

# Moroccan Kheffara

Dale R. Lightfoot

## Abstract

A 300 km network of kheffara (qanat) subsurface irrigation channels was excavated in the Tafilalt basin beginning in the late 14th century. More than 75 of these chains provided perennial water following the breakup of the ancient city of Sijilmasa. Kheffara continued to function for much of the northern oasis until the early 1970s, when new technologies and government policies forced changes. Data on origins, maintenance, and current use were collected from archival sources, aerial photographs, Landsat imagery, and from interviews.

## Introduction

In southern Morocco, on the margins of the Sahara Desert, lies the Tafilalt oasis, a historically important caravan crossroads and trading center (Figure 1). Sijilmasa (A.D. 757-1393), the great city whose remains lie in the center of the Tafilalt (near the modern town of Rissani), was one of the earliest Islamic cities established in Morocco, and it played a crucial role in the gold trade from West Africa to the Islamic world during the medieval period. After the fall of Sijilmasa the Tafilalt continued in different form, ruled by the Alaouites who expanded the infrastructure through a large-scale irrigation network of dams and canals off the *oueds* (larger river channel) Ziz and Rheris (Lightfoot and Miller, 1996; Margat, 1959). Surface water for these canals is supplied by runoff from the Atlas Mountains, which increases during the mediterranean-like winter experienced in the mountains, wanes in early summer, and is generally absent until autumn rain and winter snow return.

Some traditional irrigation in the Tafilalt has been of the pot-watering type, using water hoisted by camels or donkeys from large public wells. Some crops are still raised today by planting in fallow lands during the more rainy months of the fall and winter, especially at the periphery where land is otherwise unusable because of insufficient water. However, even during wetter months rainfed agriculture is marginal. Crops can be dependably produced only with irrigation. Beyond the river valley oases spreading south and east of the Atlas Mountains, and beyond the margins of the Tafilalt Oasis, farming is absent.

Irrigation has mostly been made possible through the use of earthen canals (*seguias*), and there is a very dense and intricate network of *seguias* in the Tafilalt. Most canals were traditionally filled with water diverted from the larger river channels (*oueds* or *wadis*), or from small reservoirs - intermittent pools of water - impounded behind a series of low-water dams across the *oueds* Rheris and Ziz. The channel which slices through the heart of the oasis, today called the *oued* Ziz, is itself a large primary canal built sometime after the mid-11th century by diverting water from the original or true Ziz, itself known as the *Amerbouh* in this stretch today (Lightfoot and Miller, 1996; Margat, 1959). Remains of the now-refashioned diversion dam lies in the Ziz channel near Erfoud (Figures 1 and 2). Eleven smaller dams on the Ziz, and two on the *oued* Rheris, were built and/or refashioned in this region by Sijilmassians, Alouites, and the colonial French. All of these ancient and historic dams have now silted up or breached and are useless for irrigation. In the northern part of the Tafilalt, water for irrigation canals was often provided by *kheffara* (*qanats*), which will be discussed in detail in the next section.

