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Quantitative comparison between DInSar-derived surface displacements on slow-moving landslides and ground-based rainfall series

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Earth observation data are helpful in analyzing how climate-related variables affect geomorphological processes. This work aims at evaluating the influence of rainfall on slow-moving landslides, by means of a quantitative procedure for (i) identifying clusters of pixels measuring satellite-based surface displacements indicating landslide activity, (ii) comparing them with rainfall series, and (iii) applying statistical tests to assess their relationships at the regional scale. The methodology was developed within the framework of the OT4CLIMA project (Development of Innovative Earth Observation Technologies for the Study of Climate Change and Its Impacts on the Environment), funded by the Italian Ministry of Education, University and Research. The project aimed to develop advanced Earth observation technologies and methodologies for improving the capabilities to understand the effects of climate change at regional and sub-regional scale.

The procedure presented here was applied in the Basento river basin, within the Basilicata region, southern Italy. The Basento catchment, with an area of 1535 km^2 and a NW-SE trend, falls within the domain of the Apennine chain in the western part, and within the Bradanic Trough in the eastern part. The stratigraphic and structural setting of the basin plays a significant role in determining landslide occurrence and distribution.

Rainfall series were gathered from rain gauges (http://www.centrofunzionalebasilicata.it/it/) and analyzed to evaluate the presence of temporal trends. Ground displacements were obtained by applying the P-SBAS (Parallel Small BAseline Subset) technique to three datasets of Sentinel-1 images: T146 ascending orbit, and T51 and T124 descending orbits, for the period 2015–2020. The displacement series of the pixels located in areas mapped as landslides by the Italian Landslide Inventory (IFFI database, https://idrogeo.isprambiente.it/app/) and sited within rain gauge influence regions (defined as 10 km circular buffers) were studied.

Two slow-moving landslides were selected and investigated in detail. The average displacement series of the landslides were analyzed and compared to the rainfall series to search for relations,

by employing statistical and non-parametric tests. More in detail, the Kendall rank correlation coefficient and the Maximal Information Coefficient were adopted in the analysis. Significant results were obtained for the T124 descending orbit for both landslides, for a 3-day cumulative rainfall and a 7-day delay of the slope response. Given the procedure's replicability it can be applied to study areas with different physiographic and climatic features. Other applications might involve satellite- or radar-based rainfall estimates.