Terrestrial Laser Scanning Survey Project for the Geomorphic Situation of Precariously Balanced Rocks

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Scientific Objective

Precariously balanced rocks (PBRs) are pedestal rocks that are used as negative indicators for earthquake-generated strong ground motions to physically validate seismic hazard analyses. The objective of this survey was to scan PBRs and their site characteristics in order to help understand their geomorphic settings in a landscape.

TLS System Description and Specifications

The survey was performed using a tripod-mounted Riegl LPM 321 terrestrial laser scanner:

See http://www.riegl.com/ for this scanner's detailed specifications.

Survey Area

The survey was carried out in an area covering ~60 m by ~100 m in the Granite Dells precarious rock zone near Prescott, Arizona (Fig. 1), and spanned a small mixed alluvial-bedrock channel that is flanked by PBR-covered hillslopes.

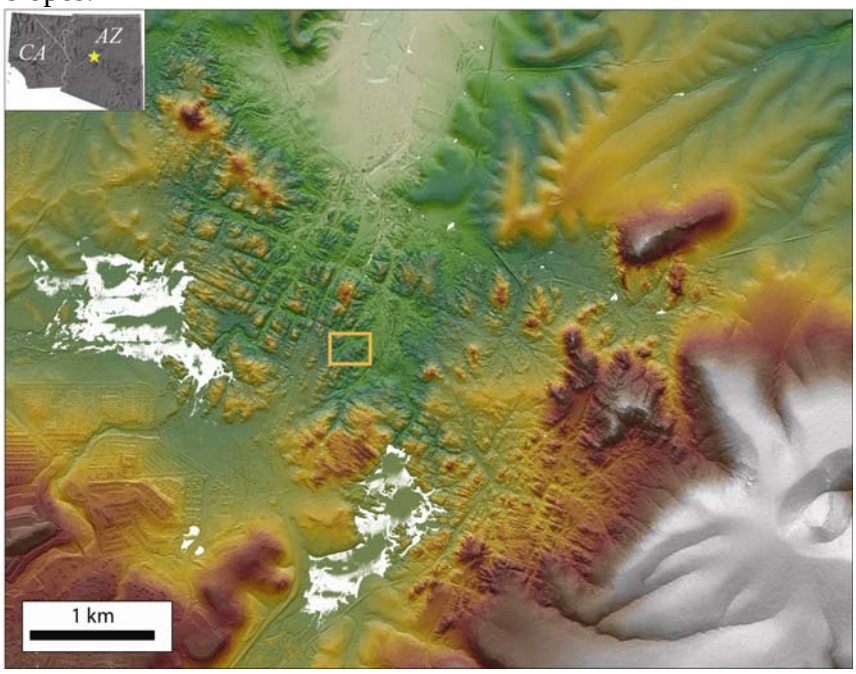

Figure 1. Location map of the TLS survey area. ALS-generated 0.25 m DEM of the Granite Dells precarious rock zone was collected by the National Center for Airborne Laser Mapping (NCALM; http://ncalm.org) for a Seed Grant. Modified from Haddad (2010).

Field Procedures

A total of six targets were used to align the scans. The targets were 5'-tall, 2"-diamater white PVC pipes with reflective 2"-wide adhesive-backed tape adhered to their tops (Fig. 2). Each target was marked by a unique number of black electrical tapes to facilitate target identification. All targets were made stationary by securing them with zip ties to wooden stakes. The stakes were driven to the ground for maximum target stability. Targets were wedged in joint openings where there was little to no soil cover in which to drive the stakes. Following target setup, the small channel and adjacent PBR-covered hillslopes were scanned from five positions (Fig. 3). All scans were aligned in the field using the Riegl RiProfile software.

Figure 2. Two examples of the targets and stakes used to help align the TLS scans.

