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Model Predictive Control for Operational Water Management: Optimal, Integrated, Anticipatory and Robust to Uncertainty

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In water systems, the most common technique for control of hydraulic structures is the definition of explicit operating rules. This is straightforward to apply, although local and non-anticipatory.
Model Predictive Control is a concept which has become widely applied in industrial process control over the last two or three decades. Its key elements are: (1) a model of the physical process for predicting future trajectories of the controlled variables over a finite horizon. (2) The calculation of a control sequence that optimize an objective function. (3) a receding strategy: at each instant the first signal of the control sequence is applied and the horizon is displaced towards the future.
The control obtained using MPC is a global optimum: this allows the centralization of a centralized management and guarantees a harmonic control of complex and strongly interconnected systems.
MPC exploits the information contained in the forecast: before the realization of the disturbance, the control sequences set the system to a state which is optimal to accommodate the disturbance. This capacity of anticipation is a clear improvement on reactive operating rules presently used.
Uncertainty in the forecast can jeopardize the performance of the control. Robustness can be enhanced by stochastic optimization versions of MPC, such as Multiple MPC or the most recent Tree-Based MPC. MPC is applied, as test case, to a polder system in Rijnland (The Netherlands).