

The Urbanisation Facing the Foggara Perinity : Case of Adrar Region Foggaras (Touat, Tidikelt and Gourara)

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Received: October 17, 2022

Accepted: November 11, 2022

Published: November 14, 2022

Abstract

The foggara is a vernacular system for acquiring and distributing water by means of horizontal drainage galleries. This study is focused on the foggara systems of Touat, Tidikelt and Gourara. Both of them are located in the Western Erg's borders. The outcomes are those of a field study carried out during 2010 in the lower Sahara and of surveys undertaken among these regions' oasis inhabitants. The aim is to draw up an assessment of the Foggara current situation. This latter is characterized by several harmful problems due to the chaotic urbanization despite the existence of the planning instruments engaged to both control urban growth and preserve the foggara.

Key words: Bas Sahara, Touat, Gourara and Tidikelt, foggara, urban planning instruments, Algeria.

INTRODUCTION

Since the middle of the 20th century, the Sahara knew a massive urbanization and experienced an exceptional demographic growth. his demographic dynamism, which has articulated an endogenous growth linked to a higher birth rate and a favourable play of internal (National Statistics Office) and external migrations (Kouzmine & Fontaine, 2018). This phenomenon should be certainly the main change marker that characterized the region by changing natural to urban environments (McDonald et al., 2020).

This happened particularly by helping to redesign and polarize the geographical distribution of its inhabitants. The observation over more than two decades of urban dynamics reveals the full extent of the changes that affected the regions of the bas Sahara. This change generated a significant growth in terms of populations and activities resulting in an important increase water demand, where water in these regions is a scarce source. French [Despois, 1969; Bisson, 1996] and German [Suter, 1959; Richter, 1995] geographers have emphasised the natural constraints, and in particular, the issues of water scarcity and patterns of water use that guide the organisation of human-space relations in these arid climates (Ghodhani, T., Dari, O., Bellal, S. A., & Hadeid, M. 2017). The availability and use of the water resource are now considered alongside its status as a shared good to be passed on to future generations. Despite efforts, these two ideas of water remain wildly incompatible. to balance economic viability, maintaining ecological balances, and participation sociale. In order to adapt to these regions, the oases have invented an ingenious hydraulic system based on galleries that drain the underground water through the foggaras system. A foggara or qanat is an underground gallery for collecting, transporting and sharing underground water, As a general principle, the Foggara is built from downstream to upstream, as is the rule almost everywhere the technique has been practiced. In a Foggara, groundwater is collected in a cross tunnel and directed to its destination. Assyrians and Persians had known it for a long time (more than three thousand years) and that the Romans used it in Syria. This system is known as "Ghanat or Qanat" in Iran. It is also in the Near East, Afghanistan, China, Japan, two or three places in Latin America and in Spain. Foggaras have been in operation in many parts of the Lower Sahara for over hundreds of years. This urbanisation has generated in these regions a significant consumption of water which has caused a significant drop in the level of the water table and consequently a decrease in the flow of foggaras (Remin & Achour, 2008). This latter is the oasis inhabitants' mental and spiritual universe structuring element as well as their social organization foundation. This system were introduced in the Algerian Sahara, by El Malik El Mansour, who allegedly dug the first foggara in Tamantit (15 km from Adrar) (Hassani 1988) in the

eleventh and twelfth centuries. Then, the foggara were developed in Touat and Guorara by the Arab-Berber tribes of southern Morocco (Mrabtine, Chorfa) exploiting the local (Harratine) black labour force from Mali, Niger and Sudan neighbouring regions (Arrus 1985). The largest foggara in Timimoun region is located in El Meghier (200 km from Adrar). It was drilled at an unknown period and was reportedly developed by the Marabout Sidi Othmane and his son (Remini , Achour 2008). But nowadays, this system is disappearing due to the over exploitation of resources, as well as water and lands inestimated need. How do the urban planning instruments in its form of urban management include the preservation of foggara?We stipulate here that urban management through these urban planning instruments require a certain tools requires some multidisciplinary research to be conducted in these regions.

This work aims mainly to preserve and perpetuate these foggaras by means of town planning tools. These constitute the main reference instruments for human settlements management and control, as rehabilitation process.

