

Florence: the geometry of urban form

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Revised version received 23 March 2017

Abstract. *Unlike Rome, a city that originated from the union of various villages, Florence is a typical city of Roman founding, which reached the peak of its development around the year 1300. At that time an ambitious plan for the city, aimed at housing within the city wall a large number of inhabitants was put into effect. It was rivalled at that time in Europe only by Paris. As in Rome, pre-existing structures heavily influenced the subsequent development of Florence: from a methodological perspective this would suggest that to 'read' the city, it is necessary to identify its 'substratum permanent structures'.*

Keywords: Florence, substratum permanent structures, city wall, city planning, historical transformations

Until our forgetful and inattentive times, humanity tried to maintain, as far as possible, the inherited structures, making them evolve organically, never negating their presence and continuity (Caniggia, 1990, p. 21).

In all regions of the Roman Empire, civilization has left numerous and varied structural traces (fortified boundaries, roads, canals, aqueducts, agricultural divisions, farms, villas, military camps, villages, colonial cities, to name a few). Their topographical presence is still clearly documented on maps and aerial photographs. Their reuse over the centuries may be viewed as a record of the long-term performance of Roman planning. This may be linked in part to the assignment to Roman settlers of ownership of property to an extent almost unknown elsewhere in the ancient world.

Not unlike London, Paris, Vienna and many other European cities, Florence was originally a square-shaped military encampment (*castrum*) with two orthogonal roads, four gates and four angular towers (Dilke, 1971; Rykwert, 1981) (Figure 1). This was

the embryo of the city, which in the course of a few decades became a *colonia*, a change which entailed a radical modification of its territory. Colonization had a twofold aim for the Romans: military control of the subjugated regions, with a network of straight roads converging on Rome, and their integration by territorial planning. Before dividing and assigning plots to settlers, it was necessary to prepare the land. The complex of techniques adopted by the Romans to that end was called in Latin *centuriatio* (or, more usually, *limitatio*), a term derived from *centuria*, the base module of agrarian divisions. A square with sides of 710 m (corresponding to 2400 Roman feet), was divided into equal-sized parcels (*sortes*), their number depending on the number of settlers, many of them soldiers from the *castrum*, who, when discharged, received a parcel of land as their permanent property.

The phenomenon of *centuriatio* is well known to historians, but less from a technical point of view. Its systematic employment on a vast scale would grant Roman civilization the status of a 'hydraulic civilization' (Wittfogel,

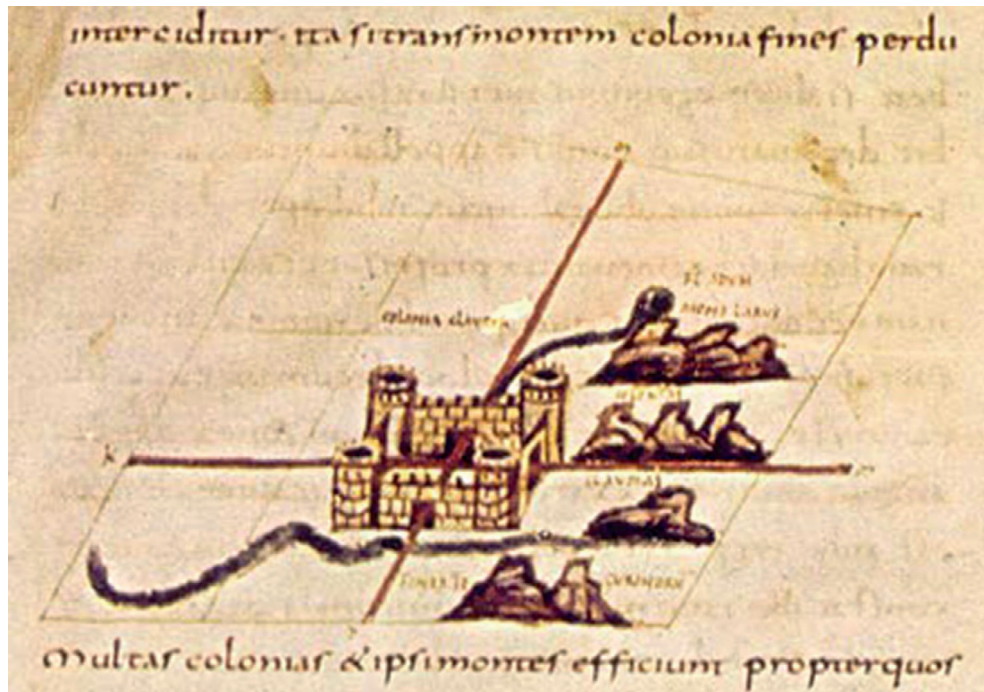


Figure 1. Iginus Gromaticus, *Corpus Agrimensorum*, *Colonia Claudia*.
Reproduced from Dilke (1971).

1980) alongside, for example, the Egyptian, Mesopotamian, Indian and especially Chinese civilizations, which, it would appear, shared various characteristics with the Roman world, such as ‘square geometry’.

The hydrographic control of surface waters is a complex matter. For this to be addressed and advantage taken of soil fertility, there was usually the need for planned infrastructural works, which in turn required the use of topographical maps indicating the characteristics of the areas analysed. Today’s satellite map of the Arno Valley (Figure 2) shows the plains largely north of the river and the orographic systems separating them. The era of communication along the ridges, which predates the founding of Florence, was one in which the Etruscan towns of Artimino and Fiesole controlled from above the caravan route along the valley floor.

The *Forma quadrata* theory

The *Forma quadrata* theory (Cataldi, 2016a; Cataldi *et al.*, 2000, pp. 4–12) aims at

identifying the technical steps that determined the planned organization of Roman territory. Various topographical and toponymic findings (Cataldi, 2016b) were interpreted and integrated, according to the new hypothesis concerning the planning procedures employed by the Roman land surveyors in their colonial planning (Dilke, 1971). To make the planning possible, they firstly would have needed maps (of course drawn according to the geographical notions of the time, and with the aid of the corresponding technical instruments) showing the form of the area. Employing the Indo-European *mundus* technique, a kind of primitive solar watch, consisting of a circle drawn on the ground around a pole (AA.VV, 1983, pp. 128–50; Rykwert, 1981, pp. 55–6), and through the use of the *groma*, a topographical instrument for tracing right angles, they were able to identify the cardinal directions (‘in accord with the sky’: *secundum caelum*). Through progressive alignments, the geodetic benchmarks of a square grid composed of meridians and parallels was identified as having its point of origin

