



## THE FOGGARA OF KENADSA (ALGERIA)

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### ABSTRACT

For more than seven centuries, the farmers of oasis of Kendsa, exploit the groundwater of Barga El Jebel by the using of subterranean drains. On the basis of missions in 2013 in the oasis of Kenadsa, forty Foggaras were dug on the outskirts of the El Barga Mountain. Today, there is only ten Foggaras a few liters per minute of flow rate. Contrary to the Foggaras of Touat of length of ten kilometers, the Foggaras of Kenadsa presents a gallery of ten meters.

The sharing of water of the Foggaras of Kenadsa occurs by turns is to say, per unit of time. In this case, the irrigation is carried out in series. The contribution of pumps in the oasis of Kenadsa greatly influenced the degradation of traditional hydraulic system.

**Keywords:** Oasis, Kenadsa, Foggara, Water, Palm Grove

### RESUME

Depuis plus de sept siècles, les agriculteurs des oasis de Kendsa, exploitent les eaux souterraines de Djebel El Barga à l'aide des drains souterrains. Sur la base des missions effectuées en 2013 dans les oasis de Kenadsa, une quarantaine de Foggaras ont été creusées à la périphérie de la montagne El Barga. Aujourd'hui, il ne reste qu'une dizaine de Foggaras de quelques litres par minutes de débit. Contrairement à la Foggara de Touat de longueur d'une dizaine de kilomètres, la Foggara de kenadsa présente une galerie d'une dizaine de mètres. Le partage de l'eau de la Foggara de Kenadsa s'effectue tour à tour c'est-à-dire par unité de

temps. Dans ce cas, l'irrigation s'effectue en série. L'apport des motopompes dans l'oasis de Kenadsa a beaucoup influé sur la dégradation du système hydraulique traditionnel.

**Mots clés :** Oasis, Kenadsa, Foggara, Eau, Palmeraie

## **INTRODUCTION**

Arid regions are characterized by the scarcity of precipitation. The average annual rainfall does not exceed 60 mm. However, these regions are known by the aggressiveness and extent of flooding that can replenish the basement, but much water evaporates. Arid regions are characterized by the scarcity of precipitation. The average annual rainfall does not exceed 60 mm. However, these regions are known by the aggressiveness and extent of flooding that can recharge the basement, but a large part of water evaporates. The appearance of technical underground drains for 30 centuries was a success in the northern part of ancient Iran (Hofman, 2007; Abdin, 2006). Called Foggaras in Algeria, the qanat in Iran (Goblot, 1979), the Karez in Afghanistan (Hussain et al., 2008), the Khatara in Morocco (Ben Brahim, 2003), the Falaj in Oman, the technique drains has been practiced in over 30 countries (Wulf, 1968; Stiros, 2006). It is thanks to this system based on a hydraulic drain slightly inclined, which allows the ground water to achieve the gardens.

The Algerian Sahara, known as one of the driest backgrounds in the world, over 1400 qanats were dug in the southwest of Algeria around the board Tadmaït. Today there are only 50% of these Foggaras in service in the oasis of Touat, Gourara and Tidikelt well known in the country of Foggaras (Abidi and Remini, 2011; Remini and Achour, 2013). Despite of environmental and social conditions extremely difficult, these hydraulic structures functioned for over 10 centuries. The sustainability of the Foggaras during this long period proves its effectiveness; it is a green hydraulic system that fits well in fragile ecosystems such as arid and particularly the Sahara.

Based on a mission to the site, this article examines for the first time the subject of Foggaras of Kenadsa.

## **LOCATION OF THE STUDY AREA AND SURVEYS**

Oasis Kenadsa is located at 800 km south west of the capital and 25 km east of the town of Bechar. The oasis of is surrounded by Kenadsa Boukais north, north-east Lahmar, Bechar to the east and south Abdla, Meridja west (Fig. 1). Kenadsa is an arid region, low precipitation but has immense capacity of groundwater.

In our mission during the month of March 2013 in the oasis of Kenadsa, we conducted investigations and surveys of the local population.



**Figure 1:** Location of the city of Kenadsa

## **RESULTS AND DISCUSSION**

### **The massive El Barga: the natural water tower of Kenadsa**

Kenadsa a charming city in the south west Algeria. El Aouina is original name which means that in Arabic the small source. This explains that the Kenadsa region contains at large capacity of water, particularly groundwater.

Delimit to the south of Oum Sba plateau, the massive of El Barga an average height of 50 m and a length of 55 km from the Guir river west towards Bechar River in the East. El Jebel of El Barga is the true water of the castle oasis of Kenadsa, since in his basement lies a huge expanse of water (Fig. 2).

