

Resources and Water Sharing in the Oasis of Beni Abbes (Southwest of Algeria); Oasis System in Decline

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Abstract

Water plays a major role in the Algerian Sahara; it is the main cause of sustaining life of all living in an arid environment. Farmers in Beni Abbes exploiting groundwater for irrigation and to supply the urban center of the oasis, now the size of the palm grove of Beni Abbes shrink by over 50%, that is to say from 40 hectares to 20 hectares only, the oasis suffers from several causes of degradation, which are many: the overexploitation of groundwater aquifers by the anarchical use of pumps and boreholes, salinity of water and soil after the lowering of the groundwater level, the narrowness of the land due to inheritance, the negligence of the earth by the youth due to lack of their production efficiency. The fellahs of the oasis used several traditional techniques to bring water from the groundwater aquifers to its land and dwellings, as foggaras, the pendulum wells (shadoof wells), the accumulations basins and open channels (seguias). Our objective of this work is to study the current state of the oasis and the impact of the use of modern irrigation systems on water and soil of the oasis.

Keywords: Oasis; Saoura; Beni Abbes; Foggara; Well; Shadoof

Introduction

The city of Béni Abbes is located on the edge of Oued Saoura, one of the most important oueds, both by its length and by its flow, that flow the atlas in the Algerian Sahara. Despite these surface nautical resources, farmers in the region depend entirely on groundwater resources of the tablecloth of the Grand Erg Occidental [1]. The oasis of Beni Abbes is considered the oldest among the oasis of Saoura, it has been populated since prehistoric times, as evidenced by the rock carvings of Marhoma region.

For an area of 13,170 km² with a population of 12,683 inhabitants [2], predominantly young as 44.75% of the population between 0 and 20 years. The 21-60 year olds represent 51.81% of the population and over 60 years only 3.44% [3] (Figures provided by the GTZ report: Restitution workshop and evaluation at Béni Abbes.

Beni Abbes is located in the department of Bechar in Algeria (Figure 1).

The administrative boundaries of the municipality of Beni Abbes.

- In the north by the municipality of Igli.
- In the south / east by the municipality of Kerzaz.
- To the west by the municipality of Tabelbala.
- To the east by the municipality of Tamtert.



Figure 1: Map of locating of Beni Abbes.

Materials and Methods

The climate of Beni Abbes

Beni Abbes enjoys a very rough and harsh climate. Rainfall is very rare (average 38 mm). Sometimes occasional rains cause flooding or flood of Oued Saoura. Generally, the climate of the oasis is hot in summer and cold in winter, the coldest months are December, January and February when it is between one and 18°C. During the summer months, the temperature may reach 45°C with a moisture content of about 10%.

Hydrology of Beni Abbes

Oued Saoura: This Oued, results from the junction at Igli, of Oueds Guir and Zousfana, Oued Saura formerly very active, is currently considered a watercourse that receives a negligible fluid intake, is right

the construction of the dam Djorf Torba, fed by the Oued Guir and located about 260 km upstream of Beni-Abbes.

Hydrogeology of Beni Abbes: Groundwater is the only resource of water supply to the oasis of Beni Abbes (Figure 2). At this locality, it was possible to identify four (04) interconnected aquifers of varying size. That of the great western erg is fuller, it communicates with a natural drain and the aquifers of alluvial terraces infero-flows of Saoura. The aquifer of Hamada Guir contained in lacustrine Tertiary limestones, present a modest ability. Finally, add the little-known fossil aquifers of the Palaeozoic. The batt of the great western erg provides good water and is the main nerve of the aquifer system, in which, there is an outlet for of choice, usually called the Great source of Sidi Othmane (ϕ : 33 l/s). According to a traditional division system overall throughput: 2/3 for the drinking water supply and 1/3 for irrigation of the palm grove order qualitative and quantitative [1].

