Water Cistern Systems in Greece from Minoan to Hellenistic Period

G. Antoniou*, R. Xarchakou**, and A.N. Angelakis***

* Deinokratous 73 Athens, 11521, Greece, antonioug@tee.gr
** Actor SA, 18, Filellinon str., 15232 Athens, Greece
*** Inst. of Iraklio, National Foundation for Agric. Research, 71307 Iraklio, Greece

Abstract: The lack of adequate water quantity in most Greek islands, since the beginning of their habitation, resulted in the construction of various water reservoir types. In Crete water cisterns have been practiced since the early Minoan era. Since then several types (of rectangular, square and cylindrical-shaped, roofed and roofless, and uncoated or coated internally with impervious material) of cisterns have been developed. However, a significant development appears to have been achieved during the Hellenistic period in all over Greece, with technology which has been extended even to nowadays. Few characteristic examples of Hellenistic cisterns are considered which justify the significance of that technology during that period of Greek history.

Keywords Ammotopos; Ancient Greece; Cistern; Dreros; Hellenistic period; Lato; Orraon; Rainwater.

Introduction

Through the historical development of Greece, because of the frequent water shortages increase, the benefits of water conservation were well understood and the value of rainwater for several use of was grown. Where water is scarce such schemes can be of real value but there are health and environmental risks that need to be tightly managed. Appropriate actions must be taken to protect human health. Thus, the first sand filters and sedimentation tanks seem to have been developed as early as the first water cisterns were used for collecting of rainwater (Sklivaniotis and Angelakis, 2006). Rainwater is defined in this paper as the atmospheric precipitation collected from on ground in impermeable surfaces and stored usually in artificial reservoirs, known as cisterns. This water is used for household purposes such as bathing or washing, dish-washing, laundering, irrigation or other urban uses. The collection and use of rainwater is known since the Minoan era (Cadogan, 2006).

A cistern is essentially a masonry tank, built at ground level or excavated few meters (3-10 m) below it. It is usually fed by rain water and/or fresh water transported by an aqueduct. Sometimes a cistern may be, in effect, a large city reservoir, aqueduct-fed, used for water supply. However, the cistern water was also for rural agricultural or industrial use (Hodge, 2002). Rainwater is normally collected and stored directly from the roofs of buildings or from open impervious surfaces. A cistern is usually a cylindrical, circular or oblong tank, often under the floor of the house. However, there are cisterns of rectangular or square shape. In most cases, the cisterns are equipped with built stairway on one side leading down to the bottom. Their walls are usually coated internally with impervious plaster. The cisterns may
most usefully be divided into covered and uncovered, but it is not so easy to categorize them by function.

There are examples of rainwater use systems in many arid and semi-arid countries. Remains of rainwater cisterns, dating from the last 4000 to 5000 of years, are encountered in ancient Greece. Some are well installed and operated for centuries. Most of them were used to collect rainwater and serve as the major source of water supply. However, in a few cases they were used for other purposes, i.e., seasonal regulation of water brought by large conveyance systems. In Greece rainwater harvesting and use has been practiced since the Minoan times, ca. 3300-1200 B.C. (Viollet, 2003; Angelakis and Koutsoyiannis, 2003). The earliest known such technology is referred to the very Early Minoan times ca. 3300-2200 B.C. Five of such cisterns are known; two in Pyrgos, and Myrtos, one in Zakros palace, one in the city of Archanes, and one in the House C in Tylissos. The two plastered cisterns in Pyrgos are the earliest known, and universally recognized as cisterns—from the Minoan culture (Cadogan, 2006). Thereafter, cisterns were developed in Middle and late Minoan periods, such as in Phaestos, Zakros, Chametzi, and Rhizenia (Koutsoyiannis et al., 2006). However, during the Hellenistic period the technology of cistern showed further progress. At that period the water supply in several cities all over Greece was dependent entirely on precipitation; the rainwater was collected from the roofs, yards and other open spaces of establishments and cisterns (Angelakis and Spyridakis, 1996).