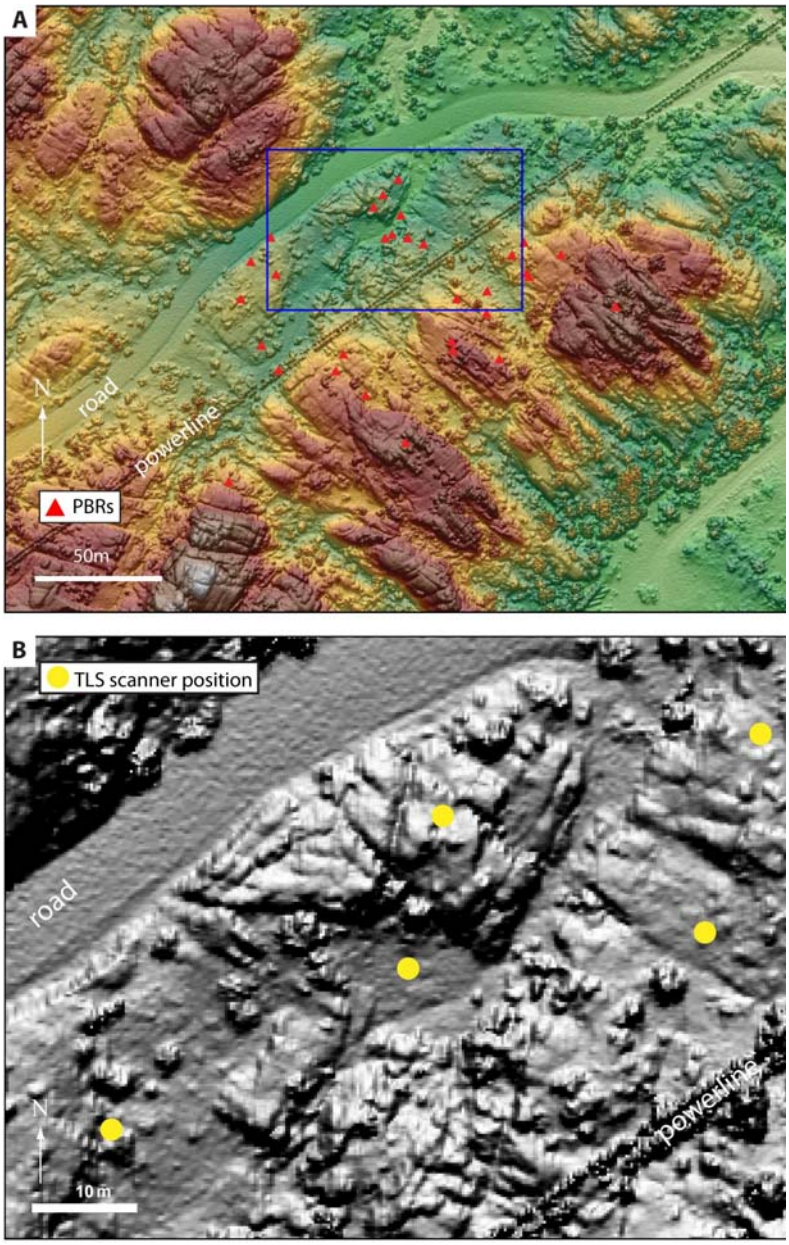

Figure 3. Location map of TLS scanner positions used to scan a small channel and adjacent hillslopes. (**A**) Overview hillshade created from an airborne laser scanning (ALS)-generated 0.25 m digital elevation model (DEM). Blue box outlines the TLS survey area. (**B**) Location map of the TLS scanner setups. A total of five scan setups were used to scan the ~60 m by ~100 m area covering PBRs, surrounding hillslopes, and a small channel. Modified from Haddad (2010).

Data Processing and File Formats

The final point cloud totaled 5.5 M points and was exported from RiProfile in ASCII format. Since no GPS control was available to georeference the point cloud, a complete 3D translation and rotation from the survey coordinate system into the UTM Zone 12 reference frame was performed using *xyzRotatorDH* (available from the OpenTopography Tool Repository). This process involved translating the TLS point cloud to an ALS point cloud using a common point, and performing a rigid-body rotation about this point to place the TLS point cloud in the ALS reference frame as follows:

$$x = x'\cos\theta - y'\sin\theta$$
$$y = x'\sin\theta + y'\cos\theta$$

The final point cloud was also converted to the binary LAS format using the libLAS toolkit (http://liblas.org/).

