CORRELATING THE UTILIZATION OF MAPS CONSTRUCTED WITH DIFFERENT METHOD AND IN DIFFERENT SCALE FOR ANALYSING TOPOGRAPHY

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KÜLÖNBÖZŐ ELJÁRÁSSAL ÉS MÉRETARÁNYBAN KÉSZÜLT TÉRKÉPEK ÖSSZEHASONLÍTHATÓSÁGA A DOMBORZAT ANALÍZISE SZEMPONTJÁBÓL

Összefoglalás

A szintvonalas térképek felhasználásával készített, a domborzat sokféle jellemzőit kvantitatívan ábrázoló, értékelő térképek pontossága egyrészt az alaptérképtől, másrészt a levezetett térkép szerkesztésénél használt módszerektől is függ. A digitális térképszerkesztés a derivált domborzatelemző és értékelő térképek új paraméterek szerinti korlátlanszámú variálását teszi lehetővé. Az új módszerek gyorsítják a térképek szerkesztését, és elvileg javítják azok pontosságát is. Nagyon fontos kérdésnek tartjuk a hagyományos és digitális módszerrel készült tematikus térképek pontosságának a vizsgálatát.

Ebben a tanulmányban először egy mintaterület 25 000-es térképéről hagyományos technikával és digitálisan szerkesztett lejtőkategória térképeket hasonlítottunk össze, majd a különböző méretarányú térképekből digitálisan előállított tematikus térképek pontosságát értékeltük. Az összevetést IDRISI szoftverben kereszttabulációval végeztük. Az 1 : 25 000 térkép felhasználásával, manuális és digitális módszerrel készített lejtőkategória térképek eredményeit az 1. táblázat tartalmazza. Megállapítottuk, hogy a manuális feldolgozásnál a kategória határok közelében halmozódnak a besorolás bizonytalanságai, és a nagyobb kiterjedésű viszonylagosan egységes lejtésű területeken belül nem mindig különítették el az adott kategóriától kis mértékben eltérő meredekségű foltokat. A szoftveres eljárás során viszont még a legapróbb foltok is megmaradnak, és bele kerülnek a statisztikába. A különböző méretarányú térképek és az SRTM domborzatmodell felhasználásával készült digitális lejtőkategória térképek adatai (2. táblázat) alapján megállapíthatjuk, hogy – az SRTM kivételével – a térképi generalizálás fokának növekedése a meredek és lankás lejtők változásában ellentétes irányú trendet eredményez (3. ábra). A 90 m-es felbontású SRTM alkalmazását a kisebb kiterjedésű területeken nem, vagy csak nagy elővigyázatossággal tartjuk elfogadhatónak.

Summary

The accuracy of the maps quantitatively depicting and interpreting the relief characteristics, prepared using contour maps, depends on the base map and on the methods applied in deriving the maps. Digital map construction enables the unlimited variation of derived relief assessing and interpreting maps regarding new parameters. New methods fasten and improve map construction. Studying the accuracy of thematic maps prepared by traditional and digital methods is highly important.

This paper compares the slope category maps of a study area made by traditional and digital techniques from a 1 : 25 000 map, then the accuracy of manually and digitally prepared thematic maps made from differently scaled maps is assessed. Comparison was made in IDRISI software by cross tabulation.

Table 1 shows the slope category map results prepared by manually and digitally using 1 : 25 000 maps. Using manual processing, classification uncertainties are accumulated near the category boundaries and the manual constructor in extensive areas of uniform sloping not separated always the patches that have sloping differing only slightly from the given category. Using the software method the smallest areas are counted in the statistics. Based on the data (Table 2) of the digital slope category maps prepared using differently scaled maps and the SRTM elevation model it is shown that – except for the SRTM – increasing map generalisation, results in opposing trends in the extent change of the steep and gentle slopes (Figure 3). The application of the 90 metres resolution SRTM onto smaller areas is either not accepted or accepted only with great caution.

