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Developing Novel Reservoir Rule Curves Using Seasonal Inflow Projections

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Due to significant seasonal rainfall variations, reservoirs and their flexible operational rules are indispensable to Taiwan. Furthermore, with the intensifying impacts of climate change on extreme climate, the frequency of droughts in Taiwan has been increasing in recent years. Drought is a creeping phenomenon, the slow onset character of drought makes it difficult to detect at an early stage, and causes delays on making the best decision of allocating water. For these reasons, novel reservoir rule curves using projected seasonal streamflow are proposed in this study, which can potentially reduce the adverse effects of drought.

This study dedicated establishing new rule curves which consider both current available storage and anticipated monthly inflows with leading time of two months to reduce the risk of water shortage. The monthly inflows are projected based on the seasonal climate forecasts from Central Weather Bureau (CWB), which a weather generation model is used to produce daily weather data for the hydrological component of the GWLF. To incorporate future monthly inflow projections into rule curves, this study designs a decision flow index which is a linear combination of current available storage and inflow projections with leading time of 2 months. By optimizing linear relationship coefficients of decision flow index, the shape of rule curves and the percent of water supply in each zone, the best rule curves to decrease water shortage risk and impacts can be developed. The Shimen Reservoir in the northern Taiwan is used as a case study to demonstrate the proposed method.

Existing rule curves (M5 curves) of Shimen Reservoir are compared with two cases of new rule curves, including hindcast simulations and historic seasonal forecasts. The results show new rule curves can decrease the total water shortage ratio, and in addition, it can also allocate shortage amount to preceding months to avoid extreme shortage events. Even though some uncertainties in historic forecasts would result unnecessary discounts of water supply, it still performs better than M5 curves during droughts.