

## **COMPUTERIZATION AND MANAGEMENT OF ARCHIVE SOURCES FOR THE STUDY OF URBAN CULTURAL HERITAGE**

K. Lelo<sup>a\*</sup>, C. M. Travaglini<sup>a</sup>

<sup>a</sup> CROMA (Centro di ateneo per lo studio di Roma) – University “Roma Tre”, Via Ostiense 139 - 00157 Rome, Italy  
lelo@uniroma3.it, c.travaglini@uniroma3.it

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### **ABSTRACT**

This paper deals with the use of advanced GIS techniques for the study of modern and contemporary cities. A methodology for the selection, computerization, integration, and management of archive sources is developed to create a historical GIS of Rome in the 18<sup>th</sup> century. Further on, transformations, organization and functions of the urban space are analyzed in depth using GIS functions. Building density, land use distribution, public and private spaces, the laic and the religious city, the archaeology, the urban quality and aesthetics, are only a few examples of the outputs obtained. The acquired historical information results perfectly comparable with the actual situation, thus offering the possibility for detailed diachronic analysis.

The utility of this approach relies on the opportunity to perform homogeneous spatial analysis, to elaborate historical topographical statistics, to diachronically compare phenomena thanks to the spatial overlay of the data. But the most important aspect of the GIS approach to urban historical studies is represented by the opportunity of integrating within the system information retrieved from different archive sources, provided that they can be structured as databases.

### **1. INTRODUCTION**

This contribution refers to the experience of the project “Rome during the 18<sup>th</sup> century”, implemented by CROMA, which results will be shortly published. The project combines research in urban history with geographical information systems.

The in-depth study of Rome’s urban and archaeological heritage becomes of a great concern every time physical transformations “menace” the integrity of the historical city centre. Problems emerging, even for small scale interventions of public utility, are strongly related to the exceptional extension, stratification and density of historical evidence. In this situation, the knowledge of the past becomes a condition for a better management of the present.

During the eighteenth century, the geometrically correct ichnographic representations of cities progressively substituted the more spectacular – and imprecise – bird’s eye views, thanks to the evolution of measurement techniques based on trigonometric calculations. In fact, scientific instruments used for cartographic productions were largely improved, and topography was codified in terms of applicative methodology as well as cartographic representation in different European States (Docci, Maestri, 1993). Establishment of specific criteria for data collection became frequent during this period, thus resulting in the production of homogeneous and better organised datasets of different spatially referenced thematic data (demographic, fiscal, etc.).

In such a context, physical transformations and spatial distribution of phenomena can be studied from a “geographical-thematic” perspective using modern information techniques. Interesting new research arguments can then be traced for historians aiming to jointly study sources of different origin and characteristics. GIS can truly help to perform comparative studies and spatially homogeneous analysis of different

contexts. Nevertheless, their use in historical studies needs the specific and careful evaluation of every single case, strictly depending on the characteristics of archive sources to be integrated into the system (Lelo, Travaglini, 2006).

This paper is organized in three sections: first, cartographic and thematic historical sources are analysed, describing the methodology for their computerization and integration in to a GIS; then, the analytic process is shortly illustrated and the most important qualitative and quantitative results obtained are discussed; finally, conclusions and recommendations for further work are drawn.

### **2. BUILDING UP A SPATIAL DATABASE**

#### **2.1 The New Map of Rome by G.B. Nolli**

The most important historical source used in this project is the New Map of Rome (Nuova Pianta di Roma), published by Giovanni Battista Nolli in 1748. This map represents an outstanding scientific result deriving from the necessity, becoming persistent in Europe during the 17<sup>th</sup> and 18<sup>th</sup> centuries to produce “precise” and “reliable” topographic information. It is the first geometrically correct bi-dimensional representation of the city characterized by an exceptionally high level of accuracy and detail. The important buildings such as churches, palaces, public buildings and sites, archaeological vestiges, monuments, streets and squares, are numbered on the map and described in a separate Index. Gardens, vineyards, orchards, and other non built-up areas have their names clearly signed on the map. There are almost two thousand objects precisely drawn and described, which makes it clear why the presence of such a highly accurate product from the point of view both of geographic and thematic information, was the first choice to make while working on a project which aim is to combine

research in urban history with geographical information systems.

