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Application of a groundwater flow model for real-time well field management - lessons learned

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The Hardhof well field, which lies in the city of Zurich, Switzerland, provides roughly 15 % of the towns 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 Groundwater and river filtrate are withdrawn in four large horizontal wells, each with a capacity of up to 48'000 m3 per day.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.

Currently, a genetic algorithm coupled to a 3-dimensional groundwater flow model is applied at the well field to determine optimal infiltration rates on a daily basis. This real-time control is based on particle backtracking in a quasi-stationary flow field. It estimates the origin of the water in the four horizontal wells and calculates the amount of potentially contaminated water in each well. Running the model iteratively and refining the parameters of the genetic algorithm at the end of each step yields the recommended daily infiltration rates.

The current model accurately predicts the change of piezometric head due to changes in the river stage. However, during periods of large abstraction rates, the model underestimates the piezometric heads in the Hardhof area. In addition, the infiltration rates suggested by the control do not always agree with the experience of the Zurich water works (e.g. during periods with large abstraction rates) and hence the actually applied infiltration rates are sometimes chosen differently from the calculated ones.

This work analyzes the performance of the model and the control during the year 2011. The computed heads of the on-line model are compared to the measured piezometric heads in over 80 measurement locations in the model area. Furthermore, differences between the computed management decisions and the actual management decisions are analyzed and suggestions for an improved management are made.