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" Application of modeling in the optimization of Sidi Okba wellfield (W. Biskra)"

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Abstract

The existence and expansion of arid region, after being accepted as a natural inevitability, is now the subject of many studies, essentially devoted to the problem of their recharges water. Also, the exploitation and use of groundwater were they high specificity in the water economy.

For the region of Sidi Okba (in W. Biskra), which experienced a major agricultural development which required extensive drilling, six (08) holes capturing the Mio-Pliocene water table, the latter is more extensive supply sources more stable than surface water.

In this research, we will try to restore the hydraulic head of the water table using the MODFLOW computer code. This numerical model was developed on the basis of an overall synthesis of acquired data. This data is geometric and hydrodynamic order to better manage these resources. Map of lowering is drawn using Surfer.8.0. The Excel Solver is application used to optimize the operation of capturing the water table.

This work has identified the main groundwater flow in the deep aquifer (Mio-Pliocene) and deducts the possibility of further exploitation in boreholes serving the city of Sidi Okba.

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Keywords: groundwater; Mio-Pliocene; modeling; optimization, ressources; Sidi Okba.

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1. Introduction

Sidi Okba, is a desert steppe region (Fig.1) characterized by wadis with steep banks that reject further south, in the vast depression of Chott-Melghrir, in all, the region of Sidi Okba has some homogeneity decided by the wadis running down the hills will recover the plain of the debris generated by the current erosion (pebble conglomerates)

The topography of the study area belongs to a relatively flat area. Coordinates and altitudes operating items are collected at the DHW Biskra. However, we have completed the GPS data for the wells of the Islamic complex Garta those of N°.1 and N°. 2, and that of Esseda.

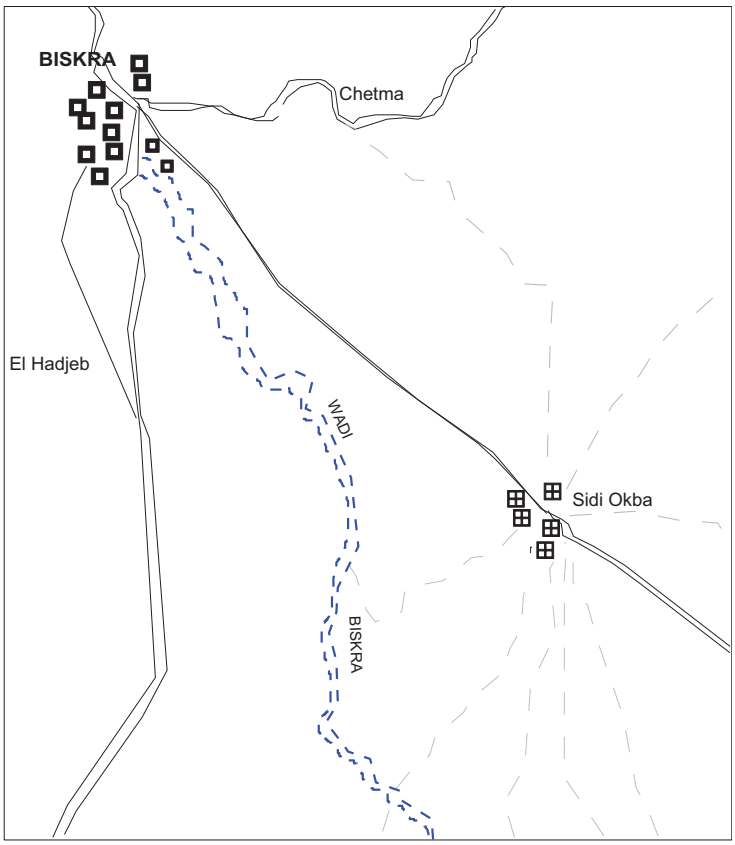

Fig. 1. Geographical location of Sidi Okba.

