Water shapes
Strategie di valorizzazione
del patrimonio culturale legato all'acqua

PALOMBI EDITORI
Il volume è pubblicato nell’ambito del progetto Water shapes. Meanings, uses and the architectural works of the most precious gift, coordinato dal Consiglio Nazionale delle Ricerche - Istituto per la Conservazione e la Valorizzazione dei Beni Culturali di Roma e finanziato con il supporto della Commissione Europea.

Gli autori sono i soli responsabili di questa pubblicazione e la Commissione declina ogni responsabilità sull’uso che potrà essere fatto delle informazioni in essa contenute.

© 2012
Tutti i diritti spettano a
Palombi & Partner Srl
via Gregorio VII, 224
00165 Roma
www.palombieditori.it

Progettazione, realizzazione grafica e assistenza redazionale a cura della Casa Editrice

Nessuna parte di questa pubblicazione può essere memorizzata, fotografata o comunque riprodotta senza le dovute autorizzazioni.

Indice

Il progetto europeo Water shapes.
Strategie di valorizzazione del patrimonio culturale legato all’acqua
Helene Porfiryou

Catalogazione, Divulgazione, Fruizione: le tecnologie di supporto
Alessandro Dei, Lisa Tavarnesi

PARTE PRIMA. Acqua, forme dell’abitato ed emergenze monumentalì
ACEA e la valorizzazione del territorio, dei beni architettonici, archeologici ed ambientali legati all’acqua
Giorgio Martino

Aqua Urbis Romae: the Waters of the City of Rome
Katherine Wentworth Rinne

Roma Caput Aquae: un rapporto di lunga durata tra la città e il territorio
Laura Genovese

The water in the city of Braga from Roman Times to the Modern Age
Manuela Martins, José Meireles, Maria do Carmo Ribeiro, Fernanda Magalhães, Cristina Braga

PARTE SECONDA. Acque e forme di comunicazione

The Grand Canal - Qingkou Complex Case Study on its Engineering Heritages
Bing Yu, Tinghao Zhang, Jianming Qin

Toulouse e i suoi corsi d’acqua, una costruzione urbana
François Blanc, Christian Davies

I canali di Toulouse, dialogo tra una città e i suoi corsi d’acqua
Samuel Vannier

Integrated approaches to the archaeology of Portus
Simon Keay, Roberta Cascino, Stephen Kay

PARTE TERTIA. Acqua e forme di produzione
Il lago di Bolsena, il Sistema museale e la Toscana
Pietro Tamburini

L’acqua, il sistema produttivo e le trasformazioni del paesaggio intorno al lago di Bolsena
Pierluigi Giacchetti, Emanuela Todini

The HYDRIA Project. A website on the collection, storage & distribution of water in antiquity that highlights links between ancient wisdom and modern needs
Iro Alampe

PARTE QUARTA. Sistemi idraulici in aree sacre
Acque mitiche, acque sacre e acque curative nell’antichità greco-latina.
Una introduzione
Joaquín Ruiz de Arbulu

L’acqua in età antica nel nord-est ispanico. Dal sacro all’ordinario
José Alejandro Beltrán-Caballero, Ricardo Mar Medina

Ana Costa, Jose Maria Nolla, Luis Palahi e David Vivó

The world reflected in the water. The eighteenth-century hydraulic system of the São Martinho de Tibães Monastery, Braga
Luis Pontes

Antica rete idrologica di Petra. Studio e restauro nell’ottica della conservazione dei Beni Culturali
Andrea Angelini, Roberto Gabrielli, Roberto Franchi

ABSTRACTS

151
173
189
201
215
231
247
272
The water in the city of Braga from Roman Times to the Modern Age

Manuela Martins, José Meireles, Maria do Carmo Ribeiro, Fernanda Magalhães, Cristina Braga
(Universidade do Minho - PT)
mmmartins@uaum.uminho.pt

Introduction

The ever-growing concerns with water are on the global, regional and national agendas. There has been a significant effort to find solutions that address the threats faced by this critical resource to life, while, at the same time, we witness a generalization of the debate of how to fight the lack of water in several world regions. Whereas a rehabilitation of traditional practices focused on efficient water usage worldwide is occurring, a growth in projects and actions designed to value the water heritage are underway and focused on developing a wider civic awareness based on the need to preserve this key resource.

