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Cartographic patrimony in the Spanish SDI. The cadastral series of nineteenth century: *Hojas kilométricas (Kilometric Sheets)*

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Summary

Currently, there is a clear commitment from the Spanish Civil Service for SDI (Spatial Data Infrastructure) paradigm for access and use of geographic information of all kinds. This paper presents a pilot test conducted by the Spanish IGN for publishing historical mapping through a WMS (Web Map Service). It describes the process of scanning, georeferencing, tiling and exploitation of information both literally and geometric for the mid-nineteenth cadastral series known as *Hojas kilométricas*. This is a simple but striking example, it offers clues to future possibilities of this strategy. It also identifies some difficulties.

Introduction: the development of SDI in Spain

The application of new technology has revolutionized –and still continues to– the use of geographic information by any user. Computers constantly increase their computing power and the Internet allows their interconnection. But there is still a low level of access to geographic data available, mainly caused by ignorance of its existence, the little degree of harmonization between the various producers and the lack of effective and manageable tools.

Various strategies have been tried to overcome these drawbacks and, currently, there is a clear commitment from the Civil Service for the paradigm known as Spatial Data Infrastructure (SDI). The concept has been already in operation for several decades, but it is not until very recently that has spread its development (Maguire and Longley, 2005). The conceptual objective of an SDI is improving access to and exchange of data generated by different producers (Grus et al., 2007). The SDI advocated a framework which promotes Description of geographic data through metadata, creating Web services based on standards that ensure interoperability and information technology policy development, legal frameworks, meeting forums and dynamics of understanding with the aim of promoting the SDI paradigm, encouraging the publication of data and metadata and reaching agreements for the the necessary harmonization of those among different producers.

In Spain the SDI show an important development (Vandenbroucke et al., 2008). Since 2002 the Supreme Geographic Council is conducting a strong momentum of this technology through the Specialized Commission for Spatial Data Infrastructure (CE IDE) and the Working Group of the Spatial Data Infrastructure of Spain (GT IDEE). As responsible for the Technical Secretariat, the Spanish IGN (National Geographic Institute) has launched the IDEE geoportal¹, and it chairs the CE IDE and provides resources for the empowerment of SDI. The result of this effort are the Spanish Nomenclator Model (MNE)² and the Spanish Metadata Core (NEM)³.

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¹ <http://www.idee.es>

² http://www.idee.es/resources/recomendacionesCSG/MNEv1_2.pdf

³ <http://www.idee.es/resources/recomendacionesCSG/NEM.pdf> and User Guide <http://www.idee.es/resources/recomendacionesCSG/GuiaUsuarioNEM.pdf>

Recently, the development of SDI has been legally supported by adopting the European Union's closely Directive INSPIRE⁴ and the launching of the National Cartographic System⁵ by Spain.

In this context, the IGN wants to promote the publication of historical cartography through SDI. This paper will discuss our first experience in this field through a pilot test. The next section will be dedicated to some general considerations. Afterwards, the process of scanning, georeferencing and extraction of information from the historical series published, known as *Hojas kilométricas* (a cadastral essay from the mid-nineteenth century that covered part of the province of Madrid), will be explained. Subsequently the procedure used to publish this series in the SDI will be described, and the article will be finished up with some conclusions, which will announce the future course of work scheduled.

The SDI as a means for publishing historical geographic information

The SDI are intended for publication on the Internet from any type of geographic information. But there are few initiatives related to historical cartography. One of the most important is the DML dedicated to the Canary Islands (Spain) launched by the Mercator Working Group of the Polytechnic University of Madrid (Fernandez-Wytenbach et al., 2006)⁶. This group discusses the reasons why the use of SDI has not spread among those responsible for maintaining the cartographic heritage. Firstly, one of the reasons is the vast gap between the technical areas devoted to each subject: SDI development is restricted to a circle which is technically far away from the sector of the map libraries and map files. Secondly, there is the hierarchical structure of SDI being confined to its territory, while in the field of historical cartography every archive and library can have cartographic funds of anywhere in the world (Fernandez - Wytenbach et al., 2007). Both objections are important and related to an issue on which those responsible for SDI are very aware of: the importance of cooperation and coordination between all parties involved. In addition, the term *historical cartography* or *cartographic heritage* includes a wide range of documents and besides this, the current legislation is not considered a priority.

