

Case of the Algerian Oasis after its Invasion by Modern Irrigation Techniques; Example of the Oasis of Beni Ounif in Southwest Algeria

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Abstract

The oasis of Beni Ounif depends on water to ensure its sustainability, like all the Algerian oases which suffer from overconsumption of this precious element in a desert of more than two million kilometers. Because it is the most important factor in preserving the lives of all who live in this arid environment. Beni Ounif farmers use groundwater for irrigation and supplying the urban center of the city, and now the palm trees have been reduced by more than 50%. The oasis suffers from several reasons for deterioration, including: the excessive exploitation of groundwater by the chaotic use of pumps and the random sinking of wells, the salinity of the water and the soil after the drop in the level of the water table groundwater and the drop in the water level of Oued Saoura. Decreasing land area due to inheritance and neglect of land by young people.

Oasis farmers have used many traditional techniques to bring water from aquifers to their lands and homes, such as foggaras, outrigger wells (chodouf wells), collection basins and open channels (seguias). Our objective in this work is to study the current state of the oasis and the effect of the use of modern irrigation systems on the water and soil of the oasis.

Keywords: Oasis; Beni Ounif; Eater, Foggara; Tradition; Well

Introduction

The oasis of Béni Ounif is totally dependent on groundwater, it is a good example to discuss the impact of urbanization and irrational modernity on the traditional oasis. In fact, since the oasis inhabitants rely entirely on their agriculture on the exploitation of groundwater, the real important sources of water in Béni Ounif are those called artesian. These water sources are exploited by a technique called "foggara", they are kinds of conduits for the flow of water or more simply drains. The commune of Béni Ounif is located 111 km northeast of the wilaya of Bechar. It covers 16,600 km², the population is 15,707 inhabitants. The exploitation of artesian sources which allowed the development of oasis agriculture. The choice to increase the exploitation of very low-renewable underground resources was made despite the risks associated with increased costs and increased salinity. The oasis of Béni Ounif is a garden of palm trees, of very diverse varieties, concentrated around an artesian source (ain) [waters that emerge from the earth without human intervention]. Groundwater is the only water supply resource for the Béni Ounif oasis [1].

The Impact of the Oasis Site on the Population and Their Activities

Until the beginning of the 20th century, the oasis inhabitants of Béni Ounif adopted in their economy on agriculture, trade and crafts, taking into account the strategic location of the oasis as a crossroads of major roads and later the construction of the Oran-Béchar railway line, with the construction of a station at Béni Ounif in 1903, which contributed to the stability and prosperity of the oasis. The propagation of traditional buildings makes it possible to understand it. The strategic location of the oasis had a considerable impact on all of their inhabitants, proof of this is the large number of tribes who settled in the oasis that are not found elsewhere in the Saoura region.

Hydrology of the Oasis

Surface water

The hydrographic network consists of wadis with intermittent flow, which are mostly dry except in autumn and winter, during which they evacuate flood water. The main vein of the water table of the oasis of Béni Ounif, it is the Zouzfana wadi, which is the great collector of a vast mountainous region originates in the Saharan Atlas where the rainfall is still sufficient, whose waters come to meet in the region of Figuig-Béni Ounif. It then sinks into the Sahara to Igli, where it merges with wadi Guir to form wadi Saoura. In addition to the wadis: wadi Nemous, wadi Melias and wadi Sidi Abdelkader.

The Groundwater of Beni Ounif

Groundwater is the main hydrological resource of the oasis. Generally, the boreholes and the main works capture the Albian aquifer (lower Cretaceous), these are sandstones, of excellent quality, the Zouzfana wadi infero-flux aquifer, which is at the origin artesian springs and water from traditional wells.

The Agricultural Land of the Oasis

The Béni Ounif palm grove covering an area of 31 hectares, it represents an exceptional interaction of man and his hostile environment, supplied with water from a source through foggaras and wells dug in the infero - flow of 'wadi Zouzfana. However, this palm grove lost more than 50% of its surface by several human and natural factors, becomes more and more threatening: the disease of "bayoud", socio - economic transformations, the salinity of the groundwater, the reckless propagation of the use of pumps inside and around the oasis and urban expansion to the detriment of the oasis have contributed to this deterioration of the palm grove.

