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A – study design
B – data collection
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E – manuscript preparation
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The Mzab foggara: an original technique for collecting the water rising

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Abstract

This paper describes for the first time an original foggara, different from the classical foggara (foggara of Gourara) which collects water from the Intercalary Continental aquifer. Located in the middle of the Mzab River, this hydraulic system called the Mzab foggara is intended to exploit the flood waters. Two missions were carried in 2009 and 2010 in the Mzab Valley to describe the hydraulic system. The Mzab foggara constitutes of a gallery of ovoid form 200 m long equipped with 9 air shafts and a 900 m long seguia. The foggara of the Mzab River can drain water flow of $5 \text{ m}^3 \cdot \text{s}^{-1}$ to irrigate western part of the palm plantation of Ghardaïa (located 600 km south of Algiers).

Key words: *foggara, Ghardaïa, Mzab, rising, wadi*

INTRODUCTION

The creation of oases is conditioned by the presence of a water source. Thus, in hyper-arid regions of the Algerian Sahara characterized by low rainfall, farmers developed over time different traditional techniques of extraction of ground and surface water (floods). To capture and store flood water, farmers developed small dams (made of local materials) and seguias for the distribution and delivery of water to gardens. For the acquisition of groundwater, villagers developed techniques for capturing groundwater from wells that evolved over time from a vertical well driven by human or animal energy to a well using only the horizontal slope. The water arrives more easily to gardens by gravity.

This technique called foggara is extensively developed in the oases of Touat and Gourara, since the topographic and hydro-geological conditions in the region are favourable for realization of this hydraulic

system. Over 1400 foggaras were dug in these regions over the last centuries. Today, because of technical and socio-economic problems, only about 880 remain in operation [REMINI *et al.* 2011].

The foggara has been developed in all arid regions of the planet, since it exists in over 35 countries [BOUSTANI 2008]. Iran is the country which possesses the greater number of foggaras known as the qanat. There are about 22000 qanats operating in arid regions of Iran [LARSON, McLAUGHLIN 2006]. Morocco has 570 khattaras out of which 250 are operational [Ministry... 2006].

The hydraulic system was developed for the exploitation of surface water. Improvements and enhancements have been introduced to this system during time. For example, in Iran there are qanats with two galleries superimposed one above the other [SAFI NEZAD-BALLAND 1992].

In this paper, we describe an original foggara that we saw in 2009 during a study on flooding in the

Mzab River. It is conceived to capture flood waters drained by the river of Mzab which is located 600 km southwest of Algiers.

STUDY SITE

During a mission in 2009 by the Mzab River to study the impact of flooding on the degradation of traditional hydraulic system, we saw in the middle of a Mzab wadi a foggara particularly different from the classical foggara of the region of Gourara. In 2010, a second mission to the site was completed to take all the characteristics of the foggara.

Ghardaia is a tourist town located 600 km south of Algiers. The study site is located in the centre of the Mzab River about 2 km upstream from the palm plantation of Ghardaia (Fig. 1).

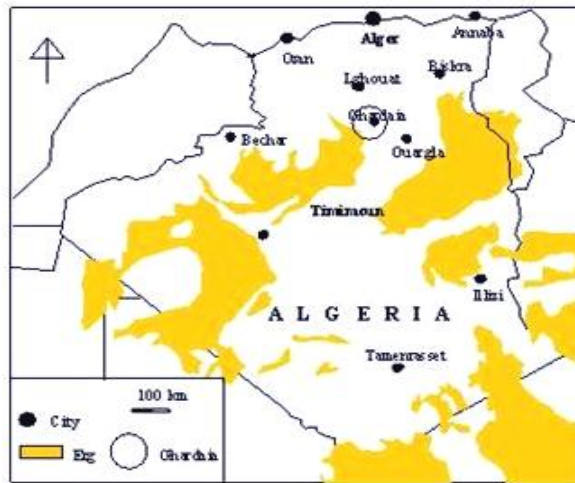


Fig. 1. Location of study area

To take the geometrical characteristics of the foggara: length and slope of the gallery, depth, diameter of wells and spans between wells, we used a decametre wheel and a GPS (Fig. 2).