The pilot test described here wants to be a first approach to the problems raised. From the organisational point of view, the IGN has the advantage of having both a Documentation Service which holds a major documentary fund and an SDI service that offers several website services and maintains the IDEE geoportal. The documentation that is presented in this paper does not exceed the Spanish area, they are geometric documents with a consistent geometrical basis, which has allowed them to be geo-referenced, and tiles been generated, all of this having been done in a short period of time.

The digitization processes in the Documentation Service of the IGN

Description of the cartographic series Hojas kilométricas

The Topographic Archive of the IGN has the documentation generated by this organization since its founding until the moment that aerial photogrammetry for mapping purposes began to be considered as a mapping tool. Most of the documents are handwritten and there are available literal and mapping information. The oldest documents are dated mid nineteenth century, and among them it is possible to find the *Hojas kilométricas*, approximately 7,000, that were carried out between 1860

⁴ Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) http://www.ec-gis.org/inspire/directive/1_10820070425en00010014.pdf

⁵ Royal Decree 1,545/2007 which regulates the National Cartographic System (BOE 2007, november, 30th) <http://www.boe.es/boe/dias/2007/11/30/pdfs/A49215-49229.pdf>

⁶ <http://mapas.topografia.upm.es/cartotecanarias>

and 1870, under the leadership of Francisco Coello (Figure 1). Its implementation was conducted by the General Board of Statistics, which was the forerunner of the IGN.

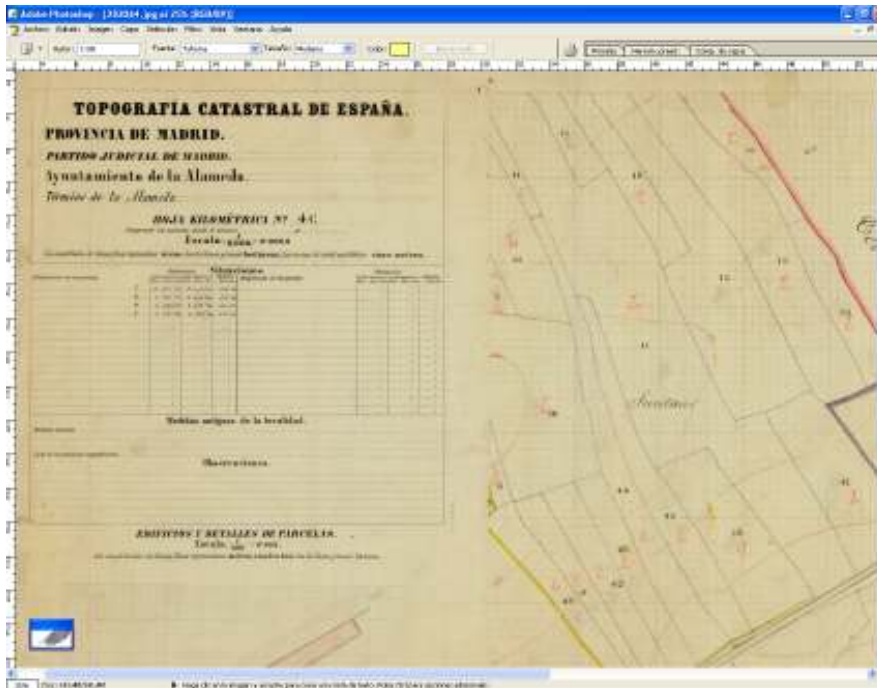


Figure 1. Fragment of a *Hoja kilométrica*.