2. Geological context

The various training Neogene show an alternation of marl or clay, sandy clays, sandstone or sometimes clayey sands and conglomerates at the top with the presence of gypsum in almost all levels and some limestone beds

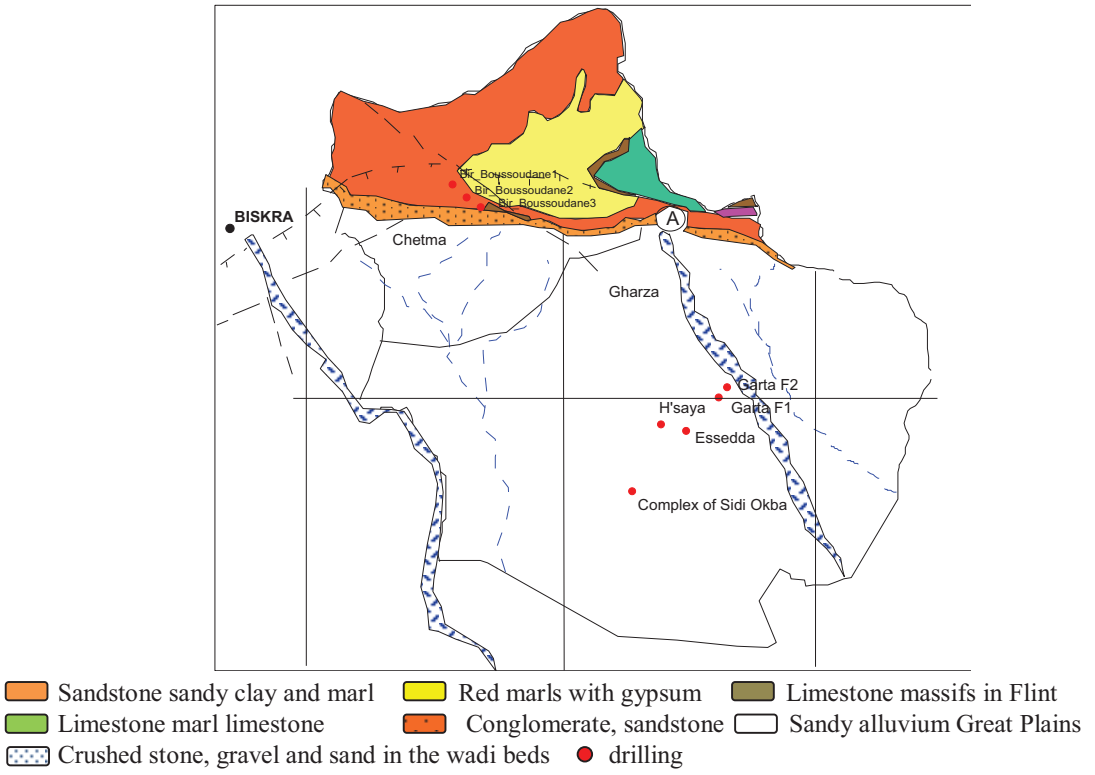

Fig. 2. Geological map and drilling position

3. Numerical modeling of Mio-Pliocene groundwater

3.1. Input data

The model input data mainly concern the topography of the area, the geometry of the aquifer, operating and observation works, some drilling data are given in the following (Table 1).

Table 1. Coordinate drilling of well field (Source: DHW S.Okba [1])

Drilling name	X (°d)	Y (°d)	Location	Exp. Date	flows (l s-1)
Bir_Boussoudane1	5,824722	34,863611	Chetma	1954	7
Bir_Boussoudane2	5,82972222	34,85944444	Chetma	1979	10
Bir_Boussoudane3	5,8361111	34,85472222	Chetma	1980	7
H'saya	5,911111	34,775	S.Okba	/	/
Essedda	5,92166667	34,77222222	S.Okba	1990	15
Road of Garta F1	5,93613889	34,78402778	Garta	1983	10
Road of Garta F2	5,94055556	34,78738889	Garta	1994	5
Complex of Sidi Okba	5,89741667	34,750861	S.Okba	/	/

4. The Modflow model

The MODFLOW model [2] is software that simulates the flow at two or three dimensions of a sheet it is steady or transitional. This software is developed by USGS with MC Harbaugh and Donald A. W [3].

