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Highlight of piezometric fluctuations of groundwater through piezometrics network in the region of biskra (Algeria)

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Abstract
The Aquifer System of the Sahara shared by Algeria, Libya and Tunisia contains huge reserves of water, characterizing by a lower renewable resources. It consists of two aquifer levels, the Continental Intercalary and the Terminal Complex. The reserves are estimated at 30.10^9 m^3 (SASS, 2003). The last thirty years have shown an increase in exploitation of these aquifers, with an annual throughput of 0.6 10^9 m^3 in 1970 to a rate of 2.5 10^9 m^3 in 2005, indicating overexploitation.
The Biskra region belongs to this group of aquifers. It has in recent years, a large hydro-agricultural development with a growing population, resulting in a considerable increase of water demand.
For the setting up of a monitoring system for exploitation of water resources in the Saharan zone, the ANRH services in collaboration with CRSTRA have established a monitoring network to monitor changes in groundwater piezometric level of Terminal Complex. This includes 23 piezometers located in different exploited aquifer system.
The piezometric mapping shows a drawdown of about 20 m in lower Eocene in the localities of Tolga and Doucen. This drawdown differs from an area to another in the Mio-Pliocene aquifer system, and it is 30 m between Ourellal and Sidi Okba and about 6 m in Zribet El Oued.

Keywords : Biskra, groundwater, piezometric map and water resources.

Introduction
In developing countries having arid climate, the role of groundwater is particularly important that they are often the only resource of drinking water and are therefore vital for the development of these countries [1].
In the northern of Algerian Sahara, the bulk of resources consist of groundwater. The latter, contained in the continental formations of Continental Intercalary (CI) and the Terminal Complex (TC) constitute one of the largest water reservoirs in the world [2, 3], where the water resources mobilization is estimated at 5 billion cubic meters [4]. In this effect and as part of a tripartite agreement signed between the ABHS, the ANRH and CRSTRA. The water resources management and soil in arid regions division of CRSTRA, takes part in work related to the achievement of quantitative and qualitative monitoring of groundwater resources in the wilaya of Biskra. Thus, piezometric measurements were realized on fifty points from 2006. The results thus obtained will be used to develop different piezometric maps, which will contribute to the understanding of hydrogeological and hydrodynamic phenomena and the evolution of different groundwater in time and space.

Material and method
In order to perform successfully the piezometric evolution, two aquifers namely, the aquifer system of Mio-pliocène and that of the lower Eocene, a monitoring network consisting by 20 piezometers was conducted. These piezometers are divised in two sites.

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The piezometers of site 1 were located in the North-east and South-east of Biskra city. These piezometers are intended to control the Mio-Pliocene aquifer system, which is exploited by a considerable number of wells. Regarding to the piezometers of site 2, it is settled in the North-west and South-west of the Biskra city. These piezometers are used to control two aquifer systems, namely the Mio-Pliocene and lower Eocene.

1. General framework of the study area:

The wilaya of Biskra is located in the South-East of Algeria. It covers an area of 21,671 km^2. It constitutes a transition zone between the Atlas Mountains areas and folded of the North (Mediterranean Algeria), and the flat expanses and desert of the Sahara septentrional in the south (Algerian Sahara), (Figure 1**)**. The flexure South atlas is through the study area and is responsible for the location of the aquifers systems. It consists of a set of under-basins aligned almost parallel North-South **[5]**.

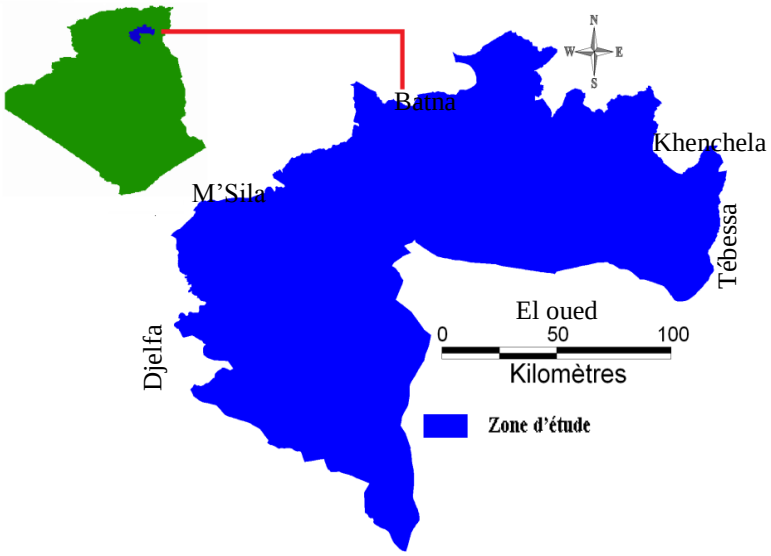

Figure 1: geographical Situation of the studied region

2. Geological framework

The region of Biskra is characterized by sedimentary rocks ranging from Barremian to the base of the Quaternary (Figure 2). In the North is a mountainous country while in the South is a country collapsed part of the Northern Sahara. The transition between these two distinct areas is through a set of flexions, folds and faults, faulted east west orientation called Saharan Flexion [6].

