

The ancient water system at the Upper city of Hasankeyf, Turkey

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Abstract In this paper, the water distribution system at the Upper city of a well-preserved medieval town of Hasankeyf near the Tigris is questioned and its relation to the urban settlement pattern is assessed. The discussions are based on the cistern-intensive and available canal data collected within the residential borders of the Upper city in 2005. Being the third level features of the water system, the cisterns the majority of which are now attributable to the “conical, small and individual” typology, have shown that they were actively operated through the open rock-cut canals which were fed by the backbone of the distribution network—namely the siphon system, until recent times. Although a considerable number of converted cisterns hallmark shifts in the function of the water system and the changing conjectures over time, the blue prints of such a big “hydro-design” reveal the competence of semi-arid occupational environments in Upper Mesopotamia in showing how to cope with the topographical constraints and climatic disadvantages and turn these into an opportunity through the efficient use of terrain along with a carefully designed settlement area. That the Upper city now offers numerous water features makes this piece of land quite a representative of the regional works and shows the apex of the perception of ancient technology

achieved with the siphon that could have been launched in the Roman era, and the state of art of planning ancient natural and man-made habitats.

Keywords Hasankeyf · Upper city · Water · Distribution · Cistern

Introduction

Hasankeyf, located in the Upper Mesopotamia (36 km southeast of modern Batman in Southeast Turkey) on the banks of the Tigris, has a unique status with a harsh topography and distinctive outlook. Situated at the crossroads of the Near Eastern and Anatolian cultures (Fig. 1), it is one of the well preserved medieval towns in the southeast of Turkey, however is also a place where the ancient cultures of the West, Iran and Central Asia meet. It has a distinguished setting with thousands of cave dwellings scattered throughout the Upper city and the environs while these dwellings maintained their importance until the twenty-first century. The importance of the whole site is also due to the position of the Lower city nearby Ilisu Dam -an irrigation hydropower project, formerly launched as part of the South-East Anatolia Project (GAP). Unfortunately, the Lower city of Hasankeyf, amongst the assets which suffered from being called as “cultural heritage victims”, has been living a misfortune, perhaps its destiny for years. It has been striving against being inundated by the waters of the mentioned dam for the last decade while many

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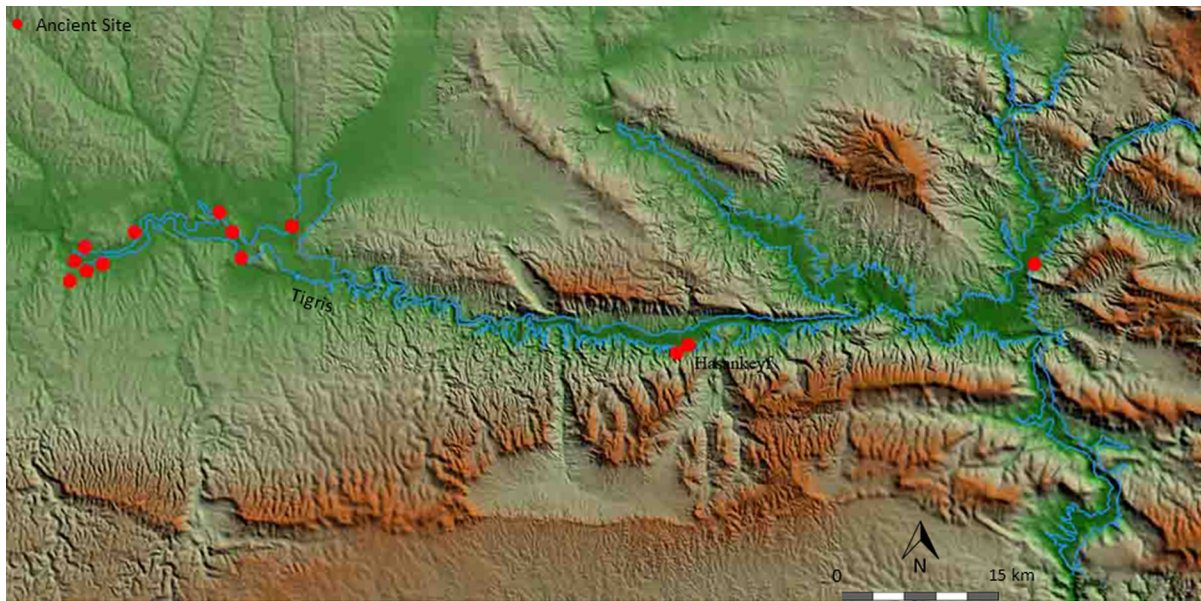


Fig. 1 The Environs of Hasankeyf Near the Tigris (Source: TAÇDAM, 1998–2003)

issues have remained arbitrary up to now. On the other hand, the Upper city, due to its physical setting 100 m above the Tigris, is comparatively less vulnerable to the potential onsets of the project. A field study aimed at unveiling the poorly known sides of the water system of this part of Hasankeyf, in June 2005.

Preliminary evidence pertaining to previous works on Medieval Hasankeyf comes from the archaeological excavations and salvage projects that were launched from 1986s (Arik 2001: 777–794), particularly conveyed through the publications of Prof. Dr. Oluş Arik and his team between 1989 and 1991 (Arik 2003). The architectural features of the Upper city were surveyed by TAÇDAM (Tarihsel Çevre Değerlerini Araştırma Merkezi-Centre for Research and Assessment of the Historic Environment) in 2002, including all the settlement areas (TAÇDAM 1998–2003). Further information has been reported by Prof. Uluçam and his team about the presence of some Roman ruins found at the Lower City and, traced nearby the bath building which is supposed to have been constructed by the he Artukids (Uluçam 2006: 78–79).

The chronological background of the town is traceable far back to the Bronze Age. There is scant information about the identity of the first settlers of Hasankeyf, however, its suitable position in the Fertile

Crescent near the Tigris made the ancient town be of attraction, beginning with the Assyrians and the town was later passed onto the Romans, Byzantines, Sassanids, Abbasids, Artukids, Ayyubids, Seljuks and Ottomans. The original name of the town, “Castrum Kepa” (the castle of rock) was inherited from the Assyrian language, which was also acknowledged by the Romans, Umayyads and Abbasids in a similar way. What we also know is that the Byzantine, Ottoman and Seljuk texts attribute a strategic importance to the Middle Age. On the contrary, there is only a handful of information about the pre-Byzantine periods. In the late Roman period, Sassanids passed Hasankeyf to the Byzantines and the occupation continued until seventh century. The fortress, now also identified with the Upper city, was constructed in fourth century by the Byzantine Empire and formed the basis for further conquests. The reputation of the city comes from the settlement of an ancient Christian community and establishment of an independent religious institution in the beginning of the Early Medieval Period. The Muslims conquered the town only after seventh century and it began to take a “city pattern” with the advent of the Seljuks in eleventh–twelfth centuries A.D. The town reached the peak during the reign of the Artukids, which was a

principality of the Seljuk Empire around 1100–1234 A.D (Plüss and Arik 2001: 96).

The literature on the water works of Hasankeyf start with the Artukid period when the entire system also evolved into its mature period and took the recent outlook. As Plüss and Arik (2001) convey, the convergent tubes and a siphon system were the two remarkable features of the Upper city during the rule of the Artukid Sultan Karaaslan. In this period, the castle was reconstructed on the rocky plateau and vineyards and gardens were formed on the banks of the Tigris. Since there was no permanent water at the Upper city, fresh water was brought from about 14 km distance, from a natural spring up on the high plateaus in the southeast, via canals and was circulated from a cliff to the castle. That is, it was funneled down from the tops of cliffs to the valley and was simply pressured up to the cave-dwellings of the Upper city (*Ibid*:98; Toprak and Süzen 2004). Arik (2003) further clarifies that the canals, in the form of big window shape pipes were carved into the rocks inside which smaller canals made of clay transported water. The remains of the depot where the canals reached the castle and the ruins of a “maksem”¹ similar to its equivalent in Taksim-İstanbul have proven that water was first brought to the famous public building of the Upper city- the so-called Grand Palace and then distributed to the districts and quarters via a secondary network, for drinking and cleaning purposes as well as irrigation in the surrounding terrain. The cisterns were a kind of preventive mechanism which collected water not only from the rainfalls for the dry season but also from the fountains and Tigris via zigzag stairways that were carved into the northern scarp. Such structures have been dated to a time span long before the Artukids (122, 136).

Water must have been a significant agent in the urbanization process of Hasankeyf. Notwithstanding, the knowledge disseminated until now predominantly relates to the operational principles and some very technical aspects of the water management system whose components have not been discussed in a contextual manner. Although scholars have provided quite a broad perspective pinpointing its relational status with the surrounding habitat, new evidence and systematic study (basically the cisterns and canals) on

the constituents of the distribution network now lead the way to additional clues and reveal some specific aspects in the occupational background. The preliminary objective of this paper is to explain the water distribution system, specifically its relation to the natural and man-made environment, in an area limited with the Upper city which is surrounded by a natural scarp of about 2.5 km. The field work which was carried out in 2005 focused particularly on the cisterns and canal remains, and was confined to the settlement area (excluding the public spaces), and the main canal, the siphon and the reservoir (hereinafter referred to as the “Pool”), all lying in the southernmost end of the Upper city. As a matter of fact, the research has been the first attempt to make a solid move toward the canal extensions which now have eroded to a great extent and 185 cisterns with various characteristics and provide some insight about the links between these two and the settlement pattern, within the environmental context. In doing that, parallels with the ancient water systems in the regional and contemporaneous background are also sought.

