Geophysical Research Abstracts
Vol. 13, EGU2011-8200, 2011
EGU General Assembly 2011

Modelling mass movements to estimate the risk potential for Alpine tourists and infrastructure in the Grossglockner-Pasterze glacier area (Hohe Tauern, Austria)

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As a result of climate change, numerous natural processes in high mountain areas are becoming more intense. This study in particular focuses on processes like rockfall, rockslide and other gravitational mass movements which are of great interest for the estimation of risk potentials. When areas were mass movements occur spatially overlap with humans or infrastructure, natural processes can quickly become natural hazards. Mass movements were always a risk for people and/or infrastructure in high mountain areas, but if the frequency, magnitude and range of hazardous events increases due to climate change and by tendency more people are staying in its reach at the same time, it can be assumed that at least on a regional scale the risk potential is rising in the future. The aim of the study is to develop geomorphological hazard and vulnerability maps on a regional scale to estimate the present and future risk potential for Alpine tourists and infrastructure caused by rockfall and other denudation processes. To achieve this goal, a tool is needed that is able to exactly identify dangerous spots. This tool should be extensively and easily comprehensible and thus facilitate the implementation of targeted measures.

The Grossglockner-Pasterze glacier area, one of the most visited high mountain areas in Austria, serves as a study area. Within the project rockfall as well as denudation processes were modelled in this area. For this purpose, the first step was to model the disposition, i.e. the susceptibility of an area to trigger a process, to identify potential rockfall and denudation source areas. Information about these areas was obtained by combining various types of information (e.g. slope, geology). Then potential mobilizable rock and debris masses needed to be estimated. The second major step was the process modelling. Therefore a mass-conserving multiple direction flow propagation algorithm in combination with a digital elevation model (DEM) was used to determine the erosion, transport and deposit of rock/debris over the whole study area. Finally, the processes were assessed and served as a basis for the generation of a geomorphological hazard map that subdivides the study area into four hazard classes. In addition to the estimation of the present risk potential, a potential future scenario 2030 was created, where additional climate data and information about glacier retreat was well as permafrost degradation were considered for the development of a geomorphological hazard scenario map.

By overlaying the hazard maps with trail- and routenetwork information, vulnerability maps were created. These maps make it easier to recognize how severe certain trail or route segments are affected by dangerous processes. The results clearly show, that both the amount of surface as well as the amount of trails and routes in classes with a high risk potential increases until 2030. Thus the risk potential is indeed rising.

In a final step local stakeholders reviewed the maps and evaluated them with regard to possible measures. These include local (e.g. closing down or new installation of trails) and organizational measures (e.g. installation of a trail information system) as well as an improved training of people who spend their leisure time in high mountain areas. The developed method is easily transferable to other study sites.