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The Garden Foggara of Timimoun (Algeria): The Decline of Hydraulic Heritage

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Abstract: The foggara has been used for centuries for irrigating gardens of the Timimoun oasis. The most famous foggara in the region is one that collects water from the Continental Intercalary aquifer (classic foggara). We conducted five missions (2007, 2008, 2010, 2012 and 2014) in the Timimoun oasis to another foggara that is less studied. It is a small foggara that collects water seepage and leakage of water from the classic foggara. Not exceeding the 1500 metres in length, this foggara is located in the gardens. We call it the garden foggara. In 2010, of the seven foggaras (operating) recorded, the Zahzaa foggara is the only one remaining and is operating at a low discharge. But in 2012, this foggara has dried.

Key words: Foggara, garden, oasis, timimoun, water.

Introduction

Arid regions are characterized by low rainfall or very limited surface water. Faced with this hostile environment, the ground water reserves mainly constitute the base of formation of the oases. To tap the water table, man first used traditional wells that were based on human or animal effort. It is a technique with low yield significant energy to have a low flow. Over time, man has improved the water catchment system with the invention of the galleries technique. This technique appeared in the North West of Iran for the first time in 3000 years (Goblot, 1963, 1979; Wulf, 1968; Kazemi, 2004; Stiros, 2006). This is one of the most beautiful inventions in the hydraulic history. Due to the success of this irrigation system in the Iranian oasis, it has been adopted in thirty arid countries under different names (Hoffman, 2007). A recent study showed that the foggaras were exploited in 52 countries of the planet (Remini et al., 2014). The galleries is known as the qanat in Iran (Goblot, 1979), foggara in Algeria (Arrus, 1985; Kobori, 1982; Guillermou, 1993), khettara in Morocco (Lightfoot, 1996; Ben Brahim, 2003), the Karez in Afghanistan (Kahlown and Hamilton, 1994), falaj in Oman (Abdel Rahman and Omezzine, 1996; Al Marshudi, 2001, 2007) and qanat Romani in Syria and Saudi Arabia (Kobori, 1990; Lightfoot, 2000). In addition to the large number of tunnels dug in arid areas: 50,000 foggara in Iran (Ghorbani, 2007), 1400 foggaras in Algeria (Arrus, 1985; Remini et al., 2010; Remini et al., 2011), 4112 Aflaj in the Sultanate of Oman (Al Gharfi et al., 2003), and 300 khettara of Tafilalt in Morocco (Ben Brahim, 2003), the farmers have improved these techniques to increase the water discharge. Thus, various models of foggaras were developed in Iran and Afghanistan for irrigation and drinking water. For example, the lack of water surface in arid regions has been replaced by a special

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Nomenclature
Ksar: City of the farmers. Plural: ksours
Kasria: Small triangular basin, with a comb-shaped diverter. Plural: kasriates
Guemoun: Garden
Djamaa: Wise committee of oasis
Seguia: Canal. Plural: souaguis
Madjen: Basin water storage

type of foggaras intended to operate the wheels of the mills. Called foggara to mill, the stepped qanat is composed of three foggaras. The hydraulic system is designed to irrigate the gardens and feed mills (Papoli-Yazdi, 1992). Spectacular foggaras and karezes were observed in Iran and Afghanistan, showing the genius of villagers. For example, one can cite the mountain Karez in Afghanistan. It is a very short underground gallery not exceeding 15 m, completely devoid of ventilation wells (Balland and Brognetti, 1992; Balland, 1992). To increase the flow of irrigation, the farmers of the Mun village (Iran) realized a foggara with two superimposed galleries (Safi Nezad, 1992). In the Algerian Sahara, the foggara the most known and most studied is the Albian foggara (classic foggara) which is located in the region of Adrar (south west of Algeria). This article brings new evidence on one type of original foggara which we found in the Timimoun oases in Algerian Sahara.

Missions and Observations

This study is based on observations and investigations conducted with the population of Timimoun oases during several missions in 2007, 2008, 2010, 2012 and 2014. Timimoun is known for the beautiful oasis and use of foggaras to irrigate the gardens. Timimoun lies 1200 km southwest of Algiers (Figure 1).

