

# The Augustan aqueduct of Capua and its historical evolution

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## ABSTRACT

At his own expense Augustus built his own aqueduct, known as *Aqua Iulia*, for *Capua*, located in today's Campania region of southern Italy, which was in Roman times, one of the most important *civitas* of the empire. The course of this aqueduct and of its likely branches, destined for two small towns, *Saticula* and *Calatia*, is hypothesized, in part based on the re-use in the seventeenth century of about 8 miles (i.e. 11.8 km) of the ancient aqueduct for another water supply that served Naples, namely the Carmignano aqueduct. The subsequent transformation in the eighteenth century in a new water supply along a new route at a higher altitude is described. This third water supply served the Bourbon royal palace of Caserta, a magnificent construction built in the same period. In summary, the historical evolution of the Augustan aqueduct of *Capua* is discussed in the context of the communities served and in the context of the organization and history of the territory supplied, demonstrating the richness of information that may be obtained by an integrated study of the transformation, over time, of this important water infrastructure.

**Key words** | *Aqua Iulia*, aqueducts, *Capua*, Carmignano aqueduct, Carolino aqueduct, Roman

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## INTRODUCTION

To be eligible for the title of '*civitas*', a Roman city had to have, among other things, enough water to supply fountains, public and private baths and other necessities (Hodge 2008), such as for military purposes, as was the case of the magnificent Augustan aqueduct Serino-Misenum (De Feo & Napoli 2007). The Romans were well aware and proud of the great benefits of aqueducts. The importance of these facilities for public support was well known to the first Roman Emperor, *Gaius Octavianus Augustus*. It is no coincidence that *Vipsanius Marcus Agrippa* (Octavian's friend since childhood), the chief architect of military victories at sea as well as being his son-in-law, chose to take on the role of '*curator aquarum*', thereby emphasizing the priority attributed to this issue. In Roman times, *Capua* was one of the greatest cities in Italy and the whole empire. *Capua* had a famous school of gladiators and an amphitheatre, which was second in size only to the *Colosseum*. In one of his orations, Cicero ranked it among the three most important cities in the world, in

addition to Rome (Cicero, I century BC). In the third century, *Ausonius* ranked *Capua* eighth among the most famous cities of the empire, and third, after Rome and *Mediolanum* (Milano), among those of Italy (Ausonius, IV century AD). Therefore, *Capua* could in no way lack a water supply delivered by an aqueduct system similar to the other important cities of the Roman Empire.

The main aim of this study is to present the Augustan aqueduct of *Capua* in the context of the communities served as well as in the context of the organization and history of the territory.

## THE AQUEDUCT OF CAPUA

The construction, known as *Aqua Iulia*, was promised and then made, at his own expense, by Octavian in 36 BC, as a reward for the local population, along with the loan of the

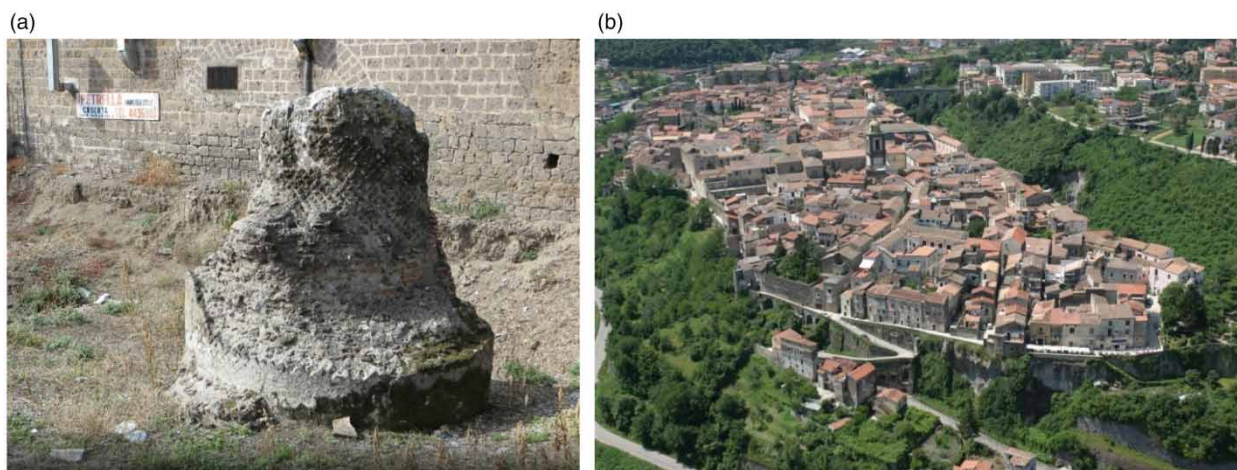
land of Knossos in Crete. *Capua* was forced to cede part of its territory for distribution to its veterans in the war against Sextus Pompeus (Cassius Dio, II century AD). The historian *Cassius Dio* reports the events: 'In this way Caesar calmed the soldiers temporarily. The money he gave them at once and the land not much later. In addition, since what was still held by the government at the time did not suffice, he bought more in addition, especially considerable from the Campanians dwelling in Capua, since their city needed a number of settlers. In return, he also gave them the so-called Julian supply of water, one of their chief sources of pride of all times, and the Gnosian territory [Κνωσός, i.e. Cnosso, on the island of Crete], from which they still gather harvests' (translated into English by Foster 1905). However, it is worth noting that in the monumental cartography of the Barrington Atlas (Talbert 2000), and in its references, there is no mention of the aqueduct of *Capua*.

