CAN BE ABANDONED A TRADITIONAL IRRIGATION IN THE OUAKDA OASIS (ALGERIA)?

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Abstract

Can we abandon traditional irrigation to the detriment of modern irrigation in the oasis of Ouakda? Is the question we posed in this study? Indeed, based on three missions carried out in the oasis of Ouakda during the years 2013, 2015 and 2016, we made visits and investigations to ancestral works as well as surveys of the local population. The results indicate that the Ksourian population irrigated the gardens and the palm grove by surface and underground water. Two ancestral dams made on the Bechar River for irrigation the gardens of the lower part. On the other hand, the foggaras irrigated the upper part of the palm grove. Today, new land has been built on the upper part of the palm grove. Thanks to new hydraulic techniques such as drilling and motor pumps, modern agriculture has developed on the other side of the palm grove to the detriment of oasis agriculture.

Keywords: Algeria, Oasis, Ouakda, Foggara, Irrigation, Agriculture

1 INTRODUCTION

Ouakda, an oasis that developed in a barren environment on the banks of Bechar River. This region is characterized by low rainfall and high temperature which can reach 50 °C during the summer season. However, flash floods occur in the Bechar River for 24 h to 48 h once or twice a year. These floods are generally devastating, causing animals and trunks of palm trees on their way. Despite negative consequences, floods are always welcome for the population. Some of these floods rapidly evaporate; another replenishes the underground reservoir, protecting it from pollution and evaporation. Groundwater extraction was carried out using ancestral techniques such as wells (pulleys, animal traction or pendulum). With the discovery of qanats (foggaras) in northern Iran for more than 3,000 years [1, 2]. Irrigation in oases has taken another dimension with this new system; the irrigation efficiency has improved significantly. In view of this feat, the qanat was exported in the oases of 30 countries in the world [3, 4]. According to a recent study, the qanat was used for irrigation in the oases of fifty countries [5]. Achieving a foggaras conditioned by topography and hydrogeology of the site [6, 7, 8, 9]. Thus the level of the water table must be higher than the level of the gardens to be irrigated. However, the farmer has developed other traditional irrigation techniques thanks to hydraulic know-how. We can cite the Ghouts that resemble bowls dug by the oasis in the middle of the Grand Erg Oriental [10]. The implantation of a hundred palm trees in a Ghout allows their roots stay in the water of the aquifer. In this case, the farmer only deals with the cleaning of the Ghout and to fight against silting. Other groundwater harvesting techniques as well made well for the removal of water hidden in the ground beneath. One finds the wells with animal energy (khotara in the valley of Mzab). Wells to balance in the valley of the Saoura. For the oases located on the periphery of the wadis, the storage of surface water is carried out by the construction of dams of local materials along the wadis. Then thanks to hundreds of kilometers of seguias (open canals) that these waters are transported to the gardens and the palm. In recent years, the contribution of new hydraulic techniques (pump and drilling) in these regions have caused the abandonment of traditional irrigation to the detriment of modern irrigation. It is recalled that these dry areas are fragile ecosystems and the slightest disturbance could cause an ecological disaster. Thus the development of new agricultural land requires a supply of water drawn from underground by drilling well beyond the natural threshold. This caused one side of the flood in the wadi of oases: Souf, Ouargla, Ghardaia and Oued Righ following the rising water of the aquifer [11]. On the other hand, this situation led to the drawdown of the water table and the drying up of foggaras in the oases of Touat and Gourara. In this context, this paper examines the consequences of the conflict between new and old irrigation techniques in the oasis of Ouakda in the Wilaya of Bechar.

2 STUDY AREA AND WORK ASSIGNMENTS

2.1 Location and characteristics of the study area

Ouakda means in Berber language depression. Ouakda, a charming oasis located 6 km north-east of the Wilaya and more than 850 km south-west of Algiers (fig 1). Ouakda holds good quality agricultural land and has significant water potential that can flood the regional market with these high quality agricultural products.

