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Scenarios analysis of sediment variation after catastrophe in slopeland area: Case study of Typhoon Morakot in GaoPing river watershed, Taiwan

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Typhoon Morakot formed in August 3, 2009, and struck Taiwan during August 7 to 10. The storm produced copious amounts of rainfall, peaking approached 3,000 mm, surpassing the previous record of 1,987 mm caused by Typhoon Herb in 1996 (Lin et al., 2011). A total of 127 debris flows, enormous mudslides and severe flooding were triggered by the extreme amount of rain (SWCB, 2010), which resulted in the heaviest casualties and significant property loss in southern Taiwan, especially in the slopeland area of Gaoping River watershed. Because of the large sediments caused by Typhoon Morakot would impact the public safety and stability of environment in next decade. Therefore, the sediment variation is what we concerned in the future. This study used a sediment budget model (SBM) to analyse the sediment change for different scenarios of rainfall. The SBM was developed by Water Resources Agency (WRA, 2000) which mainly composed of hydrological, sediment yielding, and transport modules. The heavy rainfall events are regarded as most active condition to cause sediment erosion and deposition, Therefore, there are three rainfall scenarios proposed by statistical analysis results of historical rainfall events as hydrological module input data which are Normal Type (returned period for 48-hour rainfall below 50-year), Extreme Type I (returned period for 48-hour rainfall less than 100-year) and Extreme Type II rainfall scenarios (returned period for 48-hour rainfall approached 200-year), respectively. The parameters of sediment yielding and transport modules were collected from the airborne LiDAR scanning, field survey and multi-period digital terrain that included before and after catastrophe data. The regression equations of rainfall with vegetation recovery rate and increased landslide ratio were also established from analyzing the relationship between typhoon-triggered landslides area and historical accumulative rainfall, and used to predict the sediment volume of slope failure triggered by the rainfall scenarios mentioned above. Finally, these rainfall scenarios and regression equations are incorporated with model to simulate the variations of sediment transport. The results shows that the vegetation in landslide area would be gradually recovery, the riverbed of tributary was tend to be slightly erosion and the sediment would be deposited in the mainstream for normal rainfall type. For both extreme rainfall type scenarios, heavy rainfall would induce a large number of landslides and bring large amounts of sediment that raise the elevation of riverbed substantially and might cause severe damage to the slopeland communities. In extreme rainfall type I, the maximum depth of riverbed variations may be approached 20m which are mainly appeared in the upstream area and the part of larger tributaries. Furthermore, a wider range of sediment variations could be observed in extreme rainfall type II. In recent years (from 2011 to 2013), several rainstorm and typhoon events were observed which returned period of 48-hour rainfall were all under 50-year in slopeland area. During 0610 rainstorm and typhoon Talim had led to sediment disasters since the riverbed elevated by sediment exhausted from upstream catchment of tributary in 2012. This actual phenomenon is coincided with the analysis result of normal rainfall type.