In *Capua*, one of its gates, *Porta Iovis*, opened onto a road leading to the temple of Jupiter *Tifatinus* on the summit of Mount Tifata, hence the name of the gate. However, the same road was called '*Via Aquaria*' as the aqueduct placed it side-by-side (Marmocchi 1858): 'The way out the gate of Jupiter, was leading to the temple of this deity on the same Tifata Mountain, and as it ran in part to the right side of the aqueduct, also had the name of *Aquaria*. From the southern roots of Taburno Mountain, Augustus by a long aqueduct brought to *Capua* the healthy waters of the Isclero River, which has its source near the

hamlet of Olfizzo; its waters therefore obtained the name of Julian, and are the same of the famous Carolino aqueduct and was one of the great delights of Caserta. The new aqueduct ran above the old path of *Aqua Iulia*, but was deeper, ... then it passed in the road of Coccagna, and there are thicker ruins near the village of San Prisco, beside the *Via Acquaria* of the town, coming out of this village it goes into a place called Sant'Augusto (one of the magnificent tombs of the ancient Capuans) and for a long stretch the ancient construction is still visible, this is where the long aqueduct was conducted, with a winding route of no less than 26 miles!'

It should be specified that Coccagna, once *villa Coccagna*, refers to a small town in the north of the main built-up area of Casagiove, and that, since the twelfth century, had been called Casanova; in 1863, after the aggregation of villa Coccagna, it assumed the name of Casanova e Coccagna. Subsequently, in 1872 it adopted the modern name, a cast of the hypothetical ancient name *Casa Iovis* (house of Jove) (Vv.Aa. 1990).

On the site of the ancient *Capua*, inside the walls and right next to the place where there was *Porta Iovis*, we can find the remains of the *Castellum Aquae* where the end point of the aqueduct stood (Figure 1(a)). Ancient *Capua* corresponds to today's Santa Maria Capua Vetere. It should not be confused with the modern *Capua* corresponding to *Casilinum*, port of *Capua* on the *Voltturnum* River, where Capuans fortified themselves after the



**Figure 1** | (a) Remains of the *castellum aquae* of Capua (S. Maria Capua Vetere); (b) Sant'Agata dei Goti in a panoramic view from the north.

destruction of the city by the Saracens in the ninth century. These details inform us about the terminal part of the *Capua* aqueduct. There is other evidence about the origin, from springs near the small modern centre of Bucciano in the Caudina valley, namely near Montesarchio, and from other springs in the area, and about the subsequent path along the small valley leading to Sant'Agata dei Goti, the ancient *Saticula* (Figure 1(b)), and then through the valley of Maddaloni. Considering the subsequent historical development of the aqueduct, which is shown below, and of the constraints determined by the altimetry, we have depicted the layout shown in Figure 2.

The length of this route is about 37 km (possible branches excluded). The aqueduct started from the aforementioned springs and then ran into a small valley to the north-east and the north of Moiano, following roughly the route of the road nos 19 and 48 of Benevento province. Near a place called Ciardullo, it curved toward the west and then toward south-west, passing through a locality called Castrone. Afterwards, it curved again toward the west, passing just south and next to the walls of *Saticula*, to which it is likely that a branch of the aqueduct was destined. Then, the route ran in the direction of south-west towards the modern town of Valle di Maddaloni and the homonymous valley. Next, after circling

around the hill overlooking the ancient city of *Calatia* and today's town of Maddaloni, it reached the Campana plain. A shorter route would cut the hill by a tunnel, but this would have required quite a long, expensive and deep underground path through a hard, white rock, which is currently extracted by quarries and used as gravel.

