THE USE OF OPEN SOURCE SOLUTIONS IN THE PROCESS OF GEOREFERENCING THE HISTORICAL MAPS

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Abstract*. The present paper presents the aspects of the georeferencing concept, especially applied in the georeferencing of historical maps. The topographic map had a culminating evolution since 18th century, from a military perspective. The Banat and Transylvania territories, being under an Austro-Hungarian domination, appeared as the first topographic maps, at the order of Maria Theresa, in 1704. Due to new computing technologies, the study of metrical proprieties on early maps grew in time, the historical map having an important role in nowadays surveying. This is possible with the help of the georeferencing process, which refers to a process of bringing a cartographic image in a spatial location, defined in relation with a known system of coordinates. In this paper, a vivid example of this concept has been addressed, namely, the georeferencing historical map of the Timisoara citadel and its surroundings, a map dating from 1864-1865. An open-source georeferencing software was used to accomplish this task, an application that offers the possibility to visualise dates, to edit and to analyse them. The importance of this paper results from the difference between the historical map presented and the actual emplacement of the citadel of Timisoara in the past. The old settlements and Bega canal bed can be seen using importing and overlapping in Google Earth.*

Keywords: *historical map, georeferencing, software, Google Earth*

INTRODUCTION

The simplest definition a map could receive is that of a reduced representation of a piece of territorial surface (HERBEI AND ULAR, 2011). The definition presented has the quality of being concise, but at the same time the drawback of not rendering the entire content of the map notion. This characteristic is observed in a more compendious analysis of the map. First of all, it can be easily observed that a map is a plan representation of a terrestrial surface (Herbei, 2015). This representation is different from the globe ones, which even if they aren't as used, but are the most correct. In exchange, on a map, all known deformities are registered. And because, the map presented large pieces of terrestrial surface, the curvature of ground surface is taken into consideration, while in plan representations, this feature is left aside.

Another characteristic easy to observe is that all elements represented are reduced using a mathematical base (MORARU ET AL., 2014), which are rigorously exact, at a certain scaling. This characteristic offers it the necessary precision for different practical and research activities.

It can also be observed that a map is not a photo of a terrestrial surface. The elements of a terrestrial surface are presented as drawings, which sometimes, don't even resemble elements of nature. Those drawings represent conventional signs; which means that a map is also a conventional representation.

Another characteristic of the map (HERBEI ET AL., 2014) is that is doesn't show all terrain elements, these may appear in connection to the size of the surface represented, the most obvious elements being presented. Thus, the map is also a cartographical generalisation.

When studying the contents of a map one may observe that some maps contain all elements that can be represented (the ensemble of natural and anthropogenic elements from a territory), these being called general maps; maps with only one element are called special or thematic maps (HERBEI, 2009). Thus by summarizing all characteristics mentioned so far, a more complete definition can take shape.

A map is a plan representation, reduced in size, conventional and generalised of a terrestrial surface, with natural and social phenomena from a certain point in time, realized on mathematical principles and at a certain scale, by keeping in mind the Earth curvature.

The plan is a representation with the same characteristics as the map, the difference being that is presented a smaller terrain surface, but with more details and precision.

Because a large scale doesn’t allow the presentation of a large terrain surface, terrestrial pieces represented are considered to be in a plan, thus these don’t take into consideration the Earth curvature.

During the last years, due to new technologies progresses, the study of metrical properties on early maps had become of interest, historical mapping being of an important role in present topographic developments (TIMAR, 2004; TIMAR ET AL., 2010).

MATERIAL AND METHOD

Scientific discoveries, technology process, the development and perfecting of measurement instruments (Herbei et al., 2016), connected to human effort (Gâf et al., 2015), have led to an incredible evolution. Starting with the 18th century, cartographic art becomes cartographic science, the freedom of all cartographers being bordered in the improvisation of ornamental compositions, which could blur the lack of geographical knowledge.

In other words, during those periods of time, an altimetry representation (of the level curvature) together with cartographic symbols, gradually turn the map in a scientific document, rather than an artistic one.

At the basis of map realisation evolution one could observe military motivation. Thus, during the 7-year War, lead between 1756 and 1763, Austrian troops felt the acute need of accurate maps. As a result, Field Marshal Daun proposed Maria Theresa, in 1764, to realise unit cartography of all the Empire countries. Until today, the realisation of maps was in the attribution of land lords, who asked for maps of their lands.

Figure 1 Iozefine topography map
illustrating the citadel of Timisoara and its surroundings realised in 1769

The first documents were realized for Bohemia and Moravia. The number of documents realized during that period was referred to as Iozefine topographic development, started by Maria Teresa and finished by Joseph the 2nd.

