for sharing ideas and discoveries because they evolve every day.

Methods

•The TLS unit used in this project is an Optech ILRIS-3D (Figure 3), which consists of a Class 1 laser and internal 3-megapixel digital. camera and external 12-megapixel digital camera.

•Three scan sites for a total of twenty scans.

•Static GPS and Real Kinematic GPS Survey.

•Preliminary processing in Innovmetric's Polyworks 10.x software.

•Communicating with TLS practitioners to find out field practices (University of Texas at Dallas, Arizona State University, UNAVCO).

Figure 5. TLS unit with gray tilting base showing RTK-GPS and antenna.

Figure 6. West Bijou Creek Gully Network showing control points (foam balls),numbers representing the ID's in the RTK-GPS data.

Figure 7. Photo of east side of main headscarp

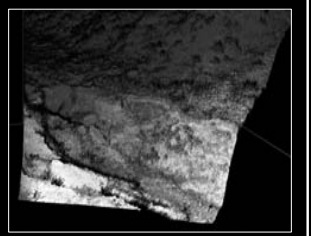

Figure 8. 3D point cloud of features in Figure 7.

Preliminary Results

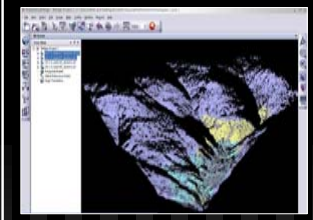

Figure 9. 3D point cloud mesh of the fours scans from the first scanner position showed in IMMalign.

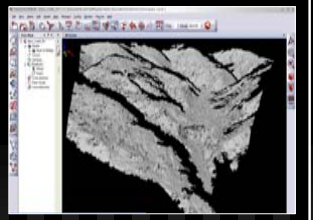

Figure 10. 3D preliminary model of West Bijou Creek Gully Network with only four scans showed in IMMedit.

Data Collection Recommendations

•CONTROL POINTS. Set up a sufficient number of control points on surveyed monuments within the surveyed area. Make sure they are at different depths, heights and angles from the scanner position. Put reflective material in the control points (e.g., red reflective fabric material). Make separate high resolution scans of the control points.

•SCAN RESOLUTION. Desired resolution depends on the study objectives. Resolution determines the scan time. A window of time of 20 to 40 minutes per scan tends to work well.

•SCAN AREA. A single scan should include a minimum of 3 control points as well as easily identifiable natural features if possible (e.g., trees, outcrops features, etc.). Use plenty of overlap area in adjacent scans (30 to 40 percent is ideal). Add extra space around the area that you want to scan to avoid accidentally cutting off the edge of the target.

Conclusion

•There is a need for doing monitoring, experimental and modeling studies of gully erosion for making predictions.

•Additional work is needed to develop best practices for TLS data collection and analysis for gully erosion studies.

•The integration of TLS data with Airborne LiDAR data would be an excellent approach to improving our understanding of gullying processes.

•We created a website to share results from this project and ongoing TLS developments with the community. The URL is: www.unavco.org/research_science/science_highlights/tls2008_summer_project

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