Impact Assessment of Hydrologic and Operational Factors on the Efficiency of Managed Aquifer Recharge Scheme

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Abstract

Due to increased demands on groundwater accompanied by increased drawdowns (ca. 2-3 meters/year), technologies that use alternative water resources have been suggested for Dhaka City, Bangladesh. Preliminary studies show that managed aquifer recharge (MAR) would help in optimal use of available water resources and to reduce adverse effects of pumping in the Dupitila aquifer of the city. In this paper two potential approaches are considered to implement MAR using rainwater in Dhaka City. The approaches are: storm run-off harvesting and roof top rainwater harvesting combined with managed aquifer recharge. This study estimated that 20% of today's water demands could be met by rainwater harvesting. It is suggested that recharge trenches and pits would be the most appropriate MAR technique that can be implemented in most parts of the recharge area (ca. 277 km2 out of 370 km2). In case of a recharge trench, the lower parts (15 to 20 m) that are in direct contact with the aquifer can be backfilled with biosand filters (BSF) with a reactive layer containing metallic iron (Fe0) to offer pre-treatment of the infiltrated water. Regarding water quality of the injected water, residence time of more than 6 months is recommended. As the distribution of pumping wells in the city is very dense, it is important to investigate the movement of the groundwater in the aquifer after injection. In this paper, groundwater flow models were created to assess the impact of hydrologic and operational parameters on the aquifer within the context of MAR project implementation. Flow /particle tracking and solute transport models were used to track the movement of injected water during injection, storage and possible recovery. We used the software package COMSOL Multiphysics 4.2 and Visual MODFLOW to create the groundwater flow and transport models. This paper critically examines and compares the performance of both models. Another 1D flow and transport model using the Richards equation, included in COMSOL, will be created to assess the water quality changes during the injection of stormwater through the BSF filter. It is also planned that both COMSOL models will be integrated to investigate the possible mixing of injected water with native water, to assess the development of clogging layers, considering physical and biological processes, and finally to optimise the height of the layers of the BSF column.