Groundwater exploitation for public and private uses in the towns of the Roman province: the emblematic example of Formia (*Latium adiectum*: central Italy)

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**ABSTRACT**

Formia was a Roman municipality (central Italy) and one of the Roman notables’ favourite holiday destinations from the 2nd century B.C. to the 1st century A.C. The town was also a strategic hub for sea and land trade and drew its strength from its geographic position, climate and abundance of spring waters near the sea. This wealth of freshwater, managed by special magistrates (*curator aquarum*), had multiple public and private uses: (i) intake structures (draining tunnels, cistern and an octagonal hall/musaeum/nympheum which may have been used as a model for the most famous octagonal hall of Nero’s *Domus Aurea* in Rome); (ii) supply structures (above all aqueducts); (iii) storage structures (above all cisterns); and, finally, (iv) utilisation structures for public use (thermal baths, probably a pond/piscina dulcis and at least two fountains located along the Appian Way, the *regina viarum* of the Roman period) and private use (*balnea* and *nymphaea/oeci* described by the famous architect Vitruvius who was born in Formia). Hence, as a municipality located in the hinterland of the *caput mundi*, Formia may be regarded as a typical example of management and public and private use of water resources in the Roman period.

**Key words** | aqueduct, cistern, cult of water, groundwater exploitation, Roman period

**INTRODUCTION**

Among the ancient Roman municipalities of central-southern Italy, Formia (located in *Latium adiectum*) is perhaps the least known. And yet, this town played a key role in some of the socio-political events which marked the transition from the Roman Republic to the Roman Empire (2nd–1st century B.C.). Since Italic and, maybe, Magna Graecia times, Formia has been a safe harbour with an enviably temperate climate (Formia from *homiae* = landing place: Strab., *Geog.*, 5, 233) and a port of call rich in coastal springs, as recalled by Symmachus (Simm., *Ep.*, 8, 23): “…*tanta coeli salubritate et aquarum frigore*…”.

The modern town is the result of historical vicissitudes, which culminated with the destructions of the 2nd World War and the fast post-war reconstruction process. These events obliterated or upset most of the Roman vestiges, leaving little trace of what must have been one of the Roman notables’ most sought-after short- and long-holiday destinations. Formia ranked second only after Baia, in the Gulf of Naples, for various reasons. First of all, its position: half-way between the *caput mundi* and Naples, reachable in one night of navigation from the Ostia or Pozzuoli harbours or through the Appian Way (*regina viarum*), which acted as its *decumanus maximum* (*Figure 1*); then, the barren scenery of its Aurunci Mountains, almost a corner of Greece, and an exuberant vegetation, with vineyards and olive groves and the presence of many of the most renowned figures of the Roman Republic and Empire (Cicero and Mamurra among the most prominent ones); all contributed to making Formia a prestigious destination. Soon, the structures of
the old municipality of the Republican age (including its stylish polygonal walls of the 2nd and 1st century B.C.) were replaced by more significant architectural works in the late 1st century B.C. and in the following one. The wealth of the Formian notables derived more from their African latifundia than from their oriental trade. It was only then, more than one century after the war of Marius against Jugurta (106 B.C.), that these large landed estates became full-fledged components of the Roman agricultural trade. The architectural results of this process were the total restructuring of the forum, of the adjoining basilica and of the entire urban centre, as well as redevelopment projects in neighbouring areas, which were immediately studded with villae of otium, balnea, nymphaea, oeci and piscinae salae.

FORMIA AND ITS CULT OF WATER

In the sinus formianus, the first cult of water was the one of Neptune, deus aquarum. Neptune had previously been worshiped as a pre-Roman Italic god of inland freshwater (fluvial, lacustrine and spring water).