Method and limitations

The results imported to this paper are very much based on the field study and the base map previously generated by TAÇDAM. 1/1,000 scale map of the Upper city (Fig. 2) produced by the TAÇDAM Project Office was utilized as the substantial material for remapping and visualization of the *loci* of the water features. A database which includes, to the minimum extent, the attributes of all the identifiable features, was created to enable analyses (in consideration of the variables such as topography, (cistern) proximity, density and distribution) through the application of GIS. Then, a most common cistern typology was formulated by setting the criteria according to their frequencies, and shape, volume, size and pattern categories. Finally, some famous works was revisited in respect of the Roman and pre-Roman samples. Although data and analyses regarding the main canal, the siphon (referable to e.g. that of Aspendos; Ortloff and Kassinos 2003: 417–421) and the Pool were dismissed, they are echoed below, whenever necessary, in order to assess the integrity of the water distribution network.

¹ The water tower which increases the level of water, thus the pressure and distributes to the city and/or its surrounding.

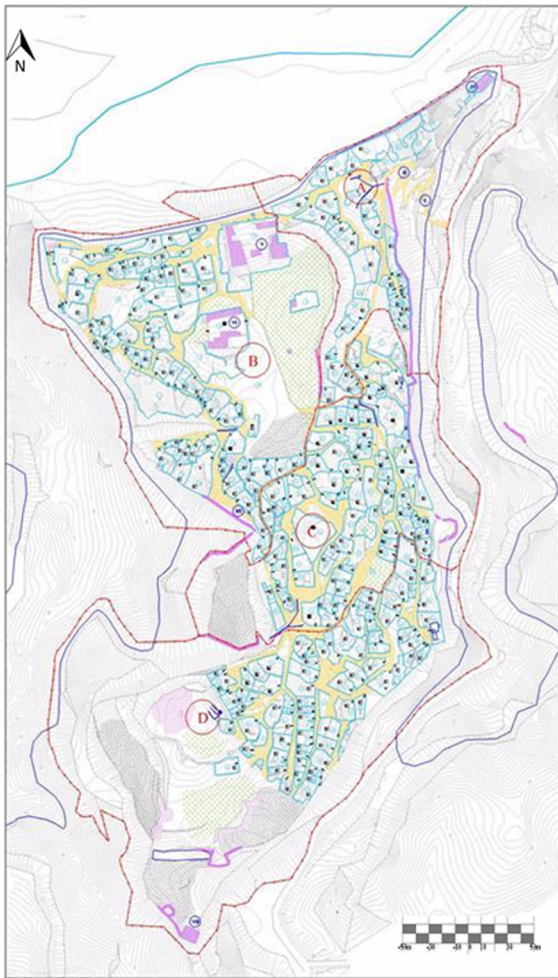


Fig. 2 1/1,000 scale map of the Upper City (TAÇDAM)

Obviously, the study area abounds in cisterns which make up the considerable part of the data. But, the evidence on the canal network is subject to many questions when taken as the complementary side of the system. A limitation is that some of the cistern data and those relating to the canal remains are missing due to natural abrasion or disturbance on purpose. Hence, the estimations (regarding the dimensions and/or shapes) had to be made where evidence was absent or weak. That is to say, the cisterns which lack one or more dimensions and make up about 24 % of the total population (including two more cisterns embedded in the database as the pool and the special one; no: 83 and 187, respectively) were excluded in the computation while only 10 % were subjected to estimation in terms of shape, however the shapes were more or less verifiable through miscellaneous criteria which shall

not be debated hereunder. Another disadvantage is that a thorough scientific global positioning (GPS) method could not be applied due to ± 6 m error in the readings. Although the remnants of the siphon system (substituting the maksem), which is closely located near the Pool, as was previously mentioned, are well recognizable over the city texture, the full identification of the water network is troublesome. Despite some early material, the evidence does not go far beyond glazed/non-glazed ceramics, cross-shaped octagonal porcelains and some decorative plaster fragments. Brief to say, it is difficult to date the water features as no systematic study pertaining to the pre-Medieval period has been conducted up to now, so no strict chronological attempt and assignment of a cultural sequence has been endeavored in this study.

Data

Rock type, topography and climate

What makes Hasankeyf a suitable land for settlement through the ages is that the Lower city is situated in the floodplains of the Tigris over a fertile soil cover. Also, the topography eased defensibility at the Upper city on the hilltop castle. The natural boundary of Hasankeyf District is formed by the Raman Mountain range in the north, and the Midyat Mountains and Tigris River arc lying in the south. There is a great possibility that the morphology of the Upper city was similar in the ancient times. It seems that the Upper City, presenting a rolling but defensible topography, made it available for the residential borders to attain a certain degree of flexibility (Ny Dahl 2002: 35–39) for daily life activities.

Shale, sandstone and limestone (Oligocene) constitute the key lithologies of the terrain. There is also the co-existence of thin bedded soft and resistant rocks which form suitable environments for carving of all the cave-dwellings and other types of buildings throughout the study area. From a geo-archaeological aspect, the dip amount of rocks (5° – 7°) controlled the slope at the Upper city where the elevation difference measured 75–30 m respectively in the south and northern parts that were embraced with two hung valleys near the Tigris. Due to the sloping conditions (a mean slope between 5° and 28° where the mean value is 14–15), some of the sections were artificially leveled to produce the morphology of the city. The



Fig. 3 Dwellings at the Upper City

slope degrees of the terrain are moderate in most parts of the public areas which are below 45° while they can reach 45° in the private areas and the road network. The cisterns and small canal extensions were constructed on the terrain allocated to the latter two. The maximum degrees can be measured along the natural scarp where the main canal remains were worked (Toprak and Süzen 2004: 804–807). The housing pattern exploits the advantages of a defensible topography. The dwellings had to stand very close to each other and that this was probably facilitated by the rock-cut building practice. As Peker (2004) concedes, they are located in parallel with the landscape (Fig. 3)² whereas the monumental structures and buildings which served the public are placed on the highest levels on relatively flat grounds toward the northern part of the Upper city.

On average, a mild climatic zone prevails in Hasankeyf and its environs. Warm conditions, especially in winter time are normally expected due to the mitigation effect of the Tigris. However, the city is quite vulnerable to arid currents coming from the very south; temperatures which may easily rise up to 43–45 degrees are typical of the dry summer conditions. Due to continental climate and hydrological conditions of Upper Mesopotamia, cities and irrigation lands were often below the level of river beds and canals. The Upper city is distinctive with comparatively an advantageous position, high above the Tigris River

² All the space appearing in yellowish color and connecting the *insulae* of dwellings relate to the road network, in Fig. 2.

so that it could also avoid perennial inundations. Although the climatological constraints may seem a significant determinant on hydraulic solutions, the geological conditions draw the framework for easy flow of water down and across the harsh topography.

The water structures

The water system of the Upper city is composed of five main visible elements: the “main canal coming from the source”, the “siphon system”, the “Pool”, “distribution canals” and the “cisterns”. Seemingly, there were three methods of distributing water. The first one was achieved with the help of a main Pool (*castellum*), which falls outside the borders of the dwelling quarters. The second one was the use of canals traceable inside and outside the mentioned area. The last category is associable with the small water depots and cisterns which were documented over the entire settlement.

The incredible abundance of a major component of the water system (cisterns) and internal methodology

Pertinent to the main group of evidence, the cisterns (as well as the canals) were recorded according to four sections (A, B, C, D) and the housing unit codes documented by TAÇDAM (1998–2003) on the maps (Fig. 4a, b) where the public areas (e.g. the Grand Palace, Ulu Mosque, cemeteries) and invisible parts of the city most of which now lie beneath the archaeological deposits were excluded.