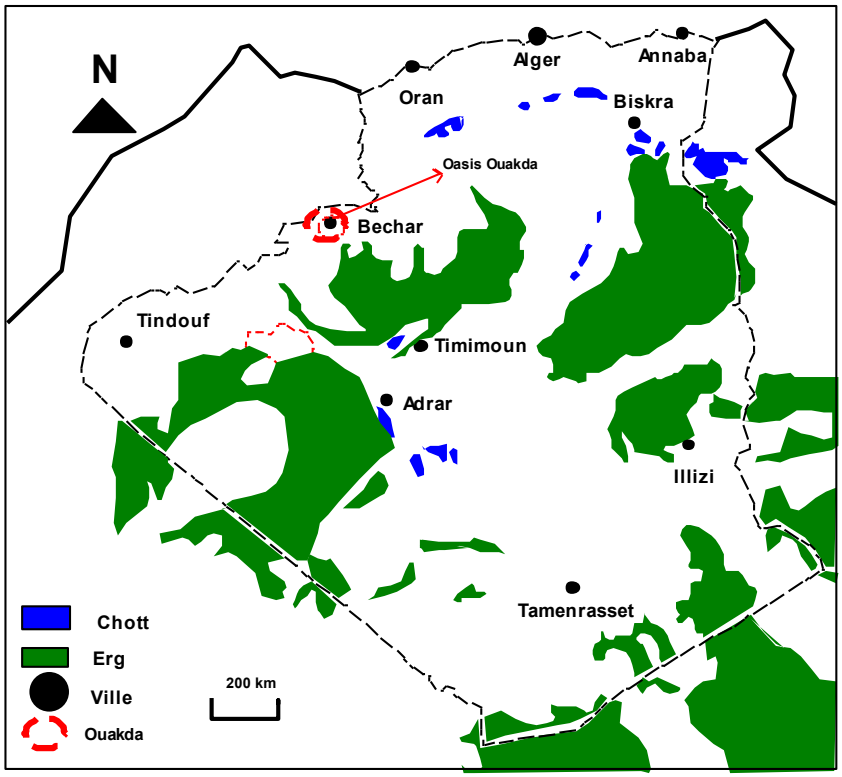


Fig. 1. Situation of the oasis of Ouakda

2.2 Missions and investigations

It is outside of a research mission in the Saoura valley during the year 2013, 2015 and 2016 that we discovered the oasis of Ouakda. On the national road number 6 going towards the town of Bechar, it attracted us by its degraded palm plantation as well as its abandoned ksar. This first visit allowed us to see the state of degradation very advanced

3 RESULTS AND DISCUSSIONS

3.1 Water harvesting and traditional irrigation

The oasis of Ouakda is located on the left bank of the Bechar River (fig. 2). Farmers built two traditional stone masonry dams and lime at a distance of 2 km from each other. This two-containment system was designed to collect water from distributed sources along the banks and on the bed of the river. Through a seguia (open channel) of more than two kilometers, the water is conveyed from the dams to the palm grove (fig 3 and 4). In winter, the Bechar River drains floods of light and devastation that carry trunks of trees, aggregates, silts and mud. The mud rich in organic matter is beneficial for the palm grove. However, Bechar River floods posed many environmental problems such as bank erosion. The flash floods last 24 hours to 48 hours, which occur during the months of October, November, March and April. In addition to a torrential flow, the water level drops from a height of 2m to 10m (the wadi is dry), which causes an erosion of the banks of the watercourse. It should be noted that the phenomenon of the erosion of the banks is spectacular on the Bechar River. Over the last 20 years, the grove and Ouakda an area of 30 hectares has lost more than 10 hectares of its fertile land due to undermining of the banks, more than 50% of its total area. This phenomenon caused several damages to the two dams. Even

the seguias did not withstand the sliding of the banks. Over time the population finally abandoned the hydraulic system. The first dike (Foukani Dam) was swept away by a flood during the eighties. There is no trace of the first dike on the watercourse. However, the second dike (Tahtani Dam) was swept away by a flood during the Nineties (fig. 5). The flood of November 2008 was a disaster for the entire region of the Saoura, since the remains of the seguia and the dikes were completely washed away.

Fig. 2. A view of the oasis of Ouakda oasis
(Photo. Authors, 2015)

