Acta Geod. Geoph. Hung., Vol. 45(1), pp. 1–7 (2010)
DOI: 10.1556/AGeod.45.2010.1.??

THE ADVANTAGES OF USING THE SECOND MILITARY SURVEY MAPS IN FLUVIAL STUDIES

G Kovács[1,2]

[1]Institute of Geography and Earth Sciences, Eötvös Loránd University,
Pázmány Péter sétány 1/C, H-1117 Budapest, Hungary

[2]Department of Cartography and Geoinformatics, Eötvös Loránd University,
Pázmány Péter sétány 1/A, H-1117 Budapest, Hungary,
e-mail: s_kovacs_gabor@hotmail.com

The Second Military Survey of the Habsburg Empire, completed in the 19th century, can be very useful in different scientific investigations owing to its accuracy and data content. The fact, that the mapmakers used geodetic projection and the high accuracy of the survey guarantee that scientists can use these maps and the represented objects can be evaluated in retrospective studies. Among others, the hydrological information of the map sheets is valuable. The streams were drawn with very thin lines that also ascertain the high accuracy of their location, provided that the geodetic position of the sheet can be constructed with high accuracy. After geocoding these maps we noted the high accuracy of line elements.

The goal of this paper is to verify the accuracy of the rectified map sheets of the study area in order to test the applicability of such an analysis of the represented geomorphologic features like relief and streams. In the geomorphologic investigations high geometrical accuracy is needed due to the quantitative character of measurements. The study area is located at the Austrian-Hungarian boundary, south from Kőszeg Mountains/Günser Gebirge and west from Rába River/Raab Fluss.

Keywords: neotectonics; Second Military Survey; sinuosity; watercourses

Introduction

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 are not uniform in their content and implementation due to the extended period of time of the mapping (1806–1869). According to recent experience in their present-day usage, the map sheets are fairly well applicable even today (Timár et al. 2006, Jankó et al. 2005).

From the beginning of the 1990s specialists of various branches like archaeology, hydrology, forestry and nature protection started to used the map sheets to reconstruct the contemporaneous landscape. It required the accurate rectification of the map sheets (Székely 2009, Podobnikar 2009, Timár 2009, Čada and Vichrová 2009). Despite the difference in the mapping style, the excellent geodetic basis of the cartographic work made possible to compare the recent and former topographic features in specific study areas with acceptable accuracy. Hungarian Institute and Museum of Military History and Arcanum Ltd. published a series of DVD-ROMs containing the scanned digital and rectified map sheets. Timár et al. (2006) described their method of rectifying map sheets with a 150–200 m average accuracy, but for certain map sheets the accuracy can be even twice as better.

The goal of this study was the investigation of the applicability of the Second Military Survey for geosciences. The case study which required this investigation is the neotectonic evaluation of the western part of the Pannonian Basin, bordered by Pinka, Rába and Répce Rivers. The watercourses, especially alluvial ones, react very sensitively to tectonic forcing, so that the sinuosity is changing along the streams. However, the present-day course of the creeks and rivers are mostly regulated, therefore they are unsuitable for such studies. Consequently, the watercourses should be reconstructed from maps surveyed prior to the main water control measures. The Second Military Survey is a perfect source for such studies because it is the first survey drawn in geodetic projection in the period when the creeks haven't been regulated yet.

The maps show intensive agricultural cultivation and silviculture in the study area. Especially grazing cultivation precincts of the streams is important for us. That phenomenon and data from other sources prove that most of the streams haven't been regulated in that time. The streams were able to meander, and flood its banks, while only natural levees are present. In this study the location and the geometrical accuracy of the depicted streams are measured, the general observations of the applicability are mentioned.

The specific features of the study area

Topography of western Hungary is characterised by slightly tilted blocks to SSE bordered by relatively steep scarps; the latter features often define the course of several streams that drain the area. In previous studies (Kovács et al. 2008) the author considered the neotectonic origin of these significant scarps. These remarkable topographic features are depicted in the Second Military Survey by hachuring technique; furthermore they are also detectable as borders between agricultural cultivation and silviculture (Fig. 1).

These scarps are, compared to the recent surveys, illustrated accurate except the interior areas of the hills, maybe due to the difficulty of the survey method on detailed terrain.

