

IMPACT OF THE INVASION OF MODERN IRRIGATION SYSTEMS IN THE OASIS OF LAHMAR, SOUTH WESTERN ALGERIA

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For centuries, the oasis dwellers of the Algerian Sahara exploit the groundwater through the use of traditional techniques such as foggaras (traditional technique of irrigation in the Algerian southwest), and wells of chadouf (pendulum wells). In the oasis of Lahmar, in Southwest Algeria, the farmers use foggaras (known by the name of foggaras ain - foggaras of source) to irrigate their fields. Nowadays though, due to the indiscriminate use of modern systems (boreholes and pumps) to procure water for irrigation and urban consumption, over-exploitation and drying off of water sources have been one the rise while traditional techniques are becoming day by day out of service and, what is more, palm groves have almost completely disappeared.

Key words: oasis, Lahmar, foggara, sequoia, palm grove.

1. INTRODUCTION

The oasis of Lahmar is amongst the three ksour (castles) (Lahmar, Boukaïs, Mogheul) locally also called the Northern ksour. They are located 50 km north of the county town of Bechar. Lahmar has been a capital city (Daïra) since 1991 and is located 30 km from Bechar (**Figure 1**). Mogheul is located at an altitude of 902 m and is the highest point of the wilaya (Governorate). These three villages are all agro-pastoral and raising goats is predominant. Their resources are only agricultural and the existence of permanent water helps them maintain the fertile

gardens whose products are intended for local consumption.

Lahmar is surrounded by a mountain range known as: Jebel Antar 1953 m and Djebel Grouz 1835 m.

The limits of the municipality of Lahmar are: the municipality of Mougheul to the north, the municipality of Boukaïs to the east, the Jebel Grouz to the west and the town of Bechar to the south. The Lahmar region has a considerable quantity of groundwater, despite the climatic constraints of the environment. In spite of the low rainfall in the region the oasis

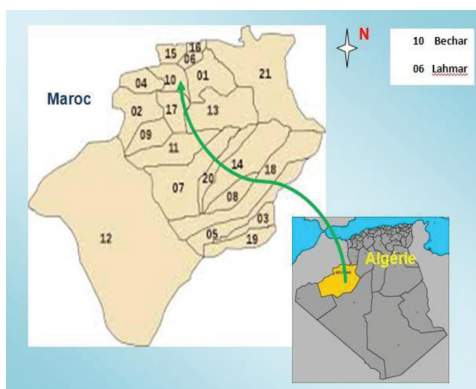


Fig. no. 1. Geographical location of Lahmar

dwellers of Lahmar have been able to cultivate their land by exploiting groundwater gushing from a source (Ain) by foggaras technique and have thus preserved the fragile ecosystem.

By way of contrast, today water needs are essentially met through exploitation of groundwater through the introduction of motor pumps, which in the long run proves detrimental to ecosystem balance and hence, to the health and safety of the locals.

2. PHYSICAL FEATURES

2.1. The climate

The Ksour of the North benefits from a less torrid climate than those of the rest of the region. Winter is rigorous; temperatures drop below 0°C. In general, humid periods correspond to the colder seasons, while drought reigns for the hot season.

2.2. The water in the oasis

The principal valleys that cross the perimeter of Lahmar are those

of the Elhassra, Lahmar and Sefsaf rivers (wadi), all of which feed into the Morra river, a tributary of the valley of Guir [5]. The water resources available in the region are in the intercalary Continental aquifer where the majority of foggaras are dug.

2.3. The vegetation of the oasis

The vegetation of the oasis is on three layers: the date palm predominates in the tree stratum, and it is accompanied by fruit trees at the shrub level and by numerous annual crops in the herbaceous stratum. The palm grove is made up of numerous varieties of date palm trees of different economic importance. The fruit orchard is composed of a great diversity of species, lemon and grenadier. Annual crops are represented by cereals such as barley and wheat.

3. MAIN CAUSES OF PALM GROVE DEGRADATION

The peasants of the region had the impression that Lahmar territory was in decline, affected by the degradation of its oasis ecosystem. Several factors interfere in the accelerated deterioration of the oasis, and the most important are:

- The overexploitation of groundwater by modern pumping systems that are mostly fraudulent, uncontrolled and they shall replace the old system;
- The urbanization of the ground in the course of the foggaras on

account of the extension of the city towards the palm grove;

- Lack of maintenance of traditional systems (foggaras wells, springs, seguias - earthen open channels, and accumulation basins);
- The nonrenewal of old palm trees and clandestine grubbing young palms and palm hearts;
- Slightly cramped nature and parcels of productive lands on account of the inheritance that nowadays makes the size of most of the fields owned by peasants no more than 1 hectare.

