Analysis of hydrological deep-seated landslides triggering mechanisms in Mt. Wanitsuka, Kyushu Island.

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1. Introduction

In September 6th of 2005 Kyushu Island was hit by the typhoon No 14 causing several damages and large slope collapses such as deep seated landslides and debris flows due to heavy rain conditions. According to Tanigushi (2008) the typhoon caused about 124 landslides events in Miyazaki prefecture. Some of those landslides, specifically deep seated landslides, were observed in Mt. Wanitsuka (1,118 m a.s.l.), 18 km to the southwest of Miyazaki City. In this area, from September 3th to 6th the total precipitation observed was 1,013 mm with a peak of intensity of 46 mm/h. This motivates this research which has objective to analyze the hydrological conditions which trigger deep-seated landslides in Mt. Wanitsuka.

2. Study Area

The study area is defined as the Tano River basin (15.2 km^2) and Kataino River basin (7.8 km^2) as shows in the figure 1. In order to know the hydrological and hydrogeological conditions of the study area, three small catchments were controlled. Those catchments are located in the Shirinashi River basin, a subbasin of Tano River basin, in the vicinity of a deep seated landslide scarp which took place in 2005. The geology in the study area is mainly shale interbedded sandstone partially fractured, part of the Sedimentary complexes of the Shimanto Terrane (Late Early Oligocene - Early Miocene) according to Geological Survey of Japan (2005).

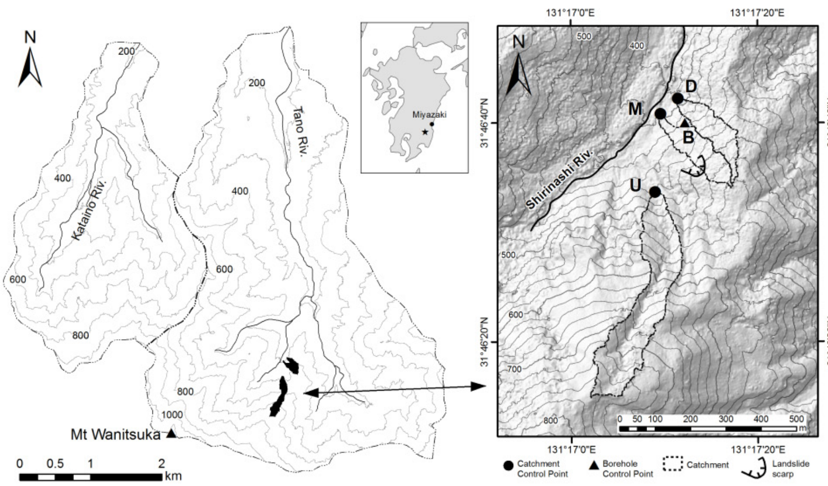

Figure 1. Study area and control points.

3. Methodology

For this study it was prepared 4 control points represented in the figure 1 with the letters D, M, U and B. In three of those points (D, M, U) it was installed parshall flumes and water samplers to control runoff of the small catchments and its discharge O18/Deuterium isotopic concentration. Additionally in the area it was installed 2 boreholes (point B in figure 1), 40 m and 10 m depth, to control the groundwater level and the isotopic concentration in order to compare with the runoff concentration. The control period starts on 2010 until the present.

4. Previous studies

According to previous studies based on analysis of effective rainfall and groundwater level, the effective rainfall with a half life of 84 hours show the best correlation with the lag time between the peak of rainfall and groundwater level peak (Tanaka, 2010). Using that correlation it was possible to estimate the timing of landslides event in 2 min after the rainfall peak which is acceptable if it is compared with the estimation time of landslides occurrence, less than 30 min. after the rainfall peak. In other hand, Takahashi (2010) analyzing the Ca+2 concentration of streams water in the same study area demonstrated the high correlation between the sites where deep seated landslides deposit are located and the influence of deep groundwater.

