What are the benefits and challenges of multi-purpose dam operation modeling via deep learning : A case study of Seomjin River

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Abstract

Multi-purpose dams are operated accounting for both physical and socioeconomic factors. This study aims to evaluate the utility of a deep learning algorithm-based model for three multi-purpose dam operation (Seomjin River dam, Juam dam, and Juam Control dam) in Seomjin River. In this study, the Gated Recurrent Unit (GRU) algorithm is applied to predict hourly water level of the dam reservoirs over 2002–2021. The hyper-parameters are optimized by the Bayesian optimization algorithm to enhance the prediction skill of the GRU model. The GRU models are set by the following cases: single dam input - single dam output (S-S), multi-dam input - single dam output (M-S), and multi-dam input - multi-dam output (M-M). Results show that the S-S cases with the local dam information have the highest accuracy above 0.8 of NSE. Results from the M-S and M-M model cases confirm that upstream dam information can bring important information for downstream dam operation prediction. The S-S models are simulated with altered outflows (-40% to +40%) to generate the simulated water level of the dam reservoir as alternative dam operational scenarios. The alternative S-S model simulations show physically inconsistent results, indicating that our deep learning algorithm-based model is not explainable for multi-purpose dam operation patterns. To better understand this limitation, we further analyze the relationship between observed water level and outflow of each dam. Results show that complexity in outflow-water level relationship causes the limited predictability of the GRU algorithm-based model.

This study highlights the importance of socioeconomic factors from hidden multi-purpose dam operation processes on not only physical processes-based modeling but also aritificial intelligence modeling.

Keywords : Dam Operation, Gated Recurrent Unit (GRU), Bayesian Optimization

Acknowledgment

This study was supported by the National Research Foundation of Korea (NRF-2021R1A2C1093866).

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