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A framework based on IoT and human sentinels for a municipal landslide early warning system: a case study in southern Italy of the project "The HuT"

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Rainfall is considered the most important triggering factor for landslide initiation. It is expected that changes in the precipitation regimes, as a direct consequence of climate change, will influence slope stability at different temporal and geographical scales altering the frequency and the distribution of rainfall-induced landslides. Therefore, there is a need to develop and implement efficient landslide risk management to deal with the increasing landslide risks. In this context, territorial landslide early warning systems (Te-LEWS) can be valuable tools to warn authorities, civil protection personnel and the population about the occurrence of rainfall-induced landslides over wide areas, typically through the prediction and measurement of meteorological variables with a limited consideration of soil behaviour. Currently, widespread deployments of Te-LEWS integrating monitoring data collected at local scale have been inhibited by the high cost of sensors, the requirement of frequent maintenance and the inflexibility of cable-based systems.

The use of advanced monitoring and communication technologies could provide the means to solve these challenges.

This study proposes a four-phase approach to set up an IoT-based early warning system at municipal scale. The territory of a municipality has been chosen as the reference spatial unit of assessment because it has an extension that is intermediate between slope units and regional warning zones. The framework is based on the following four phases: monitoring, modelling, forecasting, and warning. The study focuses on the first phase of the proposed approach, i.e., combination of widespread meteorological data and local real-time measurements coming from monitoring networks installed at specific locations of great geomorphological interest within the study area. The measurements—specifically soil water content, pore water pressure and suction—are used to provide additional information to be used for enhancing the performance of the warning model. It is important to highlight that, within the proposed framework, an important role for the warning system will be played by community members and other people working or living in the municipality, herein called human sentinels, which will be involved, for instance, in the proper maintenance of sensors and for documenting the impacts of extreme climate events (e.g., photos and reports uploaded in local data platforms).

The monitored sites are located within the municipality of Amalfi, southern Italy, and the implementation will be addressed within the activities of the Horizon Europe project "The HuT: The Human-Tech Nexus - Building a Safe Haven to cope with Climate Extremes". The territory of Amalfi consists of a steep mountain front that rises abruptly from the Tyrrhenian Sea. Steep topographic gradients forced human settlements to develop along the coast at the mouth of the main streams. The town is a densely populated area with high touristic impact. The town is located in a morphologically complex zone of southern Italy frequently affected by dangerous and calamitous landslides.

This study aims at highlighting importance of considering both climate forcing factors and in-situ geotechnical parameters within a warning model operational at municipal scale.