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Digital rock mass characterization for landslide risk mitigation in a nature reserve

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The analysis of a three-dimensional digital model, derived from aerophotogrammetric data, is presented herein as an alternative and homogeneously improved tool for the study of rock masses in restricted areas, such as nature reserves, which are often protected by dedicated management strategies. Airborne photogrammetric and infrared thermography techniques were applied for the geostructural and morphological characterization of the tourist path at Lachea Island, belonging to the nature reserve archipelago "Lachea Islet and Cyclop Rocks" in eastern Sicily (Italy). Geologically, it is considered one of the earliest evolutionary stages of the volcano Etna that occurred about half a million years ago, which has been on the UNESCO World Heritage List since 2013 due to its exceptional level of volcanic activity. It is a world-renowned tourist destination that suffers from limited enjoyment due to the instability of the rock masses. This methodological approach provided quantitative and qualitative data on both the spatial orientation of discontinuities and the location of major structural features, as well as the volume of protruding blocks and the identification of areas of block detachment. The digitally derived spatial data were used to perform a kinematic analysis of the rock masses, highlighting the most recurrent unstable failure patterns. Infrared thermography allowed also defining the most relevant discontinuities. Through the detailed analysis of the 3D model, it was also possible to recognize potential source areas of future rockfalls, which were modelled through trajectory simulations. The results showed that rockfall threat is a crucial issue affecting the nature reserve and that the methodological approach carried out allows a quick, reliable rock mass characterization for practical purposes. Digital data were validated by a field surveying campaign, which returned a satisfactory match proving the usefulness and suitability of the approach, allowing quick and reliable rock mass characterization in the frame of practical use and risk management purposes.