PRESENTATION OF THE CASE OF STUDY

Grown out of the 1974 administrative departmental division, the Adrar Wilaya extends over the northern part of the Algerian south-west (see figure 01). It covers an area of 427,968 km2 constituting 17.97% of the national territory. This Wilaya accounts 11 Daira and 28 Municipalities. Its population is estimated at 320,390 inhabitants in 2008); that is to say that 0, 75 inhabitants/km2. All this population is distributed through 294 ksour (the term ksar (plural: ksour or ksars): It is the urban form of the cities of the South and has the evocative meaning of a palace. In North Africa, it designates a fortified village, characterised by a typical form of very concentrated settlement, built in traditional materials pisé or toub) , themselves dispersed in the three regions: Gourara (Timimoun), Touat (Adrar) and Tidikelt (Aoulef). The Wilaya of Adrar is limited from the north by the wilayas of El-Bayadh, the north-west by the wilaya of Bechar, the west by the wilaya of Tindouf, the south by Mali, the south-west by Mauritania, the south-east by the wilaya of Tamanrasset and to the north-east by the wilaya of Ghardaïa. Adrar region climate is characterized in particular by low and irregular rainfall, intense luminosity, high evaporation and large temperature variations, (OZENDA, 1991) .The temperature is high all year round, especially during the summer when it exceeds thresholds beyond which life becomes impossible. Precipitation and surface water are rare. Indeed, the continental intercalaire is used for centuries in this regions (Table 1).

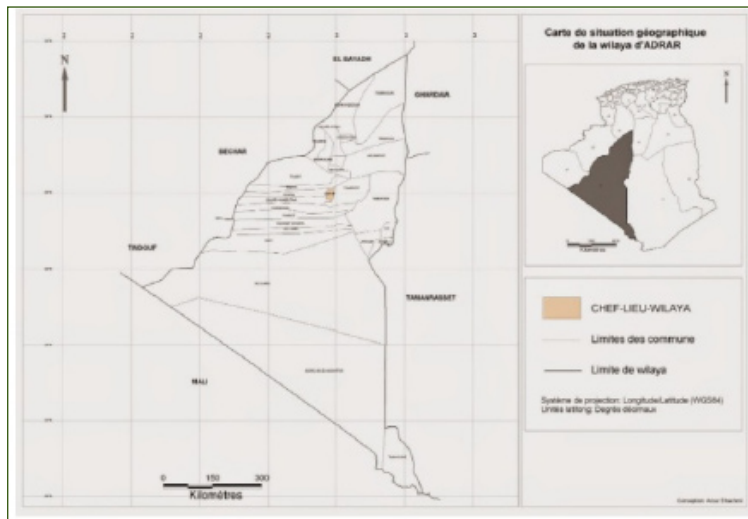


Figure. 1. Location of the study area.Source (Arour ,2014)

Table 1. Monthly average rainfall and temperature (1986-2019). Source: Adrar weather station.

Month	J	F	M	A	M	J	J	A	S	O	N	D
P (mm)	0	2,8	3,1	6	12,4	3	3,1	0	0	3,1	0	0
T °C	12	15	19,5	24	28,5	33,5	33,5	35	31	25	18	12,5

METHODOLOGY

This study was based on the outcomes of field works'as well as in situ surveys. These latter were carried out among oasis and foggaras owners, during 2010, as a part of an academic internship in the Bas Sahara, more specifically in the Grand Erg Occidental' peripheral oases. The concerned foggara are those of Gourara (Timimoune), Touât (Adrar) ,and Tidikelt (Aoulef) .).This field work enabled us to collect quantitative data on the situation.

*A literature review was previously undertook with a focus on the Oases theme embracing various aspects such as case studies as well as the old and recent transformations in the oases.

*In addition, related local settlements data have been collected. For in situ surveys, interviews were used as appropriate research tool. In addition to the oases' inhabitants, the persons interviewed were those in charge of the town planning technical services.