The Project Water shapes had its origin in the concerns affecting the euro-Mediterranean countries with regards to water. With the main goal of studying, conserving and valuing both the tangible and intangible water heritage, this project aimed to underline water as a cultural value and highlight the multiplicity of expressions associated with it, specifically in Southern European countries. Each participating partner sought to provide a group of contributions related with water cultural and material expressions in their countries selected from a wide chronological scope ranging from Antiquity to the Pre-Industrial Era.

As project partner we have selected as our case study the city of Braga and its surrounding area with the aim to increase the knowledge and appreciation of the water urban heritage. Some of this heritage has been recovered by archaeology while other was obtained using written, iconographic and cartographic documents, which we have analysed in order to understand water supply, management and use in its urban context.
Aims, methodology and results

Among the wide and diverse water heritage present in Braga region we have focused our attention in the ones represented or linked with the city and its surrounding area. In fact, the city presents itself as a privileged background that enables a coherent assessment of the different ways water has been managed and used throughout times. As a millennial city established by the Emperor Augusto between 16 and 15 BC under the name Bracara Augusta, Braga offers a rather rare opportunity to travel back in time allowing us to understand the way the continuous urban centres developed a sustainable interaction with water.

Our work focused on two different but complimentary goals. The first one was concerned with the topographic and geo-hydrological framing of the city and the respective surrounding region in order to assess the potential water resources that could have been explored throughout times. A second goal encompassed an heritage preliminary inventory associated with water, which could be recognized as our intervention key objective. This assessment contributed towards the knowledge about the consecutive hydraulic systems implemented in the city between the 1st and the 18th centuries.

Archaeological remains recovered in excavations performed throughout the past 35 years were used to identify water use material expressions. Some of them stand as indicators of the ritual and religious use of water at the time preceding the establishment of the Roman city. However the large majority of data is linked with the occupation of Bracara Augusta, between the 1st and 4th centuries AD, most of them referring to large infrastructures that captured, stored, distributed, managed and drained water.

The understanding of the medieval city hydraulic system led us towards written and iconographic sources, understood as the best way to identify the water supply and distribution within the urban centre. Nevertheless, the limited time to execute this project made it impossible to carry out a systematic research of the extensive and rich written medieval documents, which still needs a thorough future assessment. In fact, we limited ourselves to documentation already transcribed and to references present in works focused on the medieval city. It was possible to establish a reasonable interpretation related with the water supply systems, which was mainly provided by wells and other capture conduits channelling water from outside the city.

The analysis of the modern city hydraulic systems used available written and iconographic documents, while, at the same time, took into considera-

tion the surviving infrastructures that enabled us to understand both the water capture within and outside the city and its subsequent distribution network. The written documents focused on water are significantly improved from the 16th century onwards, with particular emphasis towards documents from the 18th century that had to be selected as their diversity required deep analysis not compatible with the project's timeframe.

We tried to list and map all the material preserved evidences linked with both the distribution of drinkable water within the city and the existing supply structures dating back to the 16th, 17th and 18th centuries. In terms of their diversity, but also with regards to their key role as water suppliers and social sites, we underline the fountains, some of them still preserved throughout the city. However, the most important water supply infrastructure is the hydraulic system of Sete Fontes¹, finished in mid 18th century and performing an outstanding engineering project.

Our main goals as project partners was to assess the available water resources used to supply the city and to fully understand the hydraulic systems that ensured the capture, managing, distribution and use of water in Braga between the Roman Era and Modern Times. Both the goals were considered to be a valid way to properly acknowledge the studied water artefacts, since they could correctly be framed within their respective frameworks.

The main results of the project will be summarized on this essay and will be made available in a book thought to perform a guide for the water heritage of the city of Braga.

