



The empirical rainfall thresholds to trigger debris flows in Central Taiwan after 1999 Chi-Chi earthquake

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The empirical threshold to trigger debris flows during the Typhoon Toraji (2001/07/30-2001/08/01) and Typhoon Mindulee (2004/07/02 - 2004/07/09) in Central Taiwan are identified. 59 debris flows are recognized in SPOT image taken after the Typhoon Toraji and 59 debris flows are identified in the FORMORSAT-2 image taken after the Typhoon Mindulee. The corresponding rainfall information in places where debris flows occurred is interpolated from recorded 10 minute interval rainfall data by using Kriging method. To eliminate the scaling effect induced by Kriging method, the dimensionless semi-variogram model is also applied when the rainfall data are interpolated. In order to get more debris flow events to identify the empirical threshold, principle component analysis and cluster analysis are used to group the gullies which have potential to trigger debris flows and to induce hazard into four clusters. Eight factors including lithology, geological structure, landslide area, vegetation (NDVI), area of drainage basin, slope of drainage basin, length of gully, slope of gully, and geometry of drainage basin have been grouped into 3 dimensionless principle components. Each component mainly represents slope of gully and drainage basin, area of drainage basin, and lithology, respectively. According to the magnitude of three principle components, 413 gullies in central Taiwan are classified into four clusters; and each cluster has 58, 46, 121, and 188 gullies, respectively. Most of debris flows that triggered during the Typhoon Toraji and Mindulee mainly distributed in the cluster 3. In the rainfall intensity ΔV cumulative rainfall plot, the critical limit that is traced to envelop 90% of the points on the graph for the cluster 3 is described by $R + 1.99 I = 291$ for the Toraji and $R + 7.17 I = 735$ for the Mindulee (where I = rainfall intensity, R = cumulative rainfall). This result indicates that the impact of the 1999 Chi-Chi earthquake on the rainfall threshold to trigger debris flows is decreased.