# SWAT 模式營養鹽參數之敏感度分析

## Sensitivity analysis on the nutrient-related parameters of Soil and Water Assessment Tool (SWAT) model

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## 摘　要

本研究使用 Soil and Water Assessment Tool (SWAT)半分布式水文模式對流域營養鹽傳輸進行分析。選用鰱魚堀溪流域作為研究區域，探討模式內農業管理措施參數、作物生長參數及土壤參數對營養鹽傳輸之影響。在農業管理措施方面選用作物達到成熟時所需的總熱單位(HEAT UNIT)、作物施肥操作的管理措施內有關肥料施用在土壤表面前 10mm 的比例(FRT_SURFACE)及管理措施內收割效率(HARVEFF)。作物生長方面選用產量中氮含量比例(CNYLD)、最佳生長條件下的收穫指數(HVSTI)、植物生長最適溫度(℃)(T_OPT)及土地覆蓋和植物保護土壤的能力(USLE_C)。土壤方面選用水文組別(HYDGRP)、土壤深度(SOL_Z)、土壤孔隙比(ANION_EXCL)、土壤體積密度(SOL_BD)、土壤層有效蓄水量(SOL_AWC)、有機碳含量(SOL_CBN)、飽和土壤的水力傳導率(SOL_K)及土壤侵蝕指數(USLE_K)。農業管理措施、作物生長及土壤方面分別選用 3 個、4 個及 8 個參數進行獨立測試，單次只調整一項參數檢視營養鹽傳輸的結果。營養鹽傳輸的項目包含作物吸收(NUP)、有機氮含量(ORGN)、地表逕流(NSURQ)、側向流(NLATQ)、土壤滲漏(NO3L)及地下水(NO3GW)。分析參數調整後與未調整前(基期)營養鹽傳輸項目的變化。分析結果顯示，農業管理措施中 3 個參數(HEAT UNIT、FRT_SURFACE 及 HARVEFF)對營養鹽傳輸有影響。作物生長參數中產量中氮含量比例(CNYLD)對營養鹽傳輸沒有影響，其餘 3 個參數(HVSTI、T_OPT、USLE_C)對營養鹽傳輸有影響。土壤參數中水文組別(HYDGRP)對營養鹽傳輸沒有影響，其餘 7 個參數(SOL_Z、ANION_EXCL、SOL_BD、SOL_AWC、SOL_CBN、SOL_K 及 USLE_K)對營養傳輸有影響。綜整分析結果，本研究將提出水文模式在有限的基礎資料情況下，建議使用者在模擬營養鹽前應建立相關參數。

關鍵詞：SWAT、參數敏感度分析、營養鹽傳輸

# Abstract

This study uses the Soil and Water Assessment Tool (SWAT), a semi-distributed hydrological model, to analyze nutrient transport in a watershed. The Dayijae Creek watershed is selected as the study area to investigate the effects of parameters related to agricultural management practices, crop growth, and soil on nutrient transport within the model. For agricultural management practices, the selected parameters include the total heat units required for crops to reach maturity (HEAT UNIT), the proportion of fertilizer applied to the top 10mm of soil surface (FRT_SURFACE), and the harvesting efficiency (HARVEFF). In terms of crop growth, the parameters include the proportion of nitrogen content in the yield (CNYLD), the harvest index under optimal growth conditions (HVSTI), the optimal temperature for plant growth (°C) (T_OPT), and the land cover and plant's ability to protect the soil (USLE_C). For soil parameters, the chosen ones are the hydrologic group (HYDGRP), soil depth (SOL_Z), soil porosity (ANION_EXCL), soil bulk density (SOL_BD), soil available water capacity (SOL_AWC), organic carbon content (SOL_CBN), saturated hydraulic conductivity of the soil (SOL_K), and soil erosion index (USLE_K). Three parameters from agricultural management practices, four from crop growth, and eight from soil properties are tested independently. In each test, only one parameter is adjusted at a time to examine the impact on nutrient transport. The nutrient transport items include crop uptake (NUP), organic nitrogen content (ORGN), surface runoff (NSURQ), lateral flow (NLATQ), soil leaching (NO3L), and groundwater (NO3GW). The study analyzes changes in nutrient transport items after adjusting the parameters compared to the baseline (before adjustment). The results show that all three agricultural management parameters (HEAT UNIT, FRT_SURFACE, and HARVEFF) affect nutrient transport. Among crop growth parameters, the nitrogen content in the yield (CNYLD) does not affect nutrient transport, while the other three parameters (HVSTI, T_OPT, USLE_C) do. For soil parameters, the hydrologic group (HYDGRP) does not affect nutrient transport, but the other seven parameters (SOL_Z, ANION_EXCL, SOL_BD, SOL_AWC, SOL_CBN, SOL_K, and USLE_K) do. Based on the comprehensive analysis of the results, this study suggests that users should establish relevant parameters when simulating nutrients, especially when limited baseline data are available.



Keywords: SWAT, sensitivity analysis, nutrient transfer