At the foot of El Barga massive appear sources of water through of cracks and of openings. This is from these sources that Foggaras were excavated to the periphery of the palm grove. From the output of the Foggaras, water flows in a Madjra (open channel) to Madjen (storage pond), then from of seguias (channel section lower than the madjra) , water arrives in Guemouns (garden) (Figs. 3, 4, 5 and 6).

The massive of El Barga resembles the Tadmaid plateau which represents the water tower of oases of Touat, Gourara and Tidikelt (Fig. 7 (a and b)) (Remini and Achour, 2013), since it contains one of the largest tablecloth of the planet: the Intercalary Continental. Foggaras depart from the limit of the outcrop of the tablecloth to Intercalary Continental up to gardens.



**Figure 2:** Massive El Barga : the reservoir of the Foggaras of Kenadsa



**Figure 3:** Output of an the Kenadsa Foggara



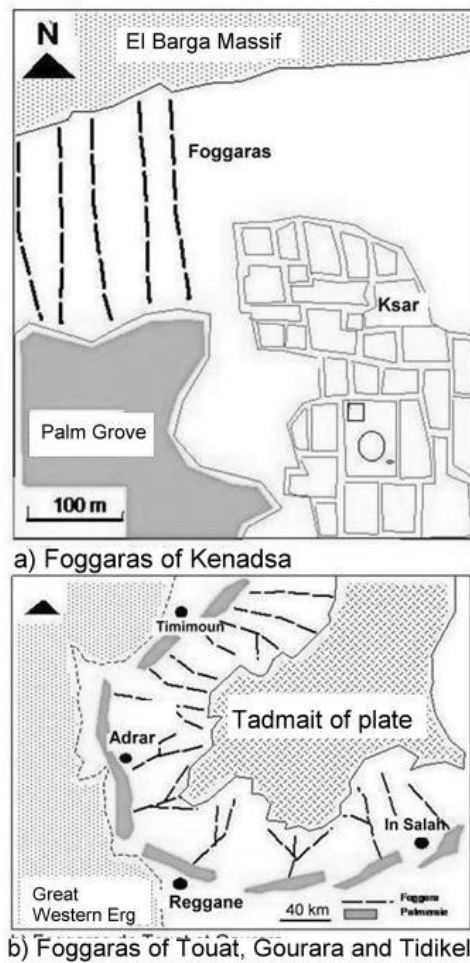
**Figure 4:** A madjra in the palm grove of Kenadsa



**Figure 5:** Madjen a collective the Foggara of Kenadsa



**Figure 6:** An irrigated garden in the palm grove of Kenadsa



**Figure 7:** The Massif El Barga and plateau Tadmaït

**Massive El Barga: A nature reserve of building materials**

Ksar and hydraulic installations such as galleries, walls fences, Madjens and seguias were achieved through materials extracted of Massif of El Barga and the palm grove (fig. 8). Traditional ovens that resemble with those of the Mزاب valley were installed around the massive of El Barga for lime production using the rock of Jebel. In addition to stone and rock for the realization of walls and basins, massive clay also provides for the construction of walls fences. As for the palm, it provides beams, columns, door frames and windows.



**Figure 8 :** Overview of Ksar Kenadsa

### **Foggaras of Kenadsa**

The farmer took advantage of terrain topography very conducive to the realization of Foggaras. A slightly inclined slope from north to south from the foot of the mountain El Barga, which induces a gravitational flow of water without any energy. The existence of water resurgences at the periphery of the massif have facilitated the task of farmers for creating forty Foggaras ranging the foot of the massif El Barga to the gardens with an average length of 150 m. The Foggaras of Kenadsa is an underground an average length of 150 m and low slope gallery (Fig. 9).

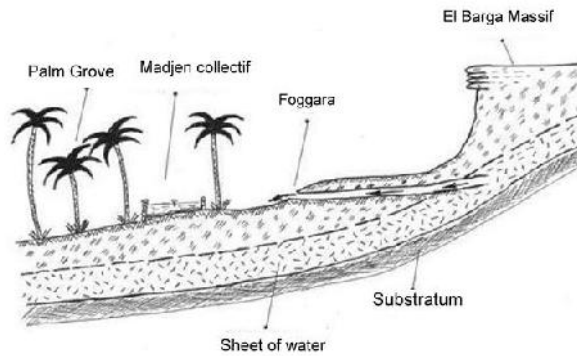
Devoid of ventilation shaft, it resembles the Mountain Karez of Afghanistan whose length of the gallery does not exceed 15 meters (Fig. 10). Called "Ain" (source water), the Foggara of Kenadsa is a family asset. The water sources discovered by the first families have become their properties.

