

INTEGRATION OF CARTHOGRAPHIC AND CADASTRAL DATA IN A COMMON INFORMATION SYSTEMS

Giuseppe GENTILI
CISIG

Consorzio per l'Innovazione dei Sistemi Informativi Geografici
Parma, Italy

ABSTRACT

The project entailed the construction of a land use database for the Public Administration of "Borgo Val di Taro" in northern Italy. The task was accomplished by integrating the existing data provided by the Regional Cartographic Service of the Emilia-Romagna region and the Cadastral Office, consisting of regional maps (CTR) at the scale 1:5000, cadastral maps at the scale of 1:2000 and their related archives. The project provided also an opportunity of outlining a methodology for updating the regional cartography and the land databases with digital orthophotos, from which the newer features could be extracted. The updated regional land database became the reference system for the integration of the cadastral features by means of topological functions. In particular, the overlay of the regional and cadastral building themes generated a new relationship between them that helped in the classifications of the buildings of the project area.

1 INTRODUCTION

The recent popularity of geographic information systems (GIS) as a tool for combining diverse data sets to manage land resources and to model future land uses, increases the need of collecting and acquiring data, especially from historical sources such as cadastral and cartographic maps, as well as public registers providing information on land ownership of private and public property. The type

and the availability in digital format of these data is related to the manner in which they have been developed and have progressed (Maguire *et al.*, 1991).

In the area of Borgo Val di Taro, in the northern Italy, the "Regione Emilia Romagna" and the "Comunità Montana delle Valli del Taro e del Ceno" planned the building of newer land databases. These were to be managed by GIS technology, and included the development of methodologies for updating existing resources such as older landbase data as well as cartographic and cadastral maps.

In developing the land databases for the study area use was made of the regional database and the regional

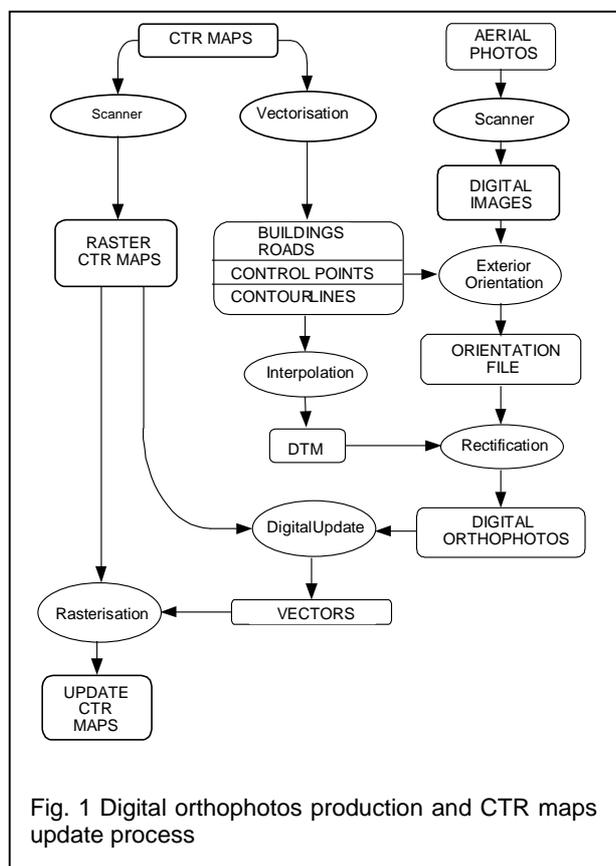


Fig. 1 Digital orthophotos production and CTR maps update process

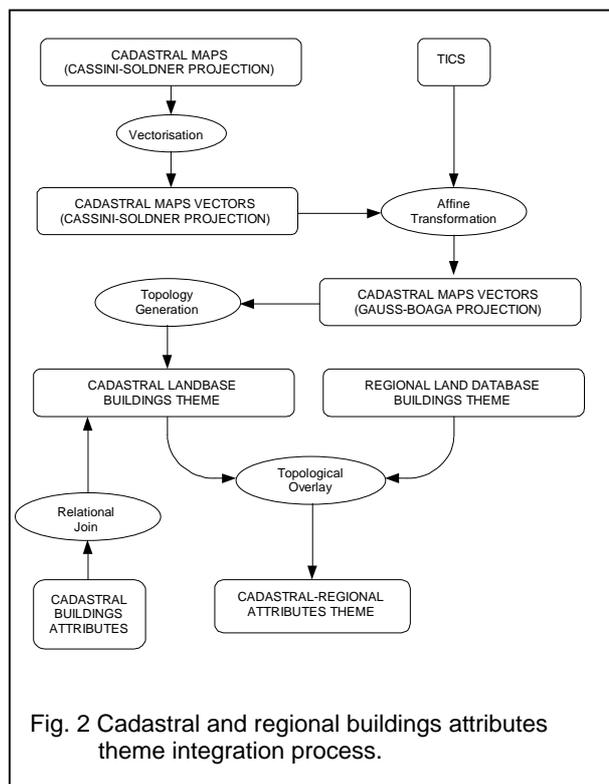


Fig. 2 Cadastral and regional buildings attributes theme integration process.

