

THE FOGGARA IN THE ARAB WORLD

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ABSTRACT:

The Arab world is located in the northern hemisphere between the equator and the Tropic of Cancer in the hyper-arid regions and arid planet. In this environment hostile to life, the Arabs have developed the technical to develop foggara oases on the passage of caravans and trade. Foggaras about 4200 are in operation today on a number 11500 dug in 16 Arab countries. The Sultanate of Oman tops Arab countries concerning the use of this technical. 3017 aflaj be involved in the irrigation of gardens in many oases of Oman. Algeria, with 903 functional foggaras is ranked second. Over 150 khattara are still operating in the region Tafilalt, Morocco is in third place. About 30 qanats Romani are still functional in the oases of Syria. Water flows again in a few tens of qanats throughout Yemen, Saudi Arabia, its UAE, Jordan and Tunisia. The foggaras are off and abandoned in Iraq. Remains and traces of foggaras have been identified in ancient oases of Libya and Egypt.

Keywords: *Arid, Arab Countries, Foggara, Oasis, Water.*

1. INTRODUCTION

The territory of the Arab world is localized in the drylands of the world, in which are combined with low rainfall and high temperatures. To compensate for the lack of rainfall, the Arabs have developed an original technique of water extraction from underground to fertilize the soil and adjust the oases.

The technique is known in Algeria in the name of the foggara of khattara Morocco from falaj the Sultanate of Oman, the kriga Tunisia, Ain Saudi Arabia, qanat Romani Jordan and Syria. The foggara system is a technical associated with a social work group led by a committee of elders whose role is to ensure its maintenance and distribution of water among its copyright holder. Technically, the foggara is an underground tunnel, equipped with several ventilation shafts, which involves draining the water from the groundwater to the surface of the soil, then water will be distributed among farmers by kasria. Before coming to the garden, water will be stored in small basins (**Fig. 1, 2, 3, 4, 5**).

The foggara can reach a length of 20 km of tunnels and a depth of 20 meters for the air shaft. The foggara, known as qanats, an invention is Iranian. It developed from mining techniques since 3000 years and is the north-west of the Iranian plateau, which is considered the home of this technique (*Goblot 1963 and 1973*). His transfer to neighboring countries and especially to Arab countries remains unknown. More than 35 countries worldwide have adopted this technique (*Hofman, 2007*). Iran remains a country with a relatively high qanats still functional are 22000 qanats (*Boustani, 2008, Goldsmith, Hildyard 1984, Wulff, 1968*). Concerning more particularly the Arab countries and apart from the Sultanate of Oman, Algeria and Morocco, we do not have enough data and studies on the current state of foggaras other Arab countries. However, the number of abandoned annually foggaras is clear evolution in the three countries mentioned above.

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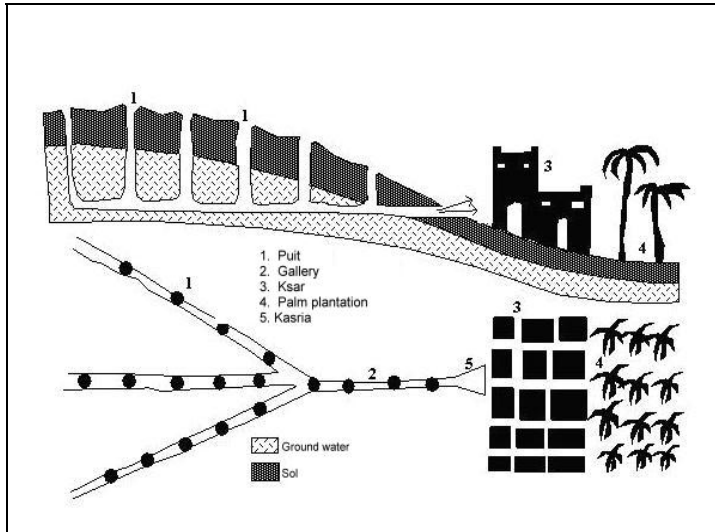


Fig. 1 Diagram of foggara Algerian Sahara

It is now essential not to leave endangered cultural heritage that has been 2500 years participated in the economic, social and environmental region. This study provides a current operation of the foggara in Arab countries and the main problems of degradation.



Fig. 2 Ventilation shaft of foggara through the Adrar city



Fig. 3 Kasria of foggara of Timimoun



Fig. 4 Basin water storage called *Madjen*



Fig. 5 Garden irrigated by foggara

2. FOGGARAS DEVELOPMENT IN THE ARAB WORLD

The Arab countries are hyper-arid and characterized by limited surface water (**Fig. 6**). It is considered the poorest region in the world by the quantity of water available. Any development in this region is intimately linked to the exploitation of groundwater.

