GROUNDWATER STRESS AND VULNERABILITY TO POLLUTION OF SAISS BASIN SHALLOW AQUIFER, MOROCCO

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ABSTRACT

The chronological evolution of the piezometric surface of the Saïss basin shallow aquifer is completed by observing its fluctuation at several piezometers. This evolution puts in evidence the continued decline of groundwater level. This decrease is due to the combined effects of reduced water supplies (precipitation) which has reduced the natural recharge of groundwater, and increased pumping intended primarily for irrigation. This situation generates an imbalance between the exploitation of the shallow water and its recharge. The drawdown of groundwater level has affected the flow of some sources issued from this aquifer such as the source of Ain Amer (X = 536.68, Y = 377.7) where this decline is very pronounced; from 90 l/s in 1984, a few l/s in 1997 to almost dry today. The diagnostic of the vulnerability to pollution of this shallow aquifer, according to DRASTIC method, reveals that this vulnerability is present with different degrees. The highest degree has been observed in the Northern zone of the aquifer, which corresponds to the urban area of the Fez city. This vulnerability is facilitated by the shallowness of the aquifer in this area and also by the permeability of formations hosting the studied aquifer.

Keywords: Saïss basin, shallow aquifer, piezometric fluctuations, vulnerability.

1. INTRODUCTION

The shallow aquifer Saïss Basin is located in the centre of Sebou watershed (Fig.1), and corresponds geographically to the plain of Fez - Meknes. This aquifer is bordered by the valleys of Sebou and Beht respectively from the East and the West.

The arid climate of the Saïss basin undergoes that groundwater in this area is suffering from an increasing demand both for domestic and agricultural uses. Several

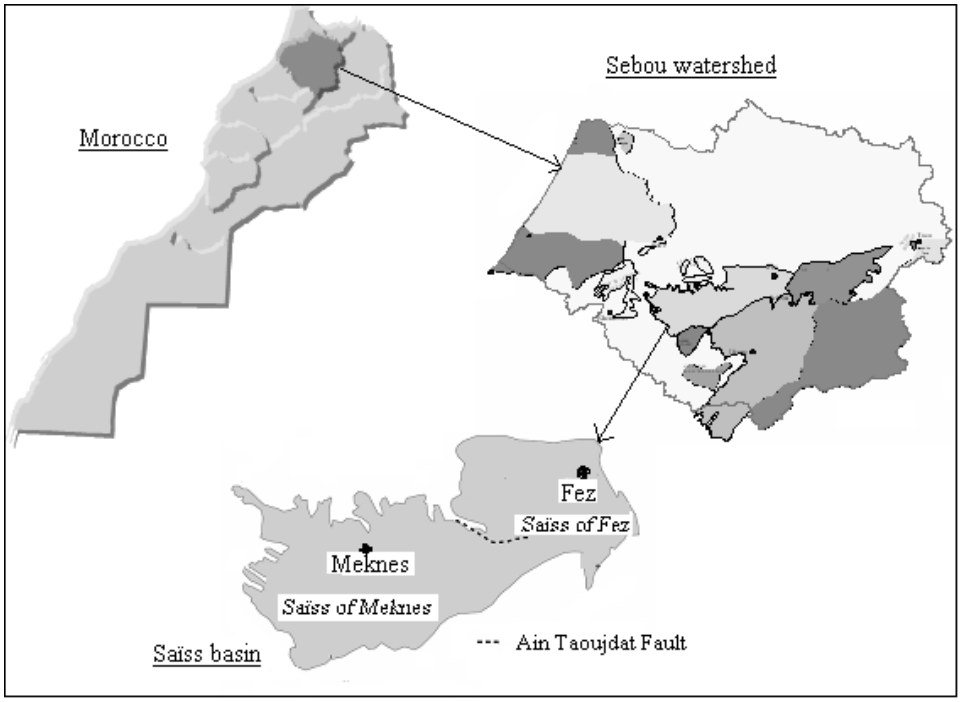

Fig. 1 Situation of the study area

previous studies have been carried on this shallow aquifer basin Saïss; Taltasse [1], Margat [2], Mac Donald et al. [3], Benaabidate [4], Sendid, [5], Amraoui [6], Benaabidate and Fryar [7] etc…

This work aims to determine the water stress in the shallow aquifer of the Saïss basin and to approach the vulnerability to pollution of this aquifer which water are in an increasing demand both for domestic and agricultural uses.

