

Communal Rainwater Cisterns of the British rule on Paxos, Greece

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Abstract

The needs for water supply at the island of Paxoi, Greece were depended –almost totally- on rainwater cisterns. Despite the extremely high –for the country- rainfall levels on that island the geological synthesis of its underground does not permit the accumulation of underground water. The problem was historically treated by building of rainwater harvesting cisterns. Constructions of that type, communal and private ones, dated in the Venetian era are still surviving on the island. Thorough efforts to improve the water supply, with that kind of structures, was done also during the short period of the French sovereignty. The examples built during the British sovereignty of the Ionian Islands are characterized by well-designed and organized formations and structures. In addition some examples present profound features for better hygiene of the harvested water. The incorporation of morphological elements in these utilitarian constructions reflects their importance for the society of the island. The Municipal cistern of Agioi Apostoloi is a remarkable construction with a vaulted rectangular main tank and impressive access through a monumental stair. On the other hand the cistern of Ag. Anargyroi is a well formed and larger example of a common kind of cistern formation on the island. The remarkable constructions reflect not only the need for adequate water supply in Paxoi, through the only available, then, method of rainwater harvesting but also the well organized efforts of the European sovereignties on the island on that category of vital public infrastructure.

Keywords

Rainwater harvesting; runoff surface; Paxoi; Gaios; Ionian islands

INTRODUCTION

Paxoi, or Paxos in English, is one of the islands of Ionian Sea. It is said (Doikas, 1985) that their name is the same since the antiquity, originated from a Phoenitian root, despite the limited information from that period. During the recent historical times the island, along with the neighbouring Antipaxoi, was part of the Venetian state since the mid 15th century (Doikas, 1985). During the Napoleonic wars, the Ionian Islands were taken by the French in 1797 and few years later by the Russo-Turkish alliance. In 1807 Napoleonic forces occupy again the island. On 13 February 1814, the island of Paxos surrendered to the United Kingdom. In 1815 the British sovereignty established the Ionian Union. In 1864, together with the rest of the Heptanese, the island complex of the Ionian sea plus Kithira island, Paxos was ceded to Greece.

Despite the extremely high, for Greece, rainfall level Paxos island is characterized by water scarcity. Ithaki island as well (Antoniou 2014a) and some mountainous areas of northern Corfu face similar problems. That scarcity was treated throughout historical times with the construction of rainwater harvesting cisterns, either private or public, a common practice in the greater region through the millennia (Mays et al 2013, Antoniou et al 2014). Structures of the type survive till the Venetian era, some being still in use! (Pantazi, 2005). Even though communal rainwater cisterns were planned also by the French at the first decade of 19th century, during the British sovereignty, among other infrastructures, water supply was also improved. At the case of Paxoi –despite the presence of several domestic and private cisterns (Doikas, 2005, Pantazi, 2005, ΦΕΚ, 2007) - that improvement resulted the construction of new rainwater reservoirs and the renovation of pre-

existing ones. Two of the most characteristic examples are been found in Gaios, the capital village of the island.



Figure 1. General view of the monumental rainwater cistern of Ag. Apostoloi.

CONSTRUCTION AND FEATURES OF THE CISTERNS

The public rainwater cisterns on Paxoi are characterised by well designed layouts. Not only the tanks but also the run off surfaces are properly placed. All the references to these constructions up to nowadays (Tranakas, 1988, Doikas, 2005, Pantazi, 2005) were mostly focused to either historical matters or general descriptive remarks including, quite often, their capacity, usually in *xestes – sextarios*. Xeste is a liquid measurement unit equivalent either to *a.* a pint, approximately 0,54 lt, or *b.* to a pitcher holding 18 kgr of water or wine and therefore 1000 xestes are 18 m³ (Doikas 2005). The communal rainwater cisterns on Paxos during the British rule were well engineered examples incorporating not only hygiene provisions but also morphological aspects. Most of these cisterns are built underground and the most characteristic exemption is the impressive for the place communal cistern of Agioi Apostoloi at Gaios (Figure 1).

All of them were constructed out of stone masonry and vaults. Regular or hydraulic mortars were used for the building and watertight purposes, either at the tanks or at the runoff surfaces. Slab covered surfaces were made at the main –central- runoff surface, usually on top of the reservoir. The main parts and other features of the cisterns are presented below.

