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DFOT as tool for landslide monitoring

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The increasing number of landslides during the last decade, especially nowadays in combination with the defrosting of permafrost due to climate change, is a growing challenge for engineers. Complex interactions of hydrological, subsoil hydraulic and soil mechanical processes are the reason for the collapse of slopes. An early detection of potential landslides and a reliable assessment of the resulting risk can be considered as a supreme task in alpine engineering. Therefore the closer understanding of hydraulic and geotechnical subsurface processes in hillslopes are eligible.

Up to now, the actual condition of endangered hillslopes, e.g. pore water pressure, degree of saturation and deformation, is measured punctually by a single gauge or by a series of single gauges, respectively. The number of required gauges is directly connected with a time and cost consuming installation of the instruments, the measurements as well as analysis of the results. In addition, depending on the number of gauges there is a lack of information considering the entirety of the hillslope. Thus, a more promising approach would be the monitoring of the entirely of the hillslope in a distributed way.

During the last decade the technology of Distributed Fibre Optic Temperature (DFOT) measurements was adopted for several engineering applications. By means of the heat-pulse method some of the parameters possible triggering potential landslides, i.e. the local filter velocity as well as degree of saturation can be obtained in a distributed way based on the temperature measurement along a fibre optic cable. For this derivation a calibration curve developed in a pressure tank has to be investigated. The main advantages are the cheap, robust fibre cables and the high information density along the fibre with a high spatial resolution within a range of some kilometres. Because of its features DFOT is serviceable for long time monitoring. Thus, this approach has to be considered as a clear quality step ahead, particular in alpine hillslopes. In the first part of the paper the basics of DFOT as an instrument for long-time-monitoring will be described in more detail.

The second part will deal with the project “Distributed Saturation and Flow Velocity Measurement in Alpine Hillslopes” funded by the Austrian Academy of Sciences and regards the behaviour of shallow landslides. The primary goal of the project is the introduction and verification of suitability of distributed saturation and velocity measurement for monitoring subsurface flow in hillslopes as well as the optimisation of the specific application in hillslopes.

For this purpose the fibre will be installed lamellar in different levels within the natural slope. The installation procedure as well as the refilling of the ditches will be investigated. To take care of water deflection in ditches different types of refill material have to be considered, e.g. trench refilling, artificial surroundings, etc.

Short heavy rainfall as well as long time rainfall will be simulated by using a sprinkler irrigation system. The approach of graduated rain intensities along the slopes width will show different, comparable results within a single irrigation. To ensure fibre optic temperature deliverables also some conventional instruments, e.g. TDR-probes, temperature sensor, rain gauge, etc. get installed.

Based on the high information density and the knowledge of the main triggering parameters the processes within hillslopes, e.g subsoil hydraulic failure mechanism due to water-flow in soil, will be more understandable. Moreover, the actual condition of hillslopes will be pre-estimated by long-time-monitoring.