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Laser Scanning for the definition of high resolution topography in the Apuan Alps (IT) marble district

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The present paper describes the results of five laser scanning surveys performed by a Leica™ ScanStation2 with the aim of producing an high definition topography of a quarry, at the scale of 1:1,000. The project comes from a joint research carried out by the Authors in collaboration with the Local Sanitary Unit Agency (ASL n.1) of Massa and Carrara (IT).
The main objective of this work has been the survey of both the exploited quarry walls and the upper residual and natural slopes. The area of interest is characterized by several quarry fronts which develop to variable and alternate directions to create very evident rock spurs, from NW–SE to NE–SW trending for a total wideness of about 2 hectares. Moreover, the quarry walls are sub-vertical and sometimes overhang by a total height of 100 m in respect to the quarry floor.
Differential GPS and orthometric correction have been applied in order to co-register and to georeference the five point clouds; for these purposes a series of optical targets have been measured using a Laser Total Station. The subsequent phase has been the mesh construction and editing, from which a topographic map, 25 cm equidistance contours lines, has been created. The planimetric map shows the position and the geometry of crests, banks, escarpments, walls and all others exploitation features and the characteristics of the upper natural slopes.
Morphological profiles along the maximum slope have been realized in order to better plan the future extractive activities according to the regional law. In order to make easier the prospective observation of detailed and overall areas, 3D views of multi-directional orientation have been realized.
The produced data has been published by using the free LeicaTM TruView plug-in for Internet Explorer in a way to easily view the photographs and to measure the laser scan point clouds.
Processing results have highlighted the higher spatial resolution of data coming from laser scanning in respect to the traditional topographic methodologies. Such information can be used for multitemporal evaluation of mining volumes. For local authorities the control of extraction volumes can be more easily and rapidly executed by map algebra function of image differencing between bi-temporal Digital Dense Surface Model (DDSM) of the quarry walls.
Finally, the DDSM has been utilized by the Authors to analyze the rock slope stability, to collect geological-engineering data, such as joints attitude and spacing, and to perform detailed analysis of rockfall trajectories.