Two major steps, identification and measurement, were completed during the collection of cistern data. The initial aim of the first step was, for the first time, to fill in the gaps for numerous unidentified cisterns taking their current conditions into account (based on the criteria set as: well-preserved, badly-preserved, completely or partly disturbed, filled, closed or converted for different purposes) and also classify them according to shape and pattern. The next step aimed at creating cistern categories by measuring the dimensions based on height (opening-to-base, neck-to-base), and diameter (top diameter in the NS/EW axis, base diameter in the NS/EW axis, respectively) values, with a maximum possible accuracy to come up with volume and size data (See the cistern samples

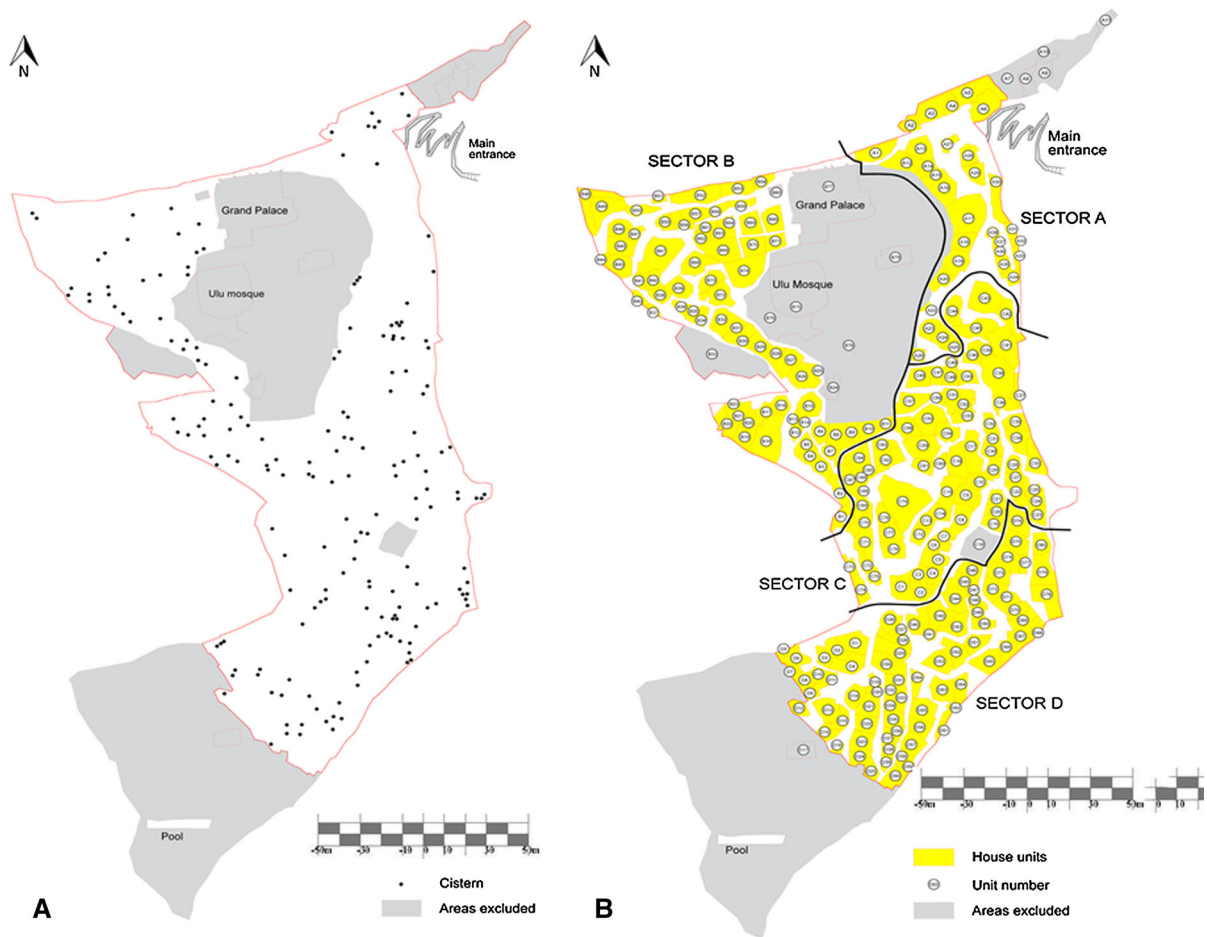


Fig. 4 Cistern distribution map (a) and housing unit codes (b)

(Fig. 5; also see Fig. 11) from the Upper City which were observed to be well-preserved in a courtyard (D78), located on a main road (B71-2), closed (A5), filled (A6), partly destroyed (D26) or badly destroyed (D44)). The former method (measurements from opening-to-base) is applicable to the cylindrical and conical forms while the latter relates to the pear-shape cisterns. Out of 185 rock-cut cisterns, the heights of the cylindrical and conical forms measured between 90 cm (min.) and 710 cm (max.). The neck-to-base measurements ranged between 150 cm (min.) and 600 cm (max.). The smallest diameter recorded for an opening was 35/35 (N–S/E–W) cm and the largest was 330/200 (N–S/E–W) cm; the smallest base diameter measured 60/80 (N–S/E–W) cm and the largest one(s) occurred as 740/660 (N–S/E–W) and 710/690 ((N–S/E–W) cm.

Cistern characteristics

To put it in a more specific context, the cisterns documented at the Upper city revealed the following:

Shape They can be assigned to three main shapes (Fig. 6). Apart from those which are filled or cannot be accessed, it was determined that 4 cisterns are cylindrical, 132 cisterns are conical and 21 cisterns are pear-shape. The shapes of 28 cisterns were allocated to the “undefined” category either because they were filled, broken, disturbed or could not be reached at all whereas the cisterns whose bases could not be reached but were viewed from above were incorporated into shape classification.

Volume and size The cisterns have various sizes, independent of their proximity to each other. However, sizes are often dependent on certain categories of



Fig. 5 Samples of cisterns

location (Table 1). They were grouped under six³: very small (30), small (114), medium (17), large (14), very large (8) and extremely large (2) (See the histogram of cistern size categories in Fig. 7).

Pattern As long as the cisterns appear as individual structures, their shape and size are the basic parameters. A third parameter, “pattern”, refers to the spatial relationship of a cistern with the surrounding ones, in the physical context. Those which stand very close to each other were either referred to as “twin” or “triple”. A common observation on the neighboring cisterns was the elevation difference at the base level. Such cisterns were called “hung”. A distinctive

³ The values in the parentheses indicate the number of cisterns relevant to each category.

feature for some of them is that they are accessible from two openings, thus were named as “two-chimney” (Vitruvius (8.6.15)). In summation, the following pattern categories (Fig. 8; Table 2) were assigned as: (a) Individual, (b) Twin (c) Triple (d) Hung (d.1 Single-hung; d.2 Twin-hung; d.3 Triple-hung) (e) Two-chimney.

The individual cistern category is not given as it is deemed to be very common, by definition and nature. All of the twin and triple cisterns have conical shapes most of which fall into the “very small” and “small” size category with one exception; a triple cistern in C45 unit is in a hung position having a pear-shape. Although both of the two-chimney cisterns have conical shapes, one of them is “extremely large” while the other is “small”.

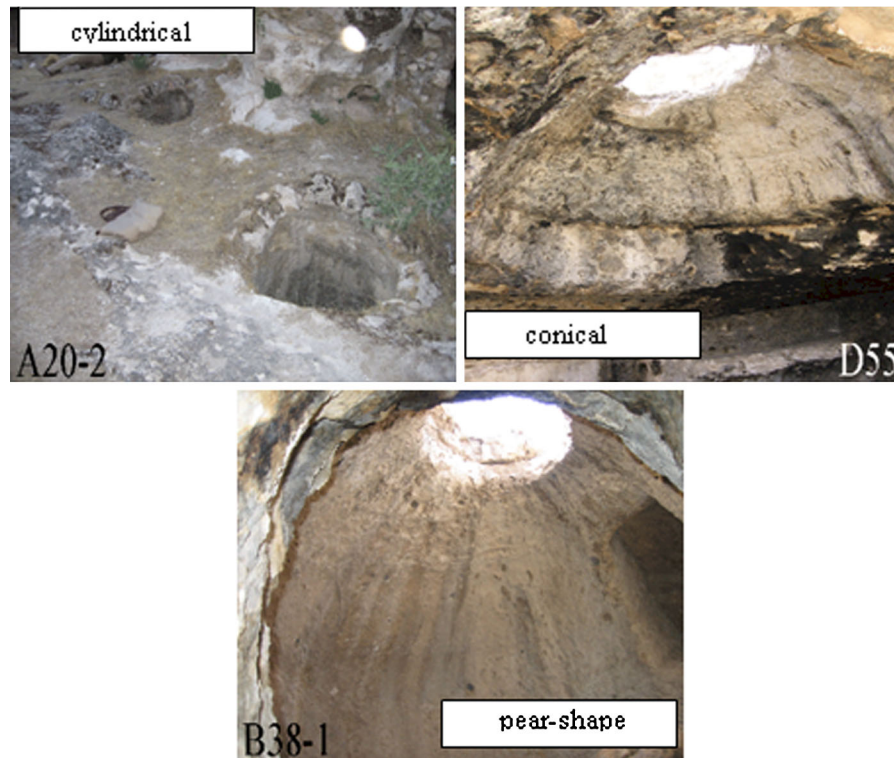


Fig. 6 Cisterns attributable to three main shapes

Table 1 Total number of cisterns satisfying size categories according to locations

Total # of cisterns	Location categories	Size categories					
		Total # of cisterns					
		Very small	Small	Medium	Large	Very large	Extremely large
163	Housing units	20	93	16	12	8	1
23	On road	4	13	–	1	–	1
17	Near scarp	7	9	1	1	–	–
2	Near road and scarp	1	1	–	–	–	–
29	Above 591 m	6	20	2	1	–	–

Conversion

An interesting observation has been that, almost half of the cistern population was subject to conversion over time (Oğuz et al. 2011: 438). But a lack of chronological study leaves us to be contented with morphological scrutiny; hence it gets difficult to assign them to a certain period. Notwithstanding, extensive conversion activity and secondary use of cisterns divert the attention to late usage.

