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MTInSAR long-term monitoring of nonlinear slope instabilities on hilltop villages in Southern Italy

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Multi-temporal SAR interferometry (MTInSAR) provides mean displacement maps and displacement time series over coherent objects on the Earth surface, allowing analysis of wide areas to identify ground deformations, and studying evolution of displacement phenomena over long time scales. MTInSAR techniques have proven very useful for detecting and monitoring also slope instabilities.

Nowadays, several satellite missions are available providing InSAR data at different wavelengths, spatial resolutions, and revisit times. The Italian X-Band COSMO-SkyMed constellation acquires data with spatial resolution reaching metric values, and provides revisit times of up to a few days, leading to an increase in the density of the measurable targets, thus improving the monitoring of local scale events as well as the detection of non-linear displacements. The recent Sentinel-1 C-band mission from the European Space Agency (ESA) provides a spatial resolution comparable to previous ESA SAR missions, but a nominal revisit time reduced to 6 days. By offering regular global-scale coverage, better temporal resolution and freely available imagery, Sentinel-1 improves the performance of MTInSAR for ground displacement investigations. In particular, the short revisit time allows a better time series analysis by improving the temporal sampling and thus the chances to catch pre-failure signals characterised by high rate and non-linear behaviour. Moreover, it allows collecting large data stacks in a short time periods, thus improving MTInSAR performance in emergency (post-event) scenarios. These characteristics are very promising for early warning of slope failure events and monitoring subsequent displacements trends.

In this work, we present the results obtained by using both COSMO-SkyMed and Sentinel-1 data for investigating the ground stability of hilly villages located in Southern Italian Apennine (Basilicata region). In the area of interest, several landslides occurred in the recent past (e.g. Montescaglioso in 2013) and more recently (e.g. Pomarico in 2019), causing extensive damage to houses, commercial buildings, and infrastructures.

SAR datasets acquired by COSMO-SkyMed and Sentinel-1 from both ascending and descending orbits have been processed by using the SPINUA MTInSAR algorithm, in order to exploit the potentials of these two satellite missions to investigate ground displacements related to slope

instabilities. Mean velocity maps and displacement time series have been analysed looking, in particular, for non-linear trends that are possibly related to relevant ground instability episodes and, thanks to the high spatial resolution, useful in terms of early warning, in the case of rigid soil masses. Results are presented and discussed in relation to known events occurred in the area of interest.