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## *Water management in Medieval and Early Modern Malta*

The known historical documentation on the water sources and management employed for domestic and agricultural use in late medieval Malta is limited. The earliest record does not predate 1467 and the surviving documentation cannot be regarded, as being a representative sample of what probably existed (Wettinger 1982: 1). When trying to reconstruct day-to-day life in late medieval Malta, including water storage and management, fifteenth century notarial deeds are a multifaceted source of information. The notarial deeds of Notary Giacomo Zabbara show entries for *aqua*, *aque*, *aqueductus*, *aquarum pluviarum conductus*, *cisterna*, *conductus* and *irrigacio* (Fiorini 1996; 1999). Sixteenth century notarial deeds might yield more evidence in this respect, but their investigation has still to be systematically undertaken.

In the absence of further primary documentation, precious information may be gleaned from a detailed analysis of 'Della Descrizione di Malta' by G. F. Abela published in 1647 (Abela 1647: 64-74). A study of toponyms and an archaeological assessment of the late medieval rural and urban centres, coupled with a sound knowledge of the archipelago's geological properties and stratification can also be richly rewarding.

Dating to the Oligo-Miocene era of the Tertiary period, the Maltese archipelago (fig. 10.1), is entirely composed of sedimentary rock which started to form in a marine environment between 30 to around 6 million years before present (Zammit-Maempel 1977: 18; Pedley *et al.* 2002: 18). Four distinct rock layers constitute the basic geology of the archipelago (fig. 10.2). When undisrupted by land faulting the horizontal stratification from bottom to top reads as follows: (1) Lower Coralline Limestone, (2) Globigerina Limestone, (3) Blue Clay, and (4) Upper Coralline Limestone (Pedley *et al.* 2002: 35). Based on micro-chemical similarities, this classification takes the Greensand layer as being the lowermost stratum of the Upper Coralline Limestone deposit and contradicts older classifications which regarded the Greensand deposit as being a completely distinct entity from Upper Coralline Limestone.

With the exception of Blue Clay, Upper Coralline, Globigerina and Lower

Coralline Limestone allow water percolation. This is often boosted and enhanced by joints and fissures present within the geological deposits. It is due to the impervious qualities of Blue Clay that areas in the north and north-western section of Malta enjoy more abundant water resources than the central and southern plains which are predominantly composed of Globigerina Limestone formations. Water stored above the Blue Clay deposit has since antiquity been recognised as an important and easily accessible resource. Areas possessing this geological stratification in some instances yield a perennial water source, as is the case with Bahrija and San Martin valleys. Numerous wells and water galleries are dug into Upper Coralline or Greensand strata in order to tap this underlying water source. In comparison to Malta, the island of Gozo has more abundant clay deposits.

Local geological stratification furnishes the archipelago with two main types of underground water deposits: (1) the perched aquifer and (2) the mean sea level aquifer. The *perched aquifer* is a technical term referring to water deposits collecting above the Blue Clay outcrops. The *mean sea level aquifer* is the term assigned to fresh water deposits present mainly within Globigerina Limestone and Lower Coralline formations and which is found beneath 150 sq km of the island of Malta (Schembri & Baldacchino 1998: 41-43). It is estimated that only sixteen to twenty five percent of the total water yielded annually through rainfall, manages to percolate through the rock fissures and is eventually stored in either the perched or the mean sea level water tables. The mean sea level water table has for the past 130 years been the island's main source of water supply, but prior to this period of time, its existence was unknown and the population of the islands exclusively obtained its water supply from the perched aquifers.

The present day Maltese climate is that characteristic of a Mediterranean region. The archipelago's dry summers and limited erratic rainfall make water supply a perennial problem (Bowen-Jones *et al.* 1961: 48). Air temperature conditions are stable and predictable, the warmest months being July and August, when temperatures occasionally sore up to around forty degrees Celsius. Rainfall is much less predictable and an annual average rainfall of 568 mm classifies Malta as falling within the parameters of a semi-arid zone (fig. 10.3). Since the Early Modern period, water availability on the islands has been further aggravated by an increase in the population and rising living standards.