In this segment of the aqueduct, as the distance between the walls of *Calatia* and the hypothesized path was about 1.7 km, it is reasonable to assume that a second branch existed to serve this *civitas*. However, for this branch there is no known archaeological or literary evidence, while there is some evidence for the other branch (see Figure 3).

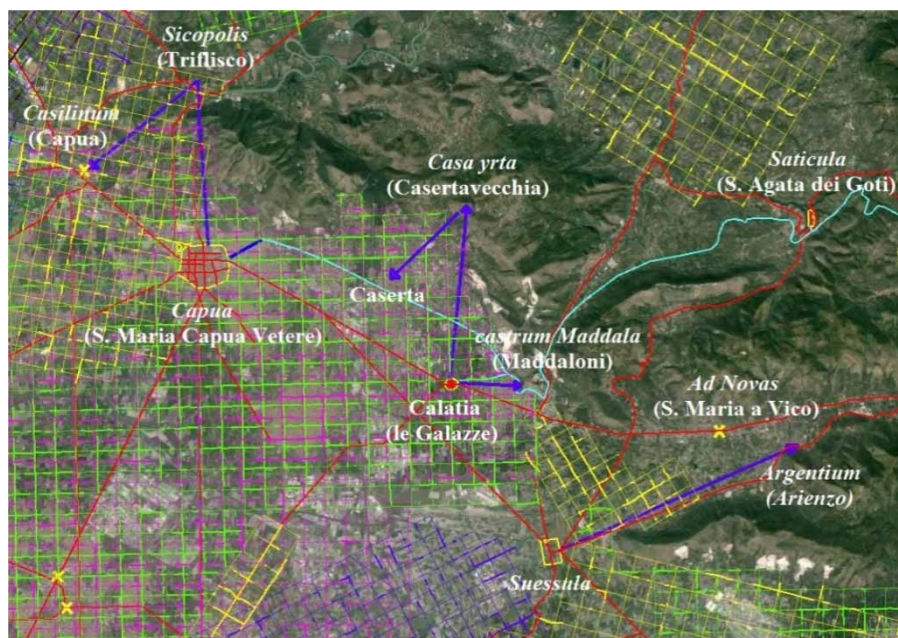
After this possible branch, the route had to reach *Capua* passing through the flat area that is between *Calatia* and *Capua* (Figure 4).

It should be considered that the *Via Aquaria* (current Trieste avenue and Monaco street in the municipality of San Prisco) pointed toward the north-west, not directly towards *Calatia*, a direction that, at first glance, may appear illogical, but altimetry considerations suggest that this choice was rational. The *Castellum Aquae* of *Capua* is at an altitude of about 41 m above sea level (asl), while the end of Monaco street on Colombo street (both in the municipality of San Prisco) is about 52 m asl. In the final

