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FUTURE OF AN OASIS TO THE DETRIMENT OF A HYDRAULIC MONUMENT "CASE OF TIMIMOUN"

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ABSTRACT

"Foggara" certainly reflects a system of conventional irrigation, which has long served as caravan dwellers and roaming in their travels through the Sahara. But, it reports ingenious irrigation process conjecture, is adapting to the climate, inherent social context to this region. It's a method for groundwater capture who assured the payment of local institutions in the Algerian Sahara. History testified to an evolution of the oasis, where the parties y related to abandoned, while others replaced the percolates gardens. Causes emanate from the drawdown of the sheet, either to silting, or at the same time. There are overriding reasons that justify the occupation of the ground of human settlements in the Gourara.

If the foggara, has of sustainability for long periods the Algerian oasis; It is also important to mention that the hydraulic evolution, which were subject, has been proven in the Gourara: typically at Timmoun. Unfortunately today we are witnessing the decline of countless oasis of foggara. Thus, it can be assumed a quasi interim implementation in the Gourara; even can be downright fear further severe natural conditions, final desertification in the region. In view of this is to ask: How can we preserve and safeguard this hydraulic heritage?

KEYWORDS: Foggara, Hydraulic Monument, Decline, Heritage Approach to Backup, Timmoun/Gourara

INTRODUCTION

This is the Algerian Sahara, a vast area, which is divided, if it is by nature itself, then by men, in three parts: The Gourara region, the Touat, and the Tidikelt. And to improve the representation of the Sahara, it is sufficient to see the picturesque landscape of terrain projecting: the dunes of unequal intensity, which is grafted scattered oases, where life is possible as a result to the presence of water. These oases near consistency have housing combining in their rich literature, which became the vernacular heritage. Human activity runs the aforesaid, the dispersal of the population imposed by the weakness of the water resources.

To survive in this case, in a ruthless environment, and extend the life of the oasis, oasis farmers, have developed distinguished methods that get used to the local conditions. These are the foggaras, authentic permanent struggle, who have done this prodigy grant life in this desert region, with a very fleeting rainfall, unbridled temperatures, high winds and perpetual silting.

Purpose of Safeguarding the Foggara

The foggara water presence therefore extensively justified implantation of vernacular establishments, and the attitudes of men for its subsequent exploitation, through a system governing until an entire population society.

This system that contains an art, a symbolic, a technique, and rules on water resources. And it is because the survival of the foggara dwindles for multiple reasons, and that its decline is inevitable, that this paper complete to highlight the desirability and urgency of this anthropogenic monument backup. This, to ensure the delay of the inhabitants of the oases, witnesses of a collective memory.

Foundations That Animate the Safeguarding of the Foggara

- The foggaras are now challenged by plural drilling, which intensively exploited, induce a drawdown of the water, therefore, a gradual depletion of the existing foggaras
- The consumptive use of water (low renewable, or fossil) groundwater resources, risk the peril of the foggaras, due to the drawdown of the hydrostatic level of the water
- The risk of depletion of the water. Dissipation of agricultural surfaces, and pertinently the incremental risk of decline of oasis is a cause major
- Agricultural surfaces scarcity generates de facto unemployment, encouraging poverty. A phenomenon that arouses the exodus in search of work.
- The difficulty of maintenance (in issue rock slides...), and the extension of the foggara (as a result of the drawdown of the water), from certain depths.
- The danger that manifest dredging operations, how many men in the history were killed buried, sacrificing to ensure access to water in their community, and therefore to life.
- This traditional method of capture is unable to respond to domestic and agricultural, current and future water needs without recourse to modern
- The use of pumps, exempting a tiring manual spot.

Today, many of these foggaras debiting more (see some data on the foggaras of Tidikelt, Tuat, Gourara). Plural are the oases which destroyed. While they gave an ingenious societal organization, and prodigious water work carried out by the man. It would therefore be absurd to abandon a world heritage, which was evidence of an efficient method for the management of water resource in the oasis ecosystem.

PRESENTATION OF THE CITY OF TIMMOUN

Set Timmoun, one of the inherent in the Algerian Sahara oasis, located in the region of the Gourara (see Figure 1), and which is inevitably designed around water points, as it overlooks the Sebkha. Including relevant is it recalled that it is graft on the caravan trade route, ensuring as other oases, the relay and the resupply of the transhumant.