4. TRADITIONAL IRRIGATION SYSTEMS

Traditional knowledge is characterized by an integrative approach (society, culture, economy and natural environment) and the prospect of long-term, unlike modern practices geared towards efficiency.

At the level of the oasis of Lahmar, irrigators exploit the groundwater by using an ancestral technique to irrigate their land, it is called the foggara of source and unlike the classical foggara (Figure 2), the foggara of El Ain captures natural spring waters.



Fig. no. 2. The foggara itinerary of Aine Djemal of Lahmar oasis

The palm grove of Lahmar was served by a network of four (4) foggaras (Aine Djemal, Omran, Tawrirt and Lahmar).

The biggest of these, Tawrirt consists of 18 wells maximum depth exceeding 25 meters and the smallest Omran consists of six (6) wells, 10 meters deep.

5. SHARING AND WATER DISTRIBUTION OF FOGGARA

For centuries, the people from the oasis have exploited the few water sources in the region by resorting to their wisdom and a high level of technical skills. They established and controlled hydraulic structures the most sophisticated of which is



Fig. no. 3. A well foggara in the oasis of Lahmar, in January 2008

known as the “foggara” (Figure 3).

Around this ingenious technique, a traditional social organization the “*Djemâa*” is set up.

This can ensure sustainable management of the work, equitable distribution and access to resources for the entire population of the oases and the *Ksar* according to Islamic laws respected by the whole community. This organization, “the *Djemâa*” consists of representatives of each tribe, family of landowners and owners of water rights, who are entitled to take decisions as to opening new *foggaras* and irrigation canals, repairing or undertaking maintenance work. Moreover, the “*Djemâa*” acts as an arbitrator and settles conflicts,

approves changes, sales, rentals or the sharing of water by their owners. As far as the owners are concerned, the owners appoint a person (*Elhassab*) who monitors the calculation of shares and inheritances.

For domestic use, the entire population of the oasis is entitled to free access to water for domestic consumption, a portion being reserved for the mosque and the imam of the *Ksar*.

Once the water reaches the gardens, its sharing is done in two ways: by volume and by schedule.

5.1. The Volume method

This type of sharing is the most widespread in Algeria.

Each owner is a recipient of a volume of water determined by its contribution to the upkeep and maintenance of the *foggara*. This breakdown is provided by *kasriates* (plural of *kasria*). The distribution network has a number of *kasriates* which is proportional to the number of subscribers. The *kasriates* are arranged in a pyramid: from the



Fig. no. 4. An example of a *kasria* in the southwest of Algeria [6]

kasria Lakbira (main), a kind of triangular basin provided with a diverter (comb) receives all the water

from the *foggara* and distributes the flow into three, four or even five channels (*seguias*). From the main *kasria*, the *seguias* (earthen open channels) open to all directions. From these *seguias*, several side *kasriates* take over and distribute the water in a rollout manner to *guemouns* (gardens).

5.2. The time method

In Algeria, the sharing of water per unit time is currently done for water of two *foggaras* in Moghrar (Naama) and it functions the same way as Moroccan *khattaras*. The distribution of water between the co-owners unfolds in turn. In the region of Adrar in South Western Algeria, the watershed of the *foggara* Hanou,



Fig. no. 5. The water storage basin "Majen", January 2008

a schedule *foggara*, is carried out in turn. There are no *kasriates* as in other neighboring *foggaras*.

Relatively large *seguias* go directly to a large *madjen* (reservoir).

The *foggara* is obstructed once or twice per day to allow to restore the required level, then the water is released in a given time, proportional to the financial contribution paid by the beneficiary (**Table 1**). Those operators who are not beneficiaries are obliged to purchase or rent access to this resource. The mosque has a day of water for irrigation of lands.

Table 1. Characteristics of *foggaras* of Lahmar oasis
(source: personal inventory)

Types of foggaras	No. of foggaras	Capture Origin	Mode of sharing	Foggara/oasis name	State of foggara
foggara of wadis	2	water from inferoflux and surface waters	schedule and volume	oasis of Lahmar (Bechar)	2 abandoned foggaras
foggara of mountains	2	water from the phreatic zone	schedule and volume	oasis of L a h m a r (Bechar)	abandoned foggara

According to **Table 1** Lahmar *foggaras* are divided into two types: the first type is the *foggaras* of *wadi* fueled mainly by surface water and they irrigate the central palm grove. Nowadays they are abandoned because of water scarcity. The second type is the mountain *foggara* fed by the groundwater and that has dried up after the drying of the groundwater.

6. IMPACT OF MODERN TECHNIQUES SHAFT SINKING

Previously the waters of *foggara* were used for all purposes, whether domestic (laundry, drinking water) or agricultural.

