HISTORICAL CADASTRAL MAPS OF CLUJ-NAPOCA

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ABSTRACT

Cadastral maps are usually the highest scale ones of a piece of land. Cities have the highest terrain element density among almost all of the terrain types. The quick changes in the built environment can be analyzed by using the repeated cadastral surveys, if they were carried out and are available for the research. Nevertheless, the availability of the maps is just the first step; they have to be fitted to each other and to modern cartographic coordinates to make quantitative analyses. Here we present the map sheets of two different cadastral systems of Cluj-Napoca (from 1912 and 1940) with the coordinate system definitions and the method to find out the coordinates of the sheets in this system. The cadastral maps of the Cluj-Napoca external parts of 1912 and the inner parts of 1940 can be fitted to the modern maps and spatial databases with an error no more than 3 meters, which can be corrected by a simple manual horizontal shift.

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1. INTRODUCTION

Cadastral maps, usually the highest scale ones of a piece of land, are made for land reG.I.Stry to complete the database of the land ownership information. Their accuracy defines the real preciosity of the ownership signals on the terrain. Besides, to provide help for set up the local signals in reality, they contain almost all terrain elements in their ground-plan form.

The research of the former ownership systems is sometimes interesting. The knowledge of the former state of the natural and build environment, however, is of broader interest in the environmental geosciences. High-scale cadastral maps with their precise representation of terrain elements have the maximum potential for this kind of analyses. The only hindrance of their usage is just because their high scales: for a research concerning a large area the number of cadastral sheets can be very – and sometimes uncontrollably – high. Projects for limited or moderate-extent territories, such as research and representation of the historical topography of a unique city are almost the limit of the cadastral map usage at the present state of the geographic information systems.

Cities have the highest terrain element density among almost all of the terrain types. The quick changes in the built environment can be analyzed by using the repeated cadastral surveys, if they were carried out and are available for the research. Nevertheless, the availability of the maps is just the first step; they have to be fitted to each other and to modern cartographic coordinates to make quantitative analyses. Finding identical points (ground control points; GCPs) is a tiresome work when the study area extends to several map sheets. If applicable, it is easier to find a system that defines the coordinates of distinct points, e.g. the corners of the sheets in a pre-defined coordinate system. Fortunately, the city of Cluj-Napoca has all of these requirements. Here we present the map sheets of two different cadastral systems (from 1912 and 1940) with the coordinate system definitions and the method to find out the coordinates of the sheets in this system.

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2. THE CADASTRAL SYSTEM OF THE HABSBURG EMPIRE AND HISTORICAL HUNGARY

The cadastral maps in the 19th century, prior to the introduction of the metric system, in these territories were using the Viennese fathom as a length unit (1 fathom equals to 1.89648384 meters (Kretschmer et al., 2004) – this accuracy is really needed for the transformation in country-wide applications; Varga, 2002). In Transylvania, the 'Marosvásárhely system' (centered at Dealul Câstei, west of Târgu Mureş) was used for cadastral purposes after 1890 (Raum, 1986). Sheet units are organized in rows and columns from the projection center. Columns are indicated by Roman numbers, and the rows by Arabic ones (Fig. 1), starting with 'I' and '1' from the center. Directions were indicated first by German then by Hungarian abbreviations: NW as É.N., NE as É.K., SW as D.N. and SE as D.K., respectively (e.g. the sheet group having the projection center at its southeastern corner has the ID of É.N.I.1). Each column and row have the width of 4000 fathoms.

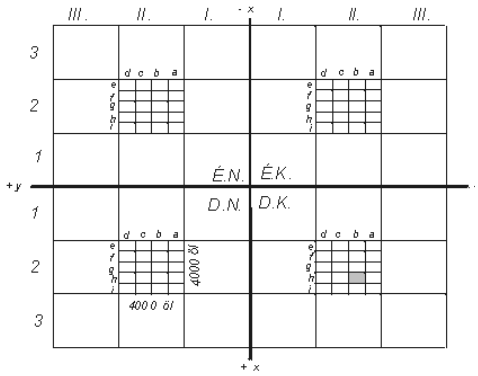


Fig. 1 ***Sheet numbering of the Viennese fathom system of cadastre in the 'Marosvásárhely' system (Varga, 2002).***

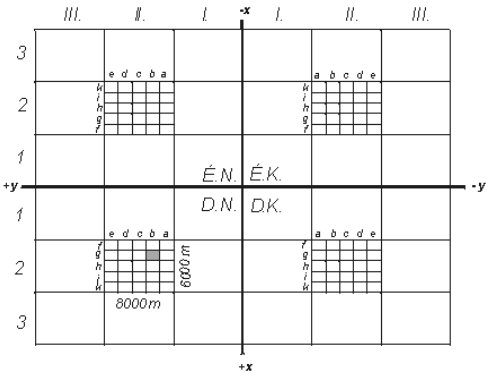
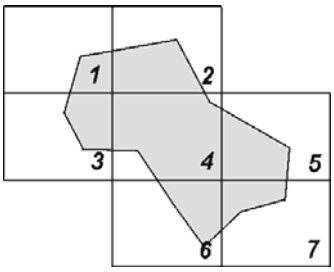