Water resources of Braga

The city of Braga is located on a flattened hill with 199 meters high. This hill is the last elevation of a succession of secondary relieves that start in Serra do Carvalho (479 meters) and gradually diminishes their altitude towards the west. Such relieves are represented by the northern foothills of that particular mountain, which dominates the Este river valley on the northern side, and they help to establish the dividing line that signals the physical boundary between the Cavado and Ave rivers' basins. Both these rivers perform the two most important watercourses in southern Minho.

Braga occupies a rather privileged topographic location distinguished on its northern side by the wide Cavado river valley, whose lowlands almost reach the city, while on its southern side runs the Este river and its affluent, the Ribeira
da Veiga. This southern area features rather distinctive relieves and is represented by the highest peaks of Sameiro, Monte Frio and Santa Marta (Falperra).

From a geological point of view both the urban and peri-urban space lay on the top of hircline granitic rocks, the so-called Braga granite. On the northeast side these crystalline terrains are joined by a group of meta-sedimentary formations dating back to the Palaeozoic Age, in which another granitoid rock, this time called Sameiro granite fits in. Furthermore, this eastern city sector corresponds to an area delimited by plentiful lithological contacts, to which a rather wide fraction running NNW–SSE, ENE–WSW and NW–SE is associated. The latter direction represents an important structural decline that is part of the Vigo–Regua shear fracture.

In terms of its hydro-climatic record, the region of Braga registers a high annual rainfall of around 1515 millimetres, with average levels of evapotranspiration rounding 511 millimetres per year. However, a large part of that rainfall water is lost on the superficial drainage, being the percentage of retained water of around 1,3%.

Adding to this, the granites from the Braga region generally present an average to low or extremely low permeability (0,3 1/s), events only different in the areas where an intense substrate fraction and alteration of it or several lithological connections are registered. Within this context it is possible to observe productivities of around 2 to 3 1/s Km².

As previously referred, these are the exact circumstances taking place within the region located on the northeast side of the city, which reveals itself as an area registering several lithological contacts, ranging from meta-sedimentary formations to seared granite rocks with a high level of substrate fracturing. When that happens within granitic terrains an important alteration mantle is revealed. Under these circumstances, the hydro geological features of this region present themselves as highly favourable to both water infiltration and aquifer feeding. The latter were formed on the top of hard rock’s prompting the formation of natural water springs.

Moreover, we can identify on the northeast region of Braga the existence of the meta-sedimentary basin of Sete Fontes, located at around 5 kilometres from the city. This basin is surrounded by a group of small relieves, from which we emphasize the hills of Pedroso (339 meters), Montariol (309 meters), Gualtar (313 meters), Sete Fontes (303 meters) and Quinta do Amorim (288 meters). We know that water capture would happen at these hills, most likely directly from the aquifers, which fed and still feed the Sete Fontes aqueduct. This aqueduct was responsible for supplying water to Braga until 1929, remaining even today partially functional.

The abundance of water resources at the Sete Fontes region is the result of a series of events, such as the area high degree of rainfall, the local substrate fraction, the terrain alteration and also the site affluence of lithological con-
tacts, which control the feeding and refilling of the aquifers. Adding to the
topography assessment of the surrounding region, which presents itself
as favourable to aquifers exploration, its high location when comparing to
the city makes the use of gravity possible in the flow of water.

Considering Braga’s surrounding area topography with particular empha-
sis towards the Sete Fontes hydro geological basin features, we think that this
is the area presenting the best conditions to supply water to Braga through-
out the different periods of the city’s occupation. In fact, the importance of
the site as a water capture area is well documented from late 15th century on-
wards. Adding to this, we deem as probable that the Roman city also used
this particular region as its prime water collection area.

Hydraulic systems and water heritage

A. Pre Roman Era

Our journey throughout the water heritage of Braga starts in the Proto-
history. There are two sites in the urban area that document well the rela-
tionship between the pre-Roman communities with water: the indigenous baths
of the railway station and the Idolo sanctuary/fountain, known for its Ro-
man features.