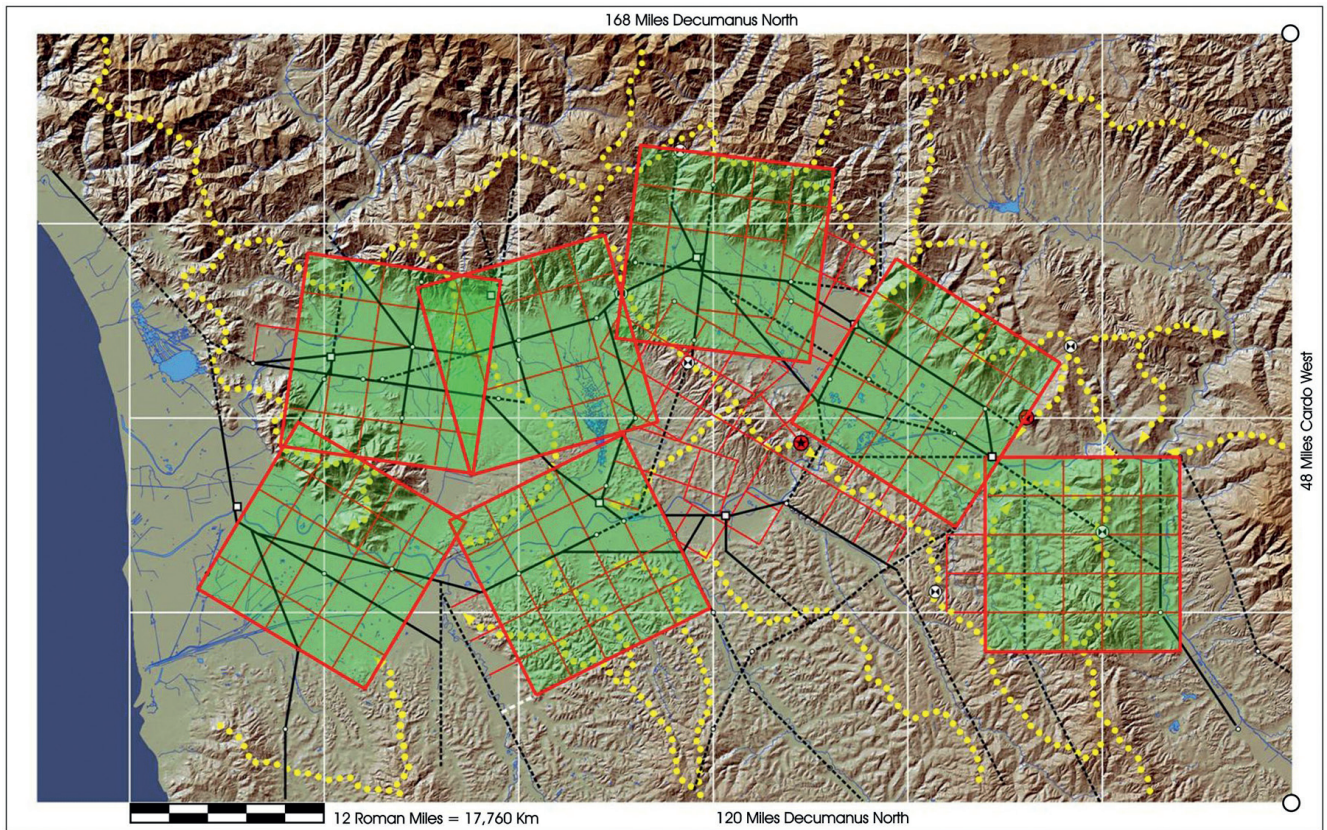


Figure 2. The Roman planning of the Arno Valley. Hypothetical reconstruction according to the *Forma quadrata* theory. Each square represents a single planned unit oriented *secundum naturam* in the direction of the corresponding straight stretch of the main road.

at the top of the Campidoglio, the historical seat of the Comune di Roma (Cataldi, 2004, 2006, 2016a). On such maps, conventionally referred to as *quadratae* ('square'), the Roman land surveyors planned colonial projects, choosing first the best direction for water runoff ('in accord with nature': *secundum naturam*) and tracing the two orthogonal axes as the basis of the system, the *cardo* and the *decumanus*. In parallel to these, the boundaries were traced and the parcelling of the land was determined. Using metrological analysis of the structural signs of Roman origin (mostly the alignments of straight paths), it was possible to reconstruct hypothetically on current maps the planned geometrical Roman layout of the Arno valley between Florence and Pisa (Figure 2). It was made up of a mosaic of large modular square tiles (the *colonial territories* with a side 12 Roman miles long), oriented in

accordance with the characteristics of the territory and forcing the two main routes to go through two vertices of the geographical system of co-ordinates. The geographical technique of 'squaring' the territory in meridians and parallels (Cataldi *et al.*, 2000, p. 8), aided by drawing with ruler and set square, allowed the preservation of angles and distances when the map was drawn at another scale.

Roman planning of the Florentine territory

The Roman planning of the Florentine territory (Castagnoli, 1948, 1993, p. 746; Schmiedt, 1989, pp. 27–8) is a model that illustrates well the *Forma quadrata* theory, due to its clear geometrical system, oriented on the basis of the geographical system of co-ordinates in accordance with the ratio of 7:11:≈13. The

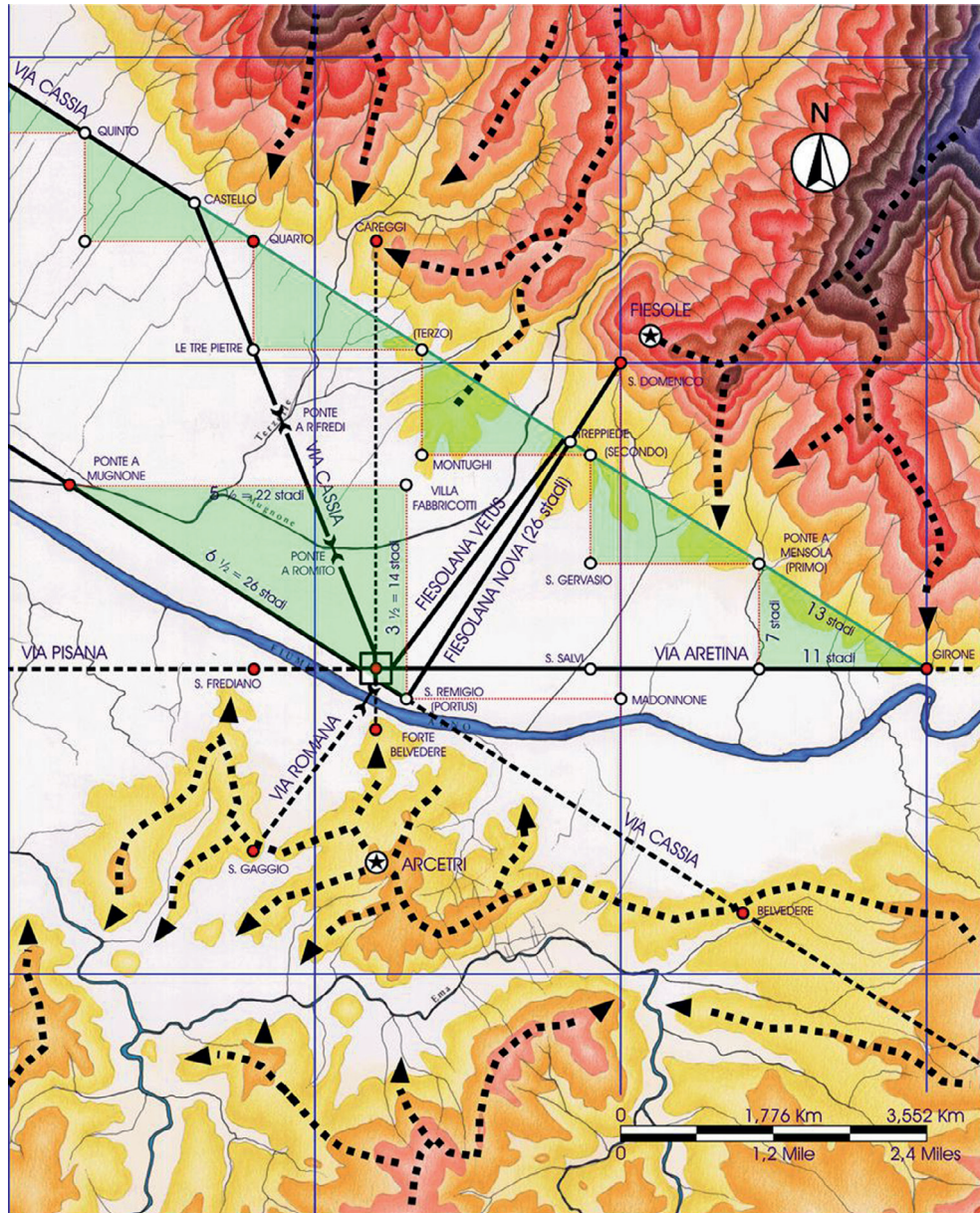


Figure 3. The construction of the *centuriatio* of Florence: main roads and control triangles. Hypothetical reconstruction according to the *Forma quadrata* theory.

use of sets of three numbers allowed Roman surveyors to check, with further subsequent triangulations, the precision of alignments and the control of right angles (Figure 3). This empirical method, based more on geometrical rules than mathematical notions, is likely to have been known also to ancient Chinese land surveyors (Granet, 1971, pp. 111–223).

On the maps and on the ground, the first lines to be drawn were of course the two main axes, aligned with the numbers of the ratio inverted (x/y and y/x) on four vertices of the co-ordinate system. Parallel to them were traced the boundaries of the colonial unit with a side of 12 Roman miles and the internal parcelling into *saltus* and *centuriae* (Figure 4). Quinary metrology, based on submultiples of

