CADASTRAL DATA FITTING IN A LARGE SCALE DIGITAL CARTOGRAPHY

P. Boccardo*, G. Comoglio*
***DIGET, Politecnico di Torino, Torino, Italy**
email BOCCARDO@POLITO.IT

ISPRS Commission VI, Working Group 3

KEYWORDS: Fitting, Cadastre, Digital Cartography.

ABSTRACT

Cadastral data (geometric and attribute data) are undoubtedly a very important information when related to urban Geographic Information System. Unfortunately, the Italian cadastre faces some problem related to different projection system that requires differential planar transformations (based upon a cadastral fiducial points grid) when linked to a standard cartographic projection system (e.g. an UTM projection), and a low metric map accuracy, that does not fit the precision required for a standard technical map at the same scale.
The aim of this study is the management of such cadastral data by means of particular procedures able to perform a fitting of the cadastral maps on technical maps and viceversa, based on a series of differential affine transformations over the cadastral fiducial points grid. The case study regards a medium size municipality located in the Piedmont region (north-western Italy) where the management system is based on Arc-View application operating by means of a standard PC. The procedures proposed in this methodological approach are not strictly related only to the Italian cadastre, but could be useful for all those cases where is necessary to fit technical and cadastral maps in different projection systems and with different map accuracies.

1. INTRODUCTION

The huge market availability of different Geographic Information Systems (G.I.S.) softwares, that nowadays are particularly efficient, user friendly and can be purchased at low costs, in conjunction to digital cartography, has been permitted to approach, in an integrated way, the geographic data management.

Different data sources (geometrical and attribute data) managed by a GIS has to be carefully managed, in particular in the project stage of the GIS itself.

The aim of this work is to analyse two different problems frequently faced in the GIS project phase:

- different digital cartography integration, such as a technical map and a cadastral one;
- association of non metric attributes suitable to buildings management.

3. Available data

The experimental stage, conducted by the Department of Georesources and Land of the Polytechnic School of Turin and a medium size municipality located in the north-western part of Italy, foreseen the realisation of a technical urban map at 1:1.000 scale, the integration of cadastral digital maps and the assistance to the project and management of a local GIS.

The digital technical cartography, will be produced in accordance to particular specifications (Artioli, Dequal, Canella, Neri, 1990) related to the realisation of digital photogrammetric cartography.

Particular attention has been paid to a stereo plotting of a sample area, surveying all the geometric elements specified in the guidelines. In these guidelines, all the geometric elements are divided in 12 different groups, that are:

- Roads and railways
- Buildings and technical infrastructures
- Water, pools, pits and technical infrastructures
- Energy and materials transport lines
- Terrain divisions
- Terrestrial shapes
- Vegetation
- Altimetry
- General representation elements
- Administrative boundaries
- Control network
- Streets names and numbers

As implementation tools a copy of ArcView software has been utilised; figures 1 and 2 show the technical map.

Taking into account cadastral maps, they are directly converted by a NTF format (figures 3 and 4). Four different element has been converted:

- parcels polygons;
- parcels centroids;
- cadastral fiducial points;
- names and labels.

