Geophysical Research Abstracts
Vol. 15, EGU2013-11813, 2013
EGU General Assembly 2013

Landslide velocity prediction using a rainfall to displacements transfer function. La Barmasse case study (Valais, Switzerland).

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We present a model for ground displacements prediction using a transfer function. Model was mainly tested at the Barmasse rockslide (Valais, Switzerland) which is an active structurally-controlled instability formed by intensively deformed and metamorphosed mica schists. The kinematics of the slide, which currently threatens roads and inhabitants of the Bal de Bagnes Valley, is characterized by a continuous displacement with variable rates of displacements. Indeed, the velocity is strongly affected by external forces: a sharp increase in landslide velocity is observed with a short delay after every snow melting period and after each rainfall pulse. The instability is currently monitored by different remote sensing and in situ techniques (Terrestrial LiDAR, GB Radar and extensometers).

In order to predict ground displacements, we developed a new model composed by two different parts: (a) calculation of the Effective Rainfall (Peff) and (b) modelling of the landslide velocity. First of all, Peff was obtained using Thornthwaite (1946) method, which estimates the water that infiltrates into the terrain as a function of the total precipitation, Real Evapo-Transpiration (ETR) and water recharge. Afterwards, the rates of displacement were modelled through a stochastic transfer function which links the Peff (input) with daily displacements (output). Model computes the displacement rates at each time lapse (e.g. one day) as a convolution of the above mentioned transfer function times daily effective rainfall during a certain time lapse (50 days in our case). The transfer function has two components: first component account for the sudden increase of landslide velocities after each rainfall pulse and second component account for the progressive decay. The variables of these functions were optimized in Matlab in order to minimize the error between the real and the modelled velocities. The model performance was assessed for two different response functions (following either exponential or power laws) through errors in timing, duration, magnitude and Root Mean Square of the differences between the model and the real measurements. Furthermore, predictive capabilities of the model were tested by using training and testing sets, showing good resemblance between modelled and real displacements. Nevertheless, we observed a non-stationary response of the transfer function along the different years of the period of study, which should be analysed more in detail.

At a wider perspective, we tested the applicability of our model to other pilot study areas using both digitised datasets available in literacy and RAW datasets provided by other research groups. This analysis proved generalisation of our method to different environmental conditions, materials permeability, failure mechanisms, degree of damage, etc. Due to the ease of data input variables (rainfall and temperature), relative simplicity of the model, high performance of the results and generalisation of the model to other study areas, it is our belief that transfer function models will be a common tool for landslide velocity forecasting in the near future.