Other typical geomorphic characteristics of the area that can be deduced from the archive maps are the planform of the watercourses. In the study area they have a tendency to flow from NNW to SSE with sudden, almost perpendicular curves to

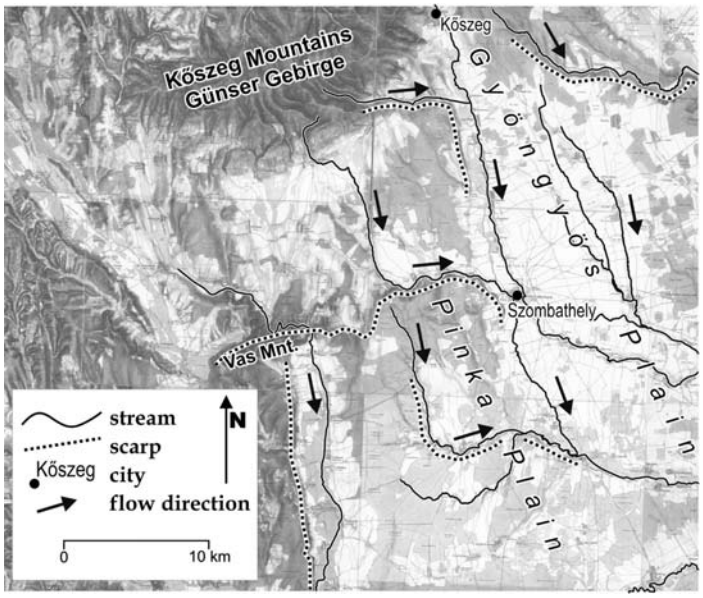

Fig. 1. Escarpments and flow directions of a part of the study area shown on the Second Military Survey

left, eastwards. This secondary direction is not always followed by scarps, it also occurs on almost plain areas. The creeks are arranged in a parallel pattern that has a typical spacing at ca. 1.5–2 km distance, the dendritic pattern and bifurcations are subordinate. The parallel pattern is complicated with the aforementioned set of eastward offsets that also seems to follow a regular structure.

The above described specific behaviour may indicate neotectonic activity; however, it may also be caused by human influence supposing that the watercourses were affected by flood control measures or defence efforts.

The opportunity of using the different surveys

The Second Military Survey, because of its period of surveying, is one of the few cartographic works that provide information on the almost natural, uncontrolled state of the watercourses. Furthermore, although there is no detailed information on the elevation, the aforementioned hachure and the fine drawing of the watercourses together make the map sheets suitable for such analyses.

The important structures and phenomena that had military relevance in the 19th century are represented with high accuracy and are rich in details. Therefore these elements of the topographic maps can be evaluated and are useable for other natural sciences. The relief was portrayed with hachuring technology that is not quantitative (Jankó 2001). This is because the accurate elevation is not readable from the maps, only the slope angle changes can be revealed. This inaccuracy was not disadvantageous at all; the map fulfilled its original aim, as this kind of representation was sufficient for planning the troop's campaign.

Fig. 2. The different accuracy of investigated surveys

For our study the very thin and accurate lines of stream-pattern was a quite valuable feature of the survey. The scale of 1:28 800 and the usage of thin lines result in very high geometrical accuracy, what is the most important for our method. Rivers with higher discharge, illustrated with double-line, are 2 or 3 times wider than in reality. This line style decreases the geometrical accuracy.

There is a complex reason why I chose the Second Military Survey for analyse the stream pattern to evaluate neotectonic origin. The present-day pattern of the stream network is not modified by natural impacts, because most of them have been already regulated. The typical pattern of the earlier meandering streams is only seen on local relief as curving dry gullies, but these usually are not illustrated in recent topographic maps, due to their shallowness. In my method the most important phenomenon is the distribution of variable meandering. The purpose of regulation was to straighten these curves, so on the older map we use less artificial changes occur. The other limiting factor is, however, the geometric accuracy of the map: it is only usable if it can be rectified accurately enough. Figure 2 shows that there are less illustrated watercourses, in spite of the fact that recent maps of Hungarian National Mapping System are of higher scale. This decrease may be ascribed to the variable detailedness of different surveys.