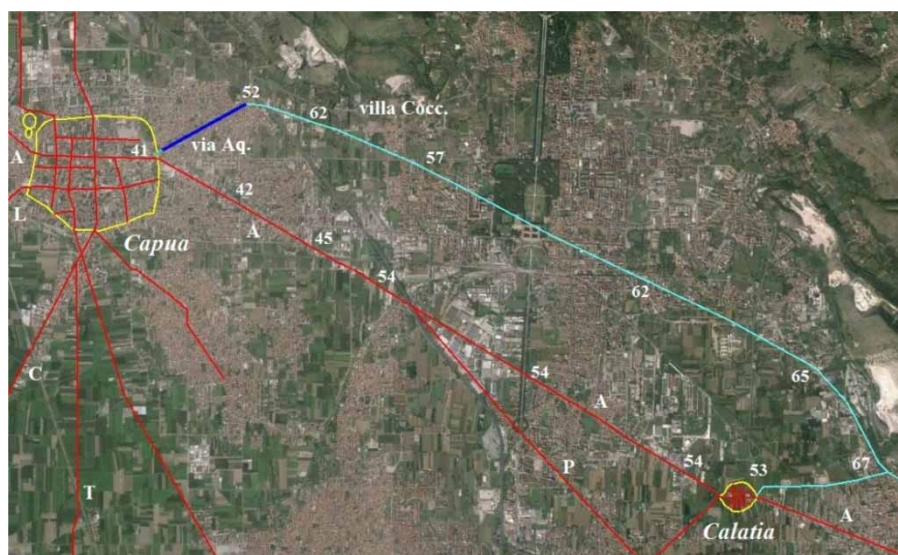


**Figure 2** | Overall view of the route of *Aqua Iulia* aqueduct. 1: route of *Aqua Iulia*; A: via Appia; P: via Popilia; C: part of the centuriations (land divisions) *Caudium I* and *Caudium II*; D: part of the centuriations *Ager Campanus I* and *Ager Campanus II*; M: part of the centuriation of the middle Volturno river; N: part of the centuriation *Capua-Casilinum*; O1 and O3 parts of the centuriations *Nola I* and *Nola III*; S: centuriation of *Suessula*; T: part of the centuriation *Atella II*; A: part of the centuriation *Acerrae-Atella I*. Sant'Agata dei Goti in a panoramic view from the north.





**Figure 3** | Transfers in the centuries of the urban and episcopal seats of Calatia and Capua.

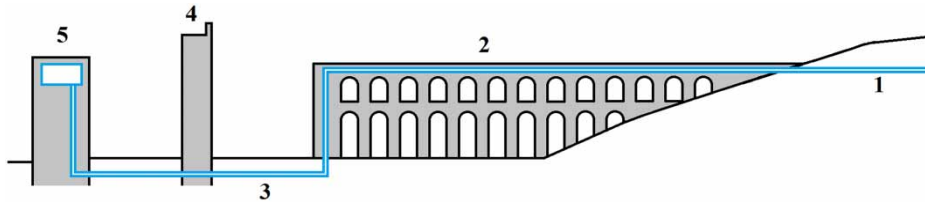


**Figure 4** | Vision of the western part of the hypothetical route, with the notation of some elevations above sea level. For the eastern part of the route, see Figure 9. Via Aq.: via Aquaria; villa Cocc.: villa Coccagna; A: via Appia; P: via Popilia; T: via Capua-Atella; C: via Capua-Cumae; L: via Capua-Liternum.

part of an aqueduct, it was logical that the water ran to a greater height to give a certain pressure to the *Castellum Aquae*, and then to the distribution network. This was obtained by having the final part of the aqueduct on a bridge-channel, but with the foresight to terminate the bridge-channel just before it reached the walls and to

continue the flow by an inverse siphon to prevent the bridge-channel becoming an easy access route for possible enemies (Figure 5).

Thus, the difference in altitude between the two ends of *Via Aquaria* was very useful for this purpose. In contrast, if the aqueduct had pointed directly to Calatia running at



**Figure 5** | Penetration of an aqueduct in a *civitas*. 1: underground part of the aqueduct; 2: part of the aqueduct on arches; 3: inverted siphon; 4: the walls of the *civitas*; 5: *castellum aquae*.

the side of the *via Appia*, it would only have reached a sufficient elevation after a longer distance and this would have required a longer series of arches and incurred higher costs. However, following the hypothesized route, the aqueduct once reached the upper end of *via Aquaria* and could continue towards *Calatia* through places that had a height of land surface a little greater so that the water could run underground, although not far from the surface. These segments of aqueducts were optimal because they were less expensive than the parts on arches and maintenance was easy via appropriately spaced vertical shafts (Hodge 2008).

We do not have any archaeological evidence about this section through the plain between *Capua* and *Calatia* and so appropriate surveys would be necessary to be certain about the path. However, the route is constrained by the fact that with a path moved to the north the elevation of the plane of the surface above the aqueduct increases and, therefore, the cost and difficulty of maintenance would have been higher. In contrast, with a path moved to the south the altitude decreases and then the track would become too shallow with a danger of accidental or intentional damage.

An interesting fact is that the *Aqua Iulia* aqueduct crossed an area that was already densely populated in Roman times, and has been constantly cultivated from those ancient times to today. This is demonstrated by the persistence of many traces of *limites* (border country roads) of the numerous centuriations (land divisions) of the area (Chouquer et al. 1987; Libertini 2013) (see Figure 2), which would have been lost if the land had been abandoned even for a single generation.

## THE CARMIGNANO AQUEDUCT

With the break-up of the Roman Empire and the devastation caused by the German invaders, as well as with the final

destruction of *Capua* in the ninth century by the Saracens, at some unknown time but certainly prior to this last event, the *Aqua Iulia* inevitably ceased to fulfil its functions. It is likely, but not documented, that this happened when *Capua*, together with the whole area, was badly damaged by the Goths of Alaric.

