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This volume is dedicated to the memory of

Azza Karara

Significant and exceptional member of the society

Water Management in the Mareotic Region

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Introduction:

Lake Mareotis represented a unique water body in the north-west coast of Egypt. It was exceptional compared to other lakes on the Egyptian north coast, since, unlike other Egyptian coastal lakes that were formed as a result of the sea inundating the north coast of the Delta; Mareotis was mainly made by the Nile[1]. Moreover, Mareotis played an unparalleled role in the economy of Hellenistic and Roman Alexandria[2]. Its connection to the Nile, the Mediterranean Sea and to Alexandria influenced significantly the development and prosperity of the city. Therefore, not only Lake Mareotis was a crossroads for internal transport, but also it was a major centre for industrial and agricultural activities during the Hellenic and Roman times. Thus, it is believed that the location and characteristics of Lake Mareotis, gave the city of Alexandria one of its major advantages (Strabo, *Geography*, XVII, 1.7). Accordingly, this paper will be looking at the different means that were used for water management along the shores of Lake Mareotis considering its unique characteristic, extent and function.

The Ancient Lake:

It is well known that the ancient limits and extent of Lake Mareotis were much larger than its present extent[3]. For example, when Strabo (*Geography*, XVII, 1.14) speaks of the size of the Lake, he states that *"… it has a breadth of more than 150 stadia (c. 25km) and a length of less than 300 (c. 50km)*". On the other hand, Pliny (*Natural History*, V, 11.63) speaks of the dimensions of Lake Mareotis stating that it was *"… 30 miles (c. 45km) across and 250 miles (370km) in circumference*", which is not far off the figure Strabo gives. Also, according to Warne & Stanley's sedimentological and petrological study of the north-west Delta region[4], the circumference of the ancient Lake was about 360km; very close to Pliny' suggestion. Furthermore, one of the maps produced by surveyors of the Napoleonic Campaign and published in their encyclopaedic work *Description de l'Egypte* in 1809, depicts Lake Mareotis after it has been

1 Said, R., 1993: 69-77.

2 Blue, L., & Khalil, E., (eds.), 2011.

3 Awad, I., 2010: 11-24.

4 Warne, A. G., & Stanley, D. J., 1993: 26-64.

inundated by the sea in 1807 [5]. The map shows the lake extending from north to south for about 40km as far as north of Abu El-Matamir, while it extends from east to west for about 50km as far as east of Taposiris Magna (Fig. 1).

However, it is important to mention that the ancient lake could be considered as consisting of two sections; the main body of the lake and its western arm. The lake's main body, which extended for 40 - 50km from north to south and merged with the Delta Plain, has changed dramatically during the past two millennia. As water ebbed, most of the basin became dry arable land . On the other hand, the situation in the western arm of the lake is quite different. The western extension of the Lake was always controlled in its extent by coastal ridges delimiting it from the north and south[6]. Therefore, the extent and limits of this part of the lake has not changed significantly since antiquities. Moreover, the present water level of the western sub-basin of Lake Mareotis is relatively close to its ancient level[7]. On the other hand, it was realized through extensive archaeological research along the shores of the western Mareotic arm that it contains the majority of archaeological remains in the entire Mareotic region which indicates dense occupation during antiquity. The western Mareotic arm also contains the only surviving evidence for the islands that existed in antiquity in Lake Mareotis. It is worth mentioning that ancient authors have mentioned that Lake Mareotis contained a number of islands (Strabo, *Geography*, XVII.1.14; Pliny, *Natural History*, V.11.63); however, at present, due to the diminishing size of the lake, most of these islands have become unrecognizable. Nevertheless, the western extension of the lake still contains at least one main island which is 4km long and 500-800m wide. Moreover, archaeological investigation of that island revealed that it was one of the most densely occupied areas in the Mareotic region[8].