The secondary use quite relates to the current condition of the cisterns. Some cisterns are located in

the courtyards of the dwellings while some rest inside the dwellings as private platforms. Many were converted to living spaces like kitchens, rooms, stalls and weaving platforms. Also, some cisterns now lie on the main roads, near a wall or a scarp. There are some fine examples as far as hung cisterns are concerned, as well. Some of them were cut from the base probably when the two dwellings were adjoined, for the enlargement of space. Further, late interior walls were added to segment the space, thus produce new dwellings forms, e.g. in unit C45. Another occurrence is column construction, as part of the conversion

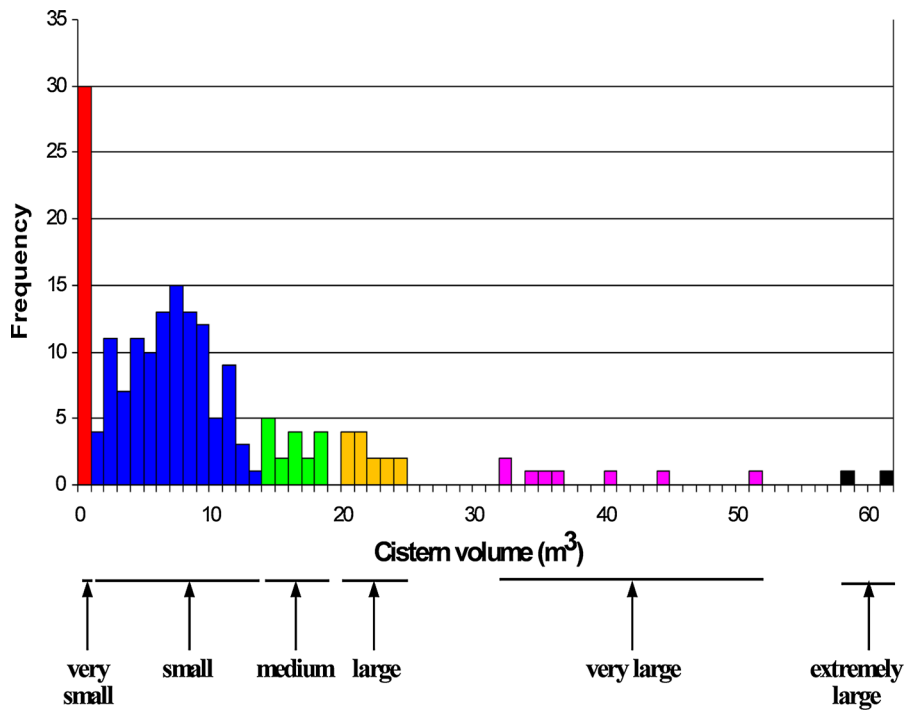


Fig. 7 Cistern size categories

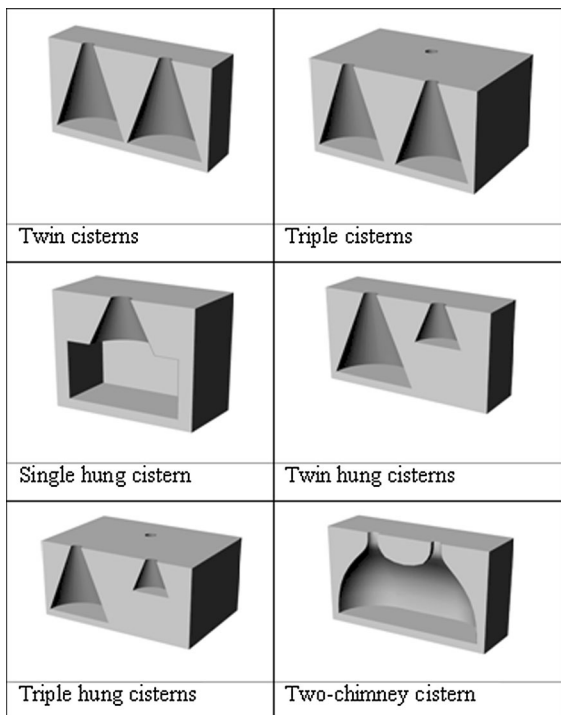


Fig. 8 Cistern pattern categories

Table 2 Total number of cisterns satisfying cistern patterns

Pattern	Total number
Individual	157
Twin	6
Triple	4
Hung	39
Single-hung	36
Twin-hung	2
Triple-hung	1
Two-chimney	2

activity. The two columns, on which twin-hung cisterns (Fig. 9a) are standing, were observed in C55 unit. However, it is, time to time, dubious whether a cistern subject to conversion with its hung position, kept the original type as the bases may not always clearly show whether they were cut or they became hung when an adjacent chamber of a dwelling was enlarged from a lower elevation. Some cisterns were obviously plastered but it is difficult to claim about the period(s) of application. These may have openings over which bonding was applied in which case it may

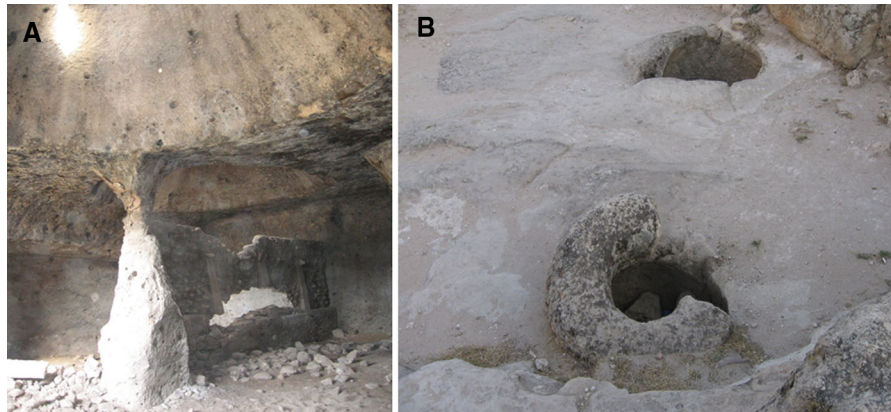


Fig. 9 Twin-hung cisterns in C45 (a); well-like structure in A2 (b)

relate to restoration in later periods to reinforce the original construction of the opening. Other indicators for secondary usage are the late decorations and inscriptions. The cistern in D76 unit is a sample whose ceiling is made of ceramic, perhaps a work in the Roman style but is hardly diagnosable. The cistern in B62 is also a fine case for this category. A final indicator for secondary usage is the cistern in D65 unit which was used as an entrance to a dwelling (*Ibid.*427–461) (Fig. 11).

Suffice it to say here for the cisterns, we also understand that the wells were part of the dwellings in light of the data produced by TAÇDAM (1998–2003). But we can barely propose a conversion for them. Additionally, well-like structures with rings over their openings were documented outside the locations of wells. Two dwellings were checked in detail. The first one is in A2 unit where a well-like structure (Fig. 9b) with a ring and a small hole nearby were recorded. This must have been a well simply because traces of rope usage are quite visible. Although most of the cisterns lack lids or special covers today, we venture to suppose that some could have possessed similar protectors for hygienic purposes.

Canal data

The canal extensions (Fig. 10a, b) running across the borders of the Upper city start from the Pool in the south and reach the cisterns that are scattered across the settlement area and along the scarp. They are traceable in (Fig. 11)

- the very south of D60, outside the borders of the dwelling area
- in the southwestern corner of the Pool
- at the opposite side of D2 and D3 units near the southwestern scarp
- in B22 unit near the western scarp
- between A18 and A36, A37 units on the main road falling to the northeast.

Several other minor canals (in the vicinity of cisterns) lie particularly in D6 unit in the SE of the city. Presumably, these were connected to the canal extension near the southwestern scarp which is relatively poor in respect of cisterns when compared to the S and SE. However, the canal remains seen in D6 toward the southeast and the extension observed on its northern side travel at relatively higher elevations than the others traceable in certain parts of the city. Apart from the major canals, small canal remains (exhibiting a capillary diffusion) mostly make their course towards the cisterns within the entire settlement. Relational evidence may be found by tracing part of the visible terra-cotta remains deposited in the public area as has been also conveyed from the previous archaeological excavations carried out at the site.

A direct relationship between the canal remains and cisterns is clear while indirect relations are also likely. Besides, some gutter-like deposits found in the eastern interior part and on a main road in the SW sector have shown that the city could have possessed a discharge system although only two examples (possibly part of a canal extension coming from W and SW) could be recorded. The southwestern part of the city is indigent

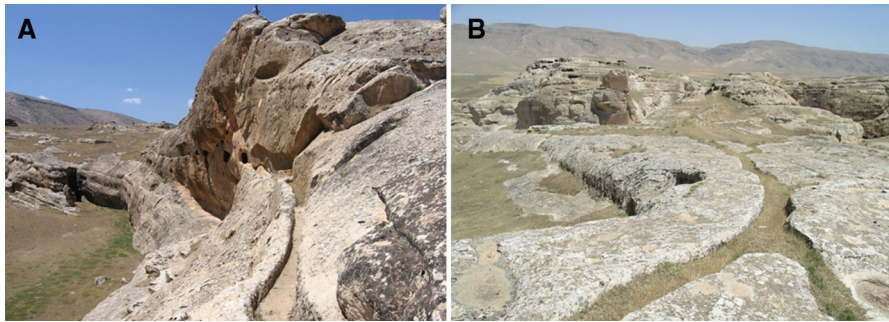


Fig. 10 Traces of canal extensions

in terms of cistern availability. It could be that the sloping character of the terrain hereabouts facilitated the distribution of water. However, it is arbitrary whether water was conducted to such higher elevations via other means, e.g. through the subterranean (Vitruvius (8.6.3)) canals or similar assisting constructions.

