



Analytical Framework for Connecting the Hedging Rules with Conventional Rule Curves

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Hedging rules arise from tradeoffs between costs and benefits due to the diversification of risks. Although proposed long ago, hedging rules have been considered as a reservoir operation system independent of conventional rule curves. This study attempts to build an analytical framework for connecting the hedging rules with conventional rule curves at the planning stage. We analyze the multiple water supply rule curves using hedging rule theory and prove that the release curtailment and the discrete rule curves is consistent with the idea of hedging. The design of flood control standard is found based on the conflicting objectives of maximizing the amount of empty space available for storing future floodwater to reduce downstream damages and maximizing the amount of water availability for economical purpose. The starting points of refill and drawdown circle are tradeoffs between short-term and long-term benefits or costs. Generally, the conventional rule curves can be interpreted by hedging rules. This analysis is illustrated via a case study with real-world reservoir in northeastern China. Based on the historical records, the obtained hedging-rule-based rule curves are similar to the conventional rule curves. Using nonstationary inflows, predicted using an autoregressive integrated moving average model, as inputs, the hedging-rule-based rule curves can easily be updated compared with conventional rule curves. This demonstrates the need of theoretical explanation of conventional rule curves and adaptive operations under streamflow unstationary.