Geophysical Research Abstracts,
Vol. 11, EGU2009-5471, 2009
EGU General Assembly 2009


# Rockslides in a changing climate: evaluating rainfall and temperature as triggering factors in southwestern Norway

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Climatic conditions such as rainfall and temperature often play an important role in the triggering of geohazards, such as landslides, rockfalls and snow avalanches. This is especially true in coastal, mountainous areas such as Norway. In the last 150 years, geohazards have resulted in over 2,000 casualties in Norway, making it an important area of study. With recent climate research indicating significant climate change in northern regions, it has become apparent that a better understanding of the link between climatic conditions and geohazards is required to help prepare for future events.

To this end, Norwegian authorities initiated an interdisciplinary research project, called "GeoExtreme". By studying the climatic conditions of historic geohazards, GeoExtreme is establishing relationships between climate variables and geohazards. Following these studies, GeoExtreme will endeavor to forecast geohazard scenarios using state-of-the-art climate change projection models and to assess the socio-economic consequences of future geohazards (Jaedicke et. al., 2008).

The work presented here, carried out under the GeoExtreme project, is focused specifically on the effect of rainfall and temperature on rockslides and rockfalls in the southwestern coastal counties of Hordaland and Sogn og Fjordane in Norway. The Norwegian Geotechnical Institute (NGI) has provided an inventory of 3,595 rockslide events, recorded by the Norwegian Road and Rail Authorities, that have been recorded in the area since 1963. In order to study the effects of climate on these historic slides, the Norwegian Meteorological Institute (met.no) has examined precipitation and temperature data from local weather stations to interpolate the climatic conditions at each rockslide location on the day and the days preceding the event. As a result, each rockslide in the database includes climate variables such as temperature, accumulated precipitation of one to several days, degree-days, and frost cycles.

The rockslide database comes with some constraints. Rockslides in the region have been recorded by Transportation Authorities. As a consequence, the data is only available along road or railway corridors. Rockslides that occur away from transportation infrastructure are not recorded and hence the dataset contains substantial spatial data discontinuity. There is also a temporal variance in the data. The county of Sogn og Fjordane has been recording rockslides semi-frequently since the 1970's, but there is a distinct increase in rockslide incidence in 1997, as recording procedures became more detailed and comprehensive. The county of Hordaland had very infrequent recording of rockslides prior to 2000, but since then has kept a very detailed rockslide inventory.

Research completed thus far includes statistical analyses to establish relationships between the rockslides and their corresponding climate variables. Preliminary results indicate that short-term antecedent rainfall (less than 7 days before the event) and freeze-thaw cycles have the most important effect on the triggering of rockslides in the region. In fact, a high proportion of rockslides occur when these conditions occur simultaneously, when warm Atlantic storms make landfall during the cold winter months. These storms bring intense rainfall and raise temperatures above freezing levels, thus creating high runoff conditions. This ongoing research includes the study of historical storm events to gain a better understanding of the precise climatic conditions required to initiate rockslides.

A primary goal of this research is to use geographic information system (GIS) technology to complete a rockslide hazard susceptibility map of the study area. A statistical approach is proposed, including many of the traditional factors (i.e. layers) used to generate hazard maps, such as: slope angle, slope curvature, geology, land use, etc. Factors related to climate will also be included as trends become apparent from the data analysis described above. It is expected that elevation, distance from the coast, and proximity to fjords will all be factors that will emerge from this analysis. It is then proposed to introduce time-dependent precipitation and temperature layers for the susceptibility map, creating a dynamic susceptibility map that is weather-dependent. Maps for normal and extreme climate conditions will be generated. In addition, maps of future decades will be projected using downscaled climate models.

Reference

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