Results and Discussions

The Classic Foggara

There are seven types of foggaras in the Algerian Sahara (Remini et al., 2010). The most widespread foggara in Algeria is the foggara that collects water from the Continental Intercalary aquifer. It is called the classic foggara. The technical system is linked to a social group work, led by the djemaa, whose role is to direct and oversee the maintenance of the foggara and distribution of its water. About 250 classic foggaras are currently in operation in Timimoun and provide a flow of 355 l/s (Remini et al., 2011). The classic

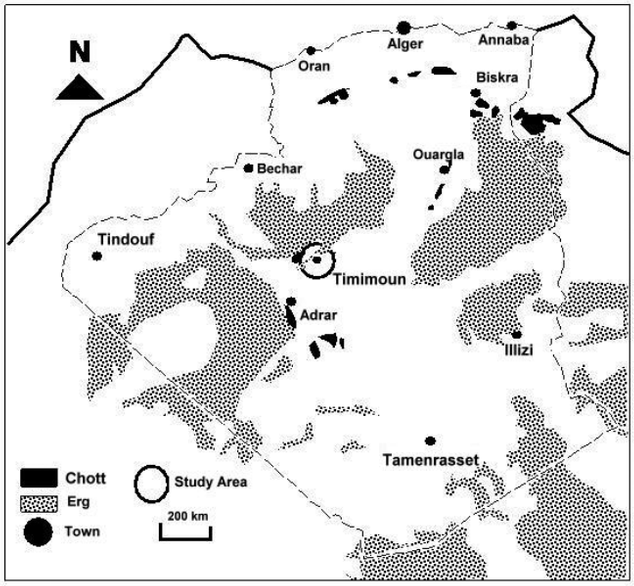


Figure 1: Location of study area.

foggara has two functions: collection and distribution. The collection of groundwater is provided by a gallery of several kilometres and low slope which drains water from the Continental Intercalary aquifer to the surface soil. This gallery is equipped with several wells that are used for maintenance and ventilation of the foggara. The distribution of water takes place just outside the gallery. Once water arrives at the exit of the gallery, it will be distributed between the owners by the principal kasria (Figures 2, 3 and 4), then the secondary kasria and finally by the multiple kasria. Once the water is distributed, it will be conveyed by the seguias until madjen, and finally it will arrive in guemoun.

The Garden Foggara

The Main Features of the Garden Foggara

The garden foggara is a small foggara which does not exceed 1.5 km in length (Remini et al., 2010). It is a foggara that belongs to one family. Its flow is weak compared to that of the classic foggara. It is found downstream of one or more classic foggaras. It picks up the water of drainage and leaching of irrigation of the palm. Any water lost by the classic foggara (by water infiltration of seguias and madjens) is recovered by this small foggara (Figures 5 and 6). The distribution of water for this type of foggara is simple and does not require any division. This type of foggara is not equipped with a classic kasria, but rather with a special kasria whose comb has only one opening (Figures 7 and 8).