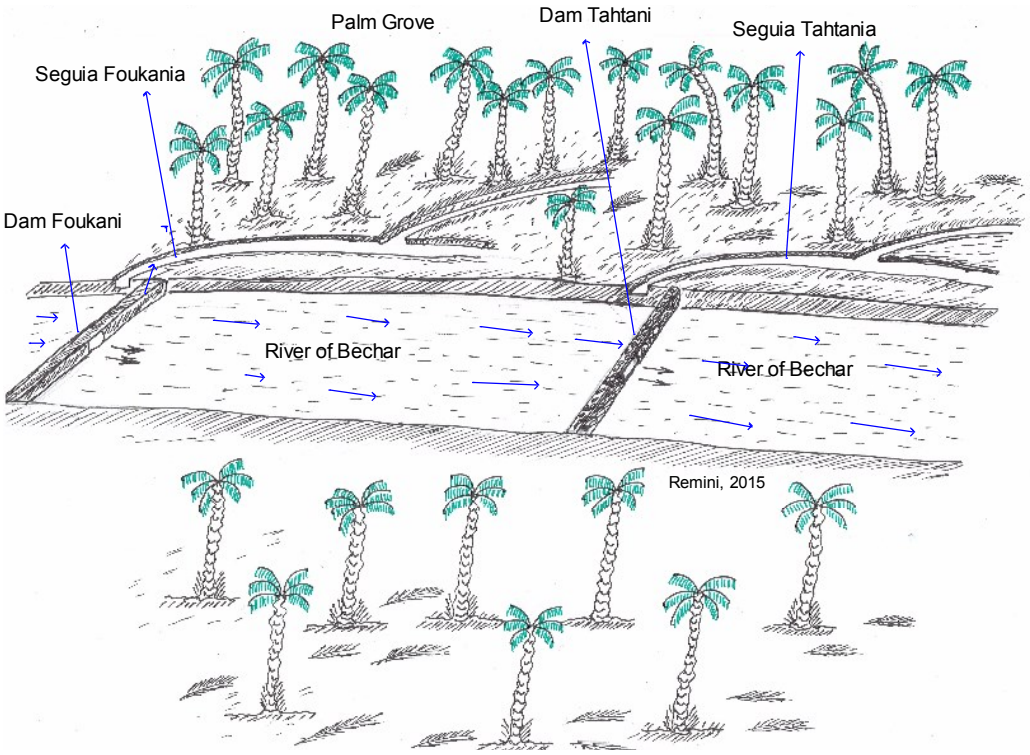


Fig. 3. Diagram of the traditional dams system
(Schematization Remini, 2015)

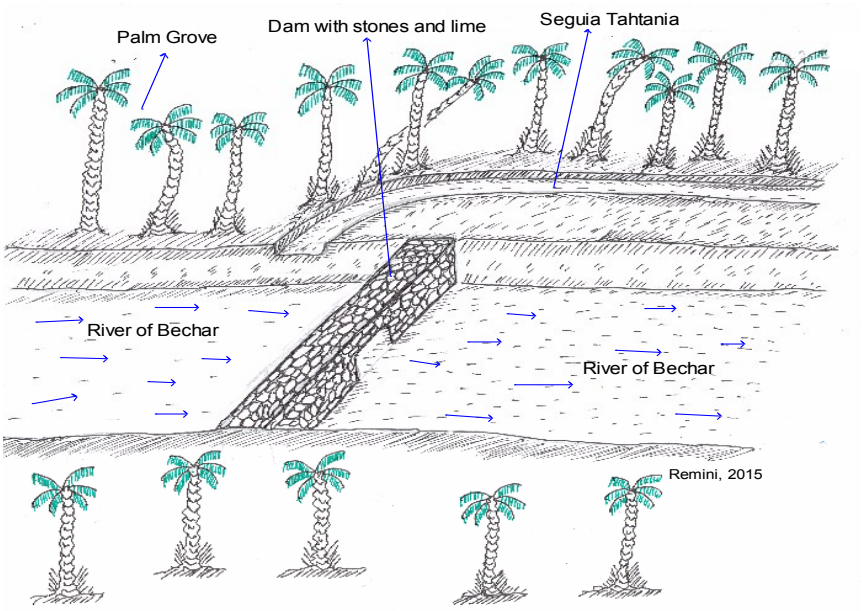


Fig. 4. Probable pattern of the former dam (Schematization Remini, 2015)

Fig. 5. Ancient dam destroyed by a flood (Photo. Authors, April 2015)

3.2 New dams on the Bechar River

The first dam with a height of 2 m (20 trapeziums) was built on the same site of the old dam (Foukani dam) at the beginning of the two thousand years, the objective of which is to regulate floods of the Bechar River. The shape of the dike with 13 alternating trapezes prevents the passage of floating and charred materials on the bottom (fig. 6 and 7). This work was unable to prevent the damage caused by the new floods, prompting local services to construct a Greager weir dam in 2004 upstream of the first dam (fig. 8 and 9). This new hydraulic system, which has replaced the former, has a dual function; reduce the intensity of floods and promote the artificial recharge of the aquifer (fig. 10 and 11).

Fig. 6. New weir barrage constructed at the end of the years Ninety (Photo. Authors, April 2015)

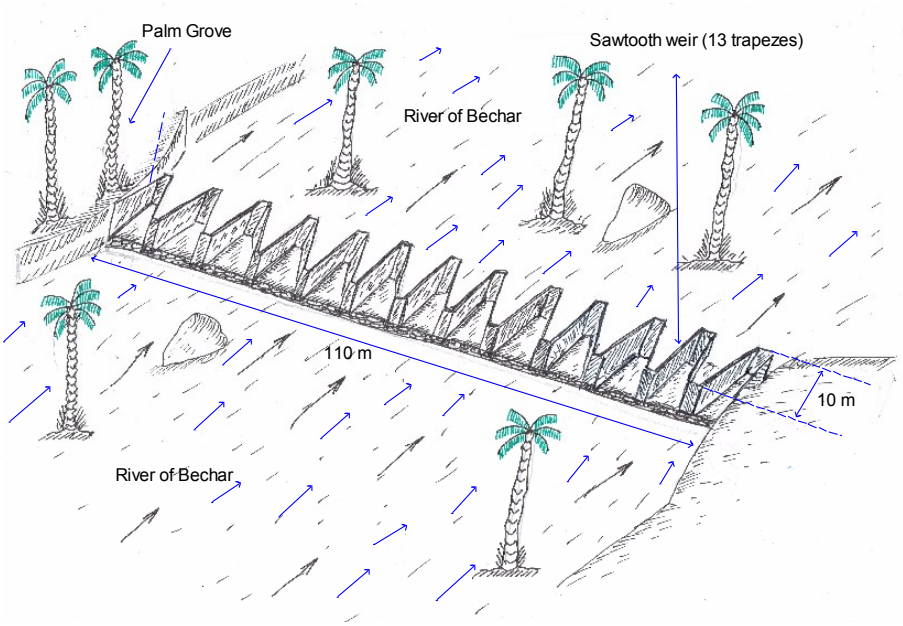


Fig. 7. Diagram of the first weir dam constructed at the end of the nineties (Schematization Remini, 2015)