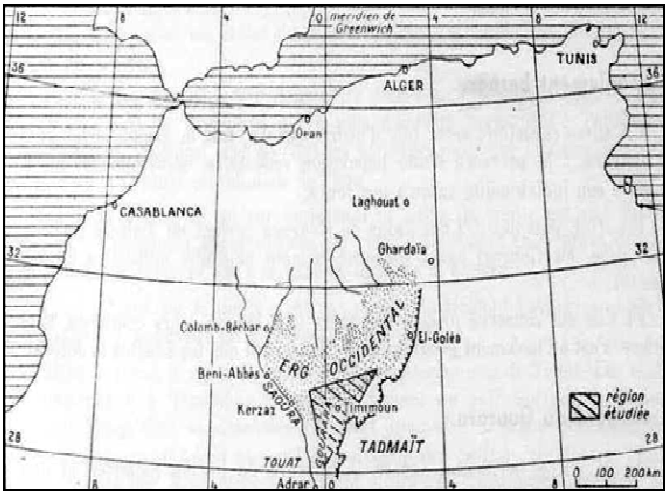

Figure 1: Map of the Situation of the City of Timmoun from A.Cornet

In this very aggressive environment, man has sought forms and built works: Aghem (House) and the foggara, which enabled him to life in the plateau-sabkha area. The shape that emerged allowed adaptation to a hostile environment and most importantly, the domestication of a territory.

HYDRAULIC TRIAL IN SAHARA

Cope with severe climate constraints intrinsic to the Saharan regions, and the scarcity of flows on the surface (see figure 2), only the structures to withstand these conditions can promote the agrarian production: it is at best, collect rare and difficult to reach, through efficient development and important these developments are based on a novel technique of the foggara, which drains ground water to the surface by gravity. This evolving system boasts with thousands of kilometres of galleries and several kilometers deep. [1]

The foggaras in this area draw water table of the Gourara, feeding water at origin of "the Saharan Atlas", a set designated by "water of the Erg"[2]. Large duct of these waters is rock reservoir water.

Therefore, to use, and effectively of the water table, it needs to dig galleries capturing: "the foggaras." However, the groundwater drawdown is not only a cause for resignation of the foggara.

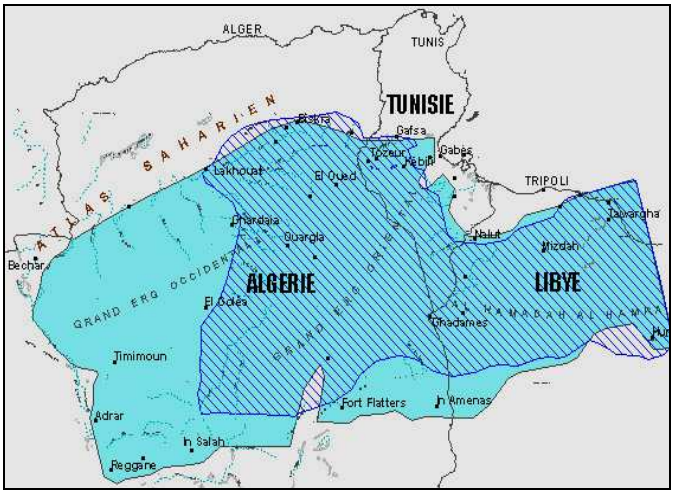

Figure 2: Foggara (Interlayer Water of the Continental) Water Supply

THE FOGGARA PRINCIPLE

Origin of the Foggara

Its ancestry goes back over 3000 years in the country of Persians (Iran today) and was sent to through the religious axis to the countries of the greater Maghreb. It adopted multiple designations: "qanât" in Iran, "ngoula" or "kriga" in Tunisia, "khettara" to the Morocco or even "sahridj" to the Yemen, and "foggara" in Algeria. The first foggara who was born in the Algerian Sahara have been excavated in the area of Tamentit 15 km of Adrar. [3] This hydraulic technique which is operated primarily in the area of the Tuat, the Gourara and South of the Morocco, was able to connote a prodigious deployment, in terms of mobilization of water flow.

Definition and Principle of Operation

"A foggara is a gallery which brings the waters of groundwater to irrigate with an appropriate slope field." "Thus provided a watering simple gravity, hence the interest of the foggara" [4]. The useful part of the apparatus is entering the water see figure 3.