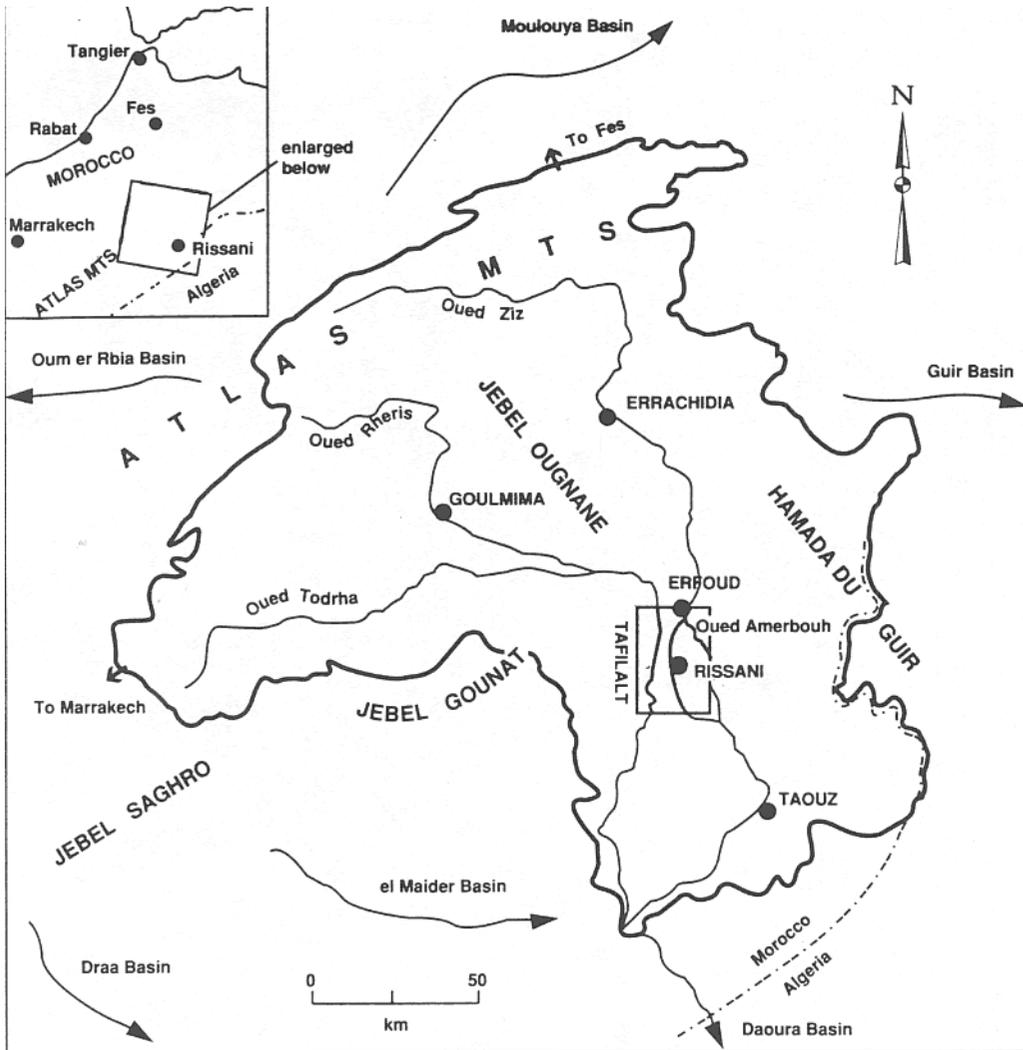


Figure 1. The Tafilalt oasis, Rheris/Ziz basin, southern Morocco.

