



ANTHROPOGENIC MODIFICATIONS TO THE DRAINAGE NETWORK OF ROME (ITALY): THE CASE STUDY OF THE *AQUA MARIANA*

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ABSTRACT: Rome is characterized by millennia of urbanization. Long lasting geomorphological investigations have allowed the geomorphological description of the city centre and the valorisation of its geomorphological heritage. In this paper the spatial change of the hydrographic network in historical times is illustrated, with some examples showing how deep has been, and still it is, the link between the historical-cultural development and the natural geomorphological and hydrological characteristics of the Roman territory. In particular, the most relevant human interventions on the drainage network, in the southern area of the city centre, have been investigated. Before the land-use modifications of Roman-age, this area was drained by the most important left tributary of the Tiber River within the city walls, the *Nodicus* River, more recently known as *Aqua Mariana*. This stream has undergone many anthropogenic modifications and diversions during the centuries, and its original path is known only downstream of the San Giovanni Basilica. According to geomorphological, archaeological and geological evidences, it is possible to hypothesize that the dimension of the pre-urbanization drainage basin, as known and reconstructed in the available literature, should have been until now underestimated.

Keywords: Rome (Italy), urban geomorphology, urban landscape, Tiber River, *Aqua Mariana*, *Nodicus* River

1. INTRODUCTION

The history and cultural heritage of Rome are well known all over the world. Not so its geo-environmental heritage, which is also very important and has guided the initial settlement choices and the subsequent growth of one of the most important cities for the development of civilization.

Although many geomorphological features have been hidden or completely eliminated during millennial urbanization processes, the landscape of Rome still preserves the main landforms of the original physical landscape.

After a general description of the geo-environmental characteristics of the area corresponding to the historical centre of the *Urbs* and the lower Tiber Valley, to the neighbouring coastal belt, the historical spatial changes of the hydrographic network are illustrated in more detail. By some examples we demonstrate how deep has been, and still it is, the link between the historical-cultural development and the natural geomorphological and hydrological characteristics of the Roman territory.

In this paper, we focus on the most relevant human interventions on the drainage network within the city walls. In ancient times, the southern area of the *Urbs* was drained by the *Nodicus* River, according to

Lanciani (1881), that was the most important left tributary of the Tiber River (TR) in the city. Geomorphological, archaeological and geological evidences show that *Nodicus* was a very significant tributary of the TR in terms of fluvial energy, as attested by the wide valley hosting the *Circus Maximus*. Despite the extensive urban modifications during the Roman times, including land reclamation and backfilling, the Medieval *Aqua Mariana* artificial stream was carried out to flow within the *Nodicus* valley, at least downstream of the San Giovanni Basilica. As a consequence, we hypothesize that, until now, the *Nodicus* River's dimensions, in terms of drainage-basin area and hydrographic-network evolution have been underestimated.

2. STUDY AREA

Rome is located in the Tyrrhenian side of central Italy, W of the Lazio-Abruzzo Central Apennine (Fig. 1). The physical landscape, mainly hilly, is characterized by the presence of two volcanic reliefs, i.e. the Sabatini Mountains and the Alban Hills (*Latium* volcano). On the right and on the left sides of the TR, which links the city to the coast, two clearly different areas from a geomorphological point of view are present. The territory on the left side of the TR (SE) hosts a large volcanic plateau, which formed during the Middle-Upper Pleistocene from

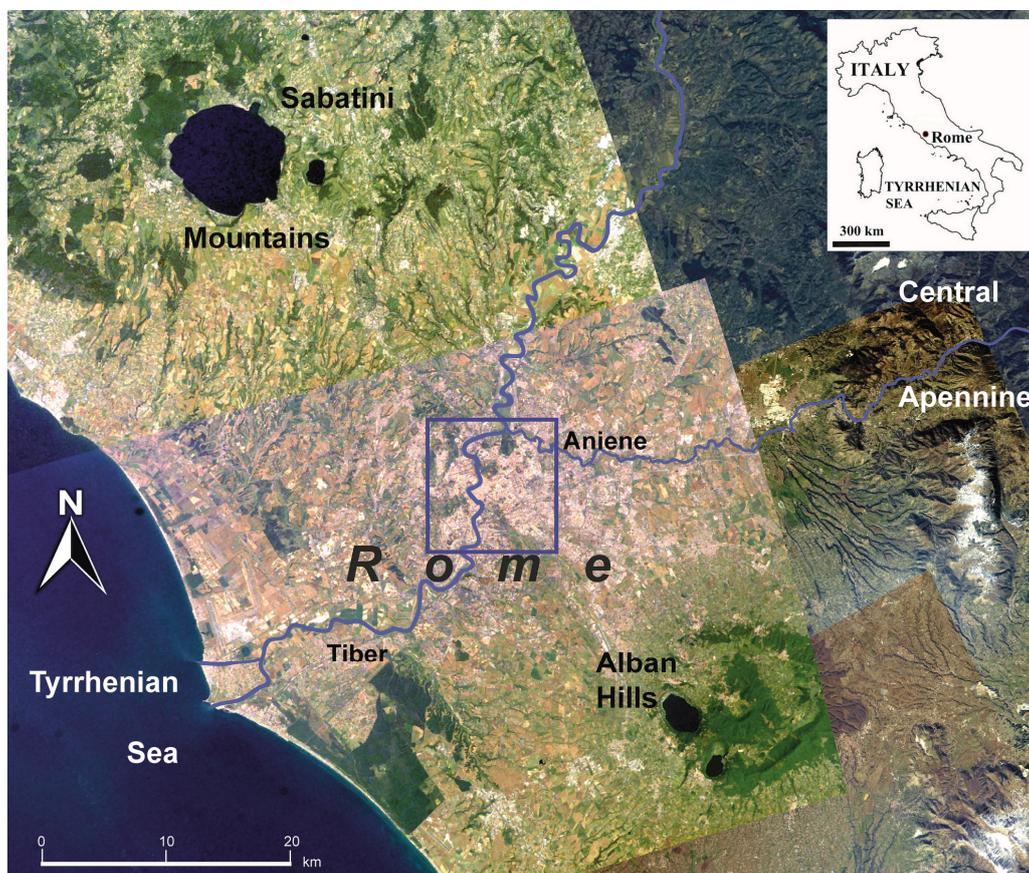


Fig. 1 - The present-day urban area of Rome. It extends from the volcanic flanks of the Sabatini Mountains and the Alban Hills, located NW and SE respectively, to the Tiber River mouth, SW of the city centre. The urban centre, which is represented in Figure 2, is within the square blue frame. Upper-left corner coordinates: 42° 13' 29" N, 12° 00' 58" E (mosaic from NASA satellite images).

several eruptive phases belonging to both previous volcanic districts. Over the same time, this plateau started to be deeply carved by the Tiber fluvial system, many times, in occasion of sea-level low standing (Bellotti et al., 2007). Thus, in the Upper Pleistocene a long phase of in-depth fluvial incision carved the same valleys as canyons or gorges (Pica et al., 2016; 2017, and references therein). The TR tributaries created a series of very deep valleys, with steep slopes. The most important valleys, including those drained by the main water course, today appear flat-bottomed, due to post-glacial fluvial depositional processes, which originated the flat surface (Fig. 2) corresponding to the current city centre (*Campus Martius*, Campo de' Fiori).