Item	Data
Area covered	301,200 Km ² (all of Italy)
Direction of flight axes	E-W and W-E superimposed on axes of 1:25000 scale maps of the national cartographic agency (IGM)
Km of flight	about 31,000
Relative flight altitude	11,500 m
Average photo scale	1:75000
Number of photos	5,500 (overlap 60%, sidelap 20%)
Camera	WILD RC30 equipped with FMC, f=152.82
Aircraft	Lear Jet 25C
Film used (negative)	KODAK PANATOMIC X

Tab. 1 Technical data concerning the high altitude aerial photo coverage of Italy of 1994

cartography (CTR) maps at scale 1:5000 provided from the Cartographic Service of "Regione Emilia Romagna" and the cadastral maps and the databases of land ownership.

From these maps the focus of the project was its development based on the following steps:

- production of digital orthophotos at the scale of 1:5000;
- updating the CTR by tracing the outline of newer buildings and roads through superposition of the CTR maps on the digital orthophotos;
- regional databases update of planimetric features outlines as traced in the previous step;
- creation of a cadastral data base of buildings and their associated information such as parcel identifier and address;
- integration of regional and cadastral data bases;
- outlining of differences in thematic maps.

These steps of the project were planned in two phase as is shown in figures 1 and 2.

2 DIGITAL ORTHOPHOTO DATA

The digital orthophoto is developed from high altitude photography executed in 1994 by Compagnia Generale Ripresearee of Parma, that is a member of CISIG consortium. Although in 1988-89, for the first time, all Italy was photographed from about 12000 m, it was only in 1994, in a period of about 90 calendar days, and therefore almost synchronously, that the best photographic coverage was acquired with the material and equipment described in table 1.

The photographs were accurately scanned with the ZEISS SCAI scanner at the pixel size of 14 μ m that corresponds to the resolution of about 1 meter on the ground (Greve, 1996).

The digital images are rectified with exterior orientation files imported from the analytical stereoplotter Zeiss Planicomp P1. In this step use was made of geodetic points and control points taken from the cartography with digital tools to give the same accuracy to the digital orthophoto.

The Digital Terrain Model (DTM) used in the rectification step was generated from the interpolation of contour lines derived from the vectorisation of the raster image of the cartography. The DTM was checked by calculating the

isolines from the grid of the DTM and comparing them with the original altimetric data. This process was iterated until the errors introduced during the raster-to-vector conversion were minimized. The 20 meter grid size was considered suitable to produce digital orthophotos at the scale 1:5000.

The size of the final digital orthophotos is the same as the CTR maps that cover the area of Borgo Val di Taro.

3 CTR UPDATE PROCESS

The CTR map sheets provided by the Cartographic Service of "Regione Emilia Romagna" were scanned at 800 dpi resolution with a large-format drum scanner.

The digital image of the map was georeferenced by an affine transformation performed on the registration of the four boundaries points and all the cartographic net intersections.

Vectorisation software was used to convert the raster maps into a set of vectors representing the contour lines, buildings and roads. These features were distinguished in separate themes and classes that were entered in the regional land databases.

The raster maps were superpositioned on the digital orthophotos and the outlines of the newer buildings and roads were digitized.

The update of the maps was realized both by converting in raster form the set of vectors representing the newer features and by deleting from the raster maps the non existing features.

The updated maps were plotted for field checking of the features that could not be clearly interpreted with the digital tools.

The newer features extracted in the CTR update process were appended to the existing thematic material provided by the regional land information system as Arc/Info coverages. The errors introduced from the automated process as dangle nodes and missed label points in the polygons of the buildings theme were identified and corrected. Key items were introduced in the feature tables to permit the development of relationships between attribute tables.

4 CADASTRAL LANDBASE

Cadastral data were organized into three themes: the building feature table and building attribute table and parcel attribute table.

To generate the first theme the building footprints and their parcel number were extracted by raster-to-vector conversion tools from the rasterized cadastral maps. These maps were scanned and georeferenced in their Cassini-Soldner coordinate system in the same manner as the regional maps.