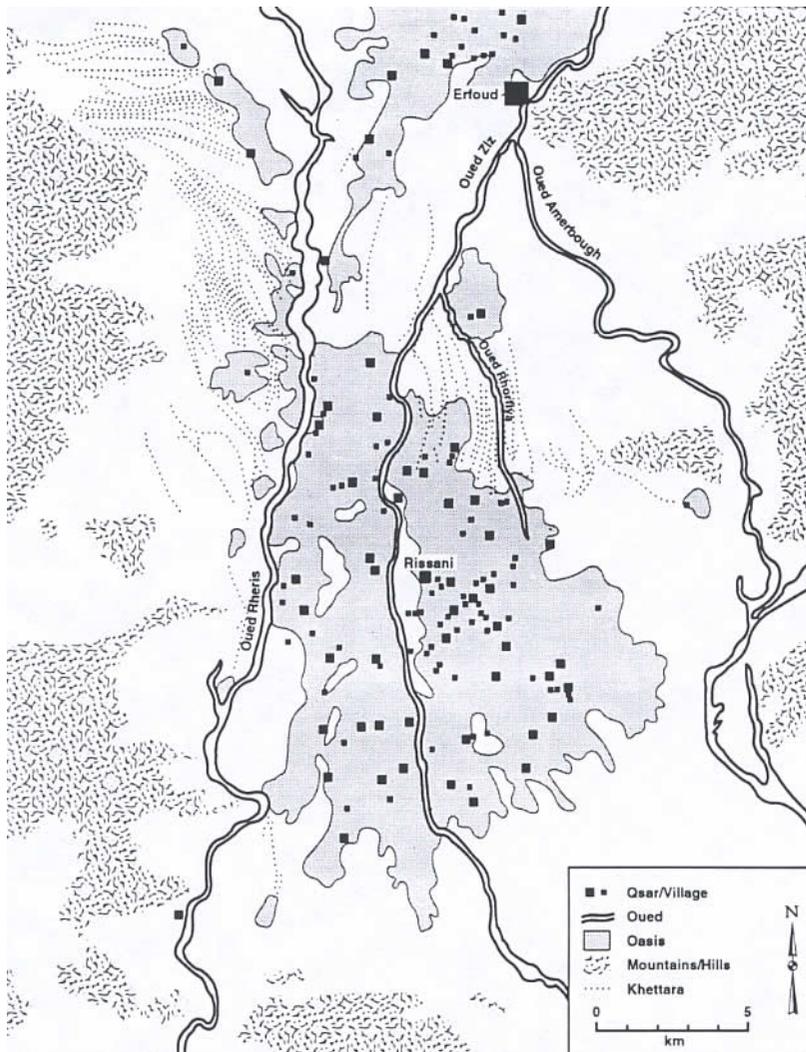


Figure 2. Qsour and khettara in the Tafilalt basin, Morocco (Data from Margat, 1961; satellite imagery, and fieldwork interviews).

The availability and distribution of water in the Tafilalt changed dramatically after the 1971 opening of the Hassan Addakhil dam near Errachidia, impounding the oued Ziz about 75 km north of the Tafilalt (Figure 1). Water from the oued Ziz used to flow unimpeded into the Tafilalt basin and provided the primary source of water for irrigation since the time of Sijilmasa. Floods were not uncommon. Now water from the reservoir is released through government canals only three to four times per year, depending on reservoir recharge, with each water release lasting 20 to 23 days (to allot 10-12 hr of water flow per village) and timed to correspond to more critical periods in the growing season (Miller, 1996). This water contributes to the irrigation of about 9400 ha, more than 75% of all arable land currently used in the Tafilalt, but the water is so thinly spread that no longer can fields be irrigated solely with water from the oued Ziz.

Because of their ubiquity, private and cooperatively owned diesel-pumped wells have now become most important to Tafilalt irrigation. The first private motor pump was installed on a well in 1965 (information from the Office Regional de Mise en Valeur Agricole du Rissani). Seven larger, public pumps, irrigating about 950 ha, had been installed by the French in the 1930s. Some of these public tube wells were deepened after the early 1970s, when the water table began to fall. One was even extended twice but again went dry and was abandoned in 1985; the remaining six are still in operation. Today there are almost 750 private diesel-pumped wells operating.

## Kheffara in the Tafilalt

### History of kheffara

An impressive 300 km network of kheffara was excavated in the Tafilalt basin beginning in the late 14th century. Some of these tap into the aquifer at the base of mountains along the western margin of the oasis. Others exploit the shallow water tables adjacent to major stream channels which pass through the basin. Eighty of these chains provided perennial water for 28 qsour (villages; sing. qsar) in the northern part of the oasis (Figure 2). The qsour and kheffara simultaneously developed following the breakup of Sijilmasa (Lightfoot and Miller, 1996). Qsour in the central and southern oasis—where the water table was and is much deeper—continued to rely on the same sources of water (wells and surface canals) for irrigation and drinking water that sustained Sijilmasa.

It is possible that kheffara first came to Morocco from the Middle East following the Islamic revolution; the pattern of diffusion closely follows the historic dispersal of Islam. However, it is not certain if this technology was introduced by Muslims first to Morocco and later to Islamic Spain, or whether it first swept into Islamic Spain from North Africa, and then diffused back into Morocco (Goblot, 1979; Joffe, 1992). It appears that qanat technology had earlier diffused to Roman Spain from the Near East where the Romans, presumably borrowing Persian technology, had built and used qanats in Jordan and Syria, so there could have been an Iberian precedent to Morocco's filtration gallery systems (Fleming and Barnes, 1993; Glick, 1979).

