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Sediment Transportation Induced by Deep-Seated Landslides in a Debris Flow Basin in Taiwan

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Typhoon Morakot brought huge amount of rainfall to the southern Taiwan in 2009 and caused severe landslides and debris flow hazard. After Typhoon Morakot, it was found that the volume of sediment transported by the debris flow and its effects on the affected area were much more significant compared to previous case history, which may due to the huge amount of rainfall causing significant deep-seated landslides in the basin. In this study, the effects and tendency of the sediment transportation in a river basin following deep-seated landslides caused by typhoon Morakot were evaluated. We used LiDAR, DEM, and aerial photo to identify characteristics of deep-seated landslides in a debris flow river basin, KSDF079 in Liuoguey District, Kaohsiung City, Taiwan. Eight deep-seated landslides were identified in the basin. To estimate the potential landslide volume associated with the deep-seated landslides, the stability analysis was conducted to locate the critical sliding surface, and the potential landside volume was estimated based on the estimation equation proposed by the International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory (WP/WLI, 1990). The total potential landslide volume of the eight deep-seated landslides in KSDF079 basin was about 28,906,856 m^3. Topographic analysis was performed by using DEM before and LiDAR derived DEM after typhoon Morakot to calculate the landslide volume transported. The result of erosion volume and deposition volume lead to a run out volume of 5,832,433 m^3. The results appeared to consist well with the field condition and aerial photo. Comparing the potential landslide volume and run out volume of eight deep-seated landslides, it was found that the remaining potential landslide volume was about 80%. Field investigation and topographic analysis of the KSDF079 debris flow revealed that a significant amount of sediment deposition remained in the river channel ranging from the middle to the downstream section of the channel, and the channel has been widen. Such large proportion of landslide volume remained in the basin on deep-seated landslide scars and debris flow river channel would likely to cause further debris transportation in the future events. The stability analysis used in this study provided a feasible method and satisfactory results for estimating sediment volume transportation associated with the deep-seated landslides in the study area. Combination of the stability analysis results and the topographic analysis provided estimation of sediment transportation caused by the deep-seated landslides, and trend variation of further sediment transport of the basin, which could provide vital information for hazard mitigation.

Keyword: deep-seated landslide, sediment transport, DEM, LiDAR, stability analysis