ANCIENT WATER SYSTEMS AND PRACTICES IN TUNISIA AND MOROCCO

Report for GreenCom
The Middle East Peace Process Water Conservation Project

Melanie Mason, Ph.D.
AAAS Fellow
G/ENV/ENR
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Introduction

This report was undertaken as part of the Middle East Peace Process Water Conservation Project. Under the auspices of the Water Working Group, USAID/GreenCom is working to develop a media campaign on "best practices" in water conservation among several North African/Middle Eastern countries to increase awareness of the critical nature of water throughout the region and how it is being addressed. However, the importance of water uses and practices is not a modern issue. Civilizations of the North Africa/Middle East Region have been confronted with the problem of water use and distribution since antiquity: the ancient phoenician, roman, arab, and berber civilizations all developed lifestyles around water and, where necessary, built systems to support such lifestyles. USAID/GreenCom proposes to include ancient/historic water practices as part of its water conservation awareness campaign by presenting water use and distribution as age-old concerns, rather than solely as modern issues.

This report covers ancient/historic water systems and practices in Tunisia and Morocco, focusing on roman and early muslim periods, roughly between 1C-11C AD and covering primarily urban uses. It recommends two or three sites of specific focus for each country while noting several others sites that may be of interest. Each specific site was selected according to various factors: historic and cultural importance to the country; differences in water systems based on civilization, water availability, and climate; and visual remains. For each country, site visits and interviews with university and museum experts helped to determine the selection of the recommended sites. Travel occurred from November 25-December 19, 1996. USAID/RHUDO/Tunis, USAID/Rabat, and the respective US Embassies were very helpful and supportive of the work conducted for this report.

Overview

Tunisia and Morocco share long histories with Mediterranean and Middle Eastern civilizations and have played important roles in the development of the region. The ancient histories of Tunisia and Morocco include the histories of phoenician, greek, roman, northern european, turkish, berber, and arab expansion and development. Water has been a critical factor for these countries and for their contributions to the development of the civilizations of the region. The romans and muslims have left the greatest display of waterworks and water practices, in part because the others either used previously built systems or were not there long enough to develop their own.

Water systems for municipal use were usually for agricultural use as well. For some of the recommended sites, as much as 95% of the water went to agriculture. However, these sites also provided water to cities and households and such a large discrepancy between water for agriculture and muncipal use is not completely unknown today. Indeed, the issue of water

distribution by sector may have been as contentious then as it is now for many areas throughout the world.

Both the romans and muslims developed water systems with many built-in water conservation practices. For example, cisterns were often built underground or were covered; the romans covered their aqueducts; the muslims designed their wells to be bottle-necked, opening to a large storage area; both built underground passageways to wells; private fountain water was often reused. In Morocco and Tunisia, there are areas where rain falls only seasonally, when it does, it falls in torrents but for a short time. As such, rainwater was often collected and stored underground. Transport systems were based on gravity which provided an automatic stop valve if more water was used than could replenish aquifers.

Romans and muslims in both countries were concerned with water quality. Romans were known to have tested for water quality, adding a substance to improve water or diverting the water until the contaminant was flushed out. The muslims added filters and decanting systems to remove impurities; in some areas, large reservoirs were bypassed in favor of small springs to reduce pollution. Water was often separated according to use. For example, muslims allowed certain reservoirs to be used for washing and other non-potable uses in order to protect springs and other water sources. Canals and pipes were designated specifically to remove used water out of cities.

Islam and Water

Islamic culture has developed a special reverence for water, in part, because of the tradition of scarcity that arose from the original homelands of Islam. Water was created as the source and origin of all life. Water sustains life, physically cleanses, and ritually purifies. Before prayer, which occurs five times each day, moslems must cleanse themselves with water. Moslems hold water to be the only pure physical substance; flowing water is considered the purifying agent.

Public fountains and baths (*hammam*) are significant features of Islamic cities. Cities contained a great number of public hammam in addition to whatever private baths may exist. Cleansing, ritual purifications, and family ceremonies took place in the hammam. The hammam usually consisted of a room for undressing; cold, medium, and hot baths; and a room for resting and massages. Public baths designated certain hours for separate use by men, women, and families. Public baths built for the poor was a common practice throughout the medinas in Tunisia (and Morocco?).