5. Results and discussions

The isotopic analyses of the catchments discharge confirm the influence of the groundwater in the base flow runoff. In figure 2A it is possible to observe in the runoff a significant pulse of water with isotopic signature similar to the base flow signature. The pulse is correlated with a fast elevation of groundwater level in 40m borehole (Figure 2B). The peak reaches 11.5 m and remains stable for about 5 hours. During that time the 10m borehole groundwater level has a small change of few centimeters. According to the stratigraphy in this area, the soil cover has a depth of 9.3 m. In other hand, the effective rainfall with 10 days half life show the highest correlation with the O18 concentration in groundwater during the elevation of the levels. The figure 3 show a good correlation between the discharge in D and the groundwater level in 40m borehole. For 10m borehole that correlation is not clear.

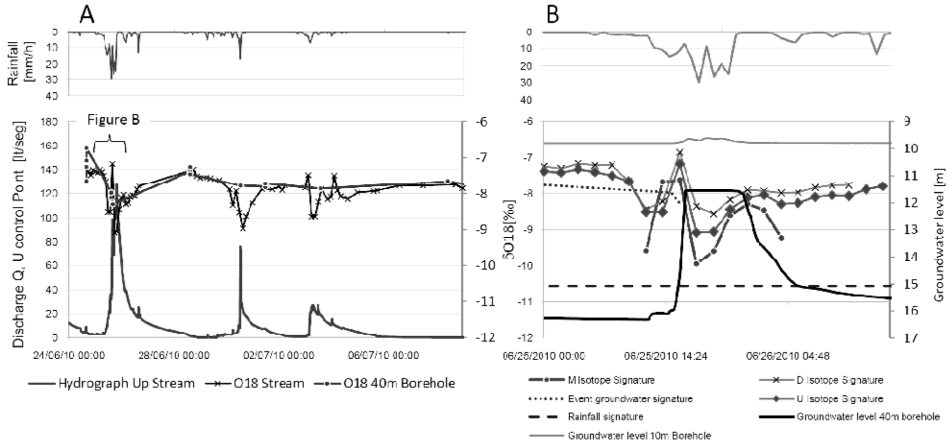

Figure 2. A: Hydrograph and Runoff isotopic signature, U catchment. B:Groundwater level and runoff isotopic signature.

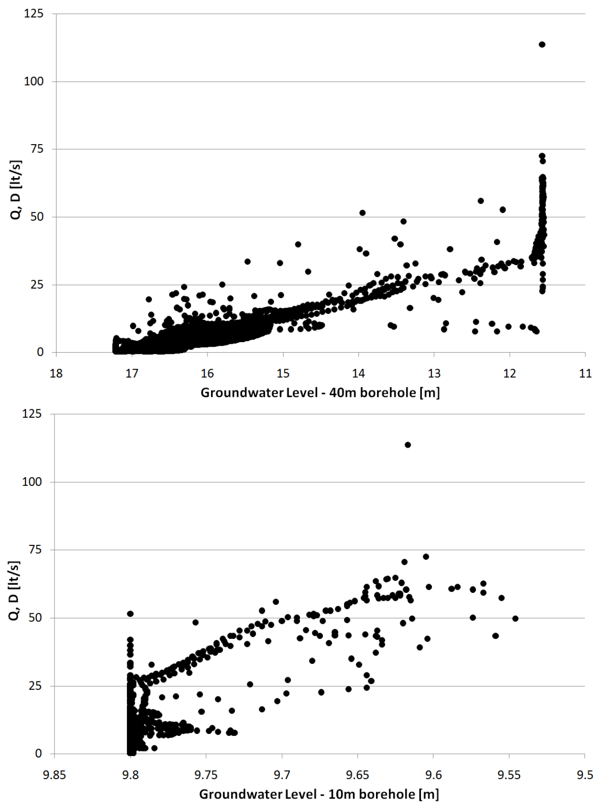

Figure 3. Relationship between discharge in D catchment and groundwater level.

6. Conclusions

The evidence suggests an important influence of the bedrock in the hydrology of the control catchments which can be associated with the triggering of deep seated landslides in terms of the high and fast accumulation of water below the soil cover due to precipitation events with high index of accumulated rainfall. Further analyses are required in order to estimate and quantify that influence and also to define the role of the soil cover.

7. References

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