



The Investigation and Mitigation Strategy of a Debris Flow Creek after Typhoon Morakot in Taiwan

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Typhoon Morakot struck Taiwan in Aug. 2009 resulted with tremendous losses, the Soil and Water Conservation Bureau (SWCB) of Taiwan launched field investigation and UAV (Unmanned Aerial Vehicle) reconnaissance to those creeks with new debris flow hazards for preventing further disaster and selecting mitigation methods. This study demonstrates the procedure and tools for the task.

The study area, Kaohsiung DF073 debris flow potential torrent, is located in Singlong Village, Liouguei Township, Kaohsiung County, Taiwan. Length of the creek is 1,505m, with catchment area of 99 Ha, average slope of the creek is 21%.

There were no debris flow history records before 2009, during Typhoon Morakot more than 1,500mm of precipitation was observed in the area from late Aug.6 to early Aug.9, several landslides were triggered by heavy rainfall in the catchment, local residents believed a small landslide dam was formed, with it's collapsing (sometime between 2 to 4AM) a debris flow followed and overflowed the channel, the width of the creek was expanded from 7m to nearly 50m, with inundation area of 1.4 sq-km and average thickness 3m. The debris flow destroyed roads and buildings along the creek, especially No.34 & 35 Jioutan were heavily damaged. Luckily, settlement at lower catchment was spared, and during the event there were no casualties.

For data standardization, this study followed the field investigation SOP which was adopted for the investigation of more than 1,500 enlisted debris flow creeks around Taiwan since 2006. The SOP includes 4 parts: remote sensing image interpretation, field investigation, identification and comparison the exposures with information from data base, and verification of evacuation information and finally mitigation strategy selection.

With the comparison of aerial photos before and after the typhoon event, the landslides triggered by Typhoon Morakot within the catchment were mapped and further identified at field. A debris flow simulation (with FLO-2D) was conducted to map the possible inundation area for evacuation purposes. Information of residents within the area was also collected. Also the photos taken by UAV before and after typhoon were utilized to help the field investigation.

From field investigation in Jul. 2010 and UAV images of 2008, 2009 and 2010, nine new landslides were mapped with total area of 8.8 Ha, equal to 8.76% landslide ratio. The average size of boulders was between 8 to 30cm, mostly slate and schist materials. From aftermath UAV images, the straight path of debris flow could be easily observed, both erosion to the banks and deposition could also be identified.

After Typhoon Morakot, SWCB launched both engineering and non-engineering methods for renovation and evacuation planning. Till the end of 2010, three renovation projects were executed within the creek, slit dams, sabo dams, and bank protections were constructed, totaling 1.1 million Euro. Currently the width of the creek is around 10 meters and no new landslides were observed.

For non-engineering method, the investigation result was utilized for renewing the debris flow emergency evacuation plan of the area. All information was integrated into an A3-size aerial photo based debris flow emergency evacuation map, which was published online and distributed to the local governments and residents. The evacuation routes, shelter location, emergency contact information, police and medical services information could be easily viewed on the map.

Also the accumulated rainfall threshold value for debris flow warning was adjusted in accordance to different events, from 450mm to 250mm (after typhoon Morakot) and further down to 200mm (after local magnitude 6.4 Kaohsiung Earthquake). The local governments should start evacuating the residents within the area when the rainfall forecast reached rainfall threshold value. With the above information at hand, the debris flow evacuation effectiveness could be enhanced further.

Key Words: Debris Flow, Typhoon Morakot, UAV, Emergency Evacuation Map