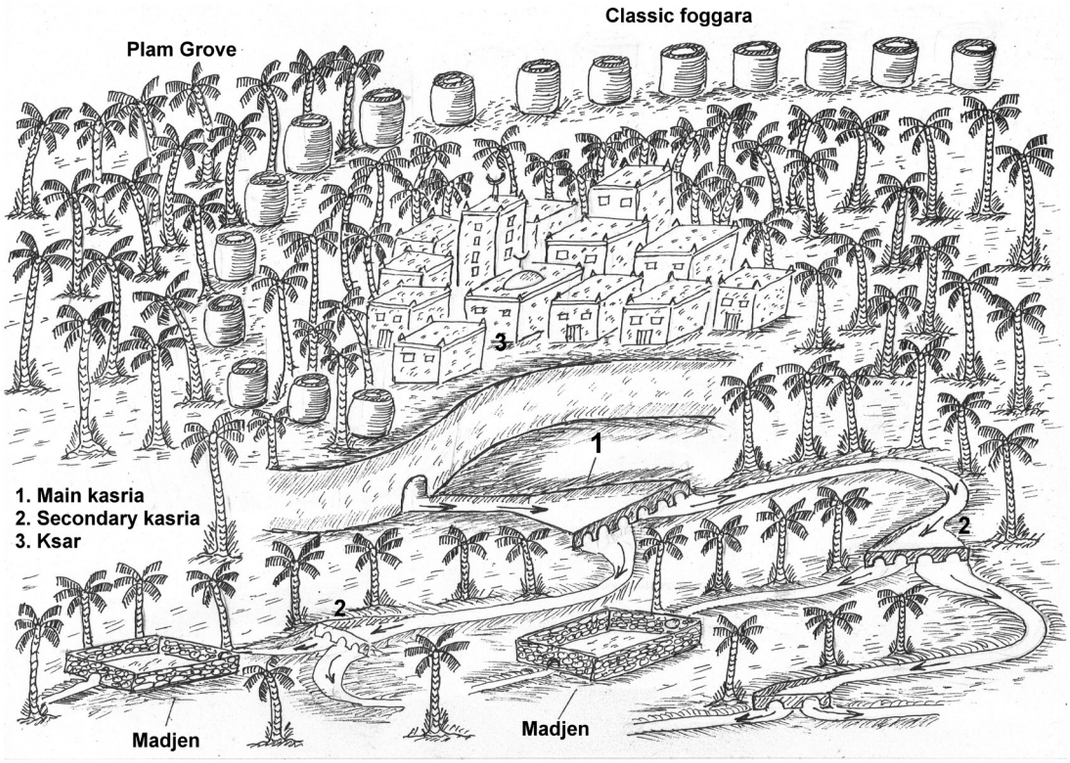


Figure 2: Sketch of a classic foggara.

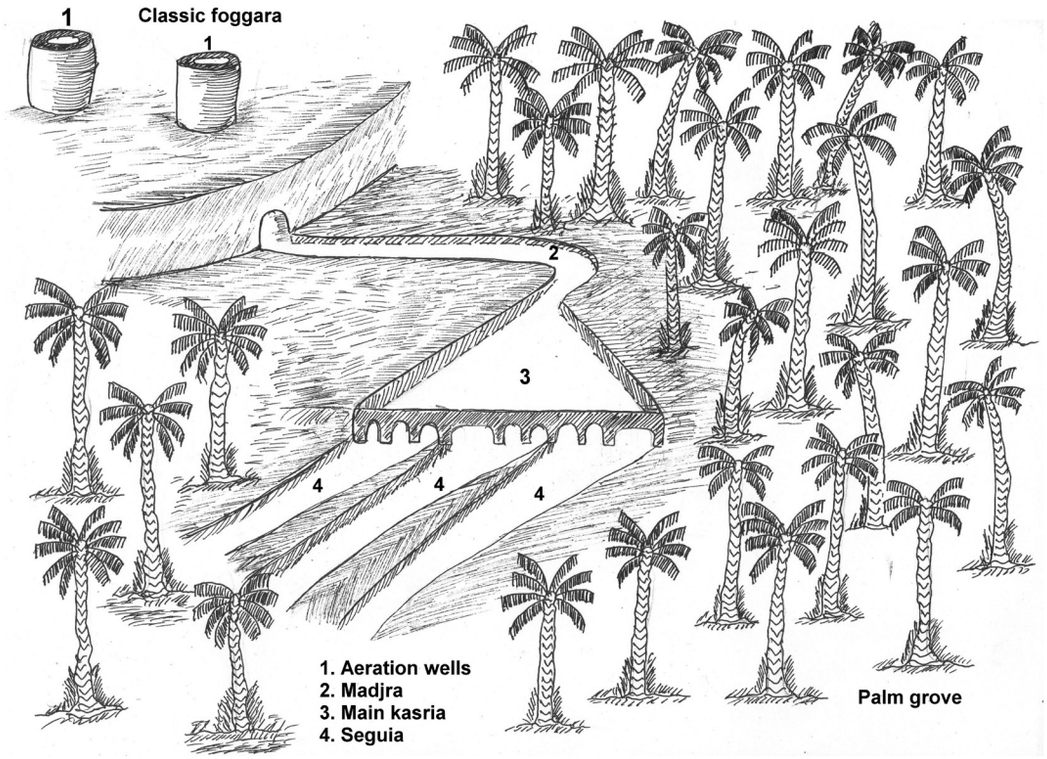


Figure 3: Schematic of a main kasria of classic foggara.



Figure 4: Main kasria of foggara of the oasis of Timimoun.

The Operation of the Garden Foggara

The operation of the garden foggara is very simple and requires no division between the co-owners as the classic foggara: it belongs to one owner. At the exit of the gallery, one finds a kasria of rhombus form and not triangular like the classic foggara. In the kasria, one places a rock plate of perforated rectangular form which is closed with a fabric soaked with clay (it plays the role of a valve). For efficient irrigation, one seals the opening and once the gallery is filled with water, one opens the opening to allow the filling of the madjens within an acceptable time. It is a particularly spectacular example which shows the genius of the Timimoun villagers. Not visible on satellite images and aerial photographs, the garden foggara is located in the gardens of the oases.

