THREE-DIMENSIONAL MATHEMATICAL MODEL TO SIMULATE GROUNDWATER FLOW AND MASS TRANSPORT IN COASTAL AQUIFER SYSTEM OF ANNABA, EASTERN ALGERIA

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Abstract
On the coastline of the Seybouse low plain, the gravel aquifer is characterised by a high conductivity. In order to determine the origin of this salinity, a monthly monitoring of the groundwater chemistry was conducted between February and December 2006. The collected basic data were used for the preparation of a groundwater flow and mass transport model for the quantitative assessment of impact of human influence on contaminant dispersal in the watershed.
Keywords: Algerian Basin, Models, Pollution, Salinity

The potentiometric surface in the Seybouse basin, which covers an area of 264 km^2, has declined significantly since 1978. Earlier studies in this area (1-3) have shown that i) groundwater is used intensively near the coast; ii) the decrease of water levels creates piezometric depressions and the extension of zero level towards the south (Fig. 1); iii) the dip of the gravel strata is mainly towards the sea; and iv) the steady decrease of hydrochemical features from the sea to the continent on about 15 km (Fig. 2).

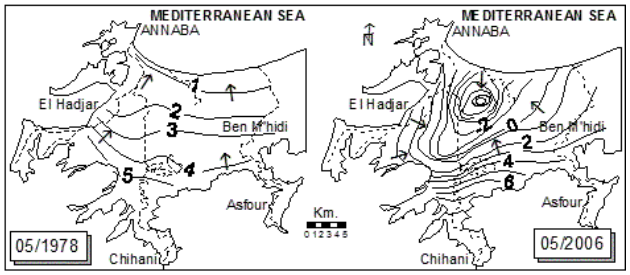

Fig. 1. Variation of piezometric levels between 1978 and 2006

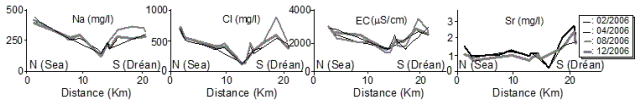

Fig. 2. Variations of hydrochemical features. Graphs for chlorides, sodium, Strontium and EC from the sea to Dréan, in southern sector

A transient multilayer model has been developed to synthesise the hydrologic data and study the regional changes in aquifer interactions caused by changes in discharge. The model consists of two layers, the first corresponding to the alluvial phreatic aquifer and the second to the deep confined aquifer, and it is calibrated against the steady state groundwater heads recorded before 1983. Model verification was done by history matching over the period 1978-1996. Under steady-state conditions, the correspondence between simulated and observed water levels is generally good (average difference of 0.4 m). For the deep aquifer, the simulated time-series hydrographs closely match the recorded hydrographs for most of the observation wells. For the alluvial aquifer, the recorded hydrographs cover only a short time period, but they are reproduced. The model indicates that groundwater pumping induced a decrease in natural discharge, a downward leakage in most of the basin and a continual water-level decline. The model has also been applied to the analysis of recharge impact. Simulating the behaviour of the system over the period 1978-1996 without pumping indicated small changes in hydraulic head. These results show that the groundwater reservoir has a low recharge, but excellent hydraulic properties; a solute-transport model was used to study aquifer contamination from salty intrusion in coastal sectors; it was extended to the year 2010 by simulating an optimistic hypothesis that maintains present pumping until 2010. The model indicates that the head decrease of the alluvial phreatic and deep confined aquifers will be 4 m and 5 m respectively. The simulated piezometric distribution illustrates the vulnerability of the aquifer in coastal sectors where flows with an important concentration of chloride may be observed, especially towards the Salines wells field. The solute concentration in the deep confined aquifer will increase from 1 g.L (prior 1996) to 5 g.L in 2010 m.

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