

## THE GIS-BASED HISTORICAL ATLAS OF ROME

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### ABSTRACT

Rome's territory bears the signs of more than two thousand years of continuous human presence. Building stones are part of a history that cartographic and thematic archive sources can "bring to life". The physical transformations and the spatial distribution of phenomena over this territory – in a "geographical-thematic" context – can be analysed using a GIS system, starting from the XVIII<sup>th</sup> century, when methods and instruments of cartographic survey reached a sufficient maturity to enable the production of "geometrically correct" iconographic cartography, therefore permitting their reference into contemporary coordinate systems, and the thematic sources (fiscal, demographic, etc.) became homogeneous, so as to permit their eventual organisation into relational databases. This paper describes the main cartographic and thematic sources and the procedures which have been utilised for their integration into a Geographic Information System.

### 1. INTRODUCTION

The work illustrated in this paper constitutes part of a broader project of CROMA (Centro di ateneo per lo studio di Roma – Università Roma Tre), entitled "The Historic Atlas of Modern and Contemporary Rome".

The choice of the time range is strictly related to the availability of reliable cartographic and thematic sources, offering the possibility to focus on the socio-economic and urban structure of the city, at the eve of Rome's union to the Reign of Italy, and its proclamation capital of the nation.

The objectives on which the multidisciplinary team of CROMA has been focusing during the last four years are:

- to study the "historic environment" of Rome;
- to build up an analytic tool that will help to analyse the physical and temporal transformations of the territory. In this context, the main guide lines have been defined as follows:

- databases of different origins can be associated to the historical cartography of the same period;
- the analysis of the city's physical and socio-economic transformations becomes possible thanks to the spatial overlay of the data. The paper is articulated in three

chapters: first, the physical characteristics and the main transformations of the modern city are shortly described through the most representative historical cartographic sources; then, the process of selection and informatization of the sources is analysed, and the most important results obtained are discussed; finally conclusions and recommendations for further work are drawn.

### 2. ROME SEEN THROUGH ITS MAPS

This "journey" starts in 1748, when Giovanni Battista Nolli (1692-1756) published the New Map of Rome, the first geometrically correct bi-dimensional representation of the city. In Nolli's map the city is shown in what would be its definitive asset for a long time, as for more than a century only minor changes were to take place. His topographical survey was to become the basis for all the subsequent cartography of Rome, with no exceptions: over time graphic corrections were introduced in his work to emphasize the streets over the buildings, the built areas over those still undeveloped, providing conditional and guided interpretations of the city. In this regard,

the first really unanimous choice that was made by cartographers after 1750, was to privilege the built up part of the city. While in Nolli's map an essential feature was the unity of the city and its surrounding countryside, the latter would subsequently be represented with progressively greater approximation.

In the middle of the eighteenth century Rome was fully immersed in the country. Nolli's description of the countryside is as accurate as his representation of the city. This is also due to the fact that in an iconographic representation all views are equally "important" since all the portrayed objects must geometrically correspond to reality: as there is no need for a single point of view for the whole city, it is also no longer necessary to choose between what must be shown or hidden, privileged in the foreground or faded in the background. Nolli is the first one to set the magnetic north toward the top of the representation, thus choosing an abstract geographic interpretive principle, unrelated to the city. After centuries Rome would no longer be portrayed from the Gianiculum, the hill situated parallel to the Via del Corso.



Figure 1. Map of Rome by G.B. Nolli, 1748 (the Small Map).

Around mid-eighteenth century the transformation of the countryside closest to the city and of suburban Rome was complete. Nolli's map is the most accurate testimony of this urban organization: thanks to it, the relationship between the terrain, the gardens, and the villas can be clearly understood. Nolli divides suburban Rome into three categories: villas and

gardens, vineyards, and orchards. Vineyards are located in the eastern, southern and northern areas, with the vines mostly covering the slopes. Sparse and winding roads leading to dead-end paths grant access to the vineyards, in contrast to the roads around villas, which have been straightened. Orchards are much smaller than the vineyards and located closer to the valleys, the inhabited areas, and the greater villas.