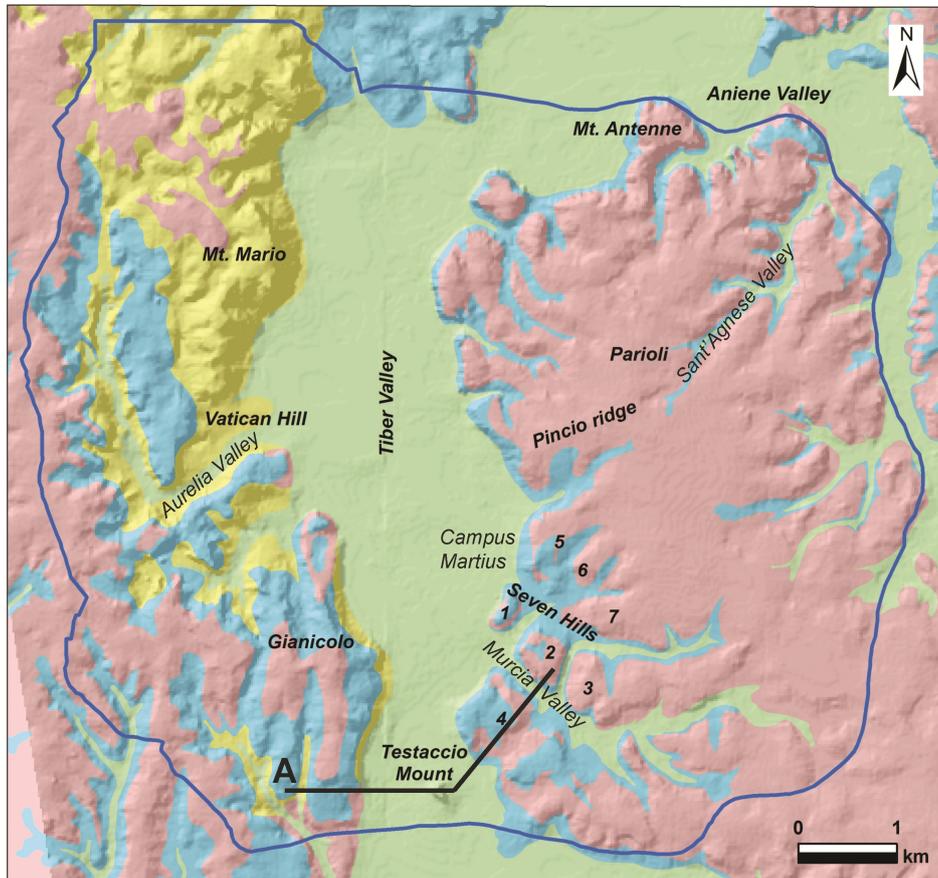
The fluvial incision led to the development of numerous elongated ridges in the interfluvium areas, flat at the summit, which still dominate the urban landscape of this eastern sector; this is the typical shape of some of the famous Roman-age "Seven Hills", such as the Quirinale. Other hills, such as the Aventino and the Palatino, appear instead as small isolated reliefs, with steep slopes, sloping from the flat top towards the underlying alluvial plain of the TR (Fig. 3).

In the western side of the TR, the alluvial plain ends at the foot of the ridge that connects, from N to S,

the ridges of Monte Mario and Gianicolo (Figs. 2 and 3). The summit of this ridge reaches 139 m a.s.l., while the hills on the east side do not exceed 50 ÷ 60 m a.s.l.

The basal outcropping lithologies of the study area (Fig. 2) consist of marine clays and marls (Pliocene and Early Pleistocene), up to 800 m thick. The marine sedimentary succession, accumulated in the depressions formed during the extensional tectonics of the Tyrrhenian margin of the Apennines, is overlain by epicontinental sediments deposited during the subsequent, progressive, crustal uplift. Starting from about 0.8 Ma the Sabatini Mountains and Alban Hills volcanic complexes produced different rocks; in fact stratified lavas and pyroclastic flow, surge and fall deposits, are widespread throughout Rome (Fig. 2). These volcanic products alternated with sedimentary deposits and both were submitted to a very complex interplay of erosional and depositional processes during sea level fluctuations, tectonic displacements and volcanic activity (Luberti et al., 2017 and references therein).

The emplacement of volcanic products changed the topography and hydrography of the area (Heiken et al. 2005 and references therein): the ancient streams and the Tiber trunk (known as "Paleotevere") progressively moved towards the Monte Mario-Gianicolo ridge.



Legend

- Recent alluvial deposits
- Pyroclastic deposits
- Transitional and continental deposits
- Marine deposits

Seven Hills

- 1 Capitolino
- 2 Palatino
- 3 Celio
- 4 Aventino
- 5 Quirinale
- 6 Viminale
- 7 Esquilino

Fig. 2 - The main outcropping lithologies of the city centre (modified after Del Monte et al., 2016, whose study area is marked by the blue line). The main valleys of Tiber River and its tributaries are recognizable, as well as the main ridges. A: trace of the geomorphologic cross section in Fig. 3. Upper-left corner coordinates: 41° 57' 56" N, 12° 25' 13" E.

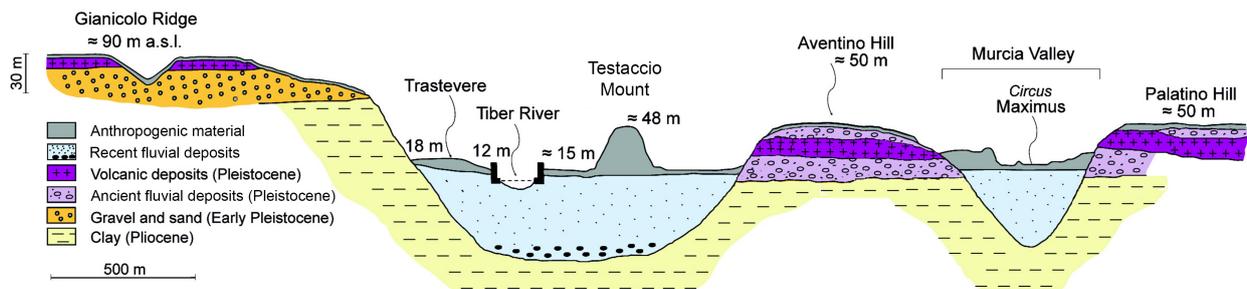


Fig. 3 - A schematic cross section along the city centre showing the main geomorphological features of the area (modified after Del Monte et al., 2013). The trace of the cross section is marked in Fig. 2.

The last change of both the Rome urban area and the facing coastline is connected to the development of the TR hydrographic network during the major sea-level lowering, in correspondence of the Last Glacial Maximum (LGM). The significant drop in sea level induced strong erosional processes; in the city centre, the TR and its tributaries cut into the Plio-Pleistocene succession to an elevation of 50 m below the present sea level. During the following post-glacial sea level rise (17-5 ka; Bellotti et al., 2007), alluvial sediments, up to 60 m thick, were deposited (Bozzano et al., 2000; Ascani et al., 2008) (Fig. 3).

