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Investigation of run-off and stability conditions and design of mitigation measures in Kittelfjäll, Sweden

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The Swedish society has relatively seldom been negatively affected by destructive debris flows despite the 1 200 km long mountainous area along the Norwegian border. The mountain terrain (Swedish “Fjällen”) comprises mountain-peaks as well as mountain-plains. Most of the mountains have a height of around 1000-1500 m above sea level, but also higher mountains exist which show alpine forms. The reason for the low amount of affected constructions is the very low concentration of built up areas in the mountain areas. Anyhow, during the last decades many new ski resorts have been built and the hazard for landslides and debris flows has come up to discussion. Investigations in some areas have shown that mass movements have occurred many times in history but the awareness and knowledge are low. The highest monthly rain precipitation values occur in the mountain terrain in Sweden during July, August and September. In Kittelfjäll the values for the same periods are around 100 mm per month according to readings made by the Swedish Meteorological and Hydrological Institute. These values are expected to increase up to 30 % during the next 100 years due to climate changes.

The Swedish Geotechnical Institute, SGI, investigated in 2008 the stability and run-off conditions in the mountainous area Kittelfjäll by commission of the municipality of Vilhelmina. The investigation was initiated due to a new local plan for the area. The aim of the study was (1) to map areas in danger for debris flows and landslides and (2) to suggest preventive measures including a calculation of the amount of material which could be transported in one occasion. The area comprises the largest gully area in Sweden with several 30-50 m deep gullies in a 400 m high till slope along the mountainside. The gullies and their belonging alluvial fans had been overviewed investigated by geomorphologists in the 1950´s. They concluded that the gullies had been formed by several debris flows mainly occurring during heavy summer storms and that the meadows below the slopes are built-up by alluvial masses. During the latest large incident, which happened in 1912, according to local people the local main-road was cut-off and huge amount of material was transported and spread far and wide over the meadows. In that time, however, only handful minor farms existed in the area.

The field investigation in 2008 included investigation of the brooks, investigations of wet sections, traces from earlier events, the amount of transportable material available to be carried by debris flows, run-out lengths and assessment of catchment areas and run-off conditions. Based on the field investigation and determination of design precipitation, hazard maps were constructed, preventive measures were suggested and restrictions were given. The preventive measures compile construction of sedimentation dams in the top of the alluvial fans and canalisation of the creeks below. The restrictions consist of buffer zones along the brooks, areas where dwellings should be avoided and forest control plans and yearly erosion inspections.

This type of investigation had only been performed once earlier in Sweden which was done by SGI in Åre in 2003.