The intentions of the author and in particular of its erudite aristocratic supporters, mostly interested in antiquities, were initially far more ambitious: the map should have been drawn in different colours representing the city's stratification (archaeological vestiges, medieval tissues and modern buildings). The information on the transformations was to be derived through the comparison of historical elder representations of Rome and through bibliographic research. Detailed explanations on buildings and other interesting places were to be found in a separate book, a sort of encyclopaedia, substituted in extremis by a far more synthetic incorporated index (Bevilacqua, 1998). This innovative and contagious spirit incites, after almost three centuries, to proceed in the same direction. The technology actually in our hands can help to accomplish the missing part of the original project, to further develop it and to share it with the rest of the scientific community.

The Nuova Pianta represents a watershed for the cartography of Rome. Nolli was the first one to orient his map North, thus marking a change of tendency with respect to the common orientation East, suggested from the comfortable observation point of the city located on the Gianicolo Hill. Nolli doesn't really observe Rome from any specific point: he walks through streets, alleys, gardens or vineyards, measuring with homogeneity angles and distances, and transferring in the Preparatory Drawing (*disegno preparatorio*) everything which is measurable: buildings, fountains, ruins, walls, streets, gardens, embankments, shores, etc., with an incredible level of detail.

The orientation North-South of the map refers to the so-called "meridiana della Certosa": an accurate sun-dial North-South line, inlaid in the marble floor of the church S. Maria degli Angeli (in the Baths of Diocletian). The line was set up in 1702 for the purpose of precisely determining the equinoxes used for fixing the feast-days of the Catholic Church (Ceon, 1990). Nolli was able to make all his sightings refer back to this base line, or to parallels of it placed on other parts of his drawing. This technique, coupled with the triangulation of prominent city features such as obelisks, towers, domes and along the axis of Via del Corso, and with the use of the *tavoletta pretoriana*, allowing for fast and precise on-site drawings, enabled Nolli to obtain the accuracy for which his plan became famous all over Europe. The accuracy of the Nuova Pianta far exceeds that of earlier maps of the city. As it is largely known, the map served as a basis for all the successive representations of Rome, until the advent of the - conceptually different - aerophotogrammetric cartography.

Thanks to its accuracy, the Nuova pianta can be compared to actual cartography. As illustrated in previous publications, a careful georeferencing procedure based on ad hoc differential GPS survey, demonstrated accuracy levels that were far beyond the initial expectations (Baiocchi, Lelo, 2005). The georeferenced map of Nolli constitutes the mile stone of this project and the first important step towards the building up of a GIS of Rome during the 18<sup>th</sup> century.

As already pointed out, geometric accuracy is not the only attribute of this map. What really makes it stand out is the wealth of detailed information it contains. Cartographic symbols are intuitively easy to understand: dark grey hatching for modern building fabric, white for open space. Ancient monuments are rendered in black indicating extant ruins, while a white outline suggests hypothetical plans of ancient

monuments that no longer exist. A series of textured elongated lines are used to indicate the slopes (contours were not in common use until the turn of the 19<sup>th</sup> century). Open spaces (gardens, vineyards, orchards, etc.) are all carefully rendered with different textures. Various cartographic symbols are used to indicate features that would otherwise be difficult to convey. These include drains, soldiers' billets, apertures in the Aurelian wall circuit and cemeteries. Pictorial elements are used to represent river craft which includes ferry boats with tethering lines, cargo craft and water mills.

The representation of administrative boundaries is of great interest. The dotted lines between the Rioni were drawn after the *Descrizione del nuovo Ripartimento de' Rioni di Roma* by Count Bernardino Bernardini, which was given the task of regularizing the Rioni boundaries by Pope Benedetto XIV Lambertini. The work was completed in 1744 and the map of Nolli, not yet published, had served as a cartographic basis (Bevilacqua, 1998).

The definition of homogeneous criteria for the interpretation of the graphical representation of this exceptional cartographic source, enabled us to obtain a digital product in vector format, representing ten land use classes (see. Figure 1, here simplified). This operation constitutes the second important phase of the project, concluded with the creation of a "geographic container" able to support thematic information deriving from other data sources of the same period. The choice to exclude from the vectorization process areas falling outside the Aurelian walls was made to avoid inhomogeneous spatial information. In fact, the territorial features in the northern portion of the map are carefully drawn and described, while in the southern part are totally missing, substituted by decorative elements and inscriptions evoking important monuments, places and symbols.