The *Hojas kilométricas* are an unfinished cadastral project, since only exist for about 90 municipalities in the province of Madrid, and within these 90, in many cases the information which should have been collected is not completed. Its scale is 1/2,000 and each sheet covers a maximum of 1 km², in square format (there are some exceptions, such as the municipality of Valdemoro, whose sheets measure 1,200 x 900 m). The sheets are arranged according to a grid model, whose structure is usually collected in an index map called "directory", being the working unit the municipality (Figure 2).

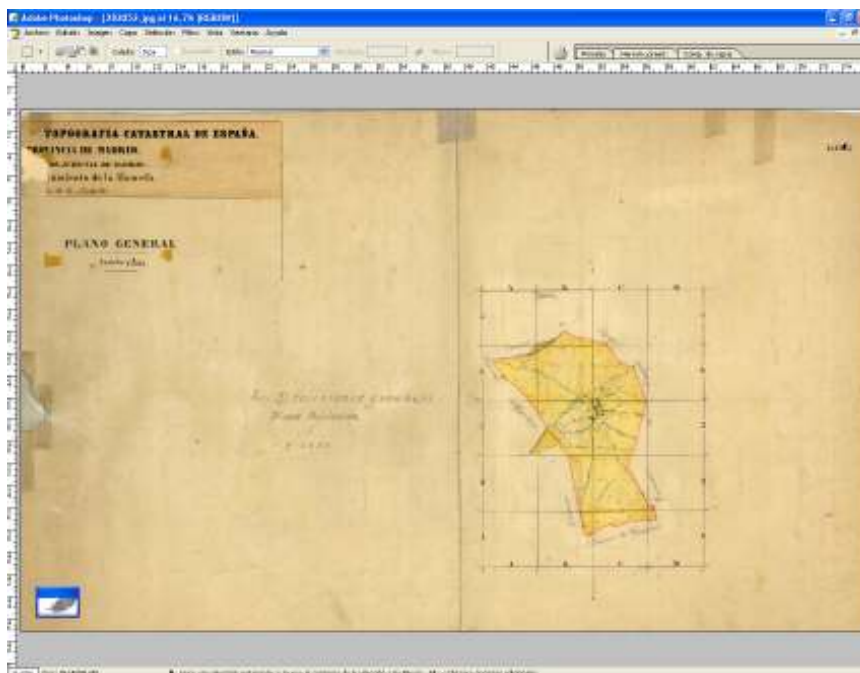


Figure 2. Index map for the municipality of "Alameda de Osuna".

The fieldwork begins with the triangulation topography of the municipality and the collection of the boundary line. This network is conveniently densified to carry out the topographical stuffing inside the municipal boundary. This process also collects cartographic data from existing plots to finally take the literal data, relating to their ownership.

Scanning, digitizing attached information, geo-referencing, tiling, generated layers of support

The first digital processing works for this documentation took place 10 years ago. The process was to photograph the maps and then scan the slides obtained. In addition to problems in the metric of the image, which suffered some deformation and, ultimately, the effects of conical projection, the chromatic quality of scans was not particularly desirable. Therefore, more recently, the original documents have been scanned, using HP large format and high quality scanners (Figure 3). The resolution scanning has been the highest optical equipment (424 dpi), regardless of the copies of these images at lower resolution in order to speed up the computer processes later.

The *Hojas kilométricas*, as already mentioned, are disposed according to a regular grid, so that each sheet has continuity in the adjacent ones up to the limit of the municipality. As the surface covering every sheet is small, and usually it does not have sufficient depicted elements to conduct a rigorous and precise geo-referencing process sheet by sheet, the method that has been chosen for geo-referencing them was to geo-reference the index map that represents the location of all sheets in a municipality. From this initial geo-referencing it is possible to extract the coordinates of each sheet corners making up the index map, and then proceed with the individual geo-referencing of the mentioned sheets. This process ensures continuity of the mapping information within each municipality.



