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Statistical assessment of Persistent Scatterers location in different landslide prone geological units

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In the last decade Synthetic Aperture Radar Interferometry (InSAR) has been applied to measure with an accuracy of a fraction of a centimetre terrain deformations induced by different geological phenomena. In particular, approaches have been developed, within the framework of InSAR techniques, to detect pixels characterized by a stable interferometric phase where it is possible to get very accurate estimation of deformation. These pixels correspond to terrain patches (Persistent Scatterers) with well behaved scattering properties in the microwave domain. The occurrence of Persistent Scatterers (PS) is related to the vegetation coverage, the presence of man-made structures, as well as to the lithological and geological properties of the observed area. Generally, a high number of PS are found in urban areas whereas vegetation causes temporal de-correlation which destroys interferometric phase stability.

An interesting research issue is to study how the probability to find a PS are related to the lithology/geology and slope angle. Knowing more about those issues could be of major importance when trying to apply InSAR as a support for landslide inventory at a regional scale.

For this study two regions at north of Lisbon, Portugal (Arruda dos Vinhos and Fanhões-Trancão/Lousa) were chosen as test sites due to the presence of a high number of landslides previously identified and mapped at the scale 1:2000 through detailed field geomorphological mapping.

Moreover, the landslide inventorying for the two regions allows the recognition of more than 500 slope movements (deep and shallow) of rotational and translational types. However, due to the dimension (in some cases, less than 50 m2) of the smaller landslides, essentially shallow translational, only a part of the landslide data base was used to compare with the correlation between PS and lithological units and slope angle.

The geomorphological settings of the test sites are in the essential controlled by an alternation of rocks with different resistance to erosion, permeability and plasticity and by a geological structure favourable to slope instability. Furthermore, those test sites presents only sparsely vegetated areas over which the current space-borne interferometric SAR missions have limitations due to temporal de-correlation.

A dataset of 58 ERS-1/2 SAR images was processed. They were acquired along both from 1992 to 1997 and from 1998 to 2002.

The map with the location of Persistent Scatterers was overlaid to the lithological/geological and to the slope map, slopes maps and the frequency distribution of PS per squared kilometres in the different lithological/geological units and slope angle classes were obtained. This distribution can be used too as a means to characterize the capability of a given lithological/geological unit or a particular slope value to generate PS when not covered by huge vegetation.

Furthermore, PS where terrain displacements were detected were selected and the corresponding frequency distribution of PS per square kilometres in the different lithological/geological units and by slope angle values were obtained. This distribution was compared to that of landslides mapped to statistically assess the map of landslides detected by SAR inteferometry.

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