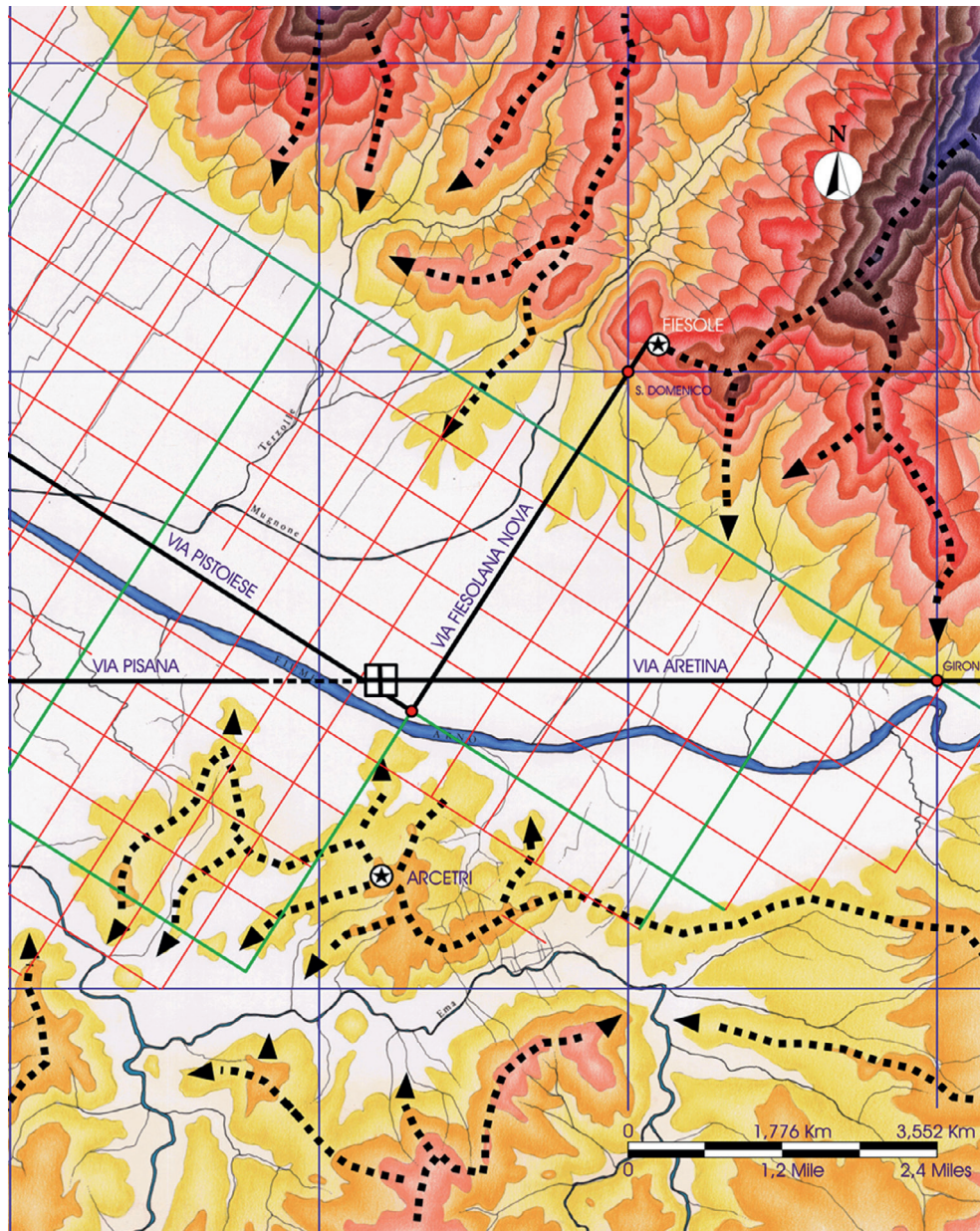


Figure 4. The *centuriatio* of Florence. Hypothetical reconstruction according to the *Forma quadrata* theory.

the number 5, had the advantage of allowing for a continuous check of the right angles of the parcels with the diagonal approximated to 7. Also in traditional Chinese land surveying the square with sides measuring 5 is one of the main 'magical squares' (Granet, 1971, pp. 111–23).

Summarizing, the Roman planning of the Florentine territory seems, on the basis of our

reconstruction, to have been carried out in the following order. First, the initial military encampment was placed close to the ford over the Arno, at the end of via Aretina, coinciding with a parallel of the geographic system of co-ordinates. Secondly, the *saltus* co-ordinate system was parcelled through geodetic benchmarks into *centuriae*; via Pisana continues beyond the river towards via Aretina. Thirdly,

via Pistoiese was aligned, beyond the western gate of the *castrum*, parallel to the river bed, between the two vertices of the coordinate system, chosen according to the ratio 7:11:≈13. Fourthly, via Fiesolana Nuova was traced with ratio inverted, through two other vertices of the system, linking the dock on the Arno to the ridge path leading to Fiesole. Fifthly, the grid of *saltus* was traced in parallel to the two axes of the base system. Sixthly, the grid of *saltus* is divided into *centuriae*. Finally, the extra-urban connection system was completed by new straight paths, usually traced diagonally between two vertices of the centurial grid (Figure 5).

The origins of the city: *Florentia quadrata*

Florence was created as a military encampment, a fact which left a permanent mark both in its urban fabric and in the collective

memory of its inhabitants, who, up to this day, identify the centre of the town with the 'Roman square' Piazza della Repubblica. This lies in fact on what was the *forum* of the colony, which in turn took the place of the *praetorium*, the main square of the military camp. The Roman city of Florence was a square with sides of 1000 Roman feet, with the four gates oriented on the cardinal directions and surrounded by a moat with rounded corners (Figure 6). The surface of the first core covered 1200 square feet (1/4 of a *centuria*) and its presence in the area was so rooted as to make it possible to hypothesize that the square structure of the *colonia* was the same as that of the *castrum*, and that the settlers (most likely the same discharged soldiers) just replaced the temporary structures of the military camp with the *domus*, and built the first public buildings in the *forum* (Caniggia, 1990; Corinti, 1976; Fanelli, 1973; Maffei, 2002).

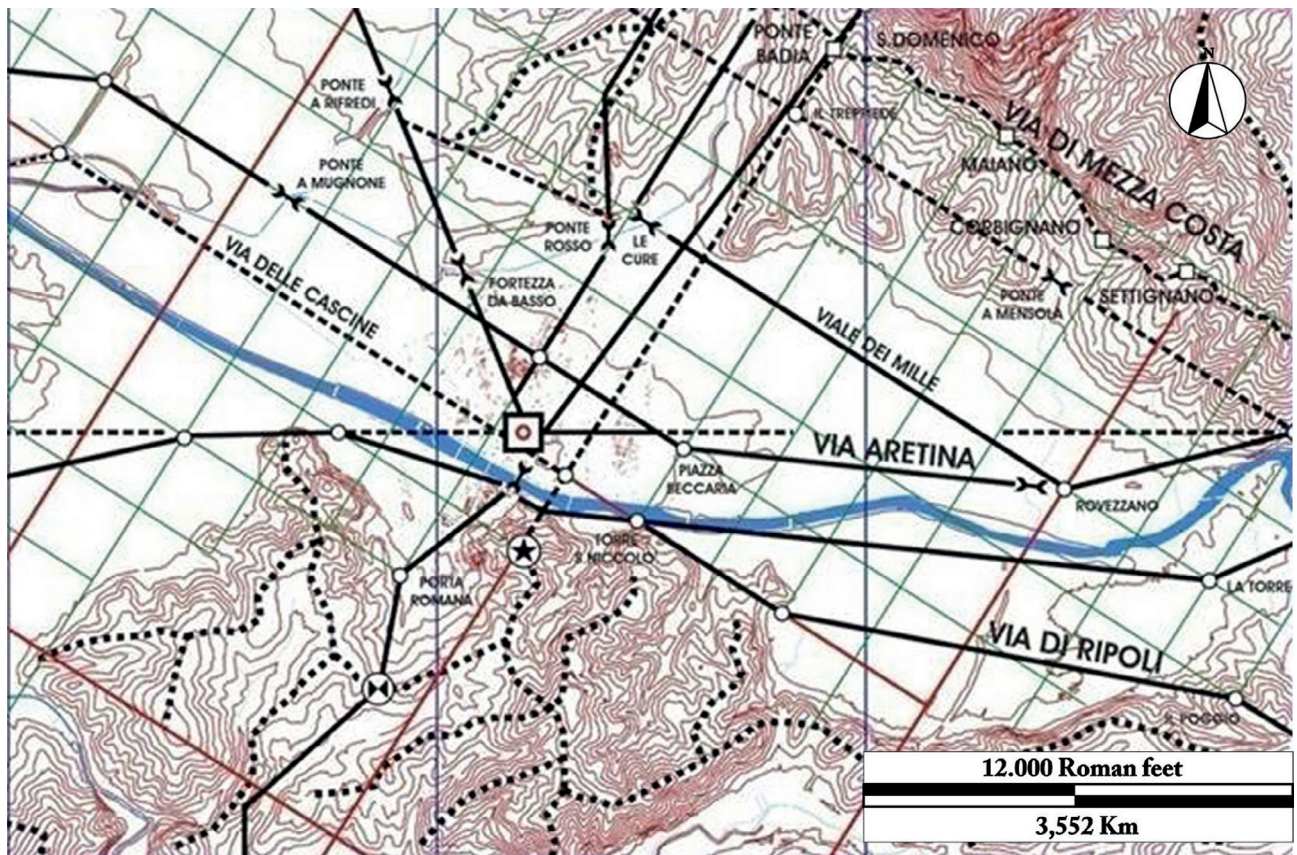


Figure 5. The Roman planning of the territory of Florence. Hypothetical reconstruction according to the *Forma quadrata* theory.

