

Cadastre and territorial government: from the first surveys to GIS

Francesco Scricco

Department of Civil Engineering and Architecture, Polytechnic of Bari, Italy

ABSTRACT

Since its birth, the Italian Cadastre has been an essential tool for the government of the territory, not only from the taxation's point of view. During the initial stages, coinciding with the unification of the cadastres prior to the unification of Italy, was collected an impressive amount of data, which led to the formation of the Land Cadastre. Through a meticulous work of survey of the territory and of the land ownership boundaries, it was made a detailed cartographic representation of the country. The cadastral mapping was supported by a network of reference points more precise and dense that adopted by the IGM (Military Geographic Institute). Subsequently, with the formation of the building cadastre, we were added data on the plans of all buildings of the nation.

The paper, after a historical introduction, will illustrate the evolution of the Italian cadastre, which involved:

- the digitalization of archived data;
- vectorization of cartography;
- the involvement of professionals both in updating the maps both the plan's archive, which now is carried out telematically;
- the creation of a GIS.

To these data are added those resulting by OMI (Observatory the real estate market) and by Real Estate Registry, allowing statistical processing of trades, real estate prices, surveys on economic and architectural features of the buildings and of the various areas in which it has divided each municipality.

The paper also discusses possible future developments of the cadastral database: by creating a SIT (Territorial Information System) fully computerized, you can consult, extract, compare all current and historical data relating to the whole country, with reference both to land both to buildings. The consultation will take place through the navigation of a vectorial map, with graphic interrogation of the building or of the parcel of land. This tool will be a valuable resource not only for the fiscal aspects, but also and especially for the management, planning and control of all the complex processes of transformation of the territory.

Keywords: *SIT/GIS, cadastre, territorial management, urbanism*

INTRODUCTION

The Cadastre has very ancient origins and its nature has evolved over time, changing also according to the various geographical and cultural realities. The final definition of its characteristics and purposes took place during the Napoleonic period. Previously, the term cadastre will indicate a generic classification of movable or immovable property and their owners; Moreover the word referred to generically whole set of operations required to determine property taxes and sometimes the tax itself. Today, it has come to an unambiguous definition, whereby the cadastre is the set of documents that ensure the technical and economic

characteristics of real estate, record all the historical mutations in terms of uses, properties and values for tax, civil and possibly legal purposes.

Tax purposes consist of determining the taxable income of the land and urban buildings; this objective requires the technical and economic knowledge of the land and buildings and ascertainment of their economic value.

Civil purposes consist in the identification of real estate and in collecting of all necessary related information, including the complete cartography of the territory.

The Italian cadastre does not however legal purposes¹, that is devoid of the possibility of legally proving the rights registered in the land registry itself. Moreover, the cadastre indirectly performs other functions, once again connected to the large amount of data collected and cataloged, with particular reference to cartographic ones; in particular, the most significant are:

- support to the real estate advertising system;
- auxiliary tool in the design, construction of public works (construction, road, technology networks) and urban design;
- provision of basic cartography;
- provision of estimate details;
- support in the real estate trading;
- support for the economic analysis of the territory and its development, and then for the development of fiscal and social policies.

HISTORICAL EVOLUTION OF ITALIAN CADASTRE

Immediately after the unification, it was posed the problem of land equalization: the birth of the Kingdom of Italy had led to the unification of the existing registers (there were as many as 24 different registers), and then the formation of the Italian land cadastre. The problem was that each preunitary registers was different from the other and had different levels of taxation, different survey and valuation methods.

In 1864 it was enacted the Law of the provisional balance, with which it tried to remedy the problem of land inequality. Subsequently, in 1865, it was decided that the taxation of buildings and any other stable construction would be determined on their net income. This decision formed the basis for the birth of the Italian buildings cadastre. The next step was the establishment of the Urban Cadastre (C.U.), in 1877.

The urban cadastre had the following characteristics:

- describe the consistency of the property;
- he operated for individual properties;
- was global (ie, without division into property units).
- for the geometric aspect and for the identification of the buildings on a map, there was used the Land Cadastre.

