

# **Georeferencing and Cartographic Analysis of Historical Military Mappings of Bohemia, Moravia and Silesia**

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The research on “Georeferencing and Cartographic Analysis of Historical Military Mappings” (2004-2006) has been carried out by the team built-up in cooperation of three Czech universities: the Czech Technical University in Prague, J.E. Purkyně University in Ústí nad Labem and University of West Bohemia in Pilsen. The project involved a complete cartographic research of the accuracy of historical military mappings focused mainly on methodology of interpretation of old maps content, localisation of those maps sheet layouts into current coordinate systems, verifying the relations between cadastral mapping and the 2<sup>nd</sup> military mapping and also the development of web interface for making the images of map sheets available on Internet.

The 1st military mapping was the first systematic military geodetic survey done on the territory of former Austro-Hungarian monarchy. The mapping (1763-1783) was done in a quite detailed scale 1: 28 800 without any geodetic control and with minimum of measurements. The content of coloured maps included settlements, roads and stone bridges, rivers, meadows, forests and grasslands. The altitude was presented by hachure which indicated the topography of foots of significant terrain slopes. Insufficient quality of maps from 1<sup>st</sup> military mapping led to beginning new surveys in the 19<sup>th</sup> century (1807-1869). The 2<sup>nd</sup> military mapping in the scale 1 : 28 800 had been preceded by creation of a trigonometric network used also for cadastral survey used as a background for topographic survey therefore the mapping was done relatively very precisely. Several coordinate systems were used for the territory of the monarchy. Mapping was done using a measuring table, distances were derived from spacing or estimated. The height of important objects was derived trigonometrically, hypsometry was presented by slope hachure. Colored originals of maps from historical military mappings are stored in the Military Archive in Vienna, Austria. Raster files (TIFF, 200 dpi) of colored copies of these historical maps have been used for the research work [4].

The first topics of the CTU project team was the investigation of the maps accuracy. The analysis of positional accuracy of map elements on maps from historical military mappings has been made for four testing areas at the territory of the Czech Republic The sets of suitable map objects have been selected: these points had to be identified in corresponding map elements within old maps and current map sheets and preferably also on the real objects in the field (churches, village chapels, way-side crosses, corners of important historical buildings, pond dams, bridges, etc.). Raster files of particular map sections of historical mappings were georeferenced by transformation into the S-JTSK system using several identical points. The coordinates of selected points identified in raster files of historical map sheets were compared with coordinates of corresponding points obtained from the digital terrain model DMU25 (scale 1 : 25 000), from coloured orthophoto with resolution 1m and from direct GPS measurements in the field. The detailed results of the analysis were presented in the papers [2, 3]. The average standard deviation (and shift of point) for the position of

objects on the maps of the 1<sup>st</sup> military mapping ranged from 176 m (shift 160m) for the area of Jindřichův Hradec to more than 1000 m (shift 870m) for the region of Nové Město. Positional accuracy of the maps from the 2<sup>nd</sup> military mapping is much better (the mentioned values less than 50m) especially due to much more precise geodetic background of those maps. It is supposed that the accuracy of old maps may differ with also various mapping localities (landscape parameters, quality of mapping work, various time periods of mapping, etc.).

The second field of interest of the CTU team was the development of web interface for visualization of these old maps. In [1] it was published that the best way how to make the data more accessible through the Internet is to georeference and publish it within the frame of web map services. The data from the area of Bohemia were georeferenced in the geodetic software KOKEŠ which provides the best results in the speed of data transformation. It is necessary to transform the data to some contemporary coordinate system because of later usage in GIS. Every map sheet was georeferenced in the national coordinate system S-JTSK to the corner coordinates using projective transformation (corner coordinates computed by Čada). Final map sheets were inserted into a mapserver. Our mapserver application is based on the Open Source CGI application UMN MapServer. There are two ways of publishing the data with UMN MapServer: web application (for displaying) and web map service (for distribution). Web application interface enables standard internet map functionality such as zoom and pan. Some other functions as interactive coordinates display or village searching were programmed in JavaScript. The data distribution using WMS (web map service) is the most valuable part. Everyone who keeps the standard of WMS can join our data to his own GIS application. Then the data can be used as GIS layer either in other web applications (mapservers) or in desktop GIS.

The results of the research project may contribute to extending the possibilities of exploitation of these unique maps especially in current GIS applications.

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