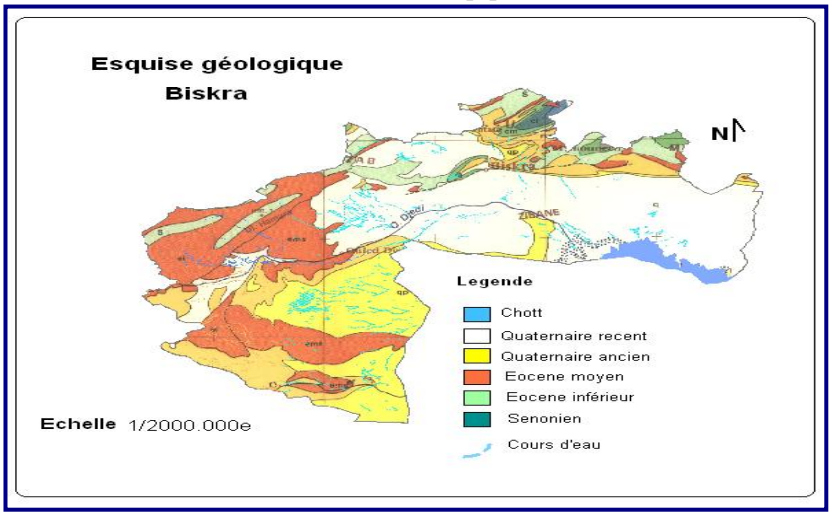

Figure 2: geological map of the studied region

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3. Hydrogeological framework

The land of the Lower Sahara ensuring groundwater infiltration and flow of water is mainly represented by sandy-sandstone formations of the Continental Intercalary, schols of marine limestones of Cenomanian-Turonian and Senonian-Eocene accumulations sandy fluvial-lacustrine Tertiary continental [7]. The region of Biskra is characterized by the existence of four main aquifer units:

- The aquifer of the Quaternary.
- The aquifer sands of the Mio-Pliocene.
- The limestone aquifer of lower Eocene and Senonian.
- The aquifer sandstones of the Intercalary Continental.

Results and discussion

1. The piezometry of the Mio-Pliocene aquifer system :

This aquifer consists essentially of an alternation of sand, gravel and clay. It is heavily exploited, particularly in the Biskra area, where a considerable number of wells are used for agriculture water consumption. The aquifer of the Mio-Pliocene has a 300 m of thickness [8].

➢ *Piezometry 2006:*

The piezometric map (Figure 3) shows a general flow direction North-west (PZ 10) to the South-east (region of Chott Melghir). We note a presence of a cone of depression in the Zeribet El Oued region (PZ2 and PZ4) probably due to overexploitation of groundwater in this location mainly for irrigation.

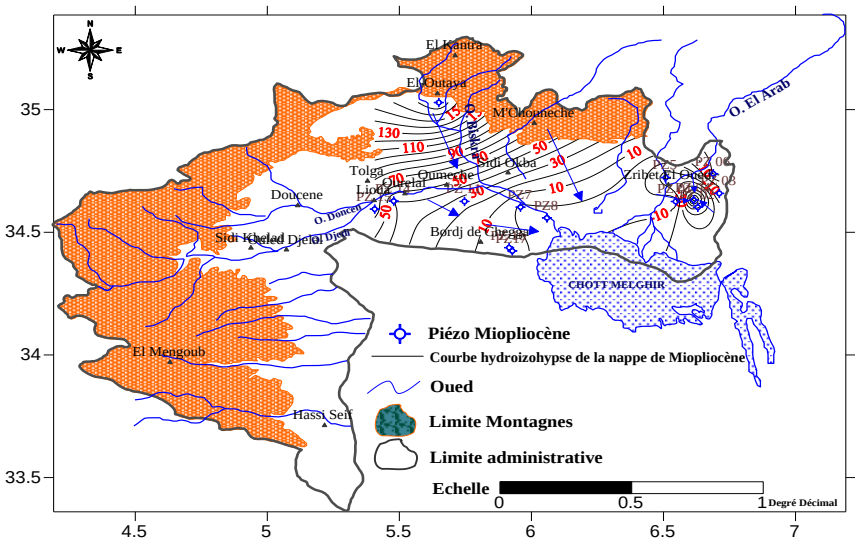

Figure 3: Piezometric map of Miopliocène aquifer system of Biskra region (2006)

➢ *Piezometry 2010:*

The same shape is observed on the piezometric map of April 2010 (Figure 4) where there is always the same flow direction is North-west to South-east.

