

THE FOGGARA: A TRADITIONAL SYSTEM OF IRRIGATION IN ARID REGIONS

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Abstract

This article discusses the traditional irrigation system in the oases of Touat, Gourara and Tidikelt. Since centuries, farmers use the system of foggaras for irrigation of palm groves and gardens.

The results obtained following the inquiries and investigations carried out on the sites of foggaras, showed that since the eighties, drilling works multiplied in the oases of Touat, Gourara and Tidikelt. However, despite the application of these new techniques of water catchment, farmers still irrigate their gardens by traditional methods. For social, economic and environmental problems, foggaras degrade more and more; 50% of the foggaras decayed. Currently, the discharge of foggaras in service greatly diminished. The adoption of modern catchment techniques entails to the lowering of the water table.

Keywords: water, foggara, oasis, irrigation system, Sahara

1 INTRODUCTION

The Algerian Sahara is a hyper-arid region where rainfall does not exceed 100 mm/year. The temperature can reach 50 °C during summer. Evaporation exceeds the threshold of 2 m/year. This dry environment with bare soil characterized by the absence of surface water pushed farmers to exploit the waters hidden in the soil. Thanks to the knowledge of farmers on hydraulics and engineering, hundreds of foggaras were developed in the regions of Touat, Gourara and Tidikelt. This ancestral water catchment system has been developed in the ancient Iran for over 3000 years (Goblot, 1963; Goblot, 1979; Kazemi, 2004). Called Qanat in Iran and Khettara in Morocco, foggaras have spread to over 30 countries around the world (Hofman, 2007). Just through this ingenious hydraulic system, thousands of hectares of land have been earmarked and promoted. Hundreds of hectares of palm groves are irrigated by foggaras. Several oases were developed in southwest Algeria.

The objective of this paper is to study the effectiveness of irrigation by foggaras during the last ten centuries. The impact of new technologies of water catchment on the degradation of foggaras is another subject of this study.

2 REGION OF STUDY AND INVESTIGATIONS

2.1 Location and characteristics of the region

The regions of Touat, Gourara and Tidikelt known as the country of foggaras are located more than 1200 km to the southwest of Algiers (Fig. 1). About 1400 foggaras have been dug for more than 10 centuries. Today, there are not more than 700 operating foggaras.