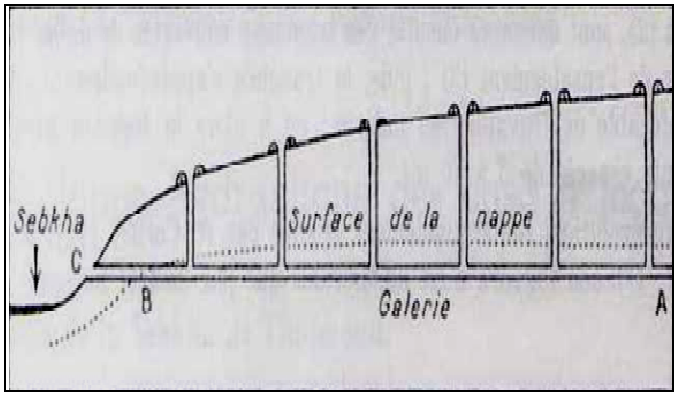

Figure 3: Flowsheet of a Foggara, from A.Cornet

The enfilade of well assembled by the underground Gallery, whose length is quite variable, actually reported the presence of the surface. These wells help during the hot seasons, and dredging operations, the aeration of the gallery. The foggara water flows constantly, but with a variable rate, moreover it is continually declining. Indeed, established by sections prelude of the foggara, drainage causes a drawdown of water. At that time, relevant is to extend the foggara upstream, to resurrect the first flow.

However, in all cases, the rate of water flow is not fast, she leads therefore sand deported by the wind, and scree from the walls. What makes the foggara unusable, unless there is annual curages. The water distribution obeys rather a share volume in time. It provides through "Combs dispatchers". Control of water being one of the main pillars of the social system, based on a general consensus [5] also, the principle of irrigation requires that the slope of the land is lower than that of the mouth of the foggara, where the direction of the foggara is interdependent topography. Which illuminates the situations and developments of the foggara oasis in depends on depression, either at the bottom of slopes. Indeed, to explore the mapping to the said methods of irrigation adopted in the Gourara, it turns out that for most, oasis of foggaras along topographic accidents. Except that at the time, many are those with wells at pendulum (see figure 4). We will see in the paper now, the reasons for the abdication of the foggaras in Timmoun system.