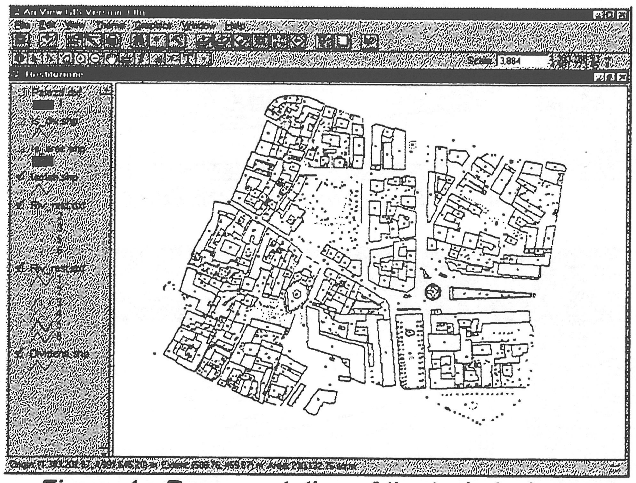

Figure 1 - Representation of the technical map

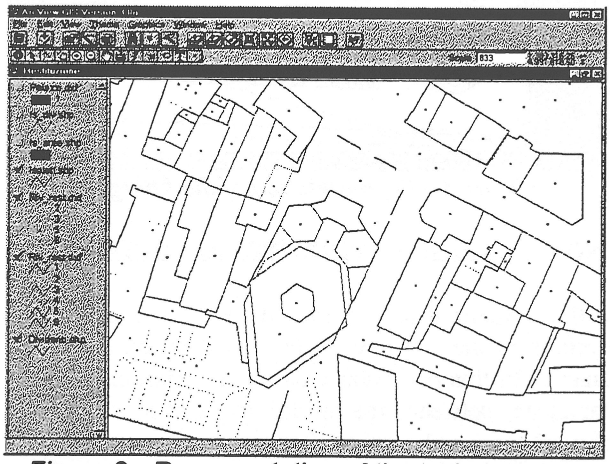

Figure 2 - Representation of the technical map

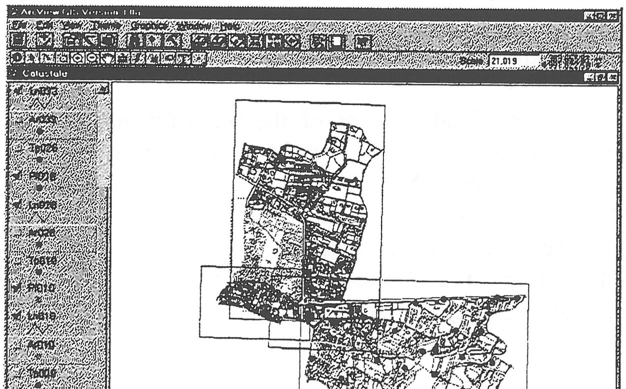

Figure 3 - Representation of the cadastral map

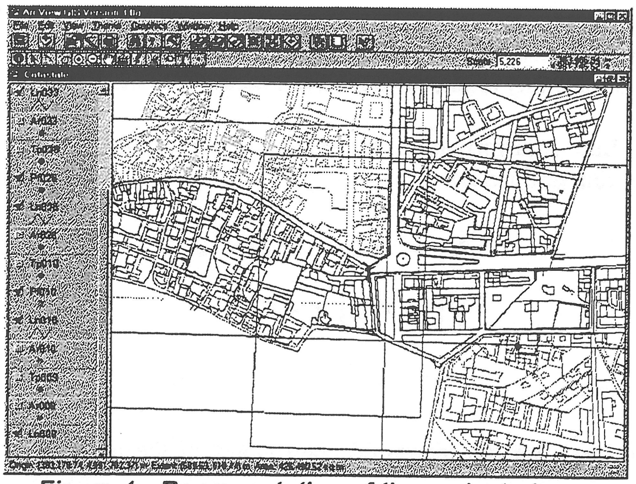

Figure 4 - Representation of the cadastral map

4. CADASTRAL *FITTING*

The integration of the technical cartography with the cadastral maps (or, in general, with other cartography), presents some problems related to:

- different cartographic projection systems. Technical maps are projected in accordance to a UTM (Universal Transverse Mercator) system, or to an Italian equivalent called Gauss-Boaga, while the Italian cadastral maps are projected in accordance to a particular system called Cassini-Soldner (a quasi equivalent projection).The conversion in the two different systems has to be performed differentially in order to assure the congruence in small part of the territory, joining, in a second step, all these parts to reconstruct the entire maps.

- Different maps precision and accuracy, being the cadastral cartography of lower quality in comparison to the technical map at the same scale.

Ignoring the low metric quality of the cadastral maps, where it is impossible to intervene, particular attention has been paid to the second issue, that traditionally could be solved by means of particular techniques called fitting.

The fitting technique is based on the calculus of the 6 parameters of a plane geometric transformation (affine transformation); in order to perform such a transformation, it is necessary to know the planimetric coordinates of three homologues points in the different maps projection (technical and cadastral maps); these three coordinates define the vertex of a triangular mesh, that, combined with other points (that define others meshes) permit the definition of a triangulated network over all the map.

Affine transformation, differently to other plane transformation, does not necessitate of a least square compensation (the system is not redundant), allowing the coincidence of homologues points and the absence of discontinuity along the borders of contiguous meshes.

Affine transformation is based on the solution of a system defined by:

$$x_i = ax_j + by_j + c$$
$$y_i = dx_j + ey_j + f$$

where:

x_i, y_i are the measured coordinates in the projection system i,
x_j, y_j are the measured coordinates in the projection j,
a,b,c,d,e,f are the transformation parameters.

Obviously, the two different projection system can be interchanged, thus it is possible to fit the technical map into the cadastral one and vice versa.

Taking into account the choice of the meshes nodes, it necessary to refer to the cadastral fiducial point net, that, even if do not have an intrinsic better metric quality in comparison to other points, has been chosen by the Italian cadastral authorities, as control points network for all the updating surveys. On the other hand, technical specifications foresee the coding of cadastral fiducial points in the technical map.

In order to perform a fitting, it is necessary:

- to individuate on the technical map the cadastral fiducial points;
- to define a triangulated network (where the above mentioned fiducial points are the nodes of the net) the more regular (equilateral) as possible;
- to calculate the transformation parameters **a,b,c,d,e,f**;
- to convert the coordinates x_i, y_i or x_j, y_j of all the geometric elements of the digital cartography.

In the proposed methodology, the meshes are defined on the base of a Delunay triangulation, the parameters are calculated for each mesh, and the coordinates are converted from a Autocad 13 DXF format.

Figures 5 and 6 show the results of the cadastral fitting.

