Universität Stuttgart

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Water Resources Engineering and Management

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Master Thesis Abstract

of Yomer Cisneros Aguirre

Optimization of irrigation operations: A case study of irrigation management in Punjab-Pakistan

Water resource is being stressed due to increasing levels of social demands, particularly in emerging and least developed nations. The arid and agro-based country of Pakistan is highly dependent on Indus Basin Irrigation System (IBIS), one of the biggest contiguous irrigation networks in the world, mainly fed by the Indus River, and its Eastern tributaries Jhelum, Chenab, Ravi, and Sutlej. With limited water resources, irrigated agriculture needs to improve its efficiency and equitable distribution. This study aims to develop a flexible network model that involves a series of nodes interconnected via links to characterize the Punjab irrigation within the IBIS system. The model is calibrated by using Bayesian Monte Carlo method, where available knowledge about gain/loss parameters is updated with the information in observed data.

After a rigorous calibration and validation, the model performance was assessed through the use of the coefficient of determination (R^2), Nash–Sutcliffe Efficiency (NSE), Kling-Gupta Efficiency (KGE), and Percent bias (PBIAS). The overall results of the proposed network model were acceptable for both calibration and validation periods, except in some particular barrage tails. Nevertheless, due to the complexity of the irrigation network and the simultaneous calibration for the entire system, the model behavior is considered satisfactory. The optimized routing gain/loss coefficients coherently explained
the field conditions in the study area.

The findings in this study imply that zones with higher flow discharges are prone to large uncertainties. In addition, posterior probability distributions of gain/loss coefficients suggest an adequate identification of the parameter uncertainties, with changes in the prior probability distributions. It also demonstrates how a selection of prior distribution bounds and model parameters could improve the reliability and robustness of the model.

The model would be helpful to water resource managers involved in agricultural water management in Punjab province. However, the utility of the model should be taken with great care because there are still uncertainties in the modeling results due to the conceptual nature and the quality of input data.

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