The next step, of fundamental importance, took place in 1886, with the enactment of Law 3682 (called Messedaglia Law, from the name of its author, or “the law of the land equalization”). With this law was born the only Italian cadastre, the New Geometric Parcelled Cadastre, and in particular are set up the New Land Cadastre (N.C.T.), which replaces the old preunitary land registers, and the Urban Building Cadastre (C.E.U.), which was the evolution of the Urban Cadastre of 1877. This law represents a revolutionary breakthrough, since it was finally solved the problem of the diversity of previous land registers and the resulting land inequality (which is why the law is also known as the “land equalisation law”): in fact, with the

¹ In some Italian regions and provinces, the Land Cadastre has however legal purposes, thanks to the association with the “Tavolare Book”. It is a peculiarity derived from the Austrian land registry, which remained in force in those areas belonged to the Austro-Hungarian Empire.

birth of a single cadastre throughout the national territory all tax inhomogeneities are eliminated. The New Land Cadastre was geometrical, ie, besides the description of the property, also it contained their planimetric representation; parceled, because planimetry represents the land areas limits; Finally, as mentioned, it was not probative. It was defined "land parcel" a portion of real estate (land or building) continues, belonging to a single municipality, belonging to a single owner, having a single production target, with a unique level of productivity.

Another key step came in 1939, with the establishment of the New Urban Building Cadastre (N.C.E.U.), which was intended to update and replace the old Urban Building Cadastre. The N.C.E.U. is geometric, considering the individual properties, is not global, because they are denounced the individual urban units (U.I.U.)². A great innovation was formed, in 1941, by the formalization of aerophotogrammetric method for the topographic survey of the land and by the obligatory use of Gauss-Boaga cartography instead of Cassini-Soldner cartography.

In 1956, 70 years after its establishment, the N.C.T. comes into conservation and permanently replaces the old Land Cadastre.

In 1962 the same thing happened for the NCEU. On this date, the buildings cadastre acquires greater autonomy from the land cadastre, with respect to which so far he had a position of dependence.

The final separation of the two registers occurred in 1984. From this date, the urban real estate are within the exclusive competence by the NCEU: every urban building or portion of urban building, every urban area or any portion of it, every yard or portion thereof, each common asset, sensible or not sensible, it must be identified with the data of the NCEU and graphically represented or with the floor plans or with a special overview called "planimetric printout" (elaborato planimetrico)³.

Finally, in 1994, there was the establishment of the Cadastre of Buildings (C.d.F.) which is the renovation of the NCEU and its extension to rural real estate units: previously the competence of the latter type of real estate was still of the Land Cadastre.

STAGES OF FORMATION OF THE LAND CADASTRE

The realization of the NCT, as seen, was initiated immediately after the enactment of the Messedaglia Law, and then since 1886. Despite this, however, the steps by which cadastre was built have been defined by law only in 1931, through the Consolidated Law on Cadastre (RD 1572/1931); they are, in order:

- formation, which is the set of all operations required for the effective "construction" of the land register;
- activation, ie the entry into force of the acts realized during formation;
- conservation, finally, that corresponds to the mature stage of the land register and has the aim to always keep updated the records.

It is interesting to analyze the stages of formation of the land cadastre, ie all operations for the relief and the determination of income for tax purposes. First, preliminary steps were carried out, prior to the topographical survey; this have the purpose of precisely identifying the cadastral particle to be detected. Through the delimitation, in each municipality, was made the

² The current definition of Urban Property Unit (UIU) is the following: the building unit is constituted by a portion of a building, or a building or from a set Buildings or from an area that, in the condition in which they are and according to local customs, it presents potential of functional autonomy and income.

³ It is a simplified plan, related to a single building. On each floor, it shows the lineout of all real estate units and the location of the staircase.

recognition of municipal boundaries, the land property included in the municipality, the recognition of the particles constituent of each property, even in contradictory with stakeholders. With the termination were placed stone elements to mark and make visible the less noticeable boundary lines. The termination was founded with the intent to give legal effect (probativeness) to the cadastral subdivisions and was carried out in the presence of the owners, who had the duty to report the boundary lines and to cover costs of terminating operations. Given the complexity and long lead times, such operation was soon abandoned.

The following actions were those of surveying. The first was the triangulation, leaning against the national network of triangulation by the Italian Military Geographical Institute (I.G.M.I.) and in particular to the vertices of I, II and III order. The vertices of the fourth order, however, were not used because they are too imprecise for Land Registry requirements. In fact they were recalculated and used as cadastral trigonometric points. At the end of the triangulation, you obtained a network of trigonometric points, each with its own description (monograph), at a distance of about 1.8 km, classified by network points, subnet point and detail point. Because it was impossible to carry out surveys of particle detail only with trigonometric points, due to the excessive width of the mesh, they were therefore made supporting polylines.