Analysis and results

Distance and density analysis of cisterns

Based on a program written in BASIC language, a distance analysis was made to attain an optimum proximity between the cisterns. Accordingly, the shortest distance between the cisterns is 1.5 m and the longest distance, 27.6 m. It was realized that a non-random decision on the locality of the majority of the cistern population and surveillance of their proximity at the minimum extent was likely in which case the highest percentages are attributable to those whose proximities change between 2 and 7 m. Further questions were raised about the concentration of the cisterns over the settlement area. This was made through another BASIC program, using grid spacing at 10 m intervals with a search radius of 20 m, in order to understand the frequency of cisterns and volume of water held by each. The results showed that the density of the cisterns in relation to frequency gradually decreases from S to N of the city, as shown in Fig. 12a where the circled areas retain no cisterns. The three highest concentration areas pointed out by circular to elliptical shapes in red color are confined to the interior parts of the Upper city. Most of the lowest concentrations take place closer to the scarp.

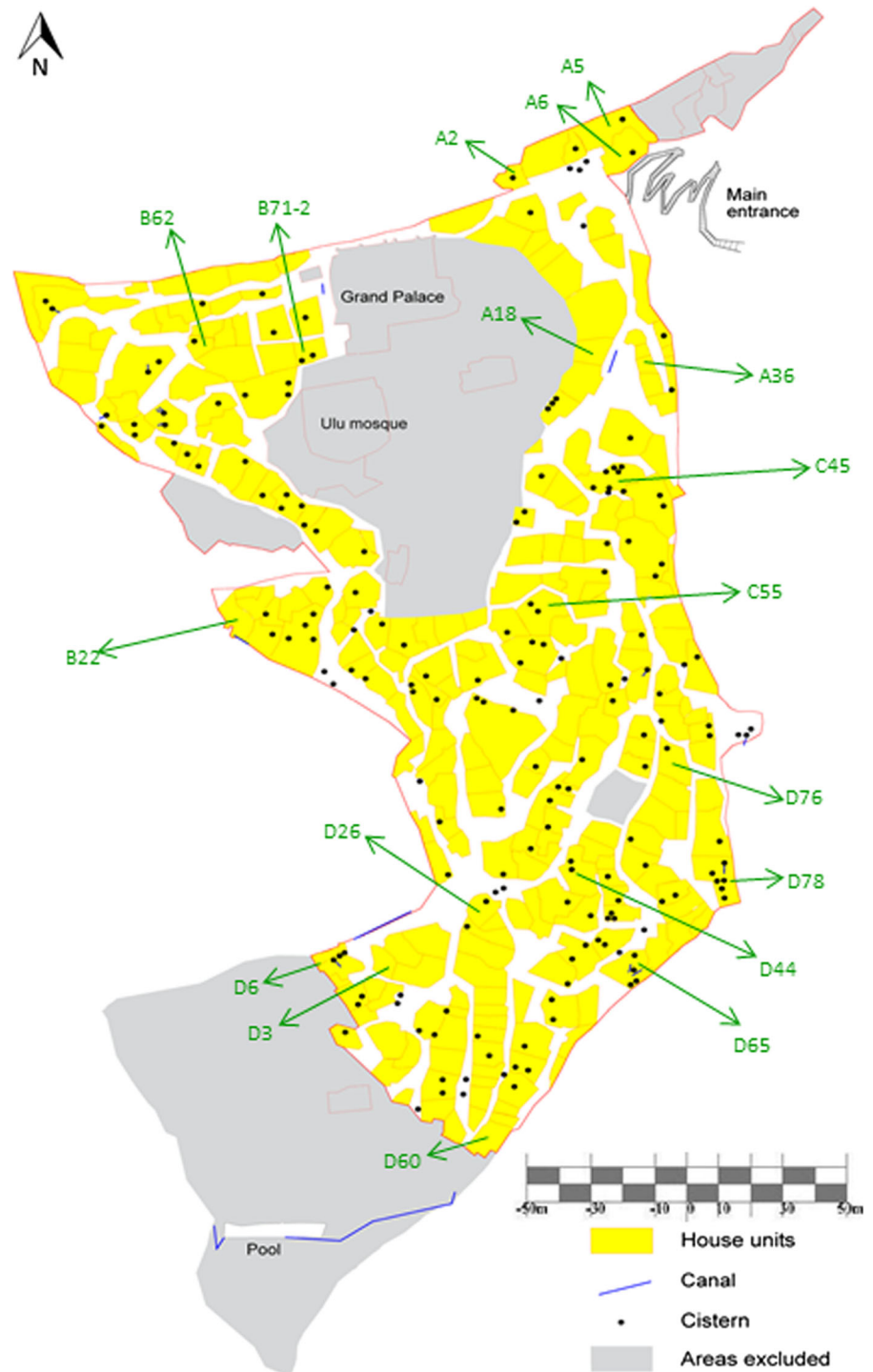
Based on the volume of cisterns, a next analysis aimed at figuring out the distribution of the available amount of water at the Upper city. The density map (Fig. 12b) shows that, excluding the circled areas where there is less than 10 m^3 of water per unit area, a uniform distribution of water volume throughout the city corresponds to an average of 30 m^3 , as indicated by the dominant blue color. Two areas, on the contrary, with the maximum concentrations can be observed in the western part. The case is explainable with the presence of large cisterns in the mentioned sector. When compared with the frequency map, the smoothness of volume in Fig. 12b suggests that the cisterns have smaller volumes in high frequency areas whereas they have larger volumes in the low frequency areas.

Distribution of cisterns in relation to dwellings and topography

The cisterns greatly vary in size. In addition, the neighboring cisterns, cisterns which have proximity to a canal extension or a canal remain, or those built in some certain locations (see Table 1) do not always indicate a systematic range which means that most of the values attributable to the size categories (in accordance with the location) are likely to be random for almost each case. Note that the numbers given for the mentioned categories for a specific location do not necessarily lead to a total sum in (Table 1). They were attained by being filtered through the cistern and canal distribution map (Referable to Figs. 4a, 11).

The relationship between the volume of water and the dwellings (Fig. 13) has revealed that no linear relationship can be proven with a correlation coefficient (R^2) equal to 0.0357. Upon a relational

Fig. 11 Canal extensions and loci of some specific units



analysis made for the topographical conditions, the results have shown that the distribution of cisterns was not straightforward for all parts of the Upper city.

Hence, the certain sections of the Upper city could have benefited from the advantages of topography. Taking the elevation of the Pool (593 m) as the