The oasis of Béni Ounif is marked by an extreme limit of the land and consequently an excessive smallness, this is due to the demographic concentration on a small perimeter and to the inheritance; more than 80% of the agricultural area is divided into farms of

0 ha to 0.5 ha (plots shared between children and becoming too small). While large farms (category of 2 ha to 5 ha and more than 5 ha) are mainly found outside the oasis (new investments). Intensive three-storey crops are practiced in this oasis: date palm, then fruit trees (fig, pomegranate, vines) below, finally annual and seasonal crops: cereals (barley, wheat), vegetables and alfalfa. This high-yield, safe gardening-type micro-plot production system is aimed at the self-consumption of the population.

The agricultural land of the oasis is weakened by several factors: water scarcity, labor problem and neglect of working the land due to the departure of young people, degradation of the palm grove due to urbanization and bayoud disease. The reorientation towards the exploitation of new agricultural extensions outside the oasis leads to disastrous negative consequences for the traditional oasis, the most important being the marginalization of the small farmers who work inside the oasis.

The fragmentation of the Land

The population is increasing rapidly in the region and the oases are subject to fragmentation and sprawl of inhabited areas. According to Islamic law, family property is distributed equitably among all sons. Over the centuries, this has resulted in a very strong atomization of plots and water rights. It is the origin of many problems, the most important of which is neglect of the soil and the share of water due to the low yield of soil and palm trees.

The Béni Ounif palm grove is generally formed by "jnan or garden" plots (it is said above that more than 80% of the agricultural area is divided into farms of 0 ha to 0.5 ha). These groves are surrounded by walls approximately 2 m high and served by accesses 2 m wide. The importance of oasis agriculture for the inhabitants of Béni Ounif has disappeared due to the decrease in their profitability, and the adoption of families to buy their food products outside, abandoning the products of agriculture.

The palm Grove in Decline

The Béni Ounif palm grove also presents aspects of degradation, but in a much larger proportion, most of the land being abandoned following the decrease in flow from the main source. For digging wells, water is available at depths of more than 20 m, but this water must be used intelligently [2].

Natural artesianism was disrupted in 1980 in Béni Ounif, by drilling which continued to multiply. The islets begin to disappear, the boreholes causing the drying up of the water table. To last, the oasis must defend itself permanently against the lack of water {rehabilitation project of the old irrigation system (Foggara) by the DRE "direction of water resources" of Béchar (2008) and the rehabilitation seguias (open sky canals). These projects, which were known to have many problems and are not yet functioning perfectly due to the absence of an effective management system, and more generally, due to insufficient experience (lack of qualified workers and preparation time). The growth of the urban population is here at the origin of a sharp increase in water needs. This increase is now leading to a drop in the level of the water table, to the limit of overexploitation.

Groundwater was exploited in the oasis, by means of hand-dug spring foggaras (underground canals collecting water from the water tables) and wells. Traditional wells (generally 1 to 2 m in diameter, reinforced with concrete nozzles) were only used to provide water to the herds and to supply the populations with water for drinking and domestic use. Today, we observe a limitation in the use of wells only for irrigation of palm trees due to the increase in salinity [1].

The oasis of Béni Ounif suffered from the destruction of the traditional underground (foggara) and open-air (segua) pipe system due to violent floods (as in the case of the October 2008 flood) and neglect, as well that the anarchic implantation of pumps.

Water Sources of the Oasis

The Béni Ounif oasis had significant hydraulic potential, despite the climatic constraints of the environment. For centuries, water needs were mainly met by the exploitation of groundwater [2].

According to all the respondents, the source flow (the initial flow is 30 l / s) of the central palm grove has decreased for 20 years during a period of drought (the flow measured in March 2008 is 10 l / s) because of the lack of maintenance and the overexploitation of the water table (Figure 1).