Today's *foggaras* are abandoned. At Lahmar over 65 private wells have been dug since the 80_s, largely because of the drought. They are used to irrigate the gardens. The mine drainage, the only manual departure tends more and more to be performed by electric pumps. The majority of wells exceeds 40 m depth. Therefore, individual wells allow culturing small areas intensively. The water is close to the growing area and can irrigate when desired. However, the initial

investment is important and cannot be supported by all families.

The development of agriculture outside the main palm groves and therefore uncontrolled digging of boreholes led to accelerated depletion of water from the aquifer.

The increasing exploitation of water is conjugated with increasingly worsening conditions concerning groundwater recharge. Indeed the area is more and more affected by chronic drought.

Secondly, the deterioration of plant cover limits the possibilities of infiltration and the possibility of the water table to ensure food is reduced.

7. THE PROBLEM OF SALINITY

Apart from the impact of increased exploitation of *foggaras*, there is also a salinization process. The observed Lahmar salinization process results from the fact that the plots are not irrigated regularly after being abandoned.

Thus, we can understand why the majority of plots suffering from salinity problems are found in the central palm grove. Indeed, on this

palm grove, many owners do not own enough water rights to irrigate their land, so they are forced to abandon some plots.

To study the chemical evolution of groundwater waters of Lahmar before the massive use of pumps and afterwards we will rely on a comparison carried out by the National Agency of water resources-Bechar (ANRH Bechar) and extracts from old inventories (Table 2 and Figure 6). The data in one of the columns show the situation during 1978 before the proliferation of pumps inside the palm grove, whereas another column displays data dating back to the summer of 2011 (ANRH Bechar). The aim of this comparison is to highlight the differences in water properties before and after using pumps inside the oasis.

Table 2. Physical-chemical analysis of groundwater in the tablecloth of Lahmar [1]

Year	2011 analysis	1978 analysis
Type	borehole	borehole
aquifer Tablecloth	Inféro flux	I n f é r o flux
PH	7.0	7.9
RS	1010	740
Cd ms/cm	1.09	0.55
Ca++ mg/l	75	70
Mg++ mg/l	69	53
Na+ mg/l	102.3	97.53
K+ mg/l	6.45	6.45
Cl- mg/l	164.23	114
S O 4 — 2 mg/l	138.22	58.75
NO- 3mg/l	7.4	6

Concerning salt concentration, the analyses from 1978 show relatively low salt concentrations in the groundwater compared to the data of 2011. The unreasonable increase in private wells and the irrational increase in pumping and neglect of traditional systems inherited from water sharing are the main causes explaining this high salinity in 2011.

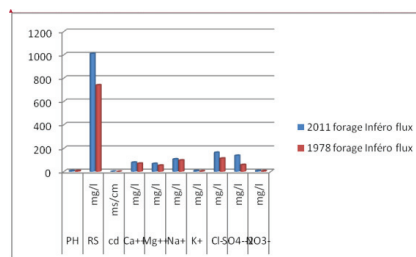


Fig. no. 6. Evolution of the inféro chemical of Lahmar flow [1]

We say that the excessive exploitation, usually exceeding the regulatory power of the water table, results in a continuous deterioration of water quality caused by human activities. The evolution in salinity of groundwater explains the high number of abandoned well surfaces.

8. CONCLUSION

The degradation of groundwater in Lahmar oasis is a good example of the transformations imposed by the anarchic use and control of modern techniques (boreholes and pumps) in an arid and hostile environment.

The invasion of the motor pump has destabilized the functioning

of traditional irrigation on which most of the oasis depends. In our work we distinguished the following:

- The adoption of the use of motor pumps inside the palm grove which conducted to degradation of the latter;
- The efforts of the community to safeguard and rehabilitate the palm grove, but without success;
- The irrigation system (irrigation channel and foggara) is in total breakdown of law and not working;
- Neglect of the land by their owners due to lack of water and salinity.
- In order to revive the oasis and to preserve it and to ensure the proper functioning of the irrigation system in our oasis and palm grove, we must implement the following solutions:
- Ensure the rehabilitation and renovation of the palm grove;
- Require a perimeter of prohibition for open boreholes to protect groundwater of the foggaras around the palm grove;
- Contribute to the maintenance of foggaras;
- Launch emergency by services concerned the rehabilitation operations of seguias to avoid wastage of irrigation water and improve the speed and flow of water;
- Ensure the repair and maintenance of storage tanks of irrigation water;

- Educate inhabitants of the city by associations that disseminate knowledge and raise awareness as to the importance of protecting this environmental wealth as a heritage.

In conclusion, for decades, motor pumps and modern irrigation techniques have created problems of groundwater depletion and soil salinity in the oasis. That led to the deterioration of the palm grove and resulted in a change in the behavior of the local community and also led to the migration of most inhabitants of the oasis to big cities. Consequently, economic and social status difficulties have emerged which currently are difficult to treat if immediate action is not undertaken in accordance with the directions already highlighted by this article.

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