During the last three thousand years, human activities contributed to remodelling the topographic surface, profoundly modifying the hydrographic network and depositing almost everywhere a large quantity of anthropogenic heterogeneous and heterometric materials, deriving from various types of waste, fragments of bricks, tiles, amphorae, etc., all incorporated into a finer matrix, made up of volcanic, alluvial and colluvial materials. This "anthropogenic layer" continuously covers the entire Roman area, with a thickness that can vary from a few centimetres to several metres or even tens of metres in the valley bottoms (Del Monte et al., 2016).

3. METHODOLOGY: MULTI-DISCIPLINARY AND MULTI-TEMPORAL GEOMORPHOLOGICAL INVESTIGATIONS

The investigations, aiming at reconstructing the natural landscape of the city centre together with the main anthropogenic topographic and hydrographic modifications, were performed over several years, during which a detailed geomorphological survey and multi-temporal analysis of aerial photographs and topographic maps were carried out.

To obtain information on morphological changes over longer periods, the geomorphological survey was supported by the analysis of aerial photographs (stereoscopic and non-stereoscopic) taken in the last 80 years.

The results of the aerial photo analysis were matched with the geomorphological study of the 'Piano topografico di Roma e Suburbio', a topographic map surveyed in 1907 for the Urbanisation Plan of Rome, and updated in 1924, at 1:5000 scale with a contour interval of 1 m (IGM, 1924). Furthermore, in order to detect ancient modifications to the topographic surface, the analysis of historical cartography was conducted using both the available previous maps, surveyed with trigonometric methods, and other maps without contours and having planimetric precision. Among them, we included the maps by Moltke (1852) and Presidenza del Censo (1839); moreover, the *Urbs* map by Nolli (1748a), even though it only covers the area inside the imperial city walls.

In addition, more ancient 'bird's eye' maps were useful to detect some landforms (e.g. Dupérac, 1577; Falda, 1676; Frutaz, 1962). Moreover, important information on missing natural landforms was obtained from paintings and further iconographic documents.

A number of old papers were also consulted, such as historical books, archaeological papers and the ar-

chaeological map of Rome of Lanciani (1893-1901). In order to collect relevant information to the study of the geomorphologic characteristics before the man-made modifications, many recent studies on the ancient topography of Rome (e.g. Quilici, 1990) were examined, as well as the preliminary archaeological results from the works for the construction of the metropolitan railway line C (San Giovanni underground station explanatory panels, edited and organized by MiBACT and Roma Capitale).

Locally, useful information about the thickness of the anthropogenic deposits, which mask natural deposits and landforms, was also collected from the drilling databases (Ventriglia, 1971, 2002) and some geo-thematic maps, such as the 'Anthropogenic deposit thickness' maps (Corazza & Marra, 1995; Ventriglia, 1971).

The spatial distribution of bedrock was traced according to the lithostratigraphic map of Ventriglia (2002) and also taking into account both other geological maps (Funciello & Giordano, 2008; Marra & Rosa, 1995) and a large body of literature.

4. THE FLUVIAL LANDSCAPE OF ROME OVER HISTORICAL TIME AND ITS ANTHROPOGENIC MODIFICATIONS

In the historical centre, the valleys crossed by the TR and its main tributaries today present a flat-bottomed configuration, due to both the depositional processes occurred since the end of last glacial and more recently the urbanisation. The main river plain (Fig. 4) extends, to E, at the foot of the slopes of the Pincio, Quirinale, Capitolino and Aventino hills, and to W at the foot of the Gianicolo-Monte Mario ridge. The main channels (including the TR) still show the effects of lateral and/or linear erosion, despite the erosion mitigation works operated.

On the west bank of the TR, the landforms shaped by the action of the surface running water are still very widespread throughout the area. The Monte Mario ridge is deeply furrowed by the Valle Aurelia, which slope progressively declines towards the TR, describing an anti-clockwise pattern near the Vatican City (Figs. 1 and 2).

A good number of the fluvial channels, in particular the smaller ones, are still in the linear incision phase. A series of small, narrow and deep valleys affects the slopes of the Monte Mario-Gianicolo ridge, on the top of which few outcrops of volcanic products are observed. Even small through-shaped valleys are quite common; their genesis is due to the combined erosional action of surface runoff and gravitational processes.

At the time of the foundation of Rome, Trastevere (*Trans Tiberim*), a flat area located at the foot of the Gianicolo ridge, was a marsh controlled by the Etruscans. Today's district lies entirely on the alluvial plain of the TR (Figs. 3 and 4).

On the left bank of the TR, the fluvial plain is overlooked by a relief summit slightly inclined, considerably dissected by the erosive action of the TR system and its tributaries. Today the main fluvial valleys, partially filled by the post-glacial alluvial deposits, show a similar shape, though obviously varying in size. For example,



Fig. 4 - Panoramic view from the Gianicolo Hill to NE (refer to Figure 2). The alluvial plain is visible in the middle of the picture, where the Tiber River is marked by the horizontal belt of trees separating the Trastevere and the *Campus Martius* districts. Beyond the plain, the Pincio and Quirinale hills represent the higher portions of the city in this photo. In the background, the Apennine chain.

the *Murcia Valley*, a small depression with a flat bottom (Fig. 2), perfectly straight for a length of two kilometres and about two hundred metres wide, represented an ideal natural landform for hosting a large stadium like the *Circus Maximus* (Del Monte et al., 2013; Del Monte, 2017).

The urbanization of this fluvial landscape started a long time ago. It is well known that the ancients began to build Rome on the legendary Seven Hills. The first villages were built on the hills closest to the Tiber River and Isle (Coarelli, 2001); these hills, some tens of metres higher than the Tiber alluvial plain, being characterized by steep slopes but rather flat summits, were easy to defend from enemy attacks and, at the same time, suitable to host stable settlements, being far from the marshes at the bottom of the valleys. Moreover, in this side of the TR, the erosional processes, already described in the previous paragraph, were and still are, of lower intensity and frequency (Del Monte et al., 2016). Thus, the Seven Hills and the other surrounding hills originated from the fluvial processes operated by the Tiber drainage system, which carved them during the Upper Pleistocene, and then were partially remodelled by natural and anthropogenic processes during the Holocene.

During modern times all the historic hills of Rome have changed their shape. In the historic centre, many of the small natural hills have disappeared, flattened or

buried up to the point that they can no longer be distinguished. And yet, as already seen (Fig. 3), the most relevant part of the historical hills, i.e. those that have not undergone a complete demolition by human activities, is detectable.

The anthropogenic modifications of natural processes and landforms have been relevant, in the city centre, at least since the 6th Century BC when the Servian Walls were built with tuff-rock blocks excavated from local quarries. When the urbanisation moved from the hills down to the plains, several land-reclamation works were put in place, among which the realisation of the *Cloaca Maxima* for the drainage of the *Velabrum minus*. Another significant Roman-age anthropogenic change was the excavation of the saddle between the Capitolino and Quirinale hills. Conversely, the removal of Velia Hill, located between the Palatino and Esquilino, was operated in AD 1932 (Insolera, 2001). Over two millennia, human activities, in addition to earthquakes, floods and other natural processes (Berti et al., 2004), have progressively covered the surface of the historical city centre with layers of materials made up of the remains of collapsed buildings, rubbish and the ruins of ancient temples and monuments mixed with colluvium and alluvium. The TR embankments, built in the last century, now protect the city centre from flooding.