RESULTS AND DISCUSSION

Region' Local Water Resources Use

In the regions of Touat, Gourara and Tidikelt, water supply is based on the exploitation of groundwater, by the traditional system of collection and irrigation which is the foggara. The foggara means, in Arabic, Fakra (to dig). Other authors believe that the word foggara is relative to Fakra, the vertebra in Arabic (Kobori 1982). The water in the foggara generally comes from the Continental Intercalaire «*The intercalary continental corresponds to regions of very attenuated relief; it contains abundant aquifers which, in depressed areas or at the foot of cliffs, provide a shallow water table that sometimes flows, or may have done so in the past, into sebkras. Its permeability is very great, and it can locally allow large flows under a low drawdown*» (CORNET & GOUSKOV, 1952.)

The foggara is a draining gallery dug in a straight line from upstream to downstream, collecting and bringing underground water to the land to be irrigated, due to an appropriate slope. The minimum slope (approx. 3 to 6 mm/m) . (as shown in Figure 2)

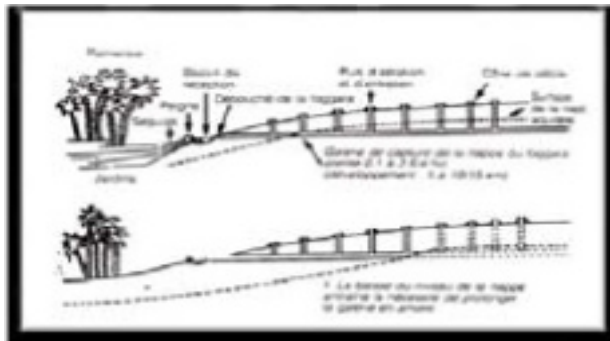
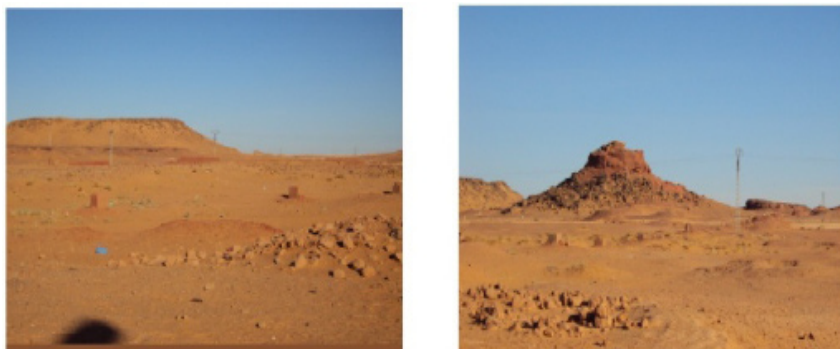


Figure 2. Layout of a traditional foggara system [Oliel, 1959].

The watering is done by gravity flow. It is favored by the appropriate topographical conditions consisting in the fact that the ground level is lower than the continental Intercalaire water table' piezometric one. The draining or essential part of the foggara is the porous part of the channel, also called the draining gallery (figure 3-4). This channel is dug so that it can circulate the water and allows the passage of the worker during the construction phase.



Figures (3-4). Views of the foggara's draining gallery. [Authors, 2022]

Wells are dug along the foggara to allow visiting the gallery for currently maintenance and cleaning. The minimum distance between each well is 80 m (Cheylan 1990).

ts implementation, maintenance, and water distribution must be controlled by the leaders of oasis society. Thus, once the foggara water reaches the level of the gardens, it is shared according to two parameters based on: water volume; and supply time (Figure 05).



Figure 5. View of the tertiary Kasria of foggara in Timimoun. [Authors, 2022]

The volumetric method (water volume):

In all Albian foggaras oases, the water is distributed following the volume method. Each co-owner receives a volume of water determined according to his contribution to the maintenance of the foggara. This distribution is carried out by the kasriates (plural of a kasria) network. This latter is provided with a number of kasriates that is proportional to the number of the owners subscribers. From the main (lakbira) kasria (figure. 5), a kind of triangular basin with a water supply system is built. The water collected within this main kasria goes through a comb device allowing to divide the flow into three, four and even five channels “seguias”. These channels fan out in various directions. At the end of these “seguias” (figure 07), are located other secondary kasriates distributing again the water. Similarly, further Kasriates are found and it is so on until arriving to the guemouns (gardens) see figure 05 (Remin, Achour, & Kechad, 2010).

