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Old Maps of Madrid and Interactive Web Applications by National Geographic Institute of Spain

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Summary: The Map Library of the National Geographic Institute of Spain (IGN), which was founded in 1870, has custody of an important cartographic collection of maps from the 16th century to nowadays, such as: maps made by the National Geographic Institute (national topographic maps or topographical works), regional maps, cartographic series, thematic map, atlases, city maps, and a valuable collection of maps of Madrid. The aim of this paper is to show a part of this cartographic heritage through different Madrid maps, that are available online, and to show how to use interactive IGN web applications for exploring the maps. Through a selection of the most significant old maps of Madrid, we can appreciate the evolution of the urban development of this city. From the first printed map, drawn by Marcelli in 1622, which shows a city where the king Philip II moved the court in 1561; the magnificent map of Texeira, which is the most important and detailed city map of the 17th century; the Chalmandrier's map, 1761, that shows what the city looked like at the beginning of the Charles III's Kingdom; the Pascual Madoz and Coello's map, 1848, or the map of Ibañez de Íbero, 1875, where it is possible to appreciate the expansion of the district outside the wall that surrounded Madrid until 1875.

Introduction

The Map Library of the National Geographic Institute of Spain (IGN), which was founded in 1870, has custody of an important cartographic collection of maps from the 16th century to nowadays, such as: maps made by the National Geographic Institute (national topographic maps or topographical works), regional maps, cartographic series, thematic map, atlases, city maps, and a valuable collection of maps of Madrid. The aim of this paper is to show a part of this cartographic heritage through different Madrid maps, that are available online, and to show how to use interactive IGN web applications for exploring the maps.

The first part of the article is about the selection of Madrid Maps we have used in the interactive IGN web applications. The paper describes every map, its importance within the historical context, its artistic value or the value of the represented information. Eleven maps had been selected: the first printed map, drawn by Marcelli in 1622, which shows a city where King Philip II moved the court in 1561; the magnificent Map of Texeira, which is the most important and detailed city map of the 17th century; the Chalmandrier's Map, 1761, that shows what the city looked like at the beginning of the Charles III's Kingdom; Espinosa de los Monteros's Map, 1769; Tomás López's Map, 1785; the Pascual Madoz and Coello's Map, 1848; the map of Ibañez de Íbero, 1875, where it is possible to appreciate the expansion of the district outside the wall that surrounded Madrid until 1875; Facundo Cañada's Map, 1900; Núñez Granés's Map, 1910; the Plot

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Map of Madrid, 1929, that shows what the city looked like before the Civil War started; and the Plot Map of Madrid, 1940-1960, displays the city at the end of the Civil War.

In the second part, the article covers the digital tools and interactive IGN web applications available on the Web for examining these maps. These are the Catalogue of IGN Map Library, the Interactive Visualize of Texeira Map, and the WMS service.

The most important old Maps of Madrid

The first historical record of Madrid dates back at the end of the 9th century when Emir Muhammad I commissioned the construction of a fortress in the village of *Mayrit*, on the banks of the river Manzanares, which nowadays it is replaced by the Royal Palace. The objective of the fortress was to defend the village from the Christians attacks and to control the revolts in Toledo.

After the Reconquista the village kept growing and between the 11th and the 12th centuries the Medieval walls were built as an extension of the original walled enclosure. In the figure 1, the red line represents the Muslim wall and the blue line represents the Medieval wall. The earliest defensive function of the first walls was lost with the time. The new fences that surrounded the city from the 15th to the 19th centuries had an administrative, sanitary and fiscal function.



Figure1: The walls of the old City of Madrid.

The Mancelli's Map, 1622

The Mancelli's Map is the oldest known printed map of Madrid. It appeared within the work edited in Amsterdam by Fredrick de Wit. The graphic scales and the name of Wit in the cartouche are shown in the map. The Mancelli's Map also appeared, in this case without scales and name, in the work by Johannes Jansonius titled *Theatrum in quo visintur illustriores*, in the volume dedicated to Spain. This work was edited in Amsterdam in 1657 and engraved by the son of Fredrick de Wit.

Nowdays it's known by documentary sources that the map was elaborated by the Italian cartographer Antonio Mancelli. He came from Modena and lived in Madrid since 1614. This cartographer gave the original map to the Madrid Council (*Concejo de la Villa*) in 1622. From the urban development shown, it is estimated that the maps should have been made between 1618 and 1621. Although it's known 152 copies were printed it is unknown where they are.

The map shows Madrid during the last years of Philip III's Reign and the first years of Philip IV's Reign. Madrid was a dense city with tortuous streets; it had six roads that crossed it. The roads had a radial structure; the center was in the Mayor Square and they ended in the following gates: Fuencarral, Bilbao, Alcalá, Atocha Toledo and Segovia.