2. GEOLOGY OF THE AQUIFER

The circulation of this aquifer occurs primarily in the sands, sandstones, conglomerates and Sahelian Pliocene lacustrine limestones and locally in the travertine. Tortonian deposits of marl are the nature impermeable bedrock of the aquifer. Cuts derived from lithological columns stratigraphic drilling Plateau Meknes (Cirac [8]) (Fig.2) indicates that the Plio-Quaternary deposits show a wide variation facies of a well to another.

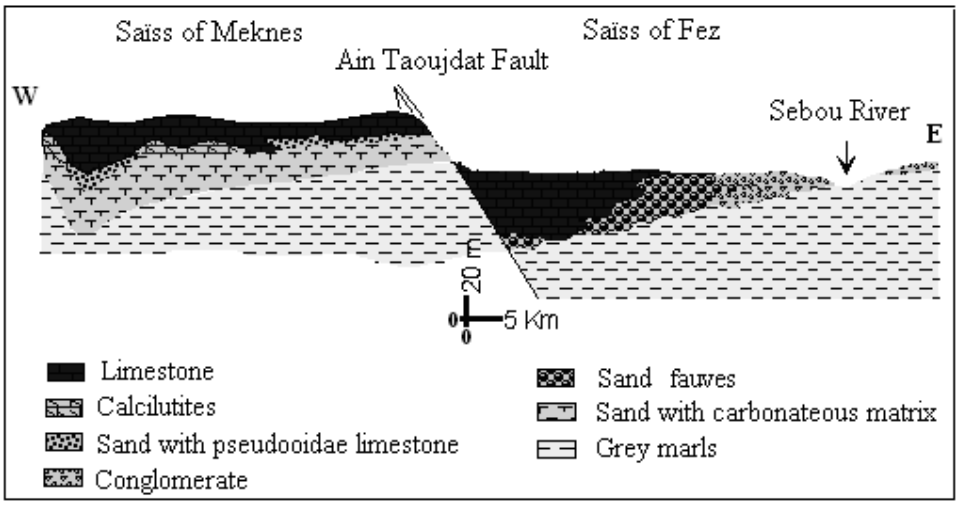

Fig. 2 Lithology of Saïss basin

3. HYDROGEOLOGY OF THE AQUIFER

3.1 Piezometric characterisation

The piezometric map (Fig. 3) of the shallow aquifer shows that the dominant flow is generally from south to north with the individualization of both flow directions. The first is South-east to north-west towards the plateau of Meknes and the second south-west to north-east. These two directions of flow are governed by the flexure of Ain Taoujdate, and are partly governed by a call for water to the north where the main irrigation schemes.

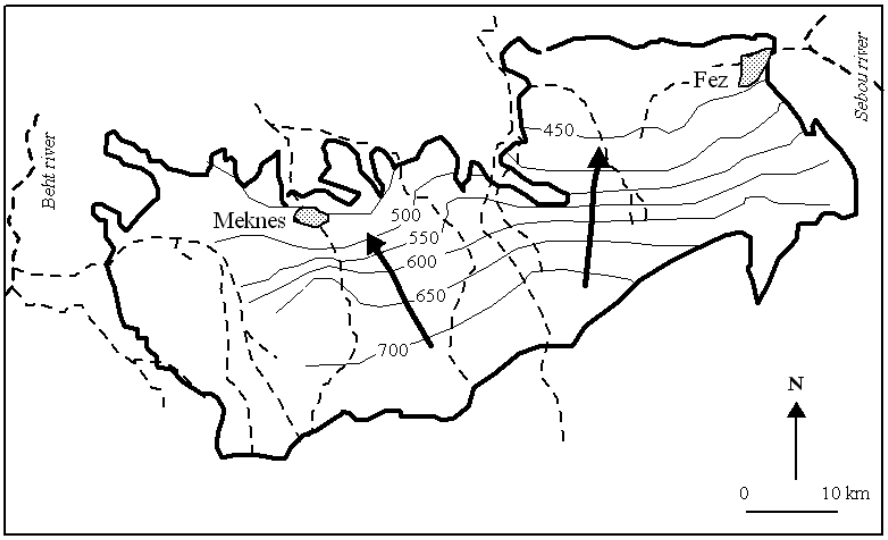

Fig. 3 Piezometric map of Saïss basin

Bordering the southern Rif Rides, water blocked northward divide eastward and westward along two axes of drainage of Oued Fez and Oued N'ja (Sendid [5]).