The hourly method (supply time)

This distributing water method is specific to the Foggara of the sources, mountains and wadis. It is based on the unit time called Nuba that means in turn. It is defined as the sufficient duration of time to irrigate completely the garden. In Algeria, there is only the foggara of Hanou d'Adrar, which is an hourly foggara and without kasriates as in the other neighbouring foggaras (Remin, Achour, & Kechad, 2010). Relatively wide seguias directly leave a large madjen (tank). The foggaras are closed, by obstruction, once or twice times per day in order to restore the required level. Then, the water is released for a given time, proportional to the beneficiary's financial contribution (Oleil 1994), shown in Figure 06.

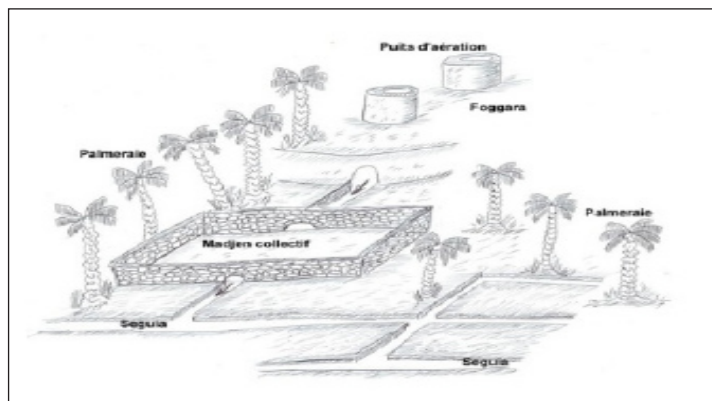


Figure 6. View of Synoptic diagram of an hourly foggara (schematised by Remini, 2015)

Urban Growth: A Very Spread out and Fast-Developing “National”

Today, these regions urbanization is evolving but its strong development is destroying the ecological balance and seriously impairing human well-being.

The first stage in the formation of Saharan cities dates back to the colonial period (since 1900) when villages were created near the most important Ksour to initially accommodate military barracks. This has contributed to the constitution of a new standardized urban fabric respectful of a technical-military logic locating the colonial villages face to the ksour (Figure 06). This urban fabric has been more extended by the massive establishment of collective facilities and new support structures to local populations. So we are witnessing a spatial boom in oasis regions, “Moving from ethnic segregation in the colonial period to functional segregation after independence.” (La Bruyère 1988, p. 343.) leading to depletion of the foggara by increasing water requirements .



Figure 7. View of the seguias of hourly foggara in Timimoun. [Authors, 2022]

This accelerated, widespread urbanization is closely linked to its new functions of this very extensive space' command and management. In fact, a massive production of open fabrics is happened similarly to the northern regions' case. It is undertaken without any significant concern for urbanity or the Saharan climate, even less cultural references. Hence, the environment deterioration and the ecosystems imbalance are occurred. One of the main reasons is the squandering of the natural resources of these oasis regions. Knowing that the primary source of these regions was agriculture (as shown in Figure 8-9)



Figures (8, 9). Various views of the massive urbanization of ksar at different scales. [Authors, 2022]

Urban Planning Tools

Legislation

Urban planning tools are part of the organizational and operational structure of the city and its area, commonly used in many world countries in respect of their various political systems (Hattab, 2014). They aim to design and provide the best spatial and social conditions for cities creation and management or urbanization functional areas. The reference to sustainable development is now essential in Algerian urban planning related legislative texts and public policies, particularly since the adoption of the city orientation law in 2006.

Relating to the protection of the environment within the framework of Sustainable Development, the Law no.03-10 of 07/19/2003 aims, among other objectives, to set the fundamental principles and the rules of environmental management, and promote sustainable national development by improving living conditions and working to guarantee a healthy living environment.

Also, Law (no 06-06 of 20/02/2006) concerning the city orientation, aims to define the city policy within the framework of the regional planning and sustainable development policies. This law is designed and developed according to a concerted and coordinated process as well as implemented within the framework of deconcentration, decentralization, and local management. This law has several components:

concerning the urban component, its objectives include, among other things, the control of urban growth, the correction of urban imbalances, the restructuring, rehabilitation and modernization of the urban fabric to make it functional. For the management aspect, its objective is to promote good governance by, among other things, the reaffirmation of the responsibility of the public authorities and the participation of associations and citizens in the management of their city.