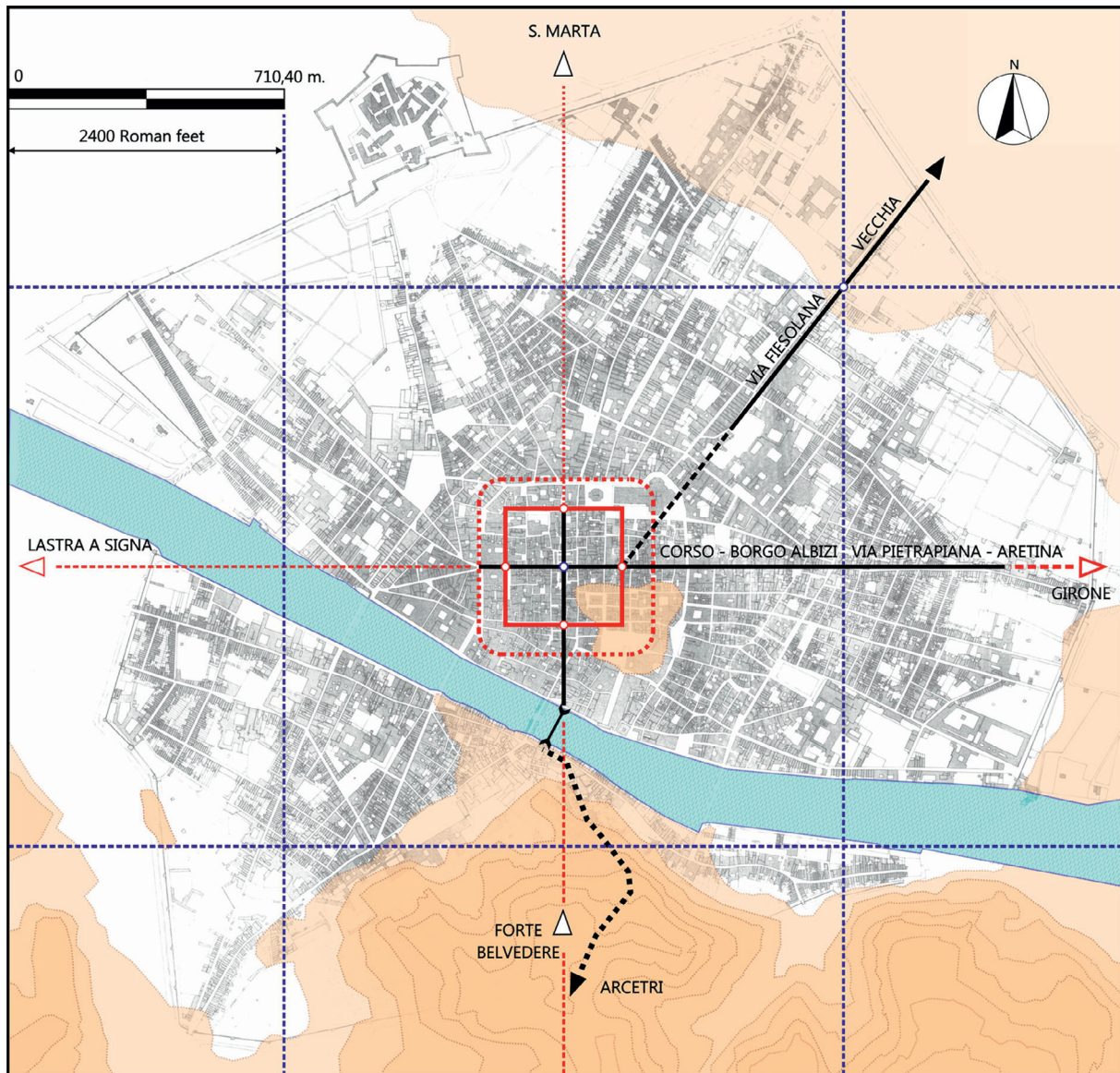


Figure 6. Florentia quadrata: the original *castrum*. The base map is the early-nineteenth century cadaster redrawn by A. Signa.

The biggest changes during this phase were represented by the works aimed at the planned organization of the colonial territory. Among these needs to be highlighted the presence of two ‘via Fiesolana’, the ‘old’ and the ‘new’, far from each other and not parallel: the first, traced from the *castrum* before *centuriatio*, passes through a vertex of the co-ordinate system, while the second, as main axis of the *centuriatio*, is oriented in the same direction as this (Figure 7).

The expansion of Roman Florence

A change concerning the administrative status of a city is usually a symptom of its growth and change. The institution of the Municipality, and a few decades later the founding of the Colony, which took place in the age of Caesar (Caniggia, 1990; Castagnoli, 1948; Maffei, 2002), was probably caused by a population increase. There was a doubling in the number of inhabitants and the enlargement of the city

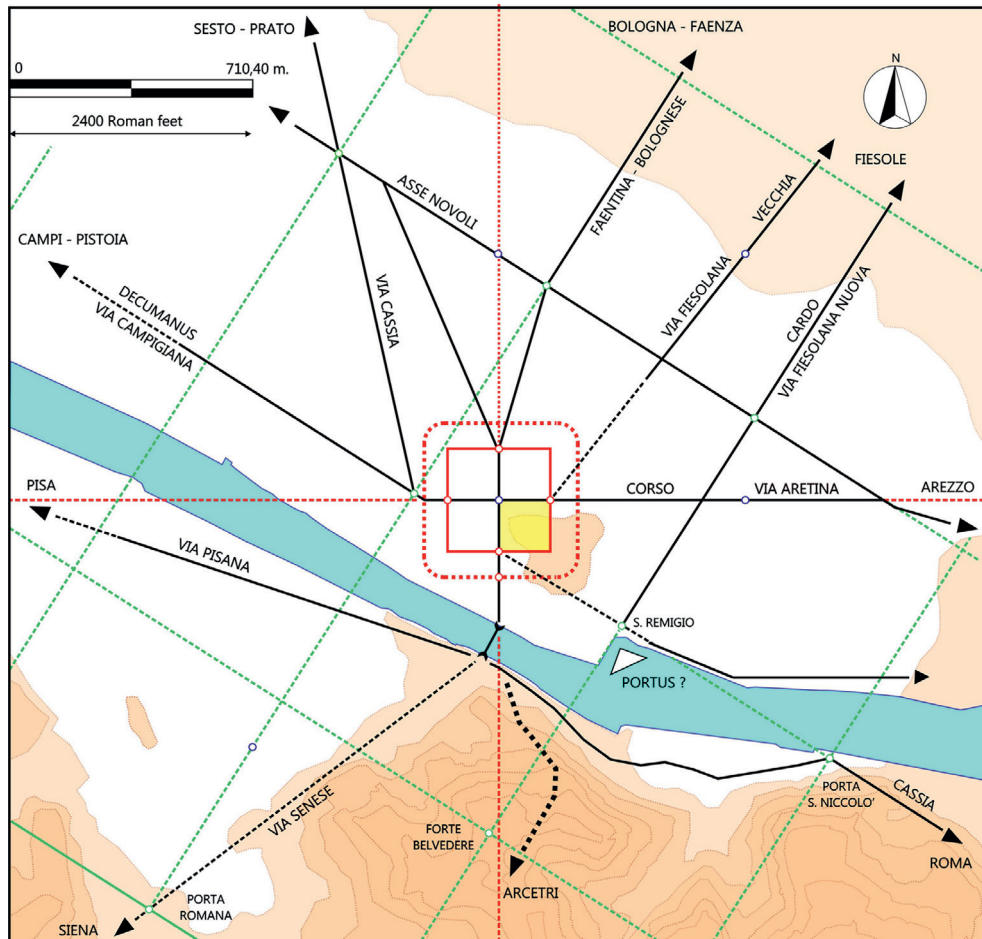


Figure 7. Roman Florence: the *castrum* becomes the *colonia*.

walls, which now encircled half a *centuria*. The layout of these walls follows the perimeter of important present-day streets (Proconsolo, Cerretani, Tornabuoni, Terme, Piazza San Firenze), which mark the inner fringe belt of the city (Conzen, 1960) (Figure 8). At the centre is still the *forum*, strengthening its hierarchical role with the architectural consolidation of the public space (Corinti, 1976). The *decumanus* is still the Corso, up to this day one of the most lively shopping streets in Florence. The *cardo* is replaced by a pair of streets crossing the *forum* on the short sides, of which the most important is (as confirmed by its toponym) via di Calimala (*Callis Maior*), leading to the bridge over the Arno. As for the geometry of the wall, the original square was replaced by a polygonal perimeter, which nevertheless did not affect the orientation of the blocks and the

urban fabric. The three main sides of the new wall are connected with an angle of 45 degrees by shorter sides: at the centre of the north-eastern one is the gate of the old via Fiesolana. The side facing the river is kept at a distance from it, taking account of the risk of flooding: its orientation (together with the orthogonal orientation of the contiguous section) appears to be the result of the choice of positioning at its centre the gate leading to the bridge.