The occurrence of climate shifts in the Mediterranean region since antiquity is a subject of controversy and debate. Basing oneself on geological and historical evidence however, it appears that Mediterranean climatic conditions in Roman times were not appreciably different from those of the present day and were subjected to temporary and minor wetter and colder interludes (Vita-Finzi 1969: 112-114). In another study, the Mediterranean climate reconstruction in the

interim A.D. 1500 – 1995 period was attempted. No drastic winter temperature and rainfall changes were detected even though fluctuations were registered (Luterbacher & Xoplaki 2003: 133-53). Local annual rainfall statistics gathered between 1851 and 1950 did not register any rainfall decrease during the course of a century. It was however noticed that a shift from the second half of the rainy season (January to March) to the first half (September to December) has taken place and since the 1950s Malta is experiencing an extended dry season (Hyde 1955: 93).

The arid nature of the archipelago made agriculture almost exclusively dependant on the annual rainfall. Dry-farming was predominantly practiced in medieval Malta and the success of the cultivated crop was entirely dependant on the annual rainfall, the adoption of contour ploughing and the harvesting of runoff surface rainwater in open-air water reservoirs. Peasants suffered widespread financial hardship when rains failed, as was the case for three consecutive years in the latter half of the 1460s, when landlords had to grant their tenants a remission of rent (Wettinger 1982: 3).

It has nonetheless been noted that in areas of the Island which possess the necessary geological stratification, irrigation aided the cultivation and growth of agricultural produce. The Maltese words *saqwi* and *baghli*, are terms which distinguish the irrigated from the non-irrigated landscape and hints a close affinity to the medieval Muslim practice of land classification into *ba'l* and *saqi* in order to be able to tax the land accordingly (Glick 1979: 83-84; Wettinger 1982: 3). *Ġnien* (eg. *Ġnien Bazili*), and *Għajn* (eg. *Għajn Tejtes*) toponyms, of which over a hundred have been recorded (Wettinger 2000: 151-164), are common references to areas containing one or more water springs, within which horticulture and viticulture were commonly practiced (Wettinger 1982: 3-4). A further two hundred toponyms refer to wells of various sizes such as, *bir*, *bjar*, *giebja*, *gibjet* and *gibjun* (Wettinger 1982: 3).

In his section on *Malta Inabitata* or *Uninhabited Malta*, G. F. Abela lists numerous *Għajn* – spring and *Ġnien* – garden toponyms, most of which are located in north-western Malta (Abela 1647: 64-75). *Ġnien* toponyms are referred to by Abela as *Giardini*. One of the most fertile districts of the island, well renowned for its water sources and the quality of the fruit produced within, is Wied ir-Rum - a river valley which cuts a deep scar through an Upper Coralline Limestone plateau (fig. 10.4). The hydrological principles practiced within the valley are representative of the water management strategies adopted in north and north-west Malta which possess a similar geological stratification.

Wied ir-Rum is composed of a number of adjoining giardini (Plate 10.6), which

Abela groups accordingly. He describes Wied ir-Rum as *Valle de' Christiani Greci, amena, e piena di giardini d'ambe le parti, che rappresentano all'occhio una bellissima veduta, e somministrano al gusto buonissime frutta*. The giardini in question are those of *La Kattara, Tal Callus, Ta Scieref, Di S. Giacomo* and *Ta' Baldu*. The latter is listed separately in order to emphasise the availability of water sources and quality of the fruit produced within (Abela 1647: 65). All giardini within Wied ir-Rum were in Abela's time probably capable of producing two or more crop yields annually, if adequately managed.

Two distinct types of water sources were identified within the valley. The first consists of a water spring which passes from within the lowest parts of the valley and the level of which is subject to seasonal fluctuations depending on the annual rainfall. This water source is the result of surface runoff water channelled into the lowest section of the valley due to the topography of the surrounding area. It is an unreliable water source and in Wied ir-Rum as elsewhere on the island, has been scarcely tapped for agricultural use. For the larger part of the year no water is visible above surface level and sub-surface water deposits can only be identified by dense bamboo growth.

The second type of water source at Wied ir-Rum originates from within horizontal galleries hewn into an Mtarfa Member deposit at right angles to the rock-face, located in the upper terraced sections of the valley. Galleries are generally easily identified from their rectangular shaped rock-cut entrance which is on average 0.8 metres wide and a bit more than 1.5 metres high. There are several instances however, where the gallery entrance lies in a cave's interior and is fronted by an underground water storage reservoir (fig. 10.7). The Ghar ta' Baldu and il-Qattara – two artificial water springs located within Wied ir-Rum, are cases in point. The depth of the galleries is unknown, but several of the recorded water tunnels may be well over half a kilometre deep and may branch into one or more minor arteries. A canal is often carved into the floor of the gallery (fig. 10.8), in order to ease the flow of the water retrieved from the perched aquifer (Buhagiar 2002: 59-83). Once on the inside of galleries, it is difficult to calculate their depth and the main gallery may fork into one or more minor arteries. There are instances when the water retrieved by the gallery is simply too deep to allow any wading through.