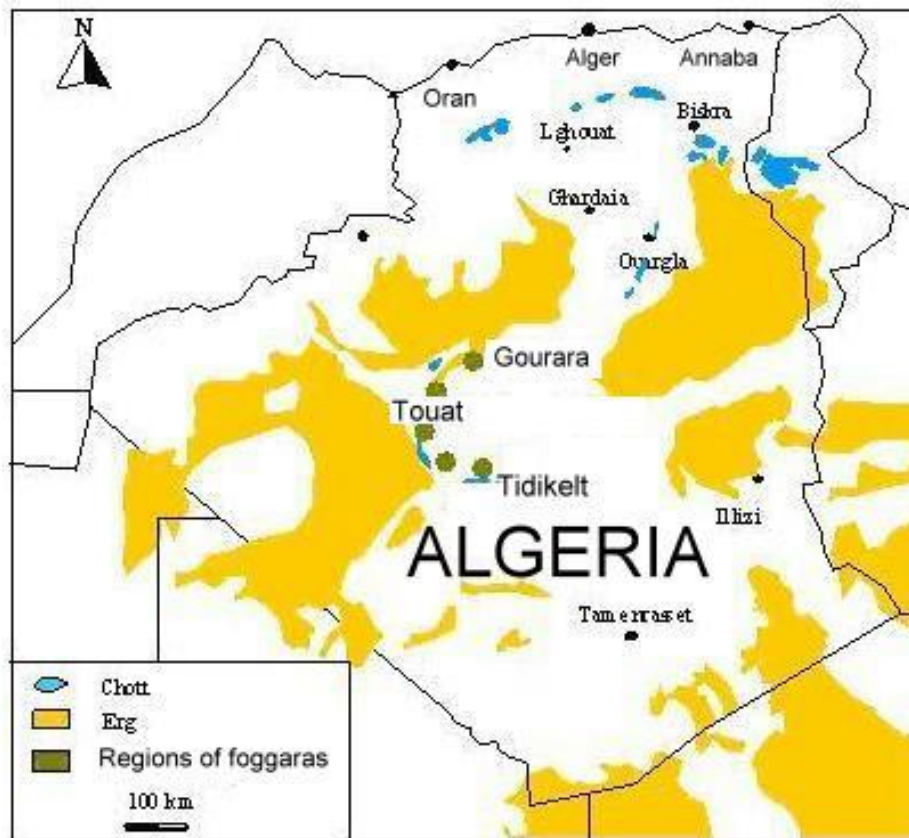


Fig. 1 Location of study areas

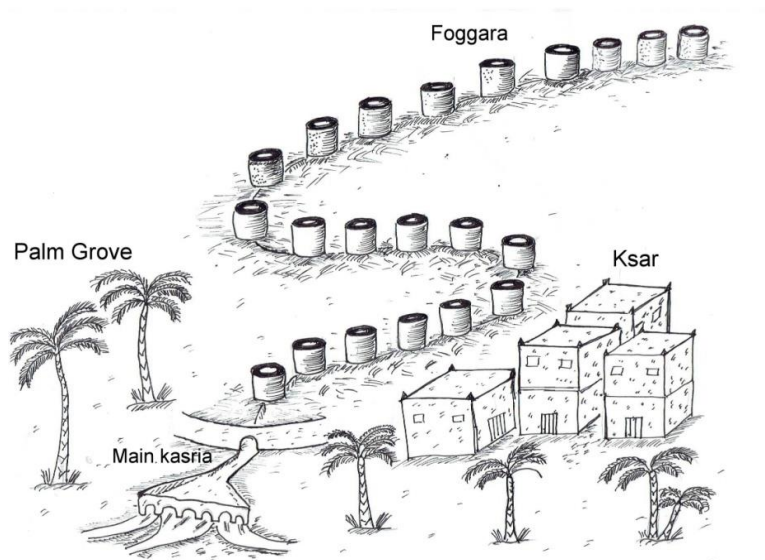
2.2 Missions and investigations

We conducted several missions in the oasis of Touat, Gourara and Tidikelt. Surveys were performed with local people and owners of foggaras. Visits were carried out to twenty foggaras to detect the real problems of degradation.

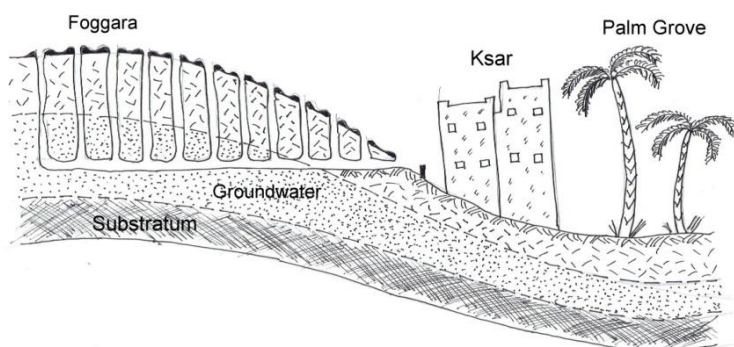
3 RESULTS AND DISCUSSION

3.1 Irrigation by foggaras

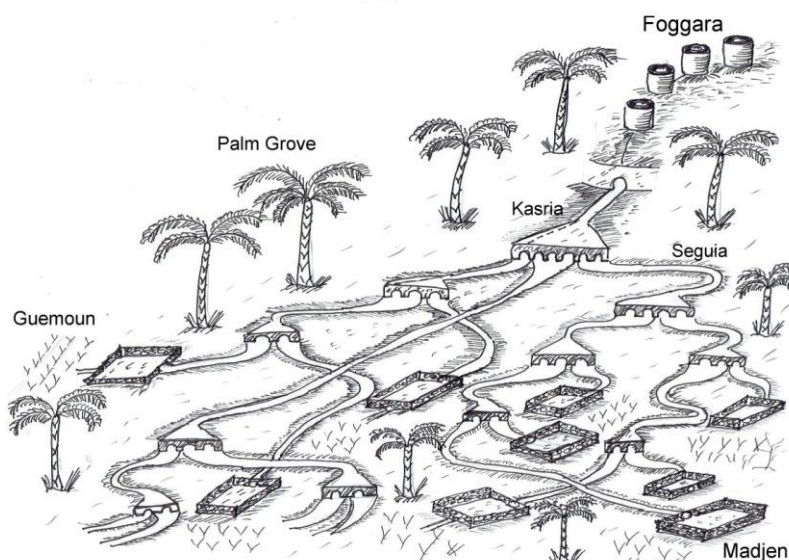
The foggara is an underground tunnel, one hundred meters in length, equipped with several air shafts for maintenance and ventilation of the gallery. To ensure gravity flow, the gallery is slightly inclined. The length of the gallery ranges from 100 to 14,000 m (Fig.2 (a, b, c)). The number of aeration wells varies from 10 up to 500 with depths ranging from 8 m to 40 m (Fig.3). The foggaras in the regions of Touat, Gourara and Tidikelt exploit the water of Intercalary Continental series. Considered one of the largest tablecloths of the planet, the Intercalary Continental series is a fossil aquifer. The gallery collects and drains the water from the underground to the ground surface. As the foggara is a collective structure, the water outlet of the gallery is shared between the owners of the foggara. A small pond triangular ending by a diverter at its base that takes the form of a comb is called kasria (Fig.4). The largest kasria (main kasria) is placed at the outlet of the gallery which serves for sharing water among the owners of the foggara. The portion of water depends on the contribution of each owner. From the main kasria, each part of water is fed by a channel (seguia) to a storage basin called madjen which is filled in 24 h (Fig. 5). From this madjen, the water flows in the small seguias embedded in the garden (Guemoun) to irrigate palm trees and other plants (Fig. 6). Generally, in the irrigation channel from the main kasria a portion of water for one family (a group of owners) flows that ends in a secondary irrigation channel. Once the water sharing is established, the water flows in seguias low sections to reach the secondary kasria. Shared by the secondary kasria, the water flows in small seguias to run into tertiary kasrias. Each owner then receives a share of water in terms of his contribution to the development and maintenance of the foggara.



