flowpath THIRD EDITION
3rd National Meeting on Hydrogeology
Cagliari, 14-16 June 2017

USING NUMERICAL MODELING TOOLS FOR MANAGED AQUIFER RECHARGE AT INDUCED RIVERBANK FILTRATION SCHEMES

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Among Managed Aquifer Recharge (MAR) techniques, Induced RiverBank Filtration (IRBF) is widely used when aquifers are hydraulically connected with surface water bodies. It consists in enhancing the filtration process through the riverbed sediments, with proven positive effects on quality and quantity of groundwater.
At the Sant'Alessio IRBF plant (Lucca, Italy), aquifer storage is increased by means of a weir (raising groundwater head) and 12 vertical wells along the Serchio river embankment. The Sant'Alessio IRBF allows withdrawal of about 0.5 m3/s by enhancing river bank infiltration into a high yield (10-2 m2/s transmissivity) sandy-gravelly aquifer, thus providing drinking water for 300000 people of the coastal Tuscany (mainly to the towns of Lucca, Pisa and Livorno). The Sant'Alessio IRBF scheme is one of the FP7 MARSOL project demo sites (demonstrating Managed Aquifer Recharge as a SOLution to water scarcity and drought; http://www.marsol.eu/).
A Decision Support System, consisting in connected measurements from an advanced monitoring network and modelling tools was set up to demonstrate the benefits of switching from un-managed artificial recharge to MAR. The modelling system is based on advanced modeling tools integrated in the FREEWAT platform (developed within the H2020 FREEWAT project - FREE and open source software tools for WATer resource management; Rossetto et al., 2015). FREEWAT is a free and open source, GIS-integrated modelling environment which incorporates spatially distributed and physically based codes for the simulation of the hydrologic cycle.
As one of the main concern is about exchanges between ground- and surface-water, especially in case of pollution events in the river water, the impact of such events on recharged groundwater and the time available to set in place remedial actions were estimated. This was done through building a hydrological and mass transport model using FREEWAT (which integrates MODFLOW-2005 and MT3DMS). Simulations were performed over an area of about 5.2 km2, with a focus in the vicinity of the river embankment and the Sant'Alessio well field. The model allowed demonstrating the importance of the weir in enhancing aquifer recharge in the Sant'Alessio plain and the efficiency of the IRBF scheme. Further modeling efforts allowed: (i) defining the well-head protection areas for the Sant'Alessio well field, by outlining isolines at selected times (10, 20, 30, 45, 60, 90, 180, and 365 days, as required by the Italian legislation); (ii) inferring expected concentration in the Serchio river for a particular

pesticide, in relation to duration of surface water pollution events, likely to cause pollution at the IRBF well field; (iii) simulating the impact of contamination events of agricultural origins on the areas adjoining the drinking wells.
Results show that the Sant'Alessio IRBF scheme is a reliable and robust one in term of security of supply and quality of the groundwater abstracted. However, the availability of a reliable operational monitoring protocol is necessary to foresee potential pollution events on time and to set in place remedial actions.

Acknowledgements
This paper is presented within the framework of the projects FP7 MARSOL and H2020 FREEWAT.
The MARSOL project has received funding from the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration under grant agreement no 619120.
The FREEWAT project has received funding from the European Union's HORIZON 2020 research and innovation programme under Grant Agreement n. 642224.

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