The Historic Charter of Barcelona (CHB)

Keywords: cartography; digitisation; history.

Summary: This paper presents the development of the Historic Charter of Barcelona. The CHB is a research compiling, to date, all knowledge about the urban history of the city and its documentary and cartographic sources via an online tool made for researchers and citizens with the aim of explaining the history of Barcelona through 26 maps.

Introduction

From the foundation of Barcino around 10 BC, Barcelona has been exhaustively drawn. The number and diversity of cartographic representations of the city is massive, since portolan charts mapping the seas in the fourteenth century to contemporary digital maps imagining 1992 Olympic City. This cartographic construction has eventually consolidated the imagery of the city. Perspectives and maps reflect the distinctive social and economic conditions of each period to the point of becoming a powerful instrument that will serve, especially from the nineteenth century, to project the image of the city into the future (Santamaria-Varas & Diez-Martinez, 2016). The first images of the city placed special emphasis on the topography of the territory and the control of the waterfront and walls. If the portolan charts (Pujades, 2007) of Vallseca (1444) and Bertran (1456, 1489) represented a partial vision of Barcelona focusing on emblematic Montjuïc, the Hill defining element of the city viewed from the sea (Fig. 1), the first global images of Barcelona created by painters and travellers such as Anton Van Wyndergaerde (1563). As Garcia Espuche (1995) discusses, the first famous view of Barcelona taken from Montjuic and published in the Civitates Orbis Terrarum (attributed to Braun and Hogenberg in 1572) was based on a previous lost engraving of Jan Cornelisz Vermeyen (1535). (Figs. 2, 3).

Figure 1: Fragment of portolan charts by Vallseca (1444) and Bertrand (1456 and 1489): Barcelona from the Hill Montjuïc and the flag tower. Source: Cebrían (2007).

* Trescientosmilkilómetros por segundo S.L., Barcelona; Departament d’Urbanisme i Ordenació del Territori, Escola Tècnica Superior d’Arquitectura de Barcelona (UPC), Barcelona.

** Trescientosmilkilómetros por segundo S.L., Barcelona; Institut d’Arquitectura Avançada de Catalunya, Barcelona.
Figure 2: Detail of Barcelona: Barcino que vulgo Barcelona dicitur published in the Civitates orbis terrarum (Cologne, 1572) and based on the lost engraving by Jan Cornelisz Vermeyen. Source: Cartographic Institute of Catalonia.

Figure 3: Anton Van Wyndergaerde painted two views of the city of Barcelona. The first, from the sea, enables to understand the extent of the city as well as its main elements (the walls, the harbour, the Montjuic fortress, religious buildings, etc.). The second view adopted as a point of view Montjuic hill, facing the walled city.

In the impasse between these primordial perspectives and the major urban plans of 1800, Barcelona will be portrayed through military cartography. Primarily in these three hundred years, cartographers focused on depicting war scenes (especially during main sieges as shown in this engraving of 1706 by Nicolaes Visscher, Fig. 4) or sketching partial elements related to military strategy (the Citadel, the bastions, the harbor, etc.).

The process of cartographic description of the territory will definitely accelerate in the early nineteenth century (Navas, 2014) in parallel to the technical advances in the field of cartography. For instance, the invention of the tachymeter in 1839 suddenly allowed covering large areas of territory and producing cartographic documents of unprecedented precision. The topographic map of the Plain of Barcelona, drawn up by Ildefons Cerda in 1855, will be the precursor of a series of documents, among which Garriga Roca Quarterons (1862), Garcia Faria map (1890), the topographic map of the City Council (1903) and the Martorell map (1936/39) (Fig. 5).

All these charts will start to illustrate the city at a municipal level, describing the walled city along with the surrounding towns (Gràcia, Sarrià, Sants, Sant Andreu, Sant martí) that will join Barcelona once the walls were demolished. These plans will become the basis of modern projects of “Eixample” (Cerda), connectivity (Jaussely) and sanitation (Garcia Faria).

The next stage in the development of cartography will occur through the “American flight” in 1956 and the orthophoto extracted by Barcelona Provincial Council (Fig. 6). This frame of the Catalan land is not only a key reference point in order to analyze recent urban processes -as it was made before the main social and economic developments of the 60s and 70s-, but also it becomes the best document to inform territorial planning, now understood in its metropolitan scale.
Figure 4: Le plan de Barcelone et ses environs. Très-exactement Levés sur les Lieux, par un Ingenieur, en 1706. Mis au jour à Amsterdam par Nicolas Visscher, avec Privilege. Source: Atlas de Barcelona.