In the centuries that followed, the history of the aqueduct was lost and it only remained in the words of *Cassius Dio* and in scattered remains, especially in the hilly area of its course.

In 1627, Celano (Celano 1856) reports that Cesare Carmignano, Neapolitan patrician, and the engineer Alessandro Ciminelli, proposed and obtained permission to use the water of the rivulet Faenza. It originated in the Caudina valley, together with the springs of the Fizzo and other springs of Airola, reached the then Sant'Agata dei Goti and afterwards the Volturno River, to create a water service to Naples. The aqueduct left a reservoir built in the territory of Sant'Agata dei Goti, obtained through a barrier on the course of the rivulet Faenza. The route followed the valley of Maddaloni and then proceeded towards Cancelli and then to Licignano and Naples, serving primarily as a driving force for a number of mills in the area east of Naples and, secondarily, to feed some fountains of Naples. It is worth nothing that the aqueduct would not have supplied drinking water due to contamination in long open stretches between Maddaloni and Naples. The complex events related to the construction of this aqueduct and the problems related to the subsequent activities are fully described and carefully documented (Fiengo 1990) and are, in any case, outside the scope of this work.

As for these events, Celano (1856) says: 'They put out also in the aqueduct the waters of the fountain of Filadelfo, which was, as there is still, in a place a mile above the town of Sant'Agata, and that was plenty of water, resulting

from three different tunnels excavated beneath the mountain of Crastone. This water flowed into an ancient aqueduct, a Roman remain, which continued as far as the place then called the *Peschiera*, adjacent to the town of Sant'Agata, and served the town itself and was also used for powering machines. From the place named *Rumore* up to Maddaloni the aqueduct was built in the slope of the mountain range of Longano with a very meandering round for the length of ten miles, in many parts joining it with the remains of an ancient Roman aqueduct, which were found there. After several disputes between the Duke of Maddaloni and Carmignano, on February 23, 1628, the following agreement was reached:

First, that as compensation of the ancient aqueducts that were in Maddaloni and of the lands that were to be occupied by the new aqueduct, Carmignano was bound to...

On the use of an ancient aqueduct, Fiengo (1990, pp. 96–97) reports: 'The limited execution times, two years in all, were made possible, as can be seen in part from reading the contract, not by imposing a labour-intensive, but by the use of a planned strategy, which included the restoration and the integration of the ancient Julian aqueduct...' However, the dispute continued, as shown by the acts of a trial held in 1630 (Anonymous 1630). These documents show that Carmignano used, at least in part and after appropriate repairs, approximately 8 miles (corresponding to approximately 11.8 km) of an ancient Roman aqueduct, and believed that these water mains '*furono fatti dai Capuani*' (were made by the Capuans). This means that the first part of the Roman aqueduct of Capua was largely still in existence in the sixteenth century and in such condition that it could be repaired and used for a new aqueduct no longer bound to the needs of *Capua* but to those of Naples.

The route of Carmignano aqueduct, which is well known, is shown in Figure 6. The initial part, in which 8 miles (i.e. 11.8 km) of Carmignano aqueduct coincide, at least in part, with the *Aqua Iulia* aqueduct, is shown in Figure 7. At some point, above Maddaloni, the two paths diverged: while the ancient aqueduct went around the hill and continued towards *Calatia* and *Capua*, the new aqueduct headed for Cancelli and then for Licignano (Casalnuovo di Napoli) and Naples. It is interesting that in this case the knowledge of the route of an ancient