The Hydrology of Lake Mareotis:

Strabo (*Geography*, XVII.1.7) speaks of the water supply for the lake stating that *"…it is filled by many canals from the Nile, both from above and on the sides*". And in another occasion (*Geography*, XVII.1.22) he speaks of *"…several canals, which empty into Lake Mareotis*". So, the lake was fed by means of a number of

5 Néret, G., 1997: 572-3.

6 El-Sayed, M. K., & Khadr, A., 1999: 191-251.

7 Khalil, E., 2010: 135-146.

8 Hopkins, D., 2010: 35-45.

canals, which branched off the Canopic Branch of the Nile, and flowed into the south and east sides of the Lake. Some of these canals were navigable, which enabled merchandise to be transported to and from the hinterland. Although these canals were mentioned in a number of ancient sources, their exact number, location and routes remain uncertain.

Since Lake Mareotis was indirectly connected to the Nile, its water level was governed by the Nile's level. Strabo (*Geography*, XVII.1.7) states that *"... at the beginning of summer the Nile, being full, fills the lake*". So, when the Nile flooded, the water level in the lake would rise and when the Nile's water level dropped, so did the level of the lake. Therefore, in the flood season, it is likely that the lake's water level significantly rose to the extent that it could have threatened to inundate the land around it. In the fourth century AD Salminius Sozomen describes what would have been a dramatic flooding of the Mareotic region by the Nile[9], so it seems that the lake's inundating its shoreline was not an unusual event in antiquity. On the other hand, it is well known that the lake was connected to the sea through a canal that ran across Alexandria probably in the vicinity of the present-day El Mexx region; that is in addition to its connection to the sea through the ancient Abukir lagoon[10]. Moreover, the northern parts of the Lake were probably subject to sea-water seepage due to their proximity to the coastline. Accordingly, it is evident that the lake's hydrological system was also affected by the relative sea-level rise, particularly for the western arm of the lake which extends parallel and close to the northern Mediterranean coastline.

Based on a sedimetological and carbon dating study of several cores around the main basin and western extremities of the lake, it was realized that the ancient lake's water had both marine and fluvial influences with seasonal variations, which could indicate flood seasons with high freshwater input and a dry seasons subject to greater marine influence[11]. However, considering the extent and geomorphology of the lake, it is likely that the areas of the lake which were closer to the Nile, had more of a fluvial influence, while those which were further away from the Nile, such as the western Mareotic arm, had more of a marine influence. In other words, the salinity of the Lake's water varied according to the location, so that the areas

9 De Cosson, A., 1936: 83.

10 Flaux, C., *et. al*., 2012: 3494.

11 Flaux, C., *et. al*., 2013: 22-33.

which were closer to the sea were more saline than fresh in contrast to the areas which were closer to the Nile. This resulted in the lake's water being generally brackish and possibly undrinkable rather than fluvial.

The Archaeology of Water Management:

Archaeological investigation of the Mareotic region has been ongoing for several decades. During that time numerous sites of industrial, religious, domestic and maritime nature were investigated[12]. Among the sites discovered, particularly during the Lake Mareotis Research Project [13] are numerous sites related to the management and utilisation of the lake's water for domestic and agricultural purposes. That included wells, cisterns, *sakkias* (water wheels) and water catchment walls. Many of those sites were noticed by the early explorers of the region. For example, De Cosson in more than one occasion, mentions the existence of a large number of wells, *sakkias* and rock-cut cisterns in the Mareotic region[14].

During the Lake Mareotis Research Project, many of such sites were recorded along the shores of the Mareotic western arm between Marea and Taposiris Magna, with a concentration on Mareotis Island. The dating of the sites discovered relied primarily on the ceramic assemblages collected during the survey. Accordingly it was realised that the majority of sites date from the Hellenistic period until the 7th century.

Wells:

Wells are the simplest means for artificial water supply in the Mareotic region. They basically consist of a simple hole dug deep enough to reach the water table. In areas where the soil is stable the shaft of the well was simply cut in the rock, but in unstable soil, the sides of the upper part of the shaft above bedrock were lined with a supporting material[15]. Both types, however, are found in the Mareotic region due to the variation in geology. Wells on top of the calcareous coastal ridges were simply rock-cut, while those in the low grounds along the shoreline had the upper part of the shaft lined with Ashlar blocks.

12 El-Fakharani, F., 1983; Rodziewicz, M., 1983; Empereur, J.-Y. & Picon, M., 1998; Rodziewicz, M., 1998; Rodziewicz, M. 2003; Szymanska, H. & Babraj, K., 2008; Blue, L., (ed.), 2010.