The Moroccan hearth for kheffara was the Haouz Plain around Marrakech, where kheffara were being built by the early 12th century, followed by the Sous Valley of southern Morocco (English, 1968; Goblot, 1979; Joffe, 1992). Although the technology was surely known in Sijilmasa by at least this time (if not earlier), kheffara did not appear in the Tafilalt until late in the 14th century, shortly after the fall of Sijilmasa (Lightfoot and Miller, 1996). Fourteen medieval accounts of substantive interest—dating from the 9th–14th centuries—describe Sijilmasa and its environs, yet make no mention of kheffara in this area, and most Tafilalt kheffara irrigated agricultural fields which lay outside of the original Sijilmasa-era fields (Lightfoot and Miller, 1996). Tafilalt kheffara are closely associated with post-Sijilmasa qsour, which were only built after the fall of the city as its inhabitants divided along family/clan lines and dispersed across the oasis (Lightfoot and Miller, 1996). It is possible that the adoption of this new water technology even facilitated the disintegration of Sijilmasa or, at least, made the devolution from central city to dispersed villages both thinkable and achievable for the northern Tafilalt. Kheffara technology accords well with the layout of scattered qsour, each with its ruling lineages and mechanisms for organizing labor at a more localized level (Lightfoot and Miller, 1996). Many of the kheffara are named after the qsour which built and used them. Many more are named after Alouite kings who ruled the Tafilalt after the fall of Sijilmasa. Therefore, networks of dispersed villages with associated kheffara appear to have emerged in the Tafilalt in the late 14th through the 16th centuries; a few of the Sifa district (northwest Tafilalt) kheffara being originally constructed as late as the 1730s (Margat, 1961).

Kheffara continued to provide the only reliable irrigation water for north Tafilalt qsour until the early 1970s, when new technologies and government policies forced changes in traditional water management. Insufficient water (from the dam) and non-sustainable methods of groundwater use (overuse of diesel pumps) have, since the early 1970s, resulted in a dramatic lowering of the water table underlying the oasis. These modern water technologies, because they are proffered and subsidized by the government, continue to replace the few remaining kheffara, which are abandoned as the water table drops.

### Siting and maintenance of kheffara

Constraints of geography have allowed only 28 of the 132 qsour of the Tafilalt to construct and utilize kheffara. For these qsour kheffara became essential to their survival. Qsour and kheffara have functioned symbiotically. With one exception, all qsour with kheffara are in the north of the Tafilalt, where the water table has always been most shallow, and kheffara mother wells did not have to be sunk into the basin alluvium more than a few meters.

Until a generation ago, agricultural maintenance in general was most often the task of the haritin, a social class held as chattel. An entire class of haritin, known as "khettater" (from "kheffara") were specialists in the difficult and dangerous work of kheffara maintenance. This is analogous to the special "mughanni" class of qanat builders in Iran, except that the "khettater", and haritin in general, were viewed with contempt, while the "mughanni", in spite of their low caste and crude work, were (and are) held in esteem for their skill and performance (English, 1968; Smith, 1953). The haritin caste has now been liberated, and while many still live in the Tafilalt and may now own land, they are no longer responsible for kheffara maintenance.

This change in social roles, and not only the loss of groundwater, has contributed to the abandonment of kheffara over the last generation. Those kheffara that are still active are maintained by all qsar inhabitants and sometimes

by friends and family from neighboring qsour who help with labor, receiving either cash or returned favors.

Typically, each family will donate one workman per day during maintenance operations, which includes cleaning sediment out of the subsurface channel as well as deepening the mother well and/or intermediate shafts. In order to encourage the exploitation of every possible water source, the government of Morocco, via the Errachidia agricultural office (and Rissani extension office) makes available small grants to fund the regular maintenance of productive khettara (at least since 1975, when the Rissani office was established). The agricultural office also provides khettara workers with education, training, and equipment (e.g. shovels, ropes, and sump pumps to remove water from khettara upstream from the work site) and gasoline (for the pumps) to aid in the cleaning effort.

