Comparison of Debris Flow Hazard Mapping between Empirical Function and Numerical Simulation - A Case Study in Taiwan -

Ting-Chi TSAO[1*], Chuan-Yi HUANG[1], Jung-Hsing CHIEN[1], Hsiao-Yuan YIN[2] and Chen-Yu CHEN[2]

[1] Disaster Prevention Technology Research Center, Sinotech Engineering Consultants, INC., Taiwan
[2] Debris Flow Disaster Prevention Center, Soil and Water Conservation Bureau, Taiwan
[*]Corresponding author. E-mail: tctsao@sinotech.org.tw

INTRODUCTION

Debris flow has been one of the most devastating sediment disasters around the world. The direct and indirect damages caused by debris flow had cost tremendous economic losses and great casualties (Jakob and Hungr, 2005). In Taiwan, the steep terrain, frequent occurrence of earthquake and heavy rainfall has made debris flow a major natural hazard in mountainous region.

Debris flow is a hazard with high repeat potential, thus mitigation based on the mapping of possible inundation area for debris flow hazard could effectively reduce the casualty and economic losses.

The technique of debris flow hazard mapping has been greatly improved in the past decade, and both empirical and numerical methods had been proposed to estimate the run-out distance and inundation area of debris flow. However, there might be different degree of impact, which would resulted to different degree of damage, within the inundation area, thus introducing a classification method is worth to study.

In this study, to improve the debris flow hazard mapping technique in Taiwan, we performed field investigation on a debris flow event in eastern Taiwan during a typhoon event in 2014, and made debris flow hazard mapping by using the empirical and numerical methods, respectively, and finally we compared the mapping results to the field investigation results, and discussed the applicability of these two methods

METHOD

To better practice the task of debris flow hazard mapping, the Soil and Water Conservation Bureau (SWCB), the agency in charge of debris flow hazard mitigation in Taiwan, published the Manual for Potential Debris Flow Torrent Mapping in 2013. The manual is a guideline based on empirical method derived from Japanese studies and modified with local experiences. With estimated debris volume based on watershed size, run-out distance based on topography inputs, together with some criteria of terrain in deposition area, one could follow the steps and complete the hazard mapping.

Following the concept of the manual, the inundation areas of 1,705 torrents with debris flow hazard potential were mapped out in Taiwan, and corresponding mitigation strategies were then conduced. However the current inundation area does not specify the intensity or the possible risks in that region, thus it is difficult to classify and implant proper treatments.

This study follows the SWCB guideline of mapping debris flow torrent to draw the preliminary inundation area. The empirical equations for designated volume and run-out distance follow the previous studies in Japan (Ikeya, 1981) and Taiwan (Hsieh, 1998), as shown in Eq.1 and Eq.2.

$$V=70992*A^{0.61} \quad (1)$$

$$Log(L)=0.42*Log(V*tanB)+0.935 \quad (2)$$

In which A=watershed area (km^2), V=estimated debris volume (m^3), L=run out distance (m), B=slope of torrent (degree).

We also conducted debris flow simulation with RAMMS: Debris Flow (5m*5m DEM, event rainfall data) to verify and compare the results with actual disaster event. Also the classifications of debris flow intensity proposed by Rickenmann (2005), based on velocity and inundation height, were introduced for detailed hazard mapping of the debris flow.

RESULTS

In July 2014 Typhoon Matmo brought heavy rainfall, which triggered sediment disaster in 8th neighbor of Mayuan Village, in eastern Taiwan. Debris was washed down with severe erosion along the torrent, and resulted in the damage of three residential houses. The disaster was triggered in the midnight of July 23, by the rainfall which had a maximum hourly rainfall of 74.5 mm/h with its effective accumulative rainfall being 328.5mm, and a total accumulative precipitation of about 544mm. The main source of sediment was believed to be the erosion of the torrent banks, with visible landslide area less than 0.22 Ha. The debris volume was estimated at 5,000 m^3, which covered about 4,782 m^2 with inundation height 1 to 1.5m.

DISCUSSION & CONCLUSION

The preliminary result shows that compare with the actual event (0.48 Ha), the area following the SWCB guideline is the largest (12.84 Ha), and the numerical simulation result and its high hazard region is similar with the actual disaster event, which shows using simulation result to classified hazard degree might provide more detail information for hazard mapping.

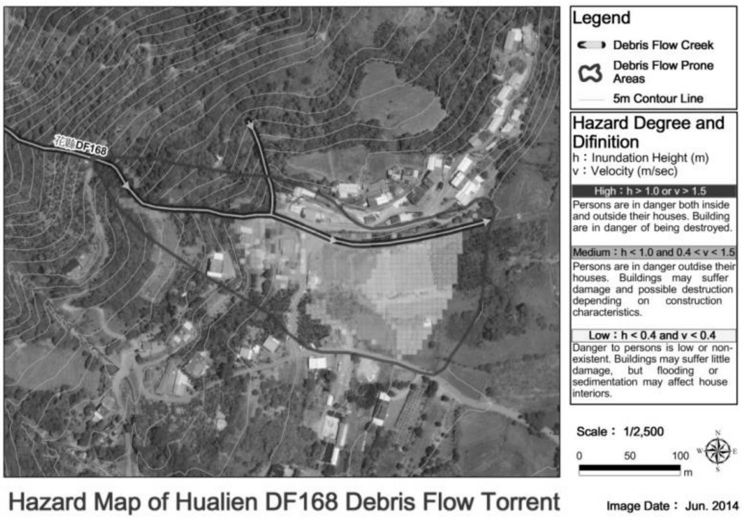

Fig. 1 Debris flow hazard map of this study

Keywords: Debris flow, hazard mapping, RAMMS