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Improving the future performance and reliability of multi-reservoir systems by multi-objective optimization

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Abstract Current climate circulation models simulate a climate change-induced decreasing amount of precipitation in the region of Saxony (Germany) in summer. Consequently, the operation of reservoirs has to consider decreasing inflows, more severe drought periods, as well as increasing demands for water. In order to adapt to these new pressuring conditions and to meet the future demands of all water sectors and simultaneously to provide flood protection, new management strategies for the reservoirs are required. This study combines multi-objective optimization and Monte Carlo simulation for finding effective management strategies for multi-purpose multi-reservoir systems. To achieve robust operations, a new framework is developed which comprises: (i) the physically-based rainfall–runoff model, (ii) a time series model for the generation of a large number of synthetic inflow time series, (iii) a comprehensive reservoir model, and (iv) an adapted multi-objective optimization algorithm and advanced visualization methods for a compact presentation of the results for the decision maker. In a real case application, the new framework is used to find operating rules of a multi-purpose multi-reservoir system in the Ore Mountains, Germany. The overall robustness of the multi-reservoir system operation is quantified and trade-offs between management goals and reservoir utilizations are shown.

Key words multi-purpose multi-reservoir system; multi-objective optimization; rule curves; visualization