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The role of deep-seated ground deformation in the Early Warning System. The experience using robotized inclinometer system

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In the field of geohazards, early warning systems represent a key element to coexist with the geological risks and to manage ordinary or emergency scenarios. Modern monitoring systems allow to follow up the evolution of the phenomena in near real time and to support decision-maker in a trustworthy and reliable way. These systems must be necessarily coupled with a robust interpretative model that must be periodically updated also using the acquired monitoring data. Particular attention must be given to the multi-instrumental analysis to the validation of each instrument dataset and to assure a global perspective of the observed phenomena. In recent years, we have observed a strong development of technologies to measure dynamics of the surface topography and the related structures/infrastructures with large scale (remote sensing) or a local scale (single landslide) approach. Many of these technologies are used to measure displacements and/or deformations. However, the measurement of these parameters does not always allow a fully description of the kinematic of the phenomena, since often the surface measurements represent a sum of deformations that develop in a complex way in the subsoil. The kinematic of the landslide, the involved volumes and therefore the interaction with the elements at risk can be heavily influenced by deep-seated ground deformations. In this context, Geohazard Monitoring Group (GMG) of IRPI-CNR has developed a robotic measuring system for the acquisition of deep-seated ground deformations and in particular the deep horizontal displacements. This instrumentation combines the advantages of the traditional measurements (manual double readings 0/180°) with a robotized approach that improves the results in term of revisit time, repeatability and accuracy. The robotized device also called as Automated Inclinometer System (AIS), allows exploring automatically all the length of the borehole (up to 120m tube length) with just one inclinometer probe. All the cables (probe signal and power supply) are replaced with a thin polyethylene cable (ϕ 2mm) only to sustain and move the probe up/down into a standard inclinometer borehole. The AIS was extensively used in landslide monitoring networks in the Alps areas obtaining interesting results in terms of: i) definition of the deep and surface kinematics of the observed phenomena ii) evaluation of the displacements accelerations iii) relationship with rainfalls/snow melting and piezometric water levels. AIS represent a reliable possibility to realize a more complete integrated network for the landslide interpretation and to realize a more efficient and complete EWS.