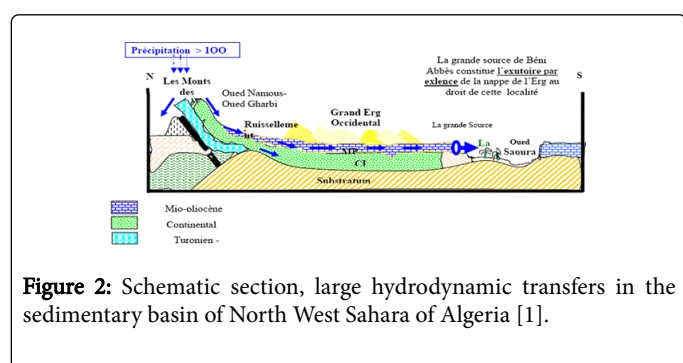


Figure 2: Schematic section, large hydrodynamic transfers in the sedimentary basin of North West Sahara of Algeria [1].

Sources and apportionment of water in Beni Abbes

As we have seen above, the water in Beni Abbes comes mainly from the issue of the source of fossil aquifer of the great Western erg, the source of Sidi Othmane. This water is apportioned: 1/3 for irrigation, 2/3 for the agglomeration of the water supply network (AEP network) [1]. The schematic below shows the general distribution of water from the source. The distribution of the city's water is also thanks to two large boreholes located on the plateau and drawing water in the fossil water aquifer. Irrigation, for its part is done with water from the Sidi Othmane source (Figure 3) and partly through small boreholes located in the gardens. The water then comes from surface groundwater (about 12 m deep) which is supplied by flood of Saoura and rare rains [2].

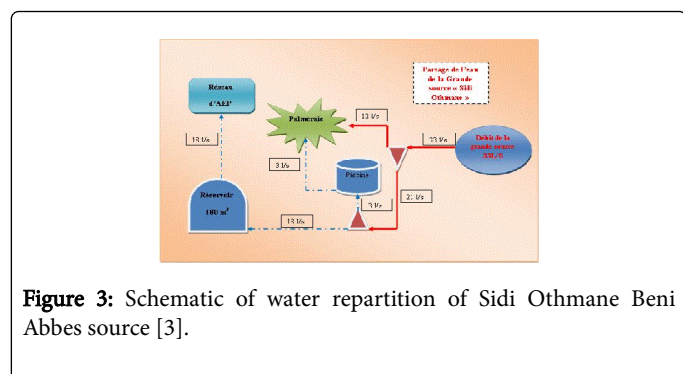


Figure 3: Schematic of water repartition of Sidi Othmane Beni Abbes source [3].

The salinity of underground water problem caused by several human and natural factors, resulting in serious problems of irrigation. A good knowledge of the aquifer system of operation preserves the potential of water resources, their quality, their evolution, in particular

to the risks of salinity, and recommend adapted management methods [4].

Results and Discussion

Irrigation water

During the centuries, farmers in Beni Abbes were implemented a technique effective and sustainable irrigation, which allowed people to live in conditions of extreme aridity while respecting the special properties of these unstable ecosystems. A portion of the irrigation water goes through the pool is then fed to the palm grove. The rest goes directly into the irrigation system of the palm grove. The distribution of water for irrigation is done in Beni-Abbes time. Every part of the palm grove is fed with water every fifteen minutes. This distribution is done, thanks to a relatively sophisticated system of galleries and feeds almost all the palm grove (Foggara Source) [5]. But the most part in the west, that is to say, the further removed from the source, is not fed by water from the Sidi Othmane source. There are near Beni Abbes many traditional foggaras which the water used for irrigation, the ray extends for 16 kilometers north of the palm grove 4 km south of the oasis.

The number of foggaras in the oasis of Beni Abbes

Number of Foggaras=20 foggaras at the central palm groves (14 died because of the collapse, lack of maintenance and depletion of the tablecloth). For all the agricultural perimeter in Beni Abbes about 65 Foggaras (Table 1).

| Parameter | Unit | Value |
|-----------------|----------------|--------|
| Number Systems | | 65 |
| Number of lines | | 84 |
| total length | m | 11585 |
| Average length | m | 138 |
| Maximum length | m | 1569 |
| Average flow | l/s | 0.18 |
| Maximum flow | l/s | 0.93 |
| Total flow | l/s | 4.03 |
| Average area | m ² | 7151 |
| Maximum area | m ² | 51000 |
| Total area | m ² | 400435 |

Table 1: Summary of an inventory of foggaras located near the oasis of Beni Abbes [3].