Take advantage of the fertility of the soil and the availability of materials (rocks and clays), these families have sent water sources to the gardens by digging underground drains. Gardens have been landscaped and homes were built by rock and stone, it is the beginning of the expansion of Ksar of Kenadsa. Foggaras bear the name of each family there may be mentioned the most famous: Ain Sidi Mbarek, Ain Sidi Sheikh, Ain Eddir, Ain Mahfoudi, Ain Bouazza, Ain Ouled Bouziane, Ain Ouled El Hadj, Ain El Arbi, Ain Ouled Sid El Houcine and Ain Sidi Mohamed.

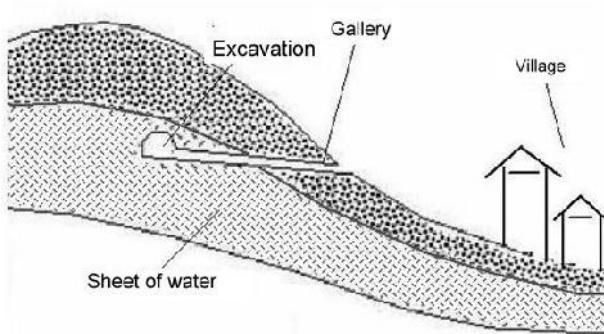
According to the testimony of ksouriens, low flow of the Foggaras was observed in the early twenty-four years (Fig. 11). It was the beginning of the decline of traditional techniques and the emergence of new technologies such as



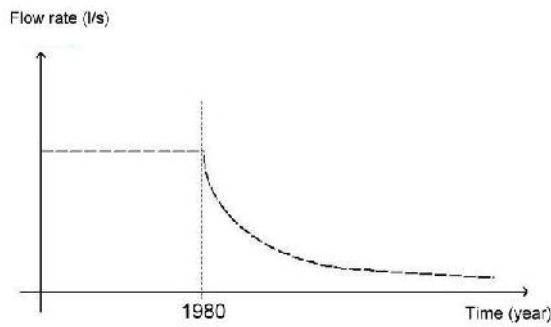
pumps. On average, each year we lose a Foggara. Today, there are a dozen Foggaras services draining low flows. For example, the flow rate of the the Foggara Sidi Mbarek does not exceed 2 l/s. Other Foggaras not drain a trickle of water not exceeding 1 l/s.



**Figure 9:** Block diagram of the Kenadsa Foggara



**Figure 10:** Schematic of Mountain Karez of Afghanistan (Balland and Brognetti in Balland, 1992)

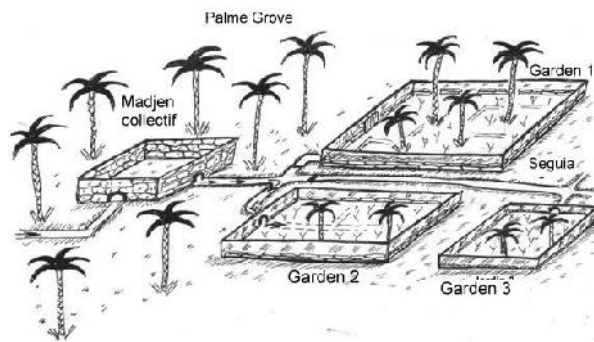


**Figure 11:** Variation in time of the flow rate of Foggaras of Kenadsa

### The distribution network

As any Foggara, the Kenadsa Foggara is divided into two parts: The drainage and transport represented by the upstream part. The distribution represented by the downstream portion of the Foggara.

Over the years, families are increasing, the water in each the Foggara becomes property of family or tribe. The sharing of water becomes a necessity among owners. Of rules and ancestral laws were introduced in the oasis to share water between owners with rigor and justice. The principle is that the share of water depends on the contribution of each owner. Like any oasis of Foggaras of Saoura and unlike of Foggaras of oasis of Touat and Gourara, unit shares adopted in the oasis of Kenadsa is time. Irrigation is performed by turns. In this case, we speak of irrigation in series. The peculiarity of the distribution network of a time the Foggara is the existence of a collective basin (Madjen) just off water gallery (Fig. 12).



