Geophysical Research Abstracts
Vol. 16, EGU2014-13676, 2014
EGU General Assembly 2014

Landslide monitoring and early warning systems in Lower Austria - current situation and new developments

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Landslides represent significant hazards in the mountainous areas of Austria. The Regional Geological Surveys are responsible to inform and protect the population, and to mitigate damage to infrastructure. Efforts of the Regional Geological Survey of Lower Austria include detailed site investigations, the planning and installation of protective structures (e.g. rock fall nets) as well as preventive measures such as regional scale landslide susceptibility assessments. For potentially endangered areas, where protection works are not feasible or would simply be too costly, monitoring systems have been installed. However, these systems are dominantly not automatic and require regular field visits to take measurements. Therefore, it is difficult to establish any relation between initiating and controlling factors, thus to fully understand the underlying process mechanism which is essential for any early warning system. Consequently, the implementation of new state-of-the-art monitoring and early warning systems has been started.

In this presentation, the design of four landslide monitoring and early warning systems is introduced. The investigated landslide process types include a deep-seated landslide, a rock fall site, a complex earth flow, and a debris flow catchment. The monitoring equipment was chosen depending on the landslide processes and their activity. It aims to allow for a detailed investigation of process mechanisms in relation to its triggers and for reliable prediction of future landslide activities.

The deep-seated landslide will be investigated by manual and automatic inclinometers to get detailed insights into subsurface displacements. In addition, TDR sensors and a weather station will be employed to get a better understanding on the influence of rainfall on sub-surface hydrology. For the rockfall site, a wireless sensor network will be installed to get real-time information on acceleration and inclination of potentially unstable blocks. The movement of the earth flow site will be monitored by differential GPS to get high precision information on displacements of marked points. Photogrammtetry based on octocopter surveys will provide spatial information on movement patterns. A similar approach will be followed for the debris flow catchment. Here, the focus lies on a monitoring of the landslide failures in the source area which prepares the material for subsequent debris flow transport. In addition to the methods already mentioned, repeated terrestrial laserscanning campaigns will be used to monitor geomorphological changes at all sites.

All important data, which can be single measurements, episodic or continuous monitoring data for a given point (e.g. rainfall, inclination) or of spatial character (e.g. LiDAR measurements), are collected and analysed on an external server. Automatic data analysis methods, such as progressive failure analysis, are carried out automatically based on field measurements. The data and results from all monitoring sites are visualised on a web-based platform which enables registered users to analyse the respective information in near-real-time. Moreover, thresholds can be determined which trigger automated warning messages to the involved scientists if thresholds are exceeded by field measurements. The described system will enable scientists and decision-makers to access the latest data from the monitoring systems. Automatic alarms are raised when thresholds are exceeded to inform them about potentially hazardous changes. Thereby, a more efficient hazard management and early warning can be achieved.

Keywords: landslide, rockfall, debris flow, earth flow, monitoring, early warning system.