

Cartography, Cadastre and Surveying and the Development of Cities during the Nineteenth Century in Spain

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SUMMARY

In mid-nineteenth century due to industrialization in Spain, as elsewhere, there is a massive migration to cities.

Because of this strong flow, cities are overflow to accommodate that population and it was necessary both to reform them and create new ones.

Initially this led to an indiscriminate growth, uncontrolled, causing a poor and disorganized Urban Planning. Thus the need of a control in Urban Planning was shown clearly.

Then, the Spanish Government developed a set of Acts that improve the quality level of Cartography and Cadastre

The aim of this paper is to analyze and compare the contents of the statements of technical requirements techniques and their impact on the quality of cartography and survey during the Nineteenth Century in Spain.

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1. INTRODUCTION

In mid-nineteenth century due to industrialization in Spain, as elsewhere, there is a massive migration to cities.

Because of this strong flow, cities are overflow to accommodate that population and it was necessary both to reform them and create new ones.

Initially this led to an indiscriminate growth, uncontrolled, causing a poor and disorganized Urban Planning. Thus the need of a control in Urban Planning was shown clearly.

To intervene a modern State needs: a legal framework, an organizational structure and direct and updated information about the territory and its territorial wealth; and in this case, a Land Act, strong Public Administrations and a map of the territory. However nineteenth century Spain did not have practically any of them.

At that moment the Authorities took the first steps to modernize the State and to improve the of government system based on two pillars:

- 1 .- The development of a new legislative framework.
- 2 .- The establishment of founds destined to Public Administration (local, regional and national) for urban management.

2. THE NEW LEGISLATIVE FRAMEWORK

We can find two lines of development in this new legislative framework: planning and cadastral. Both eventually converge on the need for cartographic representation of territory with a scale and with enough detail to provide support both to the management of resources and the improvement and growth of urban centers.

2.1 Urbanistic Acts

In the second half of the nineteenth century a set of unprecedented Acts in the field of urbanism in Spain were drawn, in all of them “the map” appeared as a reference for the study and planning.

One of the first ones was the Act of 1846 “Ley de Alineaciones” (Alignments Act) in which municipalities of “neighbourhood growth” should make a “geometric map” at 1:250 containing the existing and projected features.

However, due to lack of financial and technical resources of the councils at that moment this first law was never implemented.

Lately, this Act was reformed limiting this obligation to Province Capitals and reducing the scale to 1:1.000. But once again it was never was applied.

More successful were the successive Acts of “Ensanches” (Urban Expansions), written after 1864. This was due to the fact that municipalities were never given a budget.

In April 1867 the “Regulation Implementing” Act was published in which it was set for the first time that the content and details should include cartographic documents.

All the topographic features (rivers, roads, highways, etc) should be represented at the scale of 1:2.000. The altimetry should be represented by contours, with interval equidistance of two meters. The old element should be represented in black and the new ones (alignments, and urbanistic features) in red.

Sections were should also be represented on scales of 1:1000 (horizontal) and 1:100 (vertical). And should also include the study of the flush of all streets, both existing and new, with there sewage.

In subsequent Acts more contents were specified. Thus in 1895, the general map scale could range from 1:1.000 and 1:2.000, including longitudinal and transverse profiles, with the same scale used in general map for the horizontal plane, and ten times larger for the vertical and detailed drawings whose scale can range from 1:250 to 1:500.

2.2 Cadastral Laws and Compulsory expropriation.

Another aspect related to urban development is the acquisition of land for projects, usually obtained through complex procedures of compulsory expropriation due to the lack of a reliable country Cadastre.

The first serious attempt to carry out a census in Spain as we know it today, with a graphical representation of the property, dates from the eighteenth century, but none of the Acts created was successful because of the pressure from large landowners to prevent the making of cadastral map and, in consequence, the country did not have any mapping done with a minimum of scientific quality in the second half of the nineteenth century.

Until then, the only available map was the one elaborated by the Army. However in 1859, a landmark in the field of Spanish cartography took place: The publication of the “Ley de Medición del Territorio” (Measurement of Territory Act) for the creation of the topographical-plots map (a kind of Cadastral map), which was followed in 1865 by the regulations for the demarcation of municipal boundaries and the formation of the urban plot plan at 1:500 scale, but very few cities could apply it in the early years.