Florence during the Imperial age

Until 161 AD, the year of the death of the Emperor Antoninus Pius, the Italian peninsula experienced a period of relative calm, both from a political and military point of view, which made unnecessary the enlargement of

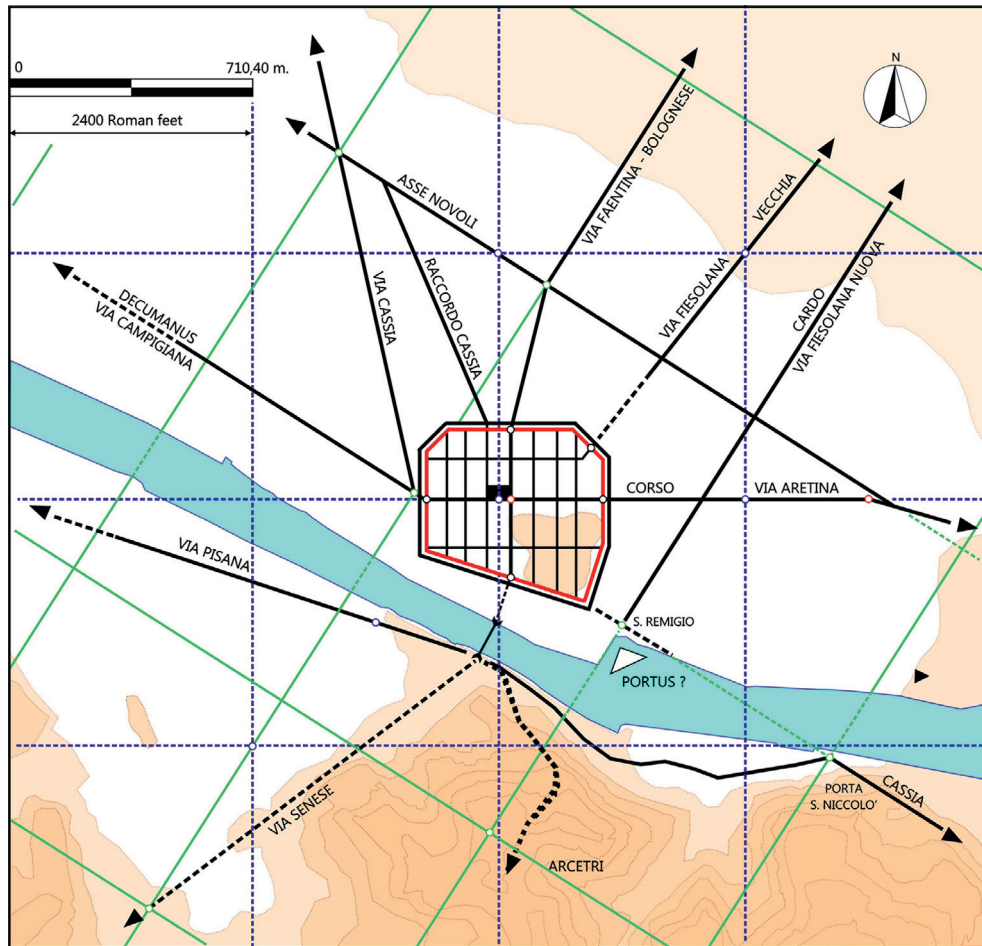


Figure 8. Roman Florence: the *colonia* becomes the *municipium*.

the city wall in connection with urban expansion. Florence (Figure 9) then covered for the first time areas parcelled in *centuriae*, beyond the inner fringe belt. In the south-eastern sector it reached the new via Fiesolana (which would become the new neighbourhood of Santa Croce) and the fluvial area, which was probably used for port warehouses and public buildings (baths). As for the remaining sectors, the northern one, which had always been the ‘weakest’, from a military point of view, was not involved in the urban expansion, except for the aqueduct along the via Cassia. The western sector, between the wall and the river, decayed, perhaps owing to limited space and the fear of flooding. Via Pistoiese, was perhaps obstructed, as hypothesized by Caniggia (Caniggia, 1990, pp. 27–9), by the building of the stadium, which determined the

opening of a new axis from the western gate towards the river (via della Vigna Nuova).

The stadium is a topographical hypothesis not supported by archaeological evidence. The amphitheatre is a case of ‘medievalization’ (Caniggia, 1963; Cataldi, 2016a, p. 55), being a big, ancient, special building, repurposed during the Middle Ages as basic buildings, and later split into three blocks by two streets converging on the new convent of Santa Croce.

The first communal wall

The expansion of Florence halted during the time of ‘barbarian invasions’. The inhabited surface shrank within the ‘Byzantine’, ‘Carolingian’ and ‘Mathildean’ walls, which basically follow the plan of previous Roman

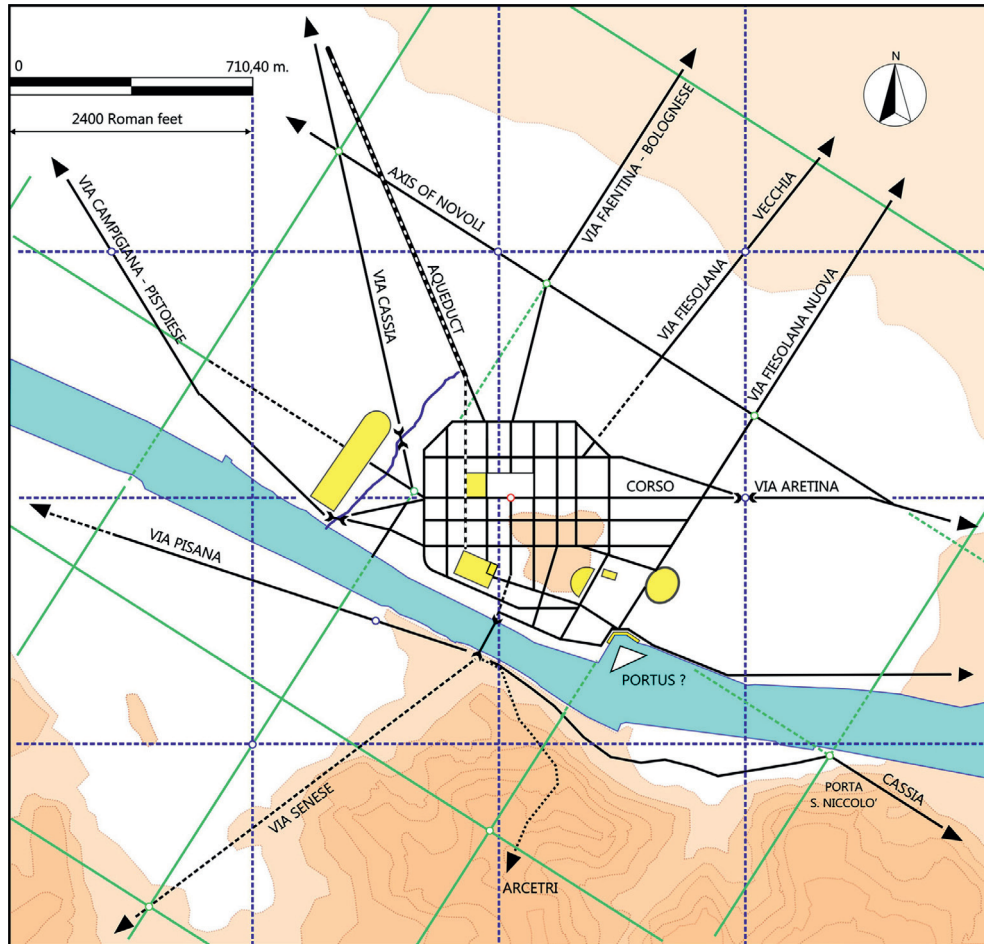


Figure 9. Florence in the Imperial age, showing special buildings.

walls, without affecting the form of the city (Bargellini e Guarnieri, 1985, vol. 1, pp. 12–13; Fanelli, 1973). Towards the end of the twelfth century, after the end of the conflicts between the papacy and the empire, and the rise of the free communes, the city began to grow again, and a wall twice the length of that of the Roman *Municipium* was constructed. It encompassed an area almost as great as that of a *centuria*, with a population of 35 000 – 40 000 inhabitants (Bargellini e Guarnieri, 1985, vol. 1, p. 14). It had a square base oriented in the direction of the *centuriatio* and thus comparable in orientation to the wall of the Roman city (Figure 10). This rotation evidently had the objective of achieving the best economic performance. The new walls contained a much larger number of gates (20, one for each path leading out of the city), the list

of which clearly indicates the greater length and complexity of the new defensive line, extending for the first time beyond the river, and encompassing strategic ridge positions. It also included, on the plain, the Roman amphitheatre. The network of extra-urban roads, was still basically the Roman one (Vagnetti, 1972, p. 81). Along the main branches from the city, the first boroughs started to develop linearly outside the gates. The inclusion of these would, in a short time, constitute one of the main reasons for the next development of the wall.

