



## **THE TRIPLE FOGGARA OF OULED SAID (Algeria): THE INGENUITY OF THE SAHARAN PEASANTRY**

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### **ABSTRACT**

Is treated in this paper an original qanat. This is the qanat Ouled Said, consisting of the encounter of three foggaras: Anrite, Amokrane and Badgha, which exploit the groundwater of the Greatest western Erg. All negotiations, sale and purchase of shares of water are conducted in this meeting place of three kasriates called Ouled Brahim.

Four missions were conducted in 2007, 2008, 2009 and 2010 in the oasis of Ouled Said for describe and understand the functioning of the qanat of Ouled Said. The measures that were conducted at three kasriates gave a flow of 3.5 l/s divided between the 150 owners of the qanat.

It is substantially less than ninety years since it was 26 l/s. Surveys and interviews conducted with owners and the population have revealed that the main causes of degradation of the hydraulic system are socio-economic and environmental. The heritage, migration and siltation are problems that worry the local people.

**Keywords:** Foggara, Ouled Said, Oasis, Siltation, Discharge.

## **INTRODUCTION**

The Sahara is the largest desert in the world, it is considered a hyper-arid region, the average annual rainfall does not exceed 150 mm/year. To address the rainfall deficit, the use of groundwater exploitation is essential for all economic and social development in the region.

To this effect, various techniques of capture of groundwater have been used by farmers from centuries. The choice of technique is subject to the hydrogeological conditions of the site and the control of knowledge of hydraulic. The technique of the well to balance (which uses human energy) called Chadouf was used in the oases of Timimoun, Adrar, Mogharrar. Today it remains a single model functional in the oases of Bousemghoun.

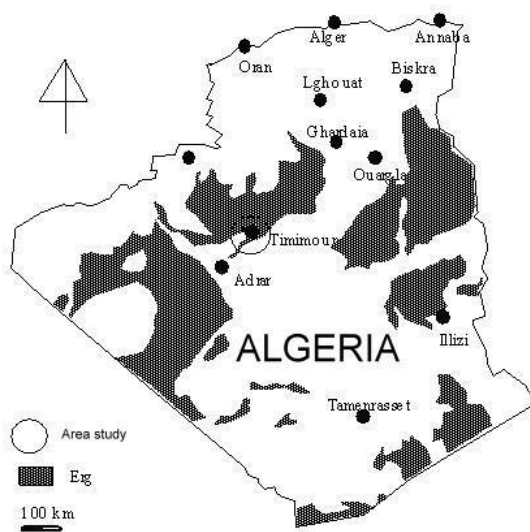
Another technique is prevalent in the valley Mzab, it is the "khottara", traditional wells which uses animal power. But the ingenuity of the farmer has been demonstrated with the invention of the foggara. It is a hydraulic system constituted by a underground tunnel of low slope which connects the water table to the soil surface. Without human or animal power, water arrives by gravity to the gardens. The gallery is equipped with a multitude of air shafts dug at regular intervals. Whether for the foggara of Algerian Sahara or qanat of Iran, the operating principle is the same. However, the origin of the qanat is well known to specialists. It has been in exploitation since 3000 years in north - west of Iran (Goblot, 1979; Wulf, 1968; Goblot, 1963). The qanat has been around the globe and is practiced in over 35 countries (Hofman, 2007). For cons, the origin of the foggara of Algerian Sahara is surrounded by doubts. Some authors argue that it is a local invention; others say it is a technology transferred from the old Iran via Saudi. Over time, the farmer has improved its hydraulic system while adapting to socio-economic and environmental conditions of the region. Generally, a foggara is designed to supply the population with drinking water and irrigation of the palm plantation. It can be made for special situations, such as El Meghier foggara (Timimoun), intended to supply of the population of ksar, the irrigation of the palm plantation and supply the communal swimming pool (Remini and Achour, 2008; Remini et al., 2011; Remini and Achour, 2013; ). Iranian farmers have developed of qanats in staircase to operate of mills in Iran (Papoli-Yazdi in Balland, 1992).