All galleries provide the surrounding area with a perennial water source, though the volume of the retrieved water varies from gallery to gallery. The majority of the galleries yield a surprising volume of water during the dry summer months, even though this is subject to yearly rainfall fluctuations. Water galleries are generally level with the highest terraced field on the valley side and water is transported from their entrance to the adjoining and underlying fields by means of

stone canals. Some of the galleries are connected to vertical shafts, which pierce the roof of the galleries at intervals.

At Wied ir-Rum alone, over eighteen water galleries have been identified, and are the life sources supporting the existence of an ecological niche which would otherwise not survive. Numerous other galleries built on the same hydrological principle and technology dot areas of northern and north-western Malta which possess the necessary geological stratification. The use of such water galleries avoids the loss of water through the means of evaporation and overcome the need for the construction of water lifting devices similar to the *sienja* or *noria*.

The investigation and mapping of different modes of water collection and storage within a rural and urban context during the late medieval period is currently underway by the author, but the emerging pattern suggests that the hydrological supply of the fortified medieval settlements of Mdina and the Gozo Citadel likewise depended on a series of galleries tunnelling beneath the bastions. Water was retrieved from the underground tunnels by means of a series of vertical shafts within the fortified settlement, which pierced the roof of the galleries at intervals. A case in point is a well at Palazzo Falsone – a late medieval house of distinction in Mdina, which gives access to a probable water gallery (Plate 10.9). Two other water galleries tunnelling beneath the northern and the eastern bastions of the city have been identified so far. On the south-eastern side of the Gozo Citadel and accessed from within the ditch, which is currently in use as a parking space are two other water galleries. By *pozzo di aqua viva* or a *well of running water*, G. F. Abela writing in 1647, probably makes reference to a number of such water sources (Abela 1647: 33).

The dating of the Maltese galleries is a task that requires caution. Not all galleries in any given area are necessarily coeval, but it appears that the majority of these artificial water springs are not recent efforts attempting to increase the hydrological potential and the agricultural yield of specifically selected areas. Interviews with farmers owning land irrigated by galleries have confirmed that these were present in their property for generations and the majority are not familiar with the hydrological principles and technology of these subterranean structures. The location of galleries in Wied ir-Rum and elsewhere, were forwarded to Water Services Corporation, the local water company, which confirmed that the springs in question were never brought to its attention and are not the product of past water exploratory campaigns organised by the company.

The Maltese galleries have been tentatively dated to the Arab occupation of the island and its immediate aftermath, when new horticultural skills were introduced. The local water galleries are in essence, very similar in nature to Qanat (fig. 10.5).

The term *qanat* or *qanawat* is Arabic in origin and means *lance* or *conduit* (English 1968: 170-181). In North Africa they are generally called *foggara*, in Morocco, *hattaras*, whilst in Iran, *karez* or *kariz* (Glick 1970: 182). Qanat are not an Arabic hydrological invention and prior to the diffusion of Islam in the seventh century A.D., they were used as an aid to agriculture at a micro-regional level in Persia, Mesopotamia, eastern Arabia and up to a limited extent, a few parts of Egypt (Watson 1983: 107; Glick 1979: 217-218). Qanat technology was also known as the *invention of summer* as these underground galleries made it possible to extend the winter growing season well into the summer months (Horden & Purcell 2000: 237-238).

Linguistic considerations hint that several Maltese toponyms and words have a close affinity to the word *qanat*. The singular of the word *qonja* in the Maltese language is *qana* and literally means a medium through which water is transported and is most commonly associated with a pipe, water canal and aqueduct (Serracino-Inglot 2000: 462). Toponyms such as *Ta' Qana*, *Ta' Bir il-Qannata*, *Ta' Qannotta* and *Wied Qannotta* all have similar implications (Wettinger 2000).

