Mapping the spatial distribution of detached boulders with the use of ultra-high resolution remote sensing data and simulation of rockfall events. The case of Kalymnos Island

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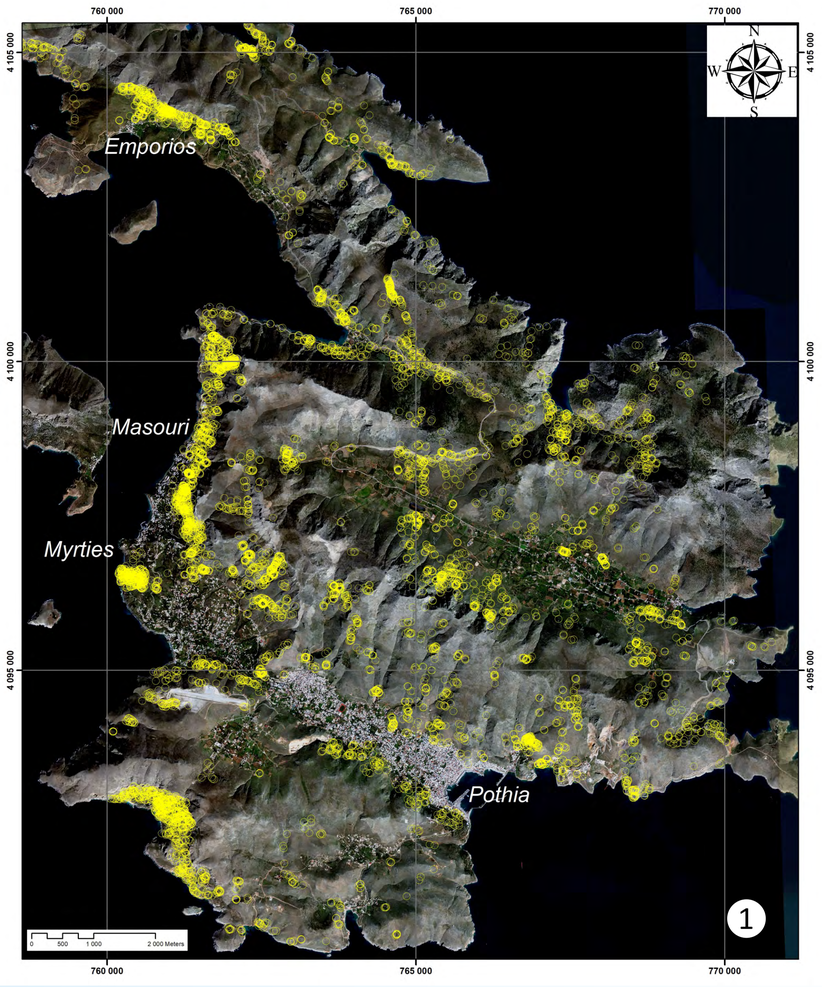
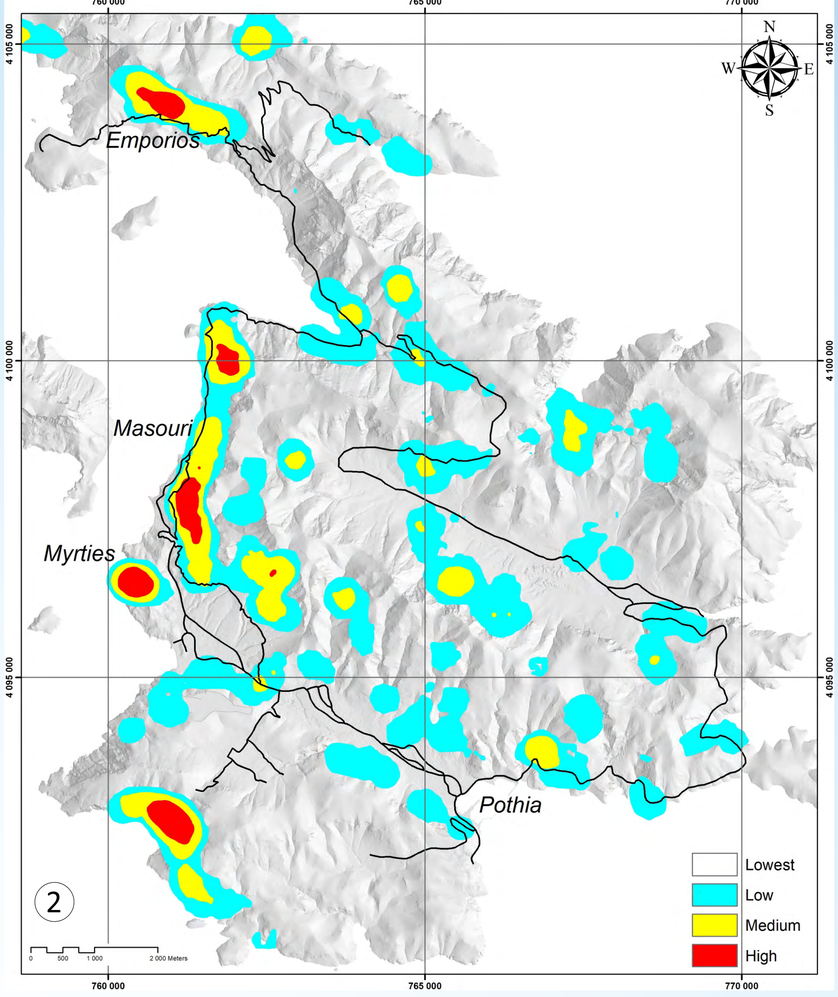
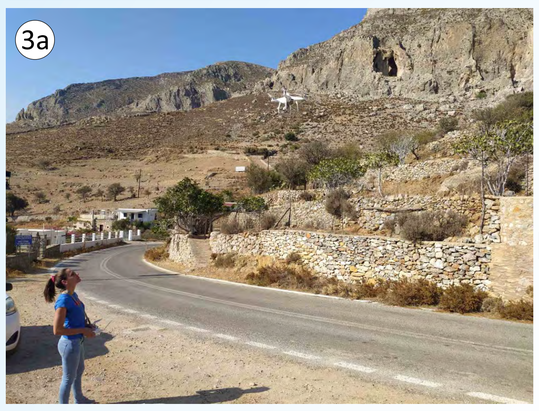
During the recent years, the demands on very high-resolution topography data are constantly increasing, leading to the generation of ultra-high density point clouds, which are used for the construction of Digital Surface Models (DSMs) and Ortho-photo-mosaics.We present a state-of-the-art multidisciplinary study of the Kalymnos rockfall risk, based on (i) classical geological mapping, (ii) interpretation of high-resolution satellite data, (iii) spatial distribution of rockfalls in GIS, (iv) close range remote sensing campaigns with Unmanned Aerial Systems (UAS), and (v) integrated simulation of rockfall events.