Figure 3. HP large format scanner used to scan the documents.

Due to the length of documents, often it is difficult to find comparable points to anchor the historical documentation over current documentation (basically 1/25,000 maps and larger scale orthophotographs).

As the *Hojas kilométricas* include cadastral information and plot owners, it has also been considered the exploitation of these data, so that each numerical label of the plots drawn on each sheet has been associated with a point with coordinates, and this allows to link the cartographic information with the literal information of the cadastral bonds (Figure 4).

The cadastral bonds are sheets of paper in Spanish “folio” size that reflects on the one hand descriptive information of the plot (owner, crop type, size, location, etc.), and on the second hand, a sketch of their shape and position regarding to the adjacent plots.

These works are monitored at the quality control stage, and once the necessary corrections have been made, if they are appropriate, they are properly validated.

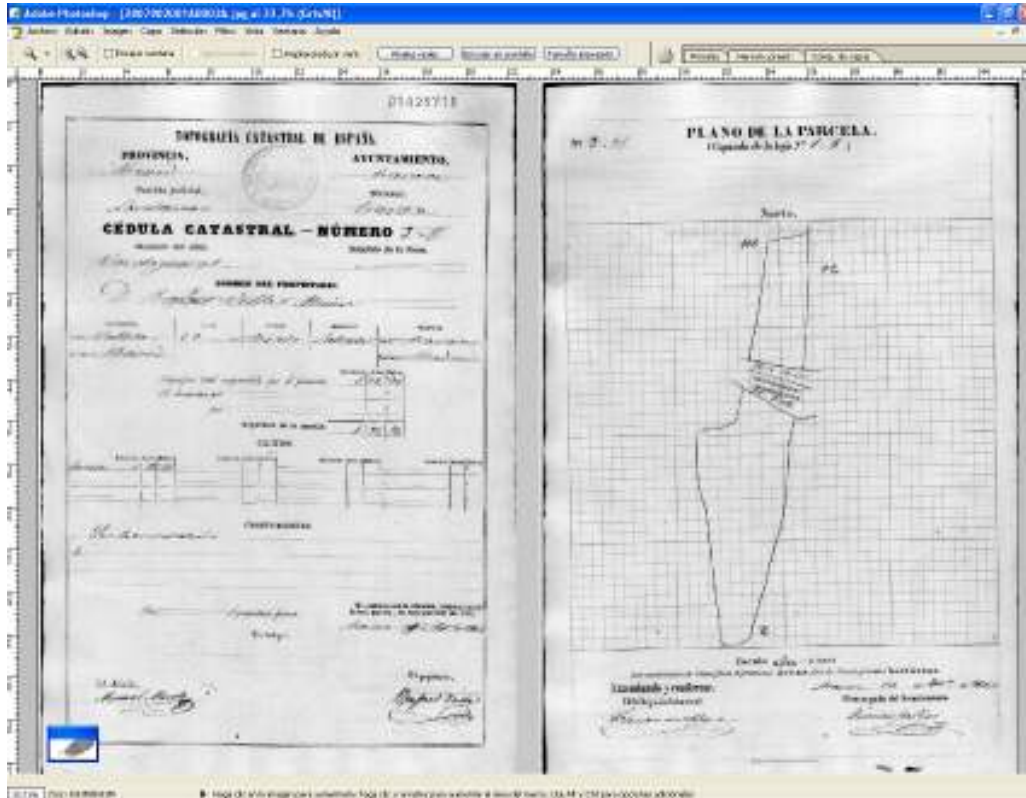


Figure 4. Cadastral bond.

Solutions adopted for the publication in the SSDI

The cartographic series is published through a mapping Web Map Service (WMS), standard OGC⁷. The tiling of each municipality forms a single layer not taking into account any temporary issues, as there is only one edition of the *Hojas kilométricas*. This web service is as simple as possible. Three operations can be carried out through interrogation via URL: *GetCapabilities*, which returns the parameters of service needed to interoperate (version, the output formats permitted, supported coordinate systems, etc.); *GetMap*, which returns an image depending on the parameters chosen (picture format, reference system, corner coordinates, width and height in pixels, etc.); and *GetFeatureInfo*, which allows carrying out consultations related to a click on the image (the answer depends on programming, varying from a text with hyperlinks to any multimedia resource).

