中華水土保持學報, 37(4): 377-387 (2006)
Journal of Chinese Soil and Water Conservation, 37 (4):*377-387* (2006)

以總變差消減法進行土石流數值模擬

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摘　　要　由於全球氣候變遷之影響，台灣地區近幾年來水澇成災，加上處於地震帶，地震頻繁使得地質鬆動，造成多起山區土石流的發生，嚴重影響下游地區人民生命安全和財產損失。本文主要利用數值計算方法模擬土石流流動特性與影響範圍。以有限差分法求解一含有源項(Source Term)之二維淺水波方程組(Shallow Water Equations)，模式中爲了減少數值上非物理性震盪，將數值通量以一階精度 Upwind 與二階精度 Lax-Wendroff 之型態相結合，以符合二階精度混和型態總變差消減(TVD)格式，搭配若干數值通量限制器，並參考 O'Brien and Julien(1988)發表之二階流變模式進行二維土石流流場計算。首先模擬土堆流動問題並與劉和黃(2002)利用有限差分法所計算之土石流流深分布結果相比較，模擬結果大致吻合。本研究進一步模擬底床具斜率變化山谷地形之圓形土石流潰壩問題、矩型河道土石流問題等，計算結果之物理現象，流動特性相當合理，證實本文數值模式之可靠性。期望未來能將模式擴展至實際地形之土石流問題之模擬。

關鍵詞：土石流、有限差分法、源項、淺水波方程、總變差消減。

Numerical Simulation of the Debris Flow by TVD Scheme

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ABSTRACT　Recently, Taiwan had been incurred lots of floods disaster. All of that can be attributed to the severe changes of global climate. In addition, Taiwan is in the seismic area around. The climate changes cause lots circumstances of mudflows and landslides also. With all of above mentioned threats, the life security and property saving of all the residents who are situated at the downstream territory of river had been endangered severely. It, the numerical method, is mainly used in this thesis to simulate the characteristics and affected range of the mudflows and landslide. A finite difference method is applied to solve the two dimensional source term shallow water equations. To lessen the non-physical damping phenomenon occurred while running the numerical simulation program. We use the second-order hybrid type of TVD (total variation diminishing) scheme and also refer to the quadratic rheological model that were published by O'Brien and Julien (1988) to simulate the 2D debris flow problems

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accordingly. Combined the first-order upwind and second-order Lax-Wendroff scheme , several different numerical flux limits are attached also to solve the said appearance during the process of numerical simulation. By taking all above numerical methods, we can obtain the most stable and accurate solutions among the numerical simulations of debris flow. At first, we simulated the mound flow problem causing and compared the final results with Liu & Huang (2002) accordingly. Almost the outcome do closely meet the report issued by them then。Except the simulations we studied above, this research in advance makes some computational calculations for the following problems as well: the circular dam-break debris flow problem, the circular dam-break debris flow within a sudden slope variation valley terrain, and the debris flow on a regular channel. The numerical results reveal that the physical phenomenon and flow characteristics are quite rationally. It strongly verifies the dependability of the said model submitted in this thesis. We expect that this numerical model of debris flow can be applied to the real topography simulation cases in the near future days.

Key Words: mudflows and landslide, finite difference method, source term, shallow water equations, TVD.