Funding is contingent on the perceived importance and benefit of the project. Although requests for assistance for installing diesel-pumped wells may or may not be approved, khettara requests are almost always granted, as they (unlike pumped wells) are seen as providing benefits to agriculture without preying on the groundwater of neighboring mother wells or pumped wells. If granted, funds are used to pay workers from the qsar that owns the khettara (about 30 Dirhams per day in 1992), or to pay workers hired from other qsour.

Khettara are employed either as primary irrigation sources or at least to supplement the water from mechanized wells and government canals. Qsour which used to operate khettara have abandoned theirs only because "the water has gone dry". Usually this means that water no longer flows through the khettara because the water table has dropped, but it may also mean that an earthquake or flood has damaged the subterranean conduit, or the tunnel has collapsed, or side walls have blown out into a neighboring tunnel as the result of dynamite (occasionally) used during cleaning operations.

### **Khettara in a Modern World**

The competition between traditional and modern water systems is both environmental and cultural. Environmentally, diesel-pumped wells and government canals have led to the abandonment of a sustainable technology in favor of systems which are capable of providing greater quantities of water but are not sustainable. Culturally, the adoption of newer technologies has led to the abandonment of traditional technologies like khettara, altering the land use patterns which evolved through the historic reliance of villages on khettara. There has been some loss of local control over water resources, because much of the water villages need comes only from the Errachidia reservoir and drinking water pipes, both regulated by the government. Khettara are qsour operated and collectively maintained, and intricate relationships have evolved to manage them and distribute their benefits according to each shareholder's inputs of land, labor, tools, and money. Diesel-pumped wells are often privately owned and, as a result, the traditional ties that bind village society are breaking down. Non-farm sources of income continue to draw young men away from villages and out of the oasis, disrupting the social organization of khettara systems. Furthermore, the traditional source of wealth in the oasis, trade in dates, has been irreparably altered. Only 60% of the palm trees in the Tafilalt still produce a date crop today. The others no longer produce dates or have died as a result of periodic date blight and/or sustained desiccation.

There were originally 80 khettara in a 300 km network providing water for 28 qsour in the northern Tafilalt. Today there are only 19 khettara in a 90 km network watering 12 qsour (possibly as many as 36 khettara for 16 qsour, if all of the galleries between Sifa district and Jorf in the northwest Tafilalt, active in 1970, were still active; a few of these still flow, but some are now dry, and the status of each of these 17 khettara between Sifa and Jorf is not known). All 80 khettara originally irrigated about 3000 ha of the Tafilalt oasis. This is about 14% of the potentially arable land in the Tafilalt, and about 20% of the roughly 14,000 ha actually farmed at any time.

The last of the khettara will dry up in the near future, as the water table becomes so deep that "following the water" by extending the depth of mother wells would necessitate the excavation of new horizontal shafts; in essence, excavating new khettara from source to terminus, parallel to the old galleries but at greater depth. This would prove prohibitively labor-intensive and expensive.

### **Summary**

Communities and cultures dependent on irrigation have forever improvised, borrowed, and improved their water management technologies in an effort to expand production or at least maintain and more wisely use existing stores. Today, more than ever in the past, injudicious attempts to expand the use of surface and groundwater, without regard to the sustainability of withdrawal, are depleting groundwater resources and feeding social and environmental instabilities.

In the Tafilalt oasis, khettara irrigation is being sacrificed in the drive to expand water supplies to meet the needs of enlarged agricultural industries upstream, and a growing population throughout the region.

Traditional water technologies may not be able to keep pace with growing demand, but are usually less expensive to operate and allow farmers and village cooperatives more direct control over the supply and distribution of their water. Newer technologies have been designed to deliver greater quantities of water, and may provide a more reliable source of water less susceptible to natural fluctuations in water regimen, yet withdrawal rates often exceed natural supplies or recharge. But 'out with the old and in with the new' has long been a trend everywhere, and must be as economies develop and populations expand, increasing the need for more water and other resources. In the Tafilalt, however, it is not only the traditional water systems that are marginalized in the march to modernization; a whole oasis is being forsaken. Khettara abandonment is merely the bellwether of a moribund oasis.

**Note:** This article is excerpted from "Moroccan Khettara: Traditional Irrigation and Progressive Desiccation," *Geoforum* (27:2), 1996, pp. 261-273.

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