The second communal wall of Florence

A famous painting of Francesco di Lorenzo Rosselli (Figure 11) depicts Florence as it

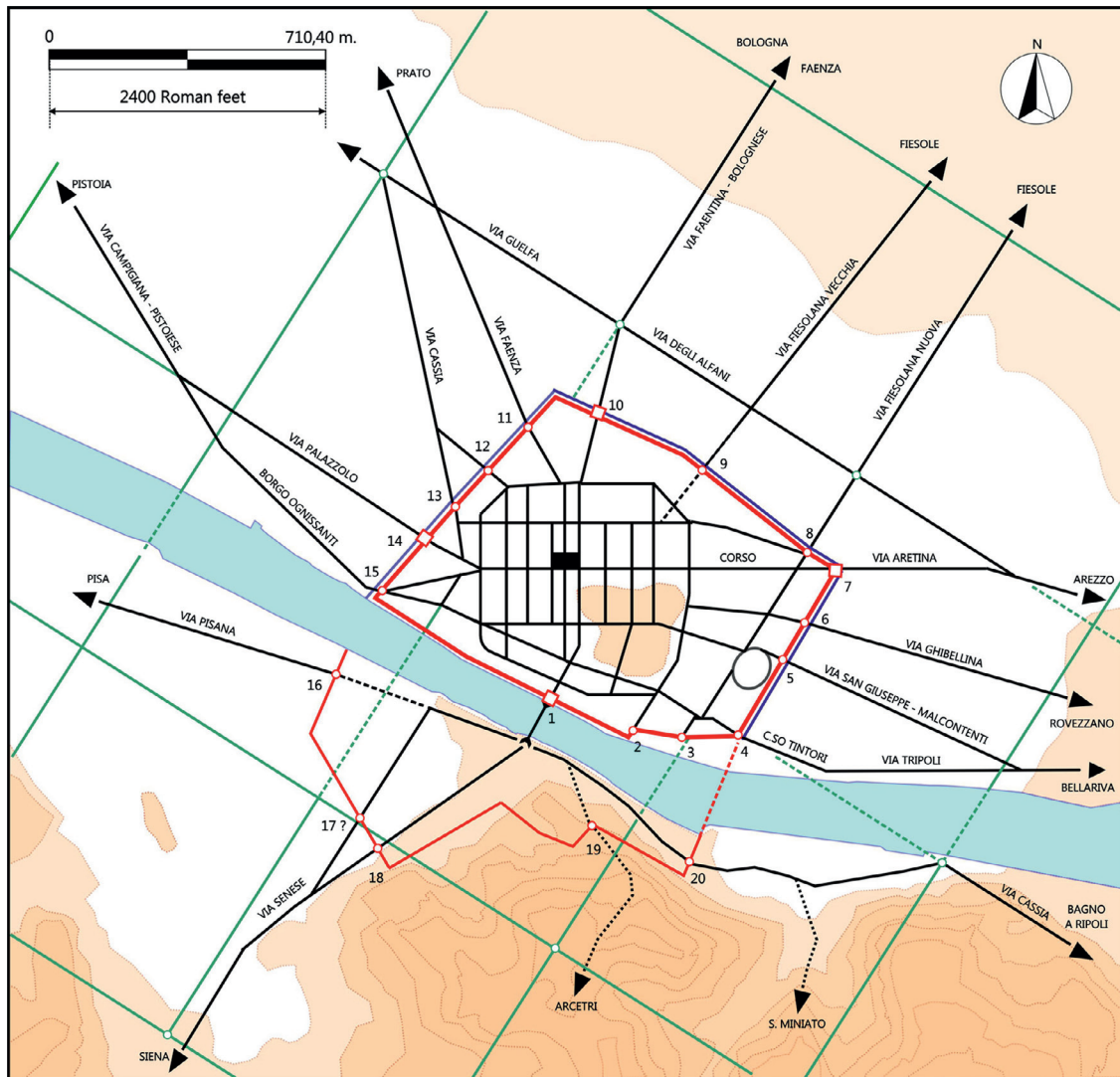


Figure 10. Medieval Florence: the first communal city walls of the late-twelfth century.

was at the peak of its development, at the end of the fifteenth century. This was 2 centuries after the start (1284) of one of the most ambitious European urban development plans. This can be considered the founding moment of the Florentine renaissance. It was the plan for the ‘great Florence’ by Arnolfo di Cambio (1245–1302). He was charged by the Comune to design the two main public buildings of the city: the communal palace (palazzo Vecchio, seat of the city assemblies) and the cathedral of Santa Maria del Fiore. His work on the cathedral, including the dome, was brought to completion by Filippo Brunelleschi (1377–1446) one and a half centuries later.

It is clearly an oversized plan (Figure 12): in the cadaster from the first decades of the nineteenth century (the underlay map of Figure 6) many marginal areas were still not developed. The initial forecasts of population and economic growth were not confirmed, for two main reasons. First, there was the political end of communal autonomy: it was drastically diminished by the course of European history, in which the centre of the Western world had shifted, after the ‘Hundred Years War’ between France and England (1337–1453). This stimulated the rise of the Atlantic nations, the economic power of which would grow exponentially after the discovery of



Figure 11. View of Florence, 1489–95, by Francesco di Lorenzo Rosselli (from Mediateca di palazzo Medici-Riccardi, Florence).

America (1492). Secondly, there was the spread in Europe of the ‘black death’ which, around 1350, reduced the population to one-half. This made redundant Arnolfo’s plan, aimed at hosting 85 000 inhabitants inside the wall (Bargellini e Guarnieri, 1985, vol. 1, p. 15). This caused Florentine bankers to invest their capital in art, contributing to the spectacular process of the development of Florence during the Renaissance (Goldthwaite, 1980).

For the realization of the new plan, a strategic role was played by the big conventional complexes, incentivized by the Comune to occupy the expansion areas within the wall, and thus function as a driving force for the new urban development processes, often alongside other economic city powers (*Arti maggiori* and *minori*, Major and Minor Guilds). Such was the case of the opening of *via dei Servi*

(which combines and replaces the last stretch of the old *via Fiesolana*), envisaged before the wall itself in around 1250, in order to connect the Cathedral to the new convent of the Servite order in *Piazza Santissima Annunziata* (Cataldi, 1984).

The best proof of the continuity underlying the present-day historical centre of Florence is a geometrical demonstration (Figure 13): the perimeter of the fourteenth century wall was traced on the basis of the Roman *centuriatio*, following planning principles quite similar to those a Roman architect would follow. If measured in metric units still comparable to the Roman ones, such as the Florentine fathom (*braccio*) and the field surveying *canna*, this technique allows hypothetically (using the Pythagorean theorem, with the *centuriat* alignments as *cateti*) for a precise