Figure 5: Zoom of the map Divisió del pla de la ciutat de Barcelona’, directed by Vicenç Martorell chief of Municipal Services, 1930-1940. Source: Arxiu Històric de la Ciutat de Barcelona.
The introduction of Geographic Information Systems and photogrammetry in public administration in the 80’s (Alegre, 1995) along with the digitisation of the 1Plano Magistral1 was used to generate the first digital topographic and cadastral maps of the city (Fig. 7) in 1985 and 1987 respectively. In the same period, the main institutions responsible for the development of cartography in Catalonia (Barcelona Provincial Council, Cartographic Institute of Catalonia) would ensure the creation of a common framework and reference standards. Nowadays, maps are adapted to ETRS89 coordinate system and distributed through various services like Cartobcn or Geoportal2 for multiple thematic applications: reference cartography (topographical and cadastral plans), urban planning (land use and qualification) or service management (greenery, urban waste, water-cycle), among others.

Figure 6: Fragment from 1956 orthophoto. Source: Barcelona Provincial Council.

Figure 7: Fragment of 1992 digital plan of the city. Source: Municipal Institute of Information Technology.

1 As Montaner i Garcia, (2000) argues the Plano Magistral, drawn from 1926 to 1936 in colour, became the base for contemporary cartographic documents developed by the Municipal Service of Cartography.

2 The Municipal Institute of Information Technology coordinates the data model and the cartographic information of the city and publishes the information via different channels. The Geoportal (Ajuntament de Barcelona, 2017) allows municipal territorial information to be made available through the web using OGC standards. Cartobcn (Ajuntament de Barcelona, 2017) is the City Council download service for cartography.
At this point, we can affirm that the image of the city for the past five hundred years is kaleidoscopic due to the different nature of the abovementioned documents: navigational charts, planimetric and altimetric surveys, aerial images or digital maps. Yet, when did we start to build knowledge about the urban history of Barcelona based on these sources?

During the 80s, local historians as Manuel Guàrdia, Albert Garcia Espuche and Mercè Tatjé started redrawing these documents in order to develop hypotheses regarding unknown or undocumented episodes of urban history. The drawings contained in seminal works like ‘Espai i societat a la Barcelona pre-industrial’ (García-Espuche et al., 1986), which shed light on the urban structure and characteristic elements of pre-Cerda city (Fig. 8), were often produced by hand by the authors using ancient maps as a base - and consequently generating significant distortions depending on the accuracy of the original source.

Figure 8: Medieval urban structure 1300. Source: Espai i societat a la Barcelona pre-industrial.

In recent years, maps, graphic descriptions and urban master plans of Barcelona have been well studied and documented. One of the most consistent works ranging from the sixteenth to the twentieth century is the Atlas de Barcelona (Galera et al., 1982), without forgetting substantial precedents of previous generations -Francesc Carreras Candi, Agustí Duran i Sampere and Vicens Martorell-, recent sectoral studies by Manuel Torres Capell and Joan Busquets and the continuous work of the Museum of History of Barcelona (MUHBA) and the Historical Archive of the City.

Following a logical sequence, the need to digitise and make cartographic information public arises today either for scientific research and dissemination in professional environments. In this respect, it is worth mentioning the work of the Institut Cartogràfic i Geològic de Catalunya (ICGC) in the digitization and online publication of most relevant historical maps as well as the development of other dissemination tools such as the Carta arqueològica d’e Barcelona by City Council.

However, until today, there is a lack of tools aimed at enhancing awareness on urban history and heritage protection among citizens. Big Time is an interactive map that links together the Heritage Catalogue of Barcelona with the cadastral base (classified according to the year of construction of

---

3 The Atlas of Barcelona, by Montserrat Galera, Francesc Roca and Salvador Tarragó, was published in 1972 (first edition) and 1982 (expanded edition), edited by the Historical Archive of COAC.
4 Big Time Bcn (Bigtimebcn, 2017) was developed and published in 2014 by 300.000 Km/s.
buildings) to create a global image of the heritage state. Unlike previous examples, this tool is aimed at a non-specialist audience to increase citizens' knowledge and strengthen their participation in decision-making processes affecting heritage conservation and transformation.

In this context, the MUHBA and the City Council express in 2015 the need to redraw and put all this information together for the first time, as a sort of experiment. Given the profusion of materials and heterogeneity of sources, matching them spatially and graphically was needed in order to compare historical periods and give a compelling narrative of the urban evolution. This is the starting point of the Historic Charter of Barcelona (Carta Històrica Barcelona, 2016).