From the set of vectors the feature tables were built as Arc/Info polygonal coverage (Pauquet *et al.*, 1990). All the coverages of cadastral features were transformed from the cadastral coordinate system into the regional Gauss-Boaga coordinate system. Common reference points located in both coordinate systems and digitized from the building theme were used to transform these cadastral features into the regional system. The transformation process was repeated after newer control points were added and the worst were discarded because they were not well located from both building feature tables. The accuracy with which the cadastral feature coordinates were transformed into the regional system coordinates is

less than 2 meters. This value was computed by comparing each control point locations in the old coordinate system with the same control points in the new coordinate system (ESRI, 1995).

The theme of cadastral parcel attributes contains the values of the numbers of parcels and of map sheet and two key item for relational links with other tables. The values of the numbers of the parcels are built with the text-point entities extracted during the raster-to-vector conversion of the raster maps used as label points for the polygonal topology of the buildings features.

The theme of the attributes of buildings was provided as tabular data imported in the landbase system of the project. It contains information about the address of the cadastral buildings and the values of one key item for the relational connection with the other tables.

5 INTEGRATION OF THE REGIONAL AND CADASTRAL DATABASE

The features of the regional and the cadastral buildings were compared by using the overlay commands available with the GIS technology (DeMers, 1997). The output data set contains the features from both the two buildings themes but whose footprints was altered because of the different cartographic accuracy. Because of the attribute tables are also updated, it contains the relationship between the attributes of the cadastral and regional building features. This relation was extracted from the overlaid features table and its key item EID_TP and

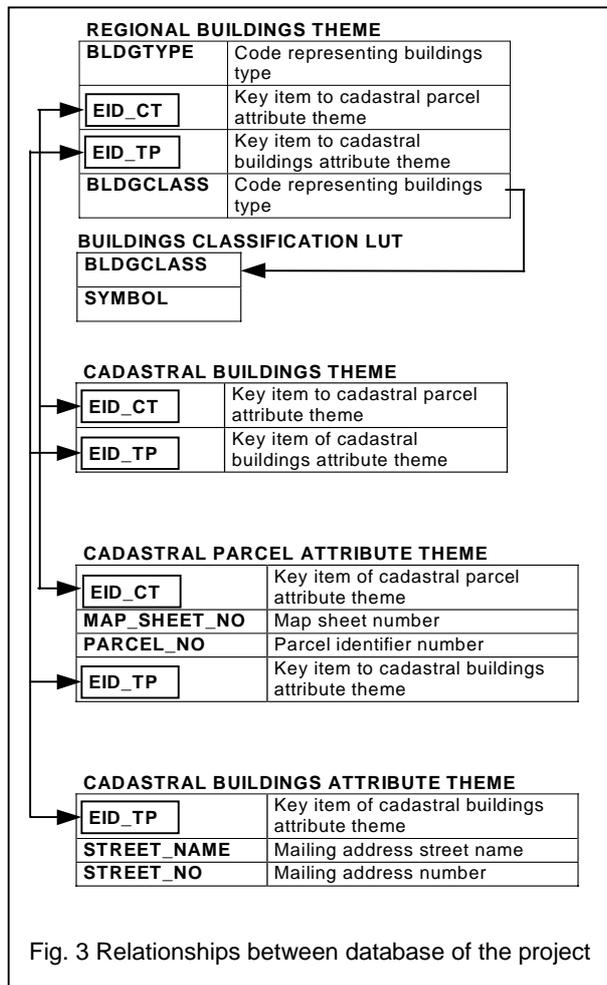


Fig. 3 Relationships between database of the project

EID_CT loaded in both the cadastral and the regional theme. So it was possible to classify the buildings of the project area in the following class whose values are stored in the item BLDGCLASS of the buildings theme:

- buildings portrayed also in the cadastral map;
- buildings not portrayed in the cadastral map;
- buildings in portrayed the cadastral map without any parcel number ;
- buildings whose footprints are too different from each other for a correct interpretation.

The figure 3 shows the relationship links established among the feature and attribute tables of the buildings theme, while figure 4 shows the classification of the buildings superimposed on the digital orthophoto and the regional cartography.

6 CONCLUSIONS

The project has made possible the development of a large methodological and technological test for integrating the tasks needed to construct and update landbase data for the Public Administration. We have avoided taking only one cartographic database as point of reference, because in view of their informational and geometric characteristics, both the regional cartographic map and the cadastral map seem to be necessary to manage land information as each fits well its given purpose.

This project leaves open some interesting applied research paths, regarding in particular:

- the verification of the utility of the updated cadastral parcel as the minimal reference unit of a land database for rural, marginal and protected area;
- the integration of technological networks in the land database;
- all aspects concerning data transmission and data privacy.

ACKNOWLEDGEMENTS

The author would like to thank Licinio Ferretti, president of Compagnia Generale Ripresearee of Parma, and the "Comunità Montana delle Valli del Taro e del Ceno" for the materials provided to the development of this project.

