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Tree-Based Model Predictive Control for Operational Management of Open-Water Systems

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In open-water systems, the most common technique for control of hydraulic structures is the definition of explicit and reactive operating rules. This is straightforward to apply, although local and non-anticipatory. Model Predictive Control (MPC) is a concept which has become widely applied in industrial process control over the last two or three decades. It makes use of a process model for predicting future trajectories of the controlled variables over a finite horizon, in order to determine the optimal set of manipulated variables by an optimization algorithm. Therefore, MPC provides a globally optimal and anticipatory control.

Standard MPC is a deterministic algorithm. This is a limitation for the applications of MPC on open-water systems, in which the presence of a considerable uncertainty, generally related to the prediction of the disturbance and represented by an ensemble forecast, can jeopardize the robustness of the control. Tree-based MPC uses the ensemble for setting-up a problem of stochastic optimal control. The key idea of Tree-Based MPC is to transform all time series into trees. A tree represents how uncertainty spread out over time. This approach delays decisions until the moment when uncertainties have been solved and makes the control adaptive to the considered scenarios. The approach is applied to a polder system in Rijnland (The Netherlands) and compared against a traditional MPC: the performances improve both under normal and critical conditions.