Fig. 8. Second New Greager Weir Dam
(Photo. Authors, 2015)

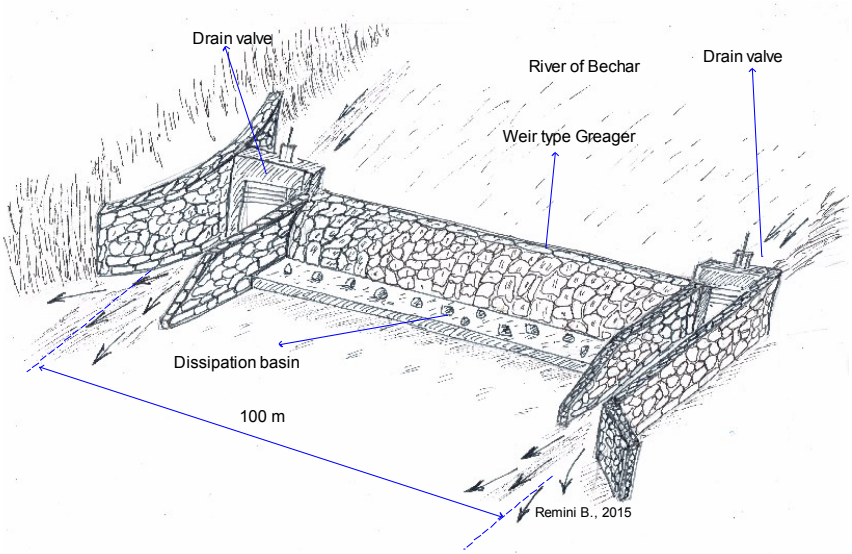


Fig. 9. Schematic of operation of the new weir dam Greager
(Schematization Remini, 2015)

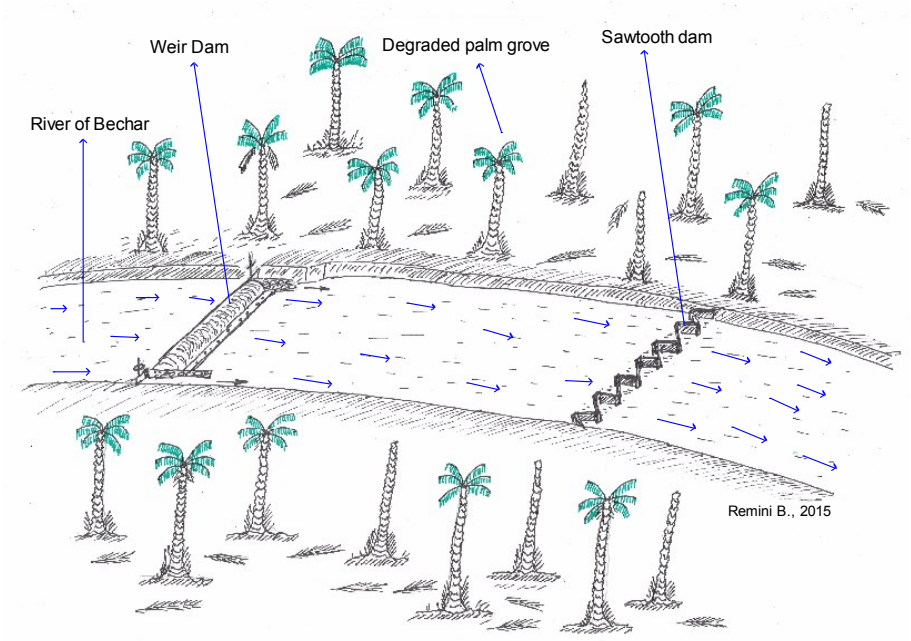


Fig. 10. Diagram of the new dam system on the Bechar River (Schematization. Remini,2015)