The passage from the built-up city to the surrounding countryside is hardly marked: villas and vineyards penetrate into the inhabited areas; the neighbourhoods are interspersed with the gardens. From the Gianiculum the Lante, Corsini, and Farnese villas extend to the Tiber. Via di San Francesco a Ripa is completely surrounded by vineyards. A series of continuous gardens linking Villa Mattei near the Colosseum to Palazzo Colonna in Santi Apostoli at the foot of the Quirinale, merges the medieval urban fabric with the sixteenth- and seventeenth-century palaces high up on the hills. The greatest expansion of the city occurs between Capo le Case and the Quirinale, along the sides of the valley that climbs from Trevi neighbourhood to Piazza Barberini (present day Via del Tritone). Valleys become the preferred areas for the city's expansion as the most important families and the holy orders occupy any properties above the hills. Another area of great expansion is the Suburra, extending from the Pantani to the Paolino neighbourhood, in the valley between the Quirinale and the Oppio hill. On the other hand, very few new buildings appear along the road to San Giovanni, Via di San Francesco a Ripa or Via delle Fornaci (nowadays Via Garibaldi), while Borgo Nuovo stands out with its grid of lots.

In the years between the Map of Nolli and the maps from the early-nineteenth century very few changes occur in the urban structure.

Only a limited part of the work carried out under Napoleon's brief domination had a noticeable effect on the existing urban fabric: the construction of the eastern hemicycle of the Piazza del Popolo (the square was completed during the Restoration); the public walk by Porta del Popolo (the buildings between Santa Maria del Popolo and Via del Babuino were demolished) and the first stage of the garden up on the Pincio; the enlargement and embellishment of the Piazza della Colonna Traiana (a number of houses, as well as the monasteries of Santo Spirito and Santa Eufemia were demolished and ruins were excavated); the demolition of the houses before the Pantheon and the work on the Piazza; and a new archaeological walk on the Palatine and Velia hills, through the excavated sites in the Forum (including the Arco di Tito). Further excavations were also carried out at the Colosseum, by the Tempio della Pace, the Arco di Giano, and the Tempio di Vesta and the Tempio della Fortuna Virile. During the Restoration Popes only completed works that had already been started. Many of the most controversial goals from Napoleon's program were to return, long after 1814 and the Pontifical Restoration, and play an important role in the formation of the contemporary city: the demolitions that would allow Piazza Venezia to host the monument to King Vittorio Emanuele II and the excavation of the Velia hill to make the Colosseum visible from Piazza Venezia; the construction of river banks along the Tiber and the demolition of the Spina di Borgo.

In 1866, only a few years before its dissolution, the Congregazione del Censo reprinted the map of the city in a 1:4000 scale, updating the one from 1829 and maintaining the same graphics and level of detail. Not far in the future were the great transformations that would accompany the end of the papal reign over Rome and the city's transformation into the capital of Italy. The few changes that occurred under Pope Pio IX are shown in the map: the first railway has reached Termini, entering the city through the Aurelian walls just north of Porta

Maggiore, and the tracks have cut Villa Peretti in two. No new constructions have yet been appeared nearby Termini but a new road running from a square alongside the tracks to Santa Maria Maggiore further divides Villa Peretti. Castro Pretorio has become the military drill ground. An iron bridge spans the Tiber connecting San Giovanni dei Fiorentini and Palazzo Salviati. A tobacco factory is located near Santa Maria dell'Orto and the newly opened Via Mastai beyond the last houses of Trastevere. New streets are visible in the area in front of Diocletian's baths between Piazza Termini, Via Strozzi, Via delle Quattro Fontane and Via di Porta Pia (presently, Via XX Settembre). These streets correspond to the present-day Via Nazionale, Via Torino, Via Firenze Via Napoli, and Via Modena and they all belong to the new neighbourhood that's being developed by Monsignor De Merode.



Figure 2. The Topographical map of Rome, published by the Direzione Generale del Censo, (1866).

### 3. SOURCES AND INFOREMATIZATION METHODS

#### 3.1 Cartographic sources

The historical cartographic sources utilized in our analysis of the urban structure and its transformations are the following:

- Map of Rome by G.B. Nolli (1748), - the big map, approximate scale 1:2900\*;
- Urban Cadastre (1819-1822), scale 1:1000;
- Topographical map of Rome, published by the Direzione Generale del Censo, (1866), scale 1:4000.