13 Blue, L., & Khalil, E., (eds.), 2011.

14 De Cosson, A., 1935: 100-5.

15 Wilson, A., 2008: 286.

Obviously, the quality of water obtained from wells depended mainly on the local geomorphology and hydrology; hence, domestic wells had to be dug to a depth that allows reaching fresh drinkable ground water, while wells used for irrigation purposes needed only to be deep enough to reach the lake's water level.

Large domestic sites along the shores of the lake had evidence for the existence of several wells. For example, in the site of Al-Quseir, c. 3km east of Taposiris Magna along the northern coast of the lake, the remains of at least three wells are recorded. The entrance of the wells are generally square or rectangular in shape ranging in size from c. 0.5m x 1m to c. 1m x 1m, and they are made of limestone blocks of various sizes (Fig. 2). One of the wells on that site has evidence for what appears to be a water collection basin next to its entrance. The water lifted from the well was poured into the basin possibly for watering animals. A number of other sites had wells in them; however, all the sites were characterized of containing ample evidence for domestic occupation[16].

Cisterns:

Unlike wells, which were a source of water on their own, cistern were water storage structures which obtained their supply from another source such as rainwater, or water lifted by *sakkias*, that was usually carried into the cistern through stone water channels . Also unlike wells, cisterns were lined by layers of waterproof mortar *Opus Signinum* to prevent the leakage of water through the walls[17].

Cisterns took different shapes, however, they generally had a narrow shafts and a wide body, occasionally comprising one or more chambers. The quality of water collected in cisterns was generally inferior to that obtained from wells since standing water becomes stagnant. Therefore, when other sources for drinking water were available, cistern water was used primarily for other purposes such as for baths and irrigation[18].

At least four cisterns were recorded along the shores of Lake Mareotis; some of them were simple rock cut chambers, while others were more elaborate multi-chamber structures such as the Late Roman cistern recorded on the

16 Blue, L., & Khalil, E., (eds.), 2011: 113-290.

17 White, K. D., 1984: 104.

18 Wilson, A., 2008: 290.

site of Al-Gamal along the northern shore of the lake[19]. Although the cistern has not been fully excavated, by looking through its opening it was realized that the cistern is at least 3m deep and it consists of more than one chamber with a vaulted entrance, which was decorated with an incised seashell – a common motif in the Roman period (Fig. 3). It seems that the cistern was largely rock-cut; however, limestone blocks were used to build and reinforce the upper parts of its walls. The cistern was plastered with several layers of red mortar (*opus signinum*).

***Sakkia* (Water Wheel):**

Sakkias were the principle means of water lifting in Egypt since they first appeared in the Ptolemaic period until the early 20th century. They were widely used in the Roman period with a noticeable increase in their use during the early fourth century AD[20]. The development of *sakkia* was a revolutionary development of water lifting techniques which allowed for the irrigation of large plots of land. The device basically consists of a row of pots attached to the rim of a revolving wheel. When the pots were dipped into an irrigation canal, they were filled with water and as the wheel revolved they lifted the water to nearly the full height of the wheel (usually 3–6 m). In certain cases, where the *sakkia* is placed higher above the water level, the pots were attached to a chain which looped over the wheel to reach down to the water level (Fig. 4). Despite the wide spread of *sakkias* in antiquity throughout the valley and the Delta, their physical evidence in the archaeological record is quite scarce, however, the *sakkia* pots (Fig. 5), due to their distinctive shape, are generally the most recognizable archaeological evidence for the use of *sakkia*.

In the Mareotic region, the evidence for *sakkia* is plentiful. The remains of at least ten *sakkias* were recorded along the shores of the lake; at close proximity of the shoreline, nonetheless, they varied in their location and context. However, in antiquity the number of *sakkias* in the region could have been up to the hundreds.