Gridded Digital Topographic Products

The high-resolution DEMs were generated using a Linux version of the GEON LiDAR Workflow's Points2Grid utility (http://lidar.asu.edu; Fig. 4). The opportunity to process these data using the OpenTopography custom DEM and point cloud processing system will be available soon.

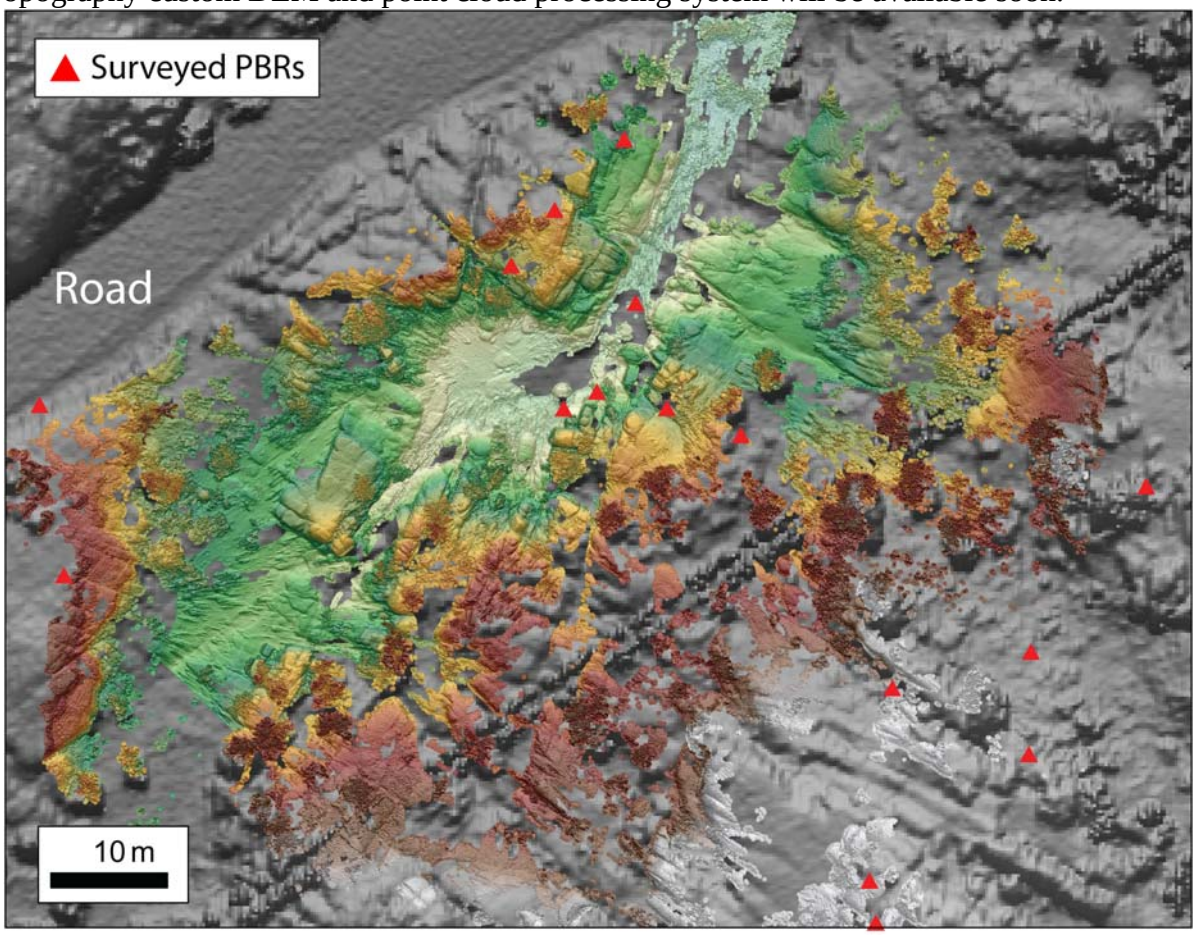

Figure 4. A 0.05 m DEM of the TLS survey area nested in a 0.25 m ALS-generated DEM. Modified from Haddad (2010).

References

Haddad, D. E., 2010. Geologic and geomorphic characterization of precariously balanced rocks. MS thesis, Arizona State University, Tempe, Arizona, 207 pp.

Acknowledgements

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