Figure 1: Source of water supply for the foggaras of Béni Ounif (2008)

Water Management in Béni Ounif in the Past

Traditionally, the Béni Ounif oasis was irrigated by a gravity network fed by a source and rarely by resurgences of oued Zouzfana (figure VI.2). Before arriving at the palm grove, the spring water crosses the ksar to supply two channels (seguias) in parallel, one for men "Ifli Nergazen" and the other for women "Ifli Netsdnan". Then the water from the source was conducted by an underground network of foggaras to irrigate the palm grove, with a continuously discharged flow rate of around 10 l / s (2008 gauging), presents 1/3 of the quantity spilled during the eighties. Each foggara feeds an accumulation basin which supplies water to a system of succession of seguias (concrete and non-concrete canals) by simple gravity depending on the topography of the land. Within the palm grove, each tribe and family has its own seguia network which conveys their share of water to its land, this system does not need energy to convey water to its destination, it is considered a positive point for this technique. The spring has now dried up, and today only vestiges of the water circulation and irrigation networks remain, destroyed by flooding and unused for decades. Their rehabilitation is too expensive and unwanted by the inhabitants, it was carried out by the DRE of Béchar in 2008.



Figure 2: A footbridge over a foggara in Béni Ounif (2008)

Foggaras of Béni Ounif

The Béni Ounif irrigation system has foggaras supplied with water to the palm grove, these foggaras are supplied by a single source which provides irrigation. Their flow varies greatly depending on the season and rainfall. Each of the foggaras (today, at Béni Ounif, there are 02 foggaras rehabilitated by the Béchar DRE) ends in an accumulation basin from which the main seguias depart.

At the entrance to the basin, the water is shared by a gravity network (segua or mesref) in units of measurement (called kharrouba) which correspond to 45 minutes of source flow. The basin must accumulate water to regulate its flow, rationalize and control the irrigation cycle (this varies from 3 days in summer to 15 days in winter). The second channel carries water from the outlet of the basin to the entrance to the plots, it branches out as many times as necessary to serve all the gardens. This centuries-old irrigation system brings water from the water table to the surface. Little is known about the exact roles that the foggaras play in the irrigation inside the oasis. Most palm trees today survive only on well irrigation.



Figure 3: The outlet at the exit of the Béni Ounif foggara (2008)

Rehabilitation of Foggaras

The hydraulic department of the wilaya of Béchar launched a program targeting the maintenance, cleaning and rehabilitation of foggaras in the oases of Béni Abbès and Béni Ounif, and the concreting of the earthen seguias that remain in the oases (more than 800 ml for the canals of two foggaras in Béni Ounif, and more than 1200 ml of seguias were rehabilitated in 2008 according to the hydro-agricultural service of the Béchar water department).



Figure 4: The rehabilitation works of the foggaras of Béni Ounif (2008)

The hydraulic department in collaboration with the local authorities is using all means to improve the efforts made for the restoration and rehabilitation of this ancestral irrigation system, fought against drought, and increased needs. Through the rehabilitation of the main seguias and the underground network with the concreting of the draining galleries of the spring water, the cleaning of the secondary seguias which gush out the water towards the plots of the irrigators. After this maintenance and cleaning, the authorities never interfered in the process of distribution and management of water in foggara, there still remains the customary role of local jmaa of the peasants.

Seguia (Souagui for Several)

The role of irrigation canals in the sustainable development of territories is particularly acute in the southern Mediterranean countries, in particular for phœniciculture developed in oases [3].

The seguia is the means used to distribute water as soon as it comes out of the foggara or well, it is artificial, therefore built by man.



Figure 5: Rehabilitation of the seguias of the Béni Ounif oasis (2008)

In our oasis, like all the oases in the region, the seguias are almost all concreted, which were replaced by the non-concreted seguias (dug in the earth). The two ways of doing things each have consequences, as positive as they are negative. Indeed, the concrete seguia conducts the water to the target point, practically without any loss of water, and saves the time of Kharrouba, while the non-concrete seguia allows the dispersion of a certain quantity of water towards the water. outside, so the owner will see that the

quantity he requested to decrease.

