SWAT 模式對輸砂量模擬之建議

Suggestions for sediment simulation by Soil and Water Assessment Tool

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摘　要

濁水溪位於臺灣中部，全長 186.6 公里，為臺灣最長的河川。流經四個縣市二十一個鄉鎮，流域面積為 3156.9 平方公里，僅次於高屏溪流域，流域面積為全台第二。集水區內山坡地佔比達 80%，加上地質脆弱、坡度陡峭等因素，依據經濟部水利署第四河川局調查資料顯示，濁水溪年輸砂量約 3,000 萬立方公尺到 6,000 萬立方公尺不等。本研究採用水利署水文年報實測輸砂量，進行 Soil and Water Assessment Tool (SWAT)半分布式水文模式率定驗證，以模擬濁水溪流域輸砂情形。然而，實測輸砂量為非連續日資料，每年約 30 筆數據，實測數據的不足對 SWAT 模式的率定驗證造成困難，因此本研究建立流量-含砂量率定曲線推估輸砂量，進行多測站(寶石橋、龍門橋及延平橋)輸砂量之率定與驗證，模擬時間為 2000-2020 年。結果顯示三個測站輸砂量在率定期間(2002-2011)統計參數R^2介於 0.68~0.76 之間，NSE 介於 0.61~0.66 之間，PBIAS 介於-56% ~ -19.1%之間；驗證期間(2012~2020) 統計參數R^2介於 0.27~0.64 之間，NSE 介於 0.14~0.17 之間，PBIAS 介於-88.7%~ 47.5%之間；顯示所選用的實測輸砂量在率定與驗證期間有極大的差異。為了解實測輸砂資料之特性，本研究進而探討降雨與瞬時流量、含砂量的關係，並檢視颱風事件對輸砂量的影響。綜整分析結果，本研究將提出水文模式在有限或變異性大之實測輸砂資料的情況下，使用者進行輸砂參數率定與驗證之建議。

關鍵詞：SWAT、輸砂量推估、率定驗證、率定曲線

Abstract

Zhuoshuixi is located in the central part of Taiwan, with a total length of 186.6 kilometers, making it the longest river in Taiwan. It flows through 21 towns and towns in four counties and cities, with a watershed area of 3,156.9 square kilometers, second only to the Gaopingxi watershed and the second largest in Taiwan in terms of the watershed area. Mountain slopes in the catchment area account for 80% of the total. In addition to factors such as fragile geology and steep slopes, according to the survey data of the Fourth River Bureau of the Water Resources Administration of the Ministry of Economic Affairs, the annual sand transport capacity of Zhuoshui Stream is about 30 million cubic meters to 60 million Cubic meters vary. In this study, the sand transport volume measured in the annual hydrological report of the Water Resources Agency was used to calibrate and verify the semi-distributed hydrological model of the Soil and Water Assessment Tool (SWAT) to simulate the sand transport situation in the Zhuoshuixi River Basin. However, the measured sand volume is non-continuous daily data, about 30 data per year. The lack of measured data makes the calibration and verification of the SWAT model difficult. Therefore, this study established a flow rate-sand content ratio curve to estimate the sand volume. Carry out the calibration and verification of sand conveying capacity of multiple stations (Baoshi Bridge, Longmen Bridge, and Yanping Bridge), and the simulation time is 2000-2020. The results showed that the SWAT model performed satisfactory streamflow with R^2, NSE, and PBIAS ranging from 0.68~0.76, 0.61~0.66, and -56 ~ -19.1%, respectively during the calibration period; and R^2, NSE, and PBIAS ranging0.27~0.64, 0.14~0.17, and -88.7~ 47.5%, respectively during the validation period. It is shown that the measured sand delivery volume selected varies greatly between calibration and validation. To understand the characteristics of the measured sand transport data, this study further explores the relationship between rainfall, instantaneous flow, and sand content, and examines the impact of typhoon events on sand transport. Based on the analysis results, this study will put forward suggestions for users to calibrate and verify sand transport parameters when the hydrological model has limited or large variability of measured sand transport data.

Keywords: SWAT, sand volume estimation, calibration and validation, rating curve