All maps were hand drown and realized at the scale of 1 Viennese inch: 400 Viennese klafters (which now correspond to an approximate scale of 1:28.800).

Altitude variations were also drawn, but by the use of shades, not by level curvatures. In the end, the Iozefine topographic development had as results more than 4000drawings, realized during the period 1764 - 1785. Some of these also represent the territories of Transylvania, Banat and Bucovina (TIMAR ET AL. 2010).

Short history

In 1807, Iozefine maps were replaced by topographic developments realized during the ruling of Francis the 1st of Austria, under the name of “Franciscan topographic development” (Franziszeische Landesaufnahme). The topographic map of The Habsburg Empire was realized during the years 1807-1869, during the second systematic cartographic campaign of the empire army on all regions ruled, the result being a series of topographic plans at the scale of 1:28800 (TIMAR ET AL., 2006).

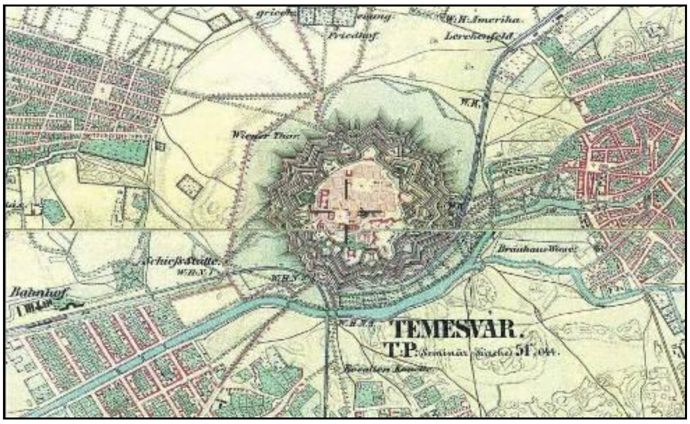

Figure 2 Franciscan topographic map
of the Timisoara citadel and its surroundings realized at a scale of 1:28800

Figure 3 Topographic map of the Timisoara citadel realized during the third campaign of topographic development of the Austro-Hungarian Empire, during the year 1910.

The third military campaign of topographic developments of the Austro-Hungarian Empire and of other neighbouring states was realized starting with the year 1869, more maps being realized at a scale of 1:200.000. Romanian historical provinces are taken into consideration by this action, all maps being finished by the year 1910 (TIMAR ET AL., 2006).

The concept of georeferencing

Georeferencing may be seen as a generic term for all techniques that refer to the unique identifying of geographical objects. The term “geographic object”, in a wider perspective, refers to any kind of object or structure that may be connected in a reasonable manner to any geographic location, as for example interest points (POI), roads, places, buildings of agriculture areas (DRAGOMIR AND HERBEI, 2012).

Georeferencing represents the process of bringing a cartographic image in a space location; define in connection to a known coordinates system. This process is realised with the help of control points, the distribution of which will be possible in a uniform manner. Usually, 4 points are used, and ideally, these are placed in the 4 corners of the piece of paper used (HERBEI, 2015).

Georeferencing is also an important source of potential errors. If the map paper is distorted in any manner or if it is not positioned perfectly in the scanner; or if the georeferencing is not correct, all of these will lead to errors in the georeferencing process. These errors will remain as basic parts of the layer result (BALLETTI, 2006). Using more control points, the accuracy of error estimation is increased. If the error is acceptable, it needs to be registered as part of the document, which accompanies the data set. The choice of an acceptable error is subjective and will greatly depend on the source quality.

Control points represent detail points which are identical on the source material (land plans – old maps) and on the reference material (plans realized at the scale of 1:5000, orthophotomaps etc.) (GOVEDERICA ET AL., 2015).

In a map, all four components of a geographic data are numerical (digital) expressed through values organised in a specific structure, thus forming a base of geographical data (geodatabase). This document contains data that define the position and shape of entities represented (graphic data) and data that express the characteristics of those entities (attributive and textual data). A digital territory map is represented by the sum of layers that were defined. A derived map will be built of one layer or of a certain combination between the existing layers (HACKELOEERA ET AL., 2014).

The computerization process (Herbei and Sala, 2016) is represented by the conversion of the existent cartographic material in an analogical format according to one of the two fundamental models of spatial data: raster and vector. A common problem of the georeferencing domain proposes the attribution of objects content in raster images to references of location. This can be realized with the use of methods and techniques from different domains, from remote sensing and photogrammetry to the processing of images and the recognition of shapes (HERBEI AND SALA, 2015; HERBEI ET AL., 2015).

Software used

The QGIS software (also known as “GIS Quantum”) is a desktop platform, open-source, of geographic images (GIS), an application that offers data view, and data editing and analysing capacities (HERBEI ET AL., 2011).