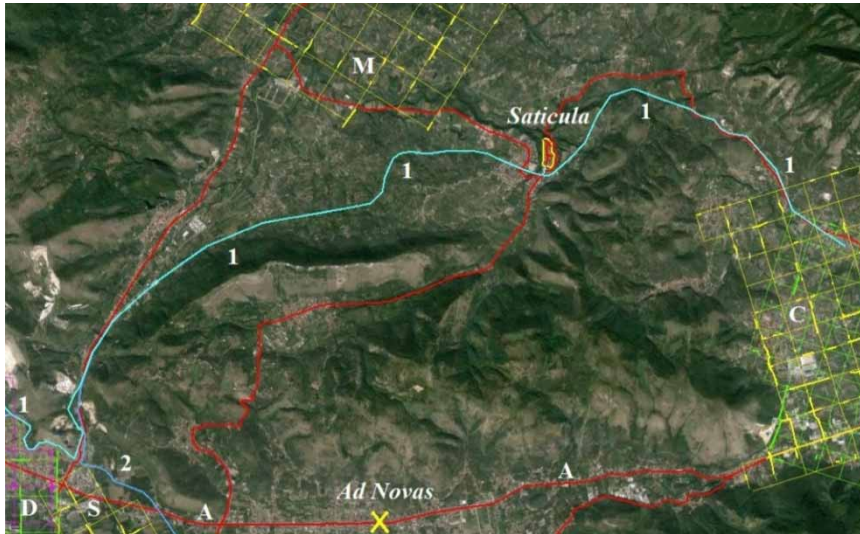
**Figure 6** | Overall view of the route of the Carmignano aqueduct. Also shown is the course of the *Aqua Iulia* aqueduct, which should be identical, or nearly so, to that of the Carmignano aqueduct for about 11.8 km (i.e. 8 miles). The map also shows the *civitates* served by the oldest aqueduct, the road network allegedly existing in Roman times, and the course of the Augustan aqueduct of the Serino. 0: Augustan aqueduct of the Serino; 0d: branches of this aqueduct; 1: *Aqua Iulia* aqueduct; 2: Carmignano aqueduct; 3: Bolla aqueduct; 1 + 2: parts of 1 and 2 in common.

aqueduct did not come from archaeological investigation but from its re-use about 12 centuries after its forced deactivation.

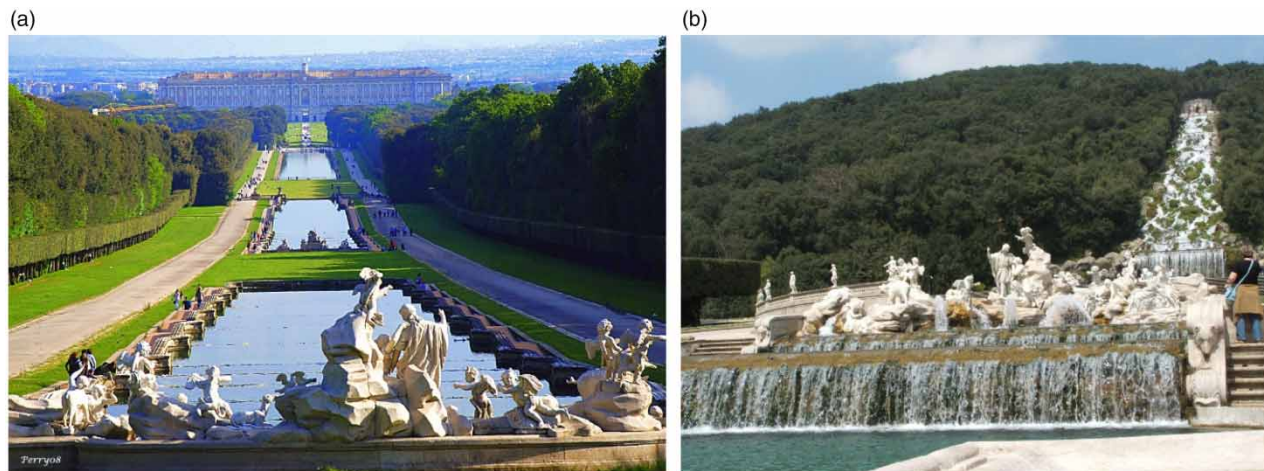
## THE CAROLINO AQUEDUCT

In the middle of the eighteenth century, Carlo di Borbone, King of Naples, convinced himself that an impressive royal palace was essential for the prestige of the monarchy. The site chosen was near a place called Torre di Caserta, destined to take the name of Caserta, while the ancient site acquired that of Casertavecchia (old Caserta). The planning was entrusted to Luigi Vanvitelli, but the grandiose project (Figure 8(a)), at the express request of the sovereign, required abundant water that the place did not have. In this regard, Vanvitelli proposed to use the same springs that had served the *Aqua Iulia* and now served the Carmignano aqueduct through a new and bold aqueduct with a length of about 35 km.





