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Exploring the potential of Sentinel-1 data for regional scale slope instability detection using multi-temporal interferometry

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Launched in 2014, the European Space Agency (ESA) Sentinel-1 satellite carrying a medium resolution (20 m) C-Band Synthetic Aperture Radar (SAR) sensor holds much promise for new applications of multi-temporal interferometry (MTI) in landslide assessment. Specifically, the regularity of acquisitions, timeliness of data delivery, shorter repeat cycle (currently 12 days with Sentinel-1A sensor), and flexible incidence angle geometry, all imply better practical utility of MTI relying on Sentinel-1 with respect to MTI based on data from earlier ESA's satellite radar C-band sensors (ERS1/2, ENVISAT). Furthermore, the upcoming launch of Sentinel-1B will cut down the repeat cycle to 6 days, thereby further improving temporal coherence and quality and coverage of MTI products.

Taking advantage of the Interferometric Wide (IW) Swath acquisition mode of Sentinel-1 (images covering a 250 km swath on the ground), in this work we test the potential of such data for regional scale slope instability detection through MTI. Our test area includes the landslide-prone Apennine Mountains of Southern Italy. We rely on over 30 Sentinel-1 images, most of which acquired in 2015, and MTI processing through the SPINUA algorithm (Stable Points INterferometry in Un-urbanized Areas). The potential of MTI results based on Sentinel-1 data is assessed by comparing the detected ground surface displacements with the MTI results obtained for the same test area using the C-Band data acquired by ERS1/2 and ENVISAT in 1990s and 2000s. Although the initial results are encouraging, it seems evident that longer-term (few years) acquisitions of Sentinel-1 are necessary to reliably detect some extremely slow movements, which were observed in the last two decades and are likely to be still present in peri-urban areas of many hilltop towns in the Apennine Mts.

The MTI results obtained from Sentinel-1 data are also locally compared with the MTI outcomes based on the high resolution (3 m) TerraSAR-X imagery. Again, even though there is lack of temporal overlap in the two datasets, the comparison shows some potential benefits of the exploitation different resolution sensor datasets. For example, when considering the costs of MTI applications, an effective approach to slope hazard assessment could rely on the use of coarser imagery MTI to secure long-term wide-area coverage, to be integrated by higher resolution MTI with more focus on urbanized or greater value areas (cf., Wasowski and Bovenga et al., 2014a,b). Now these approaches are facilitated by the regular global coverage and free medium resolution imagery guaranteed by the background satellite radar mission of Sentinel-1.

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