For irrigation of small parcels in piedmont of the mountains, Afghan farmers have invented the mountain karez, consisting of a horizontal gallery of a few meters (Balland. And Brognetti, in Balland, 1992). To improve the flow of a foggara, ramifications can be added to the main gallery, in the case of foggaras of Timimoun (Remini et al., 2013). In Iran, a qanat to dual gallery layered was invented to increase its flow (Safi Nezaad, in Balland, 1992). A Timimoun, in the oasis of Ouled Said, a particular foggara attracted our attention, it attracts every year hundreds of tourists curious about the genius of the farmer. We wanted to understand this contribution, operation and sharing of the triple foggara. The

technical, environmental and socio-economic problems facing the triple foggara will be addressed in this article.

## MISSIONS IN THE REGION OF TIMIMOUN

To study the foggaras, we conducted several missions in the oases of Timimoun during the years 2007, 2008, 2009 and 2010. A particular foggara impressed us, this is the foggara of Ouled Said. It is situated in the middle oases of Ouled Said, to 20 km at south of the Timimoun city and 1200 km at south of Algiers (Figure 1). Given the absence of studies on this foggara we conducted of measurements of flow at galleries and seguias. Surveys and interviews with owners of foggaras and farmers of Ouled Said were conducted.



**Figure 1 :** Location of the study area

## RESULTS AND DISCUSSION

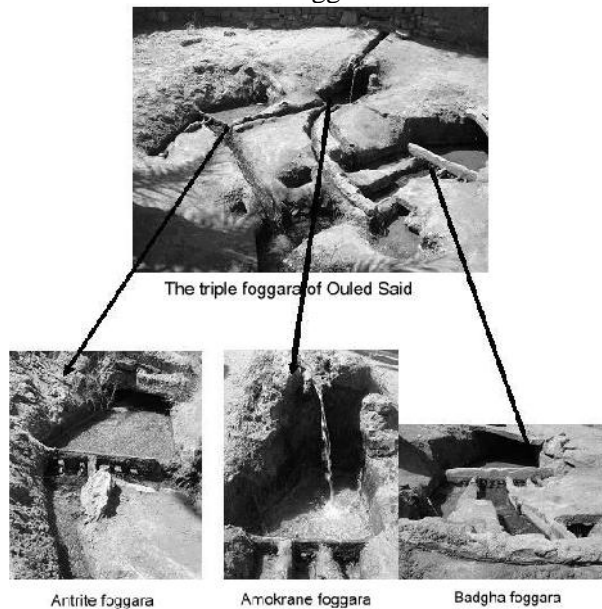
### Characteristics of the foggara of Ouled Said

Ouled Said is a town well known by those particular ksours and its 100 foggaras operational. A special foggara, located amongst the gardens of Ouled Said, includes three foggaras on the site of Ouled Haroun. These foggaras: Badgha, Amokrane and Antrite (Figure 2). Unlike foggaras of Timimoun center and Adrar that capture the waters of the Intercalary Continental aquifer, these three foggaras exploit the groundwater of the Greatest Western Erg.

This groundwater is formed below the Greatest Western Erg through to the water flows slowly under the sand of the Erg in the old river from the Saharan Atlas. The three foggaras were dug gradually over time. The galleries coming from the Greatest Western Erg are lost below the immense dunes of sand and person can not confirm their exact itinerary. At the end of the Erg, the three foggaras a length exceeding 1 km converge in one place in the middle oases of Ouled Said to form a site for sharing and distribution of water. We preferred to give this hydraulic system the name of the qanat Ouled Said.

The originality of the qanat of Ouled Said resides in its ramified network of seguias, intended for distribution of the water between the 150 owners. This is the densest network and most complicated of all the oases of Timimoun and Adrar. It's a real tangle of seguias dug and fashioned with the clay and rock.

