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Rockfall susceptibility and trajectory simulations for enhanced monitoring and early warning systems along roads: the Maratea landslide case study

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On the 30th of November 2022, a major rockfall event occurred in the Triassic dolostones of Castrocuoco cliff (Maratea, Southern Italy), mobilising a volume of about 8000 m³ (Minervino Amodio et al. 2024) and destroying the underlying SS18 national road with no fatalities. The SS18 has critical importance in an area of high tourist, landscape, and historical interests, and determined the planning of a bypass tunnel to avoid the cliff, which has been affected by recurring instability events in the last decades (Pellicani et al. 2016). However, before the tunnel could be completed, the safe reopening of the road was critical for the region. For this reason, a high-resolution monitoring system was developed, enabling the timely road closure to the traffic in case of new failure (Santo and Massaro 2024).

In this study, we describe the geo-structural investigation and reconstruction of the rockfall kinematics and triggering factors, as well as the susceptibility analysis carried out to develop the monitoring system that allowed the road to reopen. Such a system consisted of a network of sensors placed in the areas and on the rock blocks that showed high levels of susceptibility to rockfalls. The data collection was performed through field and digital surveys. The latter was carried out on Virtual Outcrop Models (VOM) following drone photo acquisition. Successively, the rock block trajectories were simulated under static and seismically induced conditions with different block volume scenarios. These results, integrated with the real-time deformation data recorded by the sensors, will enhance the mitigation plan further. Moreover, the developed methodological approach and workflow could be applied to similar situations where critical road infrastructures lie in areas of high susceptibility to rockfall.

Minervino Amodio A, Corrado G, Gallo IG, Gioia D, Schiattarella M, Vitale V and Robustelli G (2024) Three-dimensional rockslide analysis using unmanned aerial vehicle and lidar: The Castrocuoco case study, Southern Italy. *Remote Sensing*, 16 (12), 2235. doi: 10.3390/rs16122235

Pellicani R, Spilotro G and Van Westen CJ (2016) Rockfall trajectory modeling combined with heuristic analysis for assessing the rockfall hazard along the Maratea SS18 coastal road (Basilicata,

Southern Italy). *Landslides*, 13: 985-1003. doi: 10.1007/s10346-015-0665-3

Santo A and Massaro L (2024) Landslide monitoring and maintenance plan along infrastructure: The example of the Maratea major rockfall (Southern Italy). *Landslides*. doi: 10.1007/s10346-024-02409-3