## 2.2 Thematic data integration

Thematic data integration started with the computerization of the Nuova pianta's Index. The Index contains 1320 numbers organised in 19 categories and is integrated by 657 descriptions of non built-up areas directly written on the map (vineyards, orchards, villas, gardens, etc.), from which 115 are repetitive with respect to the numerical Index. Despite the consistent reduction of described objects operated with respect to the initial intentions, the thematic information contained in the Nuova pianta is the most complete if compared to any other cartographic representation of modern Rome.

The existence of the coeval *Descrizione del nuovo Ripartimento de' Rioni di Roma* by Count Bernardino Bernardini, which contents differ from the Nolli's Index mostly in terms of detail while describing the same object (more information is given by Bernardini regarding owners - present and previous - and the public use of buildings and areas) suggested a further integration of this information into the database.

The spatial connection between the map elements (polygon objects) and the information contained in the newly created Integrated Index database, containing 1898 records, allowed for additional detail in land use descriptions.

The geographic key of thematic information, further on integrated with other data sources, has given the opportunity to analyse qualitatively and quantitatively different spatial characteristics of the city: transformation of the urban space, distribution of the functions, physical and social stratification, property distribution, administrative and public welfare services, cultural institutions, public places, archaeology, represent the principal thematic descriptions we are able to

obtain by extracting, analyzing and visualizing information deriving from the historical sources integrated into our GIS system (see next chapter).

An additional database of coeval iconographic material has been created, covering most of the indexed buildings. The database contains and describes 18<sup>th</sup> century prints and drawings of the most important squares and buildings of Rome, drawn by G.B. Falda, G.B. Piranesi, G. Vasi, A. Pinelli, etc.. This aspect is considered of particular interest for divulgation purposes. In fact, a user friendly graphical interface running outside the GIS support (using common graphical software and browsers) allows the interactive overlay and interrogation of maps, databases and iconographic information. This interface will be available in CD-Rom together with the printed version of the Atlas.

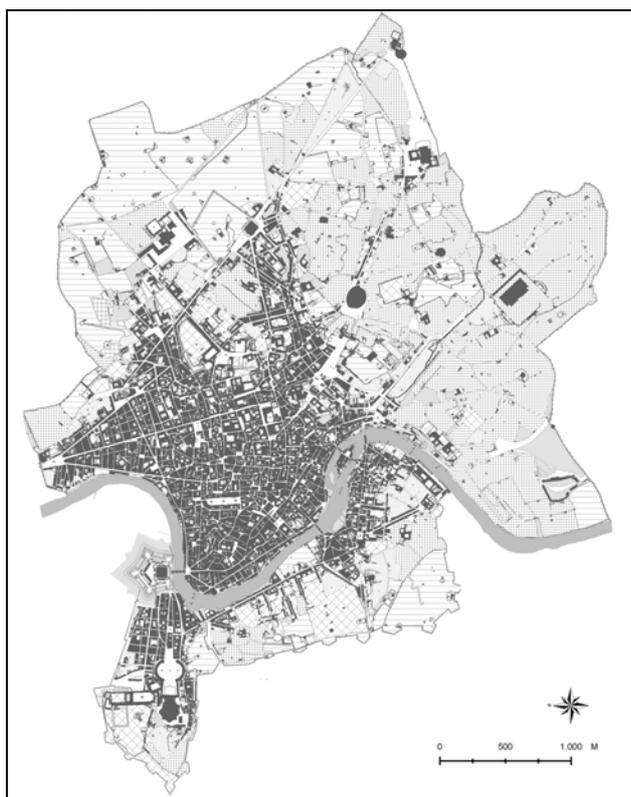


Figure 1. Rome in 1748. Informatization of the *Nuova pianta di Roma* by G. B. Nolli

### 3. EXPLORING THE MODERN ROME

The mid-18<sup>th</sup> century marked the beginning of a long period of stasis and the almost complete interruption of urban transformations. The *Nuova Pianta* by Giovanni Battista Nolli can be considered an exhaustive evidence of the image of Rome after the great urban development of the Renaissance and Baroque periods and after the minor transformations occurred during the first half of the 18<sup>th</sup> century. After its publication, in 1748, only minor changes took place; in fact, the *Nuova Pianta* remains a valid representation of the city until Rome became the capital of Italy in 1870, and it is still the most useful cartographic document for studying Rome's historic centre.