The IGN custodies a facsimile copy realized in 1923 by the Cadastral Geographic Institute. The scale is approximate, about 1:4.500. There are few texts in the map and they present some mistakes, probably due to lack of knowledge of the language. The map includes buildings in cavalier projection. Some places and building are identified in the legend, especially religious sites.

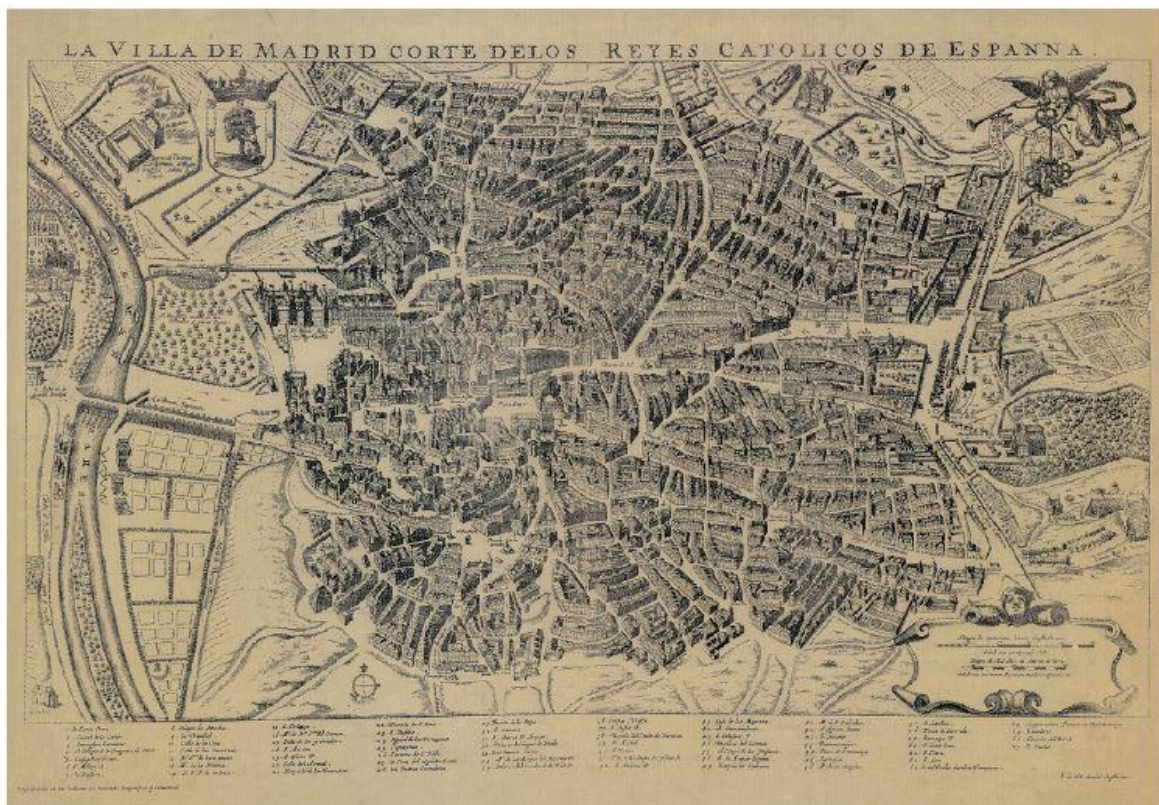


Figure2: Mancelli's Map.

The Texeira Map, 1656

This is the most important map from the 17th century. The work was commissioned by King Philip IV and it was made by the cartographer Pedro Texeira. The map was engraved in Amsterdam by Salomon Saury, a member of a well-known family of engravers, and printed in Ambers by the Van Veerde brothers, in 1656.

The map is remarkable for its details, meticulousness, extension and geometrical accuracy. Its great quality wasn't overcome in many years. It is the most representative map of Madrid.

The map is composed for 20 sheets and the approximate scale is 1:1850. It measures 180 x 285cm and represents the plan of the Madrid Villa with elevation view of the south facades of the build-

ings. It is possible to observe the distribution of the blocks, parcels, roofs, courtyards as well as some human figures.

There is a legend with several sites like: parishes, convents, hospital, hermitages, fountains, and descriptions of the Royal Palace, the Retiro Palace and Casa de Campo. Many words have spelling errors because the map was engraved in Amsterdam. The city boundaries shown in the map are before the town remodeling in the 19th century.

The Teixeira map became popular through the excellent copy that the Geographic and Statistics Institute realized in 1881. In 1881 this copy was awarded the gold medal at the International Congress of Cartography of Venice.