It was only after the encounter of the Roman Republic with the Helladic civilisation that this god was also identified with the Greek Poseidon, the god of the sea and storms. Neptune-Poseidon thus became a dual tutelary deity, reflecting the role of Formia as a harbour and a commercial and tourist venue, rich in spring waters, as recorded by plenty of classical sources. In 1840, a funerary epigraph of the late 1st century B.C. was discovered at Mamurrano, near Gianola (Formia) (Figure 2). The epigraph is still incorporated in the walls of the antiquarium of Villa Rubino, owned by the prince of Caposele, which is likely to have been donated to him. The epigraph concerns the Augustalis M. Caelius Phileros, a wealthy and powerful freedman and a prior follower of Mark Anthony. Phileros (quoted in the inscription) also decorated the temple of Neptune at Formia with precious polychrome marbles (Formis aedem Nept(uni) lapid(ibus) varis s(ua) p(ecunia) ornavit: CIL, X, 6104). These marbles are probably of African origin, given Phileros’ brilliant municipal cursus honorum in that province. In the funerary epigraph dedicated to his wife and to a friend, this local illustrious benefactor proudly stressed his munificence towards the aquarum town, Formia, thanks—perhaps—to his commercial fortunes (Arnaldi 1995). Trade had always been flourishing in this hub of sea and land trade, thanks to the Appian Way; in fact Formia is reported in the itinerarium Antonini as a strategic statio of the Regina viarum (Figure 1). Phileros must have been very devout of the god of the sea, invoking his protection during commercial or political journeys from the shores of the Tyrrenian Sea (namely from Formia) to those of Africa Nova.

The temple must have been located along the coast, just as other known examples in the Mediterranean basin (Cape Sounion and Sorrento). Under an appealing assumption, the temple might be identified with the numerous Roman remains on which the medieval tower and the Castelmola Caetani palace rest (7, Figure 2). This palace, overlooking the sea, lay close to the thermal baths supplied by the Mazzoccolo spring (9, Figure 2), whose water has the highest discharge (600 L/s) and the best physico-chemical quality among the springs of the entire Gulf of Gaeta.
It is not by chance that here, in the 19th century, an inscription is reported to have been found. The inscription made reference to an altar that a local magistrate had consecrated to another Italic deity of spring waters, Fontanus:


THE HYDRAULIC WORKS

Formia still holds signs of hydraulic works reflecting an integrated water cycle, as reported by historical and epigraphic sources and as testified by some of its archaeological ruins.

Water was used for sanitation, balneotherapy, drinking and decoration by both the municipality and individual citizens. In fact, at Formia, different kinds of hydraulic works have been identified (Figure 2): (i) hydraulic intake works (the draining tunnels of the Mazzoccolo spring which are still used in part; 10; the Castellone cistern: 5; the octagonal hall/nymphaeum of Gianola: 12); (ii) groundwater supply works, (the aqueducts of Mola: 8 and Pontone: 1, devoted to public and private use, respectively); (iii) water storage works (the Castellone cistern for public use and those of Gianola for private use: 14 and 15); and, finally (iv) hydraulic utilisation works of general public interest (the thermal baths of Mola: 8 and perhaps the pool/piscina dulcis of Via Vitruvio at Formia: 6 and the public fountain of S. Remigio nearby the LXXXVIII milestone of the Appian Way, outside the town: 3, Figure 3) and of private interest (the balnea of Gianola: 18 and the nymphae/oeci of Villa Rubino: 4).

Such a well-constructed hydraulic system was managed and controlled by special local public administrators, who were held of great account by the citizenship,
as demonstrated by the following epigraph found in the environs: L(ucio) Varronio L(ucii) f(ilio)/Pal(atina) Capitoni,/ scribae aedilic(i)o/acceso velato/[II] viro/quinquen (nali)/ curatori a(a)ram,/[p]atrono coloniae,/ordo Regalium/quorum honore/contentus sua pecun(i)a)/posuit. L(ocus) d(atus) d(ecreto) d(ecurionum) : C I L, X, 6094. The curato a(a)ram of the epigraph was L. Varronius Capito, who is likely to have been the illustrious master (bearing the same name) of the villa which hosted Horace in his journey from Rome to Brindisi together with Maecenas (Hor., Sat., I, 5, 37).

