GROUNDWATER NUMERICAL MODEL OF THE BISKRA INFÉRO-FLUX AQUIFER (NE ALGERIA)

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The Inféro-Flux phreatic aquifer is hosted by the Quaternary alluvium of the Oued el Hai-Biskra, in Northeastern Algeria. The most productive zone, near the city of Biskra, extends over a three km^2 surface. The aquifer overlies low-permeability Neogene deposits. Average annual precipitation of 150 mm/year, high evapotranspiration rates, and increasing water demand have led to the overexploitation of this groundwater resource. Indeed, extraction for drinking water occurring at twelve wells, for a total withdrawal of seven Mm^3/year, has led to more than ten metres drawdowns of the water table in the last forty years. The aim of the work was to develop and calibrate a 3D groundwater flow numerical model for estimating the spatial distribution of the hydraulic conductivity parameter and improve the knowledge on the aquifer dynamics, based on the definition of the aquifer boundaries through a 3D geological model.
Borehole reports and cartography derived from the literature and piezometric data, collected during various field surveys, were organised within a geodatabase. All the data, together with eighteen geological sections and following the geomorphological interpretation of the stream system, were implemented in the 3D MOVE software to reconstruct the geometry of the Inféro-Flux aquifer. The conceptual hydrogeological model was developed by integrating the 3D geological model, the SRTMGL1 DEM and the hydrogeological data acquired in May 1966 (SCET-COOP, 1967). They include piezometric heads, pumping rates and hydrological water budget. The MODFLOW-2005 code (Visual MODFLOW Flex Interface) was used in the design and calibration of a 3D steady-state groundwater flow numerical model. PEST was applied for automated calibration and estimation of hydraulic conductivities (k_x). Then, heads observations and pumping yields coming from a second dataset (WADIS-MAR, 2016), were used to validate the k_x obtained by the PEST code.
The 3D geological model provides the geometry of the Inféro-Flux aquifer. It showed a maximum thickness of 50 m, a steep slope on the left bank and a gentle slope rising towards the ground surface on the right bank. Results of the model calibration via PEST application show that 1) estimated hydraulic conductivities range from $2*10^{-4}$ to $8*10^{-3}$m/s, 2) residuals have a 0.05 m RMS (root mean square) error, and 3) the simulated inflow corresponds to 33500 m3/d. Results of the model validation show a RMS residual error of 1.5 m and a simulated inflow of 23500 m3/d.
The 3D geological model allowed constraining the geometrical boundaries of the model domain. The numerical model well agrees with the conceptualisation of the system as

demonstrated by low residual values. The simulated inflow volumes allow the groundwater budget closure in both calibration and validation runs. However, potential recharge from direct rainwater infiltration is not enough to justify the simulated volumes and further lateral groundwater recharge should be considered. They can be related to the alimentation from deep groundwater systems rising to the surface.
The modelling will provide a valuable tool for the sustainable and integrated management of the groundwater resource and to evaluate the effectiveness of a Managed Aquifer Recharge (MAR) system designed in the frame of the WADIS-MAR Project (www.wadis-mar.eu) aiming to restore the water level (Ghiglieri et al., 2014).

References

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