Once the phase of survey on the ground ended, one passed to the cartographic representation. Primarily, on sheets of paper, it was initially drawn the colored parametric crosslinked, representative of the orthogonal coordinate plane (abscissa and ordinate) of the adopted cartographic representation system. The cartographic representation systems used for the Italian Cadastre are Cassini-Soldner and Gauss-Boaga (the latter one was the only system to be used by law from 1941 onwards, and actually activated only in 1955). We then move on to the design of the original implantation map.

Finally, it proceeded with the calculation of the surface of the particles. Given the surface of a single sheet of map, itself divided into particles (including roads and water), the following steps were performed: first, the calculation of the area of the entire map sheet, by two separate operators, followed by a comparison of the obtained surfaces and the calculation of the average area (with tolerance of the difference between the two measurements predetermined by law); the surface thus obtained was called "surface must be"⁴. The calculation of the "must be surface", according to the viewed rules, was based on the comparison and average method. With the same procedures it measured the surface of each individual particle; by adding up the area of all the particles, belonging to the map sheet, it was obtained the surface of the sheet, which was compared with that previously measured. Any difference, that unbalance, was proportionately divided among all the particles in the sheet.

The next step was related to the estimative operations for the definition of incomes and tax aspects. The country was divided into 300 census circles, ie sectors with similar economic, agricultural, topographic and geological conditions. Within each census circle, were then defined the representative municipalities of the prevailing farming in the circle itself. In addition to the census circles and municipalities, are also present the census zones, ie special territorial subdivisions having uniform characteristics in terms of qualification and classification. Usually a census zone coincides with a single municipality; in other cases, instead, there can be a municipality subdivided into several zones or a census zone that group together the a lot of municipality.

The operation called "qualification" consisted in determining the various types of cultivation present in each municipality or census zone, according to a grid of 30 different types of farming, called "quality". The survey of the quality of the culture must be based on conditions and circumstances having the character of ordinariness and permanence. Along with the

⁴ The expression "must be" means, in cadastral jargon, a invariable data to which all other counterparts data must comply.

qualification, was also carried out the classification, which consisted in dividing each farming in classes, corresponding to different levels of productivity.

Finally, you passed to the rating, performed on site, and which consisted of entrusting to each particle of the township (or census zone) the quality and class which it was entitled. The last estimative operation performed, was the determination of the charges, namely the unitary taxable income for each particle. The determination of the tariffs was performed through economic analysis of ordinary study-cases of enterprises, choices in the municipalities, identified in order to represent the qualities and the classes.

THE CADASTRAL MAP AND THE FLOOR PLAN DATABASE

The cadastral map (called parceled map) is one of the fundamental acts of the cadastre. It is organized in sheets (size 70 x 100 cm), numbered consecutively with arabic numerals. The unified representation of all the sheets of the same municipality, or of the same census area, forms the union framework. The typical representation scale is of 1:20,000, but are also provided major scales (1: 1,000, 1: 500 for heavily populated areas) or lower (1: 4,000, mountain or sparsely populated areas). The scale of the union framework is typically of 1: 25,000, but it is also allowed to 1: 10,000. The parametric crosslinked, previously mentioned with regard to surveying work, it consists of lines equidistant by 10 cm. The drawing is with "closed perimeter", that is delimited by lines materialized on the ground (preferably formed by water courses, property boundaries, etc.). The drawing represents a finite number of whole particles, identified by arabic numerals, called number of particle or number of cadastral maps; out from the parceled map and, in general, in the cadastre records, it refers to a particle not only with the particle number, but with at least two other numbers: the first is the number of sheet (Arabic number, possibly followed by a letter in case of attachments); the second one is the identification code of the municipality which the particle belong, given by the national code of the Italian municipalities and foreign countries (consisting of a string of a letter and three numbers).

In this impressive amount of data, it must be added the floor plans database: in the buildings cadastre are counted nearly 70 million real estate units; for each of them is filed its floor plan, generally in a 1: 200 scale (but depending on the size Property, although other scales, typically 1: 100 and 1: 500).

THE DIGITALIZATION OF THE CADASTRE

Beginning in 1987, it has started a process of mechanization and digitization of land registry. For mechanization means storing of administrative and census data on magnetic media, while digitization is the transfer of geometric data in digital format. With the start of mechanization (already introduced by law in 1969), the acts of the land cadastre are maintained and updated on electronic media rather than on paper. With reference to the Land Cadastre, in total, they have been digitized over 350,000 map sheets. With regard to the Building Cadastre, all the plans have been acquired in raster format.

