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Enhanced SAR data processing for land instability forecast.

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Monitoring represents the main tool for carrying out evaluation procedures and criteria for spatial and temporal landslide forecast. The forecast of landslide behaviour depends on the possibility to identify either evidences of activity (displacement, velocity, volume of unstable mass, direction of displacement, and their temporal variation) or triggering parameters (rainfalls).

Generally, traditional geotechnical landslide monitoring technologies permit to define, if correctly positioned and with adequate accuracy, the critical value of displacement and/or acceleration into landslide body. In most cases, they do not allow real time warning signs to be generated, due to environmental induced errors, and the information is related to few points on unstable area. Remote-sensing monitoring instruments are capable of inspecting an unstable slope with high spatial and temporal frequency, but allow solely measurements of superficial displacements and deformations.

Among these latest technologies, the satellite Persistent Scatterer SAR Interferometry (PSInSAR) is very useful to investigate the unstable area both in terms of space and time. Indeed, this technique allows to analyse wide areas, individuate critical unstable areas, not identifiable by means detailed in situ surveys, and study the phenomenon evolution in a long time-scale.

Although this technique usually adopts, as first approximation, a linear model to describe the displacement of the detected targets, also non-linear models can be used. However, the satellite revisit time, which defines the time sampling of the detected displacement signal, limits the maximum measurable velocity and acceleration.

This makes it difficult to assess in the short time any acceleration indicating a loss of equilibrium and, therefore, a probable reactivation of the landslide.

The recent Sentinel-1 mission from the European Space Agency (ESA), provides a spatial resolution comparable to the previous ESA 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 PSInSAR for ground displacement investigations.

In particular, the short revisit time allows a better time series analysis by improving the temporal sampling and the chances to catch pre-failure signals characterised by high rate and non-linear behaviour signals. Moreover, it allows collecting large data stacks in a short time period, thus improving the PSInSAR performance in emergency (post-event) scenarios.

In the present work, we propose to match satellite data with numerical analysis techniques appropriate to evidence unsteady kinematics and, thanks to the high resolution of satellite data and improved temporal sampling, to detect early stages of land instability phenomena.

The test area is situated in a small town in the Southern Apennine, Basilicata region, affected by old and new huge landslides, now close to a lived outskirt.