CRITICAL ASPECTS OF AN INTEGRATED MONITORING SYSTEM FOR LANDSLIDES RISK MANAGEMENT: STRATEGIES FOR A RELIABLE APPROACH

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Te use of advanced technologies for remotely monitor surface processes is a successful way for improving the knowledge of phenomena evolution. In addition, the integration of various techniques is becoming more and more common in order to implement early warning systems that can monitor the evolution of landslides in time and prevent emergencies. The reliability of those systems plays a key role when Public Administrations have to implement actions and interventions in case of disasters or for preventing an incoming emergency. To trust the information given by the system is an essential condition for a successful policy aiming to protect the population. The present research deals with the major critical aspects to be taken into account when implementing a reliable monitoring system for unstable slopes. The importance of those aspects is often neglected, unlike the effects of a not careful implementation and management of the system can lead to erroneous interpretations of the phenomenon itself and false results.
Some of the most interesting and critical aspects that will be deeper described and analyzed are:
- strategy for planning a successful integrated system for continuous monitoring.
- Choice of the reference frame: which one is the best for referring results? A local coordinate system or a georeferenced one? Both are of concern, it depends on users purpose; that's why a GIS is also suggested.
- Stability of the site: GPS time series analysis for controlling the effective stability of the chosen master area. Thanks to the GPS master station that are operating for over three years, atmospheric disturbances affecting the signal may be removed in order to carefully verify the stability of the area and to establish whether the site is geologically stable, as originally suggested, or not. In the latter case, the magnitude of movements may also be computed for providing corrections to TS observations.
- Stability of the monumentation, both for reference points and TS pillar. This is essential aspect for avoiding misinterpretations when analyzing displacements of prisms placed within the landslide.
- Atmospheric influence on raw observations; particularly when long distances are involved such parameter needs to be taken into account for final interpretations.
- Boundary evolution: GPS rovers are located close to the landslide boundaries in order to check for widening of areas affected by instability.

The case study which ruled the present research and highlighted the actual need of a sort of guidelines for setting up a good and reliable monitoring system is the Valoria landslide, located in Appennines of the Northern Italy. The system is based on the integration of an automatic Total Station (TS), which is looking at 45 reflectors and a GPS master station, acting as the reference station for three GPS rovers placed within the landslide. In order to monitor "local" disturbing effects, a bi-dimensional clinometer has been applied on the pilaster where the total station is located in order to test the monumentation stability. Topographic measurements have been also integrated with some geotechnical sensors (inclinometers and piezometers) in a GIS for landslide risk management.
At the very beginning, periodic measurements were carried out, while the system is now performing continuously since 2008. The system permitted to evaluate movements from few millimeter till some meters per day in most dangerous areas; the entity of movements obliged to provide a reliable description of the phenomenon itself, aiming to identify suitable values to be used as alert thresholds for the early warning system.

The results of experiencies carried out by Authors about many different landslides will be presented in order to propose guidelines for a sort of procedure aiming to increase the reliability of the information provided by the system and the usefulness for local Agencies.