The WMS allows choosing display scales, so the *GetMap* calls will be done when the degree of approximation is sufficient (Figure 5). In the example, the points of each plot for which the information of cadastral bond is referred to, are shown on the images. When the layer *owners* is visible (above, in the column of layers), a click on the item returns a small report containing information of the plot (Figure 6). This report will be supplemented with links to the original documents: the list of owners, the page of the document containing the cadastral information of the plot and the raster file for the corresponding *Hoja kilométrica*.

⁷ Open Geospatial Consortium <http://www.opengeospatial.org/>

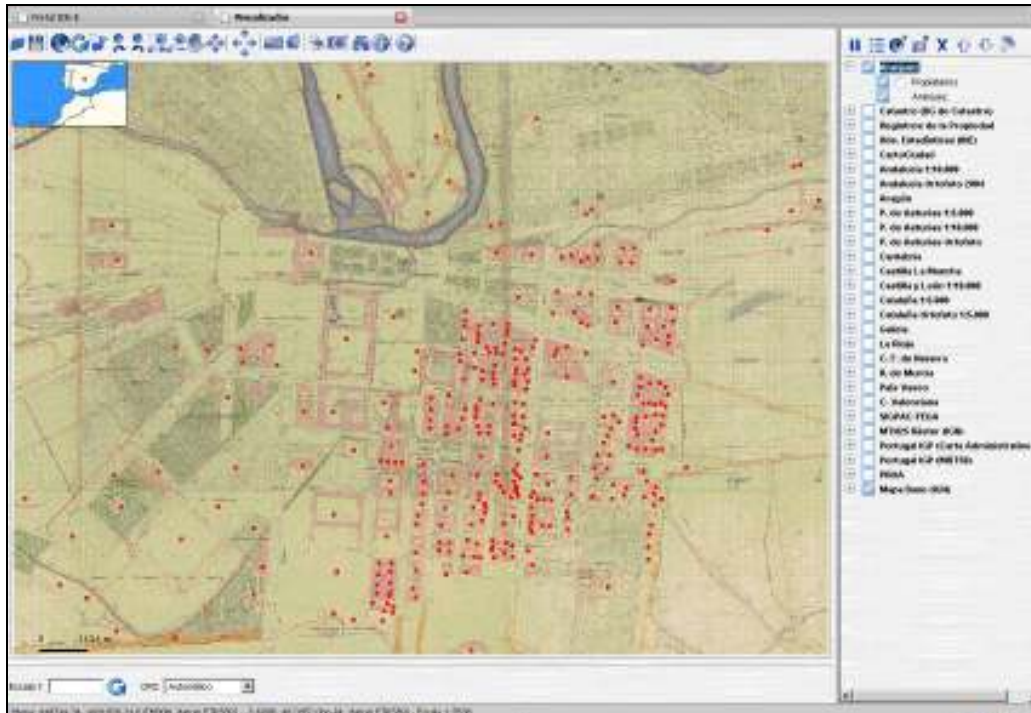


Figure 5. WMS consultation in the IDEE viewer of the layer for the municipality of Aranjuez (pilot test). The points represent the places to which the cadastral information is referred to.