All is calculated and measured at a haba almost without any error. Haba which represents a unit of measurement in the region of Ouled Said is equal to 2.6 l/min. With kasriates (plural Kasria), each owner receives his share of water according to his effort and contribution to the achievement and maintenance of the foggara. This network was conceived by the population over time in according to the evolution of the quantities of water distributed to the owners having custom actions in two or three foggaras

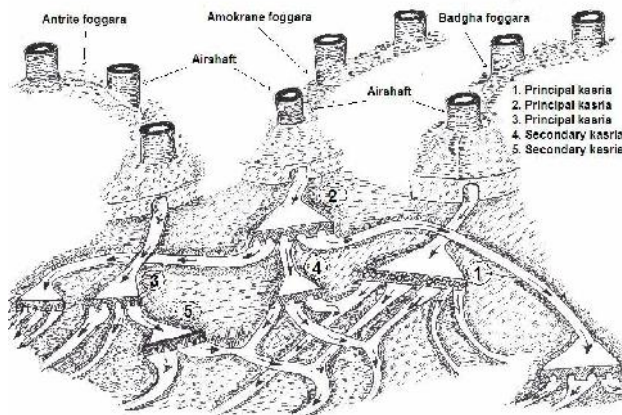


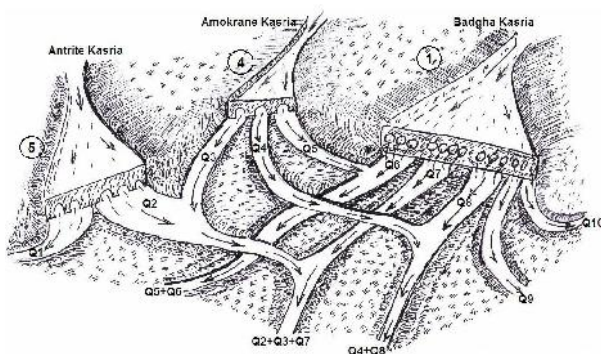
**Figure 2:** The qanat of Ouled Said (Timimoun)

### **The qanat of Ouled Said : a veritable hydraulic purse**

The distribution of water from a foggara subject of negotiations and complex regulations. Each owner may sell, buy or rent on his part. The qanat of Ouled Said has become a veritable exchange of water where people buy, sell and lease their actions representing the shares of water. This implies the existence of an organization for sharing and distributing of the water of the foggara. The focal point of the three kasriates became a meeting place for buyers and sellers of water.

At each event of sale or purchase of a share (of water), the owners, the *kial el ma* (with its *louh*), *El Hassab*, the *Chouhounds* and the population attending the operation. This is the *Kial el ma* which conducting to the measurement of flow, which will be recorded in the *Zemmam* in the presence of *Chouhounds*. Once the new owner is registered, we proceed to the digging and shaping of the new *segua* that will attach to his *kasria* to the *segua* original (which comes from his first foggara) or directly in the garden. The figure 3 shows a group of owners have three *seguias* coming from three *kasriates* (Q2 + Q3 + Q7) which occur at the same point for reach the main *segua* and gardens. This group of owners hold shares in the three foggaras. Two other groups of owners of actions in two foggaras (Q4 + Q5 + Q6 and Q8). Once defined share of water by *Kial El ma*, it will be subdivided again a second time at the downstream side by a *kasria* between owners. In this case, each receiving its share of water according to its contribution.