Similar to other software systems, GIS, QGIS allows its users to create maps, on different layers, by using different projection systems. Maps can be assembled in different formats and for different uses. The QGIS software allows maps to be composed of raster or vector layers. A special characteristic of this type of software is that vector data are storage as points, lines or polygons. The QGIS software allows the realization of georeferencing of images by using DXF file types, shape files or personal data bases (ONCIA ET AL., 2013).

The integration of map sheets and their re-projection in a modern map is realized by following the steps: the defining of an ellipsoid in the GIS software used the defining of the ellipsoid origins in the GIS software and the defining of its projection in the software. These steps are realized only once at the beginning of the project.

RESULTS AND DISCUSSIONS

This paper contains a presentation of a historical map georeferencing, for the Timisoara citadel, section 66, column XLII, realised between the years 1864 and 1865.

This process was possible with the help of the software, open source software by following steps necessary to process this project.

In order to be able to bring the map in an appropriate projection, the first step needed to be realized was the defining of the projection: Cassini, in QGIS.

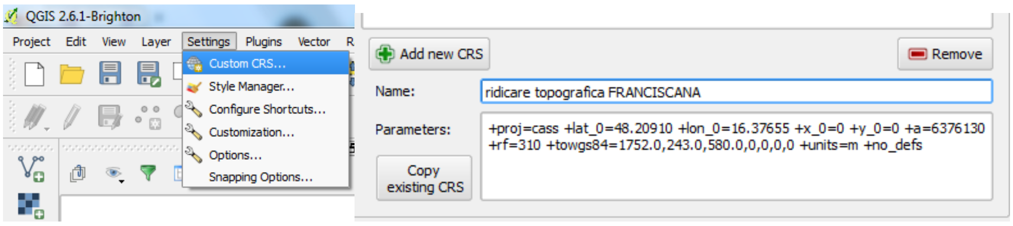

Figure 4 Defining the projection in the QGIS software

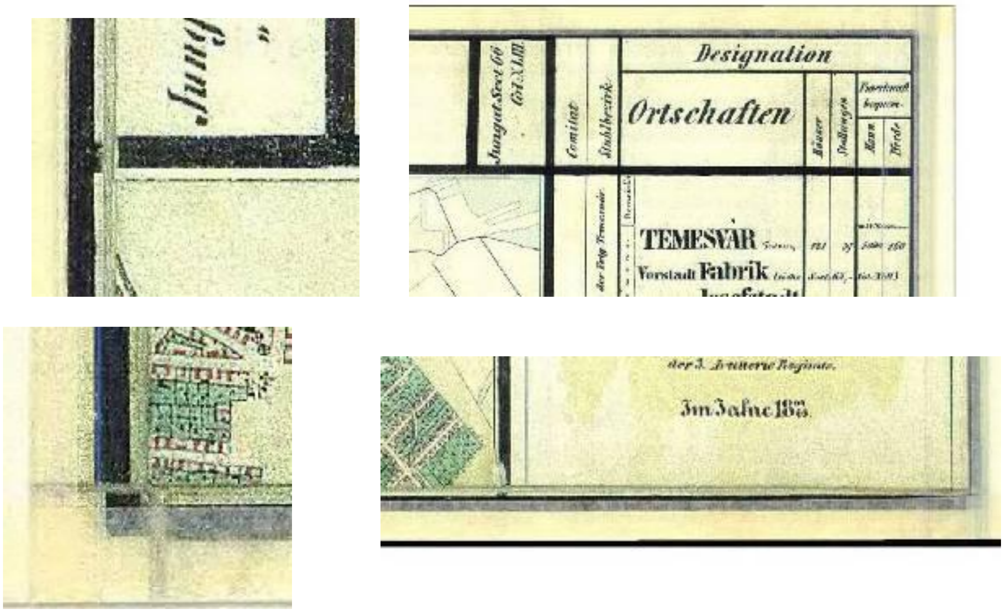

Figure 5. Choice of an ideal case for the defining of control points

The georeferencing process supposes a defining for four control points; the ideal case of the four paper corners was used for the four points, the intersections with the paper corners of the map being presented in Figure 5.

