New Surveying Methodologies for the Cartographical Updating of Cadastral Maps and Archives

Piero PANUNZI and Fiorenzo GUARALDA, Italy

SUMMARY

During the 2004, a new procedure regarding the updating acts processing (subdivision and different types of lots) of cadastral lands will be adopted using the system “PREGEO 8”. This System provides for the use of GPS, and for the subsequent introduction and adaptation of digital map and for the first time it will be also the altimetric surveying.
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1. INTRODUCTION

In 2003, the Italian Land Agency carries out a substantial change in the management and in the updating of cadastral cartography:

*Outer technicians will have the possibility to update archives, as well as to consult them.*

The fulfilment of this extreme change, make a better computarization of the updating procedure necessary, and it represents also the opportunity to renew and to modernize both operational procedures and surveying methodologies.

Absolute innovations are:
- Numeration of all paper maps;
- New surveying methodologies.

2. THE DIGITAL MAP

In order to update maps through a standardized and rapid methodology, and transmissibile through data, it was necessary to pass from old, traditional and beloved “canapine”- hamps – (paper maps deriving from original papers and updated manually) to digital maps.

This operation was not simple. In fact, actually only 120,000 paper maps, representing all national land, are available in vector format, while the remaining, 200,000, is available in “Raster” format, and for a small percentage the sole available support is just paper.

For the management of this new cadastral system, the administration office is equipped with a data processing system called “WEGIS 2000”. This system, a real GIS, is able to manage vector and “raster” data at different levels, combining them with taxable data of parcels. In this way, it can provide for all information, necessary for both consultation and updating.

The objective is to arrive, as soon as possible, to a vector cartography, easy to read, to export on other CAD and GIS applications, to update with new altimetric elements and, above all, that can be immediately updated with new publications when an outer technician will give a cartographical updating.

To achieve the above-mentioned objective, maps must be updated in a vector way. So, for this reason, each part of maps, which will be submitted to a cartographical updating, must respect the following procedure. First it will be submitted to a vector processing, then it will be updated. The vectorial analysis of “RASTER” parcels can be fulfilled whether by a
cadastral operator, through WEGIS 2002, or by an other technician interested in the cartographical updating, through “PREGEO” software.

The above mentioned software, distributed to the external users by the Ministry of Finance free, gives to the technicians the possibility to elaborate the measurements mapped in the field, to control them and to draw up an “Updating Proposal”, to update the map with the new vectors deriving from this work.

The updating procedure of the map becomes, in this way, automatic, and develops in the following stages:
3. ABSTRACT OF MAP

As what said above, the “Abstract of digital Map” (EdM) is the instrument from which, as the years go by, derive all vector maps, and it is the one used by external professionals for updating the maps.

It is issued by the Land register on magnetic support and is transmitted in a telematic way. It consists of an image (format PNG) of the portion of the map in question, in suitable scale in A4 or A3 format, and of a file ASCII (expansion EMP), containing almost all necessary information for the cartographic updating.
This file contains the following geometrical and taxable information of the surveying object:

Line 0
Date, number of progr., municipal district, sheet, parcels, office, operator, operator CF, code of control;
Line 8 vertix particel
Vertix polygon, north coordinate, east coordinate;
Line 8 PF organisation
PF name, north coordinate, east coordinate, reliability, comment;
Line 8 altimetrical organisation
Name point, altitude, reliability, comment;
Line 7
Number of vertices, list of vertices, kind of line, parcel, main parcel, surface; *(the identification of the parcel can be followed by the signales + and/or – to identify external, internal, bounderies or seamed buildings).*
Line 6 parcel description
Identification type of line, parcel, class, quality, taxable surface, cartographical surface, R.A., R.D.
Line 6 PF distance (measured)
Identification type of line, PF 1, PF 2, distance, SQM, updating art;
Line 6 “georeferenziazione”
Identification, north vertix, north ovest abstract, east vertix, north west abstract, dimension pixel-metres, north center rotation, east center rotation, rotation angles.

4. NEW SURVEYING METODOLOGIES

The necessity of the shift to digital maps determined the demand of new software of data processing.
This demand brought to the introduction of GPS and of altimetrical information within the cadastral of topographical work.
The above mentioned methodologies were considered superfluous for the normal cadastral practice (surveys of modest areas and maps without any references to the altitude), but the spreading of satellite instrumentation and the desire of a three-dimensional cadastre encouraged the General Administration to effect this qualitative leap, to coincide with the computer based updating of digital cartography.

