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Watershed Sediment Yield Estimate during Heavy Rain Period

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Taiwan is located at the junction of the Eurasian and Philippine Sea plates. The geologic characteristics of this area are frequent geological activity, young geological age, fragile rocks, and complicated geological structures. Seismic activity and torrential rain may easily trigger landslides, slope sliding, debris flow, and large scale sediment hazards. Intense typhoon events each year in Taiwan may increase sediment hazards. Consequently, the sediment hazards result in the loss of life, property and inflict damage to the economy. In this study, the estimation of sediment yields in potential debris flow watersheds was emphasized in the analysis of watershed sediment hazard.

The sediment yield estimate of watershed has been developed for a long time. The most widely used model is Universal Soil Loss Equation (USLE) developed by the United States Department of Agriculture. However, this model do not consider sediment source from landslides. For a watershed with lots of landslide areas, the eroded soil will result in a larger sediment yield than that analyzed under surface soil erosion condition. How to accurately estimate the sediment yield from both soil erosion and landslides during rainstorms is the primary for the watershed management and disaster prevention.

To improve hazard prevention capability, the estimation of sediment yields in potential debris flow watersheds has been established to understand the occurrence mechanisms, transport process, and the sediment yield. An integrated approach using FLO-2D and WINHSPF programs has been established to simulate sediment transport and estimate sediment yields. The proposed model takes into account two different sediment sources which are soil erosion and landslide, respectively. This study also proposed an approach to estimate sediment yields for both occurrence and nonoccurrence of debris flow scenarios. For the nonoccurrence condition, the WINHSPF model was adopted to route the sediment transport (source from soil erosion and landslide); for the occurrence condition, the FLO-2D model was applied to simulate the debris flow deposition.

The proposed method was applied to debris-flow potential torrents catchment in Sioulin Township, Hualien County, and analysis of its sediment yield based on a 24-hour design hyetograph for the 100-yr return period. The results showed that the sediment yield considering landslides were found increasing about 1.1 to 14.4 times than that estimated under the soil erosion conditions. It is more reality to estimate the watershed sediment yield in considering the mechanism of landslide and soil erosion. The estimate of the landslide transport capacity into main channel indicated the sediment delivery ratio was approximately 38.4%. In addition, a comparison of sediment yields computed from occurrence and nonoccurrence of debris flow scenarios showed that the sediment yield considering an occurrence condition was found increasing about 14.2 times than that estimated under a nonoccurrence condition. This implied watershed sediment hazard induced by debris flow may cause severe consequences.