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Ensemble control of the Hardhof well field under constraints

Beatrice Marti (1), Dennis McLaughlin (2), Wolfgang Kinzelbach (1), and Hans-Peter Kaiser (3)
(1) ETH Zurich, Switzerland, (2) MIT Cambridge, Massachusetts, (3) Zurich Water Works, Switzerland

Practical control of flow in aquifers has been based on deterministic models, not including stochastic information in the optimization (Bauser et al., 2010 or Marti et al., 2012). Only recently robust ensemble control of aquatic systems has been analyzed in linear and synthetic problems (Lin, B., 2012).
We propose a control under constraints, which takes into account the stochastic information contained in an ensemble of realizations of a groundwater flow model with uncertain parameters, boundary and initial conditions. This control is applied to a real life problem setting (the Hardhof well field in Zurich) and analyzed with regard to efficiency of the control compared to a similar control based on a deterministic model.
The Hardhof well field, which lies in the city of Zurich, Switzerland, provides roughly 15% of the town's drinking water demand from the Limmat valley aquifer. Groundwater and river filtrate are withdrawn in four large horizontal wells, each with a capacity of up to 48'000 m3 per day. The well field is threatened by potential pollution from leachate of a nearby land fill, possible accidents on the adjacent rail and road lines, and by diffuse pollution from former industrial sites and sewers located upstream of the well field. A line of recharge wells and basins forms a hydraulic barrier against the potentially contaminated water and increases the capacity of the well field. The amount and distribution of the artificial recharge to 3 infiltration basins and 12 infiltration wells has to be controlled on a daily basis to guarantee the effectiveness of the hydraulic barrier in the highly dynamic flow field.
The Hardhof well field is simulated with a 2D-real-time groundwater flow model. The model is coupled to a controller, minimizing the inflow of potentially contaminated groundwater to the drinking water wells under various constraints (i.e. keeping the groundwater level between given thresholds, guaranteeing production of the drinking water demand, and minimizing the total amount of artificial recharge).
In this study we show that the inclusion of major sources of model uncertainty in the ensemble control increases the robustness of the control decision.

References:
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