Water Tanks

The water reservoirs of the cisterns are simple constructions. Most of them have cylindrical form (i.e. Ag. Anargyroi and Mantropoulo cisterns) and usually are covered with a lowered dome. Besides some small constructions where the tank is a simple vaulted space, the impressive cistern of Agioi Apostoloi in Gaios has a large vaulted water tank (Figure 6), as it will be presented in detail later. On top of the covering dome or vault usually there is a pavement made of rectangular –in most cases- slabs. The placement of the water tanks is well related with the runoff surfaces and in all cases their cover operates also as a runoff surface.

The size of the water tanks is not large. The settlements or neighbourhoods that the cisterns were supplying are not big ones or high populated and therefore there was no need for larger reservoirs. Moreover it seems that there was a distribution of smaller rainwater cisterns-reservoirs in order to serve settlements without water supply pipe net work.



Figure 2. a. Main view of the Vlacherena circular rainwater cistern (Doikas, 2005). **b.** View of the paved runoff surface of Ag. Apostoloi cistern and the round orifices of the min reservoir, as well as the cubic openings of the auxiliary tank

Runoff Surfaces

The runoff surfaces which are the essential part of a rainwater harvesting construction (Antoniou et al 2014b, Mays et. al. 2013) were well constructed and carefully paved, usually with stone slabs (Figures 2a and 2b.) or with good quality mortar as in the case of Ag. Anargyroi cistern at Gaios (Figure 3a) Usually they were either on the top of the cistern (Figure 6). Rare examples had the majority of the harvested water collected in detached runoff surfaces and been brought in the reservoir through open ducts. In these rare cases there was also a typical, but smaller, run off surface on top of the tank, as the Ag. Apostoloi cistern. Attached to the reservoir spacious runoff surfaces are found in the Ag. Anargyroi cistern in Gaios (Figure 3a), see later in details. Similar but more simple formations are found in some medieval rainwater cisterns as in Chora Kalymnos and Monemvasia (Mays et al, 2013) The access to the runoff surfaces is always restricted through low or higher walls which in most cases form a kind of an enclosure as it will be discussed below. Rarely shallow half pipe ducts help to guide the harvested rainwater to the intake spouts.



Figure 3. Agioi Anargyroi cistern. a. The western runoff surface.**b.**The central-original(?) runoff surface, the orifice with the raised access corridor and the the intake spouts covered with slabs . On the orifice is visible the inscription in dark gray colour.

Other water Acquisition features. This category refers mainly to the cases when the water from

another cistern is send to another one, usually more central, as in the case of Ag. Apostoloi in Gaios, which additionally receives the water of Mantropoulo cistern from the outskirts of the settlement.

Features of the Cisterns

Several engineering features of the harvesting formations testify the design and production of these constructions by well educated and skillful people. Other features as overflow spouts, airing and cleaning spouts, siphons, pumps etc. prove the systematic and engineered design of these structures. Specifically the features of the cisterns on Paxos are the following:

Orifices. The orifices were of various types. In most cases there is an access that prevents the user to step on the runoff surface (Figure 3b). Such provisions for the improvement of the hygiene and the quality of the collected rainwater are very common in most rainwater cisterns in the Ionian Islands (Antoniou, 2014a). Most possibly this common, for that region, feature is related with hygiene rules of the British governance. Relevant protective structures, as enclosures around the collecting surfaces, exist in many late medieval and 18th - 19th c. rainwater cisterns (Antoniou, 2009, Mays et. al 2013) but not that specific kind.

The main orifices are usually circular. Square, cubic orifice constructions are found usually at the smaller private cisterns. The circular orifice constructions of the communal cisterns had a typical classic formation with a *base*, the *torso* and a simple cornice on top. In some cases the base is formed by one or two steps (Figure 3b). In some cases on the orifice construction there is an inscription referring to the year the cistern was built (Figure 3b).