Public fountains (*seqqaya*) were widespread and splendidly decorated. For a moslem, the highest merit was to build a fountain: it gave drink to people and animals and provided the means of purification. Because of its purifying character, a seqqaya sanctifies the place in which it is located. Construction of a fountain was considered to be an expiatory act.

The arabic word, *shari'ah*, literally translated as "source of water", is often used as a term for Islamic Law because it contains both legal rules and ethical principles. Finally, water is identified with abundance and paradise. Moslem rulers took great pride in providing water for large public gardens in and surrounding the medinas, for gardens are associated with paradise.

TUNISIA

Located in the central Mediterranean area, Tunisia has played an prominent role in the development of the region. Tunisia was, at times, home to several of the great mediterranean civilizations: the Carthaginian, Roman, and Arab empires. While the carthaginians (or phoenicians) remained on coastal areas, the romans expanded, building as many as 350 cities and towns in Tunisia. The arabs have had the greatest impact since they took over the region in the 7C AD, converting the country to predominantly muslim and integrating the sacred nature of water and its use throughout society and culture.

There are three primary climate regions in Tunisia: the north usually receives an sufficient amount of annual precipitation, approximately 500mm; the middle is more arid, receiving about 200mm; while the south, the Sahara, is quite arid, receives little rainfall, and is dependent on oases as water sources. This report focuses on the middle and northern regions of Tunisia. Three sites are recommended for a media campaign: Carthage, Bulla Regia, and Kairouan.

Carthage

Swathed in legend, Carthage is said to have been founded in 814 BC by Elissa (or Dido) as she fled from her murderous brother, King Pygmalion of the phoenician city of Tyre (now Lebanon). The phoenicians were merchants and set up small settlements along the coasts of northern Africa, essentially dividing the Mediterranean with the Greeks. Carthage became the primary phoenician capital after the phoenicians of the east, in the Levant, were defeated by the Greeks in 480 BC. Carthage rose to its height during the 4th and 3rd centuries BC, ruling over an immense empire united by the sea.

The phoenicians of Carthage relied on rainwater. Each house collected rainwater from rooftops that was stored in underground cisterns. Groundwater was not used, possibly because it was too salty. It is estimated that at the height of its empire the city housed between 100,000 and 300,000 people, but apparently, the phoenicians did not build aqueducts to bring in more water. Many of the ruins of the Phoenician Empire are difficult to see because the romans built on top of the ruins of the city. Nonetheless, there exists a layer of phoenician remains under roman remains showing underground cisterns.

Carthage was defeated by the Romans in 146 BC following three Punic Wars (263-146 BC). After its defeat, Carthage was razed and abandoned for more than 100 years. During the first century AD, the romans rebuilt it as the capitol of a vast and wealthy province. Carthage

eventually became the third major city in the Empire after Rome and Alexandria, with an estimated population of up to 700,000 people[1].

Zaghouan Aqueduct. The Romans were engineers at heart. They liked to build big things: tall columns, massive arches, long aqueducts. Perhaps the new Carthage came to life partly as a result of a 132 km aqueduct that brought water from what is now Zaghouan, about 90 km south of Carthage. Said to have been built by the Emperor Hadrian because of a five year drought, the aqueduct took 40 years and was completed in 122 AD[2]. It was built of stone and was covered its entire length. Portions of the aqueduct remain and are spectacular in the height of the arched columns necessary to keep water flowing by gravity.

The aqueduct terminated at La Malga, a reservoir system which consisted of 24 (or 25) long, covered, above-ground cisterns running parallel to one another. The cisterns were fed by openings in the aqueduct. Wells on top of the cisterns allowed public access. However, the water from the aqueduct was used primarily for public buildings such as temples, public baths, fountains, and cisterns, and the governor's palace. Underground pipes transported water from the cisterns; separate pipes transported used water out of the city. When the cisterns were full, the aqueduct could be shut off just before the cisterns and water allowed to drain onto the ground. Viewing the aqueduct and the reservoir system enables one to appreciate the very sophisticated water system built by the Romans to support their lifestyles.