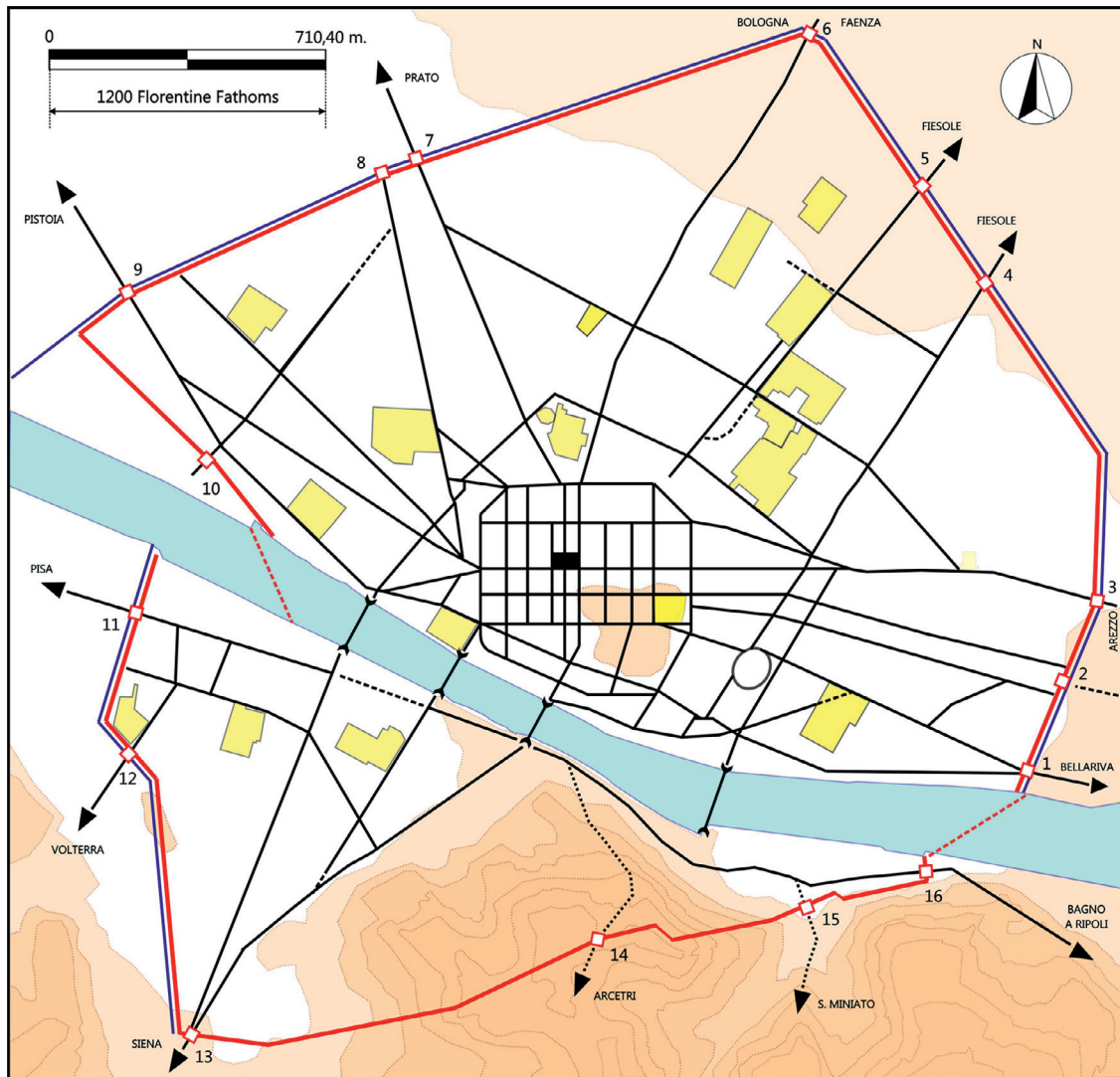


Figure 12. Renaissance Florence, showing the second communal city walls of the late-thirteenth century. The convents (in yellow) were the driving factors of the building development of the city.

calculation of the length of the various segments of the walls (Guidoni, 2002).

The nineteenth-century plan for the ring roads

For a short period towards the end of the nineteenth century (1865–70) Florence became the capital of the Kingdom of Italy. The first ‘modern’ maps (Figure 14) show the city as being substantially encircled by the fourteenth century wall, with the new development plans

of Piazza D’Azeglio and Piazza Indipendenza, modelled on the English square, with surrounding houses and public gardens at the centre. The long period of building stagnation clearly interrupted the continuity that had characterized the history of the city up to the Renaissance. The new urban plan by architect Giuseppe Poggi (1811–1901), sanctioned by the King of Italy in 1865, was clearly inspired by that of the Ring of Vienna, sanctioned by the emperor Franz Joseph in 1857. The idea behind both plans was to demolish the city wall to allow the city to expand beyond the

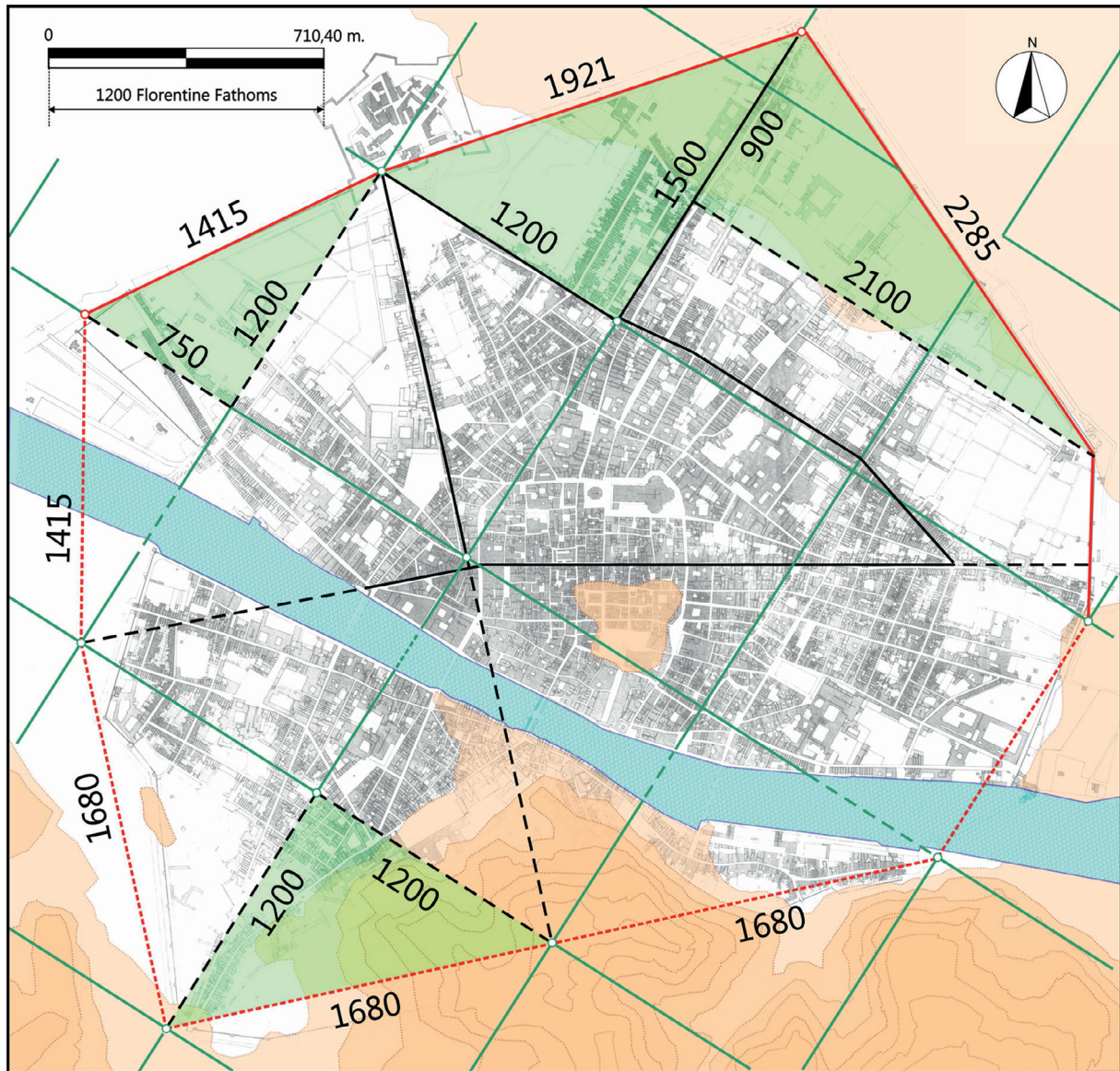


Figure 13. Medieval Florence: the plan of the second communal city walls, based on the vertices of the Roman *centuriatio*.

new ring roads. There were new expansion districts with no definite limits: a ‘very strong’ idea, marking the separation between the centre and the suburbs.

In Florence the fringe belt of ring roads, outside the fixation line of the demolished walls, is characterized by the presence of the gates at intersections, isolated at the centre of squares, and functioning as roundabouts. Passing over two bridges at the opposite ends of the river, the ‘horseshoe’ plan of the boulevards completes

its ring on the hills, where the presence of the wall, here almost completely preserved, and the characteristics of the territory, forced the designer to adopt a plan that took them into account, presenting numerous views.

