Rockfall characterization in climbing spots by means of UAV survey: the case study of the "Napoleonica" Tourist Route (Trieste, NE Italy)

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In NE Italy, fast-moving landslides represent a significant threat both to the population and to the built environment. In the eastern portion of the Italian Alps, rockfalls are common and are often responsible for casualties or severe damage to infrastructure.

To assess rockfall susceptibility, field surveys are crucial to accurately recognize the source areas of falling rock phenomena, to quantify the volumes of unstable blocks and identify the possible block trajectories.

This work takes in detailed geological and geomorphological mapping, through the identification of dislodged blocks, fractures and fallen blocks on a much-frequented limestone cliff in the Trieste Karst used as a climbing spot. Moreover, a popular tourist path (the Napoleonica) lies at the foot of the climbing cliffs.

The first identification of the most hazardous sections of the climbing sites were performed starting from field surveys and aerial photo analysis, morphometric and geomechanical characterization of the rock masses together with mapping activities.

The field data were implemented with the analysis of UAV (Unmanned Aircraft Vehicle) images and videos; this innovative technique allows to reach and study hard-to-reach sites with high resolution and precision. The main aim of the study is to perform a semiautomatic morphometric and geomechanical characterization of two of the most hazardous sections. This analysis allowed to extract orientation and spacing of discontinuities of the studied walls and to recognize and measure unstable or pre-dislodged blocks by means of 3D orthophotos obtained from the UAV image processing.

The main output of this work is a GIS-based map that will be the starting point for future 2D and 3D simulations in order to provide a rockfall susceptibility evaluation of the study area.

Moreover, the methodology used could serve as model for the study of the other popular climbing sites, where the geological, geomorphological and climatic conditions are similar. The latters in fact are the predisposing factors to slope failures and consequently could cause casualties during climbing activities.

The final outputs could form an important basis for the growth of investment in tourism policies aimed at increasing the quality of local attractions.