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Decision support tools for sustainable groundwater management

title: **Decision support system for the multi-objective optimization of bank filtration systems**

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INTRODUCTION

Within the European project TECHNEAU (www.techneau.org) the Berlin Center of Competence for Water (KWB) is investigating bank filtration (BF) and adjusted post-treatment as a managed aquifer recharge (MAR) technique to provide sustainable and safe drinking water supply to developing and newly industrialised countries. One of the tasks within the project is the development of a Decision Support System (DSS) to assess the feasibility of BF systems under varying boundary conditions such as: (i) quality of surface and ambient groundwater, (ii) local hydrological and hydrogeological properties (e.g. clogging layer) and (iii) well field design (distance to bank) and operation (pumping rates). Since the successful, cost-effective implementation of BF systems requires the optimization of multiple objectives such as (i) optimizing the BF share in order to maintain a predefined raw water quality, (ii) maintaining a predefined minimum travel time between bank and production well and (iii) achieving cost-efficiency of different well field design and operation schemes, all these objectives need to be addressed within the DSS.

METHOD

The DSS was programmed with the software MATLAB® (The MathWorks, 2009a) and compiled as stand-alone version by using the MATLAB® Compiler™ (The MathWorks, 2009b). Each of the above listed objectives can be addressed within the DSS, of which the conceptual structure is divided into four steps. In the first step the user has to specify representative substance concentrations of both, surface water and ambient groundwater. This data set is then used in the second step to calculate the potentially hazardous substances, by comparing each input substance concentration against the corresponding threshold value derived from either the German Drinking Water Ordinance (TrinkwV, 2001) or the Drinking Water Guideline of the World Health Organization (WHO, 2008). In a third step the 'optimal' BF share range is calculated using the conservative mixing approach for each potential hazard substance (local 'optimum') as well as for all substances (global 'optimum'). In the fourth step, different well field designs (number of production wells, distance to bank) and operation scenarios (pumping rates) can be simulated with the BF Simulator (Holzbecher et al. 2008, Rustler et al. 2009), in order to find an optimum well field design and operation scheme, for which the above identified 'optimum' BF share can be obtained. Since the BF Simulator also calculates minimum travel time, depression cone and infiltration length these data could can also be used as additional optimization objectives (multi-objective optimization).

RESULTS AND CONCLUSION

The DSS was tested with data from the Palla well field in Dehli/India (Rustler, Boisserie-Lacroix, 2010). It proved to be a good qualitative tool to identify and learn about the trade-offs a decision maker has to make due to the (i) inherently competing nature of different objectives (e.g. high BF share and minimum travel time > 50 days) and (ii) the inherent uncertainty connected with the high natural variability of boundary conditions (e.g. clogging layer). Since both characteristics can be addressed within the DSS it helps to add transparency and reproducibility to the decision making process. An additional advantage is that its application requires only low effort concerning time, money, and manpower. Thus the application of the DSS is recommended to accompany decision making processes especially in developing and newly industrialised countries where data availability and low financial budgets are usually the major burden for the application of more complex, data-demanding decision support tools.

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