In 2002 he completed the project of computerization of cadastral mapping by implementing a proprietary GIS system (which was given the name of WEGIS, Enable Web GIS) designed specifically for the management of cadastral data, intended for the whole territory national. The WEGIS system has the following characteristics:

- represents a multi-level database, with representative layers of cadastral themes (land particles, buildings, waterways, roads, texts, symbols etc.) and layers with the aerial photos of the national territory, consulted on the basis of three different measuring periods;

- can handle cartographic visualizations and functionality applied to map information for both vector and raster format;
- allows to compare, from the point of view of consistency and correlation, the institutional cadastral cartography with other cartographic sources, acquired as information layers of help and support to those purely cadastral.
- it is constantly fed by the acts of the N.C.T. update presented by professionals and governed by law. Thus it will guarantee the continuous alignment of the geometric information that are relevant in the cadastral field. In fact, since 1988 with the drafting of the new instructions for the cadastral survey, it was started a process that now allows technicians to online update both the Land Cadastre and the buildings cadastre, with automated procedures called PREGEO and DOCFA respectively.

Currently, the database of the Land Cadastre and that of the Building Cadastre are available separately, and cartography represents the map of the Land Cadastre.

There are then two separate databases: the Observatory of the Real Estate Market (O.M.I.) and the Property Register Records. The first collects information on real estate prices, published every six months. In each municipality they have identified the homogeneous territorial areas (OMI zone); in each area, for each type of property, it is filed a market value interval, minimum and maximum, per unit area, obtained through the detection of the trades. They are also collected information on individual properties purchased and sold (intended use, level of finishes, facilities, technological and systems equipment, etc.) and on the areas of the city (facilities, environmental quality, prevalent type of property, allocation of parkings, etc.). The OMI quotes can be consulted free of charge about the last 6 published semesters. Also, you can check the prices according to months, province, municipality, OMI area and intended use; both by using the traditional text search, both looking on the map by the spatial navigation service, called "GEOPOI". If you surf with your smartphone or tablet is available the application Omi Mobile.

The Conservatory database allows the consultation of information regarding:

- the transcriptions, related to acts of transfer or creation of rights in immovable property; through the inspection of transcripts, you can also view those relating to acts of creation of various constraints (foreclosures, seizures, judicial claims);
- the inscriptions, namely information relating to the constitution of mortgages on properties resulting, for example, by financing contracts;
- finally, the annotations, namely changes to previous transcriptions, inscriptions or notations, as cancellations of mortgages and foreclosures.

THE POSSIBLE WAY FORWARD

The upgrading of the GIS in order to constitute a real SIT (Territorial Integrated System) is the next target. First, should be the unified land cadastre and buildings cadastre information. Through the graphical navigation of vector cartography, should be viewable, simply highlighting the researched particle or building, all related information: intended use (both for buildings and for the land, indicating the cultivation), consistency, properties, income, plan (with appropriate confidentiality restrictions), providing data both current and historical. These data could be added to those provided by professionals, with the update documents of buildings cadastre: with DOCFA procedure, when the variations suffered from the building are recorded, the technician provides a range of information relating to the finishes, the facilities, the plants, the construction period, the reference to the construction permits that allowed the changes themselves.

The integration with the OMI and Conservatory databases would add a whole series of useful information for an economic view of the area, with the possibility to analyze the market

trend and the transaction flows. Still continuing in this direction, it would also be desirable to integrate with the systems of the real estate municipal registry, with the databases of private and public building of the municipalities and regional ones, which retain energy performance certificates of individual properties. They could be added such as the town planning information, with forecasts and the requirements of urban planning instruments in force at all levels (local, regional, landscape, etc.).

The main purpose of this huge amount of data might be primarily a review of valuation prices and then of the incomes. A greater and more in-depth knowledge of the territory, allow greater accuracy and a higher equity of taxation (for example, enhancing the data on the finishes level of the property, the plant and facilities equipment, the energy performance levels, the parameters of consumption, the use of environmentally friendly materials or energy production from renewable sources).

Finally, it would be possible a further implementation: the realization of a three-dimensional GIS. This innovation would be a real revolution, allowing for simple and immediate reading of the buildings articulation, which could be investigated and displayed in the map all floor levels (even those underground, becoming more complex in contemporary cities) and plans.

CONCLUSION

The paper has shown how, over more than a century of work, has been collected, cataloged, stored and subsequently digitized a large amount of data. A further technological effort, in the sense of a higher integration and a further implementation of data, would allow the realization of what stated in the introduction: in the first place to achieve a greater fairness in the tax imposition; secondly, greatly would enhance the usefulness of the cadastral database also in different contexts, especially in those urban and regional planning, design of civil engineering projects, interpretation, government protection of the land.

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