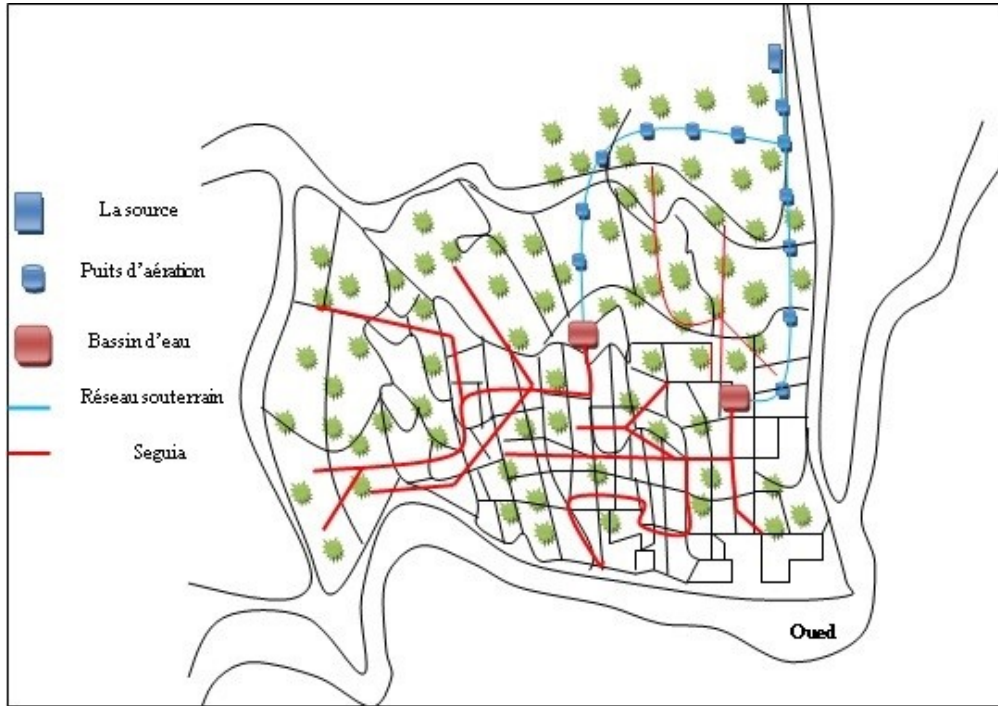


Figure 6: Map of the underground and surface water networks of the Béni Ounif oasis (Rezzoug, 2014)

Kharrouba

Constitutes the simplest part of water, the time of each kharrouba is 45 min. The Kharrouba instrument: is a so-called hydraulic watch which is used to measure the water flow time to manage the parts. This instrument is in the form of a half-spherical copper vessel that has a small hole in the bottom. To start the measurement, we place the container on a surface of water, gradually it begins to fill up through the hole until it flows, and therefore, the end of the part and the beginning of another.

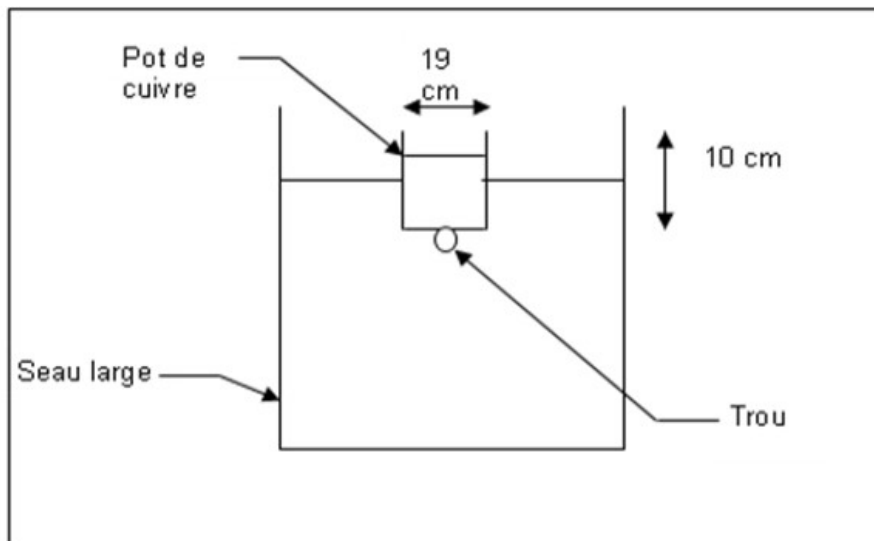


Figure 7: Kharrouba or Kial

Today to manage the water of the foggaras, the owners use other water management methods; it is the storage of water in basins to ensure the management control of the water shares by the person and not at the Kharrouba.

