Characteristics of Debris Flow in Taiwan
- A Case Study in Shenmu Area

Ming-Chang Tsai[1*], Yi-Min Huang[2], Yao-Min Fang[3], Bing-Jean Lee[4], Tien-Yin Chou[5], Hsiao-Yuan Yin[6]

[1] Graduate School of Civil and Hydraulic Engineering, Feng Chia University, Taiwan, ROC
[2] GIS Research Center, Feng Chia University, Taiwan, ROC
[3] GIS Research Center, Feng Chia University, Taiwan, ROC
[4] Dept. of Civil Engineering, Feng Chia University, Taiwan, ROC
[5] Dept. of Urban Planning and Spatial Information, Feng Chia University, Taiwan, ROC
[6] Debris Flow Disaster Prevention Center, Soil and Water Conservation Bureau, Taiwan, ROC
*Corresponding author. E-mail: akira@gis.tw

INTRODUCTION

Debris flow has become a common natural hazard in Taiwan. After several typhoons (Typhoon Mindule in 2004; Typhoon Haitang in 2005; and Typhoon Morakot in 2009), the increasing landslide in the middle Taiwan had resulted in abundant debris source at the upper streams, and therefore contributed to the higher potential of debris flow. The Soil and Water Conservation Bureau (SWCB) in Taiwan started to build debris flow monitoring stations since 2002 to observe and collect debris flow data. Sensors like rain gauge, soil moisture, and geophone, had been applied for observation. Among the cases, Shenmu was the location of frequent debris flows. The landslide area at the Shenmu area was increased after Typhoon Morakot in 2009. The monitoring features and the debris flow history in Shenmu were described in this study. The correlation of effective rainfall and soil moisture is discussed using event results. The characteristics of debris flow monitoring and analysis are summarized in the end.

METHOD

The case history of debris flow at the Shemu Monitoring Station had been used to discuss the rainfall characteristics. An evaluation of rainfall characteristics was conducted in this study. The method was derived from the soil moisture change behavior with observed data (**Fig. 1** and **Fig. 2**).

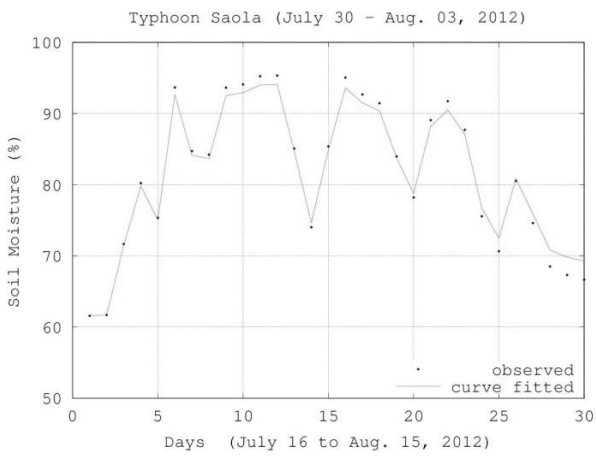

Fig. 1 Results of curve fitting using Typhoon Saola data.

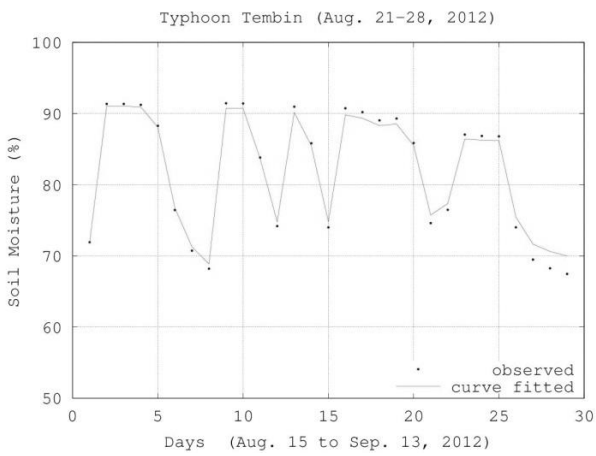

Fig. 2 Results of curve fitting using Typhoon Tembin data.

