小時尺度多灌區最適宜水資源調配架構

An Hourly Framework of Feasible Water Resources Allocation to Multi – Irrigation Area.

臺北科技大學土木工程系　聯合大學土木與防災工程學系

教授　副教授

張哲豪　吳祥禎

Che-Hao Chang　Shiang-Jen Wu

農田水利署新竹管理處　陽明交通大學土木工程學系

副管理師　博士班

褚淑慧　林宜虹

Shu-Hui Chu　Yi-Hong Lin

共同研究人員

博士

黃思瑋

Szu-Wei Huang

摘　要

農田水利署新竹管理處於竹東圳灌區內以物聯網科技建置水文監測及遠端控制電動閘門站，透過智慧化的資料收集，將監測資料即時回傳至水利署水資源物聯網雲端作業平臺提供分析與加值應用。由於大新竹地區水資源調配有其必要性，為了降低乾旱期的衝擊，本研究目標乃是建立小時等級的配水架構，且需要應用於複雜的多灌區的竹東圳上。因此，2019 年起即逐漸建立重要的現地監測資料，為進行後續資料分析的基礎。本計畫建置多處水文監測站，採用符合物聯網技術之傳輸紀錄系統，並使用 NB-IoT 與 4G 雙通訊方式進行水情資料蒐集。此外，於竹東圳也建置數處遠端控制電動閘門站，進行幹線與支線流量監測與水門遠端控制。遠端控制電動閘門站皆採用新開發之網頁圖控軟體，除可呈現即時閘門運作狀態、閘門站水情資訊與監視影像外，系統提供 4 種閘門控制模式供管理人員進行調控；一般模式、追蹤模式、目標模式與排程模式。閘門電動化內容包含：水情監測資料、閘門訊號及閘門狀態資料皆直接上傳至雲端作業平臺進行資料串接與應用。

為能夠分析可能的配水情境，且必須要到小時等級，勢必要建立動態水理模式架構。

因此，為建構更完完整的竹東圳水理模型，本計畫進行全線水準高程與斷面量測、UAS航拍等量測作業，以盡可能反映現場真實情況。同時為了可以確定閘門流量控制的可行性，在多處難以安排流量量測位置，也採用了現場尺寸之三維模擬來建立水位流量與閘門開度的關係。透過模式演算，搭配多種配水情境，提供灌溉滿足度與建議閘門開度供管理人員參考。

各支線灌溉滿足度是用來當作整體灌溉模式最佳化的依據。依灌溉計畫定義水資源需求，再搭配不同用水情境再進行個別的最佳化操作建議計算。包括中短期現況配水、夜間減供配水、輪灌減供配水、強化輪灌與延長配水及使用者自定義。系統並可呈現不同支線所計算出最佳閘門操作建議值曲線與灌溉滿足度，供管理人員於調控用水時參考。

關鍵詞：水資源調配，旱災，小時尺度，灌溉最佳化。遠端控制電動閘門站。

Abstract

The Hsinchu Management office, Irrigation Agency has built monitoring and remote control gate stations with Internet of Things in Zhudong Conal. The monitoring data will be sent back to IOW in real time for further value-added applications. Due to the necessity of water resource allocation in Hsinchu area especially during severe drought, the goal of this study is to establish an hourly framework of water allocation which should be applied to Zhudong Canal system, a complex multi-irrigated area. IoT technology was adopted to the system which was build under NB-IoT and 4G dual communication channels to collect hydrological data. Several remote control gate stations have been built with newly developed web-based graphic control software which includes the real-time gate status, the water levels, and the monitoring images. The system also provides 4 gate control modes for the management personnel: the general, tracking, target, and scheduled mode.

In order to be able to analyze possible water distribution scenarios, which must be at the hourly level, it is necessary to develop a dynamic water management model for Zhudong Canal System. This study carried out surveying such as leveling, cross-section measuring, UAS aerial photography, etc., to record the field as detail as possible. To determine the discharges at the locations difficult to measure, a 3D simulation based on point clouds from laser Scanner were used to find the relationship among discharges, water level, and gate opening. Through the model calculation, with a variety of possible scenarios, the irrigation satisfaction and the recommended gate opening are provided with the system as for the management personnel's reference.

The irrigation satisfaction of each branch line is used as the basis for the optimization of the overall irrigation system. Defining the water resource requirements according to the irrigation plan, one is able to calculate the optimal operation recommendations based on

different water use scenarios at different time points including short- and medium-term current water distribution, reduced water supply at night, reduced water supply in rotation, enhanced rotation and extended water distribution, and user customization. The system can also present the optimal gate operation under irrigation satisfaction calculated by different branch lines.

Keywords: water resources allocation, drought, hourly scale, optimization of irrigation, remote control gate station.