IWRM2018-79
8th International Water Resources Management Conference of ICWRS

A compromise, stochastic programming model framework for real-time multi-objective flood control operation of a multi-reservoir system

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Real-time flood control operation of a reservoir system is a multiobjective and risky decision-making problem when streamflow forecasting uncertainty is addressed. This paper developed a compromise, stochastic programming model framework for resolving the conflicts of objectives under uncertainty, which include maximum water released minimization (downstream-area flood protection), maximum reservoir storage minimization (reservoir flood storage reservation), and ending storage maximization (flood water resources uses). The coupled model framework is designed as follows: Firstly, the streamflow forecasting uncertainty is incorporated by establishing the actual-streamflow scenario tree which is generated from forecasted streamflow sequences and forecasting errors using neural gas method and Monte-Carol sampling method. Secondly, a multiobjective stochastic programming model under two different risky decision criteria: the expected loss minimization (the risk-neutral criterion) and the maximum loss minimization (the risk-averse criterion), is established, which uses the scenario tree as input. Finally, a compromise programming model is applied to solve the multiobjective model, which minimizes the aggregated objective deviations from the idea solution using weights. The methods are applied to simulate flood control operations of the Foziling multi-reservoir system in China during historical flood events, and the results indicate that: (1) the model framework using the risk-neutral criterion is more suited for guiding reservoir operations during small to medium floods, which can explore flood water uses with acceptable flood risk level; and (2) the model framework using the risk-averse criterion is well suited for guiding reservoir operations during large floods, which lowers down flood risk more effectively. These implications provide new insights into guiding flood control and risk aversion.