Antonine Baths. Public baths were a notable feature of roman life and required much of the water designated for public use. Public fountains and baths are found in every roman site in addition to private baths and fountains. In Carthage, the Romans constructed the splendid Antonine Baths, perhaps one of the world's first health clubs. The baths included areas for sport, massage, eating, and resting (including sunbathing). The main bath area consisted of three pools of different temperatures: hot (*caldarium*), medium (*tepidarium*), and cold (*frigidarium*), with a sauna (*laconicum*) and rooms for changing and cleansing. The baths were principle areas for socializing as well as for politicking. Apparently, many political decisions were made within the walls of the Antonine Baths. Certain times of the baths were designated for use by women only, though the sports and other areas could still be used by men. The baths were supplied water from the Zaghouan Aqueduct.

The Temple of Water. Although the Romans did not apparently display any special reverence for domestic uses (compared to the many mosaics depicting the God of the Sea, Neptune, and agricultural products), the Temple of Water was built at the source of the aqueduct in Zaghouan. Little is known about the temple; it is believed to have been a tribute to a water nymph, a lesser deity associated with the god, Apollo, and was built during the 2C AD.

Roman Carthage fell in 303 AD and was occupied by Vandals and Byzantines until the Arab conquest of 698. During this time, the aqueduct fell into disrepair. The Arab Hafsids occupied Carthage for a short period, building on top of the Roman ruins, including private cisterns to collect and store water. The Hafsids restored the aqueduct but changed its course

into Tunis, leading to its replacement of Carthage as the main city of Tunisia (then known as *Ifriqiya*). At present, the terminus of the Hafsid aqueduct in Tunis is unknown[3].

Bulla Regia

Located near the Algerian border, this site was was founded during the 4C BC and became romanized during the 1C AD and was an affluent Roman town. With an abundance of groundwater, this city was able to be somewhat lavish in its private and extensive bath system. At its height, the city was said to have consisted of 20,000 romans and 50,000 slaves (the slaves lived on the nearby hillside). Many of the underground houses are in magnificent condition, with mosaics and fountains still beautifully intact.

The houses were uniquely two-storey. One level was built underground, presumably for protection from the summer heat, and another, nearly identical, built above ground for the winter months. The underground levels retain the high columns and ceilings favored by the romans, and separate kitchens and sleeping quarters. Private fountains and baths are found in every house (private baths are found only on the first level). Each house had a cistern to collect and store rainwater in addition to wells for drinking water.

Although each house did not have a private well, there were many public wells available and residents built underground passageways to the wells. Each house had an open patio on its underground level that collected rainwater. Terracotta pipes transported fresh water within the houses and to public baths and fountains; lead pipes drained used water back to the river, Oued Mejerda. Canals were built under the roads to transport used water from the baths, toilets, and public fountains out of the city.

Though water seemed to be abundant, the residents of Bulla Regia recycled private fountain water for cleaning and other non-potable uses. This town had seasonal public baths, winter and summer; hot baths were supplied from nearby hot springs. The town fell to the Byzantines and soon after was destroyed by an earthquake and abandoned during the 6C AD.

Kairouan

The first Arab city in Tunisia, Kairouan was founded in 670 AD by the Aghlabid dynasty and was the capital until 909, when the Fatimids took over rule of Tunisia. Though no longer a commercially important city, it remains the most holy city in Tunisia. Kairouan lies in the cental, arid region of Tunisia, receiving only 200mm of water annually. Consequently, water was often scarce and supplying the city with water has been a concern for officials since its founding. The inhabitants collected rainwater from rooftops and stored them in covered cisterns. In addition, the city built wells and cisterns for domestic use; this water was available to anyone at anytime. Water in Kairouan was free; transport was not. Water delivery men, known as *saqqa*, delivered water to residents for a fee.

The Aghlabid Pools. While the Arabs built upon and expanded roman water systems as they took over Tunisia, the Aghlabids built their own water system, the Aghlabid Pools. These are

large, uncovered reservoirs, typically 160m in diameter and 4-5m deep, that stored water transported by an aqueduct some 32 km long[4]. Water from the aqueduct first drained into a small catchment reservoir, attached to the main reservoir and at a slightly higher level, that acted as a natural filter. When the water reached a certain level, it flowed into the larger reservoir. Underground rooms with wells connected to the large reservoir allowed public access.

