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The issue of reproducibility in multi-temporal geomorphological SfM-workflows – Examples from a laboratory experiment

Jörn Profe and Raphael Steup
Justus-Liebig-University Gießen, Department of Geography, Gießen, Germany (Joern.Profe@geogr.uni-giessen.de)

Photogrammetry, in terms of combined structure-from-motion (SfM) and multi-view stereo (MVS) workflows, experienced a revival in the last decade to address geomorphological research questions. Ubiquitous availability of low-cost sensors such as consumer-grade or smart phone digital cameras together with the emergence of unmanned aerial vehicles (UAV) revolutionized the temporal and spatial resolution of derived point clouds and raster products. Recently, more attention has been paid to data quality and its influencing factors such as image overlap, image coverage, number of images, illumination changes during image capture, angle of view, camera specifications, surface texture as well as selection and capture of ground control points (GCP). Such considerations are of utmost importance when multi-temporal data sets are analyzed. In addition, multi-temporal data sets may suffer from another source of error if consecutive single data sets are not recorded by the same camera.

To illustrate effects on volume estimation resulting from independently captured multi-temporal image data sets by various cameras, we ran a laboratory experiment on a modeled, inclined landscape. Simulating a heavy rainfall event led to slope erosion and sediment accumulation downslope in a 'riverbed'. The obtained consecutive data sets (pre- and post-event) were processed by PhotoScan Professional (Agisoft) to dense point clouds. RMSE of the GCP range from a few millimeters to about a centimeter. Volume was calculated by first estimating the M3C2 distance between consecutive point clouds as implemented in CloudCompare and second averaging the M3C2 distances into 1 cm^2 raster cells. For better comparability of different pre- and post-event data sets, volume changes were estimated in pre-selected, confined areas of erosion and accumulation. First results indicate volume differences of up to 20 %. Therefore, this experiment suggests careful interpretation of multi-temporal data sets as it rarely occurs to capture more than one data set per time in the field. Only a dense network of control points may help to avoid misinterpretations due to multi-temporal data set-inherent variabilities.