Although there aren’t any archaeological remains supporting the idea that
Braga witnessed a permanent proto-historic occupation that preceded the es-
ablishment of the Roman city, the two referred monuments show the reli-
gious use of the area. Such use suggest that the small hill where the city was
later established was strategically important in regional terms to the pre-Ro-
man communities settled in the hill forts in the area. These communities are
known as the Bracara.

The indigenous baths building was identified in 2003, during preventive
excavations within the city railways station refurbishment project. Despite
the fact the monument was found partly destroyed it was possible to identify
architectonic remains that allowed a subsequent partial reconstruction.
The remains comprised an oven that was not conserved, a steam chamber and an
antechamber with side benches and seats accessed through a paved courtyard.
The latter performed the only open space within the building, while the oth-
er ones were buried. This is a monument similar to many others present in
the hill forts of the region and its primary function was to provide both cold
water and steam baths. This indigenous type of baths, referred by Strabo (III,
to be used, it is possible that other aqueducts would exist. In fact, we should mention the remains of an subterranean aqueduct identified in 2005, located in the Gualtar and presenting 91.5 meters length. Based on the preserved Roman remains we know that the underground water resources within the city terrain were equally explored through wells (pustei). With masonry granite walls, they all have 0.90 meters of inner diameter, variable depths and were dominant in houses and at craftsman shops. It is safe to assume that wells could have ensured water supply on a first occupational stage of the city, similarly to what happened in other Roman cities, namely Lugo. Nevertheless, the growth of the urban centre between the Flavian and Antonine periods demanded more complex water supplying techniques. This evolution is well documented at the Carvalheiras quarter, which was firstly occupied by a domus with both an atrium and a peristyle, where a well is located. In mid 2nd century a public baths building (balneum) was constructed on the northern side of the house and the need for water increased significantly. It was then channelled through lead pipes (fistulæ) identified at the excavations.

One tangible evidence associated with the existence of an aqueduct is an underground structure with an N/S orientation, measuring around 60 meters and believed to have supplied the public baths of Alto da Cividade, constructed at the beginning of the 2nd century nearby the theatre. Taking this structure into consideration, we believe that it represents a derivation of another one, which would have crossed the city with an E/W orientation.

We don't have evidences of cisterns but we have recognized the existence of tanks that gathered rainwater integrated within the open areas of the city domus, located either in the atrium (impluvium), or in the peristyles. Similarly to other Roman cities within the Empire, Bracara Augusta must have had fountains and turridores to ensure the public water supply. However, we only know of the existence of one public fountain integrated within the northern façade of a public building, dating back to the 1st century.

The roman hydraulic system integrated drainage conduits and sewages that ensured the elimination of the dark waters (aqua caducae) and were normally organised around a complex and hierarchic network. They represented technical solutions towards communities' healthiness and wellbeing (salubritas civitatum). In Bracara Augusta there are numerous draining conduits for rainwater collection and for the drainage of water coming from inside houses and other buildings. We also know of the existence of a big sewer settled under the northern part of cardus maximus. It is a large collector measuring around 1,60 meters high and with an extension of around 50 meters.

However, it must have had over 200 meters and ensured that dark water and other residues would be drained outside the urban area.

Bracara Augusta had several baths that document the social and playful use of water within the Roman city. The best-known example is located at Alto da Cividade and was constructed in the early 2nd century. It displays all the common features of these types of buildings, such as wide glass windows facing the sunset and a wide panoramic palaestra. Similarly to other Roman thermal buildings, they were subjected to several reforms until its abandonment at the end of the 4th century.

Representing well the urbanitas and romanitas principles, the public baths witnessed the relationship between the city's inhabitants and water, always present in swimming pools and alvei that integrated the bathing spaces. They also allowed the interaction of their users with gardening areas with water tanks, generally present at the palaestra area, which created fresh and sophisticated environments.
The second most important public baths known in Braga is located within the Carvalheiras quarter and was constructed in mid 2nd century over the northern part of a previous domus. The peristyle was transformed into a palaestra and the surrounding rooms became shops (tabernae)\(^2\).