a) An overview of the foggara



b) A longitudinal cup of the foggara



c) A distribution network of the foggara

Fig. 2 Schematic diagram of the foggara



Fig. 3 An airshaft at the foggara of Gourara



Fig. 4 The secondary Kasria at the foggara of Gourara



Fig. 5 The segua in an oasis of Gourara



Fig. 6 Guemoun (garden) in an oasis of Touat

3.2 Relationship between the palm grove and the foggara

In the oases of Touat, Gourara and Tidikelt, there is a relationship between the foggara and the palm grove. Indeed, it is the flow of the foggara which determines the size of the palm grove. As soon as the palm grove area increases by implanting a new palm trees, the farmers increase the discharge of the foggara or they get digging a second foggara. To support this idea, we show in Fig. 7(a, b) the discharge of the foggara depending on the size of the palm grove of oases of Touat and Gourara using the inventory data on foggaras from 1962 (Arrus, 1985).

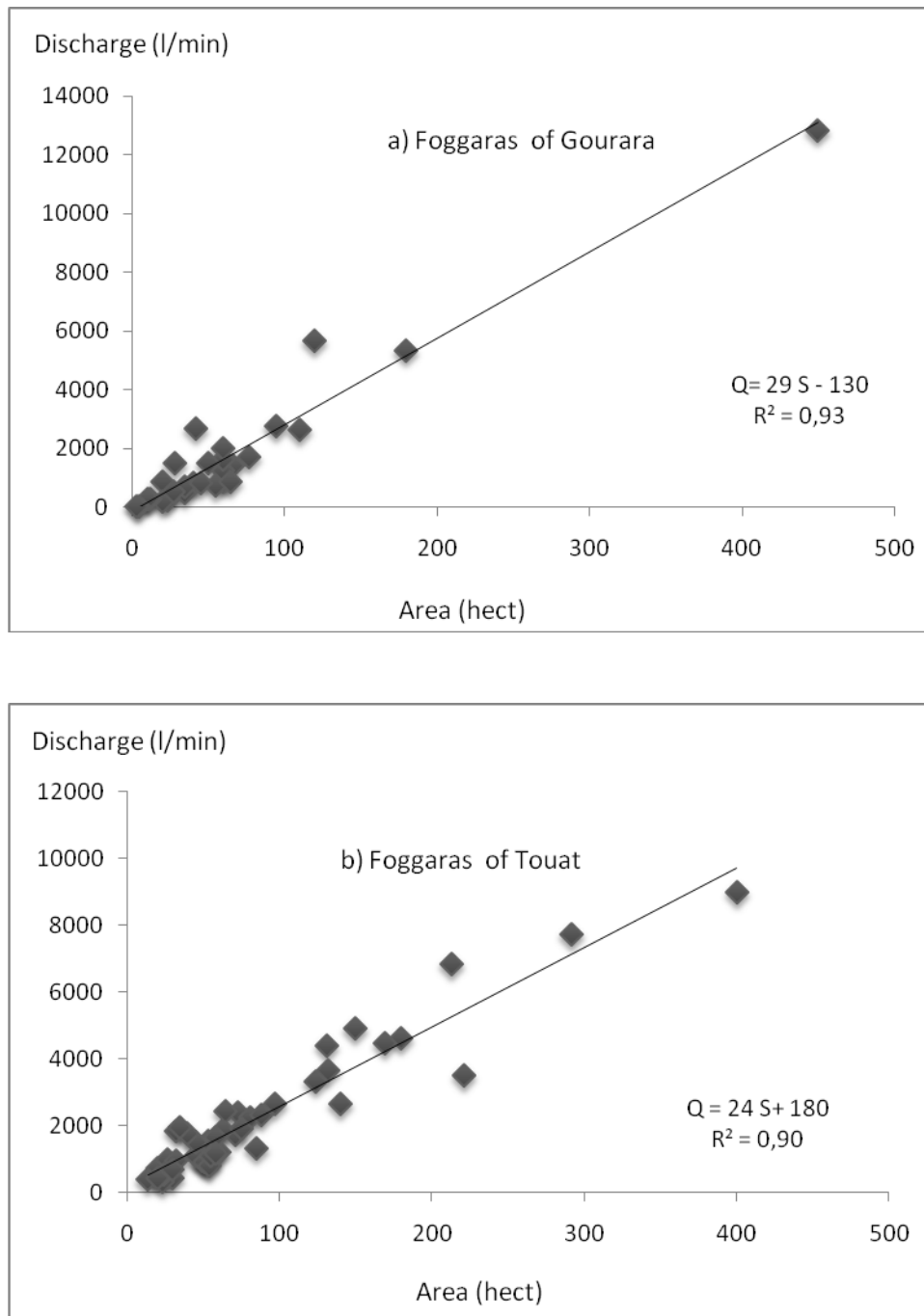


Fig. 7 Evolution of the foggara flow rate depending on the surface area of the palm grove (Data: Arrus, 1985)

It is interesting to note that there is a clear correlation between the throughput of the foggara and the area to irrigate. It consists in that there is no surplus or deficit of water. It is the know-how and engineering of farmers demonstrating that the irrigation of the palm grove was well studied by farmers of Touat, Gourara and Tidikelt. By highlighting new agricultural land, the farmers increase the discharge of the foggara by extending its gallery. Increasing the length of the gallery, automatically the number of aeration wells increases. To verify this hypothesis, the figure (Fig. 8 (a, b)) shows that there is indeed a relationship between the discharge and the length of the gallery of the foggara.

