



The empirical rainfall thresholds to trigger debris flows in Oligocene-Eocene slate formation, Taiwan

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The empirical rainfall thresholds to trigger debris flow in Oligocene to Eocene slate formation of Taiwan are obtained by using recording rainfall data and FORMOSAT-2 images. 321 debris flows are recognized in the FORMOSAT-2 images that cover the period from 2004 to 2007. The corresponding rainfall information in places where debris flows occurred is interpolated from 10 minute interval rainfall data recording at 318 stations by using Kriging method. To eliminate the scaling effect induced by Kriging method, the dimensionless semi-variogram model is applied in the rainfall data interpolation. Because the mean gradient and catchment area size of gullies are proportional to the stream order (Strahler, 1950), the Horton-Strahler stream order is used in this study to group and to represent the topographic characteristics of gullies. The 40 m DEM is used to determine the topographic characteristics and the stream order of gullies. Comparing the river system derives from DEM and debris flows identified from FORMOSAT-2 images, debris flows in western Taiwan mainly occurred at gullies with the stream order less than 4. The empirical rainfall threshold to trigger debris flows is determined by the plot of rainfall intensity versus the cumulative rainfall. The critical limit that is traced to envelop 90% of the points on the plot is chosen as the threshold to trigger debris flows. To compare the impact of the Chi-Chi earthquake, debris flows in slate formation are divided into three groups, those distribute in northern, central, and southern Taiwan. For the gullies distribute in northern Taiwan, the threshold for stream order 1, 2, and 3 is described by $R + 18.79 \times I = 633.01$, $R + 15.39 \times I = 569.15$, and $R + 32.58 \times I = 1132.87$, respectively (where I = rainfall intensity, R = cumulative rainfall). For the gullies distribute in central Taiwan, the threshold

for stream order 1, 2, and 3 is described by $R + 14.01 \times I = 408.75$, $R + 12.62 \times I = 459.97$, and $R + 11.28 \times I = 458.73$, respectively. In southern Taiwan, the threshold for stream order 1, 2, and 3 is described by $R + 93.33 \times I = 3310.66$, $R + 35.51 \times I = 1539.28$, and $R + 54.79 \times I = 2395.47$, respectively. These results reflect the impact of the Chi-Chi earthquake. For the same stream order, the threshold to trigger debris flow in central Taiwan in which near the epicenter of the Chi-Chi earthquake is always lower than those in northern and southern Taiwan.