

CARTOCIUDAD: NATIONAL DATABASE OF ALL SPANISH MUNICIPALITIES AVAILABLE FREELY IN WWW.CARTOCIUDAD.ES AND EXPLOITABLE THROUGH ITS OGC SERVICES. NEW FUNCTIONALITIES IMPLEMENTED

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Abstract

CartoCiudad is an official cartographic database with national coverage of the thoroughfares network, defined from the cadastral urban background of all Spanish cities and villages, which also contains the census and postal districts. This project has been created from the harmonization and integration of official data provided by several of the main suppliers of Geographical Information in Spain:

- General Directorate of Cadastre, (urban background and the building numbers).
- Statistical Office, (official thoroughfare names and census districts)
- Post Office, (data regarding post codes)
- General Directorate of the National Geographic Institute, (data from Spanish reference cartography to 1:25000 scale (BCN25), mainly the transport network, municipality boundaries and orthophotographies with national coverage)

Due to Spain consists of more than 8000 municipalities, the production planning of CartoCiudad was structured in four years (2006-2009) so that it started with the production of the main and biggest municipalities of Spain (> 50000 inhabitants) and currently it is involved in the generation of the smallest villages.

After checking the annual production quality all these data are uploaded at CartoCiudad geoportal (www.cartociudad.es) where they can be visualized and handled through several standard on-line services implemented (services developed according to Open Geospatial Consortium specifications).

The municipalities produced during 2006-2007 and the first part of 2008 are already available in CartoCiudad web and it is expected to upload the rest of production carried out in 2008 (municipalities and supplementary data) before September 2009.

Currently, the standard web services implemented in the geoportal of CartoCiudad are:

- *Web Map Service (WMS)*: It allows visualizing data and navigating all over territory using its tools (zoom, pan, print, etc.) as well as asking for layers information shown through the get feature info utility.
- *Gazetteer (WFS)*: Several kinds of gazetteers have been implemented: to locate a postal address (thoroughfare name + building number); to locate an administrative unit (municipality, province, region); to locate postal or census districts.
- *Web Processing Services (WPS)*: There are two kind of processing services:
 - o *Proximity area*: it allows asking for the maximum area inside which a user can locate particular points of interest.
 - o *Routing*: to calculate routes between two points all over Spain thanks to the seamless thoroughfare network all over Spain.

Recently new services and utilities have been implemented like the inverse gazetteer for getting addresses from geographic coordinates or the free web component called “CartoVisor”.

Keywords: CartoCiudad, Spanish official database, national coverage, standard web services: (WMS, Gazetteer, WPS) Cartovisor, Open Geospatial Consortium (OGC).

1. DATA PRODUCTION

1.1 Introduction

CartoCiudad is an official and seamless Cartographic Data Base of the Spanish cities and villages spread along their thoroughfare network, supplemented by postal and statistical data.

From an overall overview it can be defined as a continuous street map all over Spain with further values added. CartoCiudad consists of data regarding urban background (blocks, parcels, buildings, house numbers, street names, etc) spread throughout nationwide which are connected through the Spanish roads network enabling the seamless navigation. Besides, the post codes and ward polygons are also represented.

Different stakeholders create and maintain these data at national level:

- General Directorate of Cadastre, who takes part in this project through data referring urban background: blocks, urban parcels, building (with different coverage), streets axis, house numbers, geographical names and some auxiliary lines like the sidewalks.
It is in charge of urban and rural cadastral data all over the national territory except in Navarra and Basque Country regions, where their governments have got their own cadastral agencies. Therefore, the cadastral data shown in CartoCiudad come from national cadastral department except the data regarding those two areas which come from their own agencies.

- Statistical Office (INE) collaborates with Census Districts and Sections polygons, and also, by means of the database containing the official thoroughfare names collected from the municipality departments.
- Post Office supplies a database containing the relationship between every postal address and its corresponding post code. From that information the post codes polygons are drawn.
- National Geographic Institute (CNIG/IGN) is the organization in charge of leading and managing this project but it is also a stakeholder. Thus, it provides data from the Spanish reference cartography to 1:25.000 scale (BCN25), mainly the transport network. This information constitutes the reference geographical data giving continuity to CartoCiudad Database all over territory. In addition, IGN contributes with the municipality boundaries and with the orthophotographies from the National Plan for Airborne Orthophotography (PNOA) used to check the input data quality and to update the output layers (as reference data source).

In order to make feasible the data harmonization, first of all it is necessary to reach an agreement among all organisations involved. Once it has been achieved, the process consists in: collecting the data, converting the data format, transforming the reference system (from ED-50 to ETRS-89), adopting a common data model, and integrating the input data to obtain the CartoCiudad database.

