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How InSAR displacement measurements can be used for understanding landslide dynamics and for identifying the relationships with triggering factors.

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The measurement of superficial displacements often represents the most effective method for defining the behaviour of slope movements and for the assessment of their temporal evolution. Spaceborne InSAR has demonstrated in recent years its capabilities in providing precise measurements of ground displacements induced by slope instabilities. In the case of slow movements (up to few cm/year) affecting built-up areas the multi-interferogram approaches, such as the Permanent Scatterers (PS), are able to retrieve the spatial distribution of displacements and their evolution along the monitored period. Thanks to the availability of archieve data, acquired since 1992 from the ESA satellites ERS1-ERS2, the differed-time analysis of past movements can be extended to a time period spanning more than 10 years. The integration of these measurements with geological and geomorphological information allows a better characterization of the slope movement, facilitating the interpretation of the phenomenon dynamics. Furthermore the InSAR-derived temporal series of displacements of specific points along the slope and the multi-temporal displacement maps can be compared to the records of the triggering factors, such as rainfall or earthquakes. Here we present the multi-interferogram analysis of the slope movements affecting the Cutigliano village, in the Tuscan Apennines (Italy). The analysis, performed through the Permanent Scatterers technique, allowed the identification of more than 200 measurement points along the slope. The InSAR measurements were combined in a GIS environment with other ancillary data, such as aerial photos, topographic and geomorphologic maps to obtain an accurate analysis of the movement spatial distribution that allows the iden-

tification of the unstable area boundaries. The integration of superficial movements with data related to the underground geological conditions, such as rupture surfaces from inclinometric readings and stratigraphic and geotechnical characteristics of the involved terrains obtained from boreholes and geophysical surveys, was performed for a better understanding of the phenomenon dynamics and for the interpretation of the movement geometry. Moreover, to define the relationships existing between rainfall, supposed to be the main triggering factor, and slope movements, the temporal series of displacements were compared with pluviometric measurements. Such a comparison allowed to identify a strict correlation between landslide activity periods and rainfall, showing the presence of very short time delays between the two phenomena and acceleration phases corresponding to heavy rainfall events.