以系統動力模型評估桃園埤塘之調蓄與養分滯留能力

Assessing the Storage and Nutrient Retention Capacity of Ponds in Taoyuan via System Dynamic Modelling

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摘 要

由於桃園特殊的土壤特性與地形，先民們為了開闢農田蓄水設施以保留更多農業用水資源而誕生了許多埤塘，使桃園地區的農業灌溉系統具有特殊的埤塘系統作為其蓄水設施。然而，近年來桃園地區都市的發展，當農業已不再是桃園地區的重要產業時，也同時使得越來越多的埤塘逐漸地被填平，轉換成建地、道路建設等用途。

然而，隨著近年來永續發展議題與環境保護觀念的發展，人們也逐漸意識到基於自然的解決方案(Nature-based solution, NBS)以及城市綠地中生態系統服務價值的存在。埤塘不僅具有農業灌溉蓄水的用途，還具有養分滯留、防洪、都市降溫、提供動植物生態棲息地、景觀美化、休閒旅遊等生態系統服務。

本研究透過系統動力模型軟體 Vensim 進行建模，首先根據相關之灌溉營運辦法法規、計畫配水量、河溪之河水堰與灌區相關之土壤特性資料、合理的作物生長階段與期間等等，建立桃園大崙站灌區之大圳、河溪、埤塘與農田之間關係的系統動力模型配水模式，以模擬每日步長下的埤塘與農田的水位變化，評估埤塘的調蓄能力。

在模擬出埤塘的水位變化後，將會再根據相關之水質評估文獻，決定所取入埤塘的大圳、河溪水源的養分濃度，根據文獻評估埤塘內部相關之生物地球化學反應，再透過體積莫耳濃度換算，以決定所取入、取出以及留在埤塘中水的養分濃度變化，並評估埤塘之養分滯留能力。

關鍵詞：埤塘，調蓄，養分滯留、生態系統服務、系統動力

Abstract

Due to the distinct soil characteristics and topography of Taoyuan, early settlers developed numerous ponds to retain more agricultural water resources, giving rise to a distinctive irrigation system utilizing ponds as water storage facilities in the region. However, urban development in Taoyuan in recent years diminishes the importanc of agriculture as a primary

industry, many ponds have been gradually filled in and converted into land for construction, roads, and other uses.

Nonetheless, with the increasing focus on sustainable development and environmental protection, there is a growing awareness of the value of nature-based solutions (NBS) and ecosystem services in urban green spaces. Ponds not only serve agricultural irrigation and water storage purposes but also provide ecosystem services such as nutrient retention, flood control, urban cooling, habitats, landscaping, and recreational tourism.

This study employs the system dynamics modeling software Vensim to construct a model based on irrigation operation regulations, planned water allocation, soil characteristics of the irrigation area, crop growth stages and periods, and other factors. The model establishes the relationship between the canal, rivers, ponds, and farmlands in the Da-Lun Station irrigation area in Taoyuan, simulating daily changes in water levels in the ponds and farmlands to evaluate the storage capacity of the ponds.

After simulating the water level changes in the ponds, the study will determine the nutrient concentrations of the water sourced from the main canal and rivers based on relevant water quality assessment literature. The biogeochemical reactions within the ponds will be considered, and the volumetric molar concentration conversions will be used to determine the changes in nutrient concentrations of the water of entering, leaving, and remaining in the ponds. and the nutrient retention capacity of the pond is evaluated.

Keywords: Pond, regulate and store, nutrient retention, ecosystem services, system dynamics