- Use of GPS.
  The coming of new procedures brought to a regulation on the use of GPS (an instrument about complete positioning through radio-signales, received from a constellation of satellites), for the execution of all foreseen cartographical updatings. For obtaining a complete survey it is possible to use both single or double frequency instruments and methods of static surveying (not very well advisable for the long time of acquisition of points), kinematics and RTK.
### 4.1 Estimated Restrictions for GPS Measures

<table>
<thead>
<tr>
<th>Type of instrument</th>
<th>Static modality</th>
<th>Kinematical modality</th>
<th>RTK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single frequency</td>
<td>( \leq 15,000 ) m</td>
<td>( \leq 1,000 ) m</td>
<td>---</td>
</tr>
<tr>
<td>Double frequency</td>
<td>( &gt; 15,000 ) m</td>
<td>( \leq 15,000 ) m</td>
<td>( \leq 15,000 ) m</td>
</tr>
</tbody>
</table>

- **Altimetrical information**

  For the relative accomplishment, see law 17.08.1941, n. 1043 and Ministerial Decree 2.01.1998, n. 28. We talk about altrimetrical information because, currently, we know the altitude of only few PF. Infact, the professional man will limit himself to measure the difference of level between PF and, at least, one point of the object in question. All this implies that each PF has identified the altrimetrical point of reference, to which refer the measure of difference of level. If this point was not identified, the professional man, who used that confidential point first, has to decide this reference and has to present a monographic file to the land register, following an attached model of the new regulation.

- **New types of line**

  The new surveying methodologies, the altrimetrical information and the updating proposal have determined the necessity of other type of lines, that are able to describe the new information.

  Different type of lines are plans of an ASII file, explainable from the cadastral software through the metrical and taxable data processing.

  The information about a GPS base are contained in a type of line 1 and in a type of line 6, that follows the first one. As we are talking about geometric coordinates of the station expressed in metres, the values \( X, Y \) and \( Z \) (distance from the centre of the earth) will have 6 numbers before the comma (millions of metres).
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Athens, Greece, May 22-27, 2004
### Type of Line 1 GPS

![GPS Survey Software](image)

#### Table: GPS Details

<table>
<thead>
<tr>
<th>Type of line</th>
<th>Name of point</th>
<th>Geocentric coordinates divided by a comma</th>
<th>Height antenna</th>
<th>Materialization of the point</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of line</th>
<th>Type of receiver</th>
<th>Date and time start of observation</th>
<th>Date and time end of observation</th>
<th>Modalitiy of survey</th>
<th>Type and DOP value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Type of line 2 GPS

<table>
<thead>
<tr>
<th>Type of line 2</th>
<th>Name of point</th>
<th>Baseline components divided by a comma</th>
<th>Precision indicators divided by a comma</th>
<th>Type and value of DOP</th>
<th>Height antenna</th>
<th>Materialization of the point</th>
</tr>
</thead>
</table>

All the measures of the beaten point are expressed in differences with that one of the base. For this reason, the numbers will be very small (they only depend from the distance and from the difference of level between the mobile antenna and the base) and they can be also negative values.

As it is ascertained, the administration has chosen geometric measures that refer locally in order to execute the calculation with a local reference (net of confidential points, surveyed in the same work) and also with mixed measures (tacheometric measures and alignments).

There is also the existence of another type of tacheometric line 1, but without “instrumental height”. As all PF points and, at least, one point of the object of survey had to contain altimetric information, and the most important purpose of stations consisted in the survey of the object and in the link of the above object to the PF, it stands reason that all stations must be furnished with altimetric information. For this reason, it is better to insert in that line instrumental height measured in the field.

It is possible to use 3 types of tacheometric line 2: with horizontal distance, with inclined distance and target height. In every case, it would be always better to use the third type, fulfilling the field “Target height” only when it is necessary to have the altimetric information of the beaten point (station ahead and behind, confidential point, one point of the object of survey).

The 0 value (zero) in the field of “Target height” is valid (case of instruments in reading without prism) and it calculates the altimetric information for the point.
Type of line 1 tacheometric station with instrument h

It is advisable to fulfill always that information.

Field not to fulfill when you do not want the altimetric information of the point.
<table>
<thead>
<tr>
<th>Type of line 2</th>
<th>Name point</th>
<th>Azimuthal Direction</th>
<th>Zenithal Direction</th>
<th>Slogging</th>
<th>Target Distance</th>
<th>Materialization of the point</th>
</tr>
</thead>
</table>

Type of line 4 levelling

![Type of line 4 levelling](image)

<table>
<thead>
<tr>
<th>Type of line 4</th>
<th>Name point</th>
<th>Medium cable reading</th>
<th>Materialization of the point</th>
</tr>
</thead>
</table>

This kind of operation is needed to calculate the difference of level on PF, when this one is not surveyed directly (impossibility of calculation through GPS or prism), and it is beaten cause of alignments and surveyor’s cross. This operation can be carried out with the level, but for small distances we can use metrical canes, laser with buddles and grated metres.

Type of line 5 levelling.

![Type of line 5 levelling](image)

It is necessary after the type of line 4 levelling.
Type of line 4 levelling from the center

This operation is advisable when the nearest point of the known difference of level is not close to the desired one, so it was not possible to beat the altimetical information directly. In that case the use of the level is necessary.

5. CONCLUSIONS

What does the italian surveyor expect from all these innovations?
The elements that the italian surveyor expects from all these innovations are the following:

- The telematic transmission;
- The approval, the updating of the map and of taxable values in real time;
- The consultation ON-LINE, both of maps and of taxable information.

Today, we have at our disposal the informatic structure to realize all said above, hardware and software in use in the cadastral field can give this possibility. We are only waiting for the renew of some national regulations that allow to operate (or to better utilize) with the new procedure, and could bring our Category to the most updated and computerized level at this moment.

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