The Castellone cistern

The cistern, which is estimated to date from the 1st century B.C, lies in the upper and perhaps the oldest district of Formia (nowadays called Castellone). It is NW-SE elongated and borders the eastern side of the oldest Roman walls. Thanks to this location, the cistern could supply water to a large part of Formia (Figure 2) by means of a widespread town waterworks as proved by the archaeological find of fragments of water pipes (two leaden fistulae aquariae of the urban waterworks of Formia found nearby the Roman forum in 1864 and 1920–21 respectively: a fistula with the embossed inscription: Rei P(ublicae) Formia(norum) and a fistula with the inscription: COL(onia)AEL(ia)FOR(miae): from Aurigemma 1926). It has an estimated surface area of about 1,200 m² and a capacity of over 7,000 m³. Its long and short sides measure about 65 m and 12 m, respectively (Figure 4). The cistern was built by excavating in part the calcareous bedrock and obtaining a number of pillars, which divide its length into four aisles. The remaining pillars and its eastern and southern walls are in opus caementicium and waterproofed with opus signinum. The pillars are spaced by 2.90 m and are 0.89 m-thick (10 and 3 Roman feet, respectively); the maximum height of its aisles is 6.5 m.

The irregular plan of the cistern, with sides of different length, is justified by the need to occupy all the available

Figure 4 | Plan view of the Castellone cistern (5, Figure 2) (redrawn and partly modified from Gruppo Studi e Ricerca “L’Altra Formia”, 1985). M: manhole.
space and perhaps to tap bedrock areas richer in water, thus giving up the principle of symmetry so cherished by the Roman architecture (Cassieri 2000).

The cistern, lying at an elevation of roughly 45 m, was supplied by an aqueduct, which exploited a spring with a current discharge of some L/s. This spring is located more in the NW, about 1,750 m uphill, at an elevation of 217 m (Gruppo Studi e Ricerca “L'Altra Formia” 1985).

Given the considerable volume of the cistern and the presently low discharge from the spring, the cistern might also directly intercept the regional groundwater, which has a hydraulic gradient of 2.5% in this area. In effect, the piezometric level of two wells, placed at distance of about 500 and 300 m from the cistern, is 60 m and 36 m, respectively. Consequently, in the cistern area, the groundwater elevation is thought to range from about 47 to 28.5 m, which is consistent with the cistern elevation. On this assumption, the cistern had the dual purpose of storing and withdrawing water.

The public water supply system of Mola

A group of springs, called Mazzoccolo (MS, 10, Figure 2(B)), lies uphill of the area of Mola. Their water (discharge: 600 L/s) has excellent physico-chemical properties ($T = 13^\circ C$, $pH = 7.56$, electrical conductivity = 320 $\mu S/cm$, Total Dissolved Solids = 162 mg/L). At present, the water is exploited for drinking uses in the entire Gulf of Gaeta, through the still existing network of Roman draining tunnels (Figure 5(A)).

These springs and their proximity to the sea have always had an impact on land and water planning & management policies in this area. In Roman times, their water was used in thermal baths, public fountains and places of worship (temple of Neptune); in Medieval and modern times for aquismolae; and, presumably, in ancient times for hydrae-tae (a hydraulic system of vertical-shaft water mills from which the modern toponym “Mola di Gaeta” derives), fulling mills and pasta factories.

Indeed, in the Roman age, the water from these springs was abstracted and conveyed via an aqueduct, the first section of which was below ground. Then, more downhill, towards the sea, the aqueduct continued above ground. Relics of this aqueduct are still visible: a length of 82 m divided into three sections of 16 arcades with a span of 2.84 m (about 10 Roman feet) (9, Figures 2 and 5(B)). The cave of the aqueduct has a rectangular shape and is covered with opus signinum; the entire structure was built in opus caementitium with local calcareous materials. At the end of the arcades facing the Roman Appian Way is a trapezoidal castellum aquae with a height of a little less than 4 m. This reservoir is likely to have distributed water to the various users, using the surplus to feed a monumental fountain, of which some relict moulded blocks were found off site.