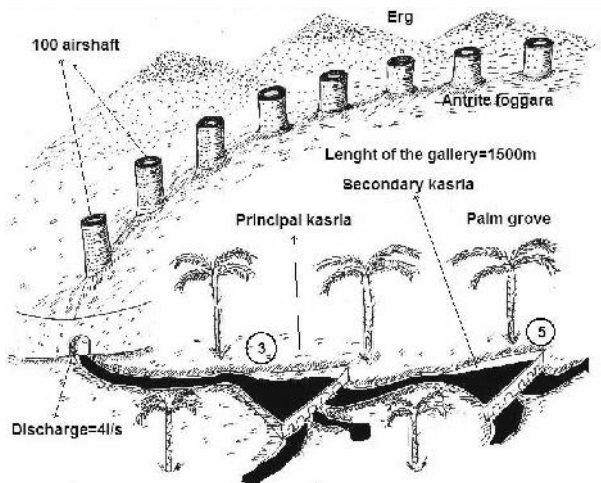




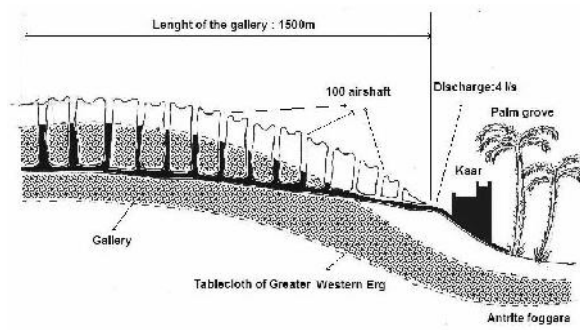
**Figure 3:** Synoptic diagram of the site of Ouled Haroun: instead of converging foggaras: Antrite, Amokrane and Badgha

**The qanat of Ouled Said address environmental problems**

The water of the qanat of Ouled Said comes from three different foggaras: Antrite, Badgha and Amokrane. The total flow measured in 2008 at the meeting place of Ouled Haroun has decreased by 85% from its initial flow (26 l/s in the early nineties) to reach 3.5 l/s. The foggara of Antrite, with a length of 1500 meters, is equipped with 100 air shaft (Figure 4). His flow is 4l/s according to the latest census conducted in 1998 by the National Agency of Water Resources. This flow decreased to 2 l/s depending on the volume measurements that we made during the month of February 2008. The flow measured at the secondary kasria, instead of meeting of Ouled Haroun, is 1.2 l/s.



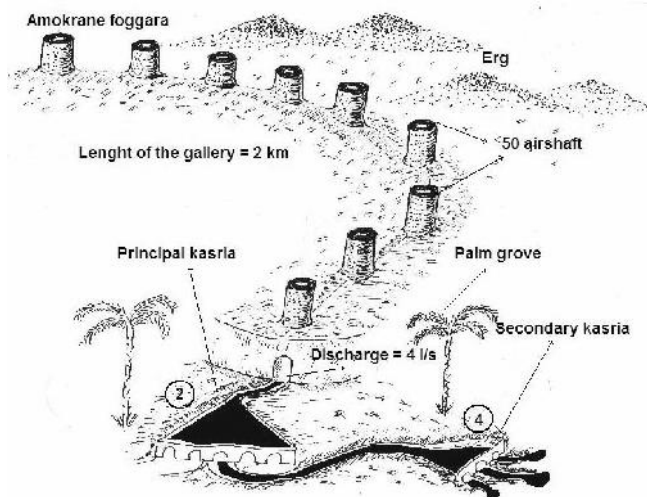
a) General view of foggaras



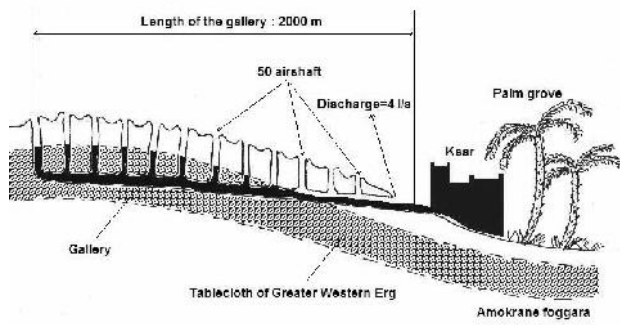
b) Longitudinal section of foggaras

**Figure 4:** Synoptic diagram of Antrite foggara

The foggara of Amokrane, of a length of 2 km is equipped with 50 air shaft debits 4l/s according to the latest census conducted by the National Agency of water resources (Figure 5). The latest measures that we have taken in 2007 and 2008 respectively a flow of 2.5 l/s and of 2 l/s. At the secondary kasria in the site of Ouled Haroun, we obtained a flow of 1l/s.