The scope of this article is not the exhaustive presentation of what is known today about water cistern technologies during the Hellenistic period in Ancient Greece. Rather, some characteristic examples in selected sites are presented supporting that the Greeks could be considered among the pioneers in the technological development of water cisterns.

The City of Dreros

Dreros, a city-state of Classical Greek period, is near modern Neapolis in the eastern Crete. Like the neighboring Lato, it was erected on a saddle between two peaks, on the slope of mount Kadistos (Davaras, 1976). The archaic city had an agora (market place) about 30x40m² in size, including some moldering steps along the southern side and a retaining wall of the eighth century B.C., and further a huge open cistern (Myers et al., 1992) have reported that a cistern, the first and larger cistern ever known is that in the ancient Dreros. It is located in the agora of the city, had a rectangular shape with dimensions of 13.0 x 5.5 x 6.0 m³ and was used for water supply of the city (Fig. 1). Davaras (1976) was reported that the depth of the cistern is 8 m. At Dreros the average annual atmospheric precipitation is 500 mm and the average cistern capacity 429 m³; to fill it would require the run-off of a roof or yard area of more than 860 m². Of course, this calculation is based upon the cistern being filled only once per year, and would require the inhabitants to live for a year on cisterns-full of water. More on this analyses are reported by Despotakis and Tsagarakis (2006).

The City of Lato

Also, in Lato named after Leto, mother of Apollo and Artemis, a goddess with strong Minoan associations is located in the eastern island; there is no spring at Lato. Thus, the basic water sources were rainwater. North of the little temple is the central cistern, in the agora (city center), which is more or less squared in plan, of side approximately 5m (Apostolakou, 2005). The area of the cistern is of 27.56 m² (Myers et al., 1992) and its depth is of about 6 m. It was originally covered by a roof supported by two Dorian colons. Its walls
are coated internally with impervious plaster and built stairway on one side leads down to the bottom of the cistern. From the location and the size of the cistern, we can only conclude that it was the public cistern of the city (Fig. 2). There are of about 15 more small cisterns. Myers et al. (1992) have reported that there is a similarity of that cistern, with the first and larger cistern ever known in the ancient Dreros. It is located in the agora of the city, and was used for water supply of the city.

Figure 1 Remains of the central cistern in the agora of Dreros.

Figure 2 Central cistern in the agora of Lato.

Town of Orraon, Epirus (Ammotopos)
The fortified ancient town of Orraon was founded at the end of ca. 4th century B.C., when Alketas was the king of the Molossioi or, at the latest, in the second quarter of that century.
The site and its history are vividly presented at the Guide book “Όρραον” published by the 12th Ephorate of Classical antiquities (Angeli, 2005). The settlement, built on a strategic position, was destroyed by the Romans in 167 B.C., but was subsequently rebuilt and finally was abandoned by its inhabitants, who were forced out to settle down in Nicopolis, after 31 B.C. Many of the houses are still standing two storey high and the street plan network is also well visible. In the town plan twelve narrow parallel streets, in an N-S direction, cross two wider streets. This network forms rectangular oblong town blocks, the insulae, 15 meters wide. A single house usually occupies the full width of each insula. Despite these, the fortification walls, with the bastions and gates, define the area of that impressively well-preserved ancient Greek settlement.