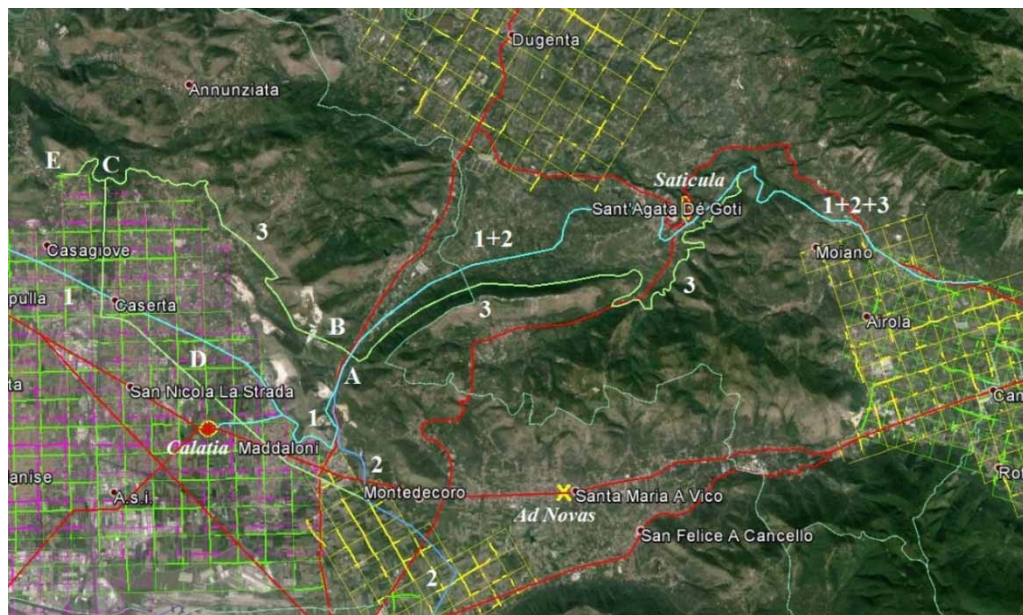
**Figure 7** | The initial parts of Carmignano and Aqua Iulia aqueducts. 1: First part of Aqua Iulia and Carmignano aqueducts, and then only Aqua Iulia; 2: beginning of the subsequent section of Carmignano aqueduct; A: via Appia; C: part of the centuriations (land divisions) Caudium I and Caudium II; S: part of the centuriation of Suessula; M: part of the centuriation of the middle Volturno River; D: part of the centuriations Ager Campanus I and Ager Campanus II.



**Figure 8** | (a) The royal palace of Caserta and its park; (b) the main waterfall in the park.

In fact, as the waters had to reach the highest part of the splendid main waterfall in the park (Figure 8(b)), i.e. a height of about 210 m asl, the ancient route that served Capua, at a little more than 40 m asl, was unusable. Therefore, the design of what will rightly be called Carolino aqueduct (aqueduct of Charles), from the name of the King who commissioned it, used the same springs of the Roman aqueduct and thus of the Carmignano aqueduct, plus other secondary sources (Bagordo 2009), however about 2 km before

reaching Sant'Agata dei Goti, a different and more meandering path at a higher altitude started (Figure 9). In the valley of Maddaloni, the new aqueduct ran about 300 m south-east of the ancient route and at an altitude about 50 m higher. At one point, while the ancient route of the Aqua Iulia began a rapid descent towards the mouth of the valley and the next turn around the hill overlooking Maddaloni, and reaching an altitude of about 70 m asl, the new route went through the valley with three impressive superimposed arcades, for



**Figure 9** | The route of the Carolino aqueduct in relation to the courses of *Aqua Iulia* and Carmignano aqueducts. A: Ponti della Valle (bridges of the valley); B: tunnel of Graziano mountain; C: tower of the main waterfall in the park of the royal palace of Caserta; D: water main that brought back the water into Carmignano aqueduct; E: branch for San Leucio; 1: *Aqua Iulia*; 2: Carmignano aqueduct; 3: Carolino aqueduct; 1+2: parts of 1 and 2 courses in common; 1+2+3: parts of 1, 2 and 3 courses in common. The course of Carolino aqueduct was obtained from R. Di Stefano (Di Stefano 1973).

a total length of 529 m and a maximum height of 55.80 m (Figure 10), remaining at an altitude of about 216 m asl (Bagordo 2009). Subsequently, it crossed the Garzano mountain by a tunnel and then, always with a mild and constant inclination, ran along the west side and then the southern arc of the hills surrounding Caserta, finally reaching the

tower located on the highest point of the waterfall. Hence, a branch went to the houses and the factories in San Leucio, activating their machines, while the main part ran towards the royal palace. After such use, the water was in part put back in Carmignano aqueduct, near the small town of Cancellio, by using a channel indicated on the



**Figure 10** | I Ponti della Valle (the bridges of the valley).



map of Rizzi-Zannone as 'Acqua di Caserta restituita al Condotto di Carmignano' (water of Caserta returned to the duct of Carmignano).