This fountain must have had the same function as the S. Remigio one, on the opposite side of Formia (3, Figures 2 and 3). The aqueduct supplied water above all to the nearby thermal baths (8, Figure 2). These baths, now buried by present buildings, were found during archaeological diggings in the 1930s, which unearthed a now dispersed magnificent geometric mosaic.

The bombings of the 2nd World War exposed some remains along the same axis as the thermal baths, at the foot
of the Mola tower. These remains, which extend from the coast to the sea, are suggestively ascribed to the Temple of Neptune at Formia (7, Figures 2 and 6). This assumption is supported by various factors: the central position of the temple with respect to the Roman harbour; Phileros’ epigraph; a decoration with dolphins found in the area; and the combination of freshwater and seawater in the same site.

Private use of the water system at Gianola

Gianola is a toponym deriving from the goddess Diana, “Janula” vulgariter for Latin peasants. The peasants considered this triform, lunar, terrestrial and chthonian deity as the protector not only of forests and hunting but also of wild places. These wild places were the Greek eschatiai, “the extreme lands” where the urbanscape bordered the wildscape towards the sea, wetlands (as in the case of the local Pescinola area: 11, Figure 2) or steep cliffs falling sheer into the sea. It is at Gianola that the ruins of the monumental and scenic estate of Mamurra were found. The estate was comparable to an entire universe, developing from the architectural pivot of an octagonal hall/nymphaeum/musaeum rising at the top of the promontory (12, Figures 2 and 7) and emphasising the value of a now extinct spring. It was a locus amoenus of otium and certainly a status symbol to its very rich owner, a known friend and financier of Caesar. Mamurra was among the targets of the ironical darts of Catullus, who compared him to Croesus, mocking his enormous estate at Formia, which was as diversified and vast as the then known world (CAT., Carm., CXV). This natural place hosted an extraordinary coeval Late Republican architectural complex with elements of the 1st century A.C. The splendid villa is built on three terraces degrading towards the sea (600 m × 150 m) and oriented according to the wind rose, so as to optimise its use and pleasantness. The villa enhanced the value of water as a symbolic and functional element in various structures. The octagonal hall was also a repository of artistic material (musaeum) and is likely to have been used as an innovative model for the more known octagonal hall of Nero’s Domus Aurea. The octagonal hall had tanks for holding the water withdrawn from the spring. The tanks survived only in part the ravages of the 2nd World War. Its reference to astronomy was reiterated in a similar mosaic with a starry sky, now lost but depicted in the drawings of the antiquarian Mattej in the 19th century.

This pivotal structure, combining mythology, cult of water and funerary customs, linked the entire villa to the triform deity of nature Diana/Selene/Hecate. In the Middle Ages, this deity matched a local witch (“Ianara”), haunting the imposing ruins of the following nearby hydraulic structures. The euripus, an ornamental channel measuring 75 m × 5.30 m, 1 m-deep and with a capacity of 390 m³, was built in opus signinum (13, Figure 2).

A set of cisterns, with a minor one (220 m³) with 32 pillars recessed into the rock (14, Figures 2 and 8(A)) and a major one (900 m³—15, Figures 2 and 8(B)). The cisterns were built externally in opus incertum and internally in opus signinum. The cisterns supplied two decorative niche
Figure 7 | Mamurra’s villa at the promontory of Gianola: plan and section of musaeum (from Ciccone 2000); in the middle a spring (1), now extinct, was located.

Figure 8 | Minor (A—14, Figure 2) and major (B -15, Figure 2) cisterns of Mamurra’s villa at the promontory of Gianola.
fountains (16 and 17, Figure 2), a thermal *balneum* on the cliff and in part carved into it. The *balneum*, composed of *calidarium*, *frigidarium* and an impressive exedra, was also used for thalassotherapy (18, Figure 2).

