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Debris Flow Risk Management Framework and Risk Analysis in Taiwan, A Preliminary Study

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Taiwan is located on a seismically active mountain belt between the Philippine Sea plate and Eurasian plate. After 1999's Chi-Chi earthquake (Mw=7.6), landslide and debris flow occurred frequently. In Aug. 2009, Typhoon Morakot struck Taiwan and numerous landslides and debris flow events, some with tremendous fatalities, were observed. With limited resources, authorities should establish a disaster management system to cope with slope disaster risks more effectively.

Since 2006, Taiwan's authority in charge of debris flow management, the Soil and Water Conservation Bureau (SWCB), completed the basic investigation and data collection of 1,503 potential debris flow creeks around Taiwan. During 2008 and 2009, a debris flow quantitative risk analysis (QRA) framework, based on landslide risk management framework of Australia, was proposed and conducted on 106 creeks of the 30 villages with debris flow hazard history.

Information and value of several types of elements at risk (bridge, road, building and crop) were gathered and integrated into a GIS layer, with the vulnerability model of each elements at risk applied. Through studying the historical hazard events of the 30 villages, numerical simulations of debris flow hazards with different magnitudes (5, 10, 25, 50, 100 and 200 years return period) were conducted, the economic losses and fatalities of each scenario were calculated for each creek. When taking annual exceeding probability into account, the annual total risk of each creek was calculated, and the results displayed on a debris flow risk map.

The number of fatalities and frequency were calculated, and the F-N curves of 106 creeks were provided. For F-N curves, the individual risk to life per year of 1.0E-04 and slope of 1, which matched with international standards, were considered to be an acceptable risk. Applying the results of the 106 creeks onto the F-N curve, they were divided into 3 categories: Unacceptable, ALARP (As Low As Reasonable Practicable) and Broadly Acceptable. In order to reduce risk, engineering or other mitigation options were suggested for the 3 different categories, and the risk ranking of the 106 creeks based on the F-N curve were provided.

Also, with the fatality statistics of each debris flow event from 1990 to 2009 available (including events of Typhoon Morakot), plotting the F-N curve and comparing it with the curve of 1990 to 2008, it was observed that the former was higher than the latter, and both curves were slightly above the suggested upper bond of the F-N curve, which indicating that in the future more resources and governance should be invested to reduce and minimize debris flow risks.

Key Words: debris flow, risk management, risk analysis, risk map, F-N curve