Revisiting Multiparameter Relative-Age Methods to Map Late Quaternary Fan Deposits of the Soda Mountains, Mojave Desert, California, with Structure-from-Motion Photogrammetry

John B. Ritter and Kaitlyn E. Seitz

Biological and Environmental Sciences
Wittenberg University
Springfield, OH 45501

ABSTRACT

Dense surface and spatial relief of alluvial surfaces derived from digital elevation models (DEMs) with 10 cm resolution are used for relative age determination and correlation of alluvial surfaces. Original studies on field measurements of individual clasts and bed and wall topography, recent studies have focused on surface roughness derived from airborne LiDAR at scales reflecting taxonomic rank and stratigraphy and pedocanopy. In this study, we bridge the difference in scale using the airborne aerial photogrammetry (a proxy for mapping by unmanned aerial system [UAS]) high-resolution DEMs and affordances of aerial survey ranging in age from late Pliocene to late Holocene were produced using Structure-from-Motion (SfM) photogrammetry and analysis of photo plots from pole-mounted cameras at 0.18 m.

Starting an outcrop at a stereometric resolution of 0.18 m is to reflect the transitions from field-to-flight-to-scales measurements. Surface topography and the roughness are measured, and the surfaces were evaluated at each aggregate size using SfM through surface standard deviation and range of elevation, standard deviation range of slope, and mean ruggedness. Each of the roughness processes can discriminate between alluvial and younger alluvial fan surfaces and the differences are statistically significant at 0.01 level for the 0.28-m aggregated data. Range of elevation and mean ruggedness can discriminate between late Pleistocene, early to mid Holocene, and mid-late Holocene surfaces. Because of the difficulty in selecting, mapping, and geological exposure, these preliminary results provide a larger DEM resolution for future mapping using UAS. DEM resolution between 0.28-0.56 m are fine enough to incorporate both larger clasts and bed and wall topography into high-resolution measurements. Surface topography and the roughness were also analyzed from different resolution, the respective standard size of elevation and range of slope, and mean ruggedness. Each of the roughness processes can discriminate between late Pleistocene and younger alluvial fan surfaces and the differences are statistically significant at 0.01 level for the 0.28-m aggregated data. Range of elevation and mean ruggedness can discriminate between late Pleistocene, early to mid Holocene, and mid-late Holocene surfaces. Because of the difficulty in selecting, mapping, and geological exposure, these preliminary results provide a larger DEM resolution for future mapping using UAS.

In this study, we start from the clast scale (10 cm) onward by using SfM technology, and proceed to the scale of depositional features. There is a clear trade-off between resolution and extent of coverage, but the significantly lower cost of data collection with the relative-age methodology, but that has largely focused on surface roughness attributes as opposed to the relative-age methodology. In this preliminary study, before deploying a mapping-grade UAS in the near future.

DISCUSSION

In this study, we use airborne LiDAR DEMs and digital surface topography to analyze surface roughness and surface elevations that reflect the relative ages of alluvial surfaces. DEMs are obtained from stereo image data of the study area, at mid-late Holocene. This DEM was conducted as a preliminary study before deploying a mapping-grade UAS in the near future.

REFERENCES

...