3D Modeling and Representation of the Spanish Cadastral Cartography and the INSPIRE buildings model

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• Introduction about the Spanish Cadatre.

• WMS of the Spanish Cadastre and the 3D representation of the cadastral cartography in the WMS
  • Shadow representation
  • Perspective representation

• 3D modeling of the Cadastral cartography
  • 3D modeling by general floor
  • 3D modeling by floors

• And then ……

• Spanish Cadastre in TWG-buildings
• The INSPIRE buildings model.
• Testing and implementation
• conclusions
The Spanish Cadastre is a register describing rural and urban real estates.

This description includes physical, legal and economic characteristics, location, cadastral reference, address, surface, uses, class of crop, buildings, graphic representation, time attributes, cadastral value and data of title holders (name, national identity number, address, type of title……. and many other data.

The Spanish Cadastre is principally a fiscal cadastre, whose databases of cadastral values of rural and urban real estate are the basis for the calculation of real estate tax and other local, regional and national taxes.
We need more information than just only information about the INSPIRE themes cadastral parcel or building. We need the information inside the building, the distribution of each property, the common areas etc...
The Exchange document (FXCC) is a scaled graphic representation of the properties forming an urban real estate building. In every exchange document the different floors and interior spaces are represented. The document contains a digital photo of the building too and it is stored in the data base parcel by parcel.


It is the exchange format with the collaborative entities: Notaries, municipalities, surveyors......
This document is stored in the system as documental information and link up to parcel data by means of the cadastral reference.
The Spanish cadastre has information of:

- 12 million urban parcels,
- 32 million urban units and
- 42 million rural parcels

in a continuous and uniform model

Unit of data capture: Municipality

Urban cartography:
1:500 and 1:1,000

Rural cartography:
1:2,000 and 1:5,000
In Urban areas, the parcels contain urban units (flats, individualized parkings, other units inside the real estate.....).

Each unit inside the parcel has his own cadastral reference, all the urban units of a parcel have the same first part of the cadastral reference.

The link between alpha-numerical information and graphic data is achieved using the cadastral reference.
The buildings are defined as sub parcels, as volume constructed.

Cadastral cartography, even in only 2D, has the volumetric information of the buildings by number of plants in roman numerals in their maps.
The Spanish cadastral service by internet gives cost-free, easy, rapid, 24-hour, 7 days a week access to cadastral data.

The Spanish cadastre is a pioneer public sector organisation in its facilitation of access and re-use of its data for free for both commercial and non-commercial purposes.

http://sedecatastro.gob.es
It has evolved from being a government tax collection and a real estate security service to being a socially valuable tool since this data is used in an increasing number of application and new services.

This approach has led progressively to a huge success in demand, with more than 8 millions of accesses a day and more than 5,2 millions of certificates issued in 2011.
WMS of the Spanish Cadastre:
Free of charge
For everybody
24h 7 days

http://ovc.catastro.meh.es/Cartografia/WMS/ServidorWMS.aspx
The subparcels are created
- by their nature (IP pool, JD Garden, TZA terrace,...)
  - or by number of plants, for example
    - I+IV basement plus four plants,
    - II+SOP+X two basements plus veranda plus ten floors,..
In the model, the texts (the numbers) that we see in the map are attributes of the construction layer CONSTRU.

Geometry of the layer "CONSTRU" defines the different volumes of the buildings and other characteristics as terraces, gardens, swimming pools, etc.
With all this, 

How to build the 3D?

The WMS service of the SDGC is developed with our own media and technology, which allow us to manipulate information obtained directly from the spatial selection of the graphic database in vector format, and to generate the resulting image of the map with the characteristics of the symbols and representations that we want to.

The CONSTRU layer is going to serve as a basis for use in the 3D representation.
3D REPRESENTATION IN THE WMS

We have defined two new layers in the service WMS, providing two different solutions one using a shading to give highlight aspect to the buildings and other that is the representation in Cavalier perspective each constructive element.

WMS Catastro

Shadow using CONSTRU3D layer

Prespective using “EDIFICIOS” “BUILDINGS” layer
Shadow using CONSTRU3D Layer

Cadastral Cartography

sub parcels that have as volumetric attribute floors above ground level

Normal representation

shift from the geometry of these compounds in the Southeast direction

semitransparent fill in grey

sub parcels that have as volumetric attribute floors above ground level

Normal representation
Prespective using “EDIFICIOS” “BUILDINGS” layer

- we order the sub parcels from North to South
- each sub parcel is drawn in its real position with semi-transparent
- for each pair of consecutive coordinates that make up the sub parcel, we construct a parallelogram in the North-South direction and with different scale by a factor multiplied by the number of floors above ground level.
- we draw the cover of the generated prism. It is a object with the same geometry of the base but with a shift towards the North of the image, based on a factor by the number of plants
3D Modeling and Representation of the Spanish Cadastral Cartography and the INSPIRE buildings model
The SDGC has developed a vector 3D modeling by parcel in KML format. This modeling is not stored in the database, it is performed in "real time" on the basis of the vector information of the geometry of objects.