Before the urbanisation, the *Urbs* territory was characterized by a rather dense hydrographic network,

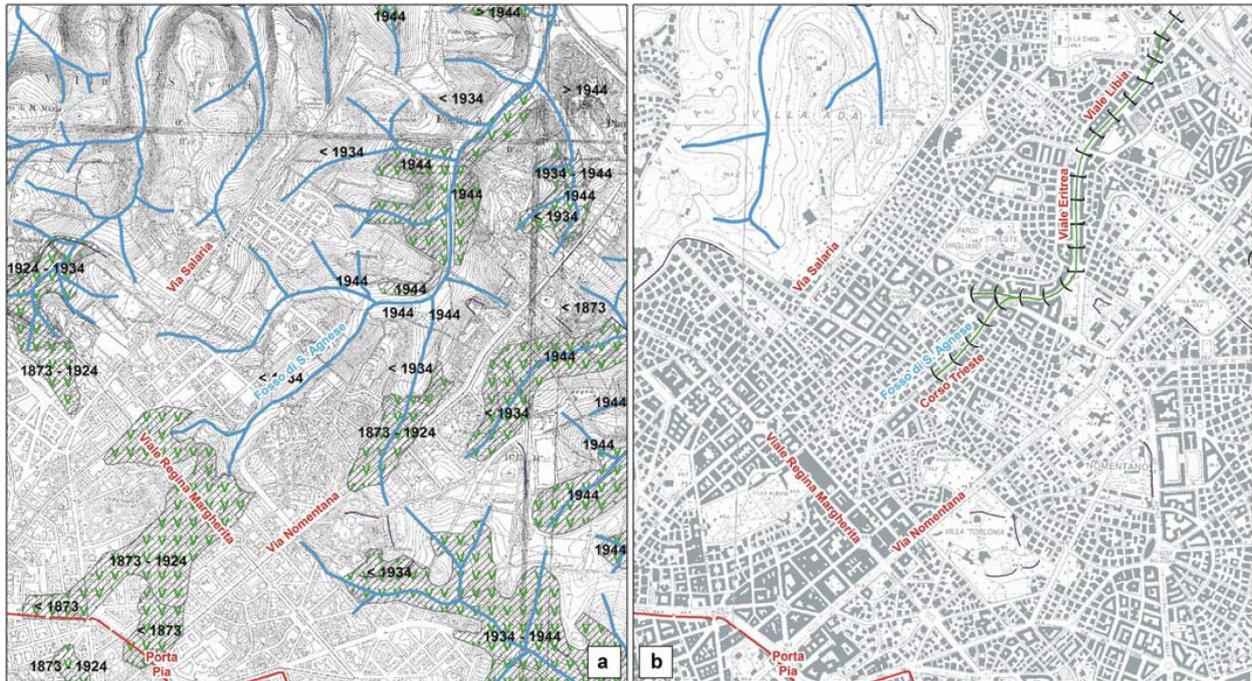


Fig. 5 - The Sant'Agnese valley landforms depicted: a) in the IGM 1924 topographic map (some 'disappeared valley' landforms, including the one at the watershed section between Porta Pia and Viale Regina Margherita, are highlighted), and b) in a recent topographic map (almost all the pre-existing valleys have disappeared, except for a few that were only partially filled by man-made deposits, so they are still recognizable although deeply modified). In both a and b: the red line in the lower-left corner marks the Aurelian city walls; upper-left corner coordinates: $41^{\circ} 56' 03''$ N, $12^{\circ} 29' 37''$ E.

whose channels drained the water of the respective watersheds. One of the most frequent forms - in the context of those modified by human activities - consists of partially filled river valleys, which have changed the shape of their natural valley section. These are valleys where the volume of anthropogenic deposits is often considerable, sometimes such as to reach a thickness equal to half (or even more) of the original altitude difference between the thalweg and the top of the slopes (Fig. 5). This type of modified valley sections (*sensu* Del Monte et al., 2016) is well represented in the historical centre: in the east side of the Tiber, the *Spinon* Valley (Lanciani, 1881), between the Palatino and the Capitolino, that of the Fosso Labicano, downstream and upstream of the Colosseum, the *Murcia* Valley, the Valle Giulia, further N, and other valleys of the Monti Parioli. Also, to W of the TR, some valleys, such as the Inferno-Aurelia Valley (Del Monte et al., 2016), exhibit a similar configuration.

Another type of anthropogenic landform well represented in the territory of the historical centre is a "disappeared" form (*sensu* Del Monte et al., 2016), or rather an anthropogenic landform that completely obliterated the pre-existing natural valley. It is a mostly flat or weakly undulating surface, under which a valley lies buried by huge quantities of anthropogenic filling deposits. In this case, its obscured (or invisible, *sensu* Clivaz & Reynard, 2017) landform (the natural valley) was detected by the authors after a multi-temporal analysis of topographic maps and aerial photographs. Its presence is more widespread E of the Tiber. The two landform

typologies (i.e. modified and obliterated valleys) are well represented just outside the city walls, along the upper part of the Sant'Agnese stream (Fig. 2), which from Porta Pia and Piazza Fiume stretched for miles to NE, ending in the Aniene River (see the valley in Fig. 2) after passing Viale Libia (Fig. 5).

5. THE AQUA MARIANA

The most relevant human interventions on the drainage network have been realized in the southern part of the city centre, in the area drained, in ancient times, by the most important left tributary of the TR within the walls. Its original path is known, with reasonable certainty, only downstream of the San Giovanni Basilica, and this valley stretch was covered by the ancient *Nodicus* stream (Lanciani, 1881; Corazza & Lombardi, 1995). Conversely, in many historical maps of the period between the 16th century and the first decades of the 20th century, the watercourse was indicated as *Aqua Mariana* or - improperly - *Aqua Crabra* (Frutaz, 1962, e.g. in Fig. 6). According to such historical topographic maps, there is no doubt that the *Aqua Mariana* has represented for centuries the only important tributary on the east side of the TR within the walls.

The *Aqua Mariana* stream originated from the volcanic system of the Alban Hills, near to the Lake of Castel Gandolfo, being part of its centrifugal drainage network (Fig. 7).

From the Marino village, close to the volcanic crater, the stream flowed to NW on the volcanic flank, down