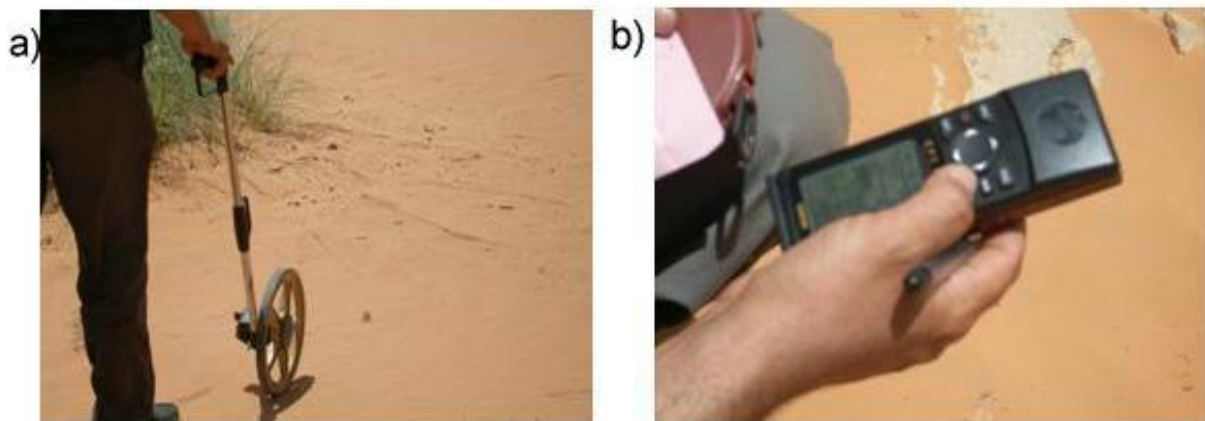


Fig. 2. Measuring instruments: a) decameter gurdy, b) garmin GPS

RESULTS AND DISCUSSION

During missions in the Mzab River valley in 2009 and 2010 we found the hydraulic system in the middle of the river. The functioning principle of this foggara was similar to that of the classic foggara of Gourara. The Mzab foggara consists of a gallery of slight slope equipped with ventilation shafts which captures the flood waters of the Mzab River. On the contrary, the classical foggara of Gourara collects groundwater. The Mzab foggara is unique in the world, but nobody can confirm its origins, nor the period of its construction.

Constructed for irrigation of the palm plantation in Ghardaia (eastern), the foggara of Mzab is composed of two parts: an underground tunnel and an open seguia (Fig. 3). The form of the gallery is ovoid and resembles the form of the Iranian qanat [DAANISH, MUHAMMED 2007]. The shape of the gallery of the classical foggara of Gourara resembles the form of the gallery of Karez in Pakistan (Fig. 4) [L'HOTE 1990].

The Mzab foggara exploits flood waters once stored in the reservoir formed by rock filled dam 77 m wide and 1.5 m high. The water is channelled by an underground 170 m long tunnel equipped with 8 air shafts 3 m deep and 1 m in diameter.

When leaving the gallery, the water is drained by a seguia 900 m long and 1.5 to 3.0 m wide, then it is again carried by a 50 m long gallery equipped with one air shaft to reach the gardens. Once in the palm plantation, it is distributed between the proprietors by a network of seguias (Fig. 5). An estimated flow of the foggara can reach $300 \text{ l}\cdot\text{s}^{-1}$ during a major flood.

CONCLUSION

Contrary to the classical foggara of Gourara which exploits the steady flow of groundwater the Mzab foggara exploits flood waters. This is a foggara