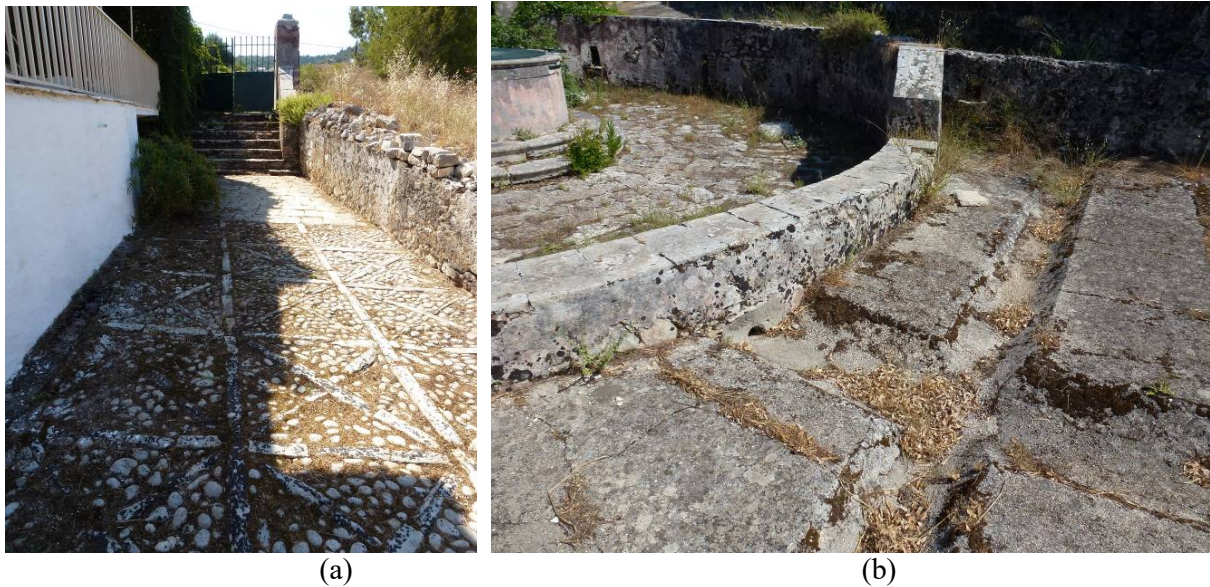


Figure 4. Agioi Anargyroi cistern. **a.** The access way and its pavement. At the background is visible the portal of the circular runoff surface. **b.** Half pipe formations and the intake spout to the main-original

Enclosures and Portals. As it was mentioned before all the runoff surfaces have walled enclosures which restrict the access to the surfaces for profound hygiene purpose (Figures 2a, 3b, etc). Enclosures of similar kind exist in almost every rainwater cistern of the historical times (Antoniou, 2014b, Mays et al 2013, Antoniou, 2009, Antoniou 2014a) for similar reasons. There are short medium and high wall enclosures. The shorter are 0,70 m in average high and the higher 1,80m.

Simple and sometimes elaborate portals (Figures 2a and 4a) form the entrance of the enclosures. The pillars of the elaborate portals are formed with a simple base, the main torso and a capping morphological element (Figure 2a). Occasionally there are inscriptions on their masonry referring to the construction of the cistern.

Accesses and Pathways. In many cases of communal cisterns –but also to some elaborate private ones- the access to them is elaborate with nice slab or cobbled pavements, flanked – sometimes- by medium height walls (Figure 3a). Rarely the access to the portal of the enclosure has two or more steps (Figures 2a and 4a). A remarkable exemption is the monumental stairway of the Agioi Apostoloi cistern (Figures 1 and 7).

Various Operational features. The construction of the cisterns incorporates operational features as intake and overflow spouts (Figure 4b), airing and cleaning openings (Figure 2b), sometimes siphons and manually operated pumps (Figure 2a), added later on, since originally the water was taken probably by buckets.

Architectural formations. The importance of the structures for the society and for the British sovereignty as well, is probably related with the elaborate morphological layouts and features of these constructions. In some cases as the cistern at Ag. Apostoloi in Gaios (Figures 1 and 7) a monumental design characterises that utilitarian construction. Elaborate architectural details i.e. pillar capitals, orifice spouts and wall capping stones relate the structures of the cisterns with the residential buildings of that period. The formations have already been discussed in brief above. The efforts for an elaborate result of these constructions can be also traced in the geometrical manner which characterises the way the slabs were laid at the original circular runoff enclosure of the Agioi Anargyroi cistern in Gaios (Figure 9).