The level of accuracy of the geocoding is also visible on Fig. 2, which is represented on a section regulated in the Roman Age and on Fig. 3 showing an incised stream section. Between the two different surveys the section was not modified by natural impacts because the previous regulation remained in its original shape. That proves Second Military Survey was really carried out with the necessary geometrical accuracy, what is very important in geosciences.

The distance of the artificial divergence on two maps is approximately 60 meters. This value is map sheet specific and not an average value. To obtain an average, one has to measure different fix point pairs to be able to estimate the average value. During the verification of the accuracy approximately 200 control points were used

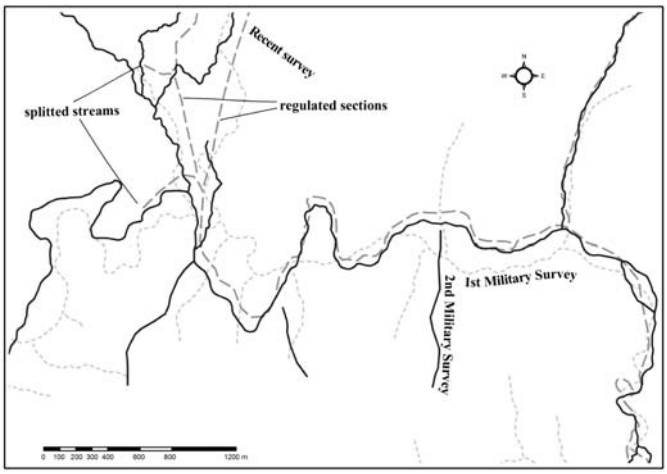

Fig. 3. The differences between the investigated surveys

on 10 map sheets. These points were usually temples, bridges, road junctions or other permanent structures.

Differences occur between 40 and 120 m, thus the average is approximately 70–80 m. This number is below the value that Timár et al. (2006) suggested, consequently the maps sheets of this area could be considered as more accurate. These facts strengthen our previous assumption that the Second Military Survey and the used rectifying method provide the suitable accuracy.

Another advantage of the Second Military Survey is that its universal map system currently usable in different countries. It is especially important for the area under study: it is currently split by the national border (Fig. 3). Because of the different national mapping standards and geodetic datums, scientists have to purchase topographic maps from both neighbouring countries. To integrate two different mapping systems in a common geodetic system can also be a good challenge at the required accuracy level.

The question may arise, why I did not use the First Military Survey prepared decades before the second one that shows even more natural state? The reason is simple: we can not trust the accuracy of that survey because the mapmakers didn't use any projection, so the rectification of the map sheets only possible with GCP-points, what cause more distortion on the shape and also on the location. Besides the accuracy, the fact that only 4% of the digitised streams had been regulated before the surveying proves the reliability of the Second Military Survey. The Fig. 2 and Fig. 3 show what a significant difference is between the shape of the Roman artificial section and incised section on the First Survey and its real form. Only these two sections are able to verify the geometrical accuracy of the depicted streams, because in their natural state, meanders are curving and moving ahead year by year.

That fact is very important for us, because the base of our method is the geometry of the streams. The smaller problem is the 250 m distance of the divergence

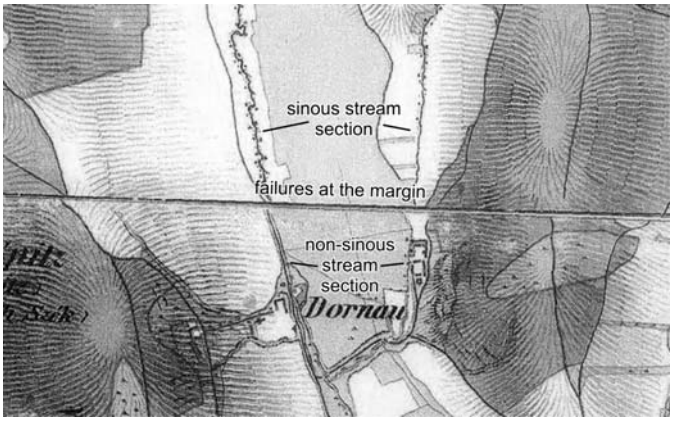

Fig. 4. Some failures of the Second Military Survey

on different maps. A further important observation is that the first survey does not contain as much streams as the second one. The reason can be the variable detailedness of different surveys as well. Even so on the uncertain sections the author used the digitised data from the first survey (not for the measurement, but in order to check lineaments) in case the stream has already been regulated in the time of the Second Military Survey.