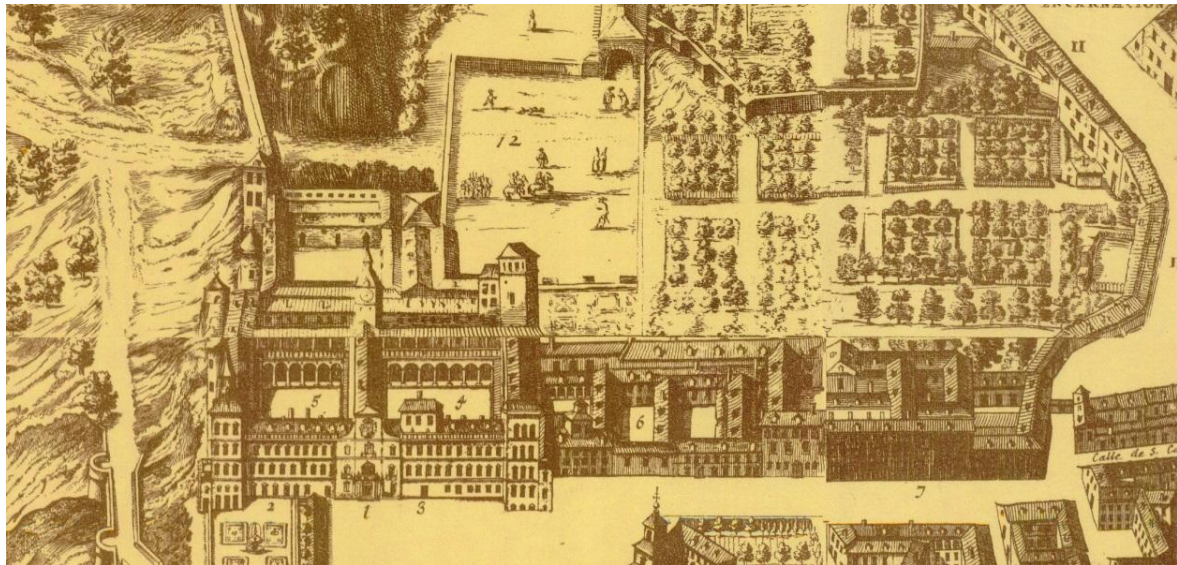


Figure 3: The old Palace, destroyed in a fire in 1734, on the Teixeira Map

Nicolas Chalmandrier's Map, 1761

This map is characteristic for showing what the city looked like in the beginning of the Carlos III's Reign, with the improvement carried out by Fernando VI. The Royal Palace appears in a map for the first time. It was constructed on the location of the old palace, destroyed in a fire in 1734. We are able to appreciate the structure and general composition in cavalier projection. Also, the map shows the Bridge of Toledo, finished in 1722, and the old bullring, *Plaza de Toros*, opened in 1722.

This map has an excellent engrave and the principal buildings are symbolized in cavalier projection. It is composed for four sheets; the approximate scales are 1:3.600. In the legend there is a list of buildings such as: convents, hospitals, schools, hermitages, and fountains.

The map library of the National Geographic Institute conserves an original copy of this map.

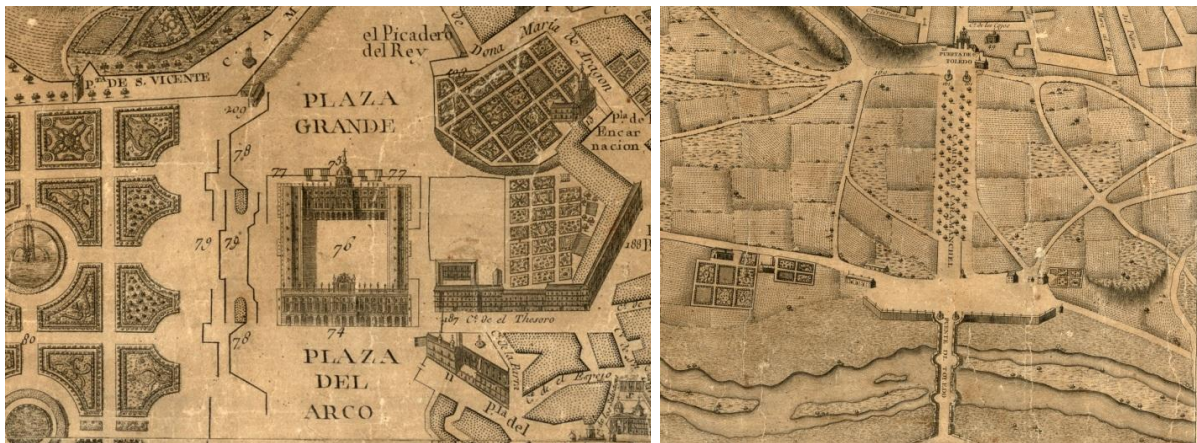


Figure 4: The Royal Palace and the Toledo Bridge on the Chalmandrier's Map.

Espinosa de los Monteros's Map, 1769

In the seventeen hundred, the century of the Enlightenment, different academies were founded to promote studies, such as, the Royal Academy of History or San Fernando Royal Academy of Fine Arts. Espinosa de los Monteros was a member of the San Fernando Royal Academy of Fine Arts. He drew and engraved a map by request of the Count of Aranda.

