

基於地溫剖面之水田垂直入滲率長期自動化監測系統開發

Development of a Long-Term Automated Monitoring System for Paddy Field Vertical Infiltration Rate Based on Soil Temperature Profiles

¹國立台灣大學生物環境系統工程學系

²中原大學土木工程學系

³精靈工匠科技股份有限公司

⁴五號館有限公司

副教授

助理教授

博士後研究

蔡瑞彬¹

林穎凡²

張家豪¹

陳宇文³

顧尚真⁴

Jui-Pin Tsai

Ying-Fan Lin

Chia-Hao Chang

Yu-Wen Chen

Shang-Chen Ku

摘要

本研究開發一套水田入滲率之長期自動化監測系統，整合地溫剖面量測與推估方法，以克服傳統入滲率推估常見的非線性收斂問題及量測設備穩定性不足等挑戰。系統涵蓋地溫剖面監測站、無線資料傳輸模組與 TFLUX 解析模型，可即時且自動化推估水田入滲率。試驗結果顯示，溫度感測器數量與配置方式對入滲率推估精度具顯著影響，其中採用非擾動土樣之配置表現最佳。於臺灣田間試驗期間，觀測到單位面積累積入滲量達 29.6 公分。本研究成果可強化農業水資源管理之科學基礎，並為水稻灌溉配水規劃提供重要參考。

關鍵詞：水田入滲率，地溫剖面，自動化監測，TFLUX 模型，農業水資源管理

Abstract

This study presents the development of a long-term automated monitoring system for paddy-field infiltration rate that integrates soil-temperature profile measurements with an estimation algorithm. The system, comprising soil-temperature profile monitoring stations, wireless data-transmission modules, and the TFLUX analytical model, addresses the non-linear convergence issues and sensor-stability limitations common in conventional infiltration-rate estimation. Field tests demonstrate that both the number and layout of temperature sensors significantly affect estimation accuracy, with undisturbed soil installations yielding the best performance. During field experiments in Taiwan, the cumulative infiltration depth reached 29.6 cm per unit area. The proposed system strengthens

the scientific basis of agricultural water-resource management and provides valuable guidance for irrigation scheduling in rice cultivation.

Keywords: Paddy field infiltration rate , Soil temperature profile , Automated monitoring , TFLUX model , Agricultural water resource management