Geophysical Research Abstracts
Vol. 12, EGU2010-4649-1, 2010
EGU General Assembly 2010

From structural investigation towards multi-parameter early warning systems: geophysical contributions to hazard mitigation at the landslide of Gschliefgraben (Gmunden, Upper Austria)

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In December 2007 the large landslide system inside the Gschliefgraben valley (located at the east edge of the Traun lake, Upper Austria), known over centuries for its repeated activity, was reactivated. Although a hazard zone map was already set up in 1974, giving rise to a complete prohibition on building, some hundreds of people are living on the alluvial fan close to the lake. Consequently, in frame of the first emergency measures, 55 building had to be evacuated.

Within the first phase of mitigation, measures were focused on property and infrastructure protection. Around 220 wells and one deep channel were implemented to drain the sliding mass. Additionally a big quantity of sliding material was removed close to the inhabited areas. Differential GPS and water level measurements were performed to evaluate the effectiveness of the measures, which led to a significant slowdown of the movement. Soon after the suspension of the evacuation several investigations, including drilling, borehole logging and complex geophysical measurements were performed to investigate the structure of the landslide area in order to evaluate maximum hazard scenarios as a basis for planning further measures. Based on these results, measuring techniques for an adapted, future early warning system are currently being tested. This emergency system should enable local stakeholders to take appropriate and timely measures in case of a future event thus lessening the impact of a future disaster significantly.

Within this tree-step-plan the application of geophysical methodologies was an integral part of the research and could considerably contribute to the success. Several innovative approaches were implemented which will be described in more detail within the talk.

Airborne multi-sensor geophysical surveying is one of new and progressive approaches which can remarkably contribute to effectively analyse triggering processes of large landslides and to better predict their hazard. It was tested in Gschliefgraben earthflow and landslide complex in September 2009. Several parameters, such as vegetation thickness, soil moisture, potassium and thorium content (gamma ray) or four layer resistivity were the principal studied parameters. These parameters were compared with the landslide inventory map of Gschliefgraben developed from differential airborne laser scan terrain models.

Since mass wasting is usually triggered by rising water pore pressure due to heavy rainfall or seismic tremors, often supported by changes in the shape, structure, and hydrology of a slope or vegetation cover. As the electrical resistivity of the subsurface mainly depends on porosity, saturation, pore fluid conductivity and clay content, the geoelectric method is a reliable method to investigate the structure of the landslide and surrounding and could be an emerging tool for observing those triggering factors. Therefore, first a multi-electrode geoelectrical survey was performed in a broader area of the active earthflow to verify the subsurface structure and to optimise the location for a monitoring system, followed by the installacion of the geoelectric monitoring system Geomon4D in September 2009. The monitoring profiles were complemented by an automatic DMS inclinometer to correlate measured resistivity values with displacement rates. Since the installation, the system works continuously and

data is processed on a daily basis at the monitoring centre in Vienna.

These works were supported by the 7th FP project “Safeland – Living with the landslide risk in Europe”.