Projection and datum parameters of the second military survey of the Habsburg Empire (1806-1869) for GIS data integration purposes

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The Second (also known as Franciscan) Military Survey is a masterpiece of the map series representing the territory of Austro-Hungarian Empire. It is outstanding in quality regarding its data content, drawing features and aesthetic appearance. Although the series is not uniform in its content and in its implementation due to the extended period of time of the mapping (1806-1869), according to recent experience in its present-day usage, its map sheets are fairly well applicable even today.

For a long time, the map sheets treasured in the archives were only available for the closed group of professionals of military cartography. In Hungary from the beginning of the 1990s their existence and, more importantly, the advantageous characteristics of the maps became known for the specialists of various branches like archeology, hydrology, forestry and nature protection. A number of reproductions of sheets portraying the most important territories, mainly as black and white copies, started to be distributed. The excellent geodetic basis of the map made possible to compare the recent and former topographic features in specific study areas with acceptable accuracy.

Partly preceding its publication, but primarily after the appearance of the digital version of the maps, the users became interested to have the digital images in georeferenced format, i.e., rectified in present-day co-ordinate systems. Concerning several selected map sheets, numerous attempts of georeferencing were worked out in the various institutions. The rather varying results and accuracy of these attempts, depending on the demands and expertise of the specialists performing the rectification, demon-

strated the imminent need of a uniform georeferencing solution, that is geodetically correct, takes the geodetic basis of the map system into account, and which generally minimizes the errors of rectification.

Our present work has been initiated by this need. Obviously, we have started the work with the maximum accuracy in mind. However, it became clear soon, that the maximum achievable accuracy of the georeference is 150-200 m, using the geodetic basis published and analysed in the literature, sometimes even worse. According to our experience gathered by rectifying a few dozen sheets before, it was clear that for those map sheets that contain numerous topographic objects that existed at the time of the mapping and still exist today, or have existed recently, the Ground Control Point (GCP) Method can provide 50-70 m accuracy.

Initially, though this work obviously requires a huge effort, we considered this solution. But after having the chance to include the map sheets not only stored in Hungary, but also all that are treasured in Kriegsarchiv (Vienna, Austria) can be included in the project, this solution has been rejected. The reason for this is primarily the large number of maps. Furthermore, the area covered by the work involves 13 states today, and the modern, high-accuracy maps, needed to define the actual position of the reference points, are not available for free. In some parts of the area, the georeferenced satellite imagery of Google Earth project were used. However, since the highest resolution images are available only for the urbanized areas in Google, this cannot be a general solution. Actually, for several map sheets, there are no enough GCPs available to reduce the errors considerably.

We are convinced that the estimated accuracy of 150-200 m, that for certain sheets may be twice better, can be improved by the experience of the users.

The scale of the maps, based on contemporaneous measuring units, can be calculated to be 1:28800, identical to that of the First Survey. In the sheets there is no indication of coordinates, except for Lombardy. The sheets are organized into rows (Sectio) and columns (Colonne), these serial numbers identify the actual sheet. In some provinces (Lower and Upper Austria, Lombardy, Venice, Parma, Modena, Hungary) the numbering of the columns is uniform: its starts at the westernmost sheet and increases eastwards. In the other provinces the starting point is the reference point, and the numbering of columns increases both east- and westwards. Tyrol and Salzburg, as well as Liechtenstein are also exceptional from the point of the numbering of sheets as well. The serial numbers of the sheets can be related to its actual geographic position only via the overview map. This property also advocates the consideration that the aforementioned sheets are rather transitional between the techniques of the two surveys. The sheets, maintaining the same scale, were produced in two sizes: 24x16 Viennese

inches (forming a rectangle) and 20x20 Viennese inches (forming a square).

For georeferencing and especially to carry out map-to-map reprojection, it is necessary to know the type of the projections in question, their parameters and the used reference surfaces (datums). As a result of our work, we present the parameters of the Cassini projections of all provinces (except Tyrol, Salzburg and Lichtenstein, the ones having no clear projection), as well as the datum parameters of the used Zach-Oriani ellipsoid. Using these data and the sheet numbering system, all of the several thousands map sheets can be integrated into a GIS application using only the sheet corners as GCPs with the aforementioned accuracy.