It is composed for nine sheets. The map composition measures 244,5 × 176,5cm. The approximate scale is 1:1.900. In the map we are able to appreciate the in construction and projected works. It's based on the *Planimetría General de Madrid* (General Planimetry of Madrid).

The *Planimetría* was a project to make an urban cadastre of the city of Madrid between the years 1750 and 1751. Espinosa de los Monteros participated in the works. The *Planimetría* was composed of 557 plans of block and textual information about owners, charges, etc. The numeration of the 557 blocks of the *Planimetría* appears in the map.

The National Geographic Institute conserves a copy for this map.

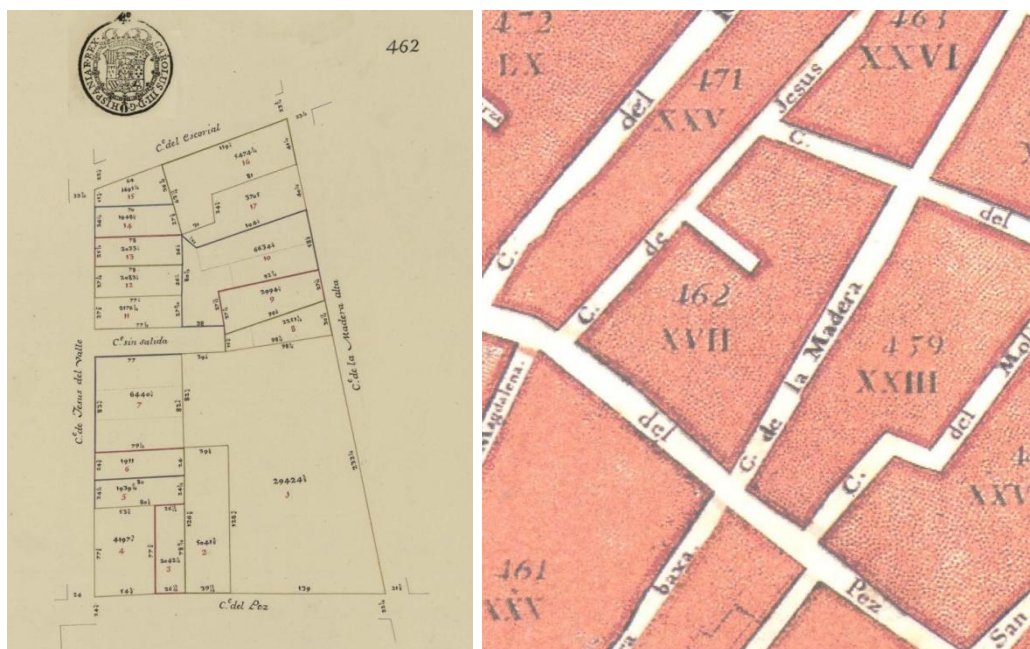


Figure 5: On the right the 462 blocks on the Espinosa de los Monteros's Map, on the left the 462 blocks on the *Planimetría General de Madrid*.

Tomás López's Map, 1785

Tomás López is one of the most fruitful cartographers in the second half of the 18th century. He was sent to Paris by Marquis of Ensenada in order to learn to engrave and publish geographic maps. When he came back to Madrid, he started a long and fruitful career dedicated to draw, engrave and commercialize the maps he had been producing. In 1770, he was appointed by Carlos III as Geographer of his Majesty Dominions, *Geógrafo de los Dominios de Su Majestad*. He was a member of the Royal Academy of History and the San Fernando Royal Academy of Fine Arts. He made the maps by compilation; gathering together all kind the information from different sources. He didn't carry out any measurement.

In order to realize this map, he used diverse sources, such as he mentioned in the map: Texeira Map, Espinosa de los Monteros's Map, Chalmandrier's Map, etc.

The map shows the urban development of Madrid at the end of the 18th century. The city was delimited by the fence constructed by Felipe IV. We are able to appreciate the urban reforms ordered by Carlos III. In the sides of the map there is a street map, and it's possible locate streets by means of a grid. The approximate scale of the map is 1:5.500.