The design of the workflow for processing cartographic sources

The CHB is a research compiling, to date, all knowledge about the urban history of the city and its documentary and cartographic sources via an online tool made for researchers and citizens. It aims to explain the history of Barcelona through twenty-six historical moments and their corresponding maps. (Fig. 9)

Today, the CHB is a unique tool in its approach, content and functionality although it relates with different digitisation projects regarding historical cartography. There are at present quite a few good international examples such as the collective digitisation campaigns of the New York Public Library and the digital collections of the Bibliotheque nationale de France via Gallica catalogue.

![Figure 9: Overview of published cartographies from 100 BC to 1750. Source: CHB.](image)

The interactive publication of historical maps continues also to gain popularity. For instance, we can browse John Rocque’s ancient London (Centre for Metropolitan History, 2011), Ile-de-France during the French Resistance period (Fondation de la Résistance, 2014) or the thematic Atlas of the United

---

5 The NYPL - New York Public Library (The New York Public Library, 2017) has developed tools such as the Building Inspector, enabling citizens to help transcribing place names, addresses, and building information from old maps; the NYPL Map Warper, which is a tool for digitally rectifying historical maps from the NYPL’s collections to match today’s precise maps and Scroll NYC, which enables to peel away layers of the city’s history and layer maps from 1660 through 2014.


[43]
On the other hand, visualisations of urban history of cities have proliferated via animations (City of Amsterdam, 2015), timelines (Rice Humanities Research Center, 2016) or layering (Tuzcu, 2017).

In contrast to the above examples, it is important to underline that the CHB requires a global approach that includes the following steps: establishing a scientific committee to oversee the work and ensure consistency, documenting available sources, digitising, georeferencing and vectorising materials, equally representing disparate documents and publishing resulting cartographies to improve user consultation and interaction.

In this sense, the design of the team, the workflow and the implementation of technological solutions has been one of the most decisive points of the project. We had to foresee the possibility of updating both the contents and the tool, correcting errors and incorporating new sources of information and documentary findings. According to these principles, the CHB should be accessible to historians, archaeologists and architects, who create scientific knowledge but are not necessarily experts in cartography.

Emphasis should also be placed in the transversal competences of the scientific committee. It has been led by the director of MUHBA Joan Roca Albert (scientific director) and composed of Manuel Guàrdia Bassols (director of cartographic surveys), Ramon Pujades Bataller (supervisor of cartographies) and Oriol Hostench, Pablo Martínez and Mar Santamaria (technical direction and processing of maps). The team has benefited from the advice of Josep Maria Palet, Júlia Beltran Heredia i Carme Miró Alaix and the collaboration of the Division of Archaeology of Barcelona, the Municipal Institute of Information Technology (IMI), the Institut Cartogràfic i Geològic de Catalunya (ICGC), the Historical Archive of Barcelona, the Master of Restoration of Monuments (MRM), the Culture Institute of Barcelona (ICUB) and the Cartography Division of the Metropolitan Area of Barcelona (AMB).

Redrawing two-thousand years of urban history

However, one of the biggest challenges of the project was to achieve a consistent graphical and temporal resolution for the twenty-six selected historical periods and their resulting maps, which were based on very diverse sources (type and accuracy). Indeed, the task of redrawing started by georeferencing historical documents to match contemporary base maps. This process is different in accordance with the type of source whether analogue (topographical maps or maps created by local historians) or digital (ancient digital maps or already treated current databases).

Regarding the base map, to be used as a guide to select reference points and define the transformation settings, we decided to use the cadastral map of Barcelona. It can be classified depending on the year of construction of buildings (Fig. 10), providing contrasting information on the dating of the various urban elements. Additionally, we employ heritage assets and archaeological sites to increase the level of detail in some specific points.

---

7 This project is collaboration between Digital Scholarship Lab (Univ. Richmond) and Stamen Design.
In all cases, we re-projected documents, contested the outcome and verified its veracity with the scientific committee. In the process of georeferencing, none of the original projections was consistent enough. Consequently, we had to deform original maps by applying a TPS algorithm\(^8\), using an average of 500 reference points per cartography (Fig. 12).