Introduction and aims

The theoretical possibility of analyzing topography objectively in detail was enabled by the idea of B. M. du Carla presented in the French Academy in 1771. He proposed the similar presentation of surface forms on maps by depicting the bottom levels of waters with contour lines (Klinghammer – Pápay – Török 1995). The much later occurring contour maps rejected the principles of stripped relief picturing, depicting not the slopes *directly* but elevation data in the form of contour lines. This made the construction of numerous thematic maps focusing on the possible different characteristics of the relief possible. As the contour line system of the base topographic maps holds abundant more or less undercover information that is significant describing and interpreting surface forms, it is strange that geomorphology researching these surface forms did not make full advantage of these information for a long time – even not in the first half of the 20th century. Seemingly contradictory is the fact that the geomorphologist made the surveying of surface forms with topographic maps in the hands (where topographic maps were available) so that topographic maps were essential base instruments. However, systematic geomorphological mapping on the basis of topographic maps became widespread only after the Second World War and the preparation of derived interpreted thematic maps boomed even later. Apparently, the use of thematic maps was increased due to social demands and their change and the occurring engineering geomorphological maps tried to fulfill these demands. Basically, there were two conditions of accuracy and utilization of maps derived from topographic maps and serving different areas of practice, depicting quantitatively, analyzing and interpreting numerous characteristics of the relief (slope category, slope attitude, relative relief, etc.): on the one hand, the accuracy and elaboration (that depend primarily on the scale of the map), on the other hand the „subjectum" of the preparing researcher (occasionally even a cartographer). This latter is regarded not on conscientiousness (this is a requirement in every time and in every work) but on the possibility of subjective decisions despite precisely applying exact preparation principles. (E.g. laying out of the border lines of different categories in the case of slope category maps prepared based on the distance of contour lines.)

In the course of relief analysis and assessment numerous thematic maps are produced in great variety. These maps have been prepared handmade with enormous work until the last decade. Their application is made difficult not only by accuracy but by the fact that maps prepared for one aspect (e.g. determined slope categories or slope attitude) could have been changed only by almost complete re-preparing. *Thus the occurrence and rapid spreading of digital map construction is comparable with that of contour line depicting in numerous aspects*. As contour maps enabled the preparation of different types of derived maps, the digitized relief makes their multiplication possible. However, work demand is still great in the digitizing, the great number of later variables reduces the rate of digitizing in the complete work.

Today better possibilities offered by new methods increase the tempo of map construction and they improve their accuracy as well as they are prepared almost completely automatically. Therefore, however, the quality of the end production is even more determined by the accuracy and elaboration of the base (topographic) map. Thus nowadays those investigations own great importance that compare the accuracy of former thematic relief maps prepared by traditional methods on the basis of given scales with that made by similar technique but from topographic maps of different scale (e.g. the 1 : 25 000 according to the Hungarian profiling and the 1 : 10 000 of the United National Areal System), and that of thematic maps produced by different techniques (e.g. on the basis of space images).

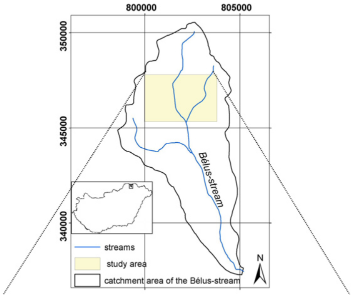
We think that these studies are interesting not only for theoretical reasons but for that the traditionally prepared thematic relief maps constructed in enormous quantity in the last few decades presenting an applicable data bank for the practice. However, the principal condition of their application is that the researcher can make well based required correlations between new and old maps and he can correctly decide the unavoidable data correction.

Studies presented in this paper serve the above aim. First – as a case study – one part of a piece (slope category map) of a thematic relief maps series prepared manually a quarter of a century ago (Szabó J. 1982, 1984) is compared to slope category maps derived from different base maps and by different methods. The study area (the surroundings of the Bélus Stream) is a middle sized (46 km^2) catchment area of the Cserehát Hills (*Map 1* and *2*). The detailed relief analysis of the area owing average hilly characteristics among Hungarian hills was made in order to assess the conditions of the Cserehát landscape from agricultural point of view.