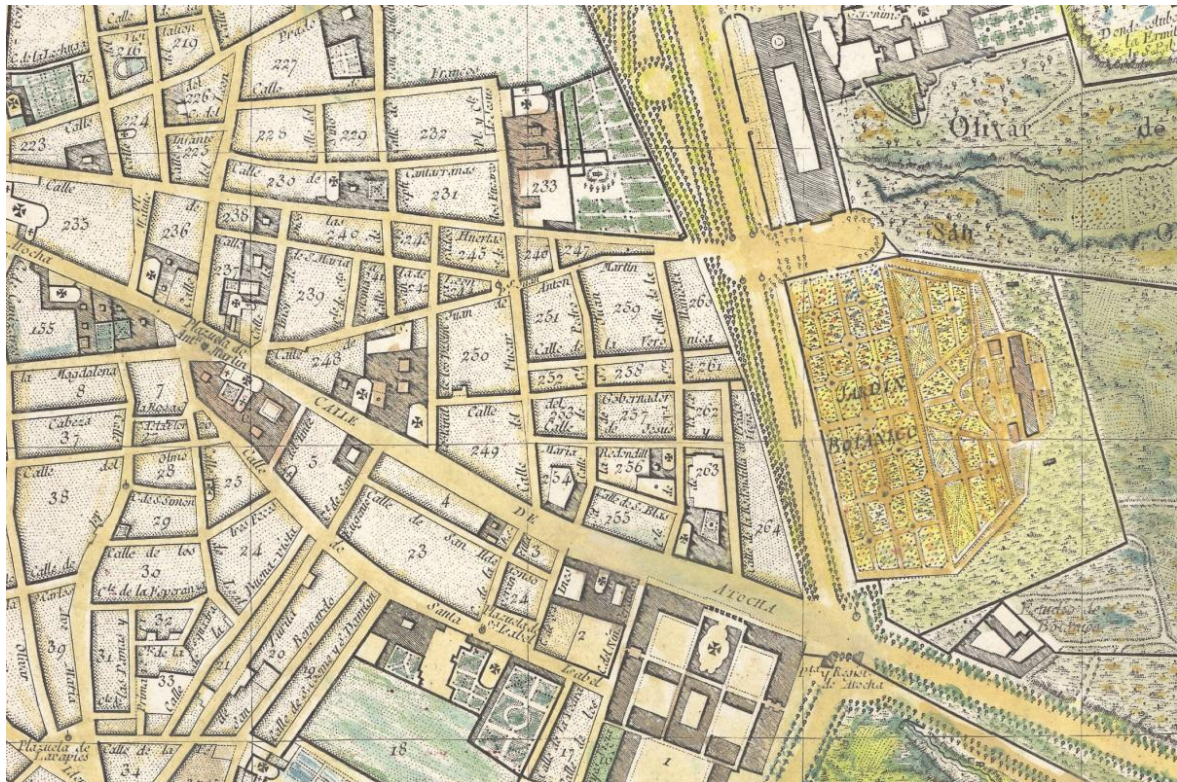


Figure 6: Detail of the Tomás Lopez's Map. We can see the Botanical Garden, *Jardín Botánico*, Carlos III ordered to translate it to this location in 1781. The numbers of the blocks coincide with *the Planimetría General de Madrid*

Madoz and Coello's Map, 1849

The map was published inside the *Atlas de España y sus Posesiones de Ultramar* by Francisco Coello and Pascual Madoz and was declared Official Plan of the Villa. This map on the 1:5.000 scale is a reduction of the map on the 1:1.250 scale made by the engineers Juan Merlo, Fernando Gutiérrez and Juan Ribera between the years 1841 y 1846.

The map includes a street map in order to locate streets and sites by means of a grid, such as: academies, libraries, museums, schools, etc.

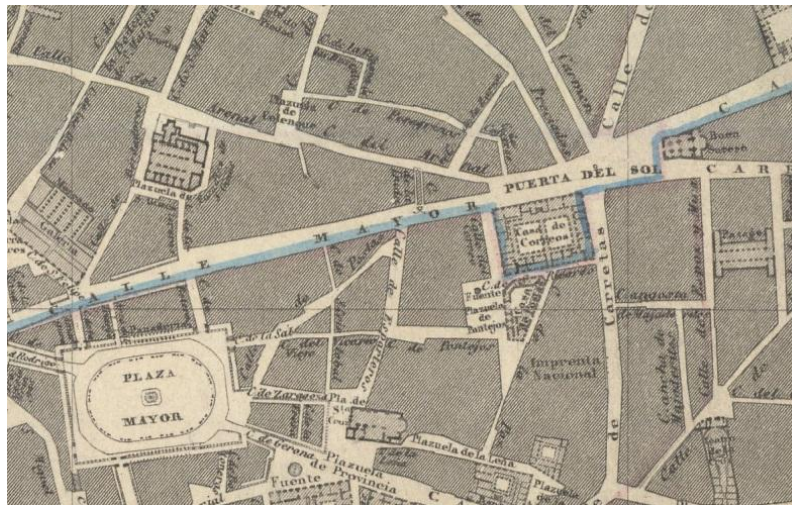


Figure 7. *Puerta del Sol* before the structural reforms of 1857, on the Madoz and Coello's *Map Ibáñez de Íbero's Map*, 1879.

Carlos Ibáñez e Ibáñez de Íbero was a military geographer who founded the Geographic Institute in 1870. He made a map on the 1:2.000 scale based on the kilometric sheet. The kilometric sheets were maps realized by the Board General Sadistic, *Junta General de Estadística*, the predecessor organization of the Geographic Institute. These sheets represented cadastral information in a sheet that had an extension of 1 km x 1km on the 1:2000 scale. All the sheets belong to Madrid were joined in 16 sheets in black and white, and composed the *Ibáñez de Íbero's Map*. Inside the map there is a legend with a street map to locate streets and public buildings by means of a grid.