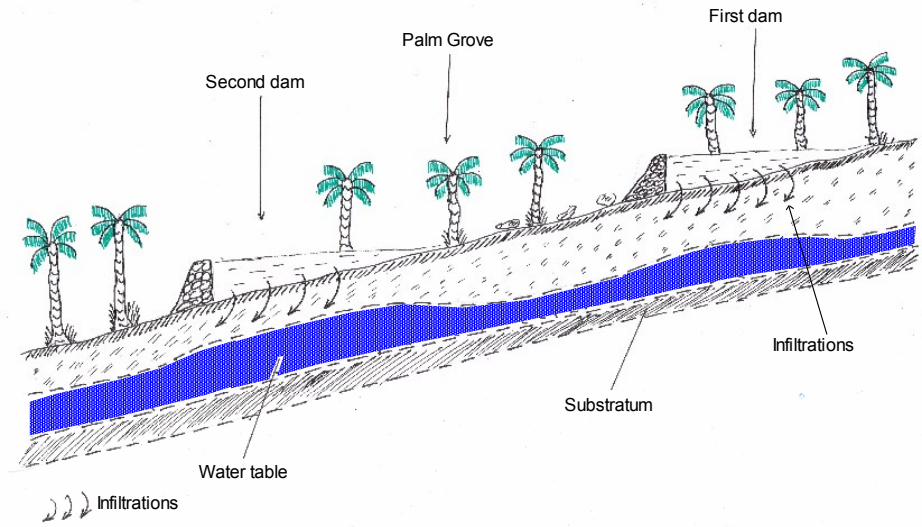


Fig. 11. Diagram of a longitudinal section of the new Dams on the Bechar River (Schematization Remini, 2015)

3.3 Exploitation of Groundwater by foggaras

The local population dug 22 foggaras for the irrigation of the palm grove with an initial area of 30 hectares. Directed from the East to the West, these foggaras are distributed along the palm grove of a length of 2.2 km to ensure the irrigation of all the gardens (fig.12). Each foggara belongs to a group of farmers. The water collected from the water table is conveyed by a gallery to the surface of the ground; at the exit, the water flows into a seguia (open channel) to the Madjen (storage basin) (fig. 13). The sharing of the water is done according to the hourly method, which is to say in turn by turn. The irrigation is done garden after garden. The share of water depends on the contribution of each co-owner in the maintenance of the foggara. A network of seguias in earth transports the water of the Madjen to the gardens of the farmers. Repeated droughts caused the water table to be drawn down and the foggaras to dry up. This situation has pushed farmers to deepen the first well of the foggara to the level of the aquifer. The well is equipped with a stem (tree trunk) 4 m long with a counterweight. The set is placed on two supports of stone 3m high by means of a wooden shaft 1 m long to form a pendulum

well. The coupling between the foggara and the pendulum well constitutes the originality of the oasis of Ouakda (fig. 14). The operation of this rather special work is very simple. The sucker once installed inside the well at the same level as the gallery makes Delou hang down the rocker by means of a rope. Once filled with water, the sucker dumps it into the gallery, the water flows directly to the Madjen. The foggara no longer plays its initial role of catchment and drainage, but it has become a transport gallery that transports water wells to the surface of the ground.

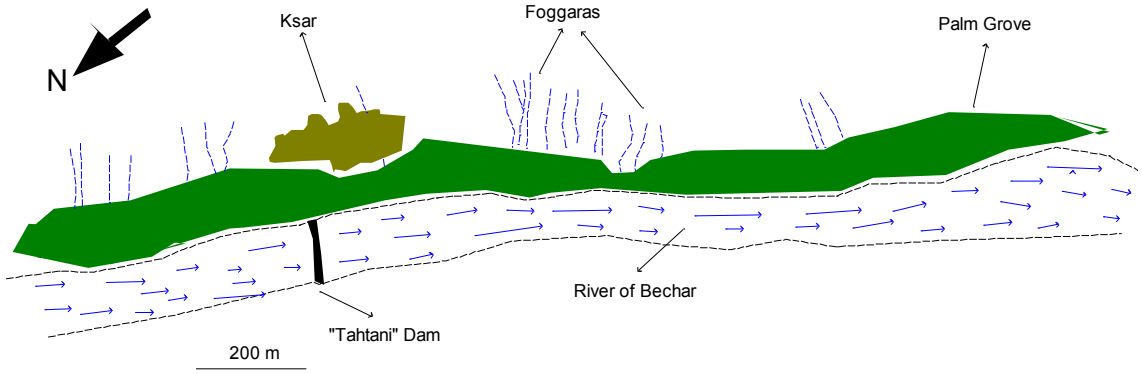


Fig. 12. Sketch of the whole oasis of Ouakda (Schematization Remini, 2015)