The source of Sidi Othmane is no longer the only source of water in the oasis, particularly for irrigation. Many wells and boreholes are multiplying in the gardens (Nbr of wells=47 wells in the central palm groves, for all the agricultural perimeters in Beni Abbes about 118 wells) [5]. The water is 3-12 meters deep about. It is less sweet than water from Sidi Othmane (which comes from the fossil tablecloth of the great erg). It is the water from the shallow aquifer flood of Saoura, rain infiltration.

Operating traditional irrigation

The sharing of the amount reserves to the palm grove, based on water rights of the owners from the source of a total of 41 Nuba for all palm groves (the unit of measurement is 1 Tighira=15 minutes, 1 man=9 Tighira=2 hours 15 minutes, Nouba=12 man), with the tower periodic water today the share of the water will be every five days of a

right to water calculated by all farmers, a volume of 1,036.8 m³/day for an initial area 40 hectares. The water from the great source is distributed according to a conventional system that farmers understand perfectly. The distribution of irrigation water is therefore in a spirit of well-preserved heritage and often confrontational (Table 2).

| Family name | Current situation: right to water by time | Proposition: right to water in quantity processed | | |
|-------------|---|---|--|--|
| | | hours /20 days | percentage of 40 Nouba | M ³ /20 jours |
| Family 1 | 2 mans | 4.5 | Acheck with theofficial listoftheDaira | 129.6 |
| Family 2 | 2.5 mans | 5.6 | Acheck withthe listofDaira | 161.3 |
| Family 3 | 1 Nouba | 12 | Acheck withthe listofDaira | 345.6 |
| Family 4 | 7 Tighira | 1.75 | Acheck withthe listofDaira | 50.4 |
| Family 5 | 1 mans+5 Tighira | 3.5 | Acheck withthe listofDaira | 100.8 |
| | | | | |
| | | | | |
| Total | 40 Nouba 40 x 12 hours=480 hours or 20 days of Water Tower | | 480 hours=100% | 480 hours=13824 m ³ *13824 m ³ of water/20 days |

Table 2: Traditional distribution of waters of foggara of the Beni Abbes [5].

The distribution of water storage basin (Majen)

There is often a storage reservoir to store water for the foggara during the night and redistribute the day.As we have seen the amount of water available to each beneficiary is usually calculated in time; for the water of basin this time is converted to water level in the basin.

Traditional wells

The traditional well is a capture device carried in the palm grove. Their depth varies from 5 m to 10 m, with a circular section of a diameter of 02 m². They are manually drilled and strengthened with concrete nozzles, prefabricated or masonry. Their debit ranges from 0.5 l/s to 4.5 l/s. More than 47 wells there are (in the central grove) almost to his each plot we note the presence of at least one well except for plots that are close to the pool (these wells was broadcast especially after flow lowering foggaras). The wells are equipped systematically

motor pump or electric pumps and they exploit the waters of the terraces and inféro-flow [6].

Modern irrigation system

The multiplication of boreholes in Beni Abbes, increasingly deep, depletes groundwater. The Irrigators communities lose hands on the water management. The environmental heritage, main wealth of productive activities in the oasis of Beni Abbes, already weakened by the effects of the recurring periods of drought and submitted to the arid climate and these operating modes irrational [7]. In addition to the Dam Djorf torba, use of the pump has aggravated the state of groundwater from the oasis of Beni Abbes. Boreholes (Table 3) have generated a rapid increase in flow rates levied on fossil water resources and very little renewable Saharan basement.