1.2 Quality Control

At the end of the data processing stage all information is checked through several quality controls. There are two different phases:

- Initial validation: where files names, identifiers and number are checked.
- Content analysis: all layers are checked through several quality control processes: topological (to detect free ends, duplicate elements, bows, etc), geometric (to check the data geo-referencing, digitalization sense, etc), semantic (to control that IDs fulfil the rules laid down) and completeness control.

1.3 Production Planning, Data Improvement and Updating

The production planning of CartoCiudad was defined to be developed during 4 years. It started in 2006 from the production of the main and biggest municipalities of Spain (> 50000 inhabitants), and it has continued with the generation of smaller municipalities as the planning has been carried out.

Thus, the production in 2006 rose to 323 municipalities what is equivalent to 51% of Spanish population; in 2007 the production reached the amount of 1245 municipalities (17% of Spanish population) and in 2008 almost more than 2000 municipalities were generated (20% of Spanish population). Therefore, during this three-annual-planning 3589 municipalities have been produced (88% of Spanish population). During this year and the first mid of 2010 it is expected to carry out the production of the outstanding

municipalities. Currently, the available data in CartoCiudad web are regarding the 2006-2008 production.

The CartoCiudad data model considers the updating and improvement of the data by means of the storage of the entities temporal life-cycle. As usual, every object has a unique identifier in the database. Moreover, temporal variations of an object are entered in the database using several records that share its identifier. Therefore, it is possible to know the date of addition and its forward modifications. If the object does not exist anymore this model also stores its previous existence.

In order to include this information the original data model has been modified so that the next attributes have been added:

- Estado (Status): numeric identifier which indicates one of the possible values of status that can be assigned to an entity of the data base:
 - Alta (Proposed): it is defined as the status of an object that has been entered the database but not yet validated.
 - Vigente (Current): status of an object that has been added and then validated.
 - Baja (Reserved): status of an object that has been proposed to be deleted or modified but not yet validated.
 - Histórico (Historical): status of an object that has been deleted and validated.
 - Provisional (Temporary): status of a geometric object whose definition can be improved in a short term.
- Fecha_Alta: Begin life object date.
- Fecha_Baja: End life object date.

That information enables obtaining which record (among those which share the same unique identifier) represents each object at any moment, as only one record has the value *Vigente* in the attribute *Estado*.

2. DATA EXPLOITATION: CARTOCIUDAD WEB SERVICES

CartoCiudad has been designed so that users can access its data through Standard Web Services (OGC), via Internet (www.cartociudad.es), allowing services cascading and the development of new services of added value. There have been developed three services so far: Web Map Service, Gazetteer and Web Processing Service.

2.1 Web Map Service

According to the OGC WMS Specification (version 1.1.0), it allows generating digital maps dynamically. This WMS allows displaying data and navigating all over territory.

The supported operations are the basic ones in a WMS:

- GetCapabilities, which offers the metadata of the service

- GetMap, to return a map after defining certain parameters i.e. Reference System, size, map layers, bounding box, etc.
- GetFeatureInfo, to obtain information from WMS layers.

The URL of this service is:

<http://www.cartociudad.es/wms/CARTOCIUDAD/CARTOCIUDAD>.

Therefore CartoCiudad WMS can be called from other GIS viewers, like for example from Spatial Data Infrastructure of Spain viewer (www.ideo.es).

The Geodetic Reference System of CartoCiudad data is ETRS89 (latitude and longitude coordinates), but the WMS allows choosing other reference systems and cartographic projections like UTM.

2.2 Gazetteer

It fulfils the OGC WFS Specification (version 1.1.0) and the Spanish Gazetteer Model (MNE), and it has the next three basic operations:

- GetCapabilities.
- DescribeFeatureType to download the XML schema of the features available in CartoCiudad project.
- GetFeature, operation that return feature instances in GML format (characteristics and location).

CartoCiudad gazetteer allows locating postal addresses defined by a thoroughfare name and a house number, or by a road and a kilometric point. It also locates other entities like postcodes or census districts and sections (wards).

2.3 Web Processing Service

This service complies with the OGC WPS Specification (version 0.4.0) which supports the following standard operations:

- GetCapabilities
- DescribeProcess, operation that allows users to request the description of the processes implemented according to the OGC Specification.
- Execute, in order to invoke geoprocesses like routings or proximity calculation by means of XML encoded requests, using the POST HTTP method. The output is a GML file according to the XML schema returned from the DescribeProcess operation.

CartoCiudad web client has two functionalities based on the geoprocesses implemented according to the WPS Specification:

- Routing between two points all over Spain. After entering the addresses of the two end points, the service calculates the minimum distance route between them

and provides a description along each street stretch. The web client shows the route on the WMS, being possible to add waypoints dynamically to change the route calculated previously.