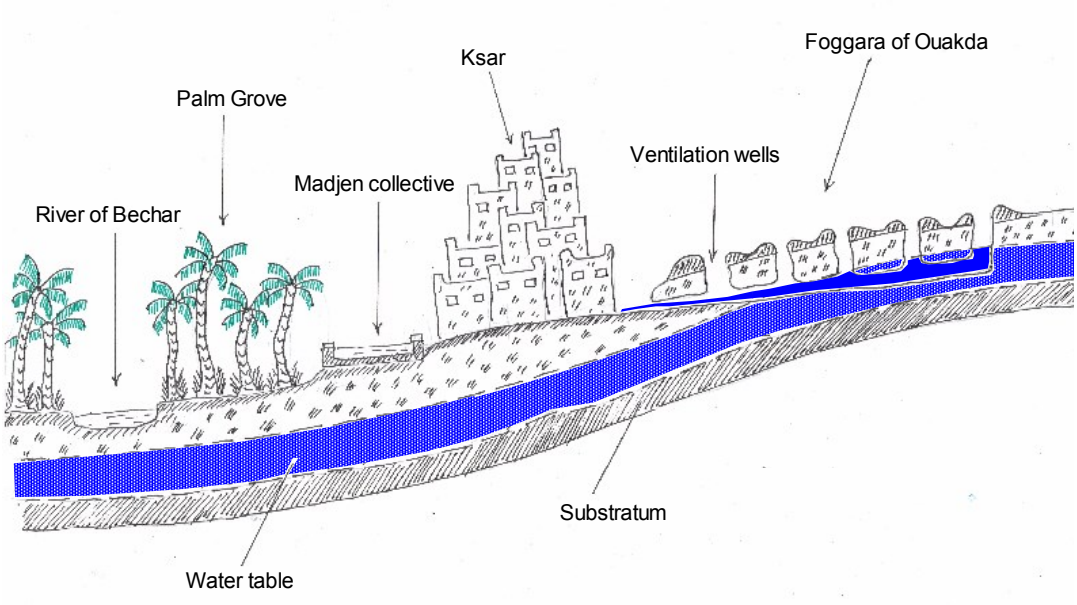


Fig. 13. Schema of a foggara of Ouakda oasis (Schematization Remini, 2015)

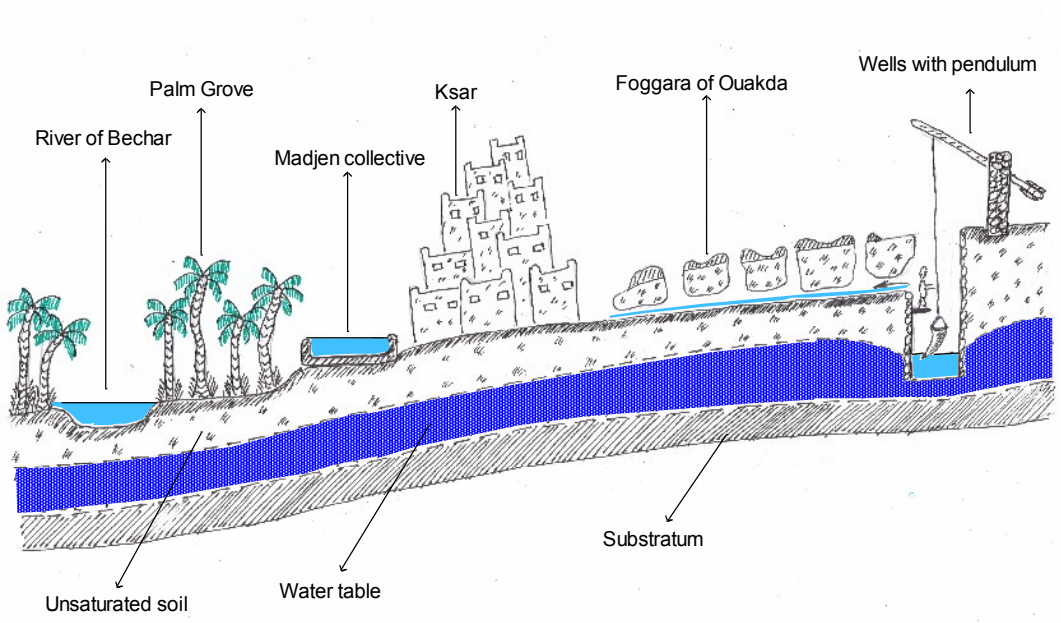


Fig. 14. Diagram of the coupling between the foggara and the pendulum well (Schematization Remini, 2015)

3.4 Contribution of new irrigation techniques

Population growth and growing food requirements resulted in the development of new agricultural land with an area of about 150 hectares (fig. 15 and 16). With the introduction of new techniques for water harvesting (wells for motor pumps, and drilling) and irrigation (drip and sprinkler irrigation) (fig. 17). The transition to modern agriculture has been achieved to the detriment of oasis agriculture. The date palm with about twenty varieties has been replaced by vegetable farming. There are all kinds of vegetables and fruits. If today, Ouakda oasis exports these food products to neighboring areas thanks to these new lands, however, the former very fertile lands have been virtually abandoned due to lack of water.