During the Polish excavation of the Byzantine town of Marea a well preserved *sakkia* structure was discovered (Fig. 6) in association with a large bath complex dating to the 6th – 8th century[21]. The *sakkia* and a well that

19 Blue, L., & Khalil, E., (eds.), 2011: 158-160.

20 Forbes, R. J., 1993: 35-37; Mays, L. W., 2010: 62-64.

21 Szymanska, H. & Babraj, K., 2008: 86-94.

supplied it with water was located 5m to the north of the bath. So, in that case the *sakkia* was used mainly for supplying the bath with water.

In another site, just across the road from Marea, about 70m south of the shoreline another *sakkia* structure was recorded[22]. The diameter of the *sakkia* is about 9m, which makes it comparable to other similar structures recorded in the region. This *sakkia* was attached to a 12m x 6.5m basin made of limestone and red brick, lined with red plaster (*opus signinum*). Considering the size and nature of the basin, it was probably a *natatio* (pool) that belonged to a bath complex. The entrance to the basin was from the north-east corner where the remains of steps made of limestone blocks still exist. The *sakkia* was probably used for lifting water from a well into the basin (Fig. 7).

However, perhaps one of the most significant *sakkias* recorded in the Mareotic region is the one located on top of a headland at the western side of the Mareotic island, about 7m above the present lake level. On top of the headland there are the remains of a *sakkia* structure that measures c. 8m in diameter. The *sakkia* is delineated by a double circular limestone wall that is c. 0.9m thick. At the centre of the circular structure there are the remains of a well through which the chain of *sakkia* pots would have passed to reach the water level. Directly to the south of the *sakkia* there is a pathway c. 45m and 2m wide which leads to the entrance of a water tank that measures 7.20m x 6.30m and is lined with red mortar (*opus signinum*) (Fig. 8). The water tank is probably part of a cistern complex that extends underground; accordingly, both the *sakkia* and the tank were part of a water management system; hence the *sakkia* could have been used for lifting the lake's water which was then transported in channels across the pathway to be stored in the cistern[23].

A number of other *sakkias* were discovered along the southern shore of the lake's western arm. however, in these cases they were probably used for lifting water for irrigation, hence they were generally associated with a network stone water channels which were used for transporting the water that was lifted by the *sakkia* into the plantation fields. Moreover, as mentioned earlier, one of the most common evidence for *sakkais* in the Mareotic region are the *sakkia* pots that were attached to revolving wheel for lifting water. During the Lake Mareotis Research Project evidence for *sakkia*

22 Blue, L., & Khalil, E., (eds.), 2011: 117.

23 Blue, L., & Khalil, E., (eds.), 2011: 257-260.

pots were recorded in a number of sites along the northern and southern shores of the lake[24] .

Water catchment walls:

The last feature that will be discussed here in relation to water management in Mareotis is what could be described as water catchment walls, which were possibly a characteristic of the Mareotic region. Those walls are mainly found in low flat stretches along the southern shore of the lake. Possibly as many as six water catchment walls were recorded in the region. They all take the form of a linear feature that extends for a distance that varied between 70m to 250m parallel and close to the lake's waterline (Fig. 9). They were generally made of one course of regular limestone bocks arranged in headers arrangement facing the lake and outcropping just above the soil.

The function of those walls has been disputed. One theory was that they were intended to define the shores of the lake and to protect them from the effects of silting and sedimentation[25]. Another hypothesis was that they were built as quays to be utilised for mooring and loading boats[26]. The nature and location of those structures, and the fact that the lake was affected by the Nile flood regime so its water level rose with the Nile flood and inundated its shoreline; this would suggest that those walls were constructed to retain the water behind them when the lake's level dropped down after the flood. Hence, it would have allowed the water to remain for a longer period in the flat arable plots of the Mareotic shoreline, enabling the fertile earth to become fully saturated and ready for planting.

In fact, this technique is very similar to the concept of basin irrigation that was used along the banks of the Nile for thousands of years.