4.1. The boundary conditions:

This second step is to provide boundary condition and assign values of concentration or loading rates defining various boundaries for all nodes located along boundary of the domain. Initial conditions and transport parameters were specified for all nodes [4] (Potential conditions - Flow conditions).

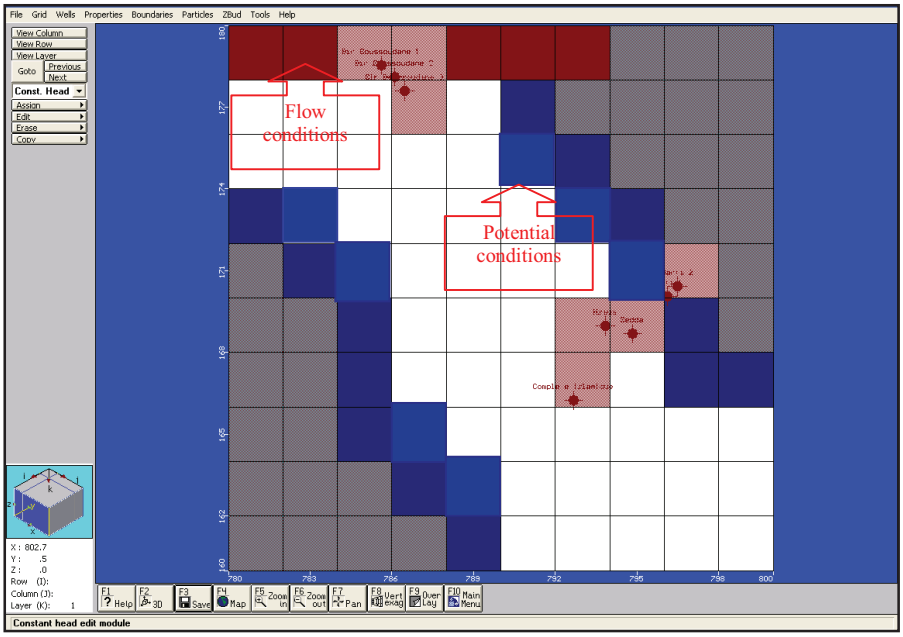

Fig.3. Map of the boundary conditions.

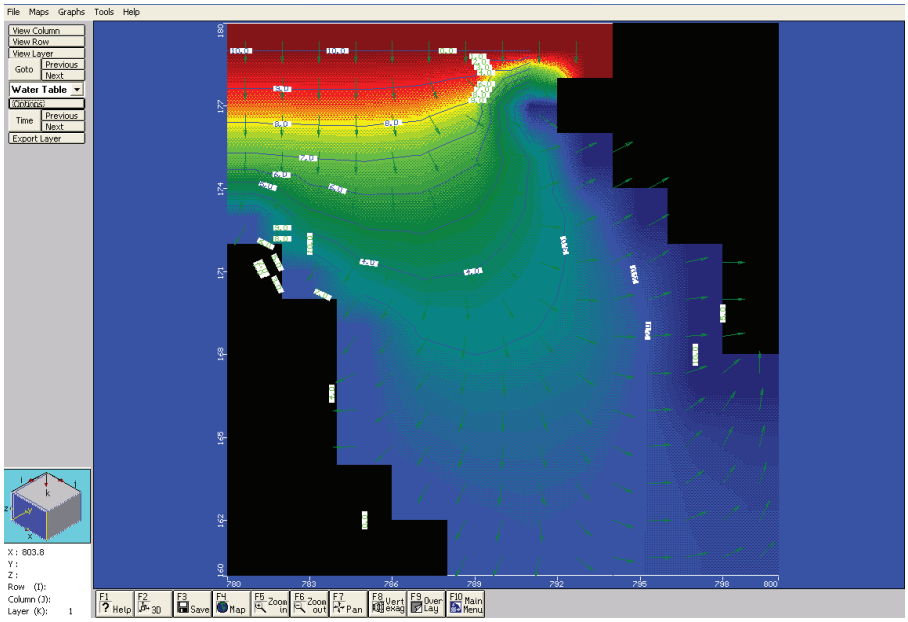

Fig.4. level simulation's of the water table of the Mio-Pliocene.