The social and sacred use of water can also be witnessed at the Ídolo sanctuary/fountain dedicated to the indigenous goddess Namia. Located in a peripheral area of the Roman town this sanctuary undergone a transformation and was converted into a Roman monument. Its vertical façade holds sculptures and inscriptions and it is believed it was surrounded by a masonry wall\(^2\). In Flavian times the sanctuary was refurbished and a small tank must have been constructed opposite the façade.

C. Medieval town

The assessment of the medieval city hydraulic system faces several problems resulting from the disappearance of the material elements associated with water, the lower amount of archaeological data available and the insufficient analysis of written documents. Thus, the larger part of data regarding the using and managing of water within medieval Braga is still to be assessed, with 16th century sources making further suggestions.

Several researchers believe that technological Roman systems for water collection and management carried on being used throughout the Middle Ages, despite the changes occurred with the urban populations' traditions with respect to its use. In fact, the need for water visibly decline from the 5th century onwards when Roman equipment and spaces that were highly water demanding, such as baths, playful infrastructures and gardening sites disappeared. We know that in Braga public baths were abandoned in the 5th century, at a time when other buildings and public spaces were no longer in use. It is not hard to imagine this would perform a disinvestment towards water supply and draining systems. Thus, the increasing austerity of social and cultural Christian customs, the new political framework and the urban population retraction contributed to smaller water consumption within medieval cities. These events significantly impacted in the maintenance of the previous hydraulic systems. Nevertheless, it is very difficult to assess both the damage to Roman aqueducts between the 5th and 8th centuries and the eventual development of lesser complex water supply structures in the same period\(^2\).

From the 11th century onwards more complex hydraulic systems were developed throughout Europe. These events are intrinsically linked with the construction of monasteries and palaces and are associated with the expansion of urban sites that also represented a significant and increasing growth in fresh water supplying. These circumstances placed the need for new hydraulic systems and water management processes to become a dominant concern of urban landlords.

We understand well the general worries related with the water supply of medieval Braga for the period between 1428 and 1433 due to the available written sources. Data revealed that the water gathered from wells was not suf-
sufficient to satisfy the population needs, so water had to be collected from the surrounding area and conducted to the city.\textsuperscript{25} References to water captures in the surroundings (\textit{5 km}) seem to indicate that the Sete Fontes area was used again to ensure the water supply of Braga. We believe that the Roman water supply system could have been partially rebuilt at this time and integrated within the medieval hydraulic system during the 14th and 15th centuries. This system was composed by pipes which conduct water to the city and by other distribution structures channelling water to fountains, tanks and watering troughs providing water to both human and animal consumption.\textsuperscript{26}

There is few known material evidence related with the management and use of water in medieval Braga, although the names of some fountains renewed or rebuilt in the 16th century are known\textsuperscript{27}. Moreover, medieval evidence equally referred to water capture through wells existing inside houses and backyards. This type of equipment was substantially increased throughout the 15th century. None of the referred infrastructures associated with the medieval hydraulic system subsisted. They are only present in written documentation enabling us to pinpoint them in the city map.

\textbf{D. Modern town}

The beginning of the 16th century witnessed a new stage of urban development associated with the archbishop D. Diogo de Sousa (1509-1534), who significantly improved Braga's hydraulic water system. The archbishops' action can be understood as an answer to the rising needs that came with the demographic and economic growth of the city. These were times demanding improved distribution and draining structures, as well as a new public fountains network.

The city water supply system throughout the 16th century could not have been very different from the one existing in the end of the Middle Ages, when the collection of water destined for public fountains and tanks come most probably from Sete Fontes area, with the remaining water being captured using wells.

At the end of the 16th century the city was again substantially enhanced in its water distribution network with the construction of new public fountains, some of which are believed to be the work of the archbishop D. Frei Agostinho de Jesus (1588-1609). The number of fountains and waterworks established throughout the 16th century demanded a supply system from outside the city, and these circumstances likely required a re-thinking about how to further improve the public water supply and distribution network.