### 3.1 Stratification

Our cartographic source conveys an immediate understanding of the city's topographic and geo-spatial structure. As previously mentioned, the committers of the map initially had in mind a far more ambitious representation of Rome's stratification in archaeological vestiges, medieval tissues and modern buildings. It is easy to imagine that this was an impossible task to accomplish in the mid-18<sup>th</sup> century, but today, considering the actual knowledge on Rome's historical urban fabric and the new technology in our hands, the missing part of the original project can be completed.

The stratification of Rome in the 18<sup>th</sup> century is represented in the Atlas using as a basis the georeferenced digital version of the map of Nolli. The polygon objects are classified according to the information on the age of buildings, obtained from bibliographical research. The final result of the 18<sup>th</sup> century stratification of Rome: "Roma antica, Roma medievale, Roma moderna", is a three dimensional representation. This choice is made to further enhance the topographic and spatial structure of the city, and to better understand the stratification, since often, medieval or modern buildings include archaeological structures. The 3D representation of the buildings is placed over a Digital Elevation Model (DEM) produced ad hoc by elaborating historical altimetry sources (19<sup>th</sup> century topographic map of Rome and surroundings, by IGM – Istituto Geografico militare, Map of Rome by R. Lanciani, 1901). This representation of the urban space is an exhaustive example of how historical data sources of different origin and typology and bibliographic research results can be integrated within a GIS system to enable in depth analysis and study of the historical urban environment.

### 3.2 Characteristics and functions of the urban space

The image of the city depicted by the map of Nolli is that of a densely urbanized area concentrated on the Tevere river meander bend. A large green belt of villas and urban orchards surrounds the city. The Aurelian walls encompass a territory of almost 1450 hectares, of which – considering the areas occupied by squares and streets beyond the built up region – only 40 % approximately is urbanized (see Figures 1 and 2).

Rione Trastevere is delimited in the Western side (lower part of Figure 1. The map is turned on its side to better fit the page) by Via di S. Francesco a Ripa, running through orchards and vineyards. Along Via della Lungara, connecting Rione Trastevere with Rione Borgo, only few buildings are settled. In the Northern side, the Tridante area (Piazza del Popolo, Via della Scrofa, Via del Babuino) is fully built up. The most peripheral urbanized areas in the Eastern side are Capo le Case and Quirinale in the direction of Piazza Barberini, and the Suburra neighbourhood which occupies the depression between the Quirinale and Oppio hills. The vast open space in the South-East is crossed by the rectilinear streets of Sisto V and Paolo V connecting the basilicas of S. Maria Maggiore, S. Giovanni in Laterano and S. Croce in Gerusalemme, and will not be reached by the urbanization until after 1870.

A constant demographic growth caused the population to move up from 120.000 inhabitants of the year 1700 to 180.000 inhabitants of the year 1798, when French revolutionary troops entered in Rome. In 1748, year of the publication of the *Nuova pianta*, Rome counted around 156.000 inhabitants, living concentrated inside a built-up area of just 409 hectares (Sonnino, 1998).

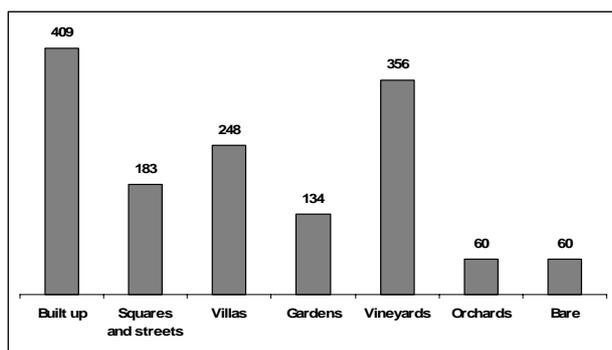


Figure 2. Land uses in Hectares, in 1748.  
Source: *Nuova pianta di Roma* by G. B. Nolli

Despite the difficult situation of papal finances, Rome during the first half of the 18<sup>th</sup> century is interested by a consistent edification activity. Although at urban scale only minor changes occur and the construction of new important buildings such as churches, palaces or villas is progressively diminishing, the image of the city is continuously evolving thanks to minor interventions related to the renovation of common residential buildings, mostly focusing on embellishment of facades and height increase, but often culminating with the substitution of entire building blocks.