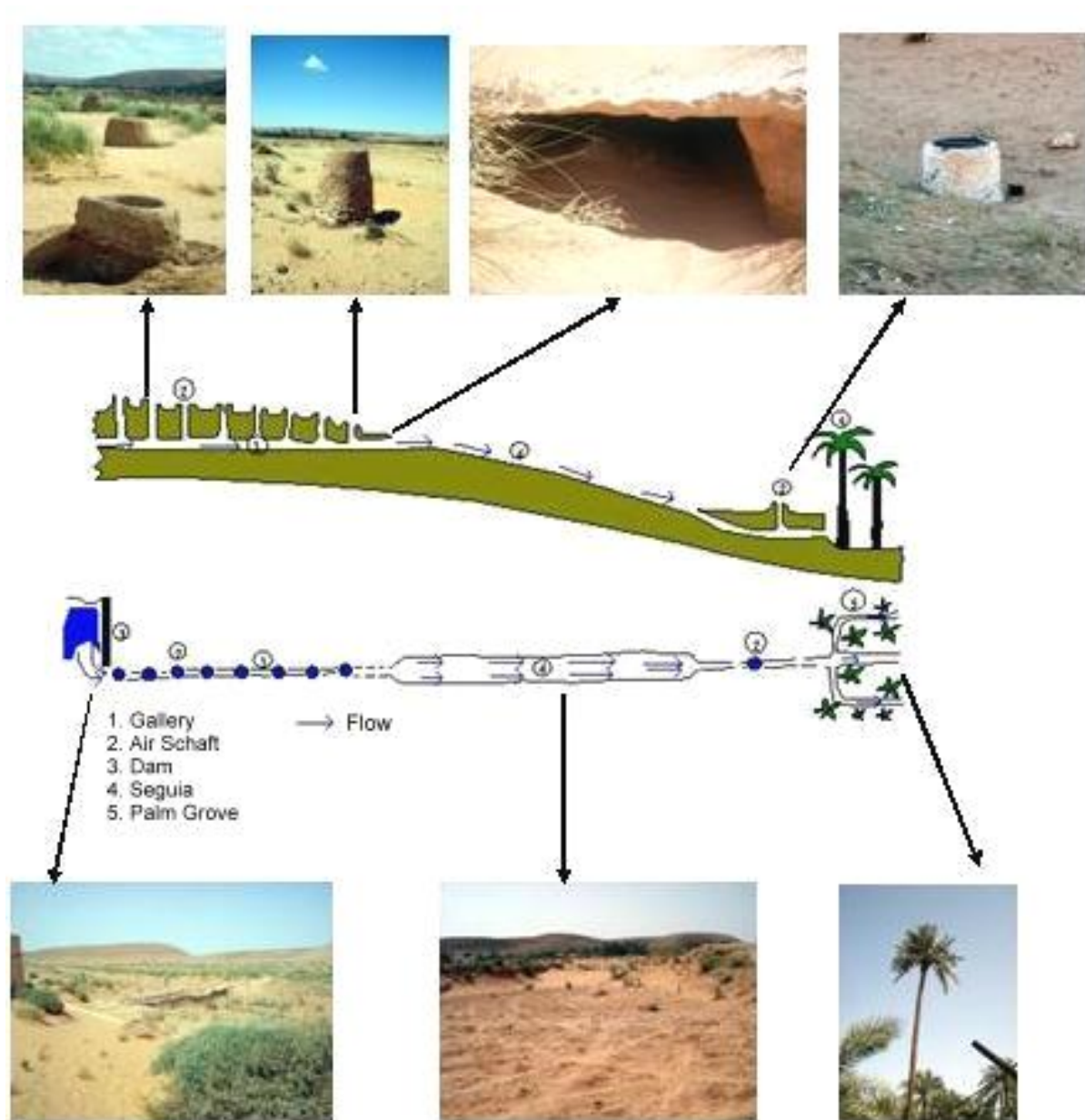


Fig. 3. Different parts of the Mزاب foggara

for temporary flow. Realized to irrigate the western part of Ghardaia palm plantation it has a gallery of 170 m length equipped with 10 air shafts of 1 m in diameter and a seguia of 900 m length and 1.5 to 3.0 m width. It is a unique foggara in Algerian Sahara.

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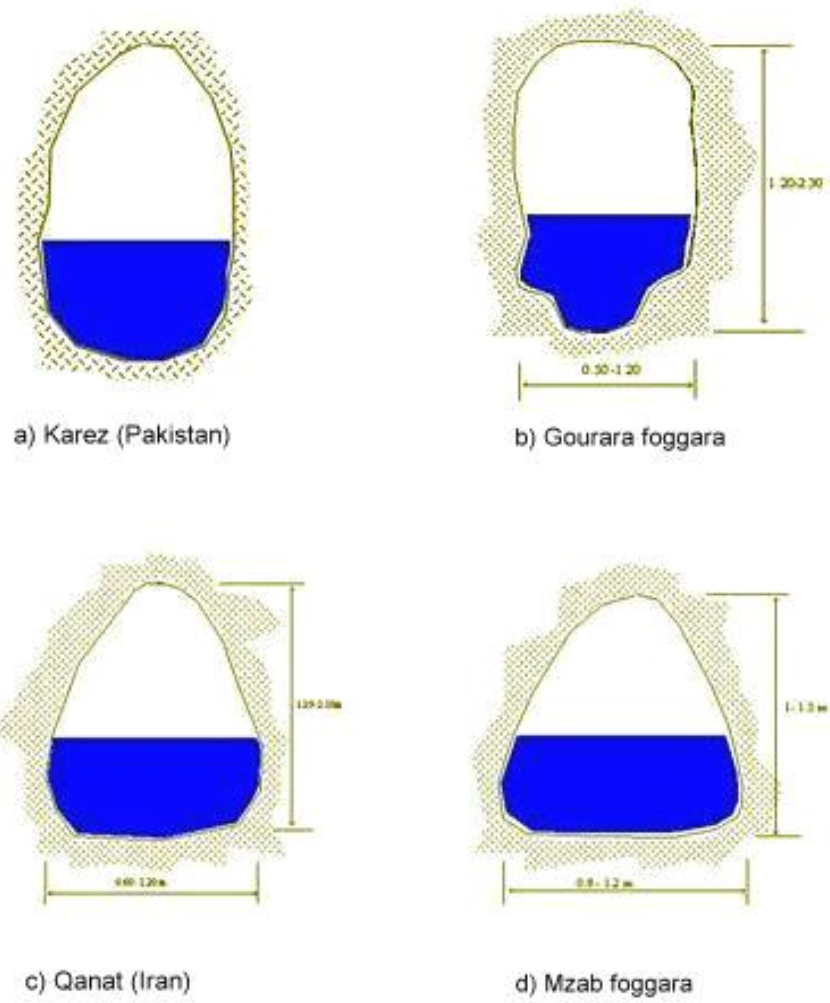