From the 17th century onwards the written sources gave notice to the purchase of lands and the construction of conducts located around the Sete Fontes, Passos, Areal and Montariol areas.\textsuperscript{28} The archbishops, as city's landlords, were fully involved in the creation of a more efficient water supply system, as it happened with D. Rodrigo de Moura Téles (1704-1728). In his mandate the water collection was diversified, seepage tunnels and dipping places were built and the water from Sete Fontes was channeled through an underground aqueduct towards the 'Casa da Água' (House of Water) constructed in Eirado and located at the city entrance. These works were carried out between 1707 and 1727 and they perform the base of what is today known as Sete Fontes hydraulic system.

This system is thoroughly described in the \textit{Livro da Cidade} (City Book), dating back to 1737\textsuperscript{29} and registering the water urban distribution network through five main pipes. These pipes conducted the water to convents, fountains and dipping places, some of which made its redistribution to other fountains, buildings and even private houses. The same written source also referred 38 fountains as constituting the majority of the city public water dis-
Fig. 8 – Chapels of “Sete Fontes” aqueduct, dated from Braga, 2011, UAUM archive.

Distribution network. We also know that wells have continued to be an important source of water supply during the 18th century.

The highlight of Braga’s hydraulic modern architectural reference is, without any doubt, the Sete Fontes aqueduct, which although is attributed to the archbishop D. José de Bragança (1741-1756) should be understood as the ultimate monumental version of an old water supply system of probable Roman origin. Although, it could have experienced periods of lesser usage, and even partial abandonment, this water supply system originating in the Sete Fontes must have been re-used and even restored at the end of the Middle Ages, becoming fully active throughout Modern Times. The fact this aqueduct is still functioning today, even though several of its head waters have been either destroyed or blocked, shows rather well the water potentialities of the area.

Conclusion

A paramount goal of our participation in this project was the assessment of the water resources used to supply Braga from Antiquity to Modern Age. Another goal was concerned with the understanding of the hydraulic systems, which ensured during the same period the water collection, managing, distribution and use, in order to properly acknowledge and enhance the material elements either recovered by archaeology or conserved throughout the city. We think that the work done is only a starting point for future research, since it re-hearsed for the first time a valuation of the long-term urban hydraulic systems. A lot of questions emerged from our approach and are demanding further research. In fact, a rigorous evaluation of the rich medieval and modern written sources is necessary for a more thorough understanding of Braga’s hydraulic systems before the 18th century. Adding to this, it is also important to make some strategic archaeological studies in the area of Sete Fontes in order to document its use both in Roman and Medieval times.

As for now, we think that the water collection from the Sete Fontes sedimentary basin performs the link joining all the different city occupation periods corroborating, at the same time, the intimate relationship of the city of Braga with the potential water resources of the surrounding region.

ENDNOTES

1 Sete Fontes (Seven Fountains) is a local place name that could have had its origin due to the water richness of the area to which it was given.
3 ibid. pp. 41-42.
4 ibid. pp. 44-45.
5 ibid. p. 46.
6 MARTINS 2011, p. 11.
7 LEMOS et al. 2005, pp. 43-46.
8 LEMOS et al. 2008, pp. 319-328.
9 SILVA-MACHADO 2007, pp. 20-60.
10 SCHUTEN 1952, pp. 210-211.
11 GARRIDO ELENA et al. 2008, p. 64.
12 MATT 2010, pp. 115-135.
13 MARTINS et al. 2011, pp. 70-71.
15 ALVAREZ ASOREY et al. 2003, pp. 20-36.
16 MARTINS et al. 2011, p. 93.
18 MAGALHÃES 2010, pp. 103-104.
20 LEMOS, LITE 2000, pp. 21.
21 MARTINS 2005, pp. 18-19.
22 MARTINS et al. 2011, p. 92.
27 COSTA 1993, Doc. 19.
28 OLIVEIRA 2001, p. 175.
29 RIBEIRO-MARTINS 2012.