New spatial equilibriums are established with the introduction in the urban structure of two functionally specialized political and administrative focal points: the Montecitorio area, completed around 1734-35 after a long transformation process started in 1694-96, when the Curia Innocenziana was settled in Palazzo Ludovisi, and the Quirinale area, which assumed its definitive asset between 1732 and 1748, with the construction ex-novo of the Palazzo della Consulta, the Scuderie del Quirinale, and of the “long sleeve” of the Palazzo del Quirinale (Curcio, 1989, 2000). The urban renovation process interested then the immediate adjacent areas, and propagated afterwards from the heart of the city towards peripheral areas.

These evolutions may suggest different analytical research directions. Those illustrated here, without the ambition of being exhaustive, offer an idea about the potentiality of the GIS tool applied to the historical cities analysis.

The spatial distribution of public political and administrative functions in 1748, obtained through the cartographic representation of the Integrated Nollis’ Index shows the absolute prevalence of the papal State power with respect to the municipal power (see Figure 3). The food stability controlled by the State through the administrations of Annona and Grascia, having the task to supply the population respectively with flour and meat, as well as the imposing charity system, seemed to compensate for the lack of freedom of the civil life.

The municipal functions are represented uniquely by the historical nucleus at the Campidoglio hill, composed by the Palazzo del Senatore NN. 920, Palazzo dei Conservatori NN. 919 and the Capitolin Museum NN. 918\*, tightened around the square designed by Michelangelo. At the contrary, political and administrative functions exercised by the papal State are dislocated in different spots: apart for the – already mentioned – locations of Quirinale (Palazzo Pontificio nel Quirinale NN. 250, Dataria Apostolica NN. 249, Palazzo della Consulta NN. 174) and Montecitorio (Palazzo della Curia Innocenziana, Palazzo dell’Ospizio Apostolico), other structures can be found

in Rione Borgo (Palazzo Pontificio Vaticano NN. 1287, Palazzo di S. Offizio NN. 1265) and Rione Parione (Palazzo del Governo NN. 614, Palazzo della Cancelleria Apostolica NN. 647). Complete lists of offices and their respective functions can be retrieved by queering the system, thanks to the transcription of the detailed description of functions operated by Bernardini.

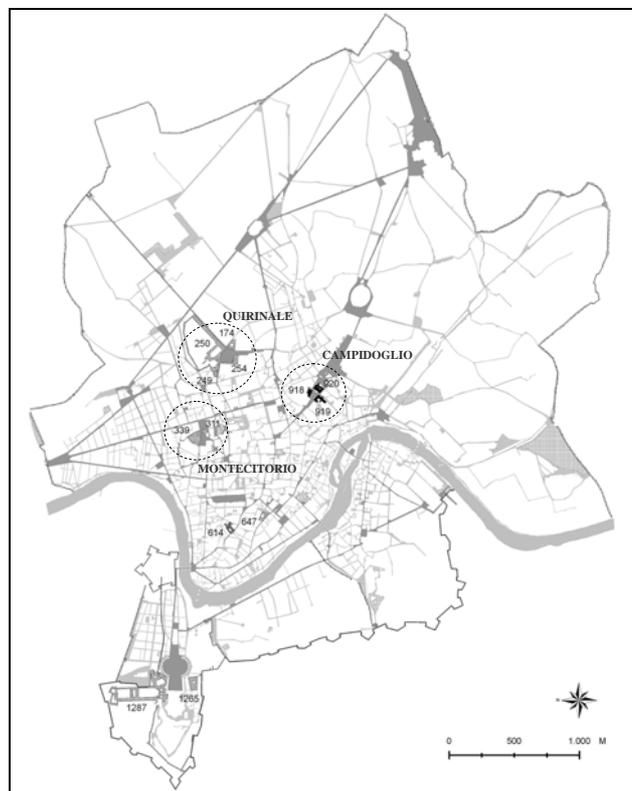


Figure 3. Spatial distribution of public administration in Rome, in 1748. Civil functions are in black, State functions are in dark grey. Sources: *Nuova pianta di Roma* by G. B. Nolli – *Descrizione del nuovo Dipartimento de’ Rioni di Roma* by B. Bernardini

The above described information constitutes only part of the Integrated Nollis’ Index falling under the denomination “Public places”. As it can be seen from Figure 4, there are 101 objects described, also including: schools, university, museums, theatres, harbours, costumes, walls, gates and bastions, prisons, cemeteries, public gardens, public magazines of grain, soldiers’ quarters, powder magazine, gun foundry, banks and mint, constituting five percent of the total number of described objects. A careful evaluation process was necessary to correctly assign part of these objects. In fact, discrepancies between sources are observed, since often the term “Palace” is used to indicate buildings where public functions are carried out.