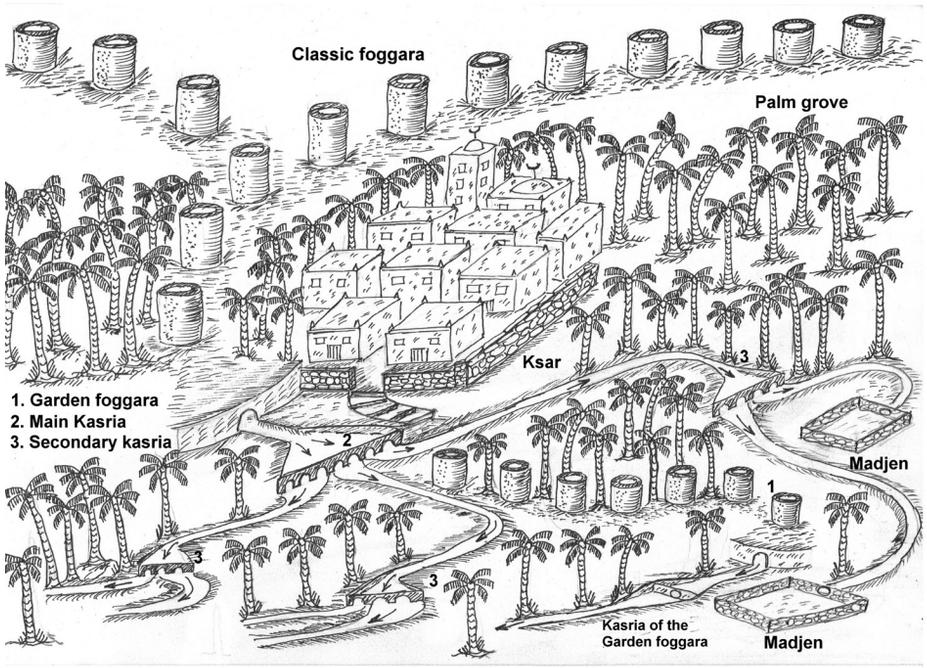


Figure 5: Sketch of a garden foggara.

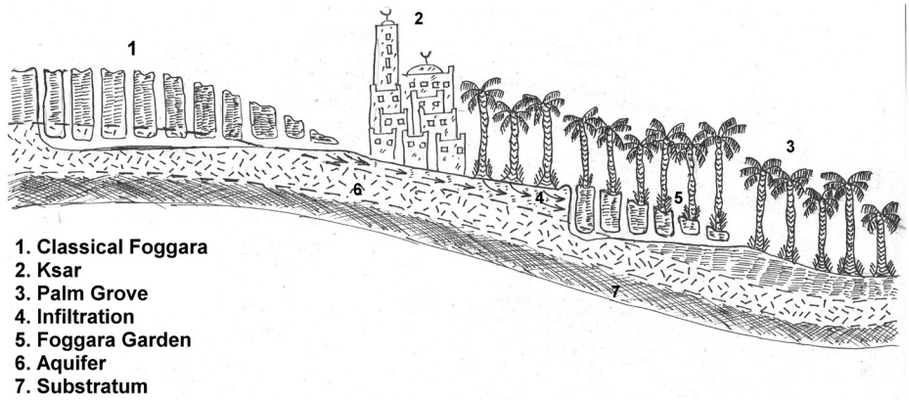


Figure 6: Longitudinal section of a garden foggara.

