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Multi-band satellite radar data for landslide events management: an example from Central Italy

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Nowadays, satellite radar data are widely used and recognized by the scientific community as a valuable tool to detect ground motions at different scales, ranging from the single landslide to an entire region or nation. Their role in civil protection practices begins to be also acknowledged by local and national governments. In this context, we exploited both C- and X-band SAR (Synthetic Aperture Radar) data for back-monitoring a landslide that affected the village of Ponzano in the Abruzzi region (central Italy). The landslide mobilized the 12th of February 2017 as a result of the combination of snow melting and intense rainfalls. The saturation of the slope was eased by the abrupt temperature increase of the beginning of February 2017, in which around 120 cm of snow melted. During this snow melting period, two intense rainfall events were recorded before the landslide failure. The resulting landslide, which recorded a maximum velocity of 4-5 m/day, is classified as complex, being composed by a rotational component in its upper and crown portions and by a earth flow-like geometry in its central and toe sectors. The landslide damaged 32 private houses, resulting in the evacuation procedures for about 100 people. In this work, we characterize the pre-failure behavior of this landslide exploiting the information retrieved by the PSI (Persistent Scatterers Interferometry) processing of C-band Radarsat-2 and Sentinel-1 radar images. In particular, both data were analyzed by means of the SqueeSAR algorithm. The PSI approach cannot detect fast deformation rates, thus we chose to exploit the amplitude information contained into a SAR image to track the surface changes generated by the landslide motion. This is made by applying an amplitude-based algorithm (Rapid Motion Tracking – RMT) to two X-band TerraSAR-X images acquired immediately before the landslide occurrence and one 9 days after the failure. The SqueeSAR data showed that the landslide was already active 9 years before its complete mobilization, evidence confirmed by inclinometric measurements, with a deformation trend increasing in the last two years. On the other hand, the amplitude data allowed to evaluate, in a quantitative way, the magnitude of the displacement generated by the landslide motion. The results obtained were finally compared with geomorphological and damage evidences collected during field and helicopter surveys performed immediately after the landslide failure. Both the amplitude and phase-derived displacement data were used to support the Civil Protection activities during the landslide emergency response. In particular, the satellite data were exploited for i) landslide mapping, ii) determining the areas with the highest displacements and so potentially more damaged, iii) supporting local and Civil Protection authorities in the selection of a relocation site for the inhabitant of the unstable areas. This case study confirmed the usefulness of SAR images for post-failure investigations and for retrieving precursors of a phenomenon.