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Methodological and experimental study of the relationship between displacement rate of landslide and GNSS strategy for deformation monitoring

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The use of GNSS for landslide monitoring is not a novelty. In the field of large slope instabilities, where the phenomena are usually wide and the use of complex monitoring networks is needed, often a continuous monitoring is required. In this case, the installed GNSS solution is composed by a dual frequency receiver, with a solar power and with a radio connection to a ground station, where the measurement sessions of the rovers are collected and processed. The management of the collected data is the most critical aspect because the approach, which is commonly used, assumes a fixed position of the GNSS antenna during the acquisition time window. When the landslide is active, the position shift of the point can be considered insignificant for the low displacement rate, but together with the increase of the velocity, the GNSS time series processing becomes a crucial aspect to obtain reliable and enough accurate measurements. Starting from real case studies as the Italian large slope instabilities of Montaguto (Avellino, Italy) and Mont de La Saxe (Courmayeur, Italy), we focused on the presence of different kinematic domains with dissimilar displacement behaviors and velocities. In particular, the range of velocities registered during the main active periods ranges from several millimeters/day up to several meters/day, so the strategy for the GNSS processing data must be very different.
Methodology for data acquisition (continuous or windowed) and its duration, type of receivers and antenna used (single or dual frequency, GPS or GNSS, mass market or geodetic), data processing strategies (i.e. single epoch, kinematic), and eventually GNSS network services are fundamental factors, which may favor one or another solution, according to time, economy and infrastructure readiness in the field. In the greater part of these studies, the choices were made based on the experience of responsible in the similar conditions.
Starting from the behavior of real cases previously cited, this work investigates a relationship between methodology and capability for displacement detection. Using a dedicated slide which allows to define a micrometric displacement, several tests have been carried out at Politecnico of Torino, where different receivers-antenna combinations (from geodetic to mass market) and displacement strategies have been considered. Furthermore, data processing has been realized by means of different software (commercial and FOS) and different kinds of solution.
The results of this experimental activity evidenced that it is possible to define a correlation between the GNSS acquisition strategy and the velocity range of the monitored landslide, which could be now coupled with the landslide velocity scale proposed by Cruden & Varnes. In this way, it is possible to optimize costs for monitoring activities and to allow a “smart” use of GNSS technologies for monitoring.