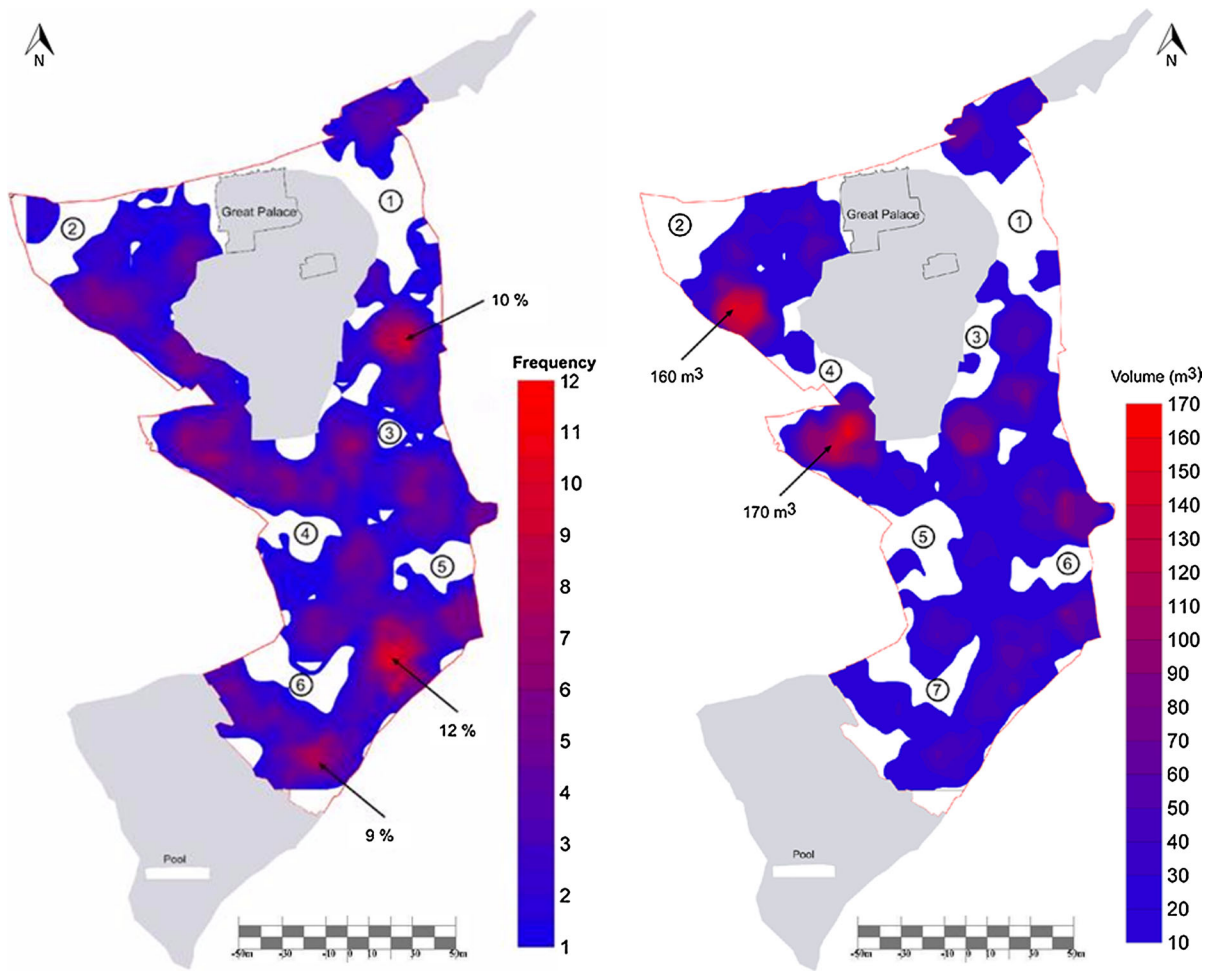


Fig. 12 Density of cisterns based on frequency (a) and size (b)

reference, a scenario was set for the dwellings, thus the cisterns below 591 m. The cisterns to which the Pool had to send water, *ceteris paribus*, had to be below 593 m as the worst case so that they could get the maximum equal benefit from a possible canal network. Few cisterns were found in the southern interior parts of the city which are often associable with undulated grounds and were designed according to terrace formations. With some exceptions, the elevation of the majority of these cisterns approximated 591 m. The cisterns recorded much below 591 m are generally associable with the plain courtyards.

In consideration of the frequency and volume of water, it is inferable that the percentages for the

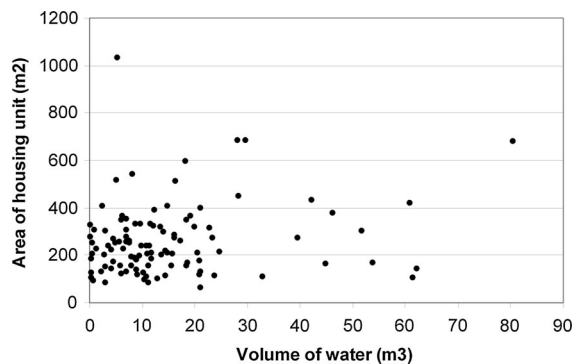
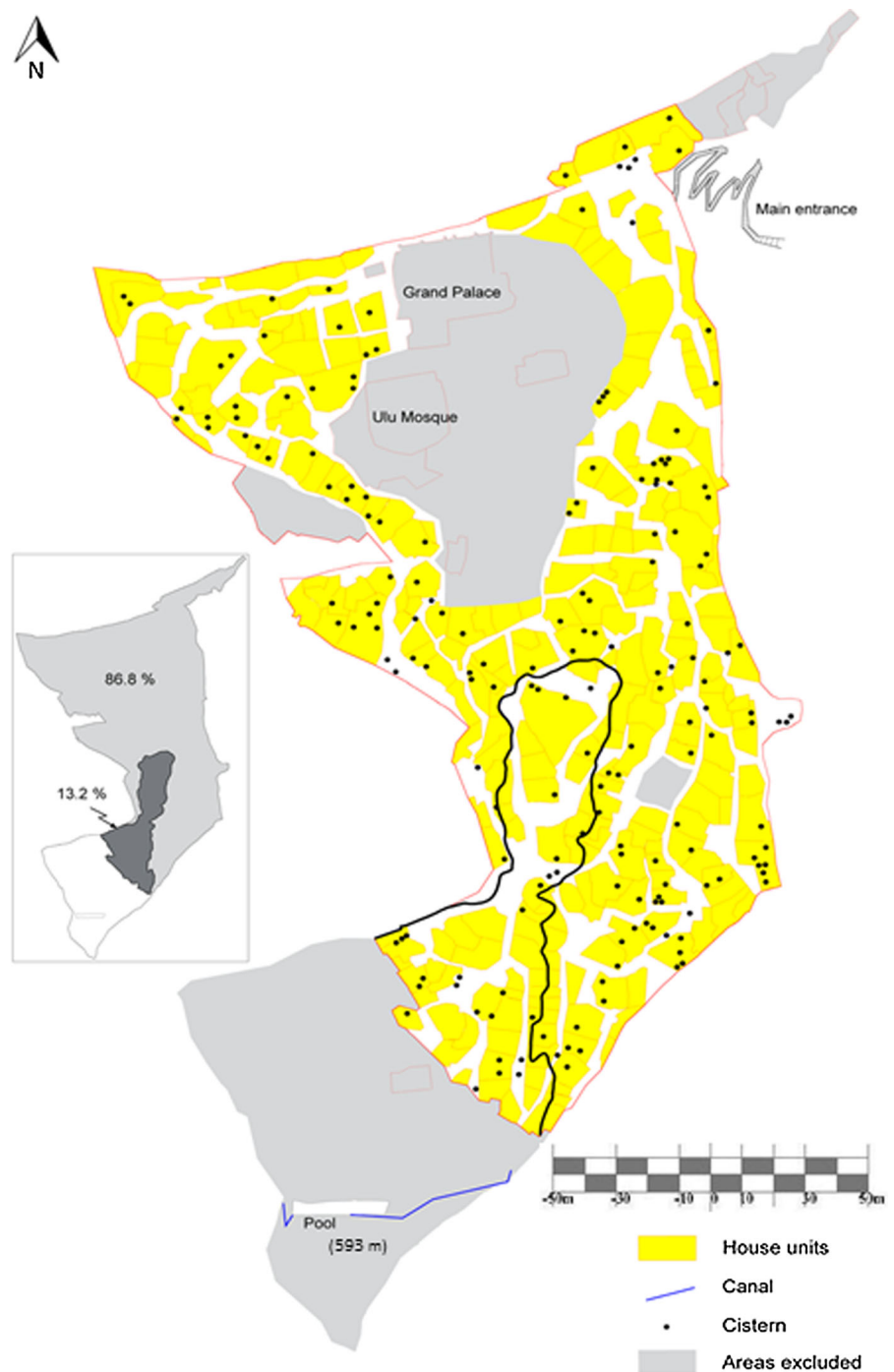


Fig. 13 Relationship between volume of water and area of dwellings

volume and frequency of the cisterns above 591 m are, in each case, less than those observed below 591 m. However, when assessed separately for the category above 591 m, the frequency is definitely higher than the volume of the cisterns in the said location category.

The elevations above 591 m make up 13.2 % of the Upper city. The catchment areas of the associated dwellings that correspond to the elevations above 591 m are trapped with a topographic contour in black (Fig. 14).

Fig. 14 Distribution of cisterns and dwellings above 591 m



Comparative work

Water was used in many different ways in ancient times. The Romans well knew the importance of water in a city. For instance, all the aqueducts were diverted to the city at different elevations in Rome. To Evans (1997), much older lines were constructed at lower elevations either because burying aqueducts underground was an easy practice against the enemies or “fine points of leveling art” was not yet ascertained. The point is, whenever water came from higher elevations, lines usually ran together after they reached the city and fell into a pool within a short distance (21–26).

Water conservation and drainage are the two major concerns when the conditions are arid. Aqueduct building comes therewith. Archaeological evidence unveils the specialization of Romans in aqueduct construction and storage of water in huge cisterns, ponds and canals in Mesopotamia. Drainage plans, whatever the climate was, were achieved by working water tunnels, often complemented with subterranean tunnels of the *qanat* type (originally developed by the Persians) with air shafts at regular intervals (Forbes 1993: 43–45, 47). Acknowledged with a complex modulation against the silting maneuvers and somewhat an extraordinary work, the 1.4 km long, 7 m high and 6 m wide Titus Tunnel in Çevlik Village within the borders of modern Antakya province is one of the greatest works, datable to the Roman Seleucid period (Alkan and Özis 1991).

More explicitly, aqueducts, *qanats* and conduits were the most advanced types of Roman water systems which were often made of lead and stone pipes beginning from the early times of Imperial Rome (Vitruvius (8.6.1–11)). The nuances put aside, tunneling in the Roman world was very similar to the *qanat* technology applied in many Near Eastern cities. Indeed, the tunnels of the Classical world offer semblance to *qanats* (quasi-*qanats*) in respect of similar construction techniques with air (inspection) shafts dug over the hill-tops with connected bottoms which prevented detours when the hills could not be skirted. Water tunnels (*sinnor*) were built on rocky hill-tops to supply water from the springs in the ancient cities of Palestine and Syria (Forbes 1993: 155, 158). Water was brought to certain cisterns and then fetched through different pipes to separate places in Arabia as early as Herodotus. Pipes made of baked

clay were advantageous solutions for repair in case any damage, breakdown or fault occurred while these were healthier means of water conduct at the same time (Vitruvius (8.6.1, 10)).