5. Optimization using the Excel Solver

The EXCEL Solver [5] is a powerful optimization tool. It uses linear programming techniques, the integer programming and nonlinear programming.

The methodology is particularly simple. This is to get the digital data of the problem and the formulas for calculating the objective function without forgetting the constraints.

When the solver finishes, whether he finds the optimal solution, or it fails to find (not possible problem or not convergence of the solution algorithm)

Finally, the solver generates demand three types of reports:

- The ratio of responses,
- The ratio of sensitivity,
- The ratio limits.

5.1. Application to the wellfield Sidi Okba

Using the following equation:

$$Q = 2\pi s(r) \log \frac{R}{r}$$

The entered data, drawdown (**s**), transmissivity (**T**) operating range (**R**), well radius (**r**), the power of the web (**e**), and the permeability (**K**).

The drawdown values were derived from data sheets drilling. The average transmissivity was arbitrarily chosen as the general characteristics of the aquifer [6]. The range is an average taken from the literature [7]. The radius [8] of the well is fixed according to the drilling reports. (Table 2)

Table 2. Data used and results obtained.

Drilling	ASE	R
Bir_Boussoudane1	7	0,02303318
Bir_Boussoudane2	8	0,02632364
Bir_Boussoudane3	40	0,13161819
H'saya	3	0,00987136
Essedda	7	0,02303318
Route de Garta F1	25	0,08226137
Route de Garta F2	26	0,08555182
Complexe islamique	2	0,00658091
		Σ = 0,38827

The comparison between the predicted and actual flow values at training and testing phases show excellent agreement with the R2 are respectively 0.932 and 0,902. Note that, data pairs closer to the 45° line represent better prediction cases. The good performance and convergence of the model are illustrated in Figure 1.

6. Conclusion

The water table of Mio-Pliocene very wooed at the Biskra region; is characterized by diversity of lithologic facies accumulation alternately permeable formations and other impermeable. The sampling rate Revenue Is the $200Mm^3.s^{-1}$

The model allows the simulation of flow in steady state and transient in a system. The simulated piezometric map shows that the flow is directed to the south (towards Chott Melghrir).

The application optimization with the Excel Solver, allowed us to optimize pumping rates, from the relationship $Q = 2 \pi T s (r) \log R / r$.

The total flow rate is obtained by the application of 388.27 l / s, which is greater than the flow rate used. This shows that the available resources are sufficient for future needs of the city of Sidi Okba.

References

[1] D.H.W : étude sur modèle mathématique de système aquifère de la région de Biskra-2008.
[2] VISUAL MODFLOW 3.1.the standard for groundwater modeling.
[3] McDonald, J. M., Harbaugh, A.W. (1988) A Modular Three-Dimensional Finite-Difference Groundwater Flow Model, Techniques of Water Ressources Investigations of the U.S. Geological Survey Book, 6, pp. 586.
[4]Bougherira ,N. & al (2014). Impact of the urban and industrial waste water on surface and groundwater in the region of Annaba (Algeria) Energy Procedia 50 (2014) 692 – 701. 1876-6102 © 2014 Elsevier Ltd.
[5] EXCEL, Guide de l'utilisateur, Microsoft, 2003.
[6] Daniel Dewolf : méthodes quantitatives appliquées à l'environnement I. Dunkerque, Septembre 2006.
[7] SHEFFI Yosef, Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods, Prentice-Hall, New Jersey, 1985.
[8] François Renard : Master Professionnel « Eaux Souterraines » Cours d'hydrogéologie Octobre 2007.