Conclusion

The geometry of the urban form of Florence suggests a number of methodological



Figure 14. The first expansion of Florence outside the most recent walls. Late-nineteenth century map of Istituto Geografico Militare Italiano.

considerations. First, the study of urban form cannot be separated from the study of the city's pertinent territory. Secondly, the study of the city's pertinent territory should aim (a) to discover the reasons for the choice of the city's location; (b) identify the original routes to the city; (c) delimit the city's pertinent territory; and (d) for a city of Roman origin, reconstruct the agricultural divisions of the *centuriatio*, which could have influenced the

development of the urban form. Thirdly, the morphological study of the city should be aimed at the identification of the phases of development. The limits of these phases are physically represented in the historical centre by the inner fixation lines of surrounding walls, and in the contemporary city by the outer fringe belt. Fourthly, the synthetic map of the surrounding walls can be considered the conclusion of this study of the urban form

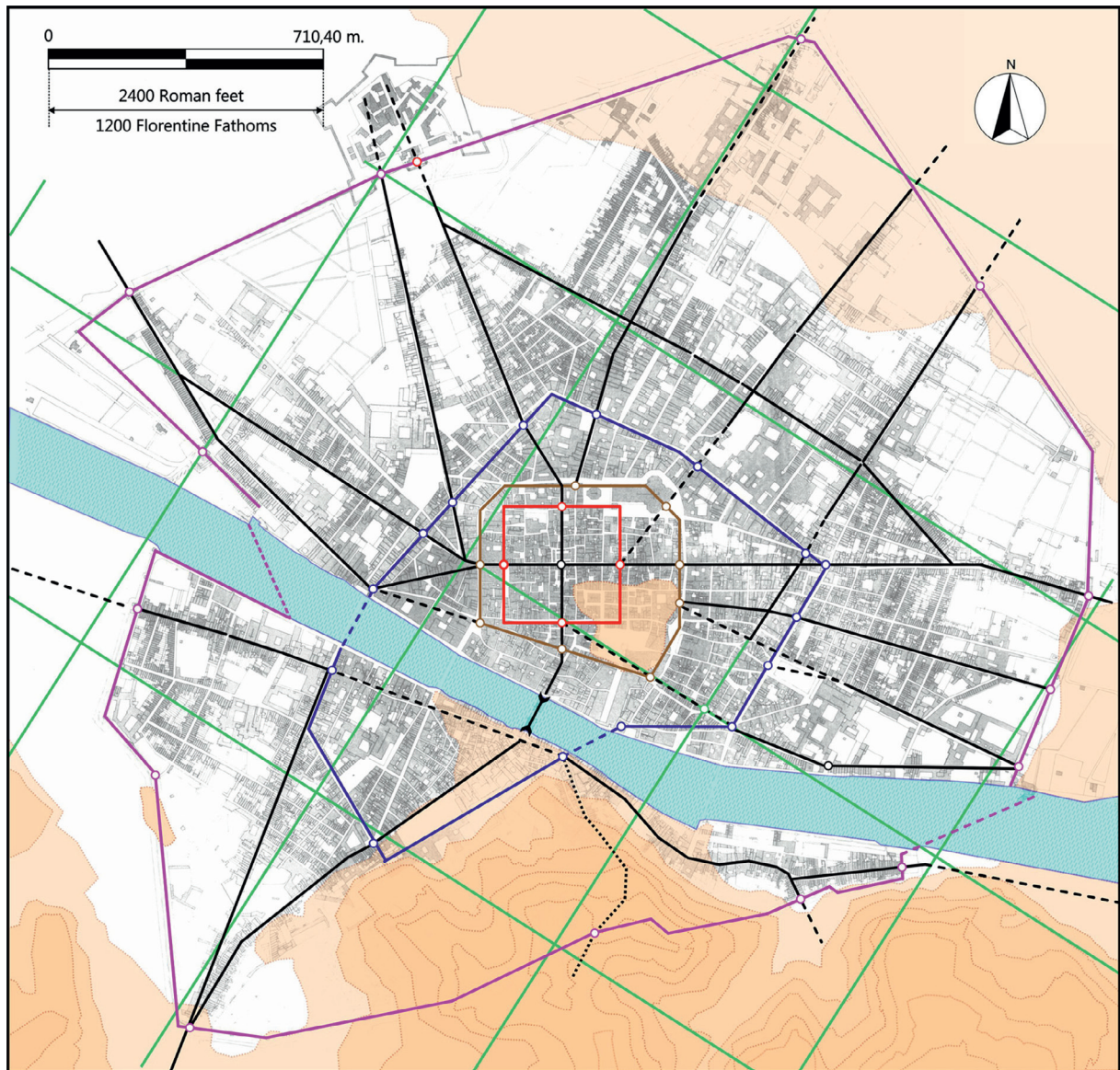


Figure 15. The four main historical walls: 1. *Colonia* (in red); 2. *Municipium* (in brown); 3. Medieval city (in blue); 4. Renaissance city (in violet).

of Florence (Figure 15), based – at substratum level – on two permanent structures: the grid *secundum caelum* of the astronomical orientation of the Roman military camp; and the grid *secundum naturam* of the Roman *centuriatio*.

The present urban form of Florence is no longer that of the compact historical city encompassed by the fringe belt associated with the avenues of the ring road. It is represented by the irregular profile of the

periphery, which like a liquid substance has been ‘spilled’ out of the walls, expanding within the geographical limits of surrounding hills (Figure 16). Paradoxically, this marks the start of the disciplinary question of the form of the contemporary city, which, to quote the Italian poet Metastasio, ‘come l’araba fenice: che vi sia, ciascun lo dice; dove sia, nessun lo sa’ (‘is like the Arabian Phoenix: everyone says it exists, but no one knows where to find it’, Metastasio, 1731, p. 24).

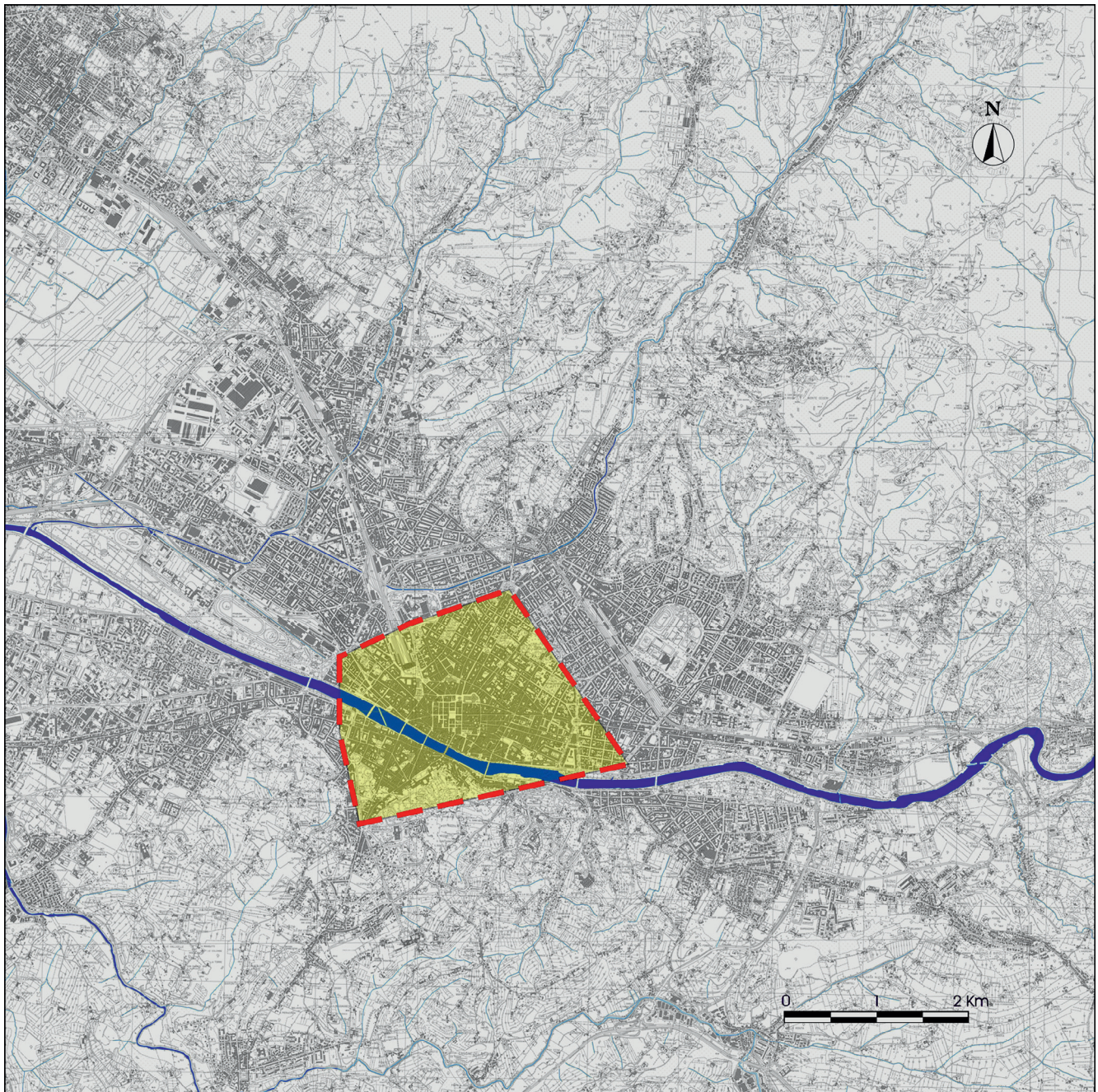


Figure 16. Florence: recent peripheral extensions. In red the line of the most recent ring road. Source: *Cartografia Tecnica Regione Toscana*.

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