THE MUNICIPAL CISTERN OF AGIOI APOSTOLOI

That cistern began being built in 1825 and was completed operationally in 1846, when it was paved (Doikas 2005), a dating which probably refers to the pavement of the runoff surface of the top. The decorative features as pillars were constructed later in 1848 and the access way with the surroundings were completed in 1851 according the Book of Demogerontion of Paxos (Doikas, 2005). Undoubtedly is the most elaborate and impressive cistern on Paxos, an elegant construction which characterizes the quality of the British works on the region. This monumental construction is a protected building by the Ministry of Culture building since 1982 (ΦΕΚ, 1982). It is situated almost at the center of the settlement in contradiction to the Agioi Anargyroi which is placed at the eastern part of it.

It has rectangular shape and a monumental central stairway at the south side. The rectangular structure embodies not only the main reservoir but also a kind of elongated sedimentation tank at the north side. Despite the difficulties for the recording of its dimensions it seems that this auxiliary tank is almost 1/3 the size of the main reservoir. Since the cistern collects water not only from the slab paved runoff surface on its top but also from extend areas in the surroundings without enclosure. Therefore a sedimentation formation is absolutely necessary. Small sedimentation basin exist in front of the two intake spouts along the open duct at the north side of the cistern. That sector of the construction has three square- cubic orifices but obviously for cleaning purposes. The exemption of the existence of square orifices is probably related to their function as cleaning openings. Behind them there are relevant intake spouts which now are filled with a set of 9 circular glass blocks. Three openings at the wall separating the two tanks, respectively to the other three openings on the top- lead the overflowing water from the auxiliary sedimentation tank to the main

reservoir.