All of them extend to encompass the city of Rome within the Aurelian walls.

We were aware of the difficulties involved in the process of comparing premodern maps to each other as well as to actual cartography, which is produced with different techniques (aerophotogrammetry). Still, the prospect of a detailed analysis over the city centre and the encouraging results of the preliminary investigations led us towards elaborating a specific procedure for the transformation of these cartographic sources, which includes calibration operations, georeferencing and projection transformation. This allowed for the overlaying of the sources and subsequent analysis of their accuracy levels.

The georeferencing procedure is one of the distinguishing features of this study that makes it different from all previous

\* Nolli published two version of the map in 1748: the Big Map, composed of 12 sheets, in scale 1:2900, and a reduction in one sheet, known as the Small Map of Nolli.

research on the historical maps of Rome. Method and results are described in detail in: Georeferencing the historical Maps of Rome between the seventeenth and eighteenth centuries, in this volume.

Nolli's Big Map is made up of twelve sheets. The copies utilized for the acquisition in raster format presented anisotropic distortions that made preliminary calibration work necessary in order to properly mosaic them. The image thus composed was georeferenced using GPS control points. Surprisingly, the correspondence of the georeferenced map with actual cartographies showed results above the expectations. The accuracy level of this product was definitely higher than the one obtained from the Topographical Map of Rome, published by the Direzione Generale del Censo (from now on, the Census Map), in 1866, georeferenced using the same GPS network. Furthermore, Nolli's graphic level of buildings detail is far more accurate than the one of the Census Map.

The two historical maps were then vectorized. This process allowed for the creation of spatial databases, in which every single polygon, line or point representing elements from the original maps can be associated to thematic information: land use, property and building typologies, number of inhabitants etc. The information thus organized can be visualized in form of thematic maps.

The Urban Cadastre (Il Catasto urbano Pio-Gregoriano) represents the first major innovation following the Nolli's map. The shift to a smaller scale, 1:1000, makes more detailed information available. Building stock and property transactions involving single parcels and urban transformations over time can be studied thanks to the cadastre. With regard to real estate the cadastral registers are a fundamental source: they show the strong relationship—strengthened over the centuries—between dwellings and their ownership, prior to the radical changes caused by the great concentration of real estate. Urban Cadastre is the starting point for any kind of historical research regarding the contemporary Rome. The acquisition of this map, together with the information from the cadastral registers, was a necessary premise for an important and challenging thematic research project that will enable to investigate in great detail Rome's physical structure and its socio-economic conditions between 1820 and 1870. The procedures followed for the acquisition of this cartographic material and its georeferencing are similar to those previously described for the Nolli and Censo maps. Thematic information was collected from the cadastral registers (*brogliardi*) that contain map references. The parcel numbers refer to information contained in the cadastral registers and organized in relational databases. The data available from the cadastral registers are grouped into four main typologies: (I) information regarding the use and position of the parcel; (II) information regarding the owner(s) of property within the parcel; (III) information describing the property, the building (or part of it) owned by one or more persons; (IV) cadastral estimate, as in the value of one or more properties owned by one or more persons. The complex interdependencies in the *brogliardi*, especially those concerning owners and properties, are handled in the database so as to avoid as much as possible redundancy. The information, acquired through a series of dialogue windows, grouped according to typology, is then loaded in five different tables that can also be linked to one another: parcels, locations, owners, properties, estimates, linked to the vectorized cartographic support, results capable of producing a number of thematic maps: property typologies, land uses, building types, etc.

### 3.2 The geographic databases

As already mentioned, parallel to the acquisition, georeferencing and vectorizing processes, we also developed methodologies for the thematic analysis and comparison in order to process the historical-geographical data we obtained. This allowed to study vertical diachronic as well as horizontal synchronic relationships. The first are the result of the comparison of data sets on a given subject, in different moments in time. Horizontal or synchronic relationships can be understood as comparison of data from the same period but related to different subjects.