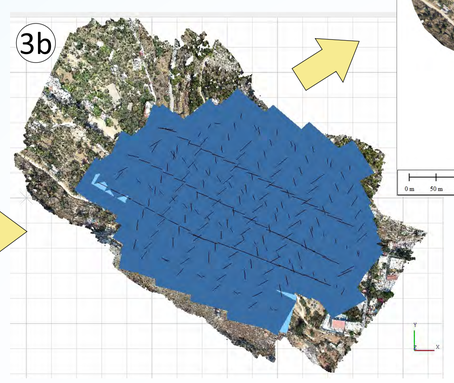


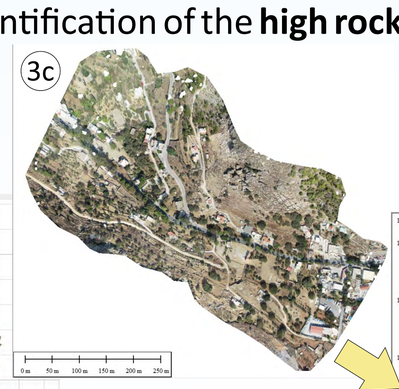
Kalymnos Island is located in SE Aegean (Greece) and is part of the northern Dodecanese.

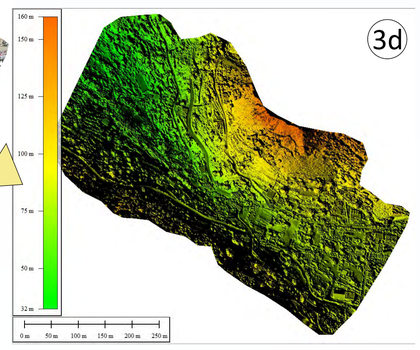
Detached boulders are observed throughout the entire island, making it one of the most ideal places for studying rockfall events worldwide. The absence of vegetation, the existence of large vertical cliffs, and the relatively uniform geological basement, consisting of limestones, are the main reasons for this. The use of contemporary techniques and tools such as **UAS image photogrammetric processing** and high spectral and spatial resolution **satellite data** within GIS platform, allows the implementation of a detailed terrain model and the detection of the spatial distribution of boulders scattered on the downslope areas of steep carbonate cliffs. With the interpretation of WorldView-3 satelite images, rock blocks with diameter greater than 3 meters were clearly identified (Fig. 1) and allowed us the identification of the **high rockfall risk areas** (Fig. 2).





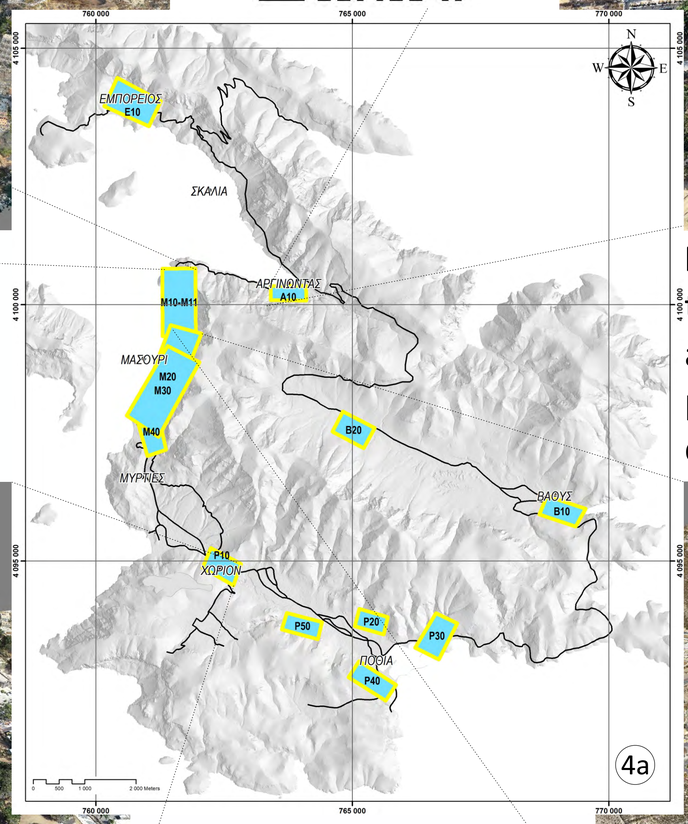




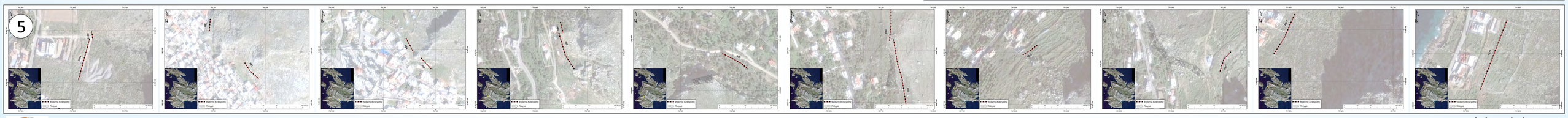


The identification of high rockfall risk areas led to the definition of high importance locations at which UAS campaigns were carried out, for aerial image acquisition that were used within structure-from-motion data processing for 3D models construction (point clouds, Ortho-photo-mosaics, high resolution DSMs) (Fig. 3a-d).

13 areas in all around Kalymnos were captured, which according to the processing and spatial analysis within the GIS, were characterized as the most critical ones (Fig. 4a-e). In total, 5,700 aerial photographs were acquired, covering a total of 6,02km².



Rockfalls simulations were achieved, providing the opportunity to draw useful conclusions regarding differentiations that may arise due to either subtle changes in lithology or topographical peculiarities, leading to reliable conclusions regarding the safe design of protection measures such as rockfall barriers (Fig. 5).



16th International Congress of the Geological Society of Greece | Patras, Greece | 17 - 19 October, 2022

Acknowledgements

This research was funded by the municipality of Kalymnos through the research grant "Reduction of landslide risk in areas of special geodynamic and seismotectonic regime. The island of Kalymnos".