Wells

The wells constitute an individual adduction system, of relatively recent appearance in the oasis. They exploit the cold and strongly salty waters of a surface water table. Most of the wells are drilled about thirty meters deep and they are all equipped with pumps that run on electricity or diesel.

Abandonment of the Palm Grove

Currently, in the oasis of Béni Ounif and due to urbanization, the number of uncultivated plots continues to increase. Only a few operations persist thanks to pumping. Palm trees are no longer maintained with high mortality and dieback is on the increase.

Among the causes of the abandonment of the oasis is the degradation of the palm grove due to several factors such as:

- Population growth and increased urbanization.
- The destruction and containment of the foggaras only two were rehabilitated.
- Overexploitation of the water table through the use of modern irrigation systems.
- Lack of qualified maintenance labor.
- The abandonment of the agricultural vocation of the palm grove has favored its decline (disappearance of the oasis system: 50% of the oasis).

The Use of pumping in the Oasis of Béni Ounif

Nowadays, traditional techniques are experiencing management and maintenance difficulties due to their obsolescence and problems of desertification, disruptions caused by modern hydro-agricultural policy. At present, the intensive pumping of the water table will reinforce the effects of climate change and reduce resources, endangering the palm trees, their production is very low in quantity and quality. The disappearance of the date palm, unavoidable if major action is not taken, would have irreversible consequences on the system.

Table 1: Indicates the number of wells and boreholes in the Béni Ounif oasis (DRE de Béchar, 2018)

Commune	Place	Designation	Type	Nbr
Béni Ounif	Béni-Ounif	Béni-Ounif B.O.F2, Fendi, Benzireg F3, Benzireg F4, Benzireg F5, Benzireg F6, Béni Ounif F(1,2,3,4,5,6) Apc Béni Ounif, Kadouri, Motrani, Mebarki, Hassani, Mejdoubi1, Mejdoubi2, Béni Ounif F(2,3,4,5,6),	borehole	25
Béni Ounif	Oued-Namous	Guern Zaia, Nouidrate	borehole	02
Béni Ounif	Rosfa-Taiba	Rosfa-Taiba1, Rosfa Taiba, Rosfa Taiba II	borehole	03
Béni Ounif	Benzireg 3	Benzireg F4 Benzireg F5 Benzireg F6	borehole	03
Béni Ounif	Oued Namous	Boussir (Oued Namous) Puits N°1 Boussir (Oued Namous) F1 Boussir (Oued Namous) Sondage	Well	04

Béni Ounif	Béni Ounif	Hassi L'hmara, Mimouni, Oulad Hassan, Sadouki, Mokhtari, Mejdoubi, Lefdil, Oglat Hadj Med, Mongar Chtitiba P3, Dahbi Messab,	Well	35
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Today, the pumping is used in the new extension plots, which are outside the perimeter of the traditional oasis. These lands are irrigated by the technique of drip or sprinkling by exploiting the water table by boreholes, and are exclusively planted with palm trees and olive trees, this is a system introduced by new farmers (generally, they do not have an experience on agriculture) very different from that of gardens.

Salinization in the Oasis

The salinization process observed in Béni Ounif results from the fact that the plots are no longer irrigated regularly after being abandoned. As the salts are no longer leached, they accumulate on the surface. After a few years, the surface of the plot is covered with a powder, "white flour", composed of sodium sulphate. Under the influence of sodium salts, the surface layers of the soil suffer from a process of alkalization and sodization, resulting in the destructuring of the soil (hence the "gray ash" which appears after destructuring). Salinity is a consequence and not a cause of land abandonment and this phenomenon is reversible.