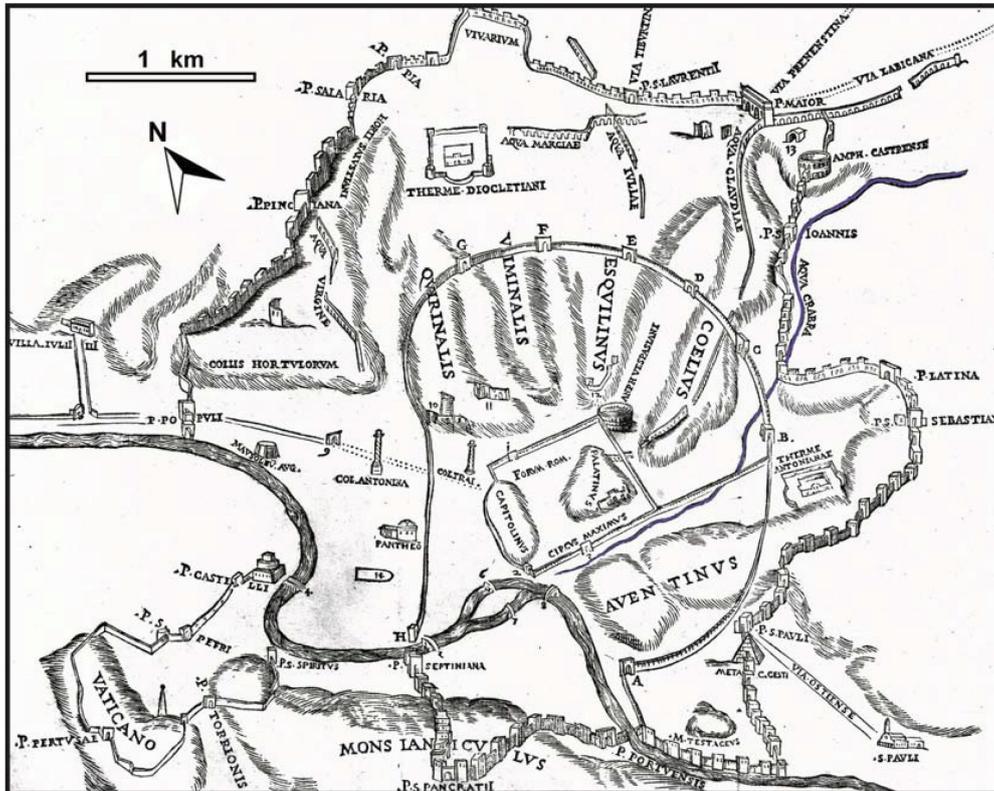


Fig. 6 - The AD 1565 topographic map by Bernardo Gamucci, who depicted the ancient city (*Urbs*). The *Aqua Crabra* (blue line) is drawn as the only Tiber River tributary, as it actually was at the time of the author. (Modified from Frutaz, 1962).

to the San Giovanni and Porta Asinaria gates (D in Fig. 8, and Fig. 9), located close to the San Giovanni Basilica (4th century AD). From that gate, the stream flowed S of the Celio Hill and out of the Aureliane Walls (whose whole circuit is shown in Fig. 6), built in the 3rd century AD. At the Porta Metronia gate (C in Fig. 8), it entered into the city. Here, the stream direction varied to NW, passing in the *Murcia* Valley (B in Fig. 8), the wide and long fluvial depression facing the Tiber Valley carved by the ancient *Nodicus* stream and exploited by the Romans for the *Circus Maximus* construction. The *Aqua Mariana* flowed into the TR (A in Fig. 8), in front of Tiber Isle. For over a century the terminal stretch of the river has no longer been visible, due to urbanization interventions.

Archive resources attest that the *Aqua Mariana* was actually an artificial stream, created in the 12th century AD, diverting a tributary of the *Aqua Crabra* River (Fig. 7), which was a natural stream, to the *Murcia* Valley and then to the TR. In ancient times, according to the Medieval sources, the *Aqua Crabra* flowed to N, in the Aniene River. The *Aqua Crabra* was reported by Frontino, 'curator of the waters' at the time of Vespasian, to be the third river of *Latium vetus* in importance, after the Tiber and

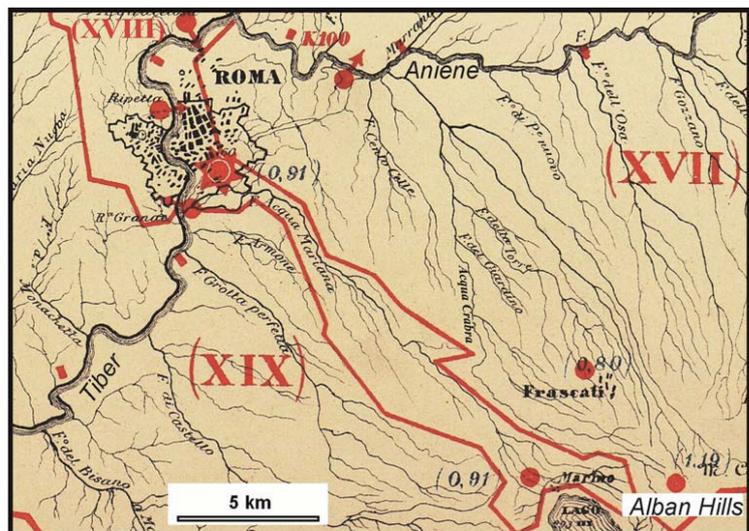


Fig. 7 - Drainage network of the SE suburban area of Rome at the end of the 19th century AD. The red lines subdivide the portion of the Tiber River Basin represented in this image in three main sectors: sector XVII borders lower basin of the Aniene River (including the *Aqua Crabra*); sector XVIII indicates the Treia-Rome mid-portion of the Tiber River Basin (including the *Aqua Mariana* sub-basin); sector XIX - borders the lower basin of the Tiber River, from Rome to its delta. Nord upward. (Modified from 'Hydrographic map of the Tiber-river basin' (Carta Idrografica del Bacino del Tevere: Anonymous, 1880) scale 1:259200, partial reproduction).