For centuries, the oasis with its know-how has taken water from the basement using techniques well outrigger (*Chadouf*) and foggaras by the hydrogeological conditions of the site. The technical of the foggara was considered at the time as a breakthrough technology in hydraulics. It has allowed people to exploit the oasis waters of the water in high quantities and without consuming energy. The rapid spread of this abstraction of groundwater in the Arab countries has generated the proliferation and development of a multitude of oases in the desert. The **Fig. 6, 7** and **8** clearly explain the relationship between the aridity, the distribution of oases and foggaras in Arab countries.

It is found that the majority of Arab countries had the foggaras and development of oases has been done on the basis of the distribution of these hydraulic structures.

The dissemination of this technical is related to the long axis of the Trade "Silk Road", but especially with the spread of Islam that foggara moved into the oasis with date palm and is the main structure of any intra desert oasis.

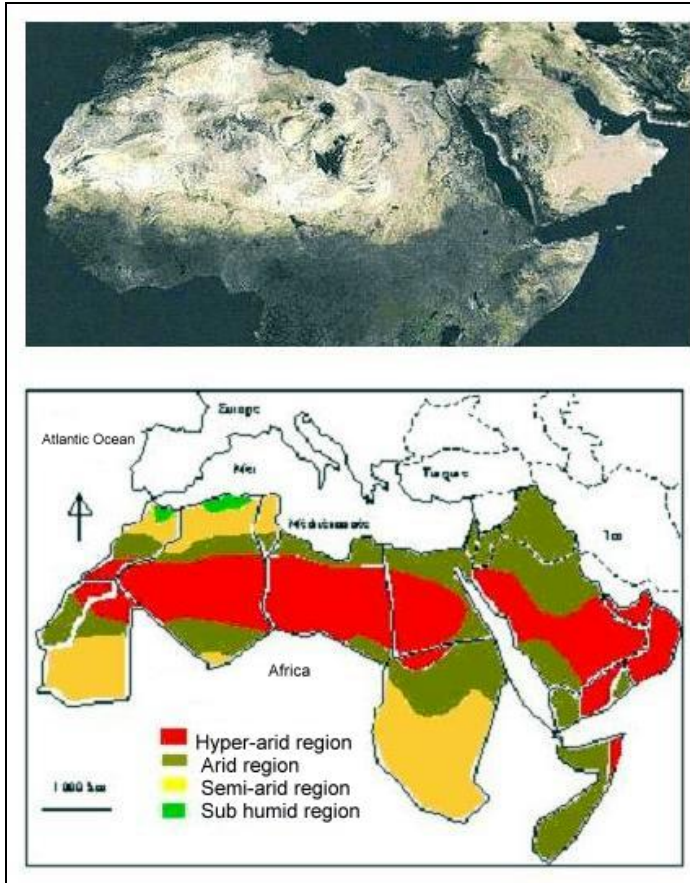


Fig. 6 Aridity of the Arab countries

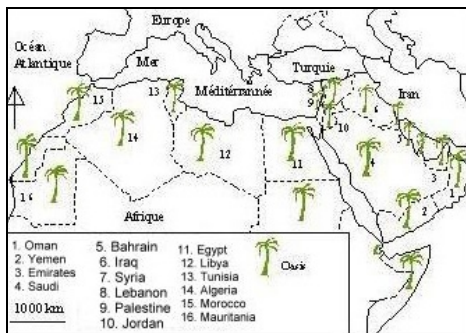


Fig. 7 Distribution of oases in the Arab countries

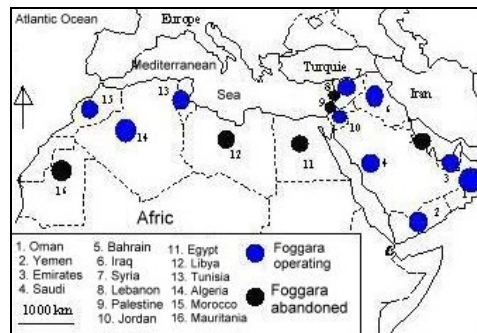


Fig. 8 Distribution of foggaras in Arab countries

Whether the foggara in Algeria, the khettara in Morocco, the kriga in Tunisia, the falaj in the Sultanate of Oman, the ain in Saudi Arabia ain, and the Romani qanat in Syria and Jordan, the principle is the same. It is based on a tunnel of low slope waters draining the water by gravity until the palm. For cons, the difference lies in the way of water sharing between the claimant and the distribution network. For foggara Sahara, Algerian oasis using mode "volumetric" Water gardens come in at the same time for all claimant. In this case the distribution system is equipped with several small pools of water storage (*madjen*) and division boxes (*kasrias*) volumes of water. For khettara Tafilalet of southern Morocco and falaj of Oman, is mode of sharing "time" is applied, the distribution is done "in turn. In this case, the distribution of parts of water is composed of a single central pool of storage and or channels "seguias".