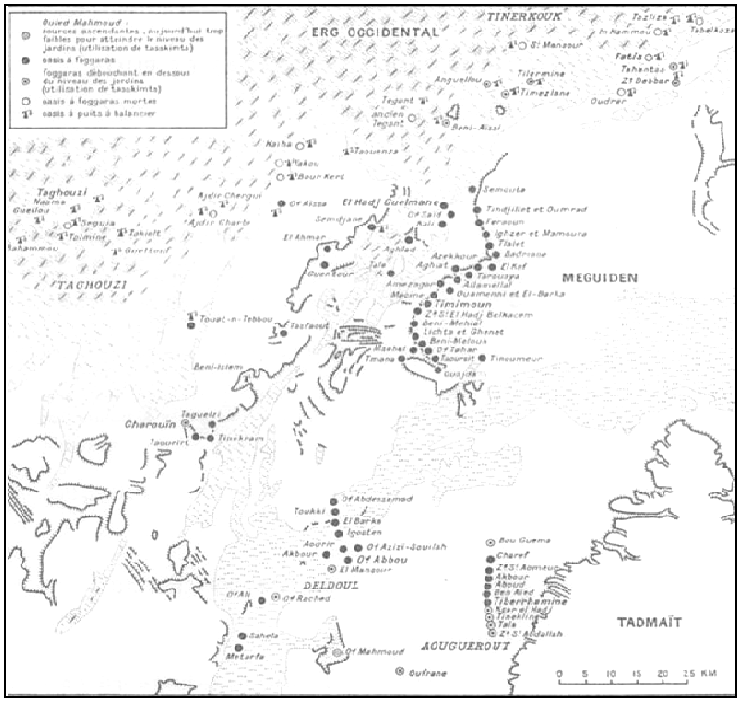

Figure 4: Map of Methods Adopted in the Gourara Irrigation

FIGHT ORTHODOX PROCESS FOR IRRIGATION, BECAUSE OF THE RELEVANCE OF WATER IN THE ESTABLISHMENT OF THE PAST IN THE GOURARA

Oasis of Foggara

The Palm Grove of Timmoun consists of two parts: one high, dense old Palm Grove begins from the ksar to contrast low Escarpment that limits the shelf. The lower more loose with Palm. Is a new part-on the one hand, the drawdown of the water, and other attempts to improve the foggara. Here up the offset to the sebkha. But as the soil y intrinsic are unsuitable for culture, with the exception of the Palm, then upstream of any use, is covered with a layer of sand, irrigated soil later in lieu of leaching this earth in ancient times, the crucible of sewage, or too full of foggaras. It produces finally, ditch to lead-laden salts to a point below the sebkha. The done can be reappeared to the inadequacy of irrigation. Just as the case opposite, occasional floods can be salty ponds. This phenomenon is explained by the rise of the water, at the same time to a low evaporation coinciding with wet periods.

This panorama is expanding a view of the precarious conditions of the oasis of Timimoun, in cause of the considerable needs water, justified by an offset to a salty land, and the extension of the lengths of the seguias promoting losses, on the other. Unfortunately, beyond vested talks to the foggaras, the chances of deficiency of water resources are very possible. Thus, oasis are favor by the topography, do not have much choice, being exposed to the downstream to the problem of the done, otherwise the probability of flooding. The high parts, occurs quite expensive for the operation of the foggaras, drilling the wells being increasingly deeper. These causes to effect, display the decadence and danger, to the day of today, foggara oasis.

Oasis of Foggara and Lift Devices

The oasis at the fringes of small depressions can be irrigated via the foggara system. It should be on creating an artificial

Example of Aouguerout

The palm groves in the upstream portion of the Wadi are currently highlight a coast (from the mouths of foggara) less than the specified sus terrace, in which irrigation requires surhausser water to the bias of a pit dug below the level of the mouth of the foggara. This system allows accumulating water, via a pendulum "Tasskimt." See figure 5, therefore, a garden can have two parts, one at the level of the sabkha and irrigation is performed by the foggara; While the other (older) party on the terrace flows through the pendulum.

Example of Charouine

The Palm Grove of this oasis is coming on the hamadien plateau. To perpetuate the use of their foggaras, the inhabitants of this village lower the level of their gardens, where the use of the séguias, whose water is high to the terrace by a "guenina" (basket of Palm fiber). See figure 5.

