Application of 3D Photo-reconstruction techniques in Geomorphology: Examples through different landforms and scales

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Recent developments made in tri-dimensional photo-reconstruction techniques (3D-PR), such as the use of Structure from Motion (SfM) and MultiView Stereo (MVS) techniques together, have allowed obtaining high resolution 3D point clouds. In order to achieve final point clouds with these techniques, only oblique images from consumer un-calibrated and non-metric cameras are needed. Here, these techniques are used in order to measure, monitor and quantify geomorphological features and processes. Three different applications through a range of scales and landforms are presented here.

Firstly, five small gully headcuts located in a small catchment in SW Spain were monitored with the aim of estimating headcut retreat rates. During this field work, 3D models obtained by means of a Terrestrial Laser Scanner (TLS) were captured and used as benchmarks to analyze 3D-PR method accuracy. Results of this analysis showed centimeter-level accuracies with average distances between the 3D-PR model and the TLS model ranging from 0.009 to 0.025 m. Estimated soil loss ranged from -0.246 m3 to 0.114 m3 for a wet period (289 mm) of 54 days in 2013.

Secondly, a calanchi type badland in Sicily (Italy) was photo-reconstructed and the quality of the 3D-PR model was analyzed using a Digital Elevation Model produced by classic digital photogrammetry with photos captured by an Unmanned Aerial Vehicle (UAV). In this case, sub-meter calculated accuracies (0.30) showed that it is possible to describe badland morphology using 3D-PR models but it is not feasible to use these models to quantify annual rates of soil erosion in badlands (10 mm eroded per year).

Finally, a high-resolution model of the Veleta rock glacier (in SE Spain) was elaborated with 3D-PR techniques and compared with a 3D model obtained by means of a TLS. Results indicated that 3D-PR method can be applied to the micro-scale study of glacier morphologies and processes with average distances to the TLS point cloud of 0.21 m.