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# A space/time deformation analysis of unstable slopes at Maratea (Italy) based on satellite radar interferometry

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We present a differential SAR interferometry (DInSAR) application focused on investigating the slope instability phenomena affecting the Maratea valley area (Southern Italy). The ground monitoring data, acquired periodically since 1983, indicate that the zone is characterised by apparently continuous, very slow movements (up to several cm/yr). This work is an extension of a previous DInSAR study presented in (Berardino et al., 2003) that revealed the occurrence of spatially variable slope movements, but that did not analyze the temporal behavior of the identified displacement phenomena. Here we report the results of a new DInSAR analysis based on the small baseline subset (SBAS) approach (Berardino et al., 2002) and relying on a large number of SAR images spanning the 1992-2000 time interval. In particular 60 images, acquired by the European Space Agency (ESA) ERS-1 and ERS-2 radar sensors, were used for analysis. Although the spatial resolution of the interferometric product (coherent pixels with displacement information) is of the order of 100 x 100 m, given the large extent of the unstable area, the results are adequate to:

- detect the area affected by deformations and distinguish it from the surrounding stable slopes;

- delimit the areas characterised by extremaly slow ($<$1.5 cm/yr) and very slow ($>$1.5 cm/yr) displacements; the former coincide with marginally stable carbonate slopes, the latter fall within an active, few tens of meters thick landslide in clay-rich materials;

- identify the landslide segments characterised by different velocities. Furthermore, the deformation time series of coherent radar targets reveal the presence of temporal changes in the velocity of landslide movements. In particular, it appears that after a roughly constant deformation rate of up to a few cm/yr in the mid ninties, towards 1998 and throughout 1999 - 2000 the landslide movements slowed down nearly to

zero. A similar trend is also revealed by the GPS observations repeated annually. To investigate a possible cause of this apparently natural landslide stabilisation we examined the temporal pattern of rainfall precipitation in the Maratea valley. The pluviometric data show that, except for 1996, the total annual precipitation was throughout the ninties always below the long-term (1920-2001) annual average of 1360 mm/yr. Furthermore, there was a decreasing precipitation trend following 1996. This trend appears even more evident considering the 2- and 3-yr moving average annual precipitation. Therefore, it appears that the landslide movements are influenced by a mid- to long-term variations in precipitation. This is consistent with the considerable thickness of the unstable masses and their low permeability. In summary, this case study demonstrates that, under favourable environmental conditions (e.g. suitable slope orientation and inclination, lack of or sparce vegetation), the DInSAR analysis can lead to improve our understanding of post-failure mechanisms and long-term mass movement activity patterns relevant to slowly deforming landslides. By revealing changes in mobility of specific landslides this technique can provide useful information for temporal landslide hazard assessments.

References

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