Figure 8: Salinization problem in the oasis of Béni Ounif (2014)

Chemical Evolution of Foggaras Water

For this oasis, we used data from two campaigns, the first carried out in 1996 and the second carried out before the rehabilitation of the foggaras in 2008.

In this study, we made a comparison between the old analyzes carried out in 1996 and the results of 2008, in order to see the evolution of the chemical composition of the waters of the Béni Ounif water table.

The analyzes of the samples for 2008 were carried out by the ANRH in Béchar. For 1996, the analysis results are taken from old inventories.

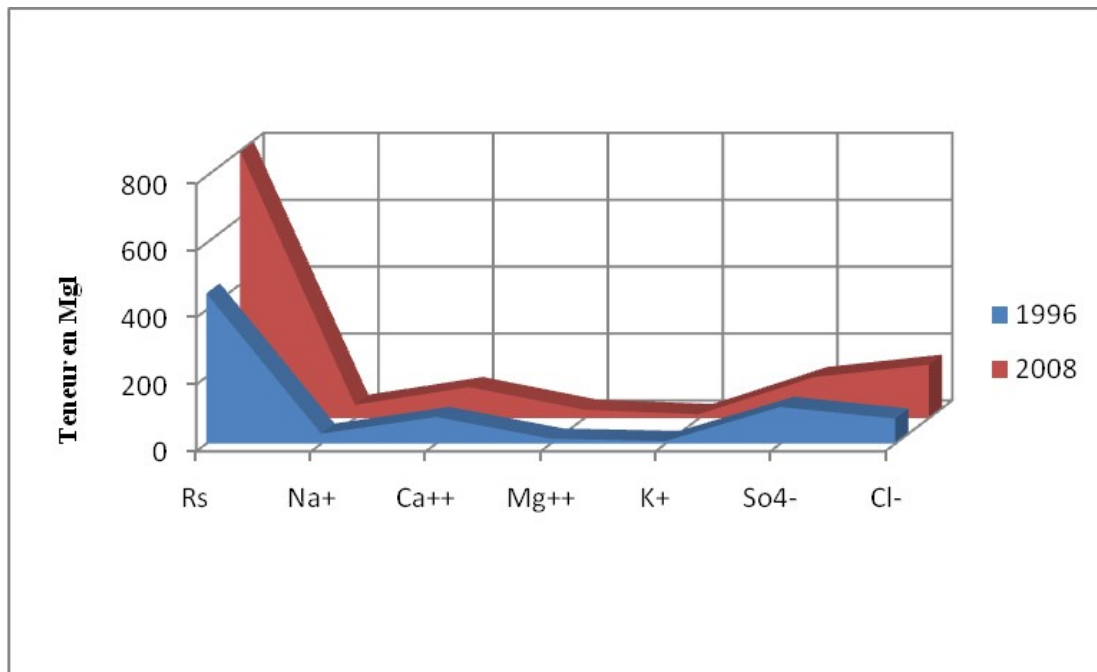


Figure 9: The hydro-chemical evolution of the layer of the Albien-oasis of Béni Ounif

Conclusion

The Béni Ounif palm grove covering an area of 31 hectares, supplied with water from a source through foggaras, and wells dug in the Zouzfana infiltration flow. However, this palm grove has lost more than 50% of its surface area, we see that the phenomenon of groundwater salinity caused by several human and natural factors, is becoming more and more threatening. Bayoud disease, socio-economic transformations, urban expansion to the detriment of the oasis have contributed to this deterioration of the palm grove.

According to this study, we observe the excessive annual degradation of the ancestral irrigation system, the use of the artesian water source is symbolic because of the drying up of the water table. The efficiency of the pumps is much higher than that of the foggaras. The boreholes installed around the oasis have contributed to the lowering of the water table and consequently the drying up of the foggaras.

It is necessary to protect the perimeter of the water table of the oases against the digging of boreholes and the use of pumps (consolidation of a buffer zone to protect the palm grove), the construction of dikes during Wadi Zouzfana to replenish the water table, the reintegration of the foggaras and these abandoned wells in the town planning, the replacement of the concreting of the earth seguias by a stone protection to facilitate the infiltration of irrigation water for the trees in the vicinity of these seguias.

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