Commission C35 - Monitoring methods and approaches in engineering geology applications

The recent activities of the commission were focused on the development and application of monitoring system to gravitational phenomena.

In particular, the activity of 2015 were concentrated on the following topics:

A. The use of unmanned aerial vehicle for landslide mapping and monitoring
B. The definition of a communication strategy aimed to the landslide monitoring results dissemination aimed to support the decision makers and the population during emergency conditions

THE USE OF UNMANNED AERIAL VEHICLE FOR LANDSLIDE MAPPING AND MONITORING

The commission continues his research activities on the use of unmanned aerial vehicle for mapping and monitoring of landslides. In particular, the increasing availability of these systems shows that more and more often they can be considered as a viable low-cost alternative for the detection and analysis of multi-temporal landslides.

Up to now, most of the published studies are focused on the technical specifications of these systems while still lack of in-depth studies that take into account the methods of application of UAV in the study of landslides. The commission's work focused on methodological development of these systems by defining a possible strategy for using that links the type of landslide to: i) the most indicated class of UAV, ii) the survey strategy and the use of ground control points, iii) the post processing strategy of the available dataset. Considering the slope materials and gradient, it is possible to identify two different categories of surveys with UAVs:

1) Steep to vertical areas (>40°) are often affected by rock falls. The flight plan for the UAV is often designed with the camera pointed horizontally to approximately 50° downward in order to take images roughly perpendicular to the slope. The UAV is typically flown under manual control because reliance on preselected GPS waypoints very close to rock walls is not possible. In this case, the most efficient systems are multi-rotor UAVs, which have good position control and can hold a position in hovering mode.
2) Slopes with gentle to moderate slopes (<40°) are more prone to landslides. Mission planning for gentle to moderate slopes can be designed using vertical or nadir image acquisition, and either fixed-wing or multi-rotor UAVs can be used.

The gradient of the slope and the type of UAV used have implications not only on the UAV mission planning, but also on the approach used for processing and analysis of data. If we consider rock falls, UAVs can be employed for emergency site inspection, when part of the rock wall has already collapsed but others sectors of the rock wall remain unstable. In this case, the access to a high resolution 3D model of the area is essential for delineation of the unstable sectors and their volumes. Thus, the acquired dataset can be used for the generation of a DEM and an orthophoto. The 3D models constructed from the images can be used for structural analysis. For example, the identification and mapping of the main joint sets are very useful for rapid analysis of the slope stability using the Markland test. The 3D models can be used to estimate the residual risk and determine whether road closures or building evacuation must occur or if remediation can begin. The availability of a high-resolution dataset can be also used for more complex analyses of the unstable area using numerical models such as analysis of potential rock fall trajectory paths.

THE DEFINITION OF A COMMUNICATION STRATEGY AIMED TO THE LANDSLIDE MONITORING RESULTS DISSEMINATION AIMED TO SUPPORT THE DECISION MAKERS AND THE POPULATION DURING EMERGENCY CONDITIONS

The management of a complex network to monitor a large slope instability's evolution is a difficult task, chiefly during emergency conditions. Usually, a specific working group of people is set up with the aim of understanding the landslide evolution, to plan civil protection activities, as well as to organize initial remedial activities. The members of this team have to accomplish different actions, depending on their specific role and the phases associated with the evolution of the landslide. The team is often composed of multiple stakeholders, including scientists, civil protection authorities, and technicians. The development of a communication strategy able to transfer the monitoring data result at these different stakeholders is an important task in particular during emergencies because allows a correct use of monitoring network results. A common issue in standard approaches of data sharing is related to representation of the monitoring results. In particular, plots versus time are the common solution to share the monitoring results, but these type of plots might be difficult to read and understand for people not data familiar to deal with this kind of graphical. The presence of different monitoring points without a map that can represent the displacement of different landslide's sectors can limit the comprehension of the plot and correct understanding of the real situation. In complex emergency conditions, incorrect reading of monitoring results can lead to misunderstandings and unnecessary concerns. Several analyzed case studies evidenced how the potential of dissemination decays depending on the complexity of the representations used. For this reason, the graphic representation of monitoring results should be compatible with the background of the different level of knowledge of the stakeholder. According with these elements, a possible communication strategy focused on the use of different representations that considered the different background of the stakeholders has been developed and published. Our aim is to define a standard approach to share the monitoring results, in order to disseminate the information about the recent evolution of the landslide, as well as the level of criticality, within all the people involved (scientists, technicians, civil protection operators, decision makers, politicians, press, population). The application of dedicated products for the presentation of the monitoring results contribute to a proper understanding and evaluation of the landslide evolution.

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