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Abstraction effect on flow systems and in obtained water quality: the nadhour saouaf sisseb el alem aquifer (central tunisia).

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ABSTRACT
Groundwater is the main source of vital freshwater supply in Tunisia; however, it has been subject to intensive abstraction resulting in high drawdown and a deterioration water-quality. Therefore, there is a need to define a sustainable groundwater management. The Nadhour Saouaf Sisseb El Alem (NSSA) aquifer in central Tunisia is one of the most intensively used water sources in this country. It is a multilayer aquifer with a vertical two-layer structure, each layer yielding groundwater since early in the 1970's. The lower aquifer (confined) having, currently, a reported yearly abstraction of 13.7 Mm3 while the upper aquifer (water-table) has a thorough tapped yield of 9.2 Mm3. The high extraction rate in the latter produced uneconomical drawdowns, so users decided to illegally tap the lower aquifer. The abstracted water quality has deteriorated from an original 1.2 g/l of TDS to a reported value of 5.8 g/l. Drawdowns of up to 23 m have recently been reported in the upper aquifer, implying that the groundwater flow regime has been altered by the increased intensive abstraction. This work is aimed at determining the functioning of the groundwater flow systems, defining how the current intensive abstraction has been able to affect the direction of flow systems and to modify the chemical characteristics of the initial tapped groundwater. Modelling techniques on historical NSSA data on piezometric values and main physical-chemical characteristics of groundwater were used to produce maps on the effects of abstraction increase, and to have an insight on the hydraulic connection between flows in the upper and lower aquifer units. To achieve a better understanding of groundwater flow functioning of NSSA aquifer and to predict its evolution under different future scenarios, a finite difference model of groundwater flow and solute transport was developed using the Groundwater Modeling System (GMS) software. The model was calibrated using data from 1970 to 2010. Groundwater levels and chemistry (i.e. TDS) recorded in 1970 were used for the steady-state calibration. Groundwater levels and TDS observed from 1971 to 2010 served to calibrate the transient state. The impact of abstraction on future evolution of groundwater level and salinity, were studied through three hypothetical abstraction scenarios. The simulation results indicate that the first and second scenarios show how an increase in abstraction rate of 30% and 50%, generate a drawdown in the hydraulic head elevation of ≈17 m and ≈23 m, respectively; and an increasing salinity of about 1.5 g/l. The center and the south of the NSSA aquifer is mostly affected. Abstraction was stopped in a third scenario, resulting in increasing groundwater reserves by ≈7 Mm3/year with a TDS of ≈1 g/l.
Keywords: Groundwater flow systems, Chemical characteristics, TDS, Intensive groundwater abstraction, Groundwater management, GMS, NSSA aquifer, Tunisia.