| Municipality | Place Known | Number | Designation | Type |
|--------------|--------------------|--------|---|----------|
| Béni Abbes | Zeghamra | 06 | Amrouni M'barek, Rahmouni Mohamed | Well |
| Béni Abbes | Ougarta | 03 | BTHS (ksauib), BTHS, Yousfi Mohamed elmizane | Well |
| Béni Abbes | Central palm Grove | 47 | Berhou, Bouanini mokhtar, Merzougui, Ben aissa, Najib-1, Nabil-2, Chadli, Cherif Bani ahmed | Well |
| Béni Abbes | Zeghamra | 14 | Zeghamra 4, Zegharma F ₁ , Zegharma 2, Zeghamra 4, F4, BERKA (F ₂) | Borehole |
| Béni Abbes | Ougarta | 09 | Azougakh, Kheneg Télaia (F ₁), Le forage BERKA (F ₂), Le forage de reconnaissance Ougarta F ₃ , Rahmouni Mohamed | Borehole |

| | | | | |
|------------|-------------------------------|----|---|----------|
| Béni Abbes | Béni Abbes+Central palm Grove | 15 | Marhouma 1, Marhouma 2, Marhouma 3, Forage Apc Beni Abbes, Apc Béni Abbés, Forage 1 | Borehole |
|------------|-------------------------------|----|---|----------|

Table 3: Shows the number of wells and boreholes in Beni Abbes.

Phenomenon of groundwater salinity

The salinity problem of groundwater from the oasis of Beni Abbes is caused by several human and natural factors, resulting in serious problems of irrigation. The hydro-chemical analyzes show a spatiotemporal evolution of the alarming salinity: the drying up of aquifers Saoura due, of the one part the impact of the construction of the dam Djorf torba, exploitation of groundwater by pumps with the uncontrolled proliferation of wells, and also to the strong evaporation prevailing, have seriously affected the quality of groundwater [6]. These factors lead to a dramatic acceleration of this destructive phenomenon of the whole oasis system of this region. For a better understanding, we compare the results of analyzes carried out at different times, for some tablecloths in Beni Abbes (Figure 4).

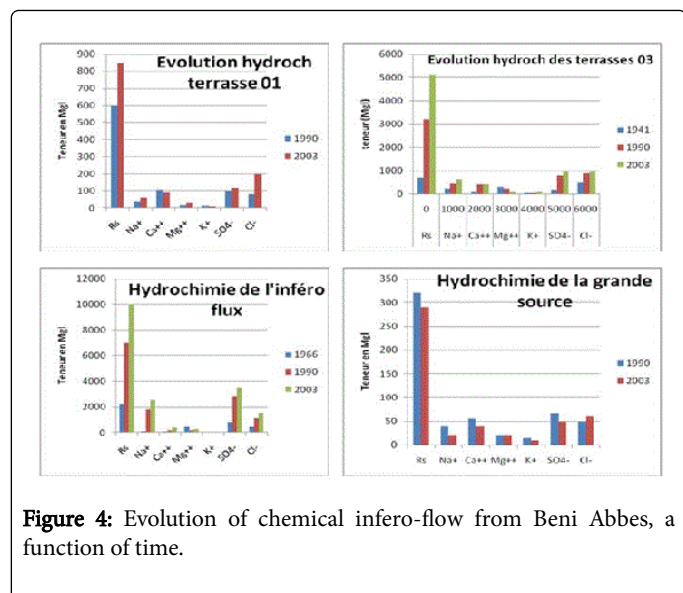


Figure 4: Evolution of chemical infero-flow from Beni Abbes, a function of time.

Conclusion

Groundwater is the only resource of water supply to the oasis of Beni Abbes. A good knowledge of the aquifer system of operation preserves the potential of water resources, their quality, their evolution, in particular to the risks of salinity, and recommend appropriate management methods. To overcome the threat of salinity, we suggest:

A perimeter protection between the Great Western Erg and the palm grove, so that the waters of the great western erg, ensures the natural role of the drain.

- If the capacity of Djorf Torba dam permit, dropped water synchronized with the flood of Zouzfana will be highly recommended.
- Recycling of treated wastewater and reuse in irrigation of the palm grove that has a plausible alternative.
- Subsurface dam construction feasibility study perpendicular flow direction towards the Oued of Erg.

For the preservation of groundwater resources of the oasis of Beni Abbes. It is recommended to be based on a strategy based on an overall consideration which includes the axes:

- Reserve water of the groundwater of the great western erg for noble uses. Implementation of a policy incentive to save water and promote techniques and of water saving attitudes.

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