DInSAR techniques for monitoring slow-moving landslides

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ABSTRACT: Remote sensing is being frequently applied in recent years to monitor slope instability phenomena. Since satellite images cover wide territories with frequent passages, their use seems to be extremely promising in terms of landslide monitoring. Among the different techniques proposed, the Permanent Scatterers (PS) technique is a multi-interferogram approach for processing SAR data that allows to overcome the limitations of the traditional DInSAR. In the present paper, some preliminary considerations are developed, deriving from the use of the PS technique in a small town of Campania region, Italy, where some slow-moving complex landslides affect the urban area. The SAR data have been relieved from the ERS-1 and ERS-2 sensors of the European Space Agency in the 1992–2001 time span. The SAR data are being compared with field evidence of structural damages to urban buildings and infrastructures, in view of further field-based observations, integrated with classical site monitoring data.

1 INTRODUCTION

The space-borne SAR interferometry is a powerful remote sensing tool, which recently has demonstrated its ability in detecting and monitoring several natural phenomena, including slope instabilities (Metternicht et al. 2005). The interferometric technique able to assess ground displacements is the Differential InSAR (DInSAR) that analyses the differences in phase values between two SAR images of the same area gathered at different times. Compared to the conventional methods for monitoring a landslide, DInSAR allows to obtain information about surface deformation over wide unstable areas in relatively short times and at lower costs. Notwithstanding its high potentiality, DInSAR has not become a full operative tool for geoscientists and engineers yet, because of some limitations. In fact, although successfully applied in several case-studies (Fruneau et al. 1996; Singhroy & Molch 2004; Strozzi et al. 2005), DInSAR is at present affected by problems such as the decorrelation noise induced by random variations of terrain reflectivity and the atmospheric noise generated by random fluctuations of the atmospheric refraction index (Berardino et al. 2003).

The Permanent Scatterers (PS) technique is a multi-interferogram approach for processing SAR images, developed by T.R.E. (a spin-off company from the Politecnico of Milan, Italy), overcoming the limitations of conventional interferometric techniques. The PS technique focuses on the use of long temporal series of SAR data, extracted from the European Space Agency archive gathering satellite acquisitions since 1991, and on phase stable targets, the so-called permanent scatterers. These latter are identified by means of a statistical study on the amplitude of their electromagnetic signal returns (Colesanti et al. 2003). PS are pointwise scatterers only slightly affected by decorrelation problems, which makes possible at these sites to measure deformations with a very high accuracy (in the order of the millimetre).

Worldwide several applications are demonstrating the high potentiality of the PS technique in different geological fields, including subsidence, mining related ground instabilities, seismic faults monitoring and landslides (Ferretti et al. 2001; Hilley et al. 2004; Colesanti et al. 2005; Burgmann et al. 2006; Colesanti & Wasowsky 2006; Meisina et al. 2006).

Landslides are among the most costly natural hazards in Italy, and are responsible for many fatalities (Guzzetti 2000). The Campania region of southern Italy is one of the sectors in the country where the highest frequency of landslides with casualties has been recorded, with several tragic episodes even in recent times.