Analyzing the relationship between Soil Water Triggering Index and landslide frequency- a case study of Typhoon Morakot

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Abstract:

Landslide and debris flow warning is a crucial issue in many countries, but no standard operational method has been globally applied because of the discrepancy between regions in terms of climatic, topographic and geological conditions. In Taiwan, Soil and Water Conservation Bureau (SWCB) has developed an empirical Rainfall Triggering Index (RTI) model to define the critical lines (CLs) as rainfall threshold values for debris flow warning. However, CLs for landslide hasn't been well defined yet. Mechanically, debris flow, which is mainly driven by surface runoff that can be directly correlated to rainfall, while landslide is not only associated with rainfall, but also requires a more comprehensive process of hillslope hydrology, such as infiltration and subsurface flow within a soil column. The Soil Water Index (SWI), calculated by a simplified three-layer tank model with fixed parameters, is used in this study to simulate the transient and conceptual soil water content during a typhoon event, and therefore to develop a Soil Water Triggering Index (SWTI).

This study focuses on the rainfall-induced landslides by the Typhoon Morakot (2009) in Taiwan. SPOT satellite images were used to interpret landslides and other information, including landslide location, landslide timing, effective accumulated rainfall and rainfall duration etc. were also collected by Major Disaster Event Reports from SWCB for the analysis. Specifically, after all SWTI values of landslide events are sorted, three SWTIs (SWTI1, SWTI2 and SWTI3), which are computed and respectively represent the simulated soil water content of three tanks, will show a positive and highly linear relationship with cumulative landslide frequency ($R^2>0.9$), indicating that the increase of soil water content may trigger more landslides. Among three SWTIs, the second tank SWTI2 gives the highest R^2 of 0.991. The preliminary results show the applicability of the proposed SWTI for landslide warning. Further, this study will focus on its potential for predicting the temporal and spatial distribution of landslides, with the aid of remote sensing and GIS (Geographic Information System) technologies.

Keywords: SWI, SWTI, Cumulative landslide frequency, Landslide warning, Morakot