Based on

- the 3D component of the constructions that it is collected as attribute of the sub parcels and

- the geometry of the premises,
3D MODELING

3D Model
General floor

Based on modeling by extrusion on the basis of cadastral mapping and the attribute of construction geometry to get the "z" component

3D Model
By floors

based on the generation of independent units models with the vector information of the cadastral sketch by plants

3D Modeling and Representation of the Spanish Cadastral Cartography and the INSPIRE buildings model
3D Model of General floor

We use the cadastral cartography in vector format of each parcel. And the number of plants, multiplied by 3 (that it is what we have estimated a priori, in meters, as the average height of each plant),

a 3D model by extrusion is generated for each sub parcel of the parcel.
Structure of KML File of 3D Model of general floor

The resulting KML has a link with the cadastral reference to get all the free cadastral data of the parcel http://catastro.meh.es
We use the information of the FXCC
Each part of the building can be then geometrically represented in three dimensions within the physical space in the building.

There are some exceptions, for example in the case of the terraces the objects are defined by a floor and walls of 1.5 meters in height.
Even, we can give to each unit a color depending on its use, owner, value or any attribute.
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3D Modeling and Representation of the Spanish Cadastral Cartography and the INSPIRE buildings model

We offer also exchange format in KML in 4D

Time

2002  2008

Catastro 4D
3D Modeling and Representation of the Spanish Cadastral Cartography and the INSPIRE buildings model
CONCLUSIONS before INSPIRE

• The cartography of the Spanish cadastre can be modeled in 3D.

• The idea of representing 3D objects in services WMS, is a novelty for us and provides a better interpretation of the city.

• Automatic extrusion of 3D data based on simple schemas that allows to reconstruct a large amount of data, offers a good solution to the demand for such products, increasingly requested by users.

• For cadastral purposes, we don’t need to store complex 3D models with description of textures, openings, …Simple 3D visualisation is enough for our current users!!!!
And then …..INSPIRE

As main buildings data provider of the Spanish Spatial Data infrastructure
We have participated in the INSPIRE Thematic Working Group of Buildings
INSPIRE status

• 5 application schemas
  – Base package:
    • Common semantics on Abstract Building
    • Common data types and code lists
  – Core 2D
    • Base information + 2D geometry
  – Core 3D
    • Base information + mandatory 3D geometry
    • 4 LoDs of City GML allowed
    • 2D geometry possible (voidable)
  – Extended 2D
    • Core 2D + additional semantics
  – Extended 3D
    • Core 3D + additional semantics
    • + boundary surfaces, openings, interior
    • + textures

Only these 3 AS in IR
3D Modeling and Representation of the Spanish Cadastral Cartography and the INSPIRE buildings model
### Building

<table>
<thead>
<tr>
<th>Name</th>
<th>Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtype of</td>
<td>AbstractBuilding</td>
</tr>
<tr>
<td>Definition</td>
<td>A Building is an enclosed <strong>construction</strong> above and/or underground, used or intended for the shelter of humans, animals or things or for the production of economic goods. A building refers to any structure permanently constructed or erected on its site.</td>
</tr>
<tr>
<td>Status</td>
<td>Proposed</td>
</tr>
<tr>
<td>Stereotypes</td>
<td>«featureType»</td>
</tr>
<tr>
<td>Identifier</td>
<td>null</td>
</tr>
</tbody>
</table>

#### 4.2.1.1. Feature types

Core 2D profile includes 2 instanciable feature types: Building and BuildingPart.

Buildings are enclosed constructions above and/or underground which are intended or used for shelter of humans, animals, things or the production of economic goods and that refer to any structure permanently constructed or erected on its site.

### Association role: parts

<table>
<thead>
<tr>
<th>Value type</th>
<th>BuildingPart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>The building parts composing the Building.</td>
</tr>
<tr>
<td>Description</td>
<td>A building may be a simple building (with no BuildingPart) or a composed building (with several BuildingParts).</td>
</tr>
<tr>
<td>Multiplicity</td>
<td>0..*</td>
</tr>
<tr>
<td>Stereotypes</td>
<td>«voidable»</td>
</tr>
</tbody>
</table>
### BuildingPart

<table>
<thead>
<tr>
<th>Name</th>
<th>Building Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtype of</td>
<td>AbstractBuilding</td>
</tr>
<tr>
<td>Definition</td>
<td>A BuildingPart is a sub-division of a Building that might be considered itself as a building.</td>
</tr>
</tbody>
</table>
| Description| NOTE 1: A BuildingPart is homogeneous related to its physical, functional or temporal aspects.  
NOTE 2: Building and BuildingPart share the same set of properties.
EXAMPLE: A Building may be composed of two BuildingParts having different heights above ground. |
| Status     | Proposed      |
| Stereotypes| {featureType} |
| Identifier | null          |

A BuildingPart is a sub-division of a Building that might have been considered as a building and that is homogeneous related to its physical, functional or temporal aspects. It is up to each data producer to define what is considered as a Building and what is considered as a BuildingPart (if this concept is used). This information has to be provided as metadata.