➢ *Difference in piezometric level between 2006 and 2010*

The map shows two zones of piezometric level, the first one is in Zeribet El Oued region, which is apparently due to an overexploitation of the aquifer system. The importance of the wells in this region identified by the ANRH Biskra shows this overexploitation. For Sidi Okba-Ourelal axis, the drawdown is also important because it reaches 34m in the Ourelal region. This drawdown may explain the importance of the wells (2145 wells in Sidi Okba and 960 wells in Ourelal,(*in* ANRH). In recent decades the drought applicants may also be involved in this drawdown (Figure 5).

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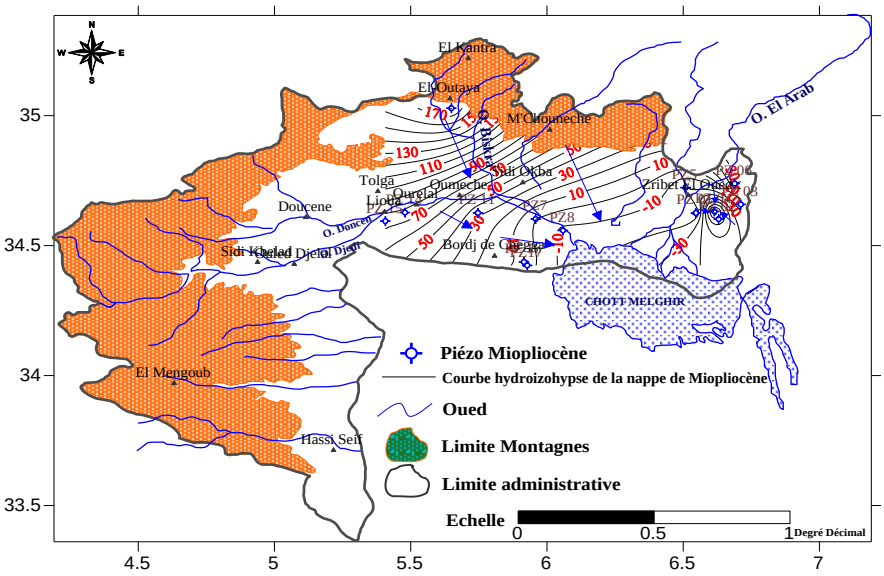

Figure 4: Piezometric map of Miopliocène aquifer system of Biskra region (2010)

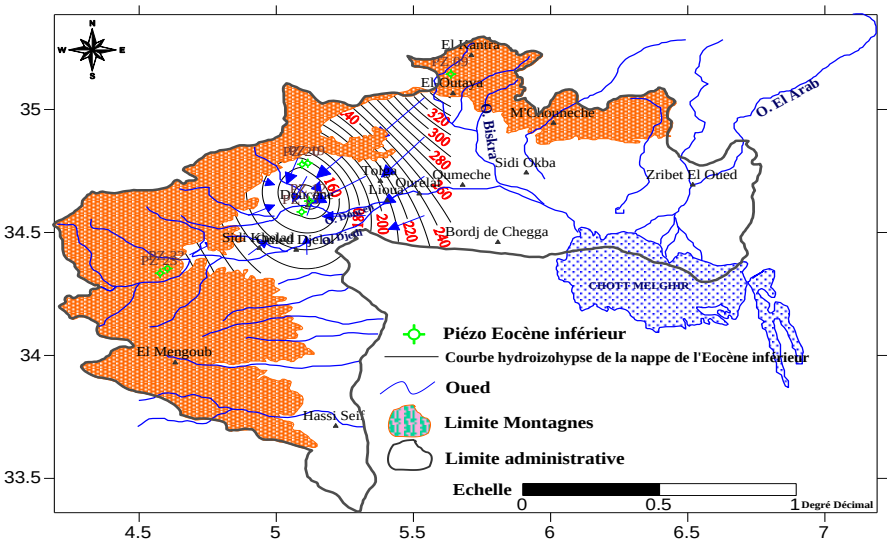

Figure 5: Difference in piezometric level map of Mio-pliocene aquifer system (between 2006 and 2010)

2. The piezometry of the lower Eocene aquifer system

The aquifer of the lower Eocene (limestone aquifer) is exploited in the North-west and South-west of the Biskra region. The monitoring of drawdown is through six piezometers which remain insufficient

➢ *Piezometry 2006:*

The map indicates the existence of a cone of depression in the Doucen region, where the flow converges to this depression; the latter is apparently due to an overexploitation of groundwater resources in this region (Figure 6). According the ANRH services, the volume exploited within three regions namely, Tolga, Ouled Djelal and Foughala is about 149.68 $Hm^3.y^{-1}$.

