Geophysical Research Abstracts
Vol. 15, EGU2013-6556, 2013
EGU General Assembly 2013

Deterministic Approach for Estimating Critical Rainfall Threshold of Rainfall-induced Landslide in Taiwan

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Taiwan is an active mountain belt created by the oblique collision between the northern Luzon arc and the Asian continental margin. The inherent complexities of geological nature create numerous discontinuities through rock masses and relatively steep hillside on the island. In recent years, the increase in the frequency and intensity of extreme natural events due to global warming or climate change brought significant landslides. The causes of landslides in these slopes are attributed to a number of factors. As is well known, rainfall is one of the most significant triggering factors for landslide occurrence. In general, the rainfall infiltration results in changing the suction and the moisture of soil, raising the unit weight of soil, and reducing the shear strength of soil in the colluvium of landslide. The stability of landslide is closely related to the groundwater pressure in response to rainfall infiltration, the geological and topographical conditions, and the physical and mechanical parameters. To assess the potential susceptibility to landslide, an effective modeling of rainfall-induced landslide is essential.

In this paper, a deterministic approach is adopted to estimate the critical rainfall threshold of the rainfall-induced landslide. The critical rainfall threshold is defined as the accumulated rainfall while the safety factor of the slope is equal to 1.0. First, the process of deterministic approach establishes the hydrogeological conceptual model of the slope based on a series of in-situ investigations, including geological drilling, surface geological investigation, geophysical investigation, and borehole explorations. The material strength and hydraulic properties of the model were given by the field and laboratory tests. Second, the hydraulic and mechanical parameters of the model are calibrated with the long-term monitoring data. Furthermore, a two-dimensional numerical program, GeoStudio, was employed to perform the modelling practice. Finally, the critical rainfall threshold of the slope can be obtained by the coupled analysis of rainfall, infiltration, seepage, and slope stability.

Taking the slope located at 50k+650 on Tainan county road No 174 as an example, it located at Zeng-Wun river watershed in the southern Taiwan, is an active landslide due to typhoon events. Coordinates for the case study site are 194925, 2567208 (TWD97). The site was selected as the results of previous reports and geological survey. According to the Central Weather Bureau, the annual precipitation is about 2,450 mm, the highest monthly value is in August with 630 mm, and the lowest value is in November with 13 mm. The results show that the critical rainfall threshold of the study case is around 640 mm. It means that there should be alarmed when the accumulated rainfall over 640 mm. Our preliminary results appear to be useful for rainfall-induced landslide hazard assessments. The findings are also a good reference to establish an early warning system of landslides and develop strategies to prevent so much misfortune from happening in the future.