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Terrain modelling in vegetated terraced landscapes from SfM and LiDAR point clouds

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In steep cultivated landscapes, terraces are one of the oldest soil conservation technique. However, land abandonment and more extensive agriculture are now questioning the sustainability of cultivated terraced landscape when terrace walls fail and terraces progressively level. The prediction of terrace walls failure is thus of high importance to help efficient maintaining of terrace walls and management of areas located downstream. Digital Terrain Models (DTM) are usually the basic data required to model the surface flow pathways for such predictive tools.
The prediction of probable terrace collapse relies on flow convergence points determined from Digital Terrain Models. As terraces are almost always located along initial terrain contour lines, this detection requires very high resolution and accurate topographic data along the terrace front. Unfortunately, in many landscapes, terrace fronts are also the location of field edge vegetation (e.g. hedges, etc) which hides the ground.

In this work, the ability to represent ground level with sub-metric details from 3D elevation points in vegetated and terraced slopes is studied. A gradient of cultivated terraced landscapes regarding slopes and vegetation cover from South France and Northern Italy were used as test sites. 3D point clouds were first generated from both airborne LIDAR or UAV SfM with high point cloud spatial density and point cloud post-processing was developed. Multi-echoes LiDAR is known to provide terrain points under vegetation canopy but laser beam does not penetrate dense vegetation. Likewise, photogrammetry and SfM only provide terrain points where terrain than can be viewed from sensor, i.e. rarely under vegetation canopy. Consequently, some specific anisotropic point cloud filtering process was developed to ensure a proper description of terrain elevation. A regular DTM from the filtered points using interpolation was used to generate sub-metric DTMs. The developed method was tested from LiDAR echoes and SfM raw point clouds on each site in comparison with centimetric ground truth data of the terrain. Error statistics show the ability of each cloud acquisition technique and each site context to represent a proper terrace wall elevation, in line or not with the accuracy required for terrace wall failure prediction.