**Figure 12:** Schematic for a network of a time Foggara

### A volumetric Foggara in the oasis of Kenadsa

Paradoxically, it was in the oasis of Kenadsa, volumetric Foggara according to the testimony of the local population (Fig. 13). Unfortunately, we did not find traces of the kasria. This type of the Foggara existed only in the regions of Touat and Gourara. There is a transfer of know-how of the Touat oasis to Kendsa oasis. How can we explain the existence of a time the Foggara (the the Foggara of Hannou) in the middle of a hundred volumetric of Foggaras the oasis of Touat. Possible that there was a transfer of know-how oasis Saoura to the oasis of Touat. It is a real paradox of Foggaras. In the oasis of Kendasa, both types of of Foggaras: Time and volumetric coexisted for several centuries (Fig. 14).

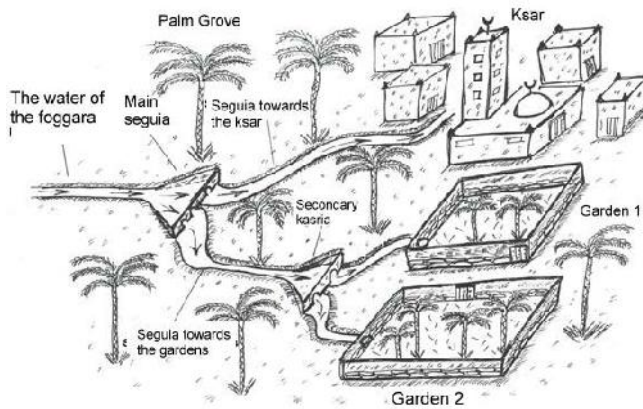


Figure 13: Synoptic diagram of a network of volumetric Foggara

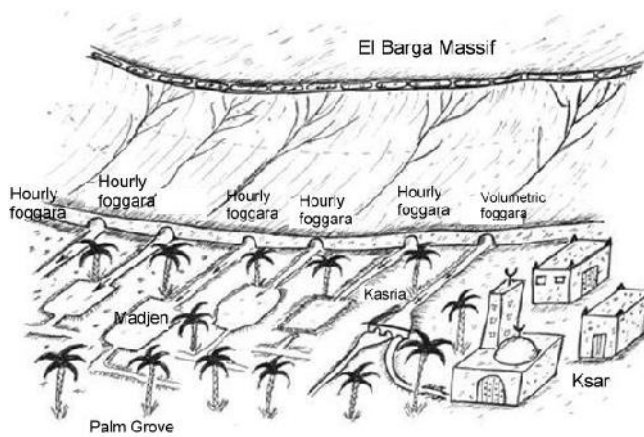


Figure 14: Sketch of a set of Foggaras in the oasis of Kenadsa

### The water of Foggara in the oasis

Once the water reaches the surface, the priority is given to the water supply of the ksar, then second position to irrigate gardens. The mosque has a share of water from the Foggara. Initially, the distribution network for forty families living was very simple. By irrigation channel, the water enters each house to be stored in a small pond formed inside the home. Then the water flows in other irrigation channel to the garden. In a second step, once the Ksar grew, the distribution network has become more complex: each the Foggara water is stored in a large basin before sharing. The mileage seguias increased in the palm. All units are powered by the Ksar water of Foggaras through the network of seguias. The water supply is done by residential housing, this is to say a supply in series (Fig. 15).

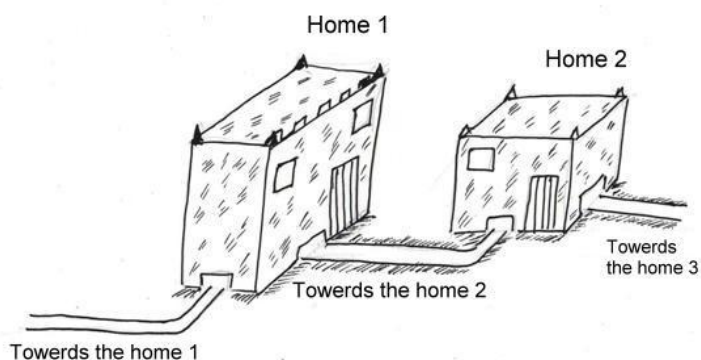


Figure 15: Sketch of water distribution within the ksar

### CONCLUSION

As we mentioned earlier in this article, the Foggara of Kenadsa has never been a comprehensive study. Different from the Foggara of Touat whose length can reach kilometers, the Foggara of Kenadsa of an average length of 150 meters drains water from springs at the foot of the cliff El Barga to the gardens. Forty of Foggaras were dug for more than seven centuries. Today, there remain ten of Foggaras service but with low flow rates. The decline of the hydraulic heritage began in the early twenty-four years. On average, each year we lose a the Foggara.

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