Fig. 2 ***Sheet numbering of the metric system of cadastre (Varga, 2002).***

Sheet groups consist of individual sheets with a width of 1000 fathoms and a height of 800 fathoms, so inside a sheet group there are four sub-columns (labeled by d, c, b, a from west to east) and five sub-rows (labeled by e, f, g, h and i from north to south). Therefore e.g. the southwestern sheet of the abovementioned sheet column has the ID as. „É.N. I. 1. d. i". Labeling system is the same throughout the mapped area, not depending on the position from the projection center (Bácsatyai, 1993; Varga, 2002). This identification method was used also in other cadastral zones of the historical Hungary and the Habsburg Monarchy but with different column numbers at the projection centers (Buffoni et al., 2003; Brůna & Křováková, 2004; Maślanka, without date).

After introducing the metric system, the extents of the sheet groups, as well as the width and height of the sub-columns and sub-rows, were changed. A sheet group is then 8000 by 6000 meters, divided into five sub-rows and five sub columns, so the individual sheets are 1600 by 1200 meters (Bácsatyai, 1993; Varga, 2002; see Fig. 2). The sub-column identifiers are a, b, c, d, and e, while the sub-rows are indicated by f, g, h, i and k (note that there is no 'j' sub-row). In local systems, the size of the individual sheets can be different (Timár & Biszak, 2007), and definitely this was the case during the so-called

'Transylvanian quick survey' carried out by the Hungarian authorities after the Vienna draw of 1940.



The sheet numbering for a settlement was based on the abovementioned sheet systems but the involved sheets has been numbered from the northwestern corner in rows (Fig. 3, 4 & 5.). The built-in 'inner parts' and the other 'external parts' of the settlements were mapped differently and usually in different scales.

Fig. 3 ***Numbering of the cadastral sheets belonging to a settlement (Varga, 2002).***

The 'Marosvásárhely' system have Stereographic projection (similarly to the Budapest system; Timár et al., 2004) both in metric and Viennese systems, while the other earlier systems in the Monarchy have 'projectionless' (Cassini-Soldner-type) coordinates (Marek, 1875; Hofstätter, 1989). The Molodensky-type projection parameters of the Bessel 1841 ellipsoid for the 'Marosvásárhely' system are the followings (Timár et al., 2004; 2007):

dX= +604 meters;
dY= -143 meters;
dZ= +528 meters,
while the projection center in the Bessel 1841 ellipsoid has the coordinates of:
Φ=46 33' 8.85"; Λ= 24° 23' 34.935" (from Greenwich).
The projection center in the maps is at: X=Y=600,000 m.

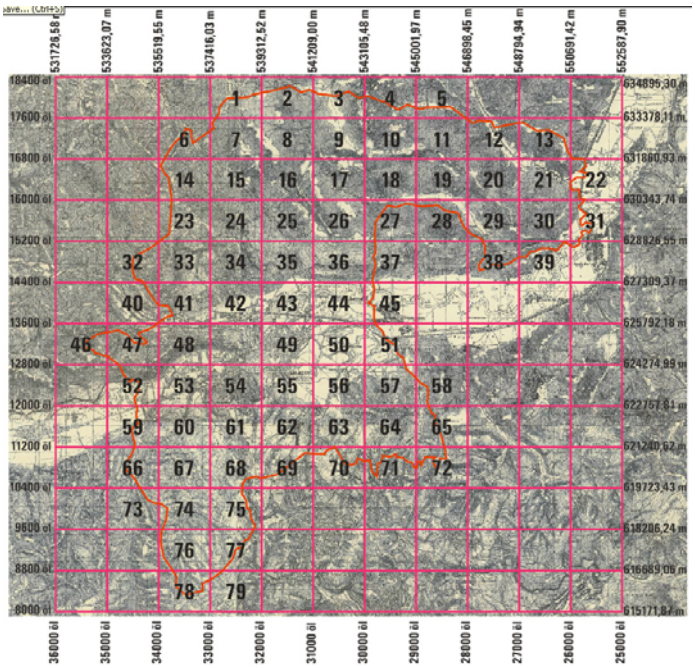


Fig. 4 ***The fathom system cadastral sheet numbers of Cluj (outskirts) in the 1912 series.***

