The Best Climbing Places in the Yosemite Valley, determined using LIDAR

Cristina Alexa

Background Information

Yosemite Valley is a ~1-km-deep, glacially carved canyon in the Sierra Nevada mountains of California that hosts some of the largest granitic rock faces in the world. El Capitan is a ~1-km-tall, vertical southeast face, that making it the tallest single face in North America, Yosemite Falls is the tallest waterfall in United States, Camp 4 is regarded as the birthplace of modern rock climbing.

With the appraisal of laser scanner technologies in geosciences, used for imaging relief by high-resolution digital elevation models (HRDEMs) or 3D models, **we can use light detection and ranging (LIDAR) techniques to determine the best places for climbing in the Yosemite Valley, and compare the results with already existing information** to assess the accuracy. There have been studies involving LIDAR in the area, with a focus on rock falls and landslides.

Because there are many overhangs, I expect there would be *shadows* (*zones* of no data) that result in holes in the 3D point cloud, that would impact the 3D interpolation. Those errors could be corrected using GPS coordinates from the routes collected by climbers, or LIDAR data from the ground, if this kind of data would be available for free. Also, determining the best climbing place is a subjective exploration.

Potential Data Sources

For this project I intend to use free LIDAR point cloud data from OpenTopography. The area of interest is defined by a quadrilateral polygon with an area of 35.1 km^2, located in the grounds of the Yosemite National Park, specifically the Half Dome and the Yosemite Valley. The polygon is located approximately 127 km east of Modesto, CA and 110 km north of Fresno, CA. The data were collected for rock fall studies in the Yosemite National Park using seismic, acoustic, and Lidar data.

Also, I will use Yosemite Roads data, Administrative Boundaries data, Geologic Resources information, Yosemite Parking Areas data, Hydrology geodatabase for Yosemite National Park data, Yosemite area waterbodies data, Yosemite geology data, Rock Fall Hazard line for Yosemite Valley data from IRMA Data Store.

Other good info sources: Yosemite Online Library page, National Park Service page, Climbing resources.

Other papers on related to LIDAR and Yosemite Valley:

- Plutonism in three dimensions: Field and geochemical relations on the southeast face of El Capitan, Yosemite National Park, California
- Use of LIDAR in landslide investigations: A review
- Assessing rockfall susceptibility in steep and overhanging slopes using three-dimensional analysis of failure mechanisms

Planned Methods

The succession of methods would be the following:

- Download the area of interest from the point cloud online store and clean it, if necessary
- Create an elevation model, derive layers needed both for the analysis and the final visualization: slope, hillshade, aspect, water network
- Extract the suitable walls, probably slopes over 75%
- Filter out the shapes that are not climbing walls, based on types of rocks in the zone
- Analyze the relation between the selected walls and the environment and determine which place would be the best on several criteria: distance to roads and water, ease of access, the distance to the rock fall hazard line.
- Compare the findings with existing info about the climbing zones
- Publish the results online, the maps as PDF or on ArcGIS Online, and 3D model using Entwine & Potree

Expected Results

I expect the LIDAR shadow areas would alter the resulting 3D model, but the climbing walls would still be easy to delineate, so that most of the well-known climbing areas would be extracted from the 3D model.

Because I have chosen to use many datasets, maybe the analysis could not be conducted in a small amount of time, so I would have to filter out data I don't specifically need. The learning curve for Entwine & Potree could be too steep to get to publish the 3D model online.

I expect the results will be subjective, unless I will find a database with what makes a climbing place perfect.