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Spatio-temporal ground displacements monitoring of the Corniglio landslide (Parma, Italy)

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The Corniglio landslide (also known as Lama di Corniglio) is a large slope failure affecting the old village of Corniglio (PR, Italy). The present landslide dimensions are considerable: over 3,000 m in length, 1,000 m width, extending from an altitude of 1,150 m a.s.l. to 550 m. Because of its extension and its recent catastrophic activity, documented since the 9th century a.C., the Corniglio landslide is one of the main landslides in the Northern Apennines.

The landslide involves the Eocene-Oligocene sequence of marly limestones and overlying sandstones of the Canetolo Unit, tectonically covered by the marly limestone flysch of the Mt. Caio Unit (Late Cretaceous). These units underwent intense polyphasic deformations, so their rocks are highly strained.

Spatio-temporal ground displacements monitoring was performed by comparing the position of the same targets recognized among the following ten successive temporal series of data: topographic maps of Emilia Romagna Region at 1:5,000 scale, year 1978; aerial photographs of 1976, 1988, August 1994, July 4th 1996, November 4th 1996, November 21st 1996, September 1998; QuickBird imagery, year 2003; aerial photographs, year 2005.

Aerial photographs were orthorectified by building digital stereoscopic models based on the topographic map, and the quality of both orthorectification and registration was assessed through precision and accuracy estimation, which resulted to be around 1 m.

The analysis of spatial variability of vector displacement data, obtained by comparing the homologous target positions within the above dataset, produced kriged multitemporal maps (in terms of both magnitude and azimuth of vectors), describing the state of activity of the landslide up to 2005.

A GPS network was installed in order to monitor ground displacement from 2006. It consists of around 30 GPS survey points, which were measured in July and September 2006, and March 2007, by means of double frequency receivers in static configurations.

Data were post-processed by means of both multipoint and baseline approaches, which allowed to obtain a precision of about 1 cm when estimating ground displacement vectors.

The metric use of multitemporal remote sensing imagery allowed to measure ground surface deformations caused by the reactivations from December 1994 to July 1996, as well as the catastrophic events of October-November 1996, and the recurrent activity from October 1998 to 2003. The total amount of ground displacement from 1978 to 2003, reached in some sectors of the main body of the landslide more than 50-70 m.

After 2003 the main body of the "Lama di Corniglio" experienced a relative stability period, in agreement with GPS measurements, these last suggesting surface displacements not larger than about 1 cm for the period July 2006-March 2007. Instead, some GPS survey points, located in the hills forming the eastern border of the landslide, indicate that centimetric displacements are still affecting the Corniglio village.

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