

# In situ and satellite long-term monitoring of slow clayey landslides and of the structures built on them

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**Abstract.** Large and slow landslides in structurally complex clayey formations are widely diffused in the Italian Apennines. This paper shows the results of the long-term monitoring of the slow movements of a landslide system developing in the formation of Variegated Clays, in the Costa della Gaveta slope (Potenza, Italy). The landslides are urbanized and their slow movements cause damage to buildings, structures and infrastructure, with important social and economic costs. Monitoring is an essential measure to reduce the landslide risk. In some areas of the slope, in correspondence of the highway and national railway, inclinometer data have been available for the last 30 years. From 1993 to 2005 many inclinometers have been installed by different public or private agencies, however each system has been working over only a few years. Anyway, the number and location of the instruments made possible the reconstruction of the movements of the landslides over that time period. In 2005 a new monitoring system was designed based on a large number of traversing and fixed-in-place inclinometer probes. Some ten devices recorded data over time intervals different from zone to zone, depending on the displacement rates. All over the monitoring period, new tubes were installed to replace those that had gone out of use for excess of displacements. Furthermore, since 2006, several GPS stations and benchmarks were installed. The availability of long and robust series of displacement data allowed for the use of DInSAR data which otherwise, at Costa della Gaveta, are not easily interpretable. In fact, as well known, the DInSAR data processing provides the components of the displacements along the LOS (Line Of Sight) of the satellite system. In the considered area, the displacements have a small component along the LOS, often in the order of magnitude of the measurement error. To minimize such problem, only the satellite data relative to areas where the displacements and their direction are clearly determined by inclinometers and GPS stations were considered. By the processing of images acquired by synthetic aperture radar sensors (ERS, Envisat, COSMO-SkyMed satellites), the kinematic history of the inhabited area over the last 30 years was reconstructed, even where short inclinometer displacement series were available. Furthermore, the effectiveness of remedial measures constructed in the monitoring period could be evaluated.

**Keywords:** Landslide, Monitoring, Displacement, Inclinometer, DiNSAR, Interaction.