Geophysical Research Abstracts, Vol. 8, 10725, 2006
SRef-ID: 1607-7962/gra/EGU06-A-10725

Displacement monitoring by multitemporal remote sensing and geophysical techniques: the Corniglio landslide (Parma, Italy).

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The Corniglio landslide is a large mass movement affecting the old village of Corniglio, located at an altitude of 700 m a.s.l. in the Emilia Romagna Region, Northern Italy, about 50 km SW of the city of Parma. The present landslide dimensions are considerable: over 3000 m in length, 1000 m width and up to 120 m in depth, extending from an altitude of 1150 m a.s.l. to 550 m (the Parma Stream riverbed).

Weakening of geomechanical properties appears to be the main reason of the landslide movements, caused both by intense rainfalls and by seismic activity (including earthquakes of surprisingly small magnitude). In the most recent seismic hazard zonation of Italy (2003), Corniglio lies in Zone 3, with a design peak horizontal acceleration a_g=0.15 g on hard ground, corresponding to 10% exceedance probability in 50 yrs.

A set of different slide bodies breaks the slope continuity. An important glacial system acting on these slopes worsen the mechanical properties of the surface deposits (up to a significant depth), representing one of the main indirect causes of the subsequent slide movements. This situation, detected in the Corniglio area is typical of all the documented landslides in Northern Apennines.

Furthermore, the landslide is located in an area that can be classified as complex from the standpoint of geological and tectonic structure. Several stratigraphical units, characterised by different lithological features, are displaced in the area by numerous faults, overthrusts, and by deep and surface rotational landslides.

Landslide movements and reactivations occurring in the study area have been documented since the 9th century A. D. The main triggering factors that caused recent landslide activity were two small earthquakes (magnitude 3.3 and 2.2, respectively) which activated new movements in January 1996, with new rupture surfaces observed. A much stronger seismic event, i.e. the M_W 5.4 Correggio earthquake of October 1996 (with epicentre some 60 km from Corniglio), generated small slide movements, but the following intense rainfall during November 1996 caused a final reported displacement as large as 6-8 m.

In the present study the surface displacements were evaluated through digital interpretation of the same sample points on five successive temporal series: the raster topographic data of Emilia Romagna Region at 1:5000 scale (year 1979); orthocorrected aerial photographs of July 1996, November 4^{th} 1996, and November 21^{st} 1996; Quickbird highest resolution satellite imagery (year 2000). Both orthocorrection and digital terrain models of each aerial photograph stereo pair were performed through digital stereoscopic models. Moreover, the spatial distributions of precision and accuracy of orthocorrected aerial photographs were calculated in order to provide assessment maps of the uncertainty of remote sensed dataset of each temporal series to be interpreted.

Superficial displacement vectors in the whole study area were measured in a GIS environment, and displacement vector parameters were calculated by means of spatial and statistical analysis techniques. Maps of magnitude and azimuth of surface displacements illustrate the results achieved.