

研析濁水溪流域地表-地下水之水文時空分布：SWAT-MODFLOW 模式之應用

Simulating the Spatiotemporal Distribution of Surface-Groundwater Hydrology in the Zhuoshui River Basin: Application of SWAT-MODFLOW model

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摘要

濁水溪流域與濁水溪沖積扇位於台灣中部，是台灣重要的水資源區域。該流域涵蓋山地、丘陵和平原地區，地形多樣，水資源豐富，對農業生產和經濟發展至關重要。濁水溪沖積扇則是台灣最大之沖積扇區域，地形平坦，是農業重鎮。隨著經濟發展和人類活動增加，對水資源之需求和利用產生了一定程度負荷。

本研究針對地表水和地下水在水文循環中之互動，特別是降雨產生之地表逕流如何影響地下水系統進行研究。為了全面考量降雨所產生之地面與河川逕流以及降雨入滲機制，整合了 SWAT 和 MODFLOW。主要目標包括，第一，建立 SWAT-MODFLOW 模式，模擬推估濁水溪沖積扇之降雨補注量及河川與含水層之交換量，第二，評估 SWAT-MODFLOW-RT3D 模式之適用性，通過模式率定與驗證，確保模式能夠反映流域內之水文過程。SWAT 模式在率定及驗證期間的流量模擬是滿意的，經模式率定後，MODFLOW 模式年平均抽水量為 26.481 億噸，年平均補注量為 27.228 億噸。SWAT 模式推估之年平均補注量約 14.77 億立方公尺，年平均補注量約為年平均降雨量 0.36 倍。河川與含水層的交換率方面，在扇頂與扇尾區域主要是河川入滲至含水層，而在扇央區域則主要是含水層出滲至河川。

關鍵詞：濁水溪流域、濁水溪沖積扇、SWAT、MODFLOW

Abstract

The Zhuoshui River basin and the Zhuoshui River alluvial fan are located in central Taiwan and are important water resource areas for the country. The basin encompasses mountainous areas, hills, and plains, featuring diverse topography and abundant water resources crucial for agricultural production and economic development. The Zhuoshui River alluvial fan is the largest alluvial fan in Taiwan, characterized by flat terrain and serving as a major agricultural hub. With economic development and increased human activities, the demand and utilization of water resources have placed a certain degree of pressure on the area.

This study focuses on the interaction between surface water and groundwater in the hydrological cycle, particularly how surface runoff generated by rainfall affects the groundwater system. To comprehensively consider the mechanisms of surface and river runoff and rainfall infiltration, the SWAT and the MODFLOW models were integrated. The objectives include the following: first, to establish the SWAT-MODFLOW model to simulate and estimate the recharge volume from rainfall and the exchange volume between the river and aquifer in the Zhuoshui River alluvial fan. Second, to evaluate the applicability of the SWAT-MODFLOW model by calibrating and validating the model to ensure it accurately reflects the hydrological processes within the basin.

During the calibration and validation periods, the flow simulations of the SWAT model were generally satisfactory. After calibration, the annual average pumping volume of the MODFLOW model was 2.65 billion tons, and the annual average recharge volume was 2.72 billion tons. The SWAT model estimated an annual average recharge volume of approximately 1.48 billion cubic meters, with the annual average recharge volume being about 0.36 times the annual average rainfall. Regarding the exchange rate between the river and aquifer, in the apex and tail regions of the fan, the river mainly infiltrates into the aquifer, while in the central region of the fan, the aquifer primarily seeps into the river.

Keywords: Zhuoshui River Basin, Zhuoshui River alluvial fan, SWAT, MODFLOW