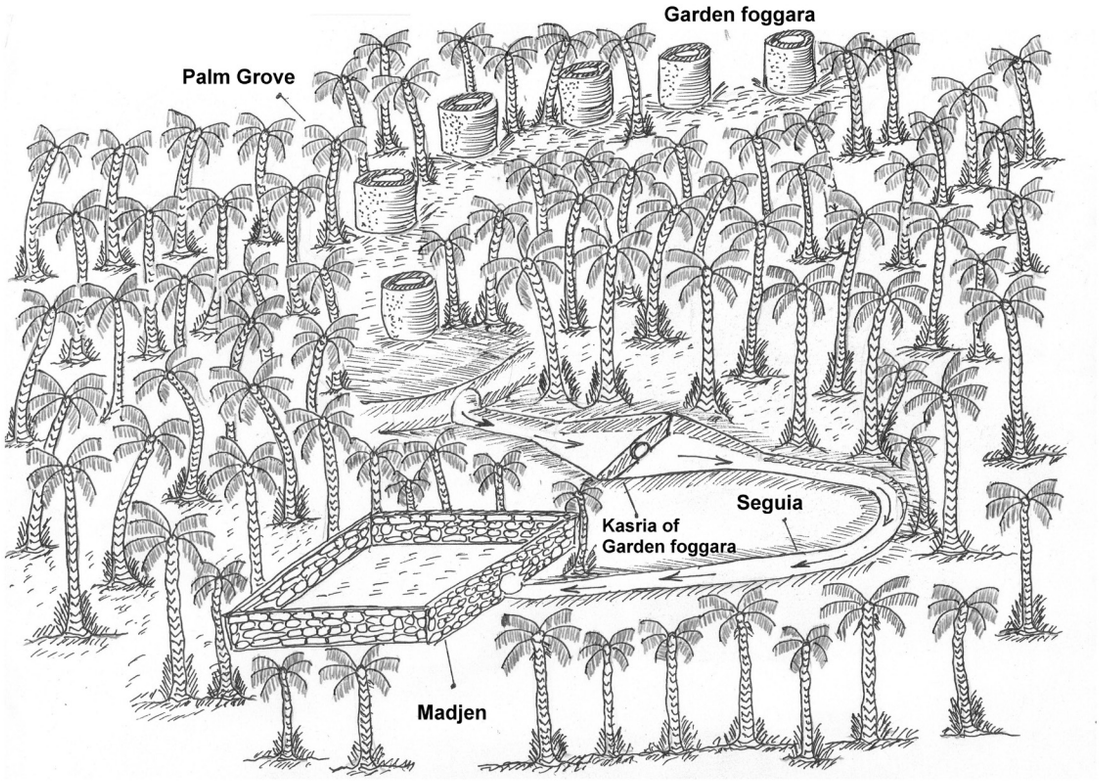


Figure 7: Schematic of a garden foggara.



Figure 8: Kasria of garden foggara in the oasis of Timimoun.

Its gallery does not exceed 1500 metres while the number of ventilation shafts remains below 20. Unlike classic foggaras, we do not know the exact origin and development of this technique. Is it about a local evolution due to lack of water irrigation of the gardens located further downstream of the principal foggara? Is it about a control of the technique of foggaras which makes it possible to better manage water without wastage and to better exploit water for irrigation? For this study, we listed seven garden foggaras in the Timimoun oasis, whose characteristics appear in Table 1. From the values quoted in the table, we notice that the garden foggara has short galleries which have low discharges. For example, it takes 12 hours (during the night) to fill the gallery of the Zahzah foggara which has a volume of 850 litres.

Limitations of the Garden Foggara

The discharge of the garden foggara is slow and relies on the discharge of the classical foggara. This technique can only irrigate gardens and can neither supply the palm plantation, nor the domestic water need of the ksar's population. The garden foggara encounters two major problems:

- Technical problem: it can dry if the discharge of the classical foggara reduces.
- Social problem relating to inheritance (all the garden foggara were abandoned because of this): It cannot be divided between more than 2 or 3 co-owners.

Table 1: Characteristics of the garden foggara

Foggara	*Length (m)*	*Number of wells*	*Flow (l/s) (2010*	*Flow (l/s) (2012)*
Agalou	100	20	0.012	00
Zahzah	120	15	0.02	00
Akraf	60	10	0.01	00
Ksar El Kedim 1	50	2	0.01	00
Ksar El Kedim 2	90	20	0.01	00
Oukala	-	abandoned		
Bouchouk	-	abandoned		

Degradation of the Garden Foggara

The classic foggara of Timimoun deteriorates from one year to another. Two foggaras are abandoned each year. Practically, the flow of foggaras decreases annually. According to the owners of foggaras and the people of Ksar, the degradation of foggaras is due to technical and social problems. The main technical factors are: the collapse of the galleries and the depletion of the aquifer. Inheritance, that is the lack of transmission of the trade to young people and the contribution of modern techniques (drilling and pumping) are the major social problems affecting this heritage hydraulics. These problems directly affect the garden foggara. Thus, the decreased flow of the classic foggara causes reduction or drying of the garden foggara. In 2010, the only garden foggara in operation was the garden foggara of the Zahzaa oasis which was working at a much lower rate than it was in 2010. The six other foggaras were abandoned by the population. In 2012, the Zahzah foggara was abandoned following the lowering of the water. Returning in 2014 in the oases of Timimoun, these foggaras were abandoned.

Conclusion

The garden foggara is called so because it is located in the gardens. It reflects the genius of farmers of the Timimoun oasis showing their interest in water, a scarce resource in an arid area like Timimoun. There is neither deficit, nor surplus of water, no drop of water is lost. It is all used in irrigation in an optimal way. The garden foggara recovers the leaked water of the conventional foggara upstream for reuse in irrigation of gardens located further downstream. We identified five out of seven functional foggaras. The garden foggaras are usually built in Timimoun. There are seven foggaras: Agalou (20 wells), Zahzah (15 wells), Akraf, ksar El Kedim1 and ksar El Kedim2. The Oukalas and Bouchouk foggaras are abandoned.

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