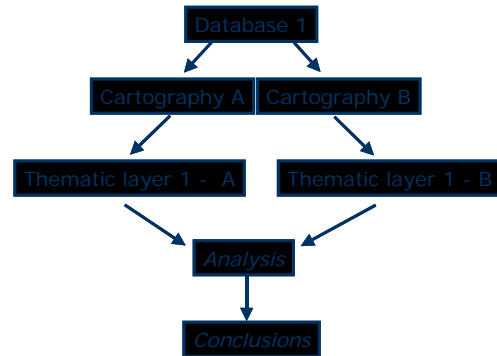


Figure 3. Synchronic relationships

Thanks to the georeferencing procedure, the results of the map overlaying can be considered satisfactory.



Figure 4. Overlaying between the Map of Nolli, 1748, and an IGM map, 1912 (black hatching on the top).

Our first observation while overlaying historical and contemporary cartography, is related to interpretation of the city's form: the historical maps represent the ground floors, therefore, in some of the most densely built up areas with city blocks very close to each other, it is very hard to distinguish entryways leading into the buildings from alleys. This may lead to a mistaken count of the number of building blocks. Contemporary cartography instead "photographs" buildings from above, losing all information concerning ground floors. Entryways, porticos, floor plans of churches, all disappear underneath roofs and terraces. Another aspect of great interest is the study of the cartographic error. The comparison between

different historical sources shows how error is more likely to be related to the shape of the building, than to a positioning mistake (see Figure 4).

The diachronic study, on both urban and single parcel scale, proved to be a valuable tool in reconstructing the historical and environmental evolution of the city. Its potential quantitative and qualitative analytical applications are numerous: city's physical structure, demography, socio-economic aspects, toponymy, etc.

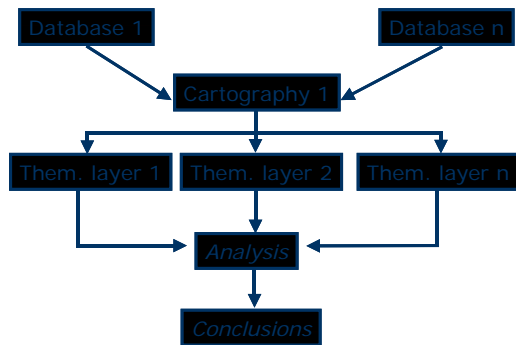


Figure 5. Diachronic relationships

The integration within the digital cadastral map of databases containing information from cadastral registers clearly showed the potential of a “geographical database” compared to a traditional one. Significant synchronic relationships can be selectively visualized as thematic maps directly deriving from database information. The analysis of the data from the Urban Cadastre is the most significant example: the information from the database containing the second series of the *brogliardi* has been associated with the polygons that represent the single cadastral parcels. Queries can be made in the database using different thematic “keys” and the results are displayed on a map. This system has an immediate visual impact and offers an easy understanding of the spatial distribution of various phenomena. The possibility of performing quantitative analyses on a single cadastral parcel, a city block, or a neighbourhood, and of grouping and representing values and indexes deriving from database (such as surface area, number of floors and rooms, total number of properties and owners per parcel, and totals from estimates and rentals) provides this project with an important tool for synthesis.



Figure 6. Thematic cartography derived the integration of the cadastral registers into the vectorised map of Urban Calastre, 1818-1822. The case of rione Sant' Angelo.

#### 4. CONCLUSIONS

As a conclusion it can be stated that the use of a GIS based territorial analysis has opened new prospects in the field of historical research. The applications could be numerous, as a flexible structure has been implemented, allowing for increasing levels of complexity and large numbers of varied data sources to be integrated within the digital cartography. Furthermore, the most recent developments in the field of geographical information systems (GIS) and web-based applications will enable in the future the accessibility of this historical information system on the Rome's territory through the internet. Another aspect of the future work will regard the integration in the system of further cadastral updates and other archive sources of the same period, allowing for a whole new range of thematic comparative studies covering the years from the 1820s to the Unification of Italy. The structure of the cadastre can host information from other historical databases, provided they can be linked to the cartographic instrument. Some experimenting in this sense has been done with the database of the “*stati delle anime*”<sup>\*\*</sup> that will integrate the cadastral maps for the years covered by the *brogliardi*. This will allow us to supplement the previously acquired data on the physical structure of the city and its socio-economic aspects with a great deal of demographic information.

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<sup>\*\*</sup> The “*stati delle anime*” are registers listing name, profession, age, and social status of the residents of Rome, divided according to parishes. Such registers were systematically compiled, at least from 1630 onward.

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