Conclusion:

It is evident that the shores of Lake Mareotis have been densely occupied since at least the 4th century BC until the time of the Arab conquest in the 7th century AD, therefore, the use and management of water in the region was inevitable. However, the techniques used for water management in Mareotis varied greatly according to the intended use of water as well as according to the location and nature of each site (Fig. 10). Wells and cistern were mainly

24 Blue, L., & Khalil, E., (eds.), 2011: 293-296.

25 Khalil, E., 2010: 139.

26 Hopkinson, D., 2010: 39.

associated with domestic areas which proved to have plenty of evidence for occupation. It is worth mentioning, however, that some of the ancient wells are still in use until today, which means that they can still access fresh ground water. On the other hand, water catchment walls were associated with the irrigation of low arable land. *Sakkias*, on the other hand, were used for both purposes, for domestic and agricultural activities. Nonetheless, it is worth mentioning that the majority of *sakkias* were recorded along the southern shore of the lake. The reason behind that would be related to the difference of the geomorphologic nature between the southern and northern shores of the lake. In most areas along the northern shore of the lake, the calcareous coastal ridges that extended along the coast ran in close proximity to the water line which meant that there is a limited flat low area suitable for plantation between the foot of the ridge and the lake. At the southern shore of the lake the situation was quite different since extensive stretch of low land existed between the southern coastal ridges and the lake's shoreline. Therefore, it is reasonable to suggest that the agricultural zone in the Mareotic arm would have extended along the southern shore which would have been suitable for growing crops such as vines, olives and palms that could tolerate the lake's brackish water. On the other hand, the north shore of the lake's western arm is believed to be civic and residential in nature, as supported by a diversity of archaeological remains[27].

It is well known that the Egyptian civilization throughout ages excelled in aspects of water use and management. However, the particularity of Lake Mareotis in terms of its nature, extent and hydrology, represented a special case in Egyptian water management. Nonetheless, all historical and archaeological evidence confirm that water management in Mareotis succeeded in making the region an economic hub in the service of Alexandria and of Egypt as a whole.

27 Blue, L., & Khalil, E., (eds.), 2011.

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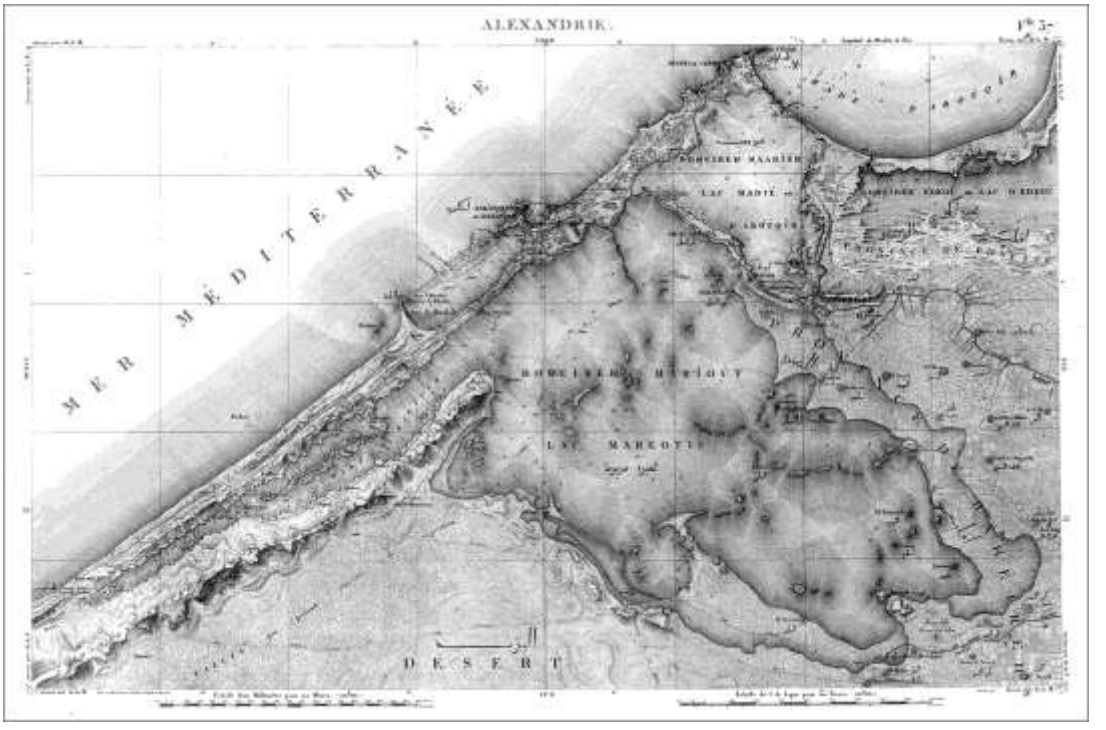