What strikes out while observing Figure 4, is the total absence of classes referring to economic or productive activities. In the original Numerical Index of Nolli, the Tobacco Fabric is classified as Public place, while the different quarries and excavation activities are drawn only and not described. The most representative example of productive activity in Rome is represented by the Fornaci quarter: a concentration of brick making factories and warehouses located close to the Vatican, not included in the Integrated Index because of its location outside the perimeter of the walls.

\* NN – Number of Nolli

A great number of ecclesiastic buildings is described in the numerical Index, including churches, monasteries, convents, hospices, and other charity structures, constituting 29 percent of the total number of described objects.

The charity system is also composed by non-ecclesiastic hospices, and a conspicuous number of hospitals.

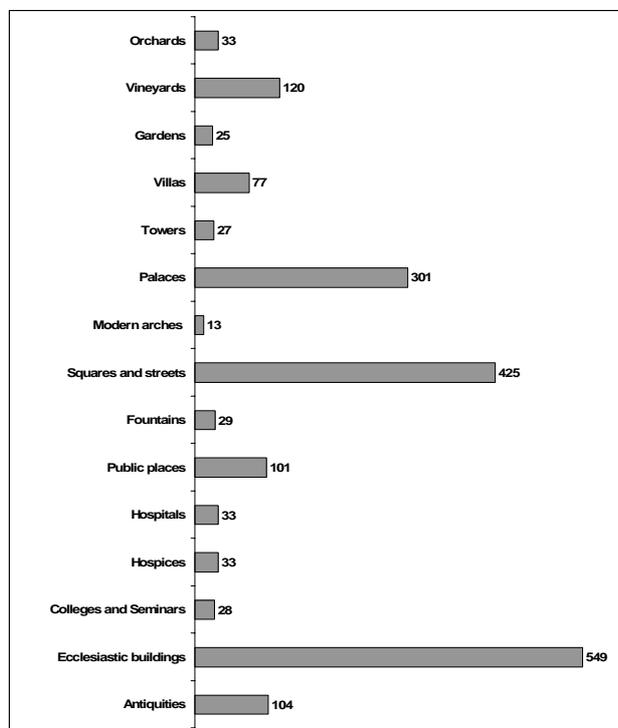


Figure 4. Distribution of the functions in 1748.

Source: *Nuova pianta di Roma* by G. B. Nolli – *Descrizione del nuovo Dipartimento de' Rioni di Roma* by B. Bernardini

Another remarkable feature of this spatial database is represented by the 301 noble palaces, precisely drawn and described in the Integrated Index. In the Nollis' map the smaller graphical unit is the building block. The exceptions from this rule are represented by church and theatre interiors, palace courtyards, entries and stairways, which are carefully drawn. The numbers of indexed buildings are usually placed inside, with the exception of palaces without or with a small courtyard: in this case the number is placed in front of the entry. It is not possible to retrieve information on buildings' shape from the map of Nolli, a part for the churches and large buildings occupying entire blocks (monasteries, large palaces, etc.). In these conditions, the necessity to homogeneously describe the urban space obtaining polygon objects for every land use typology, brought us to consider another cartographic historical source: the urban cadastre. Although the cadastral source depicts the city in the year 1818, the stable situation of the urban structure allows the assumption, with a certain approximation, that relevant changes did not occur. The overlay between the two georeferenced historical maps, shown in Figure 5, enables us to retrieve all the necessary information about the shape of buildings. The accuracy of this operation may be considered sufficient, since we are working with historical cartographic sources, and the scale of the cadastre is larger (1:1.000) compared to the scale of the Nollis' map (1:2.900 approx. The map is expressed in roman palms of architecture).



Figure 5. Spatial overlay between the Map of Nolli, 1748, scale 1:2.900 approx, and the Urban cadastre, 1818, scale 1:1.000

### 3.3 In-depth readings

This section illustrates some in-depth thematic readings obtained by means of integrating additional information to the spatial historical database described in the previous section.

#### 3.3.1 The lost urban heritage

As already pointed out, the New map of Rome by G.B. Nolli depicts the urban structure as it was before the enormous transformations taking place after the Unification of Italy and the proclamation of Rome Capital of the Nation. These transformations may be grouped in the following categories:

- demolition of historical urban fabric to leave room to the new road network;
- demolition of historical urban fabric for the isolation of archaeological sites or buildings;
- new urban expansion.