The *sienja* was an animal driven water lifting device which was occasionally fitted to wells in order to facilitate water extraction and field irrigation. The term was also commonly used in Medieval Sicilian, into which it had filtered from Arabic (Wettinger 2006). The *sienja* was a device which undoubtedly boosted the economic value and importance of an area, and a study of its relationship with water galleries is presently underway. A wooden *sienja* still survives intact in a farmhouse in the Limits of Żurrieq and a systematic survey of any other surviving water lifting machinery still has to be systematically undertaken.

In other areas of Malta such as the central and southern plains where a Globigerina rock outcrop prevails, the only possible modes of water collection were through (a) the collection of surface run-off water and its storage in underground cisterns and (b) the accidental tapping of the mean-sea level aquifer. The water management strategies adopted by the troglodytic community who till at least the 18<sup>th</sup> century inhabited a complex of caves at Ghar il-Kbir in the limits of Buskett, almost certainly represent water harvesting strategies, similar in nature to those practiced in other parts of the island where the perched aquifer was either absent or of difficult access.

Ghar il-Kbir is Malta's most famous troglodytic settlement, where a series of eight caves surrounding a natural karst cavity experienced a long succession of occupational phases (fig. 10.10-11). Troglodytes were well established in 1544, when a *Simone Camilleri de gar il chibir* was mentioned in a notarial act of Noratary Brandon de Caxaro. G. F. Abela describes the cave as being a *Grotta*

*vasta e grande* and gives the number of troglodytes inhabiting the settlement as amounting to 117 individuals (Abela 1647: 79-80).

It is improbable that a sizeable community could have inhabited Ghar il-Kbir without the availability of a nearby water source. The geology of the area makes it unlikely that the occupants of the site tapped the perched aquifer by means of shaft wells, as its tapping would have probably been too labour intensive. The nearest water spring is located in Buskett valley, over half a kilometre away. The option of a water cistern makes more sense and its presence is confirmed by a 1793 description of the site by Carlo Castone Della Torre, who nonetheless fails to give any details of its exact whereabouts. This hypothesis also seems to be confirmed by a water canal hewn into the walls of one of the caves in the complex (Eynaud 1989: 60).

Similar water harvesting and management strategies were also employed on the rock of Comino, which has a land surface area of only 2.5 square kilometres. The island was formed as a result of rift faulting and three exposed strata of Upper Coralline Limestone constitute its geological stratigraphy. In the absence of exposed Blue Clay deposits, fresh water sources are limited and consist of: (1) surface runoff rainwater harvesting, and (2) the tapping of a limited mean sea level aquifer. The unavailability of a perched aquifer hindered past agricultural activity, as this was entirely dependent on rainfall and the effective collection and storage of surface runoff. Early modern agricultural activity on the island was concentrated around Wied l-Ahmar, close to Santa Maria Bay, and was probably similar in concept to the agricultural and irrigation strategies adopted by the medieval farmer. Canals on the east side of Santa Maria Bay cut parallel to the natural gradient of the land, channelled runoff surface water to a series of rock-cut cisterns (fig. 10.12). The most fertile part of the valley was the valley bed, which was transformed and developed into a number of interconnecting fields. In the absence of rainfall, water was retrieved from the cisterns, and more recently, an open-air water reservoir, located in different sections of Wied l-Ahmar, close to the cultivable tracts of land.

The fact that throughout the late medieval period, the economy of the Maltese islands was largely dependent on agriculture, quantifies the importance of the hydrological technology and water management skills examined in this paper. A detailed analysis of the various modes of water collection and storage within a rural and urban context during the late medieval period is a work in progress, currently being undertaken by the author. An analysis of the emerging preliminary results shows a large scale intensification of the hydrological potential of specifically designated areas. In Upper Coralline Limestone landscapes, this was primarily achieved through the excavation of underground water galleries retrieving water from the perched aquifer. The hydrological supply of the fortified medieval

settlements of Mdina and the Gozo Citadel likewise depended on a series of galleries tunnelling beneath the bastions. The agriculture practiced in the Globigerina Limestone plains of the central and south-eastern sections of Malta was conditioned by the almost complete absence of perennial water sources and was largely dependant on seasonal rainfall and efficient surface runoff rainwater harvesting techniques. Late medieval agriculture was sufficiently productive to produce a surplus of cotton and cumin, but deficient in the production of wheat and other cereals, which had to be imported from Sicily. Local farming provided the livelihood for peasants and formed the basis of an economy which amongst others included craftsmen, masons and carpenters. It also paid for the island's normal needs of defence and enabled substantial rents to be sent regularly abroad to absentee landlords.

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