International Conference
Analysis and Management of Changing Risks for Natural Hazards
18-19 November 2014 I Padua, Italy

AO8

Hydro-meteorological thresholds of the Pays d'Auge landslides and their possible evolution considering climate change tendencies

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Keywords (10 words max):
Landslides – predisposing factors – triggering factors –hydo-meteorological thresholds – precipitations – ground water – Pays d'Auge - France

Abstract

The coastal and continental parts of the Pays d'Auge plateau (Normandy, N-W France) are highly affected by slope instabilities. The landslides are one of the most important issues regarding to the regional natural hazards and associated risk management. This communication proposes a synthetic assessment of the landslide triggering thresholds at regional scale combining monitoring based and regional statistical time series analysis. The assessment of the potential evolution of these thresholds is based on modelled rainfall data integrating climate change tendencies for two different scenarios.

Along the Pays d'Auge coasts, four landslides are active since decades. The "Cirque des Graves" landslide (municipality of Villerville) which is the most active and largest landslide in this region (47 ha in 2012) is characterized by seasonal very slow velocity (1-10 cm.yr 1) regularly disturbed by brutal accelerations with several meters of displacements (January 1982, February 1988, March 1995 and March 2001). To understand the mechanisms of the kinematics, this landslide is monitored since decades.

In the continental part of the region (about 2.500 km²), a landslide inventory based on the incident database, field geomorphological investigations and diachronic analysis of areal images was constituted between 2010 and 2013. 392 landslides were mapped whom 62 were identified with the exact date of failure and/or reactivation.

Hyro-climatic time series reveal similarities regarding to the landslides triggering and conditions of reactivation. The landslides are essentially controlled by continental processes due to exceptional hydro-meteorological conditions. Deep-seated phenomena are affected by acceleration phases during exceptional and prolonged (winter) rainfall episodes inducing several meters groundwater rising.(1) major landsliding events associated to long-lasting rainfall periods (several month) with groundwater water elevation of more than two meters above the mean annual level observed for the period 1976-2013 (return period of over 6/7 years); and (2) moderate landsliding events associated to low intensity rainfall periods with a limited groundwater rise responsible for a moderate seasonal kinematic (return period of every years).Consequently, preliminary conditions are a key parameter in the reaching of a critical groundwater level. Shallow landslides (mainly observed on the continental part of the region) are controlled by two types of weather conditions: (1) prolonged rainfall episodes in

winter season (more than 15 days of consecutive rainfall with an accumulation of more than 100mm) or; (2) heavy rainfall episodes in spring and summer (up to 30mm/day).

The spatial analysis of the triggering thresholds for the region area shows that the North-East part is more subject to exceed these triggering thresholds, while the statistical modelling based on logistic regression shows a homogenous distribution of the landslide susceptibility. This can explain the higher frequency of landslides observed in this part of the region. Finally, the combination of the groundwater levels and rainfall data modelling provided assessment of potential evolution of these thresholds according to 2 different climate changes scenarios (AB-1 and B-1). The results show that the prolonged episodes of rainfall in winter season, (triggering deep seated landslides) should slightly decrease, while brutal heavy rainfall episodes in spring and summer (triggering shallow landslides) should largely increase.