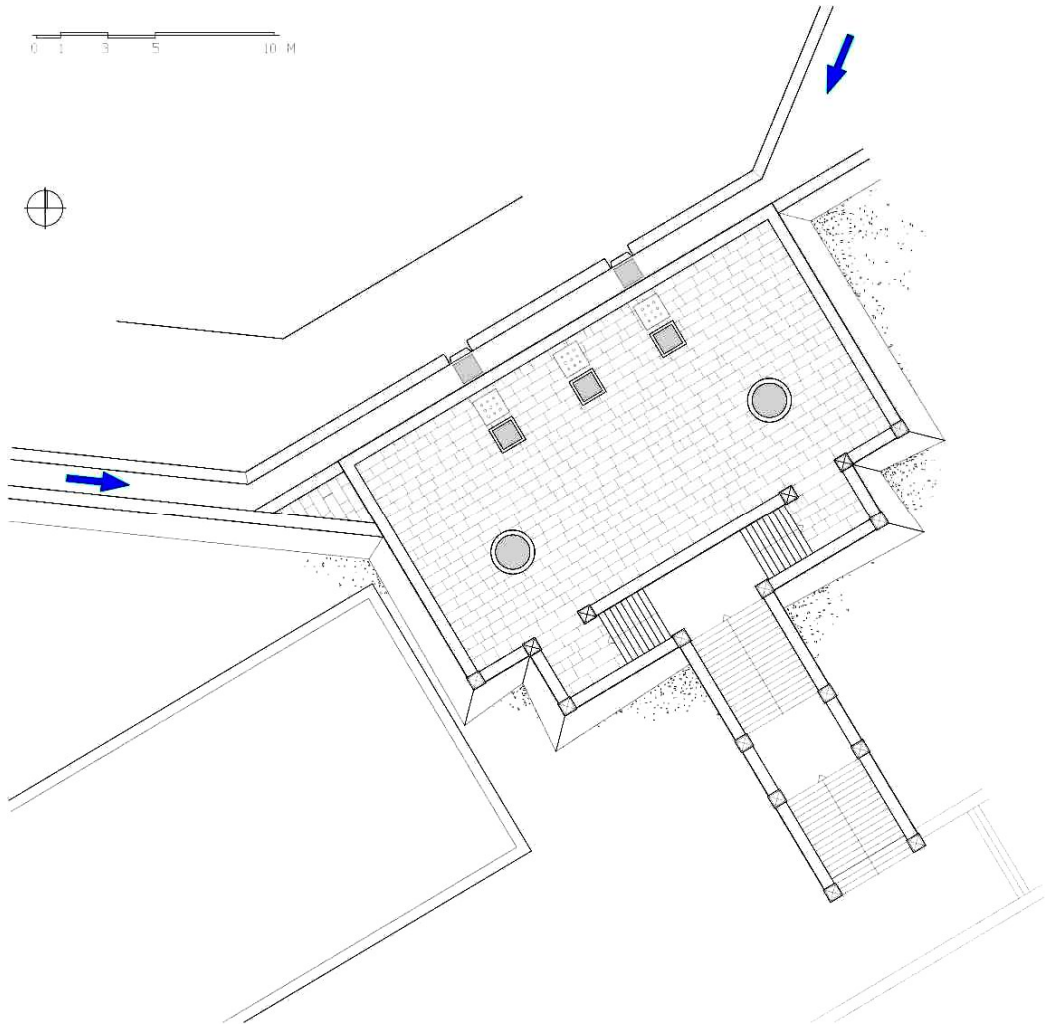


Figure 5. Agioi Apostoloi cistern. General plan

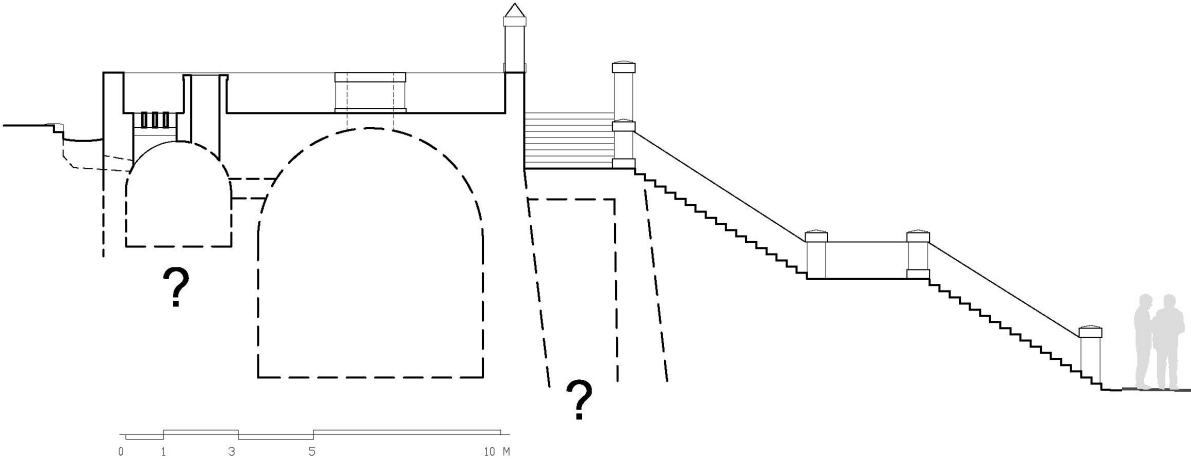


Figure 6. Cross section on the central axis of the Agioi Apostoloi cistern.