Fig. 1

Fig. 2

Fig. 3

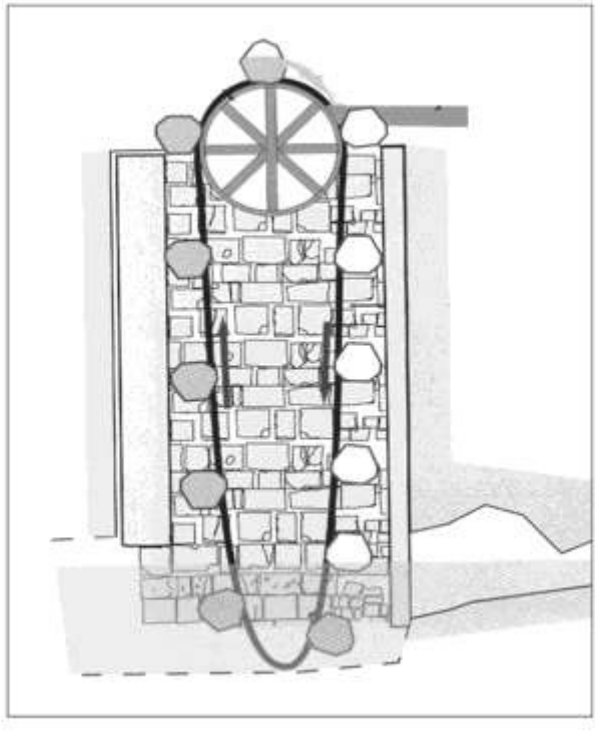

Fig. 4

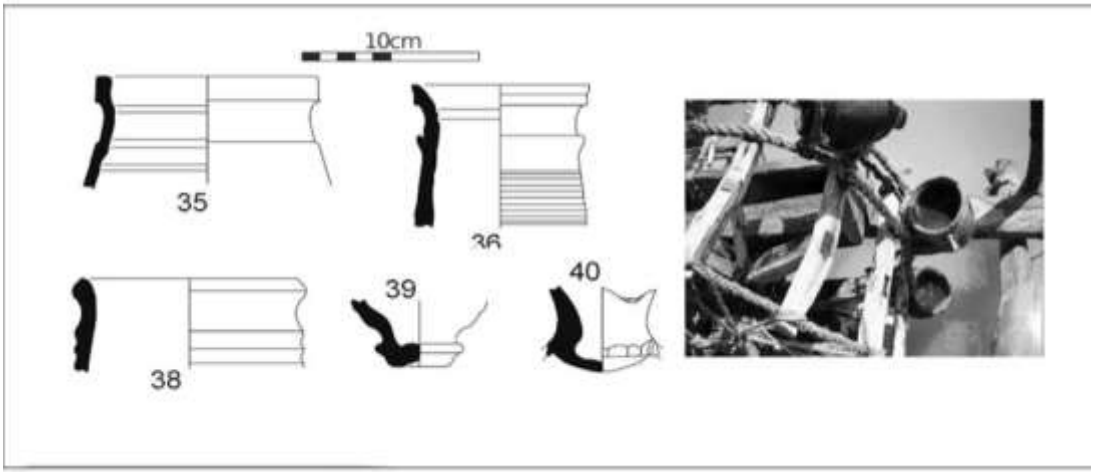

Fig. 5

Fig. 6

Fig. 7

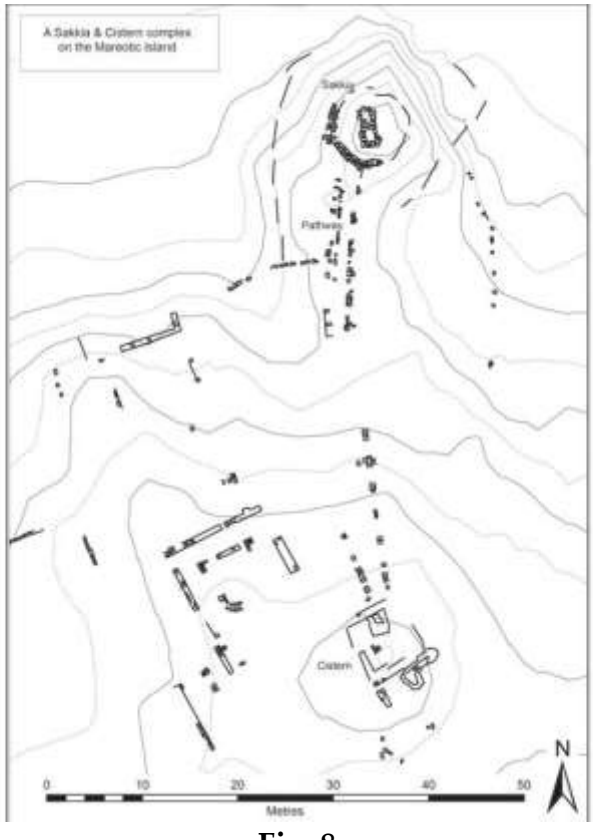
A Sakkia & Cistern complex
on the Marcotic Island
Sakkia
Pathway