The PDAU and the POS were established by Law no 90-29 of 01/12/1990, relating to development and town planning and its implementing decrees 91-177 of 28/05/1991, and 91 -178 of 05/28/1991.

The PDAU sets the fundamental guidelines for the development of the concerned territories. It determines the soils general destination as well as the nature and the layout of major infrastructure equipment. The PDAU must be respectful of the 02-02 of 05/02/2002 law' guidelines, the coastal development plan and set the reference terms for the POS. It must allow to locate areas of conflicting uses, the impact of pollution, and the existence of foreseeable natural risks. The POS is a regulatory urban planning instrument, resulting from a protection policy. In accordance with the provisions of the PDAU, the POS sets out in detail the land use and construction rights for the sector concerned and makes it possible to integrate the specificities of the place and to protect sensitive areas (SAIDOUNI, 2000)

Apart from these two laws which give no recommendations and which remain vague in determining the protection measures, the planning instruments also do not take any responsibility, during their development by design offices (state, private), towards the foggara (restoration, preservation etc) also for the future of the ksar itself.

However, it must be reminded that there is the decree N 426 of 23/06/96 relating to the protection of the foggara established by the Wali in 1996 issuing the easements to be respected during the development work in the meadows of a foggara or its source.

THE FUTURE OF TRADITIONAL HYDRAULIC SYSTEMS

Rapid urbanization has led to the emergence of dynamic Saharan cities has generated, by spillover effect, multiple transformations in small oases: introduction of wage labor; tertiarization of activities; change of habits; abandonment of agriculture in favor of other activities, use of modern means of water mobilization, etc. The actions to preserve these traditional hydraulic systems carried out here and there are isolated, their effects are reduced in space and time, they require the establishment of a global safeguard project. This deficiency of maintenance has reduced the number of functional foggaras from more than 1300 to only 820 (Remin, Achour, & Kechad, 2010), with the extension of the displacement caused by the deployment of the city, some foggara collapsed due to the shocks caused by the different transport as the foggara crosses the city in these regions

Demographic dynamics affect the spatial and social organization of the population and constitute an important element of the transformation of agglomerations and ksour in the Tidikelt, Gourara and Touat. This dynamic is spatially characterized by a trend of population concentration in agglomerated areas. That are saved by their owners, with a constant decrease in the flow rate and the lowering of the hydrostatic level of the water table; annual public funding to safeguard the foggaras comes in support, but it faces many constraints due to the multiplicity of stakeholders. Various studies have been undertaken by scientists, researchers from NGOs who have asked the public authorities to find other alternatives allowing the preservation of the foggaras and which are operational in some regions (Dubost, Moguedet 1998).

CONCLUSION

The transformation of society and space is much more profound than a simple deterioration of small oasis production and its traditional irrigation system. Unfortunately, the capture traditional method cannot meet current water needs and, in particular, the prospects for urban growth. It is visible that this anarchic urbanization contributes to the de-densification of the Ksours and reflects the death of its ancestral system, the foggara. Through the presented case study, it turns out that the urban planning instruments in Algeria and the laws supposed to protect the environment, encounter serious

difficulties in terms of application mainly due to the reluctance it arouses among local administrations (town planning, tourism, etc.). Also, there is no hierarchical control. In fact, the central administrations creating the legislation do not ensure follow-up at the local level. Despite the changes that have affected the whole of a region and a lack of natural resources, the water from the foggara still gushes out thanks to the know-how and ingenuity of the oasis inhabitants. These latter have perpetuated this ancestral system for thousands of years and support human settlements with water from a groundwater that has still not been quantified. In order to sustain this system we recommend the following:

- Preparing and training the population to participate in urban projects.
- Mobilizing and encourage the population to participate, act to make decisions relative to the preservation of foggara.
- Creating financial funds for the rehabilitation of foggara.
- Established professional training for the maintenance and rehabilitation of the foggara with its own status.

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Citation: Dr. ABDOU Yamina, Dr. KACHEF Sarra, et al. *The Urbanisation Facing the Foggara Perinity : Case of Adrar Region Foggaras (Touat, Tidikelt and Gourara)*. *Int J Innov Stud Sociol Humanities*. 2022;7(11): 133-139. DOI: <https://doi.org/10.20431/2456-4931.071112>.

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