

Long-term distribution and evolution of landslide in the landslide-prone watershed: A case study in the Chishan river upstream watershed in Taiwan

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The research focuses on the long-term distribution and evolution of landslide in the Chishan river watershed in Taiwan. Numerous landslide had been induced by 2009 Typhoon Morakot in the Chishan river watershed, and the landslide ratio was 6.5%. It has been ten years from 2009 Typhoon Morakot to now, and this research uses annual landslide inventories from 2008 to 2015 to analyze the evolution of landslide induced by 2009 Typhoon Morakot. The Chishan river upstream watershed has been reported as the watershed in which the landslide was hard to recover by Wu (2017 and 2019). The landslide ratio in the upstream watershed in 2009 was 5.59%, and that in the following 6 years were larger than 3.87%. The count and area of landslide from 2009 to 2015 are the highest in 2010, not 2009. The research uses topographic position analysis of landslide to determine the characteristic of landslide location, and the topographic position analysis was to decide the main inducing factor for landsliding. The ratio of down-hillslope landslide area to the all landslide area has been gradually increased from 2009 to 2015. The ratio of down-hillslope landslide area to the all landslide area in 2009 was 67.6% and that increased to 75.3% in 2015. This data means that the riverbank erosion was a dominant factor for the landslide distribution and evolution from 2009 to 2015. We also estimate the new and old landslide percentage in the upstream watershed, and the mean old and new landslide percentage from 2009 to 2015 are 60.1% and 39.9%. This means that near or over 50% of landslide induced by 2009 Typhoon Morakot is still hard to recovery in 2015. The river intersection area and the river source area are the two main areas where the landslide is problematic to recover and easily induced from 2010 to 2015. The main strata in the upstream watershed includes the Nankang formation, Changchihkeng Formation, and Nanchuang formation. The accumulated occupied percentage of the three strata in the upstream is around 87.9%. The composition of the three strata is slate, sandstone and shale, i.e. three landslide-prone lithologies. The landslide occurred in the three strata in the upstream watershed in 2009 occupies 85.3% of the total landslide in the upstream, while that in 2014 still occupies 87.8 % of the total landslide in the upstream. The riverbank landslide area from 2012 to 2013 in the upstream and midstream watersheds are obvious comparisons for the difference in landslide recovery. The upstream watershed had suffered two heavy rainfall events on the same date, but the 3-day accumulated rainfall of Xingakou station from August 21 to 23 and August 29 to 31 were only 449.5 mm and 353.5 mm, respectively. The riverbank landslide area in the upstream watershed in 2013 increased by 1.63 times of that in 2012, and the non riverbank landslide area also increased by 1.66 times.

Keywords: Loner-term landslide evolution, Taiwan, landslide distribution