Figure 8. *Puerta del Sol* after the structural reforms of 1857, on the *Ibáñez de Íbero's Map*.

Facundo Cañada Map, 1900

This map was executed by the military cartographer Facundo Cañada. It is composed for nine sheets on the 1:7.500 scale. Antonio Bonilla drew the map and it was printed in eight colours. The

most remarkable element of the map it is the inclusion for the first time of the approximate economic value of the terrain to the city of Madrid by square meter. Around the map there are plans of the surrounding villages. The map belongs to the Tomás Navarro Tomás Library.

Nuñez Granés's Map 1910

The map of Madrid and the municipality was made in 1910 by the engineer Nuñez Granés on the 10.000 scale. The map was elaborated, according to the text on the map, with the data from the Statistic Geographic Institute, the data from the City Council, and with the measurement realized. In the map there are public buildings symbolized in red colour on the old town in grey colour, the Urban Expansion Plan designed by the architect Castro in pink colour. Also, there is a legend with soil types, plans crops, communications, etc.



Figure 9. Legend of the Nuñez Granés's Map and details of the old Hippodrome, the Urban Expansion Plan in pink color and the public buildings in red color, on the Nuñez Granés's Map

Plot Map of Madrid, 1929

The Plot Map of Madrid is composed of eighty-five sheets. It was published by the Madrid City Council in 1929 on the 1:2.000 scale, together with a Memory of information about the city of Madrid. This memory looked at the urban planning and urbanization of the area between the Madrid expansion and the municipal district.

This map is very important for several reasons: it shows what the city looked like before the Civil War of Spain (1936-1939), so is cartographic testimony of many buildings that were destroyed during the conflict; in this map appears for the first time the building that nowadays holds the National Geographic Institute, inaugurated in 1929 and designed by the architect Pedro Mathet.

Plot Map of Madrid, 1940-1960

This map, on the 1:1.000 scale, was made by the Geographic and Cadastral Institute between the years 1940 and 1960. It consists of 939 sheets, each it is divided into four quarters. The planimetric and altimetric information are represented. This map shows the city of Madrid after the Civil War of Spain.



Figure 10: On the left, the Barrack of Mountain, *Cuartel de la Montaña*, on the Plot Map of Madrid, 1929. On the right the ruins of the Barrack of Mountain, on the Plot Map of Madrid after the Civil War of Spain

Interactive IGN Web Applications

The digital tools and interactive IGN web applications available on the Web for examining these maps are: the Catalogue of IGN Map Library, the Interactive Visualize of Texeira Map, and the WMS service.

Catalogue of IGN Map Library

The Catalogue of IGN Map Library was published on the Website in 2016. This Web Catalogue allows users to search different cartographic materials, to visualize and download the digital image and its metadata, to share maps on social network, and to interface with some maps.

In the Catalogue is possible to do searches through three ways: textual searches, geographic searches and with interactive viewers. The textual searches allow introducing some word in a text box, the simple search explores in the selected fields and the advance search combines several fields. The geographic searches enable to do queries about map related to countries and marine regions on a graphic world map. Besides, there is a search engine on a map that represents the bounding boxes of the maps. When a user clicks on a place in the graphic map, a list of result shows all the maps where the selected place appears.

Every map has a catalographic card in html format with a unique URL; in addition, every card is prepared to share on social network (Facebook, Twitter and Pinterest).