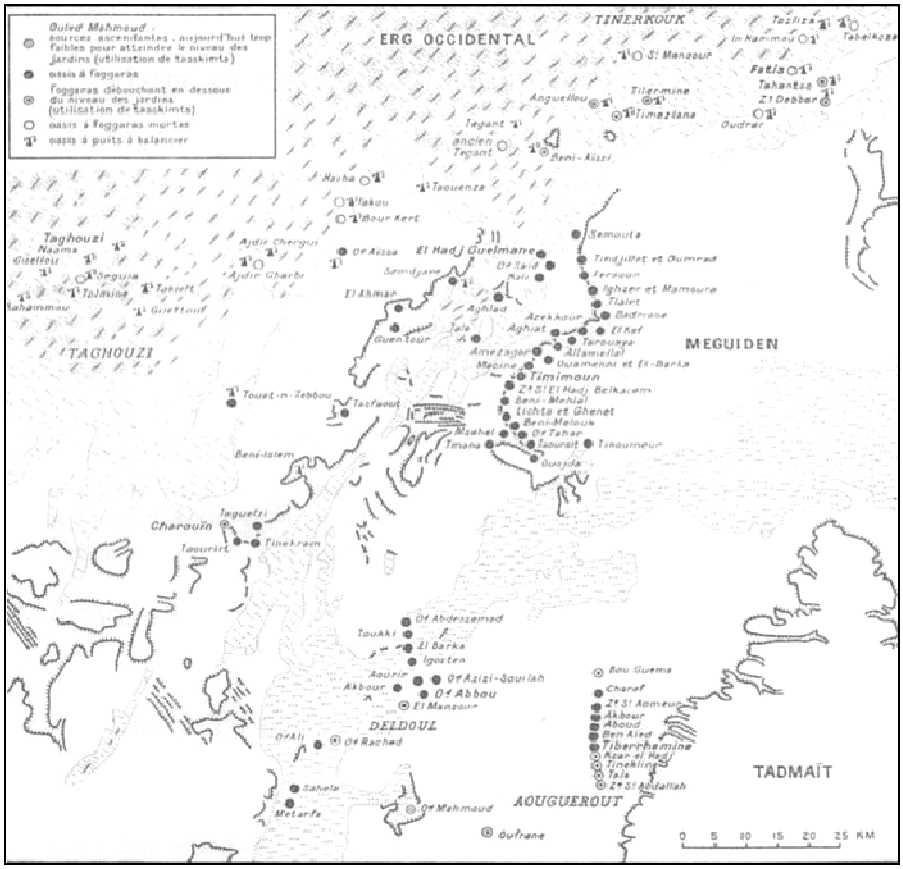

Figure 5: Evolution of Gardens

Example of Tinerkouk

The oasis of erg or those based on a reg, are subject to silting perpetuity. The various inputs farms, manure, clay, amending the land, minimize dyked the level of the gardens, the opportunities to use the "Tasskimt". From the moment that the performance of the foggaras becomes low, they are abandoned in favor of the Dipper wells. We are witnessing in sum to a circuit of irrigation from the oasis to foggara, foggara and tasskimt, and then to the well. Where the oasis enjoys mixed irrigation: part operates the foggara system, the other resigned himself to the tasskimt, and one calls the balance. Like the three systems can be adopted in a same garden.

USE AND GOVERNANCE OF THE FOGGARA CONSTRAINTS

Build, benefit, and maintain the foggara of our days, becomes a daunting mission, given the difficulty of the flushing that apostrophe a specialized workforce, under condition that she agrees to work in difficult situations. This, on the other hand, silting, the lack of maintenance and over-exploitation of the foggara during an interval of time therefore, lead inevitably to the regression of the foggara number, the weakness of the flow to the drawdown of the water, as well as the degradation of many of the foggara. Moreover, it is noted that a non-negligible amount of drained water is lost by infiltration the long inactive Gallery and its length but also by the phenomenon of evaporation.

Management of this system, basis of legal and regulatory framework which provided the right of acquisition of the water after competition to the building of the foggara recall, once was: the contribution is the ration of water. This cultural governance unfortunately fades in favour of modernity.

In addition, more that the population believes, more urban flourishes, and more that water demand is rising. In view of this, the traditional method of catchment is no longer able to meet current needs, which are already very important. From this, he must already to how so-called modern, in lieu of promoting the system, especially when the water reserves are correspondingly substantial.

RESULTS AND DISCUSSIONS: PROPOSALS FOR THE SAFEGUARDING OF THE FOGGARA

Know-How for the Preservation of the Oasis: Approach to Social

Face, deficiencies, either to the decadence of the foggaras system, the Saharans acted rekindled a will to persist in their region as follows. When oasis was steep, was a cyclic shift of the gardens to the bottom of slope, to moderate the lowering of the water. At the time where this was not possible, it should develop excavating deep trenches, the water which emanated, stood by pendulum. Where this was not possible, the foggara dropped altogether in favor of wells to pendulum. But in all cases, it is noted that the exercise was intense.

Consequently, find proposals or the most appropriate and efficient processes at the same time, able to contribute to the preservation of the foggara, is both timely and urgent action. It is to take steps against: the reduced constant plan of water and the regression of the flow and the obstruction of the galleries by the textural materials of walls, or even the burial.

Gestures That Substantially Increase the Flow of the Foggara, and Evade the Drawdown of the Sheet

When the water was subject to a drawdown, human drilling new wells, extended upstream Gallery, and it lowered in lieu to the original flow. Subsequently, the palm groves and gardens that are above the level of the new foggara, could no longer be irrigated. The time needed to achieve other foggaras in low contrast of the new mouth of foggara.

In the event that the Palm is set on a reg low slope, and unable to lower his plan; of course user extended the duration of the use of the foggara, by digging a pit which will host the water of the foggara, but above the level of the land to irrigate. Hence the principle of irrigation by gravity fades. In this case the man resigned to the lowering of the flow, without access to the improvement of the performance. At the time, irrigation wells to pendulum proved as one opportunity.