Since for compulsory expropriation proceedings were not helpful to obtain the map of municipalities, they were forced to represent the parcels to a scale of 1:100 together with the rest of the field survey information. These documents affected only specific parts of town, so there was never an image of the whole City.

2.3 The law of 1859 for the measurement of the Territory.

The preamble of the Act explains that one of his goals is to unify efforts in order to make a map useful for the fiscal and the urban management. With this purpose the regulations of the Act developed a set of guidelines about: content, accuracy, tolerances and methodology to ensure the quality of topographic, and cadastral documents.

The work was divided into two phases: the first devoted to the establishment of a Geodetic Reference System and the second where they would make the capture of information for the scientific representation of the whole territory.

For the first phase, technical specifications were prepared to perform two types of work: the construction of the first Geodetic Network of the country, with a visible and permanent bases and the establishment of other minor points that should serve as bases for the establishment of the triangulation network.

The Network Base should have a minimum length of 500 meters and an accuracy lower than 1/5.000. The errors should not exceed 1:2000 for triangulation, 1:1.000 in polygons and 1/500 in leveling.

The Act also established that the triangulations of each municipality were considered isolated but in order to link them to neighbor towns, they should have some vertex outside them to be used in common.

In the second phase the data capture of the details to represent the territory with all its elements should be carried out these are the plane of the town centre and the outskirts.

For the elaboration of this level of detail the regulation specifies nine points:

1. Marking and tracing of the current municipality boundary.
2. Marking of boundaries of public and private property, according to property documents provided.
3. Provisional Map making.
4. Measurement of the Area.
5. Formation of the cadastral lists with the agreement of the owners.
6. Verification of all documents.
7. Final map making.
8. Operations are conducted in each village independently but ensuring the link to each other.
9. The topographic and cadastral survey of each town shall be bounded by the perimeters of plots belonging to the municipality.

The Act also stated the need to get people landowners together to establish, by consensus, of the property boundaries. In the case of point 1 of the affected municipalities and in point 2 the same ones with private landowners. The Act marked also the documents that should accompany these meetings and their content.

The result of these efforts would lead to the construction of four maps levels:

- Two general with a scale of 1:20.000, the first with the representation of the geodetic network and the necessary points for the establishment of polygons and the second with all the municipal boundary, the terrain with contour lines with intervals equidistance of 10 meters, land use, roads, rivers, towns, individual buildings and geodetic vertex.
- A detailed topographic map at 1:2.000 with the parcels, their number and the crops.
- A map of towns and suburbs 1:500 with street names, the number of properties and the identification number of cadastral parcels.

All of them should be compulsorily signed by the person who performed the work.

If we compare these requirements with those that appeared in the 1864 Act (Ley de Ensanches) we can see that there were significant differences between the technical requirements of both Acts, derived mainly from the goal of each one: the territory to the Act of 1859 and the urban planning for these of 1865, but on the other hand it also gave an overlap in contents.

For example, the Measurement Act of the Territory, in which the ultimate goal is to have a map across the country with its parcels, in the measurement, special attention is given to the establishment of the geodetic network and to the points for the formation of polygons, while in the Act of Ensanches it is not mentioned, but it emphasizes how streets profiles should be made.

However, there are coincidences in the information that should appear in the detailed maps scales: the adoption of contours as altimetry representation system and reference to the metric system which it was not established in Spain officially until 1875 and later had to be ratified it on two occasions in 1892 and 1895 to achieve its final implantation.

However, as we said later, in the daily development of both Acts, both were well matched, achieving regulate and standardize the mapping of the country for the first time in the History.

3 THE CARTOGRAPHY MADE BY MUNICIPALITIES

So at that time the municipalities had to faces two major challenges: the development of the cadastre and the urban planning. The question was: would they be able to carry them out?.

The towns in Spain at the nineteenth-century were reduced mostly to small towns with little impact in the territory around them and with small financial and technical resources, governed primarily by the large landowners.

On the other hand making the cartography of the municipality did not increase the revenue in the municipal wealth, since the territorial tax was levied by and for the State. The result was that the Cadastre was not among the priorities of the city.