Fig. 4. Different sections of tunnels

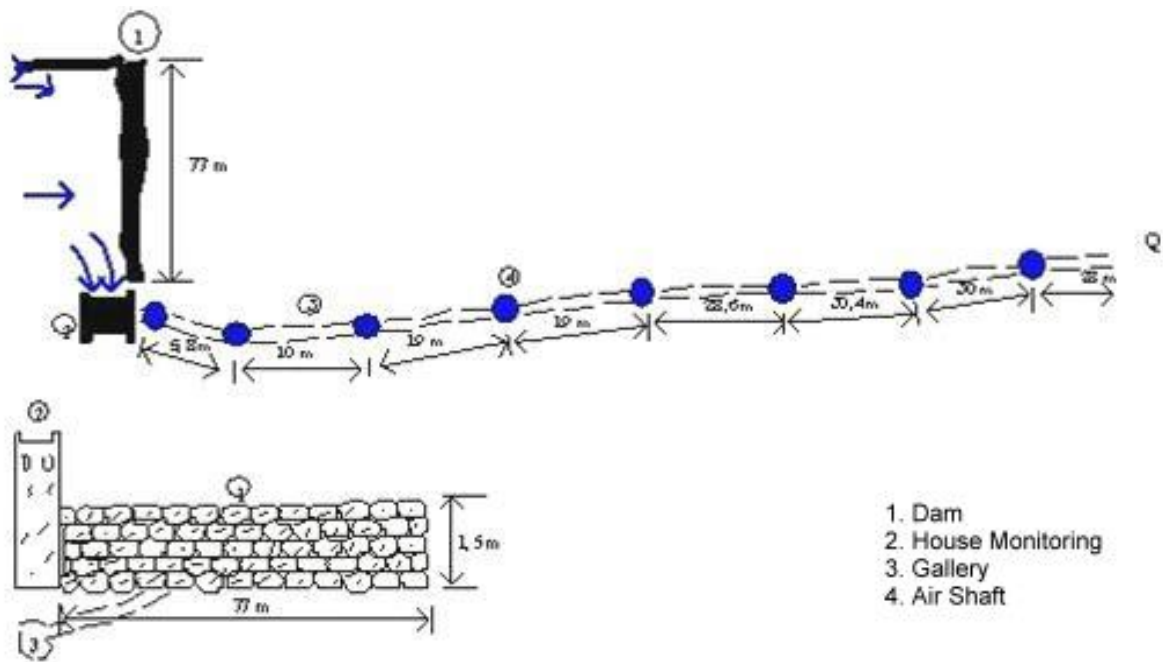


Fig. 5. Functional scheme

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Foggara rzeki Mزاب: oryginalna technika gromadzenia wód powodziowych

STRESZCZENIE

Słowa kluczowe: *foggara, Ghardaia, rzeka Mزاب, wadi, wezbranie*

W artykule opisano po raz pierwszy oryginalną foggarę (podziemna instalacja wodna, używana do zaopatrywania siedzib ludzkich w wodę oraz nawadniania pól uprawnych na terenach suchych i pustynnych; inne nazwy to kanat i kariz – na podstawie Wikipedii), odmienną od klasycznej foggary z Gourara, która gromadzi wodę z kontynentalnego inkluzyjnego poziomu wodonośnego. Ten system hydrauliczny, zwany foggarą Mزاب, usytuowany jest w środkowym biegu rzeki Mزاب i przeznaczony do eksploatacji wód powodziowych. W celu opisanego systemu przeprowadzono dwie wyprawy do doliny rzeki Mزاب w latach 2009 i 2010. Foggara Mزاب składa się z owalnej galerii długości 200 m, wyposażonej w 9 szybów wentylacyjnych i w 900-metrowy kanał rozdzielczy. Foggara rzeki Mزاب może dostarczać wodę w ilości do $5 \text{ m}^3 \cdot \text{s}^{-1}$ do nawadniania zachodniej części plantacji palm w Ghardaia (600 km na południe od Algieru).