- Proximity calculation that allows asking for the maximum area inside which users can find points of interest (POI). This area can be defined through two kinds of distance: the radius of the searching circle (Euclidean distance) or Manhattan distance (following the geometry of route along the streets).

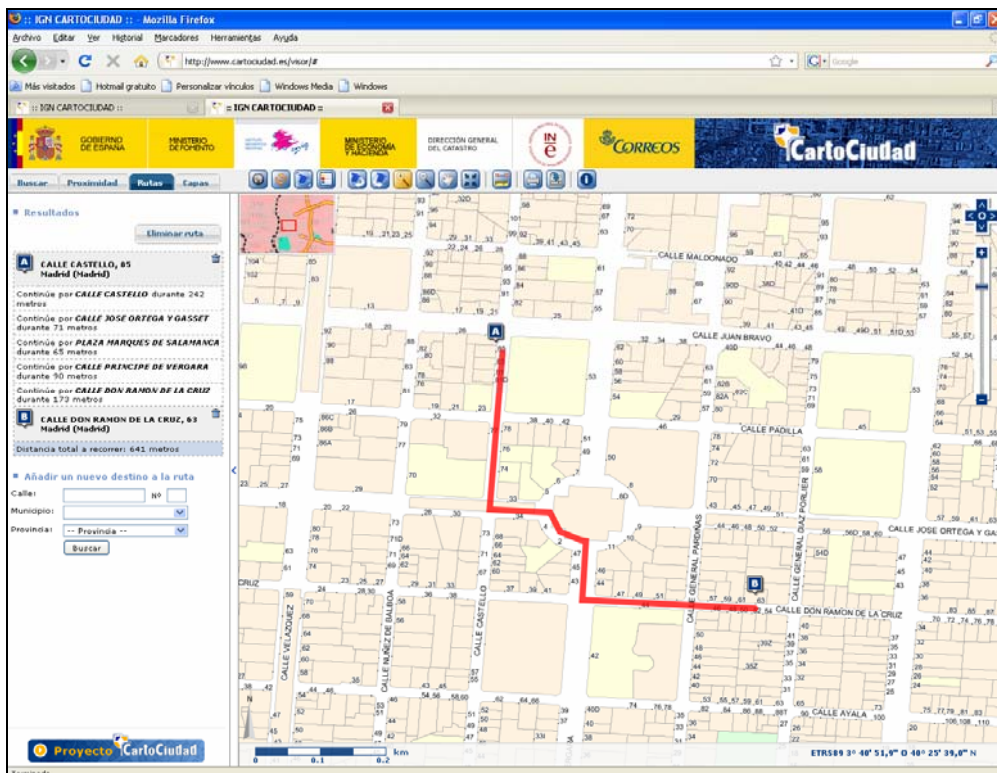


Figure 1: CartoCiudad Web Client

During 2008, new functionalities have been developed using WPS specification. One of them is the Geographical Coordinates Translation to Postal Addresses (GC2PA), i.e. the inverse gazetteer which allows obtaining postal addresses from geographical coordinates through a XML query, being possible to do a massive request introducing more than a pair of coordinates. The response is a XML document with the closest postal address to the given coordinates. This service is already available at www.cartociudad.es/wps/test.html, a HTTP POST client where a XML request can be introduced addressing it to www.cartociudad.es/wps/WebProcessingService.

2.4 CartoCiudad Web Component: *CartoVisor*

Another new utility of CartoCiudad is a free light web component called *CartoVisor*, which can be embedded in a particular web via HTML. This component, rather than

allowing users to visualize the cartography from CartoCiudad in their own webs, it also allows uploading their points of interest on it, for free.

This web component offers the basic functionalities of CartoCiudad of locating postal addresses and calculating routes throughout Spain. It also allows customizing the displayer choosing the tool language (Spanish or English) and its size.

In the web page www.cartociudad.es/VisualizadorCartografico there is detailed information regarding how to use *CartoVisor*.



Figure 2: CartoCiudad Web Component web page

2.5 Use cases

CartoCiudad data and services can be used as reference to develop new thematic projects from it. There are already two projects on going:

- Georreferenciación (Georeferencing Project): It is a project promoted by the Public Administration Ministry and the Industry Ministry of Spain and its objective is to help the citizens to look for the nearest public services to their homes on CartoCiudad cartography.
- Location of petrol stations: This project is promoted by the Spanish Industry Ministry and it allows locating petrol stations throughout Spain enabling to assess which one offers the best prices.

2.6 Improvements and future of CartoCiudad web services

CartoCiudad web was published in February 2008, and it has been permanently improved the response time of the services. In this sense, it has been implemented Tile

Cache technology, reinforcing the computer infrastructure to provide a faster and more efficient public service.