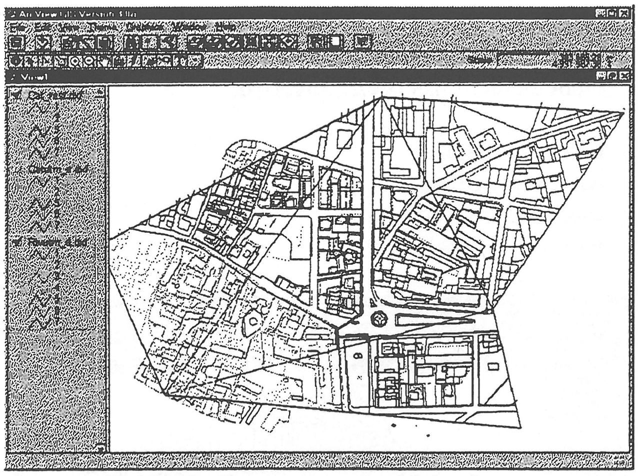

Figure 5 - Representation of the fitting

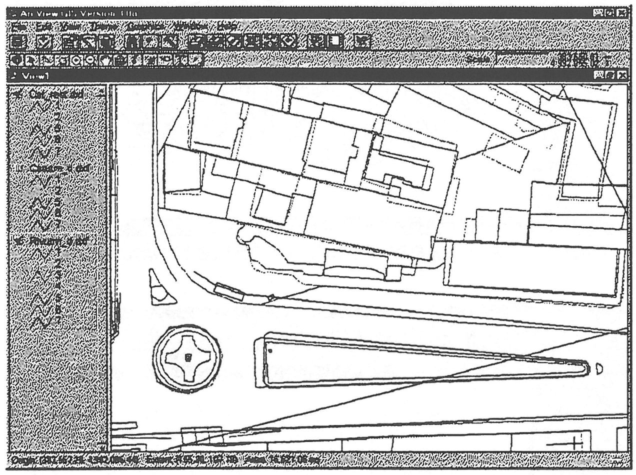

Figure 6 - Representation of the fitting

5. NON GRAPHIC ATTRIBUTES ASSOCIATION

Another important task in the GIS project phase, is the definition of the attributes to be linked to the geometric elements. In this particular case, an association has been established between the buildings centroids (in the technical map) and some attributes such the owner, street name and number. The same operation has been performed in the cadastral map, associating to the parcels centroids some information such parcel number, owner, cadastral area, etc.

The common fields, owner of the building and of the parcel, has been joined, to establish a relation between the two different archive.

In figure 7 is shown a selection based on a query (on both the maps) that defines the graphic elements (parcels and building) registered by the same owner.

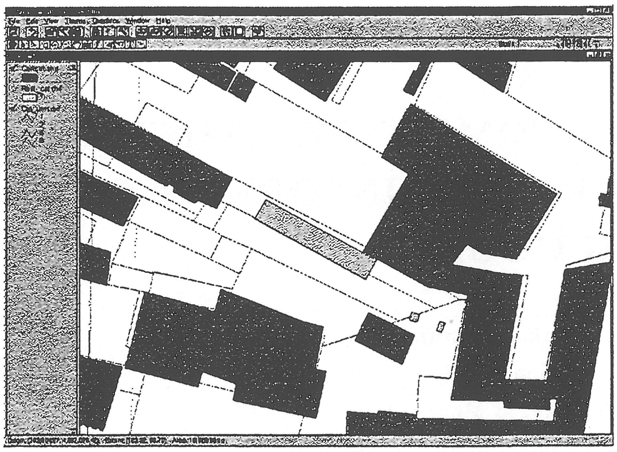

Figure 7 - Query result

6. CONCLUSIONS

Some concluding remarks have to pointed out:

1. Particular attention has to be paid to the different data nature (metric precision and accuracy and data updating);

2. some standard procedures has to be planned to allow fitting of different maps;

3. some quality codes nature (metric precision and accuracy and data updating) are strongly suggested;

4. it is always necessary to foresee an editing phase on the geometric elements in order to reconstruct topologies, that are generally lost in the conversion phase.

6. REFERENCES

Artioli, G. P., Canella P., Dequal S., Neri A., 1990. *Cartografia fotogrammetrica numerica - Capitolato speciale d'appalto*, Bologna

Cambursano C., 1997. *Cartografia numerica*. Soc. Editrice Esculapio, Bologna

Conia G., Galetto R., Spalla A., 1990. *Il sistema NTF per il trasferimento della cartografia catastale*. Bollettino SIFET n°. 1/1990

Dequal S., 1990. *Strumenti e metodi per la produzione di cartografia numerica*. Bollettino SIFET n°. 1/1990

Foietta P., Mandrile L., 1991. *Cartografia con il Personal Computer*. CLUP Città Studi, Milano

Galetto R., 1990. *Le caratteristiche qualitative e metriche della cartografia numerica*. Bollettino SIFET n°. 1/1990

Galetto R., Spalla A., 1997. *Implicazioni cartografiche nei sistemi informativi comunali*. Atti 1° conferenza Nazionale ASITA.

Spalla A., 1995. *Cartografia Numerica*. Bollettino SIFET n° 2/1995

Spalla A., 1997. *La cartografia numerica da DCT-MACROS ad AUTOCAD, via DXF*. Bollettino SIFET n° 3/1997