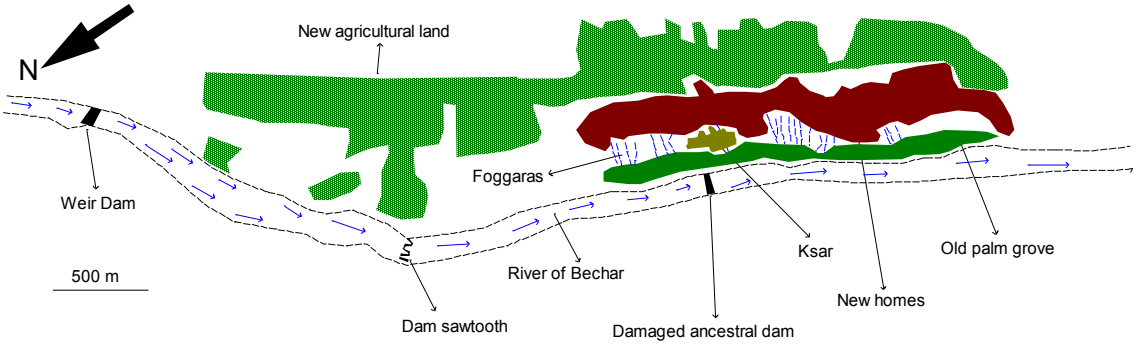


Fig. 15. Ouakda oasis enlargement Sketch (Schematization Remini, 2015)

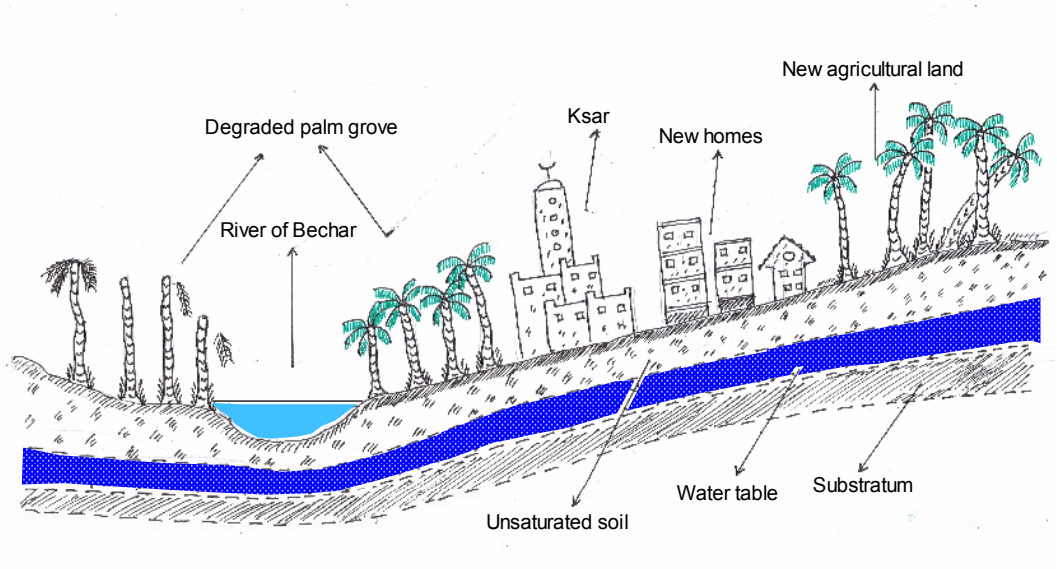
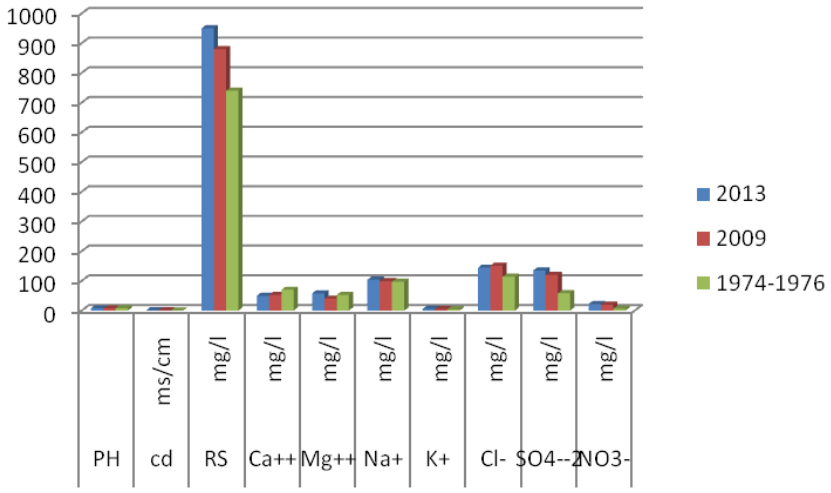


Fig. 16. Diagram of a cross-section of the new oasis (Schematization Remini, 2015)