Achieving a foggara depends on the geological and hydrogeological conditions. For this reason we do not find in some oases. In this case, other techniques of groundwater abstraction have been developed as well in balance.

3. CURRENT STATUS IN THE ARAB WORLD FOGGARAS

The digging of the first foggaras in the Arab world took place from 1500 to 2000 years in the Sultanate of Oman (*Al Murshud, 2007*). On the basis of a score of articles consulted, it is estimated the total number of foggaras to 11500. Currently, that number has declined to reach the number 4200.

Despite the drop in flow Aflaj, they still constitute an effective means of irrigation in the Sultanate of Oman. Let Aflaj 4112 which were dug in the Sultanate of Oman (*Al Murshud 2007, Al Gharfi et al. 2000*). It is now operational in 3017 Aflaj regions of Muscat, Al Batimah Al Dhahira Ad Dhakhiya Ascharquia and the Sultanate of Oman.

Aflaj of the UAE provides a flow of 630 l/s (Rizk. Sharhan et al 2003). The oases of Al Ain region are fed by 7 Aflaj still in operation and have a flow of 315 l/s (*Bej Heard, Colin de Verdure, 1999*).

Saudi Arabia had to auyounes 4000-5000 (plural ain) which operated during 1250 years (*Hussain, 2008*). Today the exact number of auyounes operation remains unknown. According to Ben Brahim (2003), on the 570 Khettaras dug in Tafilalet, 250 Khettaras were operational in 1997 and only 150 in 1'an 2000.

The number of foggaras dug in the Touat and Gourara Tidikelet the Algerian Sahara is 1400. The last survey conducted by the National Agency of Water Resources (N.A.W.R) between 1998 and 2001 gave 903 foggaras functional.

Under the INCOMED, a team from the Institute of Arid Regions of Tunisia reported the presence of 9 foggaras Tunisia. Only foggara Umm Jdour (Kasserine) is in operation. In Syria, on the 239 Romani Qanats inventoried, only 29 remained operational (Lightfoot 1996 and Bezza 2006). In Jordan, the 32 Aflaj inventoried, only 8 are operational (Lightfoot 1996 and Bezza 2006). In Yemen, on the 94 Qanats dug, 40 remain operational until 1960. In the plain of Sana'a, only two remained in operation Qanats (*Lightfoot, 2001*). The **table 1** contains the characteristics of foggaras in Arab countries

4. DEGRADATION PROBLEMS IN THE ARAB WORLD FOGGARAS

Technical problems, environmental and socio-economic changes have contributed to the gradual disappearance of foggaras in Arab countries. The contribution of modern techniques (drilling and pumps) in the oasis is the main cause of decline foggaras. Due to scheduled maintenance and low flow, the traditional system has been gradually replaced by

the well pumping and drilling characterized by the abundance of water and the simplicity of the collection. The recurrent droughts in those regions during the past 30 years have greatly reduced the flow of these works. The socio-economic problems, such as rural exodus, migration of population towards large cities, the inheritance and transmission of non-core businesses of the foggara have facilitated the decline of these ancient techniques. Despite attempts to rehabilitate foggaras which is a temporary solution, people are increasingly attracted by modern technology. The replacement of a collective irrigation by individual irrigation has led to wastage of water at the expense of saving water. This has put the environment at risk by the rising water levels in some areas and drying up the water in other places.

5. CONCLUSION

It appears from this study that the foggaras developed in the Arab world have greatly contributed to the development of oasis in the desert environments in Arab history. Indeed 16 Arab countries have adopted this technique namely, Algeria, Oman, UAE, Bahrain, Palestine, Lebanon, Jordan, Syria, Yemen, Morocco, Tunisia, Libya, Egypt, Mauritania, Saudi Arabia and Iraq. Approximately 11500 foggaras dug 2,500 years in the desert of Sahara and Arabia. Today, given the persistent drought in the Arab world, the contribution of modern technology (pumps and boreholes) and the evolution of social problems (migration, inheritance), the foggaras were gradually abandoned. Thus the number of operational foggaras fell during the past 50 years to reach strength of 4200. Today it is impossible to dig more foggaras, but it is possible to maintain what remains. It is a world cultural heritage must be saved.

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