Originally, 15 pools surrounded the medina to provide water for a population of approximately 15,000. Two have been restored for public viewing. These systems are also found in Sousse and Sfax and are unique to Tunisia. Built during the 9C, the simple and elegant design of these pools tests one's belief that they are over 1000 years old.

The Great Mosque. Built during the 9C by the Aghlabids, the Mosque provided water for all public use, but particularly for the cleansing ritual important in the muslim religion. The central open courtyard was designed to collect rainwater that flowed through pipes from the roof. The plaza sloped to a center drain with a marble filter. From there, the water passed through a series of decanting (filtering) cisterns into several large storage cisterns. Several wells allowed people to draw water for religious and domestic use.

Bir Barouta or Bi'r Ruta. Located in the center of the medina, this well is considered to be the oldest well in Kairouan and is surrounded in myth. It is believed to be the original spring that prompted the founder of Kairouan, Oqba Ibn Nafaa, to choose this site to build his holy city. The water of the well is said to be connected to the sacred well of Zem-Zem in Mecca. Finally, legend claims that those who taste the well's water are destined to return to Kairouan one day.

Other Areas of Interest

The Sahara. The arid climate of the Sahara led to different designs of water systems and practices. The southern region of Tunisia that lies in the Sahara relies on groundwater. The oases of Tozeur, Nefta, Gabes, and Gafsa, among others, developed a system to distribute water that would allow everyone the same quantity using time to determine amounts. The oued (river fed from groundwater, often seasonal) would be diverted extensively throughout the oasis until every drop was used and the oued had disappeared. The water was for both agricultural and domestic use. The oases were smaller in population and could not support the larger populations of the cities of the north. (not visited)

Other Sites Visited

Utique. Originally phoenician, this city became the first capitol of the province under the Roman occupation.

Thuburbo Maius. One of the main agricultural cities for Rome.

Uthina. A city granted to military members, it has two large cisterns for storage of water.

Kerkouane. One of the few phoenician cities not built over by romans. This city was built during the 6th century BC and was destroyed by the romans in the 3rd c. BC. It was a

commercial city famous for its ceramics and glass. Built up against the sea, its port has since been since destroyed by rising sea levels. Residents did not collect rainwater, relying on groundwater; each house had a private well.
Cheylus (*Jebel Oust*). This town contained large public medicinal baths fed by a mineral hot spring nearby. This site shows a special tank where romans tested water quality and could divert the water away from public use.

MOROCCO

Lying on the western frontier of Northern Africa, Morocco straddles the Mediterranean Sea and the Atlantic Ocean. While both the Phoenician and Roman empires extended into Morocco and Volubilis became the main roman city, roman presence was not as widespread as in Tunisia. Morocco has, however, been strongly influenced by berber tribes. Rome incorporated two large berber kingdoms into its empire. After the Arab conquest of Morocco by the Idriss dynasty in 788, three berber dynasties ruled Morocco from 1062 until 1554.

Morocco enjoys a diverse climatic and geographic landscape. Three mountain ranges transect the country, the High and Middle Atlas Ranges of central Morocco (highest peak is 4165 m) and the Rif Mountains of the north. The northern section of Morocco receives the most rainfall, the middle less, and the south reaches into the Sahara and is very dry, receiving less than 100mm of precipitation each year. Two sites are recommended for the media campaign: Fes and Marrakech. These are both muslim sites of historical and cultural importance.

Fes
Fes is the oldest of Morocco's muslim capitol cities. Founded by the Idriss dynasty in either 799 or 808AD[5], Fes was built upon an abundant water source. The medina was fed by the Oued Sebou, several tributaries, and by many underground springs. It was said that Idriss II guaranteed the inhabitants of Fes the right to free water forever, after buying the right from Berber tribes controlling the region. Such an abundance of water and the subsequent development of a remarkable system of waterworks were sources of great pride to the residents. Many historic documents praise the source of water and view water as purifying the city. Indeed, in many respects, the entire medina of Fes is a celebration of water.