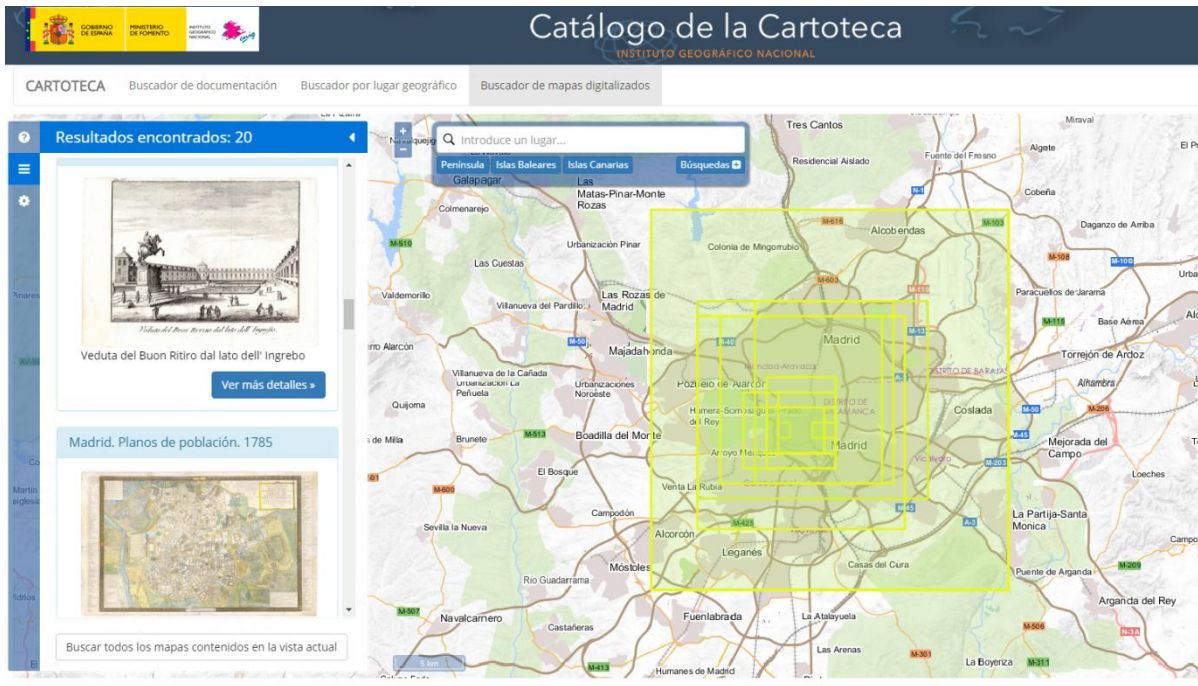


Figure 11: Web Catalogue of IGN [http://www.ign.es/web/catalogo-cartoteca/search-in-map.html]



Figure 12: Web Catalogue of IGN. Catalographic card

Other important aspect that it has been taken into account is the dissemination of the maps in order to bring the cartographic collection closer to users. The Catalogue includes a Visual Display to explore documentation. Most of them are maps composed for several sheets. A mosaic has been made and this has been georeferenced. The visual display enables to compare the maps with currently maps or aerial images. Some even include information about the map content, such as: map history, virtual tour with interesting places, etc. This is the case of some Madrid Maps like Teixeira Map, Ibañez Íbero's Map, Núñez Granés's Map or Plot Map of Madrid, dated 1929.



Figure 13: Visual Display [<http://www.ign.es/web/catalogo-cartoteca/resources/webmaps/parcelario1870.html#map=16/-412410.29/4926724.2/0>].

Furthermore, it's possible to explore the world map projected on a virtual globe. This is the case of the Van Keulen world map from 1706. We can realize a tour around the world map with interesting sites and links to external resources.

The Web design is based on Responsive Web Design rules; it guarantees a correct display of the Website on all devices (desktops, tablets and phones).



Figure 14: Virtual Globe on the Catalogue of IGN Map Library
 [http://www.ign.es/web/catalogo-cartoteca/recursos/webglobes/vankeulen.html].

Interactive Visualize of Texeira Map

On the occasion of the 4th Centenary of the death of Miguel de Cervantes in 2016, the IGN published an Interactive Visual Display. Over the Texeira Map, dated in 1656, it's possible to tour the Madrid city that Cervantes knew in the 17th century.

Due to the Geographic Information System, Web Map Services and digital tools it has been possible to locate on the Texeira Map diverse historical content. Around three hundred areas and interesting points have been defined. These contained stories, descriptions, anecdotes, and explicative texts related to Cervantes and the famous personalities of the Spanish Golden Age.

Most of the interesting points are elements that belong to the legend of Texeira Map, like: convents, hospitals, parishes, etc.

In order to explore the map it is possible to introduce any word in a search engine to use the pre-defined searches related to famous personalities and places of the legend, or to use a list with street plaques of Madrid. Also, a current street map or satellite images can be overlaid. The digital map has been published through a WMTS Service.

