Geophysical Research Abstracts
Vol. 15, EGU2013-25, 2013
EGU General Assembly 2013

Variation of the susceptibility and significance of factors on the debris-flow occurrence after a large earthquake

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The Mw 7.6 Chi-Chi earthquake, which happened on 21 September 1999, induced severe damages to Taiwan island. The occurrence of shallow landslides and debris flows was significantly increased subsequent to Chi-Chi earthquake. This phenomenon highlights the significance for predicting the debris-flow occurrence after a large earthquake. Inventories of gully type debris flows before and after the Chi-Chi earthquake along with DEM, geological maps and rainfall records were processed by using GIS approach. Logistic regression analyses are performed to evaluate the occurrence probability of debris flows. The effect of strong earthquake on the occurrence of debris flow is discussed with respect to the following aspects: (1) the performance of a debris-flow susceptibility model, (2) the probability of the occurrence of debris flows, and (3) the significance of causative and triggering factors on the debris-flow occurrence. The analysis results reveal that the performance of the debris-flow susceptibility model developed before the earthquake is poor for predicting the debris-flow occurrence after the strike of Chi-Chi earthquake. The accurate prediction rate for the debris-flow occurrence is more than 80 % before the occurrence of 1999 Chi-Chi earthquake but it is lower than 70 % after the occurrence of strong earthquake. Consequently, a statistical susceptibility model to predict the occurrence of debris flows after a large earthquake should be updated using the debris-flow inventory after an earthquake. The proper logistic regression models for assessing the debris-flow susceptibility corresponding to the debris flow inventories before and after the Chi-Chi earthquake are developed. The analysis results indicate that the occurrence probability of debris flow is significantly elevated after the occurrence of large earthquake. Moreover, the significant factors on the debris-flow occurrence are quite different before and after a large earthquake. The catchment geology is the most important causative factor before strong earthquake while the average slope of catchment and the average slope of stream are the most important causative factors after strong earthquake. This change might relate to the fact that a steeper catchment area of a gully is more susceptible to shallow landslides triggered by earthquake. Furthermore, for the triggering factors, the influence of the accumulated rainfall on the debris-flow occurrence becomes less significant than the peak hourly rainfall intensity after the occurrence of strong earthquake.