



Application of terrestrial photogrammetry for the mass balance calculation on Montasio Occidentale Glacier (Julian Alps, Italy)

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Digital elevation models (DEMs) of glaciated terrain are commonly used to measure changes in geometry and hence infer the mass balance of glaciers. Different tools and methods exist to obtain information about the 3D geometry of terrain. Recent improvements on the quality and performance of digital cameras for close-range photogrammetry, and the development of automatic digital photogrammetric processing makes the 'structure from motion' photogrammetric technique (SfM) competitive for high quality 3D models production, compared to efficient but also expensive and logistically-demanding survey technologies such as airborne and terrestrial laser scanner (TLS).

The purpose of this work is to test the SfM approach, using a consumer-grade SLR camera and the low-cost computer vision-based software package Agisoft Photoscan (Agisoft LLC), to monitor the mass balance of Montasio Occidentale glacier, a 0.07km², low-altitude, debris-covered glacier located in the Eastern Italian Alps. The quality of the 3D models produced by the SfM process has been assessed by comparison with digital terrain models obtained through TLS surveys carried out at the same dates. TLS technique has indeed proved to be very effective in determining the volume change of this glacier in the last years. Our results shows that the photogrammetric approach can produce point cloud densities comparable to those derived from TLS measurements. Furthermore, the horizontal and vertical accuracies are also of the same order of magnitude as for TLS (centimetric to decimetric). The effect of different landscape characteristics (e.g. distance from the camera or terrain gradient) and of different substrata (rock, debris, ice, snow and firn) was also evaluated in terms of SfM reconstruction's accuracy vs. TLS. Given the good results obtained on the Montasio Occidentale glacier, it can be concluded that the terrestrial photogrammetry, with the advantageous features of portability, ease of use and above all low costs, allows to obtain high-resolution DEMs which enable good mass balance estimations on glaciers with similar characteristics.