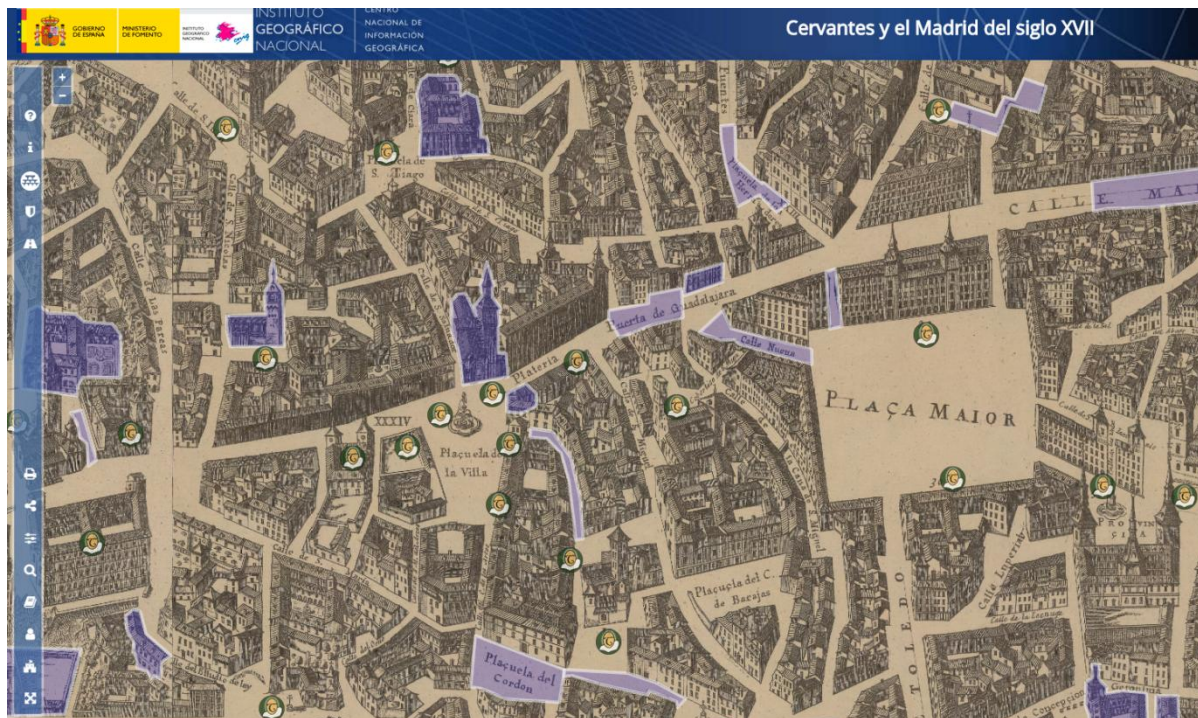


Figure 15: Visualize of Texeira Map. http://www.ign.es/web/visualizador_cervantes/#map=18/-412815.46/4926511.09/0.

WMS Service

A Web Map Service (WMS) is a standard protocol for serving, over the Internet, georeferenced map images that a server generates using data from a GIS database. The Open Geospatial Consortium developed the specification and it was first published in 1999.

The Web Map Service Interface Standard (WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, etc.) that can be displayed in a browser application. The interface also supports the ability to specify whether the returned images should be transparent so that layers from multiple servers can be combined or not.

In cooperation with the CNIG (National Centre of Geographic Information) through the IDE (Spatial Data Infrastructure) platform we have developed a WMS for the publication of all the Madrid maps described in this paper. The WMS is named Madrid Maps, *Planos de Madrid*, it is composed of eleven layers, one for each described map. Since, the Map Library of IGN conserves many others maps of Madrid, the intention is to expand the WMS with more layers that contain other interesting maps.

Conclusion

The Map Library of IGN holds an important cartographic collection. It includes a significant collection of Madrid Maps from different periods. A selection of this collection with the most important maps has been described in the article. Apart from offering the documentation available on the Web in digital format and georeferenced, we think is important to spread the map contents, such as: the value artistic of the maps, the maps historical context, the value of represented information, etc.

Also, the IGN considers that it's crucial to make available the cartographic heritage to researches, educational institutions, tourist companies, etc. providing all this georeferenced information on the current digital system of reference, enabling links and comparing the maps with other reference sources.

The map library of the IGN is working in this area, with the objective that all this geographic information of Madrid will become a reference frame over supporting cartographic work about the Madrid history. At the same time, we think it is interesting to extend this project over other maps of other cities and different subjects, for instance, we are working in an Interactive Visualizer of *Atlas Catalán*, the famous nautical chart dated in 1375, or in a Web Timeline with world maps.

The purpose it is to offer selected geographic information by diverse subjects, with available historic contents in order to bring the cartographic heritage with an added value to the users.

References

Ayuntamiento de Madrid (2001). *Madrid en sus planos (1622-2001)*. XIX Congreso Internacional de historia de la cartografía de 1 a 6 de julio de 2001.

Concepción Camarero Bullón (1988). *Planimetría General de Madrid*, Ediciones Tabapress

Miguel Molina Campuzano (1960), *Planos de Madrid de los siglos XVII y XVIII*. Instituto de Estudios de Administración Local.

Sánchez, J. (2016). Nuevo buscador de fondos cartográficos de la Cartoteca del IGN. *Revista Catalana de Geografia. IV época/ volum XXI/ núm. 54/ octubre 2016*. <http://www.rcg.cat/articles.php?id=384>

Ángela del Carmen Ruiz (2016). Nuevo visor de documentación del Archivo Topográfico del IGN y conmemoración del IV Centenario de la muerte de Cervantes con la publicación de una aplicación interactiva sobre el mapa de Texeira. *Revista Catalana de Geografia. IV época/ volum XXI/ núm. 54/ octubre 2016*. <http://www.rcg.cat/articles.php?id=382>

<http://www.opengeospatial.org/standards/wms>

https://en.wikipedia.org/wiki/Web_Map_Service