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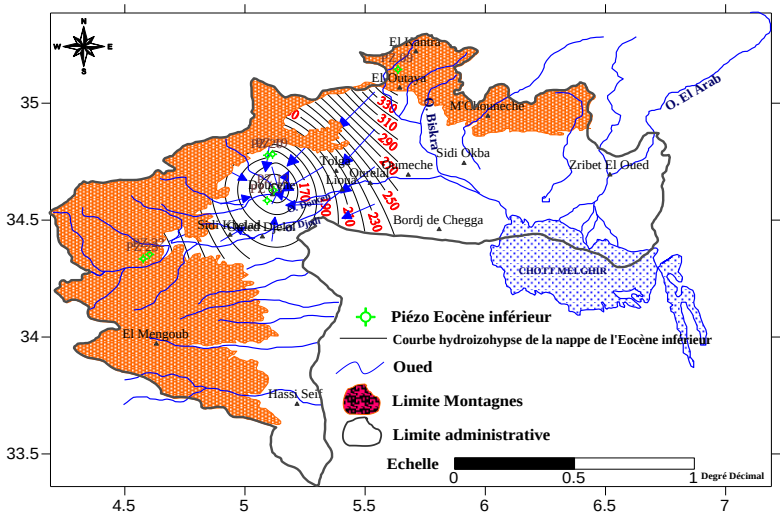

Figure 6: Piezometric map of lower Eocene aquifer system of Biskra region (2006)

➢ *Piezometry 2010 :*

We do not notice a change in the piezometric map for April 2010, where the flow continues to move towards the Doucen region (Figure 7).

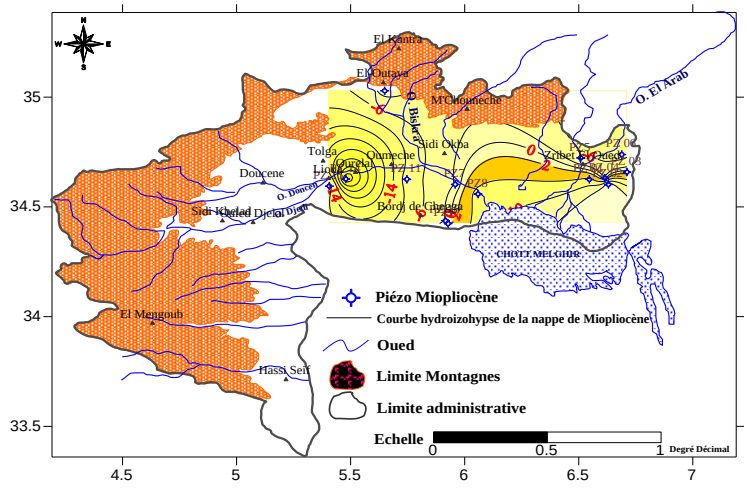

Figure 7: Piezometric map of lower Eocene aquifer system of Biskra region (2010)

➢ *Difference in piezometric level between 2006 and 2010*

The difference between the level of piezometric map , (Figure 8) shows a significant lowering towards the piezometers PZ19 and PZ20 in Chaiba area, this region is characterized by the presence of a great number of well.

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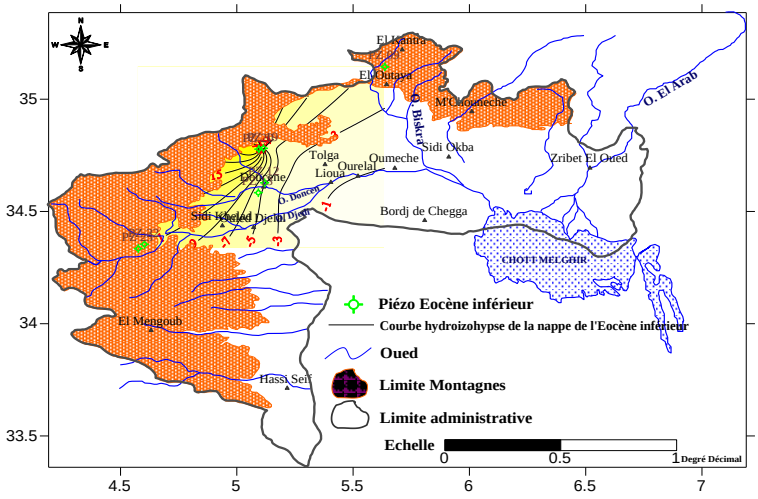

Figure 8: Difference in piezometric level map of lower Eocene aquifer system (between 2006 and 2010)

Conclusion

According to the results illustrated by the different maps above, it is worth paying attention to the drawdown, particularly in the case of the Mio-Pliocene aquifer system, especially the Ourelal region (-34m) and Zeribet El-Oued region. However, such monitoring requires a piezometer network periodic statements and long term monitoring to ensure a real awareness on this resource.

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