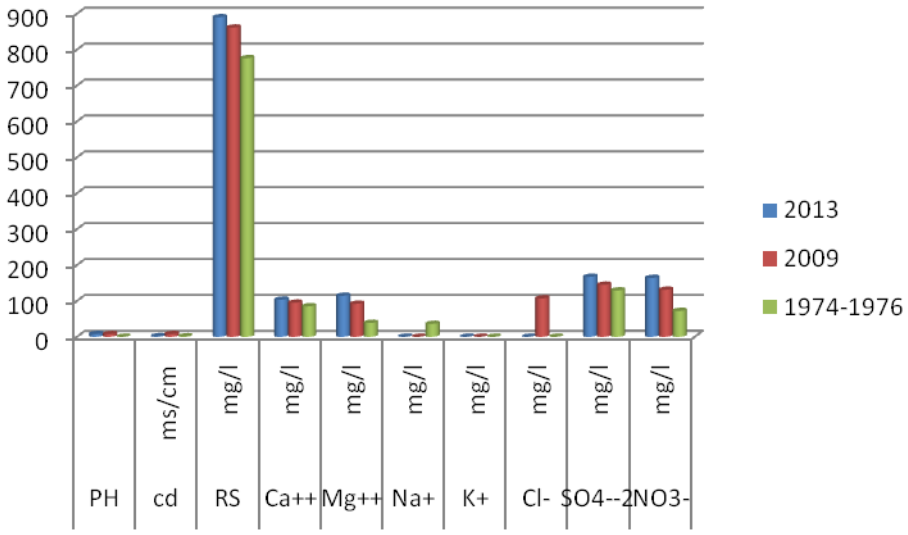
Fig. 17. Irrigation by sprinkling in new land of Ouakda (Photo. Authors, 2015)

3.5 Evolution of the quality of groundwater in Ouakda

We used the data of three companions carried out by the National Agency for Hydric Resources during the periods 1974-1976, 2009 and 2013. Water samples were taken from the Ouakda plain in 2009 and 2013. During the period: 1974-1976, the samples were taken from wells with motorized pumps. The results of the chemical analyzes obtained are shown in fig. 18 (a and b). Interestingly, during the period 1974-1976, groundwater had relatively low salt concentrations compared with 1973. The drying up of the Bechar River, the reduction of the quantity of water intended for irrigation and the anarchic evolution of wells with motorized pumps are the main reasons for this high salinity for the year 2013. The Strong exploitation of the aquifer resulted in the continued degradation of water quality caused by anthropogenic activities. The evolution of the salinity of the aquifers explains the large number of abandoned wells.



a)Turonian aquifer



b) Quaternary Aquifer

Figure 18. Chemical evolution of the aquifers of the Ouakda plain (Data of National Agency of Water Resources)

CONCLUSION

Following the investigations and observations that we carried out during our missions in 2013, 2015 and 2016 in the oasis of Ouakda, we can draw the first conclusions. The traditional dams for irrigation have been replaced by new weirs for the regulation of floods. The transition to modern irrigation through the introduction of new irrigation techniques (such as tipping and sprinkler irrigation) was achieved through the abandonment of traditional irrigation. All foggaras, numbering 22, are currently in a very advanced state of degradation and are abandoned. Today, the area of agricultural land has increased fivefold and Ouakda oasis exports its food products (vegetables and fruit) to the entire Saoura region. However, the old palm grove was abandoned. Can we abandon today the traditional irrigation constituted by the twinning of a foggara and a pendulum well? Is it possible to abandon the date palm to the detriment of vegetable farming?

REFERENCES

[1] GOBLOT H. Qanats: a technique acquisition of water, 1979, Paris, Mouton, 231 p.

[2] HUSSAIN I., SIRAJ ABU RIZAIZA O., HABIB MOHAMED AA., ASHFAQ M. Revitalizing a traditional dryland water supply system, The karezes in Afghanistan, Iran, Pakistan and the Knigdom of Saudi Arabia. *Water International*. 2008, **33**(3), 333-349.

[3] ABDIN S. Qanats a unique groundwater management tool an arid region: the case of Bam region in Iran. International symposium sustainability, Alicante (Spain), 2006, January, 24-27.

[4] HOFMAN A. Traditional water management by qanat in Iran is compatible with the concept of GIRE? Technical Summary, February, 2007, Engref, Montpellier, France, 17p.

[5] REMINI B., ACHOUR B., KECHAD R. The collecting of groundwater by the qanats: a millennium technique decaying. *Larhyss Journal*. 2014, 20, 259-277.

[6] REMINI B. Tadmait's foggara: without energy from the water of the basement to the surface of the ground. *Larhyss Journal*. 2017, 32, 301-325.

[7] REMINI, B., REZOUG CH., HAMOUDI S. The Saoura foggaras: degradation of hydraulic system millennium case of Beni Abbes, Ouakda, Beni Ounif and Lahmar (Algeria).. GeoScience Engineering. 2017, **63**(2), 40-47.

[8] REMINI B., ACHOUR B. The water supply of oasis by Albian foggara: an irrigation system in degradation. *Larhyss Journal. 2016,* 26, 167-181.

[9] REMINI B., ACHOUR B., KECHAD R., 2014. The foggara: a traditional system of irrigation in arid regions. *Geoscience Engineering*. 2014, **60**(32), 32-39

[10] REMINI B. The rise of waters in the region of El Oued. Environment Vector Review (Canada). 2004, May 2004.

[11] REMINI B., KECHAD R. Impact of the water table razing on the degradation of el palm plantation (Algeria) mechanisms and solutions. *Geographia Technica*. 2011, 13(1), 48- 56.