Development of a regional groundwater flow model, and forecasting a scenario for groundwater management of Birmingham, UK

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Birmingham is a city in the West Midlands, United Kingdom. Birmingham and the Midlands lie on the Permo-Triassic sandstone, the Sherwood Sandstone Group. It has been an important groundwater resource with good-quality water for over 300 years. Groundwater flow and sustainable study of the aquifer was performed through a numerical model in 1992 and it was developed in 1995, and 2001. It has been over 20 years since the last version of the model. Thus, this study aims to update the model due to more data available and forecast a scenario over the next 10 years (2022-2032) to increase understanding of groundwater management.

The updated model was simulated as a 3-dimension groundwater flow model by using Groundwater Vistas 7.15 software with MODFLOW solver. Recharge of the aquifer was estimated from precipitation, potential evapotranspiration, and water leakage which were analyzed under GIS-based method as land cover and land use are significant factors. A topographic map was also performed by GIS tools to turn into a surface elevation of the model. The model boundary and aquifer were specified by hydrogeological information. Data of hydrogeology, watercourse, recharge, and abstraction data were used to develop a conceptual model. After that, the numerical model was built and calibrated with historical groundwater level records. Eventually, the model was run until 2032 without changing parameters from 2022 to forecast a groundwater scenario in the next 10 years.

The flow model illustrates the groundwater's flow direction and hydraulic head of the area. In addition, the interaction between the aquifer and rivers is indicated as most rivers are gaining steam. After all, the forecasting scenario shows that the hydraulic head has increased over the period to 2032 and, if there is no change in the recharge or abstraction rate after 2022, a small area of groundwater flooding will occur in the northwestern area.

Keywords: Groundwater flow model; Numerical model; MODFLOW