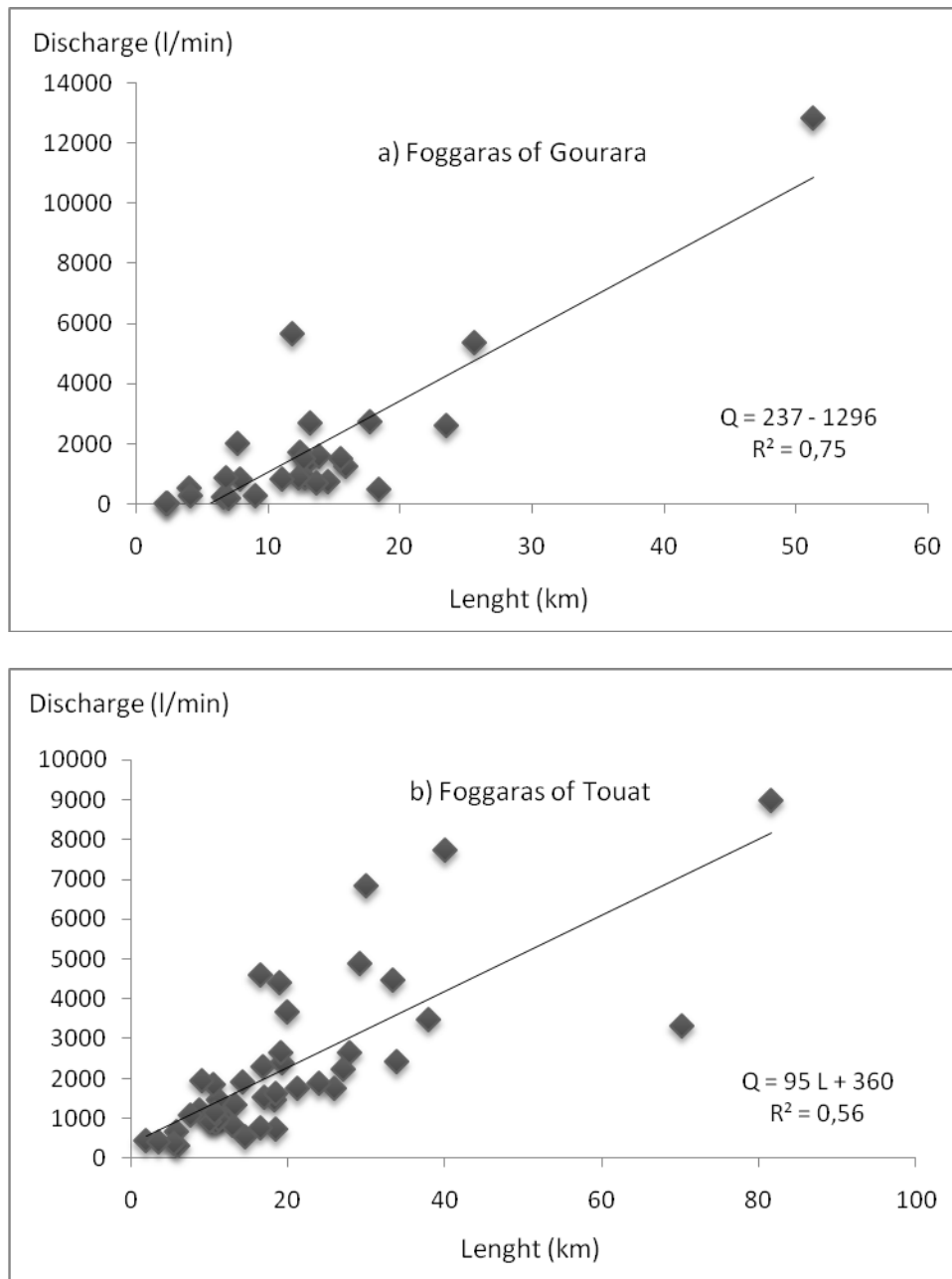


Fig. 8 Evolution of the foggara discharge depending on the length of the gallery (Data : Arrus 1985)

3.3 The contribution of drilling and degradation of the foggara

Dry environments are very fragile ecosystems. So the slightest disturbance can cause harmful consequences to the environment. For over 10 centuries, the farmers of Touat, Gourara and Tidikelt irrigate their gardens by the foggaras without causing any irregularity in the environment. No excess water was recorded during the operation of foggaras which avoided the lowering of the water discharge. The application of modern technology in the area during the fifties and the proliferation of boreholes from the eighties have greatly reduced the discharge of foggaras. On the other hand, given the good performance of a drill, farmers prefer irrigation drilling at the expense of foggaras.

For example, one foggara gives on average one liter of water per second to a 2 km long draining gallery, while the drilling method in the same fields with a well of a few meters provides a ten times higher flow rate (Bisson, 1991). This difference that allows the Sahara to get a water flow without much greater physical energy encourages the oasis to abandon the foggaras whose number continuously declines. We no longer maintain the

old galleries and build new drains. Maintaining a foggara is much more complicated than its realization. Today, it is difficult to proceed with the construction of new foggaras. There were more than 900 foggaras in the early 20th century, against 650 in 1996 (Kassah, 1998) and about 600 foggaras productive today (Kaoula, 2002). The total available discharge does not exceed 3 m³/s.

4 CONCLUSION

As we mentioned above, the foggara is the oldest irrigation technique which remains in service today in the areas of Touat, Gourara and Tidikelt. Despite its age of 10 centuries, the foggara irrigates thousands of acres of a palm grove with the best dates in the world. Unlike drilling, the discharge of the foggara is directly related to the irrigated area. There is no deficit or surplus of water in the gardens. Despite the competition with drilling, the foggara continues to irrigate thousands of palm trees. It is virtually impossible to dig new foggaras, however we can maintain and protect the foggaras in service.

REFERENCES

- [1] Arrus, R. 1985: Water in Algeria, University Publications Office, 388 p.
- [2] Bisson J. 1991: The Sahara in the development of North African states. Arab Maghreb Mashreq No 134, October - December, Studies, pp. 3-17.
- [3] Goblot H., 1979. Qanats: an acquisition water technique Mountain Edition, Paris, 231 p.
- [4] Goblot H., 1963. In ancient Iran, the techniques of water and great story. Annales, Vol. 18, No 3, pp. 499-520.
- [5] Hofman A., 2007. Traditional water management by qanat in Iran is compatible with the concept of "GIRE"? Technical Summary, February, Engref (Montpellier France), 17 p.
- [6] Kaoula A. 2002: Foggaras. Environmental Atlas of Algeria. Symbiosis Edition, 105 p.
- [7] Kazemi G.A., 2004. Temporal changes in the physical properties and chemical composition of the municipal water supply of Shahrood, north-eastern, Iran. Hydrogeology Journal, No12, pp. 723-734.
- [8] Kessah A. 1998: Water and agricultural development in Maghreb Sahara: challenges, conflicts and tradeoffs. "Revue Secheresse", Vol. 9, No 2, June, pp.95-102.