Deriving Robust Reservoir Operation Policy under Changing Climate: Use of Robust Optimiziation with Stochastic Dynamic Programming

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Abstract

Decision making strategies should consider both adaptiveness and robustness in order to deal with two main characteristics of climate change: non-stationarity and deep uncertainty. Especially, robust strategies are different from traditional optimal strategies in the sense that they are satisfactory over a wider range of uncertainty and may act as a key when confronting climate change. In this study, a new framework named Robust Stochastic Dynamic Programming (R-SDP) is proposed, which couples previously developed robust optimization (RO) into the objective function and constraint of SDP. Two main approaches of RO, feasibility robustness and solution robustness, are considered in the optimization algorithm and consequently, three models to be tested are developed: conventional-SDP (CSDP), R-SDP-Feasibility (RSDP-F), and R-SDP-Solution (RSDP-S). The developed models were used to derive optimal monthly release rules in a single reservoir, and multiple simulations of the derived monthly policy under inflow scenarios with varying mean and standard deviations are undergone. Simulation results were then evaluated with a wide range of evaluation metrics from reliability, resiliency, vulnerability to additional robustness measures. Evaluation results were finally visualized with advanced visualization tools that are used in multi-objective robust decision making (MORDM) framework. As a result, RSDP-F and RSDP-S models yielded more risk averse, or conservative, results than the CSDP model, and a trade-off relationship between traditional and robustness metrics was discovered.

Keywords : climate change, robust optimization, stochastic dynamic programming, robustness, dam operation

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