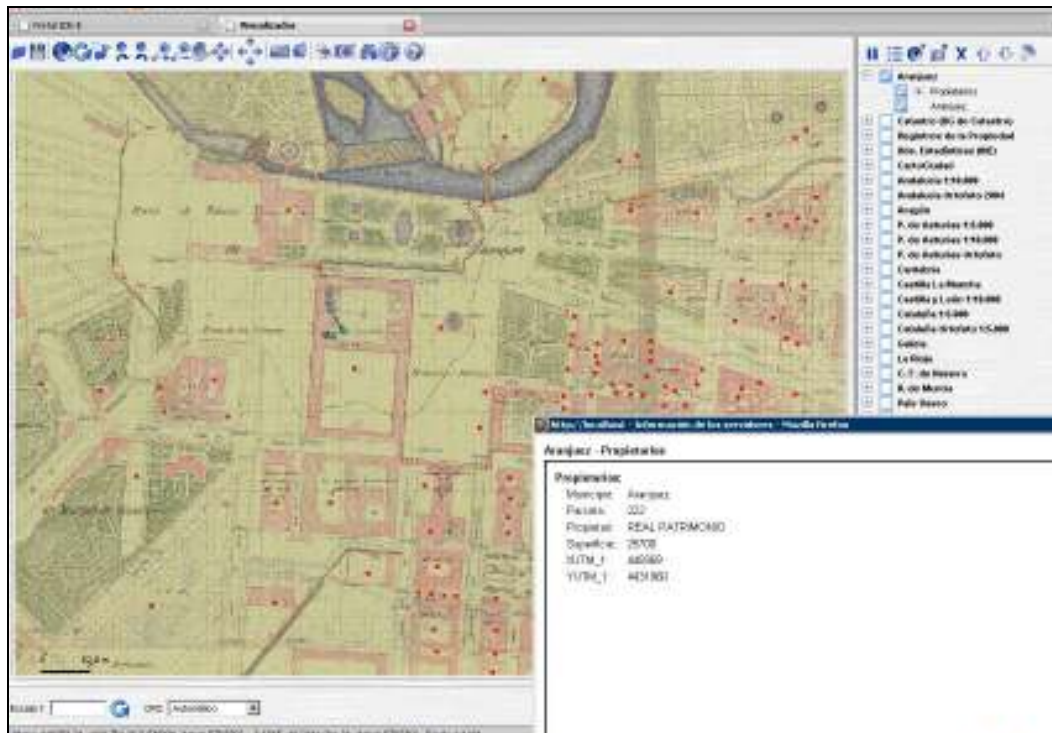


Figure 6. Answer to a click on a point of the layer *owners*.

Conclusion: future lines of work

Although the example shown is simple, it reveals much of the potential offered by the SDI strategy for the publication of geographic information. Dealing with different website services offered by the IDEE,

it is possible to superimpose the modern cadastral information⁸ or the present street layout⁹ over the corresponding *Hoja kilométrica* on the screen. In addition, it allows interacting with the document to obtain additional information.

It is, therefore, a first step. Still, we believe it is a very significant contribution. The *Hojas kilométricas* are an extraordinarily rich source of information. With its publication via SDI, any researcher can work with them in their preferred GIS system immediately, at any time by a high quality reproduction and with a precise geometric basis. Moreover, some simple analysis can be performed with the viewer, these can satisfy the questions of a wide range of users, or just discover them this kind of information.

A key conclusion obtained after this exercise is the need to conduct an interdisciplinary work. Following this thread of thought, the Joint Working Group on Cartographic Heritage in SDI has been recently established in the framework of the CE IDE section of the Spanish Geographic Superior Council, with a specific goal: the developing of a gateway between the bibliographic formats of the MARC family (specific area of libraries and archives) and the metadata formats ISO 19115 (specific of the SDI paradigm). The Joint Working Group meets cartographic institutions of government and university departments to carry out a specific and necessary interdisciplinary work. But this is not enough. We hope it will be the germ of a fruitful line of work to efficiently solve the publication of geographic information through SDI.

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⁸ WMS service of the General Directorate of the Cadastre
 <<http://ovc.catastro.meh.es/Cartografia/WMS/ServidorWMS.aspx>>

⁹ Cartociudad project <http://www.cartociudad.es/wms/CARTOCIUDAD/CARTOCIUDAD>