Hearing from the scholars and ancient writers, utilization, discharge and recycling of water all need to be considered within the criteria to be set forth for the settlement strategies at the same time. Anyhow, the issue of water management finds explanation both in the public and private context as it must have been a technical and economic burden at all times. Under the purposes of this paper, Vitruvian instructions on the methods of water transportation to urban areas are quite inspiring. As he conveys, two types of waterlines with which water was conducted via gravity were the open and closed lines. The Romans frequently referred to the former one, namely the *substructio*, which was often made of stone containing plaster or cement inside while the latter took the form of a circular water-resistant pipe, generally made of metal or baked clay. A disadvantage of an open waterline was the absolute necessity to keep the slope of the canal constant when the area was undulated. The construction of a distribution tank with three compartments through which the pipes could collect and then fetch water to different segments (mainly the fountains, basins, baths and houses) of a city takes us to a relational context: the water and socio-economic status of people are often inseparable. Strict water management policies in the Classical world essentially aimed at different interest groups in the society, for example when the houses could only use water from each of three pipes, tax dependent contractors could be continuously supported and public baths be visited frequently to yield annual incomes to the administration (8.6.1–2). Landels (1996: 54) assumes, nothing is inferable pertaining to the taps used in private dwellings. For Stambaugh (1988), the usage of tap water was dependent on the well-being of the inhabitants beginning from the second century BC. People tapped their dwellings to public fountains by paying a certain amount while the less rich could also supply water by hiring contractors for private delivery (131). Parallel to this matter, as Alston (2001) concedes, financial contributions both made by the higher officials and the rich (in return for using water within their dwellings) must have attributed significant roles to the major fountains. In the Romano-Egyptian cities, potable water was critical to the planning of districts

that were originally created by zoning the shared spaces according to water supply. Equally noteworthy was the usage of shared courtyards and narrow alleys which often make it difficult to separate the public and private space. People living in the districts of Alexandria shared facilities in the first century A.D under the Roman rule. It was only during the early Byzantine era that the individual units were enlarged by intervening public spaces, mostly the streets, whereby such instances basically come from the Egyptian cities. However, there is evidence that the late Roman cities in the Near East could have had clear gated neighborhoods with comparatively precise outlooks (165, 175–177).

When aqueducts could not be constructed or meet the water requirements all the time, wells could be dug or cisterns were built if the ground was too hard and natural channelways lay very deep. They were used for collecting water from the roofs or higher platforms (Vitruvius (8.6.12,14)). The usage of masonry cisterns of considerable size was widespread in the Assyrian “cities”. They were fresh water suppliers, occasionally sunk into rocky platforms in bottle shapes, to prevent pollution. The Romans inherited similar designs which could be reached by stairs in some Mesopotamian cities (Forbes 1993 (2): 152). That the Romans were so expert in placing cisterns within the dwellings, might be a plausible answer to why cisterns were so available in a Roman house (Stambaugh 1988: 162). Down to the Medieval Age, we are also informed of the vitality of water features as well as the techniques of construction. For Palladius, the major criterion was the availability of the landscape but also to construct elongated, covered and concrete-walled cisterns in the absence of a water source. The houses were to be built on high lands in order to have access to non-polluted quality water (1.17).

Roman periods shed light on our knowledge with many sophisticated samples of hydro-structures when pure water was obtained far beyond the boundaries, but a reality comes that the city elements inherited from the Greeks continued in the post-Roman era in different contexts. Unsurprisingly, we have, in the Hellenistic period, the occasional usage of siphons crossing sharp valleys, e.g. in Pergamon (Forbes 1993 (2): 168–171). There is evidence for the inheritance of old Greeks aqueducts constructed in e.g. Sardis, Nysa, Ephesus, Pergamon, Smyrna and Miletus. Notable advances in water management took place in many

medieval towns because some could keep the old Roman aqueducts more or less in repair while the others occasionally built primitive types, the so-called “leats” that transported water from springs via open canals (*Ibid.* 179, 181). Mundy and Riesenber (1958) refer to a crucial medieval advance which was the development of transportation by roads and rivers in the continental areas excluding some important regions such as the Tigris, Euphrates and the Nile where very ancient societies were already using similar methods. The Medieval people were fond of developing their common spaces by building bridges and public baths, as well. Similar to the Romans, penalties were imposed in case of neglect (35, 40–41), which finds links with the social aspects, anyway. But more than that, it is to be normally expected that many medieval towns inherited the readily available water structures and imported technical knowledge from the precedents. Hence, the practice of using pre-designed water features is our first standing point for the re-usage of older water works in Asia Minor cities.

Although a link to the *nymphae* is hardly possible with available data of the Upper city at hand, we can only leave a mark pertaining to their importance and popularity during the Roman Empire. However, what would make sense from our point of view would be, as Uğurlu (2009) pinpoints, the familiarity of the urban areas with *nymphae*: These “passage architectures” were the public fountains that served for the public amenity, facilitated the perception and visibility of the urban landscape with the armatures while they also helped the compartmentalization of land into meaningful wholes.

The Romans arrived at Asia Minor around ca. 191 B.C. The establishment and culmination of the Roman cities in this part of the world go back to the second and first centuries B.C. If the beginning of the water system at the Upper city has to do with the Roman era, the reasonable period when the Romans could have launched such a system must be after the mid-first century. We may further opt to refer to some famous Roman cities in Anatolia and practices in Mesopotamia, which may contribute to the foreground. The differences between the water features of Hasankeyf and pre-Roman-Roman cities are not assessed in this paper. Rather, the similarities are sought in order to base the Upper city specific discussions on already proven cases, without being stuck with the Roman era, either.

The canal extensions of the Upper city were dependent on the gravity flow across the scarp, reminding the placement of canals in Ephesus. Likewise, pressuring could have been achieved at different rates through the individual pipe lines or via canal extensions. As evidence shows, siphons were constructed on steep valleys (Ortloff and Kassinos 2003) whereby Aspendos is one good example (419). The siphon of Hasankeyf exhibits more or less a similar design although the depth values do not necessarily have to be identical everywhere as the environment can be a basic constraint to the urban works. The aqueducts (in the old Attalid capital) of Pergamon were constructed between a main water source and a pool with open canals (Landels 1996: 48–50) and that water requirements increased in the Roman period (Radt 2001: 152–155). The terra-cotta remains tracked on earth-fills between the main open canals (which are out of the borders of the Upper city and the Pool), bear semblance to an aqueduct technique (applied in Pergamon) for easy conduct of water. At this point, additional branches to increase the passage of water by aqueducts on low elevation grounds in the Roman era (Evans 1997: 71) push us to question the reasons behind the construction of discrete walls running towards the SW canal extension at the Upper city. Although it may seem possible that the walls are late, the logic could have prevailed in many periods. Briefly, they could have been the latest expressions of water raising techniques. Situated at the hilltop with no permanent water (Radt 2001: 145–147), the upper city of Pergamon could have been the initial place for preliminary water collection in the Hellenistic period. Hence, the dwellings built on higher elevations could have been the original districts for cistern usage before the city was physically extended outwards. Forbes' (1993 (2)) stress on the importation of Assyrian cisterns which were embedded into rocky platforms and reached with the help of stairs by the Romans in Mesopotamia (152) bears hints for the cistern specific side of this study to an extent. On the contrary, deep wells of Pergamon (Radt 2001: 145–147) which were placed at lower elevations of the city may only remind us of the poor number of well-like features at the Upper city while the main discussions need to be based on the placement of wells at the Lower city of Hasankeyf due to easy access to underground water where the water table let it so.