But it was not the case with the urban terrain. Cities needed to make a major transformation. Many of them were still limited in their growth by the walls that the Army refused to demolish, despite of the fact that they needed to house all the incoming population trying to work on this new industrial framework. Also almost all the Spanish cities at that time had the need to improve the hygienic conditions of the urban bound.

In addition, successive planning Acts provide mechanisms to obtain financial resources for these projects by introducing some extra taxes directly linked to the implementation of urban projects and allowing the outsourcing of works. These circumstances favored the application of successive Acts of “Ensanche”, the improvement of health conditions in many cities and thus the implementation of the first geometric map of large scale of urban cores.

3.1 The specifications

3.1.1 Bilbao Ensanche Project

Due to the lack of technical resources, the works were performed by third parties, both for planning and for the and for the elaboration of cadastral maps. In the case of the “Ensanche” designs, the Act of 1864 clearly marked the scales and the information that should appear in them, just as the Act of 1859 described in detail how the official maps of municipalities it should be done.

This, together with the fact that to run the project should be reviewed by the Administrative Board and approved by the Ministry of Development (created at the time) caused that it was not possible to get ready the technical specifications for that cartography and it was the aspirant to realize the project who make a proposal in which will be later dealt at with the city council.

Thanks to these proposals and the resolutions written on them we can analyze the degree of compliance by reviewing the approved documentation.

For example in the project for the City of Bilbao developed in 1876 by the architects Alzona, Achucarro and the Engineer Hoffmeyer, the cartographic documentation was composed by three maps. One general and two partials and a set of longitudinal profiles and cross sections of the streets.

The general map 1:2.500 was not the scale of the Act, but it was very similar, and included the representation of the municipal boundary, land use, roads, hydrography and relief (represented by contours every 2 meters), buildings, proposed changes to the existing ones and the alignments of the projected “Ensanche”.

The Project did not include any kind of cadastral demarcation, neither private or public property, which caused complaints from the adjoining towns which resulted in lengthy litigation.

In the first partial map, the new projected districts were represented at 1/1.000 (on which the study of the alignments and grades was made).

The second partial map was at the scale of 1/250 and there the old downtown was represented.

All these was accompanied by the corresponding profiles for the scales according to the Act.

As for the working methodology, we can say that the mapping was based on a triangulation for the Ensanche area and enclosed by large and closed polygons.

The triangulation works started from a base constructed and orientated for the occasion, because the town had not yet any baseline of the national geodetic network. The municipal system of triangulation was composed of 47 triangles divided into polygons using all the notable buildings in the area as vertices.

In summary, the general map fulfilled the geodetic aspects established by the Measurement Act of the Territory but it did not fulfilled the contents, because the parcels were not shown in the detail required for this.

In contrast, the level of details improved the one given by the Act, anticipating the requirements of the Act of Ensanches of 1896.

3.1.2 City maps

Many of the Ensanches in Spain were not built until the late nineteenth or twentieth century. However, for management and reform projects, as well as compliance with the Act of 1848 the cities should have a precise map with the boundary of the municipality, so many of them commissioned this work to external professionals.

On these occasions the way to proceed was similar to the case of Ensanches. The city government proposed to a specific professional or in some cases more than one, to submit a project for the municipality map; later once the document was submitted the negotiation began.

The question is again the same: Do the Local Governments fulfill all the technical specifications given by the Act?.

To give an answer we will discuss the cases of the cities of Pamplona, Vitoria and Zaragoza.

The following table shows the cases of the cities of Pamplona (made in 1882) and Vitoria (made in 1888).

