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Rockfall trajectory modelling by the integration of Digital Terrestrial Photogrammetry, Laser Scanning and GIS

Mirko Francioni (1), Riccardo Salvini (3), Silvia Riccucci (2), Enrico Guastaldi (2), Fabrizio Ortolano (2), Filippo Bonciani (2), Ivan Callegari (2), and Pierlorenzo Fantozzi (4)

(1) University of Siena, Centre of GeoTechnologies, San Giovanni Valdarno, Italy (francioni4@unisi.it / 00390559119439), (2) University of Siena, Centre of GeoTechnologies, San Giovanni Valdarno, Italy (00390559119439), (3) University of Siena, Earth Science Department, Centre of GeoTechnologies, San giovanni Valdarno, Italy (salvinir@unisi.it / 00390559119439), (4) University of Siena, Earth Science Department, Siena, Italy (fantozzip@unisi.it / 00390577233938

The present paper describes the runout analysis of rocky unstable blocks on the slope, 500 m wide and 600 m high, overhanging the railroad line Domodossola – Iselle, Italy.
In addition to the traditional geological, geomorphological and engineering–geological surveys, DTP (Digital Terrestrial Photogrammetry) by means of an helicopter was used to perform a detailed analysis of rocky blocks sited in inaccessible areas. In order to accomplish the analysis, DTP was combined with LS (Laser Scanning) to build the DDSM (Digital Dense Surface Model) of the slope.
Aim of the work is the assessment of the rockfalls potentially dangerous for the railroad line, the assessment of the efficiency of existing protection measures and the prompt of mitigation strategies and monitoring.
In order to collect the exact position and size of blocks and wedges, a digital interpretation of stereopairs coming from DTP has been carried out. The photointerpretation has been used to realize the land cover map (ex. outcropping rock, soil covered by vegetation) and to recognize the mitigation and protection measures already installed.
Starting from blocks position the DDSM has allowed to determine the probable trajectories of rockfall along the slope. These have been calculated by means of a GIS procedure by the use of the ArcHydro module of EsriTM ArcMap assuming a correspondence between probable trajectories and flowdirection.
The morphologic profile of rock falling paths has been obtained by the interpolation of 3D points coming from a properly procedure developed inside EsriTM Arcinfo Workstation environment integrated with the Easy Profiler tool of EsriTM ArcMap.
The physical-mechanical characteristics of blocks, the morphologic profile, the land cover and the location of the protection barriers (classified according to the height – from 2 to 4 m – and to the preservation status), have been used as input data in RocFall2D (RoscienceTM) software to calculate the runout analysis.
Local slope land cover has been managed by a statistical approach utilizing the coefficient of normal and tangential restitution; in this way probabilistic results about rockfall end point and kinetic energy along the falling path and on the barriers have been obtained.
Considering the railroad line proximity, the analysis has shown the high probability to reach the train track for some unstable block. Some other ends their fall mainly in correspondence of vegetated and less steep areas; the remaining blocks are stopped by the existing protection measures.
Results from this work have allowed the hazard zoning in respect to the railway; moreover, comparing them with results coming from the rock slope stability analysis, it has been possible to suggest the proper protection methods in different areas.