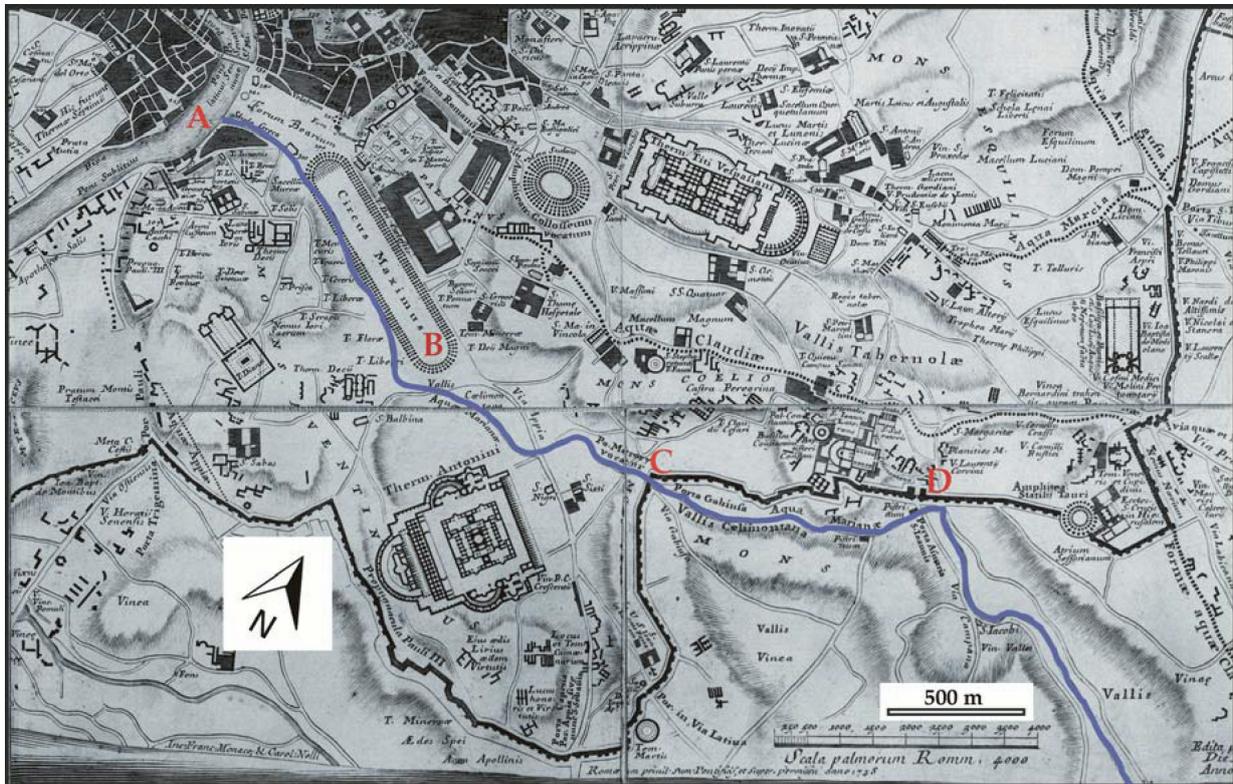


Fig. 8 - The urban portion of the *Aqua Mariana* stream, marked in blue, as depicted in the *Urbis Ichographiam* map by Nolli (1748b), here partially shown, modified. Legend: A) its confluence into the Tiber River; B) the *Murcia* Valley, where the *Circus Maximus* is located; C) the *Porta Metronia* gate; D) the *Porta Asinaria* gate.

the Aniene rivers. Therefore, it was judged by Pope Callistus II to be suitable for ensuring the water needs of the city within the Aurelian Walls, given the shortage of water that had passed since the 6th century AD, because of the damage to the ancient aqueducts operated by the king of Goths Witiges. The water deviation from the *Aqua Crabra* was made in the *Morena* area, using an underground section of the *Claudian* aqueduct and, downwards, channelling the water into an artificial riverbed, mainly built on ancient abandoned river sections (Lanciani, 1881; Anoscia, 2007; Bultrini, 2012; Capelli, 2015).

This hydrographic structure remained as previously described until the middle of the 20th century, when, because of floods affecting the urban area, the *Aqua Mariana* water was furtherly diverted to W, becoming part of the river basin of the *Fosso dell'Almone-Caffarella* (Capelli, 2015). After this second river deviation, the catchment area of the ancient *Nodicus*, the tributary of the TR that ran through the *Murcia* Valley, therefore seemed to return to the dimensions represented by Quilici (1990), and by Corazza & Lombardi (1995) (Fig. 10).

The geomorphological features and dimensions of the *Murcia* Valley, however, appear to conform to a much wider river basin

(Del Monte et al., 2013, 2016). Hence, the hypothesis that the original plano-altimetric configuration of the fluvial system belonging to the *Murcia* Valley and the *Nodicus* is different, at the time of ancient Rome, from

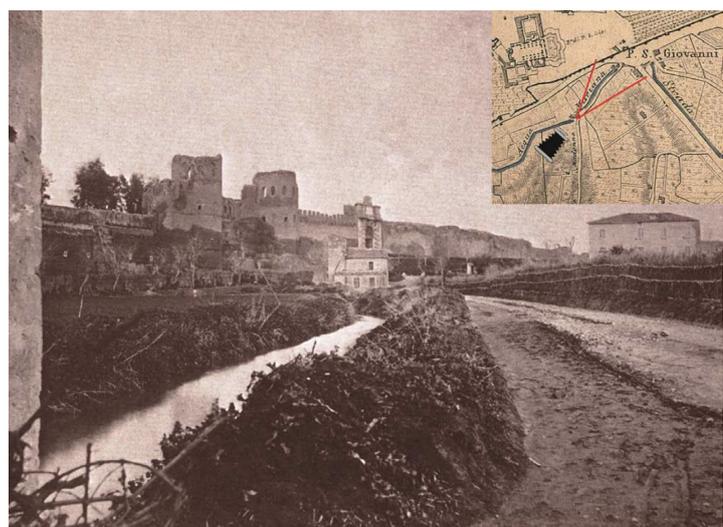


Fig. 9 - The *Aqua Mariana* stream flowing out of the Aurelian Walls, from the *Porta San Giovanni* white gate to the imperial-age *Porta Asinaria* towered gate. On the right, the *Vicolo delle Tre Madonne* road. The toponyms are depicted in the *Presidenza del Censo* map, 1839 (in the upper right box, partial reproduction). Photographer: anonymous, mid 1800s.

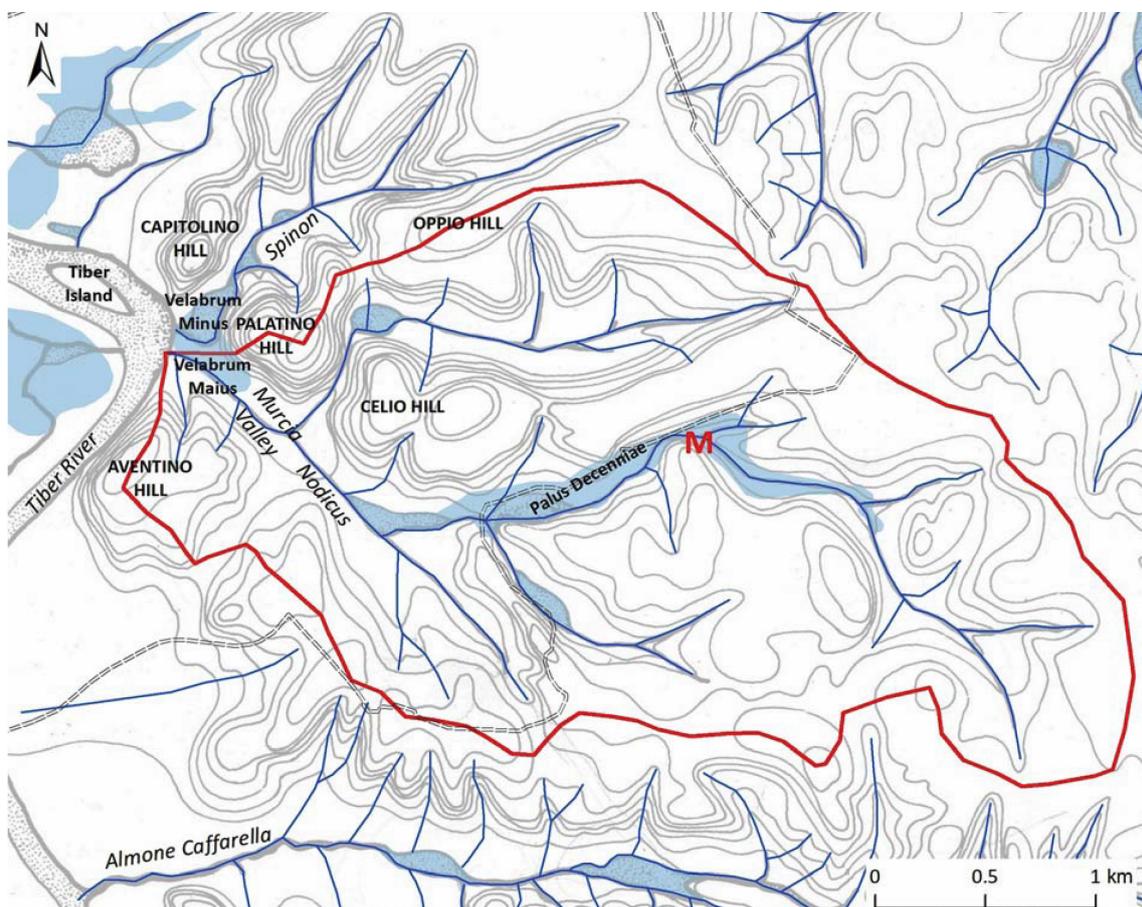


Fig. 10 - The *Nodicus* River Basin (red line) as delineated according to the pre-urbanization topography reconstructed by Quilici (1990). The red 'M' depicts the location of the 'Via La Spezia' site.

those reconstructed and represented by different authors (Quilici, 1990, Fig. 10; Corazza & Lombardi, 1995; Lombardi & Corazza, 2008), seems to be reasonable. Such a hypothesis is here argued by geomorphological, archaeological and geological evidences.