REFERENCES

Greve, C. (Ed.), 1996. Digital Photogrammetry - An addendum to the Manual of Photogrammetry. American Society for Photogrammetry & Remote Sensing. Bethesda, Maryland.

DeMers, M. N. , 1997. Fundamentals of geographic information systems. John Wiley & Sons, Inc., New York.

Maguire, J. D., Goodchild, M. F. and Rhind, D. W., 1991. Geographical Information Systems. Vol 1 & 2, Longman Scientific and Technical, England.

Peuquet, D. J. and Marble, D. F., 1990. Introductory readings in Geographic Information Systems. Taylor & Francis, London.

ESRI, 1995. Understanding GIS: the ARC/INFO method, Environmental Systems Research Institute, Inc., Redlands, CA USA.

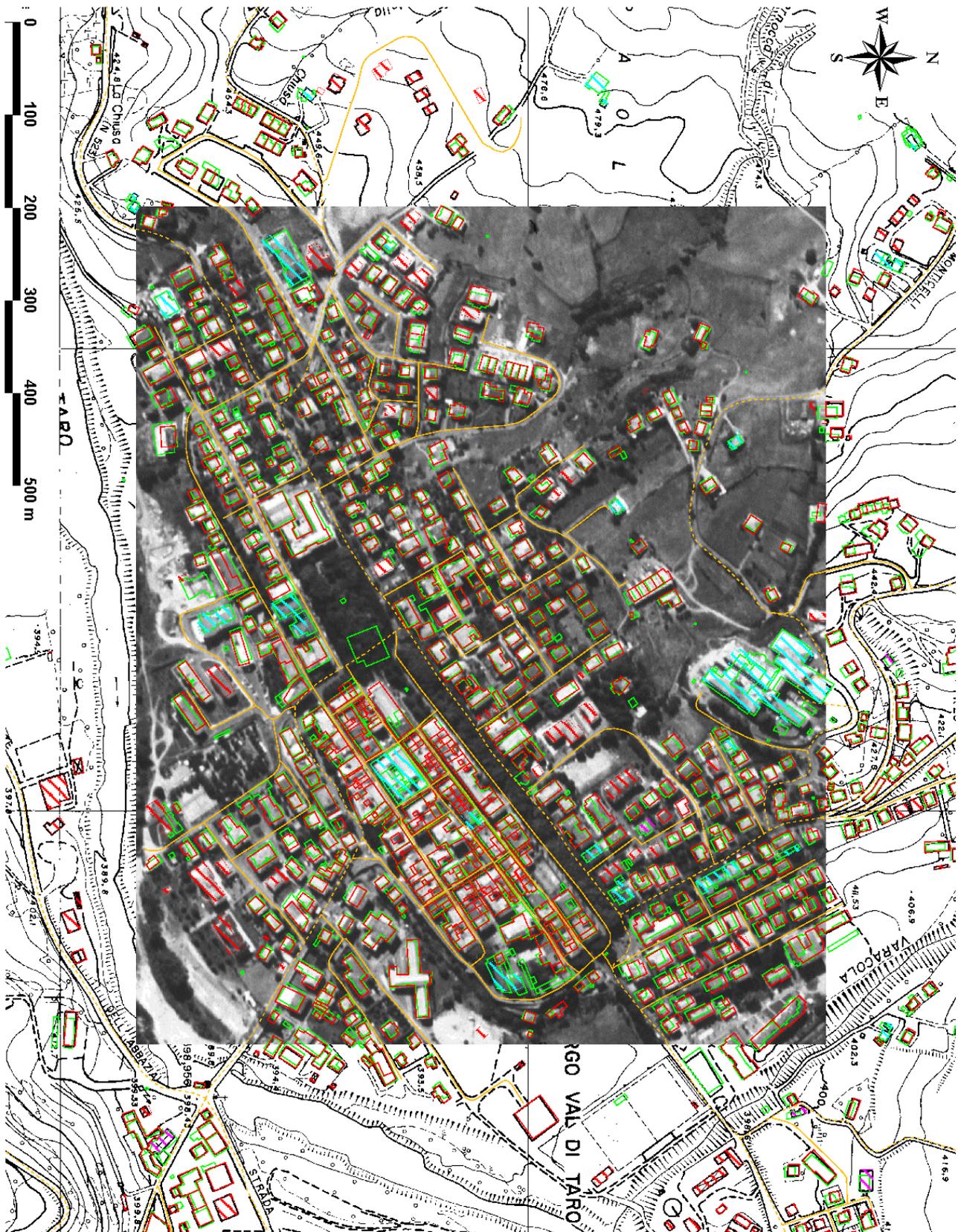


Fig4: Classification of the buildings superimposed on the digital orthophoto and regional cartography.