## CONCLUSIONS

Although built over nearly two millennia, the three aqueducts have something in common that substantially differentiates them from modern aqueducts. Until recent times, steel pipes were not possible due to lack of reliable joints and oxyacetylene welding. Moreover, only lead pipes were used in the presence of significant pressures. The technique of reverse siphons allowed significant differences in levels to be overcome. In fact, in the second century BC the Greeks served the city and the acropolis of Pergamon overcoming, by a reverse siphon and lead pipes, a dip of about 200 m with a pressure at the lowest point of about 20 atmospheres (Hodge 2008). However, lead pipes were expensive and, in case of obstructions, the repairs were very onerous. Therefore the Romans, where they had to overcome a height difference, preferred to use arcades and reserved the use of lead pipes and inverse siphons for the final ramifications of the aqueducts in a *civitas* or where this was indispensable (for example, see the case of Figure 5).

An important difference between *Aqua Iulia* and Carolino aqueduct is that the upper end of the shafts in the first case were simply covered by a stone while in the second case there was a small room with tuff walls to protect the access ('turrets for inspections'). About 67 of them remain along the course of the aqueduct and eight out of 19 on the route that led backwater from Caserta in the bed of Carmignano aqueduct (Ventrella & Ventrella 2013).

Among the three aqueducts, *Aqua Julia* and Carolino aqueducts were built by order and at the expense of the authorities of the time and for the public interest, albeit subordinated to that of the leader (in the first case: to supply water for some centres linked to the emperor; in the second case: to supply water to the representative seat of the monarchy). On the contrary, for Carmignano aqueduct, the author was a private society and the goal was to give strength to water mills and only secondarily to supply water to Naples. For reasons of economy, the first part of the aqueduct used the reactivated Roman aqueduct while

in the remaining part the water ran in the open air and was exposed to any form of contamination. Therefore, the water that reached Naples was not healthy (Fiengo 1990) and polluted water represented a serious hazard to the population in terms of waterborne pathogens (Nriagu 2011), even if they do not automatically result in an infection (Lacey & Walker 2014). This teaches that to safeguard public health the aqueducts must be protected by stringent regulations, especially if they are made by private investments.

Archaeology may be restricted to the study of the ancient remains that are visible on the surface or may be excavated from the ground. A distinct type of study, which is quite different from this rather bounded conception, although including it as an essential and indispensable element, is the pursuit of what existed in the past, the observation of its transformations through the centuries and its documentation, and its persistence in modern times. Where this type of study is possible, we may find countless water connections that have continued in time, between past and present reality. Such links are often unknown or underestimated even by the local inhabitants, but are essential in understanding the roots of the present water supply and the origin of many contemporary peculiarities that are seemingly meaningless and random.

The study of *Aqua Iulia* aqueduct and of its transformations over the millennia is an extraordinary example of this broader concept, which goes beyond the strict boundaries of archaeology. The complex and varied history of the places crossed or served by the aqueduct is interwoven with human affairs, together with the social and economic conditions of the people that have lived and are still living there.

In the Campana plain, which takes its name from the ancient *Capua*, that is from *CAPVA* → *CAPVANVS* → *CAMPANVS* (Di Resta 1985, p. 9), and in the adjacent zones, we can see the overlapping of the persistence of the *limites* (boundary country roads) of many ancient centuriations with the parallel persistence of ancient roads and centres. The centuriations are extraordinary in this area and are evidence of the continuous cultivation of these places. In the same territory, it is possible to observe the subsequent grafts of the nucleus of medieval centres and of their modern developments, which often in their own name, as well as in archaeological findings, indicate the ancient

origins. In this tangle of persistence of *limites*, roads and centres, which despite their apparent chaos reveal signs of the orderly Roman organization of the territory, the routes of the aqueducts and of their branches that served the *civitates* are added.

The partial re-use of the *Aqua Iulia* for the Carmignano aqueduct and the subsequent radical transformation of the first segment of the same to serve the needs of the royal palace are a clear example of the evolution of the structure of a territory based on subsequent historical needs.

To define this type of study as archaeological is therefore insufficient and misleading. Moreover, there is no unique word for such a type of study that seeks to fuse together the fruits of various types of approach to provide a deeper understanding of a territory overall. The critics might certainly object to the framework provided by this work arguing that it lacks many useful insights, but when you consider the same as preliminary information to obtain a broader and more detailed representation, the limits can be overcome.

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