The cistern is situated near the main gate, at the north east part of the town, which is the area with almost the highest altitude. That big public rectangular cistern (Fig. 3) is roofless, in contradiction to the more numerous vaulted cisterns of the classical period, built usually to places where crowds were gathering (e.g., sanctuaries of Epidaurus, Delos etc.; many of them, partly curved on the soft rock, have been also found in Piraeus). The place where the cistern is built, at that highest area of the town, reduces to minimum the chances for any kind of natural water flow supply. In addition to that, no traces of aqueducts or equivalent constructions have been discovered up to now. On the other hand, the high amount of rain falling at the west regions of Greece, even during the summer, provided without any doubt the essential water quantities for the cistern. There the rainfall today is much higher than the east regions of Greece and it was also higher in the antiquity, according to the descriptions of ancient writers. An enclosure wall was surrounding the cistern, approx. 2 m away of the edge of its tank and thus a yard was determined. At the middle of the yard’s south wall, was placed the antae framed entrance. The height of the stone built enclosure can be estimated three meters approximately, after the amount of its collapsed parts.

![Figure 3 Cistern in the ancient city of Orraon-Epirus (Ammotopos): a. View of the cistern from SW (left) and b. reconstruction from the same side (right), after G.P. Antoniou.](image)

Even though the yard wall is mostly ruined, the cistern itself is perfectly preserved, as well as the straight stair at the northeast corner of the tank. The less elaborated widening of the stair, dated probably in the Roman period, is not as nicely preserved. Furthermore, that widening means that the stair was not only for the access of the bottom -for cleaning the tank- but also for getting water from it, since the level of the water in the cistern was, definitely, varying within the year. The masonry of the cistern’s walls is constructed by well formed rectangular stones, made of the local light gray limestone. The very lower parts of the walls are curved on the bedrock, on which is also curved the bottom of the cistern. The edge of the tank’s walls was possibly standing higher than the floor of the walking passage,
around the cistern forming a kind of parapet (Fig. 3b). The typical form of ancient Greek shrines justifies a conclusion like that. (Travlos: 328, fig 430; Camp, 1984: 22, fig 33; Dukley, 1935-35: 183-184; Glaser, 1983). Moreover there are traces of grooves with iron joints on edge’s stones, which suggest the existence of a parapet.

Because of the high enclosure wall, it is concluded that there was care for the hygienic protection of the cistern (preventing of throwing waste or other dirt in it), as well as a kind of controlled access to the tank. Traces of a shrine nearby that could be supplied from the cistern have not been found yet. So it was the cistern itself a kind of arykrene, or was supplying an arykrene. Arykrene was the kind of shrine from which the water was taken out with a container submerged in the water. The shrines providing natural water flow were called rhookrenes. The first excavations on the site were carried out in 1972, even though Ammotopos (also called Kastri) was well visible during the centuries. The excavation was carried out by Ioulia Vokotopoulou, then director of the 12th Ephorate. In 1975, the University of Ioannina, under the direction of S. Dakaris, in collaboration with the German Archaeological Institute, started the excavation of House 1 in the ancient settlement, which was resumed in 1981. The 12th Ephorate carried out restoration works of the wall masonry of the ancient houses in 1972-1976 and 1981. (Archaeology in Greece, 1976-77; Catling, 1977 – 1978: 3-69). Unfortunately the area around the cistern and the main gate is not excavated yet.

Conclusions

Greek technological developments related to water management principles and practices are not as well known as other achievements of the Greek civilizations, such as poetry, philosophy, sciences, politics and visual arts. The first evidence of the use of water cisterns for water supply in Greek settlements lies in Minoan era. However, that technology was tremendously further developed through history with a peak in the Hellenistic period. To put in perspective the ancient water cisterns discussed in this paper, it is important to examine their relevance to modern times and to harvest some lessons. The achievements of Greeks in dealing with the cisterns and functional requirements of water collection and distribution systems can only be compared to modern urban water systems, re-established in Europe and North America from the second half of the 19th century A.D. (Angelakis and Koutsoyiannis, 2003) until present day. Thus, with a few exceptions, the basis for present day progress in technological development of water cisterns is clearly not a recent development, but an extension and refinement of the past.

Acknowledgements

This work was partially supported by EU-research project FP6-509110 (SHADUF).

References


Travalos J. *The Pictorial Dictionary of Ancient Athens*.