Interconnection of Landslides' activation with Mediterranean Cyclones. The case of Cephalonia Island, Greece

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PURPOSE

From September 17 to 19, 2020, a Mediterranean Cyclone (MEDICANE), named Ianos by the National Observatory of Athens (NOA), impacted Greece, triggering a series of landslides nationwide. Among the hardest-hit areas was the island of Cephalonia. The 24-hour rainfall accumulation recorded on September 17 at the Antipata meteorological station, located in the northern part of the island, reached 644.7mm, one of the highest ever recorded in Greece [1]. Nowadays, due to climate change, there is a growing trend in the occurrence of medicanes in the Eastern Mediterranean, along with increased intensity and duration throughout the entire Mediterranean region [2,3]. The present work aims to identify and map the landslides activated by Ianos, establish an integrated landslide inventory, and correlate it with local hydrological and geological characteristics.

RESULTS

Following the described methodology, over 600 landslides were identified and mapped. Figure 1 illustrates the created Landslides Inventory Map (LIM).

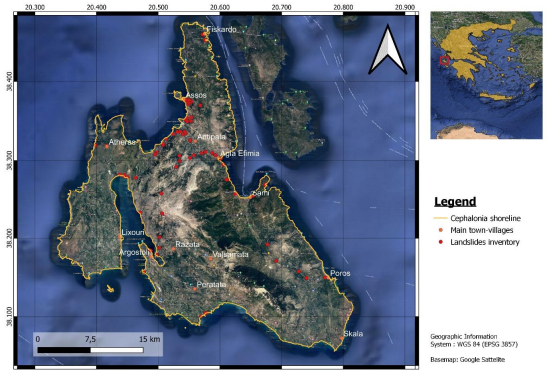

Figure 1, Landslide Inventory Map of Cephalonia

The majority of the identified landslides were debris flows and rockfalls. The most devastating debris flows were recorded in Assos and Fiskardo villages. Using satellite images, the extend of the debris flow in Fiskardo village was estimated to be almost 600 meters in length. Figure 2 provides a characteristic example of an extensive landslide over Myrtos beach, verified using Google Earth images. Rockfalls also affected many areas, leading to road network disruptions and bridges collapses, such as the Chimoniko bridge.

Figure 2, Google Earth images before (a) and after (b) Ianos.

METHODS

Creating an effective inventory map of the landslides triggered by Ianos Medicane required the development of a comprehensive landslides inventory. To begin, an initial inventory of past landslides was established using data from previous studies and publicly available geodatabases, such as the GEOLAND [4]. New landslides were identified by processing data acquired from various sources, including satellite images, open-access data, and more recent studies [3, 5–6]. For instance, as illustrated in Figures 3 and 4, the SNAP software, provided freely by the European Space Agency (ESA), and Interferometric Synthetic-Aperture Radar (InSAR) techniques were employed to analyze Sentinel-1 images, enabling the identification and documentation of new and extensive landslides.

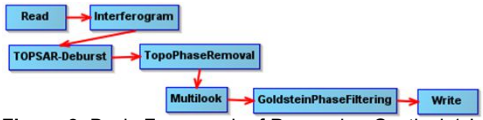

Figure 3, Basic Framework of Processing Sentinel-1 Images with SNAP

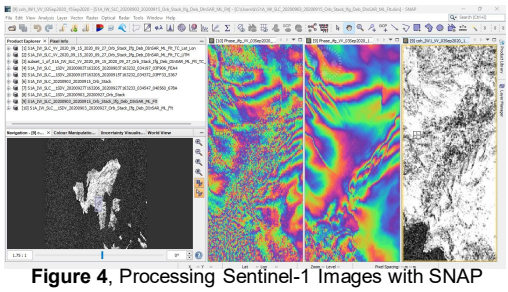

Figure 4, Processing Sentinel-1 Images with SNAP

Finally, open-access and publicly available data, such as Google Earth and Street View images, were used to verify the results.

CONCLUSION

Medicanes are extreme meteorological phenomena that, due to their growing intensity and duration, are expected to cause even more devastating results in the following decades in the Mediterranean area [2,3]. In this direction, the proposed methodology, which led to the rapid detection of over 600 landslides, highlights the potential of InSAR methods to effectively identify and map the consequences of these phenomena. The created LIM is a valuable tool that can be used by authorities (e.g., civil protection) to document the impact of the phenomenon and identify the most affected regions for the implementation of appropriate precautionary measures. Moreover, the spatial characteristics of the recorded landslides, along with the region's hydrogeological features, revealed critical insights about the local landslide activation mechanism. Thus, apart from precipitation, the most critical causal factor, the lithology, the slope's angle, and the proximity to faults, were also found to have made significant contributions.

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