Repartitieur. The underground canal system originated during the 11C and was well developed by the 14C. Water was brought to the city via aqueducts from nearby hills. At the entrance, the *repartitieur* diverted water to houses and quarters (similar to neighborhoods), and to public fountains and buildings[6]. The repartitieur consisted of a series of canals and wells of differing widths to create greater or lesser water flow, depending on the purpose of the water[7]. This canal system enabled many houses to have running water. For those houses without running water, many public fountains were available.

The repartitieur also divided new and used water, controlled by gates. Used water was sent

out via specific canals to Oued Bou Khareb, or Old Father Waste, and eventually back to the Oued Sebou, away from the medina walls. The underground canal system is so extensive you can feel and hear the hollowness of the streets as you walk through the medina.

Water from the canals was used to produce mechanical power in addition for domestic use. For example, a flour mill was located near the repartitieur that was powered by waterwheels. Allocation of water was based largely on time, rather than quantity. The system was further based on cooperation and legal rights.

Quadsi. Such an elaborate system led to the development of "corporations" of keepers of the canal works, called *quadsi*. This became an important hereditary trade in Fes. Apparently, the knowledge of the canal system rests with one last person who refuses to pass on information to anyone but an apprentice. Indeed, there is a clock in the medina that was once powered by water, but at present experts are unable to get it to work.

Drinking water came largely from underground springs. Private wells within homes were not common, but many large wells were built to service 20-30 houses. Indeed, quarters were often formed around a spring and took on the name of that spring (in arabic, *ain*). Thus, as you walk through the narrow, twisting "streets" of Fes, you see sign identifying neighborhoods as Ain---- (such as, spring that fed the donkey, or something like that).

Hammam. Public fountains and baths (*hammam*) are important features of the medina for domestic use and especially for ablutions. The public baths were elaborately designed. The fountains were beautifully decorated by ceramic tile work, *zellidj*. This ceramic tile design originated in Fes during the mid-12C. The zellidj trade was very important in Fes; fountains were constructed by the zellidj maker and often named after the artist. By the beginning of the 13C, Fes contained more than 80 public fountains, 93 public baths, 372 flour mills, 785 mosques, and 125,000 inhabitants.

Water carriers (called *Guerrab*?) provided water for households lacking running water or a private well. Water carriers also circulated in public areas such as markets and shrines, selling water to passers-by. They also acted as firefighters when the need arose.

Marrakech

With a backdrop of snow-covered High Atlas Mountains and palm trees, Marrakech lies on the transect between the abundance of water enjoyed by Fes in the north, and extreme scarcity of the Sahara in the south. Founded in 1062, it was the capitol of Morocco until 1269, and again during the 16C. The residents of the medina relied primarily on underground springs for domestic use. Nevertheless, water availability has been of concern since its founding; the people of Marrakech and to the south developed systems of transporting water from distance groundwater sources to provide water for agricultural and urban uses.

Al-Khattrat. Developed during the 11C, al-khattrat systems consisted of a series or network of

long underground canals that transported water from an underground spring up to ground level. These canals were unique in design: they included a series of shafts dug from groundlevel to provide air to the workers in the canal underground. The shafts were not used as wells; they were used to provide access to the underground canal and for air only.

These canals were quite long: the arms that led to a main underground canal were often 2000 or more meters in length; the main canal was 4000 m or more, depending on when it would reach ground level. When the water reached the ground, it was kept contained as though it were a spring, apparently to reduce water pollution. From there it was transported through open canals to legal users. Often a large pool was built solely for uses such as washing. The system was based on gravity; when the aquifer was low or more water was used than allow to replenish, there was simply no water available.

Because this was a highly labor-intensive enterprise that required constant maintenance, an entire profession developed around building and maintaining the al-khattrat. Most of these systems were privately owned by a group of people. Initially, whoever helped build and maintain a system had access to the water. Later, as the profession developed, a group of residents would contract out to have the systems built. Most of these systems were for private use only, but several were built for public use, in particular, providing irrigation for the lush palm gardens outside of the medina and for public gardens and fountains inside.