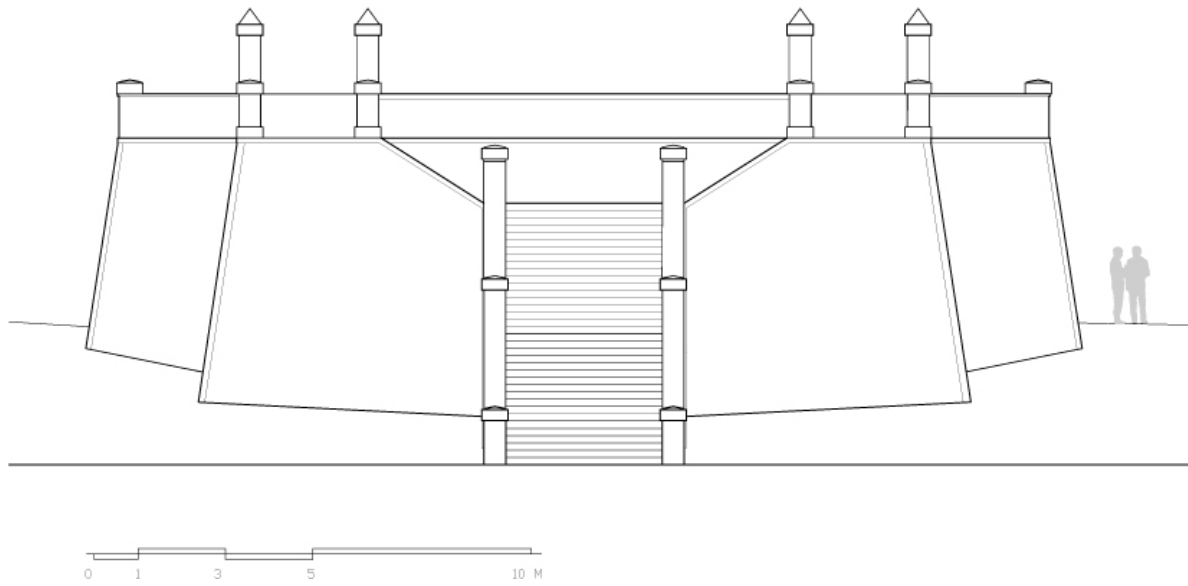


Figure 7. Ag. Apostoloi cistern. Main elevation with the monumental stairway.

The main tank is also vaulted and has a height of approximately 6,5m (Figure 6). The outer walls have a typical form of a retaining wall, wider at the bottom in order to support the increased load of the higher water pressure there (Figures 6 and 7). Two *elegant* round orifices (Figures 5 and 2b) are symmetrically placed along the centreline of the main tank.

The pillars along the south side combined to the monumental stairway give to the construction its elegant appearance. The size of the stairway is predominant over the whole construction and would fit to a palace or countryside mansion house rather to a rainwater cistern! From the road leading to the cistern and the surrounding formations do not survive much and information about them comes from archival material (Doikas, 2005, Tranakas, 1988).

The cistern had had minor adjustments and repairs made in 1931 and 1999 (Doikas, 2005). Later on and even nowadays the overflowing water from Mantropoulo well-cistern is led to Ag. Apostoloi reservoir via pipes. The cistern after the construction recently of the open lake type reservoirs, is no longer the main water supply for the Gaios town.

THE CISTERN OF AGIOI ANARGYROI

The cistern of Agioi Anargyroi was planned and started being built during the Napoleonic Imperial years. Its construction stopped for several years and resumed in 1818 under the British rule. It was completed in 1821 (Doikas, 2005, Tranakas, 1988). It was the first large communal cistern on Paxos and its quantity of water was essential for the population of the capital village, Gaios. It was repaired in 1861 as a local gazette reads (Doikas, 2005).

It is a typical cylindrical cistern with a low circular enclosure and a central elegant orifice. On the orifice there is an inscription about the year of its construction. The inscription is located on the axis of the raised paved corridor which leads from the portal of the enclosure to the orifice. This strip is a typical example for preventing the user to step on the runoff surface. That surface is nicely paved in a way that is relevant to its circular shape and to the presence on the six intake spouts. These spouts are allocated on the peaks of a hexagon (Figures 8 and 9). The portal of the enclosure

stands on the top of a short stairway. The access to the stairway is a street paved with a very fine and nice pattern made out of a combination of cobbles and elongated stones (Figure 4a). The constructional details of the cistern and its access proves the quality of the local craftsmanship and the intentions of the British rule for high quality works.