It is also being constantly improved the usability of the web like adding tooltips to give additional, useful information to the users, etc. The viewer has also increased the user interactivity with new tools accessible just clicking the right switch of the mouse. Finally the client has incorporated a layers manager which allows switching on/off the different data layers.

In 2009, the effort related to CartoCiudad services is being focused on two main objectives:

- Increasing the user-system interoperability:
 - Intelligent ordering of results.
 - Dynamic zoom while completing transactions.
 - Printing facilities.
 - WFS to display the points of interest of organisations in the CartoCiudad web client.
- Increasing the added value chain by means of new services based on CartoCiudad SDI:
 - CartoCiudad (already) offers a demanded service consisting in translating Postal Addresses to Geographical Coordinates (PA2GC) Geocoding. This service, based on WPS Specification as well, provides the closest postal address to the input coordinates x,y .

All the information about the new contents and applications can be found in the web page of CartoCiudad project: www.cartociudad.es/portal/ (or clicking on the link located in the project client)



Figure 3: Link to CartoCiudad Web

Finally, CartoCiudad team provides a public e-mail (cartociudad@ign.es) in order to receive suggestions and comments on the data and services which encourage their improvements.

3. PARTICIPATION OF CARTOCIUDAD IN EUROPEAN PROJECTS:

3.1 INSPIRE Data Specification on Addresses theme

INSPIRE Data Specification on Addresses is the technical document which contains the guidelines components of Implementing Rules related to thematic working group on Addresses, from Annex I of the INSPIRE Directive.

It has been developed by a Thematic Working Group consisting of 11 experts from Germany, Belgium, Denmark, Spain, Holland, Czech Republic, United Kingdom and Sweden who have been working since February 2008.

This specification bases on the experience of the experts involved and it is also supported by other projects regarding addresses theme considered as best practices coming from other European countries and by the contribution and the advice of the Universal Postal Union (UPU). Thus, CartoCiudad has been analysed as the most representative addresses project at national level in Spain and its contribution, reflected by means of the Spanish expert collaboration (Alicia González, author of this paper as well) is present in the whole document.

Nowadays (July 2009), the third and final technical version has been supplied to the European Commission members so that they can get it ready for the forward commitology process.

3.2. EURADIN Project

EUROpean ADresses Infrastructure (EURADIN) is a European project financed with eContent+ funds, whose objective is to contribute to harmonize the European Addresses, proposing a solution to achieve their interoperability, and thus facilitating the effective access, reuse and exploitation of that content, which will promote the creation of new added value products and services across Europe.

EURADIN partnership gathers 30 partners from 16 different European countries: Germany, Denmark, Italy, Norway, Sweden, Finland, Czech Republic, Portugal, Netherlands, Austria, United Kingdom, France, Latvia, Lithuania, Hungary and Spain.

The project last 24 months, and it is organized in 9 workpackages. The most important of them are WP3: Data, WP4: Metadata, WP5: Data Flow, WP6: Business Model and WP7: Validation.

National Geographic Institute of Spain, through CartoCiudad address system, participates in every WP and leads WP4. In this sense, two of the EURADIN Best Practices are CartoCiudad experiences regarding the harmonization of address data and the use of standard web services:

- CartoCiudad is the result of harmonization and integration of official digital cartography and information produced by several of the main providers of Geographical Information in Spain: General Directorate of Cadastre, Statistical Office, Post Office and General Directorate of the National Geographic Institute.
- CartoCiudad has been designed so that users can access its data through standard web services (according to Open Geospatial Consortium (OGC) Specifications), via Internet.

4. CONCLUSIONS

The most important conclusions regarding CartoCiudad project can be summed up in the following lines:

- **Collaboration:** CartoCiudad is the result of the cooperation among Spanish public organizations. To reach a common agreement among all the stakeholders involved required an important effort, but once achieved, it has enabled reaching two important goals:
 - The **harmonization** and integration data at national level which facilitates the harmonization within the European framework.
 - **Synergy:** The result is a value added product. The result of the data integration process enriches each original data group and, at the same time, the final product becomes the base so that users can develop new functionalities, as in a valued added chain happens.
- **Data production, maintenance and update:** The production of all Spanish municipalities is almost finished, so that it is expected to have the national coverage in the second part of 2010. The second phase of the project regarding the data maintenance and update is the new challenge which it is being already developed in collaboration with the local organizations.
- **Free data availability through Standard Services Web: WMS, Gazetteer, WPS:** The OGC Web services allow users to access and handle the data freely.
- **On going:** CartoCiudad intends to improve the services developed as well as to provide new functionalities in order fulfil the user requirements (like the inverse gazetteer or the free web component CartoVisor).

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