Cistern
N
0
10
20
30
40
50
Metres

Fig. 8

Fig. 9

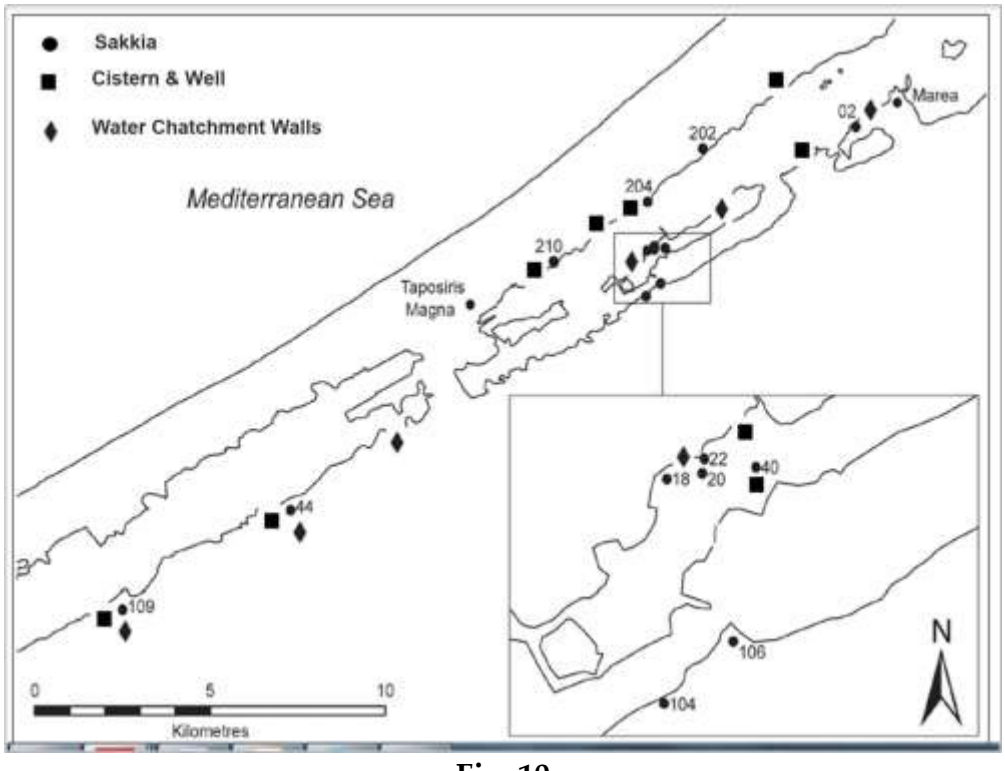
Sakkia
Cistern & Well
Water Chatchment Walls
Mediterranean Sea
Taposiris Magna
Marea
02
202
204
210
44
109
22
18
20
40
106
104
N
0
5
10
Kilometres

Fig. 10