Comparative Analysis of Optimization Algorithms and the Effects of Coupling Hedging Rules in Reservoir Operations

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Abstract

The necessity for appropriate management of water resources infrastructures such as reservoirs, levees, and dikes is increasing due to unexpected hydro-climate irregularities and rising water demands. To meet this need, past studies have focused on advancing theoretical optimization algorithms such as nonlinear programming, dynamic programming (DP), and genetic programming. Yet, the optimally derived theoretical solutions are limited to be directly implemented in making release decisions in the real-world systems for a variety of reasons. This study first aims to comparatively analyze the two prominent optimization methods, DP and evolutionary multi-objective direct policy search (EMODPS), under historical inflow series using K-fold cross validation. A total of six optimization models are formed each with a specific formulation. Then, one of the optimization models was coupled with the actual zone-based hedging rule that has been adopted in practice. The proposed methodology was applied to Boryeong Dam located in South Korea with conflicting objectives between supply and demand. As a result, the EMODPS models demonstrated a better performance than the DP models in terms of proximity to the ideal. Moreover, the incorporation of the real-world policy with the optimal solutions improved in all indices in terms of the supply side, while widening the range of the trade-off between frequency and magnitude measured in the sides of demand. The results from this study once again highlight the necessity of closing the gap between the theoretical solutions with the real-world implementable policies.

Keywords : reservoir operation, optimization algorithms, hedging rule, conflicting objectives

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