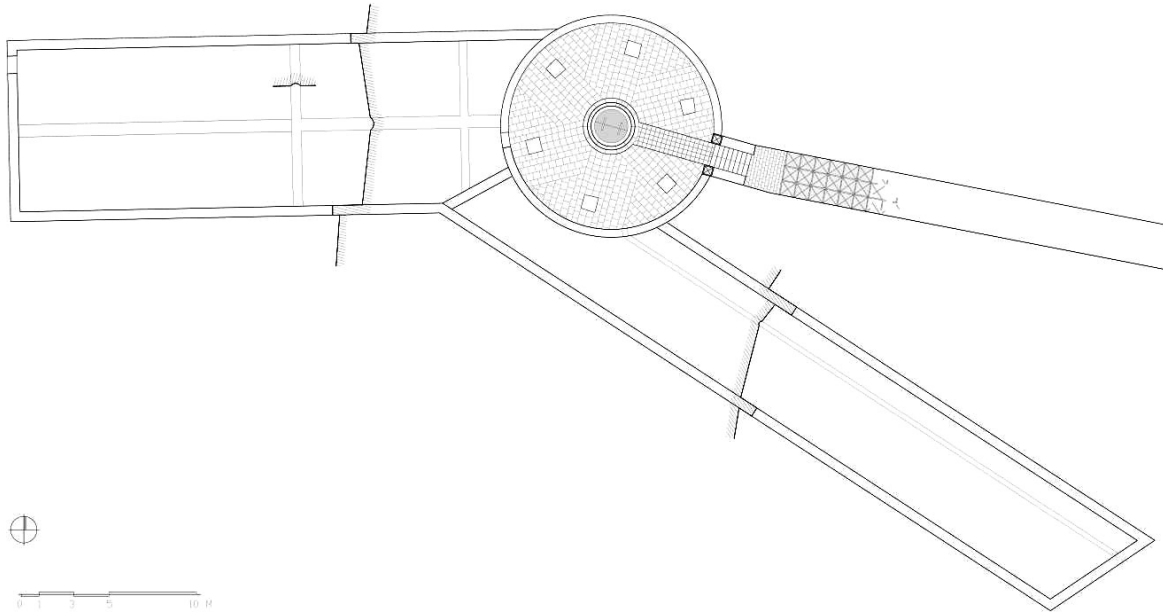


Figure 8. Agioi Anargyroi cistern. Plan and inclined sections of the added (?) runoff surfaces.

The rainwater was poured in the reservoir through the six square intake spouts, mentioned above. Nowadays these spots are covered with thick stone slabs (Figure 2b). Attached to the central circular cistern and its enclosure there are two elongated, almost rectangular, runoff surfaces. They also surrounded by a low- medium height enclosure of stone masonry. The surfaces of both runoff areas are well incline towards the central circular one. In addition their surfaces are inclined towards a central line which has a formation of a shallow half pipe (Figures 4b and 8). The wider one has also secondary shallow half pipes located vertically to its central one. These formations help to the better water supply to the two spouts on the circular enclosure of the central area. Actually they are providing with increased rainwater quantities the central-original runoff surface.

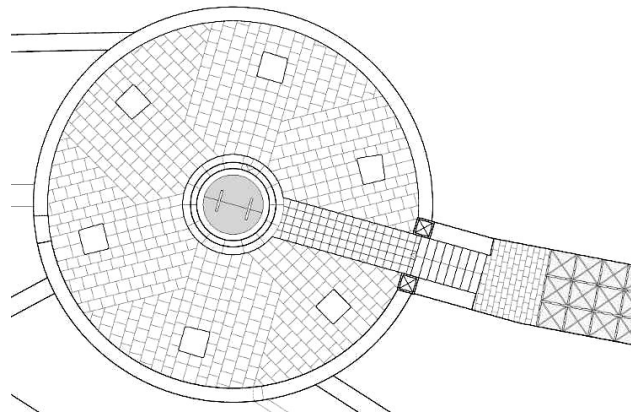


Figure 9. Agioi Anargyroi cistern. The elaborate way of the slab pavement of the original (?) circular runoff surface (detail of Figure 8).

As it can be concluded by all the constructional clues the two elongated runoff surfaces were added later to the cistern. There are no specific written sources on that conclusion but it could have had happened during the repair of 1861 as a result of the efforts to collect morerainwater. Such a short time before the withdrawal of the British from the Ionian islands, a lower quality of construction as the less elaborate paved surfaces of the additions could be another clue to date these ones during the intervention of 1861.

CONCLUSION

As it is obvious, due to the continuous use of these constructions their preservation is very good and some of them are still being used as auxiliary water supply reservoirs, mostly for irrigation purposes. Most of them have been listed as historic monuments by the Ministry of Culture (ΦΕΚ, 1982, Pantazi, 2005, ΦΕΚ, 2007) as it was mentioned earlier, for their proper protection and conservation. The study of these constructions reveals not only the importance of the only possible, for that small island, water supply resources, but also the quality of the craftsmanship applied. In addition it is undoubted that good quality materials as i.e. the nice pavement slabs, reflects the efforts of the British rules for proper and sound infrastructure works.