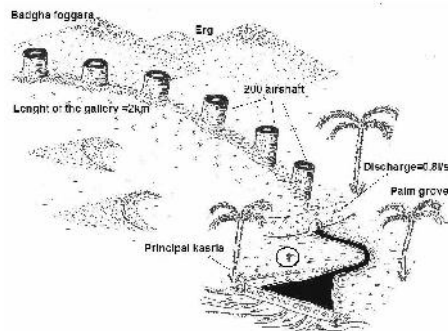
a) General view of foggaras



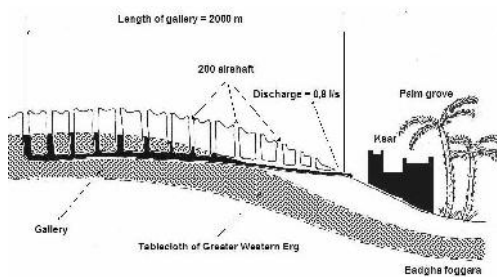
b) Longitudinal section of foggaras

**Figure 5:** Synoptic diagram of Amokrane foggara

The foggara of Badgha, of a length of 2 km, equipped with 200 wells, drains a flow of 0.8 l/s according to the latest survey conducted by the National Agency of Water Resources in 1998 (Figure 6). His flow has increased to 1.3 l/s according to our measurements in 2008.



a) General view of foggaras



b) Longitudinal section of foggaras

**Figure 6:** Synoptic diagram of Badgha foggara



It appears from these values that the flow of the qanat on the site of Ouled Haroun around 3.5 l/s. It is clearly declining and risk of vanish in the short term. The population of Ouled Said is concerned about this decline, since the share of water from each of the 150 owners becomes insufficient to irrigate the gardens. The population thinks that the drying up of the qanat is inevitable. According to the owners of the qanat, environmental and socio-economic problems are the main cause of this degradation. The sand remains a thorny problem, because every wind of sand, kasriates and galleries are being invaded by sand.

The sandstorms accentuate the deposit of sand in the seguias and galleries. The maintenance of the qanat of Ouled Said becomes a delicate operation since it requires the displacement of human resources and materials for several miles in the dunes of Erg. The contribution of pumps in the oases of Ouled Said has accentuated the digging and multiplication of wells. The population prefers more the individual irrigation (wells to pump) to the detriment of the collective irrigation by the foggara. The heritage and migration of population of ksours to large cities are of problems not solved. Several acres of gardens are abandoned because of these social problems.

## **CONCLUSIONS**

Unique in the Algerian Sahara, three foggaras unite on the site of Ouled Haroun in the gardens of the Oasis in Ouled Said Timimoun region, has been nicknamed the qanat of Ouled Said. These foggaras of Anrite, Amokrane and Badgha. A veritable tangle of seguias coming from the three kasriates supplies other seguias and gardens of the owners. Each owner receives his exact share of water allocated to start by Kial el ma according to his contribution.

Flow measurements conducted with the three kasriates gave a rate of 3.5 l/s. It is much lower than that of 1970, as it was equal to 26 l/s. This flow does not satisfy the irrigation demand of 150 owners. These are technical, socio-economic and environmental problems that have contributed to the degradation of this hydraulic system. We risk losing this socio-cultural heritage in the short term. It is the pride of the entire population of Ouled Said. His rehabilitation has now become indispensable for the preservation of the oases in the region.

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