3.2 Piezometric fluctuations

The chronological evolution of the groundwater table Saïss is completed by observing its fluctuation at several piezometers. Fig.4 shows the monitoring of the Saïss aquifer piezometric fluctuations at two piezometers 1310/22 and 566/21 (ABHS [9]). The latter reveal an obvious manner the continued decline of groundwater level. This decrease is due to the combined effects of reduced water supplies (precipitation) which has reduced the natural recharge of groundwater, and increased pumping intended primarily for irrigation. So there is an imbalance between the exploitation of the water and its recharge.

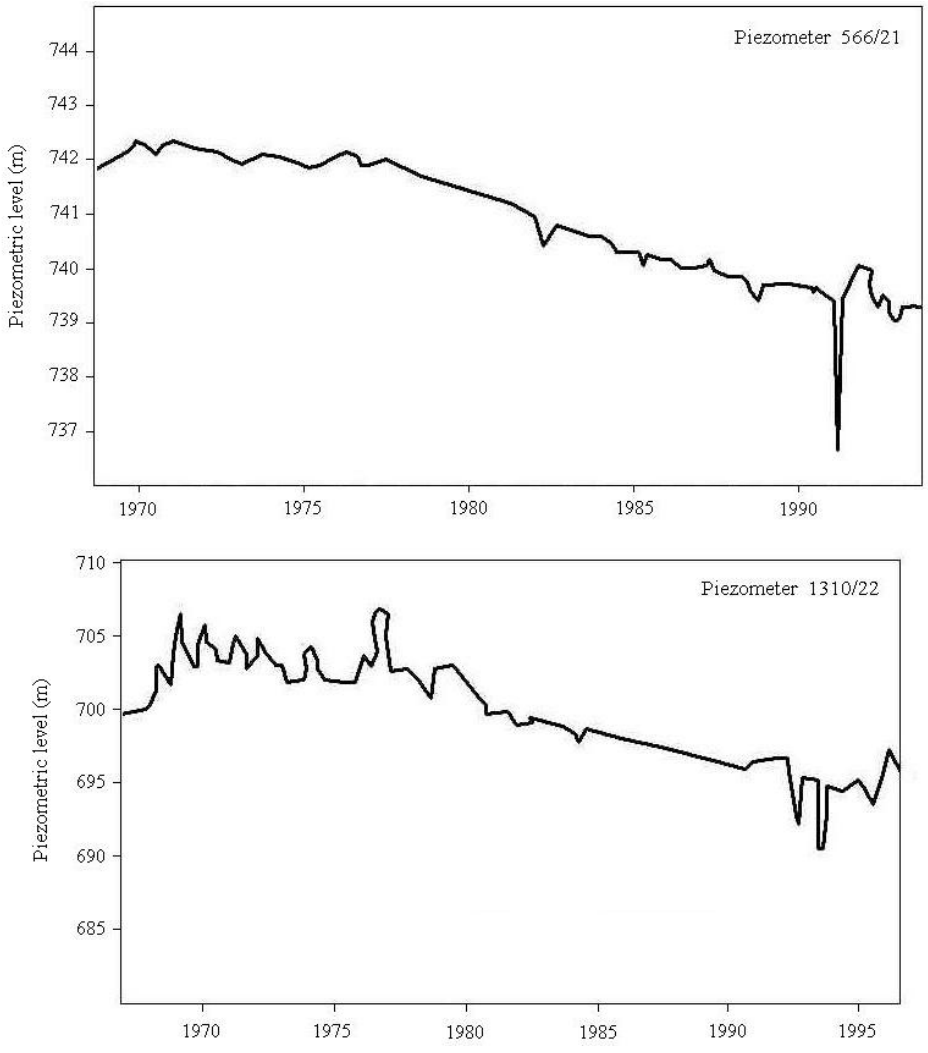

Fig. 4 Piezometric fluctuations

The drawdown of groundwater level has affected the flow of certain sources from the aquifer. Indeed, the variation rate of the source Ameir Ain (X = 536.68, Y = 377.7) is very pronounced (Fig. 5) (Benaabidate [4]). It goes from 90 l / s in 1984 to a few l / s in 1997.

