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Characterization and Modelling of Groundwater Flow towards a Public Drinking Water Well Field: A Case Study of Ter Kamerenbos Well Field

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Abstract : Groundwater is the largest freshwater reservoir in the world. Like the other reservoirs of the hydrologic cycle, it is a finite resource. This study focused on the groundwater modeling of the Ter Kamerenbos well field to understand the groundwater flow system and the impact of different scenarios. The study area covers 68.9Km2 in the Brussels Capital Region and is situated in two river catchments, i.e., Zenne River and Woluwe Stream. The aquifer system has three layers, but in the modeling, they are considered as one layer due to their hydrogeological properties. The catchment aquifer system is replenished by direct recharge from rainfall. The groundwater recharge of the catchment is determined using the spatially distributed water balance model called WetSpass, and it varies annually from zero to 340mm. This groundwater recharge is used as the top boundary condition for the groundwater modeling of the study area. During the groundwater modeling using Processing MODFLOW, constant head boundary conditions are used in the north and south boundaries of the study area. For the east and west boundaries of the study area, head-dependent flow boundary conditions are used. The groundwater model is calibrated manually and automatically using observed hydraulic heads in 12 observation wells. The model performance evaluation showed that the root means the square error is 1.89m and that the NSE is 0.98. The head contour map of the simulated hydraulic heads indicates the flow direction in the catchment, mainly from the Woluwe to Zenne catchment. The simulated head in the study area varies from 13m to 78m. The higher hydraulic heads are found in the southwest of the study area, which has the forest as a land-use type. This calibrated model was run for the climate change scenario and well operation scenario. Climate change may cause the groundwater recharge to increase by 43% and decrease by 30% in 2100 from current conditions for the high and low climate change scenario, respectively. The groundwater head varies for a high climate change scenario from 13m to 82m, whereas for a low climate change scenario, it varies from 13m to 76m. If doubling of the pumping discharge assumed, the groundwater head varies from 13m to 76.5m. However, if the shutdown of the pumps is assumed, the head varies in the range of 13m to 79m. It is concluded that the groundwater model is done in a satisfactory way with some limitations, and the model output can be used to understand the aquifer system under steady-state conditions. Finally, some recommendations are made for the future use and improvement of the model.

Keywords : Ter Kamerenbos, groundwater modelling, WetSpass, climate change, well operation
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