5.1. Geomorphological evidence

The morphology of the *Murcia* Valley and minor valleys belonging to its river basin, as well as the development over time of the hydrographic network, undoubtedly derive from both the erosional fluvial action occurred up to the Last Glacial Maximum and the subsequent sedimentation by a natural river system (Del Monte et al., 2013, 2016). At the bottom of the valley between the Palatino and Aventino hills (Figs. 10, 11 and 12), the *Circus Maximus* would have found optimal positioning (Fig. 8), thanks to the considerable width and the particular shape of the *Murcia* Valley (Fig. 12). In the portion of the TR alluvial plain close to that valley, the *Velabra* marshes were originally located, and after land reclamation the *Forum Boarium* was built in that flat area (Figs. 10 and 11). The downstream confluence of the *Nodicus* might have favoured a lowering of the fluvial current of the Tiber, determining the sedimentation of solid load and the formation of the Tiber Isle (Del

Monte et al., 2013). According to Marra et al. (2018), the Tiber Isle origin might have been triggered by the eastward diversion and loss of energy of the Tiber stream, as a consequence of the sudden collapse of the *Forum Boarium* area because of fault displacements. At this regard, it is to underline that the collapse of the *Forum Boarium* area would more likely have determined an increase in slope and fluvial power, favouring the erosion upstream. Conversely, fluvial deepening effects can be observed just downstream of Tiber Isle, e.g. on the west flank of the Aventino Hill. The eastward migration of the Tiber stream might be simply due to the normal fluvial dynamics, during a free meandering phase.

Some reconstructions show (Lombardi & Corazza, 2008) the trunk of this ancient river system would seem to come from the area where the Colosseum was built, i.e. from the narrow Labicana Valley that separates the Oppio and Palatino hills from the Celio (Fig. 10). Numerous other sources (Lanciani, 1881; Quilici, 1990; Corazza & Lombardi, 1995) and the current morphology show instead that a wider valley section - similar to that of the *Murcia* Valley - comes from SE, along the same direction (Fig. 10). Thus, the valley located between the Oppio-Palatino and the Celio, comparable in size to the *Spinon* Valley, would have been, in reality, travelled by a

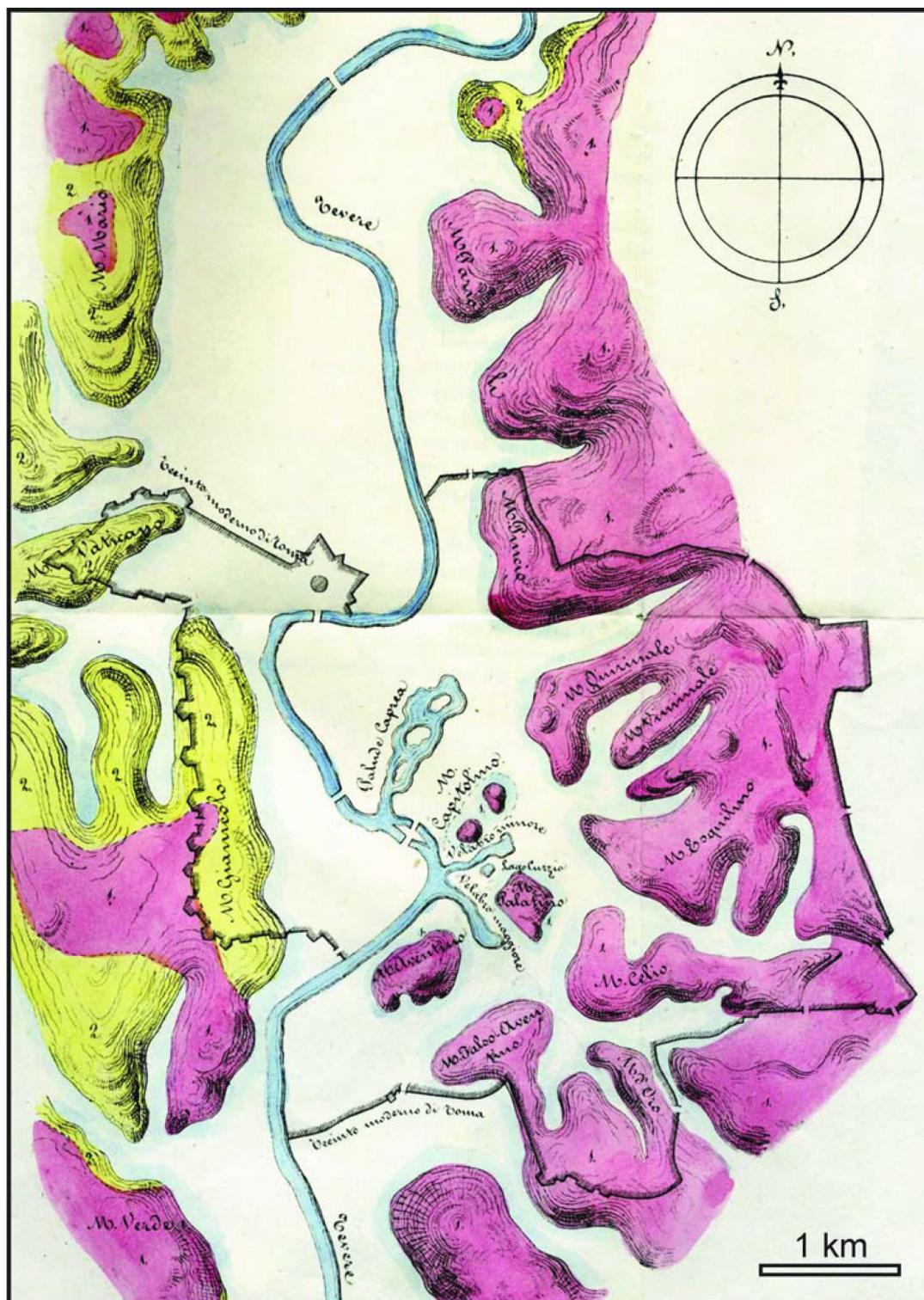


Fig. 11 - The geological map drawn by Giuseppe Ponzi in 1850 (partial reproduction of the original sheet, ISPRA Library). The map is useful to depict the landscape of the city centre. Numbers and colours refer to the main lithologies: 1. Volcanic tuffs (fuchsia); 2. sands and gravels (yellow). The light-blue colour around the Tiber River represents the 'level of the water at the ancient diluvium time', even if the map shows the walls of the city. According to the author, at the 'diluvium time' the water level was some tens of metres above the present-day level of the Tiber River, so covering the alluvial plains and the lower portions of the hills.

