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Critical aspects of integrated monitoring systems for landslides risk management: strategies for a reliable approach

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The 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 plan actions in case of disasters or for preventing an incoming emergency. To have confidence in the information given by the system is an essential condition for a successful policy aiming to protect the population. The 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.
The case study which ruled the research and highlighted the actual need of guidelines for setting up a reliable monitoring system is the Valoria landslide, located in the Northern Italy. The system is based on the integration of an automatic Total Station (TS) measuring 45 reflectors and a master GPS, acting as the reference station for three rovers placed within the landslide. In order to monitor local disturbing effects, a bi-dimensional clinometer has been applied on the TS pillar. Topographic measurements have been also integrated with 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. A more spatially continuous description has been also provided by LiDAR and terrestrial SAR interferometry.
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: local coordinate system or georeferenced one.
- Stability of the site for the master unit positioning: GPS time series analysis for controlling the effective stability. 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 an essential aspect for avoiding misinterpretations when analyzing displacements of prisms placed within the landslide.
The results of experiences carried out by Authors over last years about 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.