Documents	Scale	Information	CITY
Traversing	1:250	Front lines (buildings) Police number of the building Street name Building names (if exist)	Pamplona 1882
	1:250	Front lines (buildings) Public buildings with their names Street names and portal numbers City block polygons	Vitoria 1888
General map of the City	1:1.000	Countours (equidistance 1 m.) City blocks Buildings	Pamplona 1882
	1:5.000	Countours (equidistance 1 m.) City blocks Buildings	Vitoria 1888
Municipality map	1:5.000	Boundary Countours (equidistance 5 m.)	Pamplona 1882
	1:5.000	Countours (equidistance 5 m.)	Vitoria 1888
Triangulation	Not specified	General map of triangulation and links with the traversing	Pamplona 1882
	General map of triangulation	Not specified	Vitoria 1888
Traversing axes	1:250 0 1:500	All needed information for the municipal architect to produce again the map	Pamplona 1882
	Traversing axes	1:250 0 1:500	Vitoria 1888
Profiles	Not specified	A profile of each street, with two axes in which having a width greater than 15 meters and a cross section of every street.	Pamplona 1882
	Not specified	A profile of each street, with two axes in which having a width greater than 15 meters and a cross section of every street.	Vitoria 1888

The specification of Zaragoza (1880) is very similar to the previous document except for some technical differences. The main one is that triangulation was based on three or more bases. Another one is that the reference for altimetry was give from Alicante and the accuracy should be of 0.002 square root of the length of the development of the polygon in meters.

What primarily distinguishes this specification from the above mentioned is the importance given in it to cadastre, as it included the drawing up of reports of the municipal boundaries, following strictly the procedure set by Act in 1859.

Furthermore, the milestones should be used, as far as possible, as the vertices of the triangle network. On the other hand, the distinction between areas of forest, orchard and municipal properties in rural areas should be made, as well as the calculation of surfaces of these properties and the determination of error of 1:300 in the traverse of roads.

The graphic documentation is similar to the proposed scales and content of Pamplona, but this time adding a general map whose scale is not specific and may vary between 1/25.000 and 1/50.000.

3.2 Reference System

It should be noted the uniformity of the reference system and that in all cases studied, follows the same parameters marked in 1870 by the National Geographic Institute for National Topographic Map 1:50.000 and 1:25.000 and displayed in the following table

	CITY MAPS	NATIONAL TOPOGRAPHIC MAPS
Meridian	Madrid	Madrid
Ellipsoid	Struve, 1860	Struve, 1860
Datum	Madrid	Madrid
Cartographic Projection	Bonne & Lambert	Bonne
Altimeter Datum	Mar en alicante	Mar en alicante
Relief representation	Countours	Contours

As we can see the only variation observed is the incorporation of the Lambert projection in some work in a municipality.

It also draws attention to the fact that in all cases the altimeter Datum used is that of Alicante, where, as we have seen, some of the projects referred to the use of a Datum in Bilbao and Santander. This is because initially the National Geographic Institute was proposed to establish two datum for altitudes: one in the Mediterranean and another in the Bay of Biscay, but finally this was abandoned.

4 CONCLUSIONS

In conclusion we can see that the form of action varies according to the type of map involved. In cases in which the city had a project of “Ensanche”, this was in accordance with the provisions of the Ensanches Acts and with the graphic documentation specify by the Act of Measurement of the Territory. Also in terms of work methodology, in the more technical issues, as the establishment of bases and vertex and technical requirements for the triangulation, and leveling, as in Bilbao.

The same does not happen with all the questions related with cadastral works, mainly all those related to the process of demarcation of municipal boundaries. Probably because this work was deferred when expropriation proceedings begin.

This point generated a lot of territorial disputes that led to long disputes among cities and surrounding villages, because in many cases the projects of Ensanche occupied land not belonging to the city. This was the case of Bilbao, where lawsuits arising lasted for years and caused the delay of the final approval of the project.

Instead, municipalities without projects of Ensanche were adjusted to the Act of Measurement Territory and its regulations. Thus, we can say that the four projects studied broadly not only comply the Act in regard to working methods, but in some points they get them better. For example, the closing errors of the angles in the triangulation and traversing.

In these types of assignments, we see the largest discrepancies are found in the contents and mainly related to plot. So while at Zaragoza, the detailed specification shows how to act in the boundaries of the municipal and public properties, and in the demarcation of forest land and orchard, in cities such as Vitoria, it only specifies what should be done but no how (for technical aspects).

This approach meant that the maps fulfilled the objective of supporting the management of improvement works, but not the graphic record of the Cadastral parcels. Later when they will tried to standardize the plot of municipalities to obtain a continuous map the saw the impossibility of carrying it and they had to perform the cadastral works again.

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