The al-khattrat system is believed to have originated in Iran and was used solely in the southern part of Morocco[8]. Canals are being restored and used in the south; some 250 are in use today. However, labor and maintanence costs remain quite high and pumps are used in place of gravity. The government has restored a functioning khattrat system just outside of Marrakech to study how best to use and develop this system.

The Sekkia. This is an underground cistern that was fed by an al-khattrat located just outside the medina wall. From here, water was transported to the Mosque, public fountains and gardens, and other places for public use. [At the time of this report, the Sekkia was closed for renovation].

Other sites of interest

Volubilis. Possibly a relatively important berber town influenced by the phoenicians at the time the romans arrived in the last century BC. It was ruled under the Berber kingdom of Mauritania, as part of an area granted to Juba by the roman Emperor Augustus. In AD47, the berbers were overthrown and Volubilis came under direct Roman rule. The area became one of the granaries of Rome and was a major producer of olive oil and copper. The city was taken over by arab muslim culture at the end of the 7C. It was abandoned towards the end of the 8C. (not visited)

Chellah. Now part of Rabat; Chellah was possibly a phoenician city dating back to the 8C BC. It was built into the roman port of Sala Colonia in 1C AD, one of the southernmost

outposts of the Roman empire in North Africa. Besieged by the berber Idrisside dynasty in 8C AD, it was abandoned in 1154. Ruins show the roman public baths as well as a muslim public fountain adjoining a school.

Conclusion

This has been an informal review of some of the ancient water systems and practices in Tunisia and Morocco. Consequently, this report only just begins to touch the surface of the intricate relationship between water and the ancient cultures of Tunisia and Morocco. Time did not allow for in-depth studies of the recommended sites, though a tremendous amount of research has been done in each country. Nor was there time to visit any of the great oases of the Sahara, which have developed their own systems of water distribution and practices.

This report only briefly mentions some of the social practices surrounding these water systems. A next step may be to collect more information in this area of water use for selected sites. For example, with such elaborate water distribution systems and such arid regions, fairness and equity must have been issues, particularly during times of drought.

Nevertheless, this report does bring up some issues that are usually considered modern: the notion that water is free but transport must be paid; sharing costs of transport systems among private users, as in the al-khattrat system; recycling water, as in Bulla Regia, where residents recycled private fountain water; and water quality.

Endnotes

1. Experts I spoke with were reluctant to give a population estimate because of the difficulty in obtaining reliable estimates from such ancient ruins.

2. Source: Blue Guide, Tunisia, 1996. Other experts contend that most likely this was said in tribute to Emperor Hadrian, rather than as a historical fact.

3. It is known that the restored Tunis aqueduct supplied water for the Mosque, the Kasbah and the gardens for the Palace. The water was stored in open reservoirs with underground wells, though the whereabouts of these reservoirs are unknown. In the medina, each house had a private cistern on the roof for rainwater. Some houses had private wells but many were too salty for use. Water was also used the the public baths. Canals were built to transport used water out of the medina.

4. The aqueduct said to have supplied the Aghlabid pools is under dispute. Several studies have indicated that the main water source for the pools came from the catchment of trickling water from the tributaries of the Marguelil River. (Maoudoud, 1992)

5. There are two stories concerning the founding of Fez. The traditional story claims that Idriss II built Fez in 808 because the old roman city of Volubilis was too small. This story has been questioned by modern historians who suggest that Fez was actually founded by Idriss I in 799. Idriss II, who succeeded his father 19 years later, expanded the city to the other side of the river.

6. There were two main control systems of the water. The primary system was located at the entrance of the medina. A second control system is located about 15 km from the medina and was built during the Marinide dynasty during the 13C as a means of the controlling the people of Fes by controlling the source of water. At this time, the Marinides built Fes Jdid, or new Fes, situated nearby old Fes.

7. At the time of this visit, the main repartitieur was closed for public viewing. I was allowed to see it but was not allowed to take pictures. It would be fantastic for a video camera for it is in superb condition.

8. The al-khatratt system (in french, les khettaras) is believed to have come from Iran and Iraq, where it is called *canat*.