Small pools to collect and discharge water in Side (Mansel 1978: 79–108) recall the small pool in D78 unit (the only recorded evidence). A pitfall to this analogy is the poor number of cisterns in Side vis-à-vis the Upper city. The placement of cisterns at the *Acropolis* of Perge (Büyükyıldırım 1994: 123–124) suggests that potable water could have been used by the dwellings at higher elevations. Increases in the requirement for water could have led to alternative methods of transportation with the help of canals, if there were any. Open in-city canals (*Ibid.* 148–151) which distributed water from higher elevations in Perge flash back to similar type canals of the Upper city. The inferior pipes embedded in concrete in the (Hellenistic and) Roman city of Zeugma (basically known to the Assyrians) in Upper Mesopotamia (Comfort 1997) forces us to establish some convincing links with the small canal remains of the Upper city. Although double (stone) lines of piping in the Psidian Antioch were designed in the opposite directions, the smaller pipes to feed the workshops near Platea Tiberia hallmark the importance of water supply to strategically important districts (Owens 2000: 317–318) whereby particularly the SE and NW sections of the Upper city might be the comparative side. The cities of the Near East were often supplied with water from the surrounding rivers or wells in Mesopotamian (White 1984) but the cities of Jordan, Syria and Asia Minor which were situated up on the hills or inland often supplied their water from the springs in the valleys. The vital sources, by this way, were protected with the help of water tunnels accessible from defensive perimeters at war times. The mountainous regions like Iran or the highlands of Upper Mesopotamia used advanced means of water transport in the form of long distance subterranean *qanats*, and distributed it to densely populated areas. Whatever the sources were, they had to be kept from contamination (158, 168). Cisterns were the basic practical collectors, especially in the arid regions/cities where the division of water had to be realized in the best possible solutions. Originally rock-cut and plastered cisterns (as an expression of environmental adaptation) in Capitoliás, Jordan (Lenzen 1996: 13–15); the abundance of smaller volume cisterns which were supplied with water via small canal extensions in the residential areas of Jordan deserts (Nydahl 2002: 19–26) and, particularly the Edomite type rock-cut bottle-shape profiles imported by the

Nabataeans (*Ibid.*33); and the open canals running at different elevations in the ancient Nabataean city of Petra (Ortloff 2005) pinpoint some common grounds with which we may see minimum correspondence in the study area. The Mesopotamian cities, perhaps, best reveal the extensive usage of cisterns beginning from the Hellenistic–Roman era until the Medieval period. Hence, we have good reasons which increase the possibility that the Upper city might have been part of, at least a Roman line/network within the geographical context.

Concluding remarks

The ancient sophisticated water system is a backbone in the civic design of the Upper city of Hasankeyf. The current silhouette of the system which has vanished to a great extent but is quite rich with cisterns, presents semblance, in design and technique, to those of the Roman practices. A general theory in archaeological thought goes that the public space reveal much of the history of settlement since they often mirror the common behavior of ancient societies. Though it may seem as a reality, the scholarly world is in a trend to further center the discussions in the private habitats. Below are the amalgamated results (from 2005 field study) which benefit from the visible water installations/elements of the Upper city, which are deemed inseparable from the rock-cut dwellings while the assumptions on the semblance of the current pattern of the water works to that of the Roman fashion in certain respects inevitably push the gravity center of ideas toward a preliminary Roman design. Hence, a re-designation of the water system by the late comers could have come along with altered habits of importation. Nevertheless, we consequently remain unbiased for the said era as a *terminus post quem*.

There were three types of water distribution features at the Upper City, mainly identifiable with the canal extensions, small canal remains and cisterns. Although these, especially the canals, could not be thoroughly traced in every part of the city, discrete and complete evidence act as significant indicators to come up with a set of ideas, leaving the assignment of a precise date out of debate. Located far beyond the settlement borders, the Pool was the key to the functioning of these structures, having the burden of collecting and distributing water to the dwelling

quarters. Unfortunately, we have no visible evidence about a subterranean canal to conduct the first clean waters to the canal extensions. The construction of conical, small and individual cisterns was a widely applied practice. The canal extensions could have acted as pipe-lines- recalling the *substructio* (and regulating flow rates and enabling segmentation) while the cisterns, although no *nymphaeum* found, could have substituted the regular fountain concept. The positioning of the water features and designation of canal extensions was highly dependent on the topography. They were built according to easy flow of water along the edges of the natural scarp. However, the placement of certain cisterns also exhibit that there may have been strong links with other possible canal extensions which have now eroded.

It appears that the smaller canals, being the first-tier water conductors near the scarp, fetched water from the canal extensions and distributed it to the dwellings. Some cisterns whose sizes are remarkably large are supposed to have been the direct users of water, as storage locations. Hence, they could have been used as secondary distribution features. Also, the inner areas which are compatible enough with the topography must have possessed cisterns in which case these are attributable to the secondary distribution network, particularly in the E of the city where evidence is convincing. Returning to the first remark, the secondary features are often positioned within or occasionally out of the borders of dwellings near the scarp. Presumably, they replaced the function of third level features—namely the final collectors, to store steady water depending on the daily needs or seasonal changes. However, contextual evidence is weak and we can barely assert that all of the third level features are datable to similar or approximate periods.

The pipe-line system or any extension recalls the Roman practice but, as far the public areas are subject to discussion, the dilemma of “period” reemerges. When the sustainability of public space is given the priority, a possible *substructio*, if served the late public area, might also be a late design. However, it remains uncertain (whether a piping system fetched water to the public places on the same strict lines) due to the discreteness of canal extensions. Regardless of the exact dates unknown for the emergence, development or disuse of the water system at once and despite lack of quantifiable evidence for gutter-like remains, the Upper city unveils a discharge system, basically

designed parallel to the road system. Although unexcavated, the city possibly had a drainage system at least to cope with the problems of water run-off and send the contaminated waters away from the urban areas via the canal extensions. What is almost evident is that the canal extensions originating from the Pool followed the route at the same elevation which was 593 m. Since they had to make their course gradually from higher to lower elevations, cisterns above the optimum elevation value (≥ 591 m) probably did not directly benefit from the canal extensions unless there was a subterranean structure. Relatively less number of cisterns within the dwellings above 591 m (throughout the central and southern interior sectors) point to a possibility of now absent canal extensions which might have reached the undefined parts of the city. These may have travelled individually, along the strategic locations lying over the most suitable topographies, or with the assisting canal remains. They could well have made their course from the scarp areas. The cisterns lying on the roads and/or near the scarp display the facilitation and practicality of access to water resources.

The sub-districts were also designed considering easy access to running water. The same rationale has validity for the cisterns built according to the *loci* of the dwellings. The direction of the canal tracks on the openings of cisterns is toward the nearest canal extensions and mostly the entrances of dwellings. Presumably, these cisterns were placed to attain the maximum shortcut to water in terms of space usage. As the land seems to be divided into meaningful *insulae*, the functional division of arterial roads comes accordingly. Roads also display the facilitation of access to water resources, complementing the urban silhouette (their roles are best observed in the sub-districts nearby the scarp). The integrity of the sub-districts and water features prove a clear relationship although it seems quite possible that additions were made over time. Hence, we may speak of the effective use of the terrain which exhibits a full integrity of the city elements in different periods.

Based on the frequency results, the concentration of cisterns shows that the E and S of the city were preferable to have easy access to water from the canal extensions. The dwellings nearby these extensions were designed to be affiliated with more cisterns. To the contrary, the dwellings with larger volume cisterns in the W could have been built for maximizing water,

thus supplying it to the proximity areas from the eastern canal extensions with stable means (Doyuran et al. 2001: 847–853). The quarters hereabouts could have been the target area toward which late movements could have taken place. Even if occupied with inhabitants in the same period (when the dwellings were also absent in the districts where the frequency of cisterns was higher), the abundance of cisterns may be attributed to the difficulties of water transportation with canal extensions in the SW and E sectors. Brief to say, the genesis and maintenance of the water distribution system must have had strong links with the urban design.

Many cisterns are located within the courtyards, possibly to leave more space for daily activities. A tendency to place as many cisterns in the private space points to the making of the most efficient use of terrain. Such attempts could have been triggered due to security concerns arising from scarce supply of water in semi-arid climatic conditions. On the other hand, we can strongly suggest that the majority of converted cisterns recorded inside the dwellings could have belonged to the neighboring units due to shifts in the function and usage of dwellings in later periods.

Cisterns, in general, were the final collectors of water, often located on flatter courtyards. There seem exceptions for some of those, being the second level features, regardless of size and proximity to a scarp area, (e.g. an interior area in sector A enjoys an advantageous position with respect to its proximity to a canal extension). The abundance of cisterns expresses the extensive usage of steady water, almost all over the city, for washing, cleaning and irrigation. Inspired from the Roman and Medieval practices, small canals might yet be the indicators of means for water runoff, in order to fill the open cisterns to be used for the livestock. They could otherwise be identified as rain water collectors. That the Upper city abounds in quite number of conical and pear-shape cisterns inevitably makes a flash back to the Mesopotamian practices datable to the pre-Roman and Roman era and calls for hygienic purposes in an area interrupted with topographical constraints and scarce resources.

Turning back to the issue of conversion, more than half of the cisterns were subjected to such treatment at the Upper city. Various assumptions are likely, e.g. White (1984: 168) connects the widespread use of cisterns to demographic increases. Although it contains a core of truth, a re-designation could have been a

consequence of altered water management policies; might have come from the necessity to adapt to changes brought by the natural factors or could have arisen from the permanent habits of the newcomers whether this be attributed to the post-Roman periods or the use of recent dwellings until 1960s. Evidence pertaining to the cisterns of some cities in the Near East contributes to one assumption that the original cisterns of the Upper city could have been superseded by the late ones which are now large in size and mainly found in the interior parts of the city. Since available information comes from a very limited chronological span and area, urgent dating studies need to be carried out to eliminate such drawbacks. Evidence and literature light the way for the water works even though a settlement cannot be completely attributable to a certain period, on a single case. Acknowledged as a Medieval town, the Upper city of Hasankeyf deciphers, partially, the characteristics of a Roman type water distribution system and the way of management. To be on the safe side, we need to refrain from sharp inferences and a strict chronological assignment as the layouts of many settlements find plentiful explanations in the political, economic and cultural context.

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