Recognition of the Susceptibility of Hydrogeomorphic Processes in Mountainous Watersheds through Morphometric Indicators and Field Reconnaissance

Hsienter CHOU [1*], Chingfang LEE[2], Chengyi LIN[1], Ciyin HUANG[1], Tingchi TSAO[2], Chihhsuan HUANG[1] and Weikai HUANG [2]

[1] Department of Civil Engineering, National Central University, 32001, Taiwan
[2] Disaster Prevention Technology Research Center, Sinotech Engineering Consultants, INC.11494, Taiwan
[*]Corresponding author. E-mail: profhtchou@gmail.com

INTRODUCTION

Tremendous hydrogeomorphic disasters, including floods, debris flows and landslides, occurred in western Taiwan during the attack of typhoons and rainstorms in recent years. The identification of specific hazards associated with hydrogeomorphic process is crucial not only for proper design of countermeasures but also for land development and evacuation operation of the affected areas. This study employs topographic information, such as Melton ratio and watershed length, to categorize the hydrogeomorphic processes of watersheds in western Taiwan and the results are verified by field reconnaissance.

METHODS AND PROCEDUES

The watershed boundaries, stream lengths and stream orders were established using a digital elevation model (DEM) and GIS (Geographic Information Systems). The DEM has a cell size of 5 x 5 m and the lowest point in a watershed is the apex of the fan (Melton, 1958, Wilford et al., 2004). The watersheds in Ping-Guang Creek, Chenyulang River and Chi-Shan River were derived based on DEM and GIS. The dominant hydrogeomorphic processes, including debris flows, debris floods, and floods, were determined based on the depositional patterns in the fan areas by field studies.

RESULTS

The distributions of watershed areas for debris-flow basins in Japan (Mizuyama, 1982) and in western Taiwan are shown in **Fig. 1**. The drainage areas are within a wide range of 0.01-100 km^2, while most of them are small basins of less than a few square kilometers. The debris-flow basins of Chenyoulan River (middle western Taiwan) are generally larger than those of Pingguan Creek (northwestern Taiwan), while those of Chishan River are in between. The Melton ratio (*MR*) and watershed length (*L*) form a suitable scheme for the differentiation of the hydrogeomorphic processes in Pingguan Creek with lower bound of MR of 0.5 and the upper bound of *L* of 2.2 km for debris-flow torrents (see **Fig. 2(a)**). While the scatterplot of Melton ratio and watershed lengths for torrents in Chenyoulan River and Chishan River are shown in **Fig. 2(b)**, which depicts a lower bound of 0.43 for *MR* and an upper bound of 7 km for watershed length for debris-flow prone torrents. There is a

buffer zone for the co-existence of debris flows and debris floods under the condition of $MR > 0.43$ with $7 < L < 12$ km, and $0.3 < MR < 0.43$ in watersheds of Chenyoulan River (CYL) and Chishan River (CS) through field investigations. In accordance with analysis result and overlay by potential debris flow torrents, one may identify the sediment-related hazards occurred in three study areas.

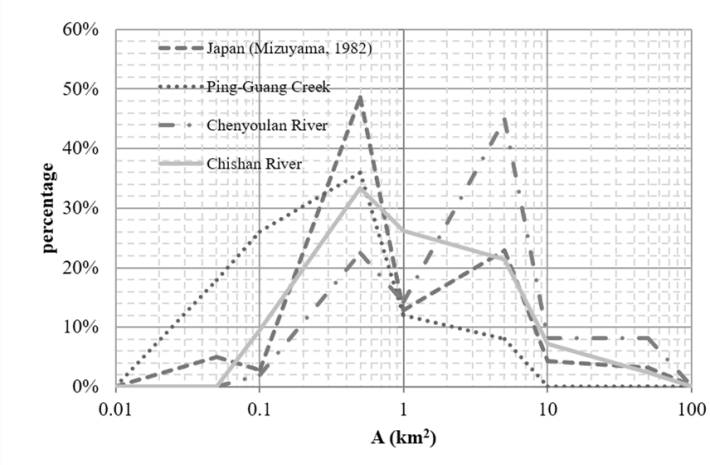
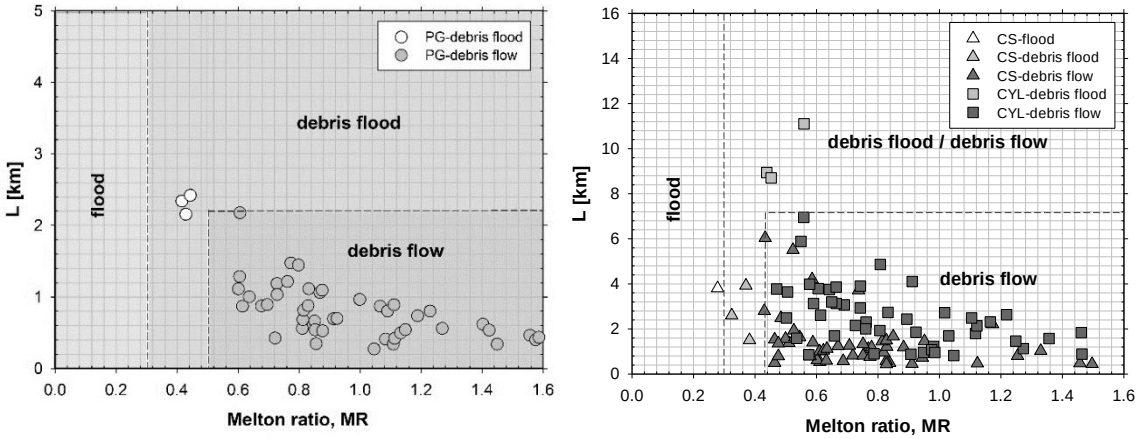


Fig.1 The distributions of watershed areas for debris-flow basins in Japan and in western Taiwan



(a) Ping-Gung Creek (Northwestern) (b) Chenyoulan(CYL) River and Chishan (CS) River

Fig. 2 The hydro-geomorphic relationship in western Taiwan.

CONCLUSIONS

The morphometric parameters, i.e., Melton Ratio and drainage length, are applicable to an identification scheme of hydrogeomorphic processes such as debris flows, debris floods and floods. Regarding the debris-flow torrents in the study areas, the lower bound of MR is about 0.3-0.5, while the upper bound of L is about 2.2 -14 km in different regions in western Taiwan and China due to their different lithology, sediment availability, geological and climate settings. MR=0.3 seems to be the lower bound for debris-flow basins as proposed by Jackson et al. [1987], and itself also serves as the upper bound for flood-related disasters. A buffer zone for the co-existence of debris flows and debris floods under the condition of $0.3 < MR < 0.43$, or $MR > 0.43$ with $7 < L < 12$ km deserves further research.

Keywords: watersheds, debris flows, morphometric parameters, Melton Ratio.