It is necessary to mention some relevant failures of the Second Military Survey. The most important advantage of this survey that represents the natural state of the streams is not realized totally. Some sections had been regulated before the surveys were done. Map sheets were made by different teams that cause differences between neighbouring sheets (Fig. 4). For instance, the details of the surveys can change at the margin between map sheets, what occur due to the detail, the different method or the weather conditions of the surveying works. Cartographic elements are usually not continuous at the margin between the map sheets due to the less accurate rectification method or the geodetic base. The representation of the streams is similar to lower level roads and the margin between lands of different agricultural cultivation, thus the recognition of the streams is usually difficult.

Discussion

As specified above the relief, represented by hachuring techniques on the Second Military Survey is only useable in small scale, just for identifying the location of the scarps, but are very useful to illustrate the state of relief due to the hachuring method (the steeper slope represented in darker). Due to the same reason the usage of these maps can be less practical on areas with higher relief.

As with our study we could prove the geometrical accuracy of Second Survey, other natural scientist can trust the data of its maps. It is in accordance to the previous investigations (Timár 2003, Petrovszki 2008, Zámolyi et al. 2007) that used the same method but on different places in the Pannonian Basin. If any scientist needs to compare the natural estate with the recent one, Second Military Survey

is useful in lower as well as in higher scale. This paper proved, that the linear segments appear correctly, thus temporal changes in shape of several elements (like road network, boundaries etc.) can be successfully investigated.

Conclusion

As we saw, the theory that more modern map is more useful for scientists have just broken. The next step can be the rectification of necessary map sheets one by one for our study area using GCP points for higher accuracy. It is possible if we need only a few map sheets and if our area contains enough fix points. The stream network can be investigated from other side, for example the moving of curves or artificial effects on stream network.

Other survey's verification and comparison is among our plans. The first cadastral survey (Arcanum 2006) can be useful and more accurate due to higher scale and provide more detailed topography content. Integrating several survey data from different times result in creation of a database about the stream pattern, which can be useful for analyzing the variable fluvial structures in longer timescale.

Acknowledgements

I appreciate the valuable help, good pieces of advice and assistance of my tutor B Székely. I am very thankful for the supervision of A Oldenburg-Nagy and K Tolnay. A Zámolyi and G Timár are also thanked for technical support. This study was carried out in the framework of a project sponsored by the Hungarian National Sciece Foundation (OTKA T-47104).

angolul kérem szépen

References

Arcanum 2006: Vas megye az első kataszteri felmérés térképein, 1856–1860, DVD-ROM, Arcanum, Budapest

Čada V, Vichrová M 2009: *Acta Geod. Geoph. Hung.*, 44, 105–114.

Jankó A 2001: *Hadtörténeti Közlemények*, 114, 103–129.

Jankó A, Oross A, Timár G 2005: A második katonai felmérés – A Magyar Királyság és a Temesi Bánság nagyfelbontású, színes térképei. Arcanum, Budapest

Kovács G, Székely B, Papp S 2008: In: Proceedings of the Junior Scientist Conference 2008. H K Kiser, R Kirner eds, University of Technology, Vienna, 309–310.

Petrovszki J 2008: Unpublished MSc Thesis (in Hungarian). Eötvös Loránd University, Budapest

Podobnikar T 2009: *Acta Geod. Geoph. Hung.*, 44, 49–66.

Székely B 2009: *Acta Geod. Geoph. Hung.*, 44, 3–16.

Timár G 2003: *Quatern. Sci. Rev.*, 22, 2199–2207.

Timár G 2009: *Acta Geod. Geoph. Hung.*, 44, 95–104.

Timár G, Molnár G, Székely B, Biszak S, Varga J, Jankó A 2006: Digitized maps of the Habsburg Empire – The map sheets of the second military survey and their georeferenced version. Arcanum, Budapest

Zámolyi A, Székely B, Timár G, Draganits E 2007: *Geoph. Res. Abs.*, 9.