Geophysical Research Abstracts
Vol. 13, EGU2011-9974, 2011
EGU General Assembly 2011

Assessing the influence of climate change on rainfall patterns associated to landslide and debris flow triggering in the South French Alps

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Rainfall is worldwide a recognized trigger of mass movements (e.g. landslides, debris flows, etc.). Hydrological triggering of mass movements can be divided in three general types: (1) development of local perched water tables in the subsoil leading to shallow slope failures and possible gravitational flows, (2) long-lasting rise in permanent water tables leading to more deep-seated slope failures, and (3) intense runoff causing channel-bed erosion and debris flows. Types (1) and (3) are usually observed during heavy storms characterized by high rainfall intensities (hourly and daily rainfall); type (2) is usually observed through increasing water content in the subsoil due to antecedent rainfalls (weekly or monthly rainfall). Many investigations have been carried out to determine the amount of precipitation needed to trigger slopes failures and associated mass movements. For rainfall-induced landslides a threshold may be define the rainfall, soil moisture or hydrological conditions that, when reached or exceeded, are likely to trigger landslides.

The purpose of this case study is (1) to analyze the relationships between the initiation of two types of mass movements (landslides and debris flows) and different patterns of rainfall at various temporal scales in the Barcelonnette basin for the period 1850-2009 and (2) to evaluate the effect of future climate characteristics on the landslide and debris flow frequency.

For the first objective, a cross analysis of an historical database of debris flows and landslides events recorded in the study area and the rainfall conditions associated to these events at different time scale (yearly, monthly, daily and hourly) is conducted. The results show a clear distinction between the rainfall patterns associated to slow-moving landslides (earth flows) and fast-moving landslide (debris flows).

For the second objective, the climate modelling part of this study comprises the simulation of meteorological surface parameters for the last 30 years of the 21th centuries (2069-2099) using the climate change scenario A2 of GIECC over the Alps for the period 2069-2099. The meteorological surface parameters were modelled with both the SAFRAN and the ARPEGE-IFS GCM models. The comparisons of the rainfall patterns associated to landslides and debris flow triggering during the period 1850-2009 and the modelled rainfall conditions for the period 2069-2099 shows an increasing of debris flow frequency and a decreasing of slow-moving landslide frequency or activity.