Besides the skilful and good quality works –which should be also related to the local tradition from the Venetian era- the efforts for the best possible hygiene precautions as the sedimentation feature at Agioi Apostoloi cistern or the raised access to the orifices –a common feature at the cisterns in the Ionian islands (Antoniou, 2014a) etc reveals the systematic approach of the rulers on that subject, possibly through also a relevant regulation. Unfortunately despite the research for that kind of legislation of the British rule there were not successful results on that up to now.

Finally the architectural formations of the cisterns, especially of the communal ones, leads to the conclusion that the importance of these constructions was high enough in order to incorporate elegant morphological features at the cisterns which in the case of Agioi Apostoloi reservoir have reached a monumental character. Possibly the last case along with other less impressive formations –i.e. as the elegant portals- would be related to intentions of the British rule to show off the importance of their presence for the Ionian Islands.

REFERENCES

- Antoniou, G. P. (2009) Communal Rainwater Cisterns in the Cyclades-Greece: The Case of Chora on Amorgos, in Proceedings 2nd IWA *Water and Wastewater Technologies in Ancient Civilizations*, 28-30 May, Bari, Italy
- Antoniou, G. P. (2014a) Residential rainwater cisterns in Ithaki, Greece, *IWA Regional Symposium on Water, Wastewater & Environment: Traditions & Culture* (ed. by I. K. Kalavrouziotis and A. N. Angelakis), Patras, Greece, IWA & Hellenic Open University 675-686.
- Antoniou, G. P., Kathijotes, N., Spyridakis, D. and Angelakis, A., (2014b) Historical Development of Technologies on Water Resources Management and Rainwater Harvesting in the Hellenic Civilizations. *International Journal of Water Resources Development*, **April**, 2014,
- Doikas, I. N. (1985) *Paxos: History, Folclore, Culture*, Δοικας Ι, Paxoi, Greece.
- Doikas, I.N. (2005) *Οι στέρνες των Παξών. Οι προσπάθειες των Παξιτών για την Περισυλλογή Νερού. (Cisterns of Paxos. The efforts of Paxians to Collect Water)*. Οξύ, Paxos, Greece (in Greek).
- Mays, L., Antoniou, G.P., and Angelakis, A. N., (2013) History of Water Cisterns: Legacies and Lessons. *Water* **5**(4), 1916-1940; doi:10.3390/w5041916

- Pantazi, M. (2005), *Χαρακτηρισμός ή μη ως Μνημείων έξι συνόλων στερνών, του Ανεμόμυλου Καστανίδα, και του Ελαιοτριβείου Πίτσιρου στους Παξούς.* (*Listing as Monuments of six cistern complexes a windmill and an olive press on Paxos*) Ministry of Culture, ΔΝΣΑΚ, Athens, Greece (in Greek, unpublished Recommendatory Report)
- Tranakas, D. J. (1988) *Από το Αρχείο της Ιονίου Γερουσίας Κέρκυρας - Παξοί 1818-1828*, Corfu, Greece (in Greek)
- ΦΕΚ 778Β, (1982). *Χαρακτηρίζονται ως ιστορικά διατηρητέα μνημεία οι Στέρνες στους Παξούς και τους Αντίπαξους. ΥΑ ΥΠΠΕ/ΔΙΛΑΠ/Γ/1259/30651/2-7-1982 - ΦΕΚ 778/Β/14-10-1982* National Gazette, Athens, Greece (in Greek)
- ΦΕΚ 143ΑΑΠ, (2007). *Χαρακτηρισμός ως μνημείων έξι συνόλων στερνών, του ανεμόμυλου Καστανίδα και του ελαιοτριβείου του Πίτσιρου στους Παξούς ΥΑ ΥΠΠΟ/ΔΝΣΑΚ/8183/206/26-3-2007 - ΦΕΚ 143/ΑΑΠ/19-4-2007* National Gazette, Athens, Greece (in Greek)