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Geological and morphostructural implication for sediment and debris supplying channels of small alpine catchments prone to debris flow

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Historical investigation of small alpine catchments throughout the Alps have shown that periods of high debris flow magnitude and frequency result from intense landslides events. Hence, the supply of sediment and debris recharging channels prone to debris flow can be closely related to rock slope instabilities. Mass wasting production through hillslope erosion processes seems therefore to be implicitly linked to the geomorphic and geostructural conditions prevailing at the source areas (mostly composed of cliffs). Since 2009, a monitoring of the cliffs and gullies connected to the Manival torrent (Chartreuse Massif, northern french Alps) has been performed periodically with terrestrial laser scanner (LiDAR). Time series comparison of the LiDAR data has enabled to observe erosion activity and sediment flux contributing to accumulate debris into gullies. The acquired high resolution point clouds enabled to perform a local scale structural analysis of the slopes supplying the torrent and tributary gullies with sediment. The main discontinuity sets and their related structural domains were extracted using the software Coltop 3D that enables an analysis of the topography by representing the dip and dip direction of the slopes of a DEM with a unique colour code ranging in value of a Schmidt Lambert projection. The spatial variability of the structural domains was compared quantitatively with the zones of debris production response in terms of morphological features (geometry of the slopes) and structural setting (dip and dip direction of the different joint sets, bedding planes, joints spacing, etc.). Kinematic analyses were performed across the entire topography to highlight failure mechanism and their correlation with zones of sediment production. The maximum discontinuity frequency and its directions were compared with the orientation of active gullies and scree deposits. Such analyses were finally correlated to the regional structure (lineaments, folds and faults, etc.) and provide an assessment of the contribution of the structural setting to the destruction/erosion of the catchment area supplying sediments to the channel. This ongoing study documents the mode of sediment production on cliffs and the temporal storage/discharge in adjacent subcatchment by analysing the morphostructural control over the debris flow catchment based on high-resolution DEM and geological field study. This study shows that the process-related morphology and slope failure susceptibility can be used as proxies for evaluating terrain implication in the process of debris supply or for preliminary assessing potential erosion zones leading to debris flow activity.