RESULTS

To better compare the approaches of this paper and SWCB, the 7-day rule was adopted in the estimation using the EF function. The results were shown in **Fig. 3** and **Fig. 4**. The results had indicated that the estimation from this study and SWCB approaches had similar decreasing trend of rainfall with time. The values of both methods were close at the beginning few days, and then varied slightly due to the different estimation functions. Overall, the two curves had similar trend. However, the values estimated by the EF method were higher than the ones by the SWCB method. The ratio of rainfall by EF to SWCB was about 1.78 to 1.98, with an average of 1.88.

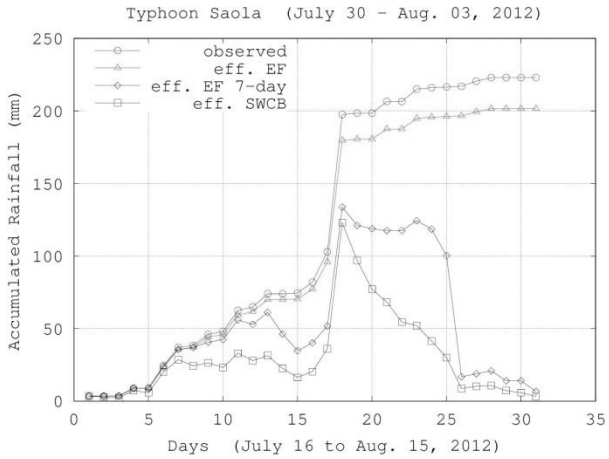

Fig. 3 Accumulated rainfall estimated using Typhoon Saola data.

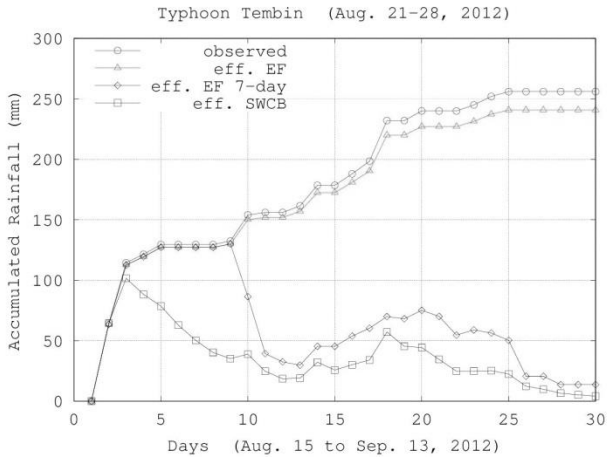

Fig. 4 Accumulated rainfall estimated using Typhoon Tembin data.

DISCUSSION

Overall, the higher estimated effective rainfall was obtained by the EF method, with an average ratio of 0.95 to the observed rainfalls. The value of 0.95 was higher than the weighting factor of 0.8 used in the SWCB approach. Therefore, the resulting effective accumulated rainfalls were different between the two methods. Generally, both the EF and SWCB methods predicted the effective rainfall in the similar decreasing trend with time. It was not clear at current status to determine which method was better than another. The EF method derived from the variation of observed soil moisture was expected to present better estimation on effective rainfall, because the soil moisture indicated the water content left on the ground. More cases and data were needed for further studies about both methods.

CONCLUSIONS

1. The analysis of soil moisture in this study had indicated a reasonable method of estimating the effective accumulated rainfall directly from the site observations. The rainfall warning derived from the soil moisture analysis can be used in the debris flow monitoring system.
2. Both the proposed and SWCB methods had similar decreasing trend of effective rainfall, and were applicable in the debris flow monitoring and warning. More cases and data are needed for analysis, especially about the relationship of rainfall and soil moisture.

Keywords: debris flow, debris flow monitoring, landslide, rainfall warning, soil moisture