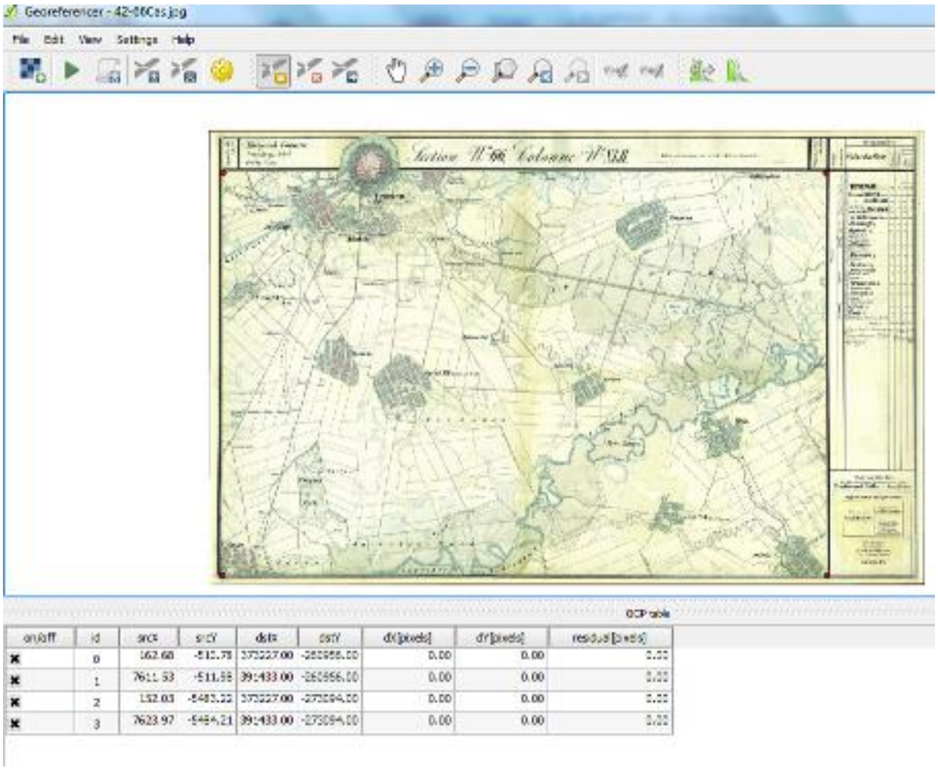

Figure 6 Defining control points

GCP table

on/off	id	srcX	srcY	dstX	dstY	dX[pixels]	dY[pixels]	residual[pixels]
✖	0	162.68	-510.78	373227.00	-260956.00	-5.33	0.60	5.37
✖	1	7611.53	-511.98	391433.00	-260956.00	6.23	-0.60	6.26
✖	2	152.03	-5483.22	373227.00	-273094.00	5.32	0.50	5.34
✖	3	7623.97	-5484.21	391433.00	-273094.00	-6.21	-0.50	6.23

Figure 7 Errors resulted from the georeferencing process

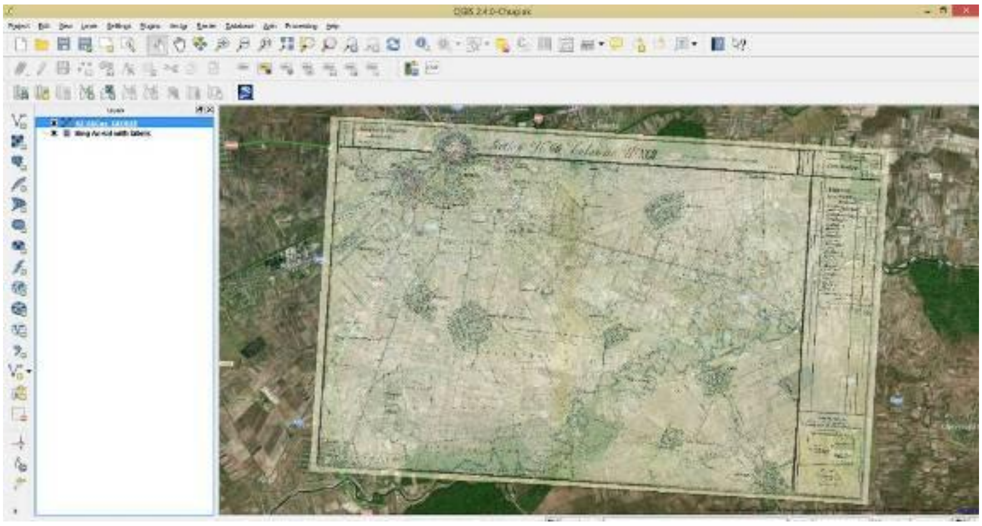

Figure 8 Overlap of georeferencing map over the corresponding orthophotomap

Figure 9 The importing of a georeferencing map in the Google Earth application

CONCLUSIONS

Historical maps were for a long time a privileged study domain, mainly by historians and not so much by specialists in cartography in the science and modern technology domains.

Thus, the historical map was considered a typical archive of a past confession, of territories and cities from different historical periods.

In order to transform historical maps into modern projections, the ellipsoid needed to receive a definition, together with the spatial position and the so-called parameters of data exchange. This can now be realised with the help of specialised softwares.

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