Thus, in the maintenance of the secular schema issue, it is here proposed some attitudes to adopt:

- Excavating the soil of the Gallery, to achieve the level of the land to irrigate. Notwithstanding, this procedure is not always possible for some gardens.
- To drill other wells upstream, by extending the scope of the intrinsic drainage Gallery at the foggara. This action is unfortunately provisional, thus perpetrating the irrigation of the gardens to the downstream.
- Achieve converging galleries (in the main gallery), water inflows from other galleries, will implicitly increase flows. The increased flow is proportional to the number dug galleries
- Make any corrections of the flow of drilling, downstream, at the level of the places of capture, thereby evading their interactions
- Limit to best evapotranspiration, by developing cultures for the purpose of child-bearing a relatively moist microclimate: it is to deploy a belt for the protection of the gardens via Palms "Palm bours" obstructing the impact of the wind and evaporation. Knowing that the compactness of the oasis, is already in part its microclimate
- Disjoin the inactive part of the foggara, the bias of a waterproof material. This, because it permeable and is lost in this case a relevant volume of water by infiltration.
- Ensure the foggara, via a concrete waterproofing that granting the reconquest of water on the one hand, infiltrated and barrier to the effect of evaporation of other
- Cutting-off and final sis drilling in the field capturing foggaras, having a negative impact on the water of the foggara.
- Avoid positioning the wells in adjacency of the heads of the foggaras (drainage of the foggaras area), otherwise the water will be at the risk of the drawdown and the depletion of the draining by pump part.

Use of Energy in the Light of Sustainability of the Process of Irrigation

- Use solar energy for pumping water. Photovoltaic technology achieved the reliability to meet energy demand.
- Drill for shallow depths downstream from the Gallery, will increase by inputs of water flow of the foggara, providing them with solar pumps
- Mechanize curages systems to deport the sand particles. This, by providing for regular, along the Gallery of the manholes, using decoy for any sand deposits.
- Equip wells pumps correcting the deficit of the foggaras flows preferentially photovoltaic.

Actions against Desertification

To protect built-up areas, fertile land, and all works; He must prevent or even halting the advance of sand, by stabilizing the soil, either reduce the wind speed gradient in situ. Hence, many dune fixation techniques are possible:

- **Mechanical Fixation**

It is to stabilize the dune by a fabric designed by such natural elements dry palms, branches, fences, or artificial plastic material.

- **Biological Fixation: [6]**

After the dunes are fixed mechanically, it is immediately possible fix definitively; by introducing a perennial tree vegetation is available directly on the dune.

Note that the combination of the two processes is most efficient. The large dune fixation is almost impossible.

- **Chemical Fixation**
  - Application of bitumen
  - Mineral oils
  - Sprays of water
- **The Aerodynamic Method is Accomplished by**
  - The orientation of the streets parallel to that of the prevailing wind, to transport sand which is beyond built-up areas.
  - The dredging of the gardens

CONCLUSIONS

Saharan men, cling to their terroir in relatively hard conditions, using archaic figures to sustain these arid regions water: wells designated by "chegga", then small trench which deepens with the onslaught of time, configuring form Gallery. Therefore we design a foggara in Wells of vents to implementing every 5 to 10 m

In this evolution, the foggara improves by his head. Indeed, it must extend his gallery upstream, on the depth of the wells of upstream is going to intensify. In Timmoun specially, the extension of the gallery requires a drilling well at 40 m. What makes the foggara economically quite costly. Also, the long galleries not only require a perpetual care and persistent (curages regular and laborious), but obstruct any hydraulic performance, and adhere to the growing losses of water it transships. Added to this, the permeability of the foggara concedes the filtration of water, which can receive a second smaller than the primary network.

In addition, the gradual drawdown of the table, due to the evolution of the system hydraulics of the foggaras in the reduction of the supply of water in the Erg, most often associated with burial, explains the urgency of intervention for the safeguarding of this centuries-old monument, as it is of course the conditio sine qua non of their survival, but mainly because the will of the Saharan continue to live in their village of origin. (The authentic rural life persists in the Algerian Sahara, life in the ksour is to confirm). These treasures of ingenuity has developed humanity for centuries, this hard to remain in the ksour of origin, deserves to be supported.

Future Prospects

Some elements are however necessary for the stabilization of the tribes: safeguarding the foggara, combat silting, and the use of the pump, or even the introduction of photovoltaic energy for such potential of perimeters of agriculture irrigation, especially since this technique is promising for the sustainable development. These are the tools which concede the economy of time and the punishment of men. In so doing, the palm groves and foggaras are more bound to drag in perpetuity.

Finally, the foggaras, a typical cultural landmark, constitute no doubt, a new point attention getter for Saharan tourism.

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