Single-frequency GNSS monitoring of the Guvano coastal landslide (Vernazza, Italy)

*Emanuele Raso[1], Ivano Rellini[1], Stefano Caldera[2], Eugenio Realini[2]

1.Universita degli Studi di Genova, 2.Geomatics Research and Development (GReD) srl

The use of Global Navigation Satellite Systems (GNSS) has become a popular technique in landslide monitoring in recent years: application of low-cost GNSS sensor technology (simple L1 receivers) has remarkably improved during the last few years and has considerably reduced the cost of GNSS sensors; the deformation monitoring with GNSS measurements is a well-known method which can be employed for both extended and local phenomena such as landslides, where a high level of accuracy is needed.The Guvano coastal landslide is a complex slow gravitational phenomenon located between the hamlets of Vernazza and Corniglia; it shows an extension of approximately 0.15 km2, a maximum length of 650 m measured across the upper portion and a width ranging between 120 m and 400 m at slope toe.From a kinematic point of view, the landslide evolution is characterized by a rock planar slide occurred in 1853 and whose fracture surface was set up of a translational fault plane between shales and argillites (Argille e Calcari di Canetolo Formation) and sandstones (Macigno Formation); at present time, three main sectors are identified: the upper one, characterized by rockfalls and topples along an active scarp, the medium one (medium to high slope angle, characterized by soil slips and earth flows) and the lower one (low slope angle, earth flow reaching the coastline). Collapses related to the right flank usually start as rockfall and then evolve in rock avalanches.An original engineering geomorphological map has been realized: actually a retrogressive failure, consequence of several crown collapses, is well visible and could represent a risk for the village of San Bernardino, located just above the main scarp, and for the safety of cars and pedestrian along a portion of the SP51 County Road. The erosion of the landslide toe by the sea waves action and subsequent offshore transportation of sediments has determined a dangerous condition in terms of remobilization of the landslide mass.Between 2003 and 2004 a geotechnical investigation (soil borings and installation of inclinometers and piezometers) was performed in order to examine the soil and rock stratigraphy of the area and to obtain information about the displacement of the landslide mass, which has alternated active phases with dormant periods: the sliding surface was identified at a depth of 11 meters.The main objective of this work is to detect displacements of the order of a few millimeters by relative positioning of low-cost receivers over a short baseline (about 2-3 km): the monitoring program has started in October 2015 when four GNSS sensors (GeoGuard Monitoring Units - GMU) were positioned along the landslide body.The GMUs include low-cost single-frequency hardware for both receiver and antenna. The receiver module is a u-blox LEA-6T, providing GPS observations which are transferred by mobile connection to the control center (GeoGuard Cloud) and processed by a customized version of the free and open source software goGPS. Single-shot displacement data and trend analyses are then processed and managed by the GeoGuard Cloud, which send it to the end-user service interface.The first results assess the activity of the landslide through the relative displacement detected between two of the deployed GMUs along a vertical (z) component (1 cm/month). With the aim of reducing the RMSE affecting the positioning estimates (currently of the order of 1-5 mm), the baseline length is planned to be further shortened by installing a dedicated reference GPS station outside the landslide mass.

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