Fig. 5 Evolution of Aïn Ameir flow

4. VULNERABILY OF THE AQUIFER

The assessment of the vulnerability of the shallow aquifer to potential pollution has been carried out using The DRASTIC method. This method is based on parametric systems, the common principle of these systems. One first has to select the parameters on which is based the assessment of vulnerability. Each parameter is divided into intervals of significant values and assigned a growing rating based on its importance in vulnerability.

This method is based on the following assumptions: the potential sources of contamination found at the soil surface, potential contaminants reach the aquifer by effective infiltration: the contaminant has the same mobility trend as groundwater. Due to the lack of parameters involved in this method, the study of the vulnerability to pollution will be held only in the Saïss Fez basin. This studied hydrogeological unit is larger about 40 ha.

The figure (6) shows the spatial distribution of the classes of vulnerability of Fez plain shallow aquifer. The analysis of this map put in evidence the importance of the land areas under medium vulnerability, which is identified from the fifth and the sixth class, high vulnerability is identified by the fourth and the fifth class and that localized at the level of the urban centre of Fez city. Nevertheless, it is necessary to note the presence of some zones of weak to very weak vulnerability. The totality of studied aquifer is vulnerable to pollution but with different degrees.

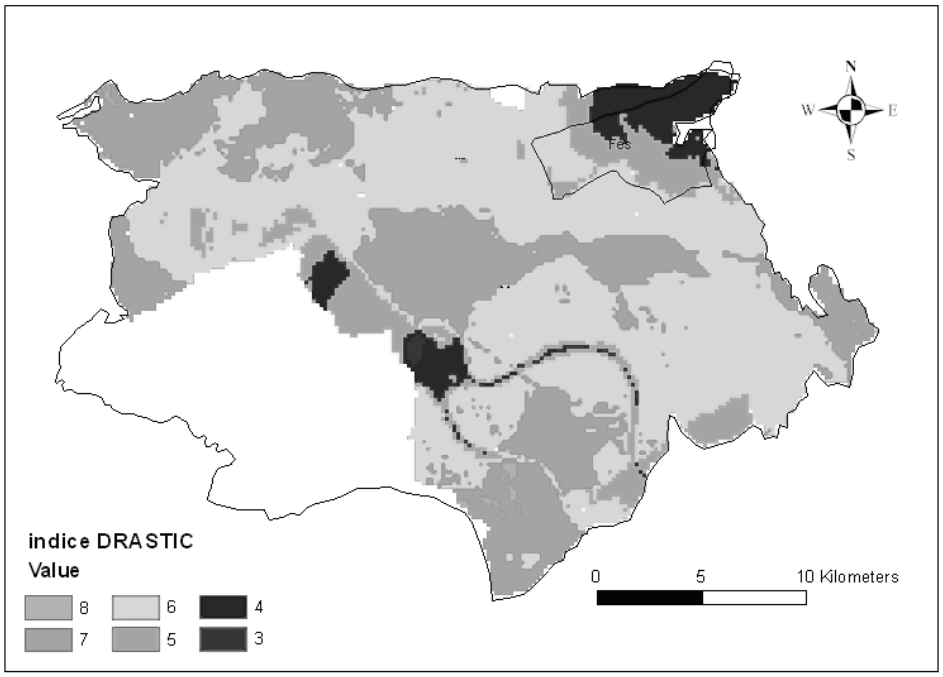

Fig. 6 Vulnerability to pollution of Saïss Fez basin

5. CONCLUSION

Changes and major features of the functioning of the aquifer over the past decades have enabled the monitoring the state of the hydraulic head during the period 1960-1998. Piezometric maps obtained show all a general flow from South to North with the individualization of two flow directions. The first is South-east to North-west towards the plateau of Meknes and the second South-west to North-east. These two directions of flow are governed by the flexure of Ain Taoujdate. The water level in the studied area is dramatically in decrease such situation is caused by the overexploitation of shallow waters mainly for irrigation purpose.

Due to its configuration, the Saïss Fez basin shallow aquifer is very vulnerable to pollution. Indeed, the surface pollutants can diffuse freely in the soil and the vadose zone to the aquifer. Rain water infiltration and vertical and seasonal fluctuations in water level can leach the unsaturated zone and generates cause the adsorbed substances. According to the lithology of the aquifer, the modes of infiltration of different pollutants are causing a variation in the degree of vulnerability.

6. REFERENCES

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