More explanations and examples about how the concept of BuildingPart may and should be used are provided in clause 10 about Data capture.

Buildings and BuildingParts share the same set of properties of geometric and semantics properties (i.e. a BuildingPart may be considered as a building). These common properties are factored in 2 abstract feature types:

- feature AbstractBuilding gathers the common semantics properties; these properties are the same in core2D and core3D profiles
- feature type AbstractBuilding2D inherits of the common semantics properties of AbstractBuilding and includes the 2D geometry of buildings
We will have “to build” the building from the buildings parts, and to create an identifier

4.2.1.4. Identifier management
The buildings and building parts have to be identified by the mandatory attribute inspireID; this unique identification enables the buildings and building parts to be target of associations from other INSPIRE themes, e.g. from theme Address.
We will have to adapt our complete classification of buildings to a much more simple classification... or to extend the INSPIRE code list

2.2.2.3.2. Classification of buildings

This data specification proposes a simple classification of buildings, based on their current use. Users will find more detailed information in the themes dealing with facilities.

<table>
<thead>
<tr>
<th>Current use – high level</th>
<th>Current use – detailed level</th>
</tr>
</thead>
<tbody>
<tr>
<td>residential</td>
<td>Provided by DS BU</td>
</tr>
<tr>
<td>agricultural</td>
<td>Provided by DS AF</td>
</tr>
<tr>
<td>industrial</td>
<td>Provided by DS PF</td>
</tr>
<tr>
<td>commerceAndServices - office</td>
<td></td>
</tr>
<tr>
<td>commerceAndServices - trade</td>
<td></td>
</tr>
<tr>
<td>commerceAndServices – public service</td>
<td>Provided by DS US</td>
</tr>
</tbody>
</table>

Table n°2: the classification of buildings

Open issue 1: the articulation between Buildings and facilities was poorly tested or not tested at all during the consultation phase. So, there is a real risk that data between these themes will not connect as expected. This will be a point to be carefully monitored by the maintenance process of INSPIRE specifications.
If we apply the core model of INSPIRE, we will offer very few data regarding those that we would have been able to provide.
We can not give 3D data in INSPIRE model, because we use KML (visualisation format) and not City GML (topologic and semantic model).

City GML stores geometry, topology and semantics in its building model.
The extended 2D profile contains 5 instanciable feature types:

- Building
- OtherConstruction
- Installation
- BuildingPart
- BuildingUnit

OtherConstructions are self-standing constructions that are generally not considered as buildings. This extended profile includes the most significant constructions that are necessary to describe landscape and to fulfil use cases such as safety or spatial planning.
Moreover, the extended profile offers, as additional properties, many attributes and association to CadastralParcel and to Address, that are feature types defined in annex I themes.

Figure n° 26: the additional attributes of Building and BuildingPart in extended 2D profile.
Floor distribution:
[-2, 8] for a building having 2 underground floors and 8 floors above ground

FloorDescription:
- floor range [0,0]
- currentUse: trade
- height : 3 m
- document: sketch of ground floor
- number of dwellings : 0
- openingArea: 40 m²

to descibe a ground floor occupied by shops.

FloorDescription:
- floor range [1,7]
- currentUse: residential
- height : 3 m
- document: sketch of first floor
- number of dwellings : 6 (6 dwellings per floor)
- openingArea: 50 m²

To describe the 7 floors above ground floor, if all these floors are similar
INSPIRE EXTENDED 2D

The extended 2D profile contains 5 instanciable feature types:
- Building
- OtherConstruction
- Installation
- BuildingPart
- BuildingUnit

- OtherConstructions are self-standing constructions that are generally not considered as buildings. This extended profile includes the most significant constructions that are necessary to describe landscape and to fulfill use cases such as safety or spatial planning.
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In the Spanish Cadastre, the building units are important. The Spanish Cadastre is a Fiscal Cadastre and the value of each unit is the basic for many taxes as the Local Property tax.

To be able to offer our building units in INSPIRE model, we should give one identifier of every unit.
INSPIRE Extended 3D

To be able to offer our building units in INSPIRE 3D model we should give 3D geometry and one identifier of every 3D unit.
CONCLUSIONS after INSPIRE

- We will have “to build” the building from the buildings parts, and to create an identifier.

- We will have to adapt our complete classification of buildings to a much more simple classification… or to extend INSPIRE code list.

- If we apply the mandatory core 2D model of INSPIRE (most likely scenario for short term), we will offer very few data regarding those that we would have been able to provide.

- May be in the future, we can apply extended 2D model and offer more 3D related information via floor description, floor distribution and documentation.

- Our way to provide 3D visualisation of buildings in KML (automatic extrusion of 2D data + height) is not enough to fill the 3D model of INSPIRE; however, we should keep this kind of view services that is of great interest for our users.

- To be able to offer our building units in INSPIRE model, we should give geometry (2D or 3D) and identifier of every unit (?)
Thank you for your attention