A water storage and distribution tower (*castellum aquae*) (19, Figure 2) in *opus incertum*, which was connected to a free flow channel (resting in part on arches) fed by an underground spring. Two fishponds (*piscinae salgae*) at the extremes of the architectural complex reflected other uses of water, e.g. for fish farming and *otium* (20 and 21, Figure 2).

The *nymphaea* of Villa Rubino and the *piscina dulcis*

Tradition has long associated (albeit with some uncertainties) the magnificent, elegant, monumental Roman relics of the present Villa Rubino with the well-known Cicero’s *Formianum*, the seaside villa of *otium* where the orator found shelter in his last flight from Mark Anthony. The lowest level of the sophisticated *basis villae*, amid concamerations and various spaces, accommodates two interesting columnated *nymphaea* (4, Figure 2). These structures monumentalised the local springs, which are still active today (Ciccone 2000). Originally, the structures enjoyed a marvellous panoramic view of the entire gulf and directly overlooked the lively hydraulic geometries of a *piscina salsa* (filled up in Borbonic times—19th century—and now representing the garden of Villa Rubino) and the calm sea of the present Borbonic marina, since then protected from currents and western winds by the structures of a neighbouring villa. These venues of *deliciae* used freshwater from springs and the sea. Both structures enhanced the value and look of spring water through a simple rectangular bottom niche in the 2nd century B.C. In the following century, the two structures dramatised the spring water theme in a different way. The smaller one (the minor *nymphaeum*) was a quadrangular tetrastyle *nymphaeum/triclinium*, with columns in *opus testaceum* and a pavilion vault providing light and relief from the Summer heat (Figure 9(A)). The larger one (the major *nymphaeum*), longitudinal, had a barrel vault with lacunar ceiling (Figure 9(B)). This *nymphaeum* was divided into three aisles by two rows of columns, like the “Corinthian oecus” of Vitruvius (that the big architect of Formia probably knew), and linked to the adjoining thermal areas. The *nymphaea* are decorated as a rustic cave with sponges, shells and concretions in their niches or as a false *opus quadratum* with polychrome stuccos showing *pelta* motifs, trophies, marine creatures and landscapes.

However, at least the niches and the lower tank must have been adorned with sculptures harmonising with the environment of a rustic cave with water (the myth of...
Ulysses and Polyphemos in the cave of Tiberius at Sperlonga or in the villa of Punta Epitaffio at Baia, but also simple water nymphs or myths, such as Narcissus).

In the 1920s, excavation works for enlarging the Via Vitruvio road exposed the ruins of a piscina dulcis (6, Figure 2). The decorative style of this pond is thought to typify the sculptures associated with the likely public use of water in an urban environment: a Roman copy of the Venus of Doidalsas, often used as an ornament for bodies of water; a Lycian Apollo; and, above all, two splendid Greek originals of Nereids on a hippocampus of the thiasos of Neptune, now kept at the “Museo Archeologico Nazionale” of Naples (Figure 10).

CONCLUSIONS

Formia was a Roman municipality along the coast of Latium adiectum and one of the Roman notables' favourite holiday destinations from the 2nd century B.C. to the 1st century A.C. The town was also a strategic hub for sea and land trade and drew its strength from its geographic position, climate and abundance of spring waters near the sea, as recalled by Symmachus (Simm., Ep., 8, 23): “…tanta coeli salubritate et aquarum frigore …”. This wealth of freshwater, managed by special magistrates (curator aquarum), had multiple public and private uses: (i) intake structures (draining tunnels of the Mazzoccolo spring, the Castellone cistern and the octagonal hall/musaeum of Gianola); (ii) supply structures (the aqueducts of Mola and Pontone); (iii) storage structures (the Castellone and Gianola cisterns); and, finally, (iv) utilisation structures for public (thermal baths of Mola, piscina dulcis of Via Vitruvio at Formia and public fountain of S. Remigio) and private use (balnea of Gianola and nymphaea/oeci of Villa Rubino). Hence, as a municipality located in the hinterland of the caput mundi, Formia may be regarded as a typical example of management and public and private use of water resources in the Roman period.

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