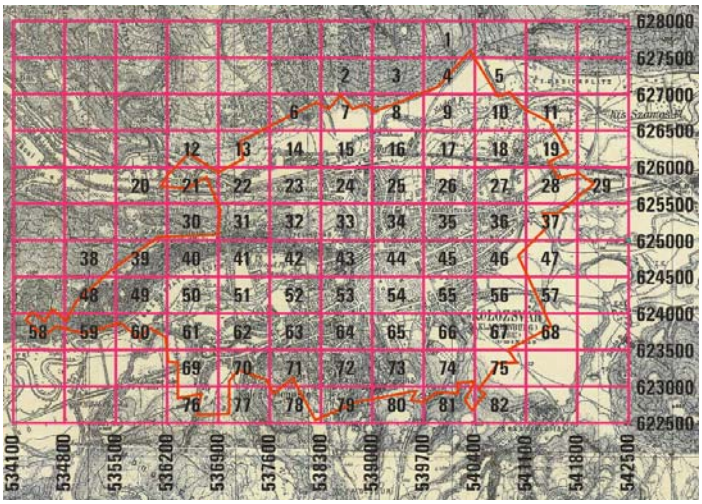


Fig. 5 ***The metric cadastral sheet number of Cluj downtown in the 1940 series***

3. APPLICATION OF THE COORDINATE SYSTEMS TO THE CADASTRAL SHEETS OF CLUJ-NAPOCA

In our analysis, the 1912 cadastral sheets of the external parts and the 1940 sheets of the inner parts of Cluj-Napoca are used. The overview of the sheet numbering is shown in Figs. 4 & 5. It is seen that the metric sheets have irregular size of 700*500 meters. Using these overview maps, the corner coordinates of all sheets can be easily computed for using the four corners as the only CGPs for rectifying the sheets in a G.I.S system. Using the initial coordinate system of the 'Marosvásárhely' system, the sheets can be reprojected to a modern projection or can even be used in a GPS (Timár, 2007).

Fig. 6 ***The fit of the 1940 downtown cadastre to a modern ortophoto (Old Castle District and Citadel sample area)***

An example is shown in Fig. 6, along the Someşul Mic River flowing through the city. The maximum error of fitting the sheets to a modern ortophoto is about three meters. Consider that comparing with ortophotoes, only the basement shape of the building has to be fit to the cadastral sheet. The main source of the error is the unknown orientation of the 'Marosvásárhely' system and can be corrected by a simple horizontal shift using just one GCP in the analyzed area.

Some example conclusions of virtual reconstruction of the old city; the case study of the Old Castle District & Citadel (fig. 6.) and Benedictine Abbey (fig. 7) areas

The Fig. 6. represents the downtown of Cluj-Napoca: in background is the modern ortophoto, in foreground the black lines are the elements of the cadastral map from 1940.

On the southeast side of the River Someşul Mic is situated the Old Castle District, in it the house where the king Mathias Corvin was born in 1443. In this area weren't changes since the Middle Ages, so the old cadastral map and the modern ortophoto show almost the same content. So here we can see the accuracy of the fitting of the old cadastral map sheet on modern coordinates.

We can attract your attention of some differences linked with the River Someşul Mic: we can see where the old bridge was and how wide was that one.

The changes are more spectacular on the northwest side of the River Someşul Mic. Here is situated the hill of the Citadel. On the old cadastral map we can see the bastions and the buildings of the Citadel built in the 18th century. In the 1970s in place of the Citadel was built a hotel, this one we can see on the modern ortophoto. We can see other changes at the foot of the hill: on the old cadastral map we can identify the little building plots of a slum which was demolished, and in place of the old narrow streets now are five blocks which we are represented on ortophoto.

Fig. 7 ***The fit of the 1912 external area map and of the 1940 inner area map to a modern ortophoto (Benedictine Abbey sample area)***

On the Fig. 7. we can see an external part of Cluj. In the first decades of the 20th century half of this area was part of the outer areas of the city so the black lines in foreground are composed by two cadastral maps. In the western part we can see the lines of the map from 1912 map which represents the external area of the city; in the eastern part we can see the lines of the cadastral map from 1941 which represents the inner area of the city. The area now is completely part of the city. The background of the picture is the modern ortophoto.

Comparing the two old cadastral maps we can see that the two maps are fitted very exactly to each other. We can observe which plots were re-classed from external area to inner area between 1912 and 1940.

Comparing the contents of the cadastral map to the modern ortophoto we can see that the area was built up in the last century. Practically only the church of the Benedictine Abbey is the single identical point. Looking at the picture closely we can recognize that

some other buildings and fragments of streets are also common elements. But the biggest part of the houses was demolished and in place of them now here are blocks.

4. CONCLUSIONS

The cadastral maps of the Cluj-Napoca 'external areas' of 1912 and the inner areas of 1940 can be fitted to the modern maps and spatial databases with an error no more than 3 meters, which can be corrected by a simple manual horizontal shift. The fit of the two cadastral systems is almost flawless at the boundary of the downtown (Old Castle District sample area). Huge changes in the built environment are detected in Citadel and in Benedictine Abbey sample areas showing only a few remaining buildings in these districts.

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