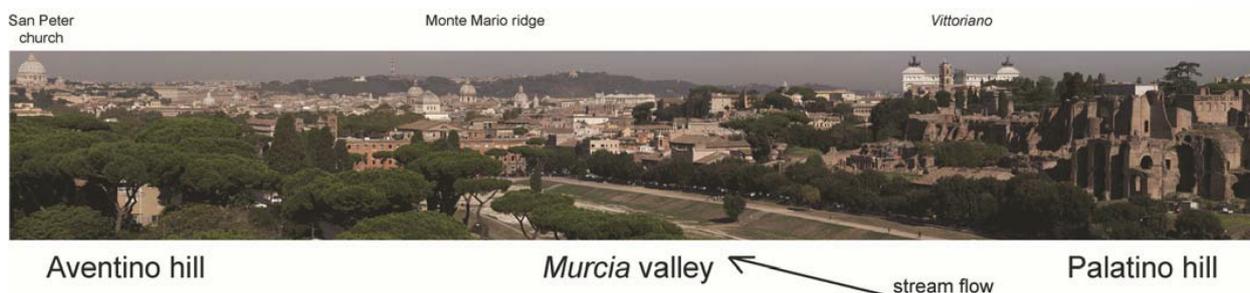


Fig. 12 - View of the Murcia valley. The photo was taken from the Terme di Caracalla area (F.A.O. building) to N.

small right tributary of the *Nodicus*.

5.2. Archaeological evidence

According to Lanciani (1881), the upstream portion of the Murcia Valley was actually travelled by the *Nodicus* River, which, in the area that then hosted the Baths of Caracalla, received the contributions of many tributaries. The main trunk seems to come from the E (Fig. 10), where, according to Lanciani (1881) and Gnoli (1939), there was a marshy area (*Palus Decenniae*), whose existence was later confirmed by archaeological excavations (Demetrescu et al., 2011). Such archaeological and geognostic investigations, connected to the construction of the metropolitan railway line C, highlighted frequent protohistoric floods in the area around the *Palus Decenniae* (Fig. 10), confirming the hypothesis that a considerable water course passed, in antiquity, in the stretch between Porta Metronia and Porta Asinaria, just in correspondence of the artificial riverbed that would have been created for the outflow of the *Aqua Mariana* artificial stream (Fig. 9).

Moreover, more recent archaeological investigations indicate that in the 'Via La Spezia' site (depicted in Fig. 10) in the 3rd century BC a bank with a length of more than 130 m and direction NE-SW was put in place in order to defend roads and crops from the floods, and an artificial basin 70x35 m wide and with a mean depth of 2 m, dating 1st century AD, was revealed, about 15 m below the present-day ground level. It is the widest Roman-age artificial basin that has ever been discovered. Artefacts that were recovered within the basin suggest that it was both a water storage and fish farm basin. At the end of the 1st century AD the farm was abandoned and the basin filled with anthropogenic deposits. From the end of the 2nd to the beginning of the 4th centuries AD relevant land-reclamation works were made (Ministero dei beni e delle attività culturali e del turismo - Ministry of Cultural Heritage and Tourism, 2018).

Owing to the abovementioned evidence, it is reasonable to state that about two thousand years ago, this river had to be very important, both for the extension of its basin, and for river flow and power.

5.3. Geological evidence

The *Nodicus* River, according to the geological evidence, had the greatest fluvial energy, compared with those of the other streams in the *Urbs*. At the *Cir-*

cus Maximus a 12 m thick gravel stratum with thin interbedded clay layers was shortly described by Signorini (1939). An erosional surface separates it by the underlying Pliocene deposits. According to the interpretation given by Ventriglia (1971), this body is part of the fluvial sedimentation that took place after the Last Glacial period, i.e. Upper Pleistocene-Holocene. Recently, Marra et al. (2016) geochronologically determined that the deposition of the basal gravel stratum in the Rome's basin occurred between the Last Glacial Termination and the Meltwater Pulse 1a (Stanford et al., 2011), i.e. during the uppermost Pleistocene. This stratum is generally up to 10-15 m thick, even in the TR urban sections (Bozzano et al., 2000; Marra et al., 2008, 2013). However, the gravel stratum is very often missing in most of the Tiber tributaries S of the Aniene confluence, or it is very thin. In the city centre, a less than 5 m thick gravel stratum was detected at the Colosseum, but it is not clear whether it is referred to Paleotiber gravels deposited at the beginning of Middle Pleistocene, as suggested by Bozzano et al. (1995) or to the uppermost Pleistocene deposits, as stated by Pagliaroli et al. (2014). Since Corazza (2012) reported that gravels detected in a borehole located before the confluence of the Colosseum stream in the Murcia Valley are just made of calcareous and siliceous centimetric clasts, whereas the gravels at the *Circus Maximus* are composed of both calcareous and siliceous, and tufaceous clasts up to 6-7 cm, it is more likely that only the gravels detected in the Murcia Valley are related to the Upper Pleistocene early sedimentation of materials partially eroded from volcanic rocks, whose massive eruptions started not before 600 ka (Luberti et al., 2017). These geological data imply that the *Nodicus* was surely the greatest river within the *Urbs*, in terms of rate of flow and energy, with the obvious exception of the Tiber.

The thickness and the fining-upward stratigraphic succession of the whole MIS 1 fluvial deposits in the Murcia Valley are similar to those of some downstream Tiber's tributaries that are characterised by much greater hydrographic basins. Among them, in the Fosso di Vallerano Valley ('F. di Castello' in Fig. 7), which is approximately 10 km S of the city centre, the uppermost-Pleistocene basal polygenic gravels up to 10 m thick were detected about 1 km from its confluence into the TR (Bozzano et al., 2016). However, the Fosso di Vallerano basin, which originates from the Alban Hills close to

Castel Gandolfo village, is 67 km² wide and its main stream is 23 km long. For comparison, the Fosso di Grottaperfetta basin, about 4 km S of the city centre, is 14 km² wide and the length of its main stream is 11 km (Ventriglia, 2002). In that valley several boreholes located about 1 km from the Tiber plain detected a very thin gravel stratum up to 3 m thick just in the central portion of the Upper Pleistocene palaeovalley. Moreover, the fining-upward deposits are characterised by several peat layers (Cinti et al., 2008).

6. CONCLUSIONS

Taking into account the evidence above discussed, it is reasonable to assume that the ancient fluvial basin belonging to the *Murcia* Valley was much wider than that inferable from the current topography and those reconstructed from the studies of Quilici (1990) or simply represented in Corazza & Lombardi (1995), and Lombardi & Corazza (2008), all belonging to an area that is too limited.

The main water course, before reaching the *Murcia* Valley, was very likely to follow the outflow direction then followed by the *Aqua Mariana*, the artificial channel that was built in the 12th century AD (Fig. 7). In other words, Pope Callistus II may have restored, we do not know how consciously, a natural outflow line, in the same place where it naturally developed and was still active at the time of Romulus.

The shape and size of the *Murcia* Valley, decidedly disproportionate to the modest dimensions of the water catchment area that can be deduced from the present day topographic map, confirm the importance of the ancient river that ran between the Aventino and the Celio-Palatino up to about two thousand years ago.

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