The urban heritage demolished between 1870 and 1940 in terms of palaces, villas, churches, etc., is extended in the entire area inside the Aurelian walls.

The spatial overlay between the Map of Nolli and actual cartography, as well as an accurate bibliographical research, enabled a precise identification of the lost urban heritage. More than 300 objects, already described in the Integrated Nollis' Index, have been identified as lost buildings. A catalogue is then compiled, including detailed architectonic description of each building, information on the period of construction, architects, period and cause of demolition, as well as iconographic illustration. Each form is interactively linked to the digital historical cartography, and compared to the actual situation.

This product, which is an integrating part of the Atlas's CD-Rom, constitutes a truly useful tool offered to researchers, teachers, local administrators and citizens, for the knowledge of the lost urban heritage.

#### 3.3.2 Modern Rome and archaeology

Our efforts to perform detailed study of the archaeological landscape of Rome in the 18<sup>th</sup> century, rely on the meticulous work of Nolli and his collaborators, and is directly related to the original aspirations of the map's promoters, mostly interested in antiquities. In this period, increasing interest and awareness of the immense archaeological patrimony produced the first examples of conservation practices and study initiatives. In 1734, Pope Clemente XII Corsini founded the Capitolin Museum, the first worlds' public museum of antiquities, having

the scope to preserve the archaeological patrimony from the systematic depredation. The appointment in 1763 as Prefect of Antiquities of a personality such as Johann Joachim Winckelmann, clearly reflects the illuminist aspirations towards the scientific study of archaeology.

Detailed written descriptions exist of large part of the ancient vestiges of Rome in the 18<sup>th</sup> century. These notes were taken by Ferdinando Mariani between 1736 and 1738, during the measuring operations of the Nollis' map, and correspond to archaeological objects drawn in the Preparatory Drawing. The manuscripts, conserved incomplete in the Secret Vatican Library, were published in 1883 and 1884 by G.B. De Rossi (De Rossi, 1883, 1884). The ruins described in these publications have no immediate correspondence with the printed version of the Nolli's map, since in the latter, only a reduced number of objects is Indexed and described.

A catalogue is compiled to describe each archaeological evidence, extending the number of recorded objects from 104, contained the Integrated Index, to 362, and assigning the correct correspondence to the map objects. The catalogue contents include: the category of archaeological object, the reviewed description of the vestige, considering that the actual knowledge may differ with respect to that of the 18<sup>th</sup> century, the transcription of the original description operated by Mariani, and bibliographic references. Each form is interactively linked to the digital historical cartography, and compared to the actual situation.

This product, which also constitutes an integrating part of the Atlas's CD-Rom, represents an innovative approach to the study of the archaeological heritage.

### 3.3.3 Administrative boundaries

The last application here illustrated concerns the demography in the 18<sup>th</sup> century. For the first time the reconstruction of the parish limits is made by transferring the traditional descriptive information into cartography. The rich toponymic information of our spatial database, allowed a precise and reliable delimitation of these administrative limits based on the map of Nolli. The registers of "stati delle anime", systematically compiled every year - at least since 1630 -, refer to the spatial units of parishes and contain detailed demographic information (name, profession, age, and social status of the residents). The opportunity to perform demographic spatial statistics adds further value to this project.

## 4. CONCLUSIONS

As a conclusion, we would like to stress out the utility of the use of GIS for urban historical studies. Applications can be numerous, as a flexible structure is created, able to support increasing levels of complexity and great variety of information coming from different archive sources. The spatial-thematic information can be retrieved and analysed synchronically and diachronically, thanks to GIS procedures, also through internet. The latter aspect may offer great perspectives for future research developments and renovation: the sector is continuously evolving, although high quality historical Web-GIS examples are not frequent. The opportunity to consult spatial historical information on-line constitutes an important step forward towards the conservation of papyery documentation and the simplification of consultation procedures actually carried out in archives. Potential positive effects may be foreseen with regard to the efficiency of data sharing within the scientific community at national and

international level, but also towards the specialized operators in the building and restoration industry, and a vaster public.

Future work will deal with the integration into the system of cadastral sources, allowing for another group of thematic comparative studies covering the years from the 1820s to the Unification of Italy. The structure of the urban cadastre can host information from other historical databases, provided they can be linked to the cartographic instrument. Some experimenting in this sense has been already successfully done.

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