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Modelling tools for managing Induced RiverBank Filtration MAR schemes

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Induced RiverBank Filtration (IRBF) is a widely used technique in Managed Aquifer Recharge (MAR) schemes, when aquifers are hydraulically connected with surface water bodies, with proven positive effects on quality and quantity of groundwater. IRBF allows abstraction of a large volume of water, avoiding large decrease in groundwater heads. Moreover, thanks to the filtration process through the soil, the concentration of chemical species in surface water can be reduced, thus becoming an excellent resource for the production of drinking water. Within the FP7 MARSOL project (demonstrating Managed Aquifer Recharge as a SOLution to water scarcity and drought; http://www.marsol.eu/), the Sant'Alessio IRBF (Lucca, Italy) was used to demonstrate the feasibility and technical and economic benefits of managing IRBF schemes (Rossetto et al., 2015a). The Sant'Alessio IRBF along the Serchio river allows to abstract an overall amount of about $0.5\ m^3/s$ providing drinking water for 300000 people of the coastal Tuscany (mainly to the town of Lucca, Pisa and Livorno). The supplied water is made available by enhancing river bank infiltration into a high yield ($10^{-2}\ m^2/s$ transmissivity) sandy-gravelly aquifer by rising the river head and using ten vertical wells along the river embankment.
A Decision Support System, consisting in connected measurements from an advanced monitoring network and modelling tools was set up to manage the IRBF. The modelling system is based on spatially distributed and physically based coupled ground-/surface-water flow and solute transport models integrated in the FREEWAT platform (developed within the H2020 FREEWAT project - FREE and Open Source Software Tools for WATer Resource Management; Rossetto et al., 2015b), an open source and public domain GIS-integrated modelling environment for the simulation of the hydrological cycle. The platform aims at improving water resource management by simplifying the application of EU water-related Directives and at facilitating the use of modeling environments and GIS tools for storage, management and visualization of large spatial datasets.
The groundwater flow and solute transport model was built using FREEWAT, where MODFLOW-2005 and MT3DMS are integrated. The aquifer of the Sant'Alessio plain was discretized using square cells $100\ m^2$ wide and two model layers, a silty-sandy superficial cover and the sandy-gravelly aquifer. Hydraulic connection with the Serchio river and exploitation of the aquifer through the Sant'Alessio well field were simulated. The aquifer model layer was further refined to simulate advection, dispersion, sorption and degradation of contaminants within the river. The objectives are: (i) estimating induced infiltration rates and travel times, (ii) optimizing groundwater exploitation in complex well field schemes, (iii) preventing pollution events, (iv) estimating time for remedial actions.

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