\(^8\) The Thin Plate Spline (TPS) algorithm is a more modern georeferencing method, which is able to introduce local deformations in the data. This algorithm is useful when very low quality originals are being georeferenced.
At this stage, we had to detect errors arising from the process of georeferencing and redrawing. First, it must be taken into consideration that ancient maps were divided in several sheets that were delineated separately. The process of completing a map could last decades - for instance, the Martorell plan was drawn during years. This means that each sheet can have a different date. The commitment of the CHB is to provide a unique image of a particular moment in history. Therefore, it was necessary to match the different sheets in the same timeframe, using the date of construction of the buildings to verify the accuracy of the data.

Second, the update rate of base maps is uneven because Barcelona’s cartographical services work with continuous mapping systems. For instance, some areas of the city have remained static and have not been updated. Other zones have experienced such enormous urban transformations that the current state has not being brought up to date (this is the case of Glòries square, once the ring road has been demolished, it appears as a big roundabout in the city map). As a result, the image we have of the recent past is becoming blurred.

Third, we have detected repetitive inaccuracies among consecutive drawings, suggesting that the authors copied each other. We could affirm that at a certain moment, no plans were drawn from scratch but cartographers use previous sources even if inheriting errors. Finally, we should mention that it has been difficult to verify the accuracy of the position of certain elements in the oldest documents; we consequently generate hypothesis that, in the future, may be verified, rejected or corrected (to give an example, the position of the Mercadal or parish churches).

The redrawing of the twenty-six maps has been developed with Microstation according to a single scheme of layers (Fig. 13) to be used to redraw urban features in the same manner regardless of the historical period - buildings, natural elements, walls, roads and major transport infrastructures. We failed to include original topography, minor roads and non-built areas due to the lack of an accurate description of these elements. In addition, some maps presented specific features that have been redrawn
according to a secondary layer scheme. This information is shown as a metadata when selected by the user in the website.

![Layer scheme and Microstation drawing during the process of redrawing the reprojected maps.](image)

Figure 13: Layer scheme and Microstation drawing during the process of redrawing the reprojected maps.

**Publishing tool**

The last stage of the project is the design of the strategy and the tool for the online publication of previously re-projected and redrawn maps. Regarding the publication workflow, we have developed a code that converts DGN files into a Spatialite database, while configuring the rendering styles (xml), the map tessellation (CDG) and the settings of the online viewer (json) according to the parameters specified in a spreadsheet (type ods). We opted for Spatialite technology, because it treats files as databases, facilitating backup and upgrade processes. Moreover, it can store in a single table of the database various types of geometries (line, point, and polygon), reaching an almost direct conversion between original DGN files and the new Spatialite database and maintaining a strong connection in the structure of information.

In the conversion procedure, we always preserve the original DGN files to be able to trace the redrawing operations and via coding, we clean and validate geometries, compress files, join similar geometries and generate singularities, such as courtyards. Even if the maps have been redrawn at the plot level, the information is aggregated at a block level to ensure an optimal understanding. The backend is responsible for converting DGN files into spatialite and makes them available to a Tilestasche based tile-server, which uses Mapnik to render the information. Regarding the rendering styles, we have applied a similar strategy as that used for the layers: a single CartoCSS style controls the appearance of all the maps that changes according to the level of zoom. In relation to the zoom, each map has a specific configuration depending on its spatial coverage and the resolution of the original source.

On the client side, the online viewer is programmed with Openlayers3, enabling to rotate the point of view of the map; this was an essential aspect in the project as Barcelona is normally represented with the Eixample parallel to the sea. The entire application runs on a low-performance VPS server (2vCore, 4gb Ram, 50GB memory, Linux-Ubuntu and Apache) since the process of rendering the tiles takes place when files are updated into the server.
Finally, the interface offers the user a series of tools to both browse information and interact with the content (Fig. 14). We have included a tool to superimpose current cartography to historical maps and another one to draw on the maps if the user wants to leave notes or compare the position of various elements. We have also incorporated detailed descriptions of each cartography as well as extra layers and reprojected documents when possible, aiming at providing key information for understanding the various historical periods (Fig. 15).

![Figure 14: CHB interface.](image)

![Figure 15: Illustration of different user functionalities: overlapping current base map, drawing, activating extra layers and zooming.](image)

**Conclusion**

Besides the cultural and technical achievements of the CHB, it is important to remind the necessity of having good tools for research and dissemination. Dissemination widely understood should be tightly linked to scientific research. In this regard, the CHB should become a reference for future generations of...
historians and citizens that will have a common background to start discussion. Providing access to files while narrating the history of the city by means of its documents is a commitment that the CHB editorial board would like to share in the light of improving and replicating this experience where possible.

References