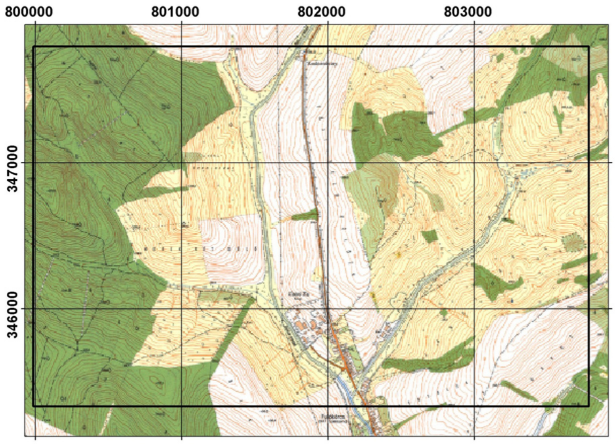
Methods and way of research

The study area extends over 9.3 km^2 in the catchment area of the Bélus Stream. The contour lines were vectorized in ArcGIS 9.0 software from topographic maps of three different scales (1 : 10 000, 1 : 25 000, 1 : 100 000). The elevation values were attached to the lines as attributes. Besides, the digitizing of the slope category maps prepared by traditional methods (marking slope steepness on the basis of manually determined contour line distances) was completed (*Maps 3-6*). Grid based digital elevation models were made in SURFER 8.0 software from the completed databases. In all of the three models the size of the element units was chosen to be 10 metres for easier comparison. This size is suitable for the most detailed, 1 : 10 000 maps as well. In the next step the grids were converted into IDRISI 32-2 software format. The SRTM relief model with a resolution of 90 metres prepared by the NASA with remote sensing methods was also imported into IDRISI then the generation of the slope category maps was made (*Map 7*).

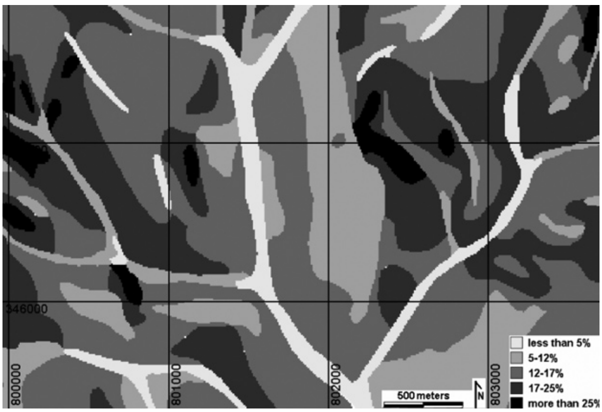
The areal extent of the slope categories (hectares) was determined by the IDRISI software. In this way, we gained a comparable data series on the extent of the areas in the given categories. The comparison of the slope categories made by manual and digital methods from maps of similar scale was carried out by cross tabulation. In the course of the operation the software compares the pixels belonging to the same co-ordinate values of the two raster files, thus it can be determined that how many changes occur in the pixel value. That is, to what extent of the area the different methods prepared the same slope category maps. In order of better comparison, the same pixels were used in the smaller scaled maps as well.



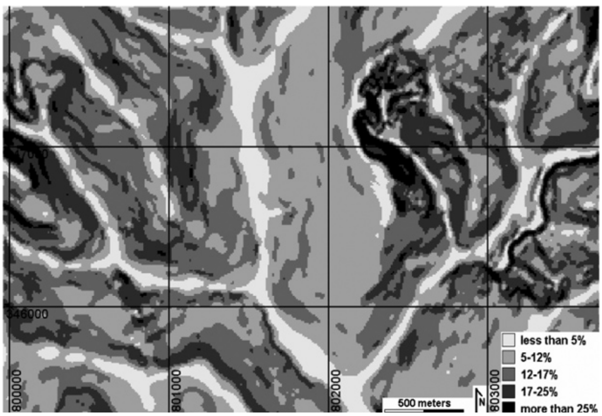
Map 1. Geographical position of the catchment area of the Bélus Stream



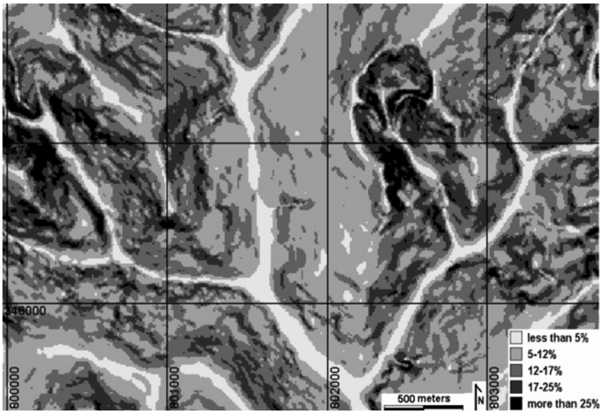
Map 2. Topographic map of the study area



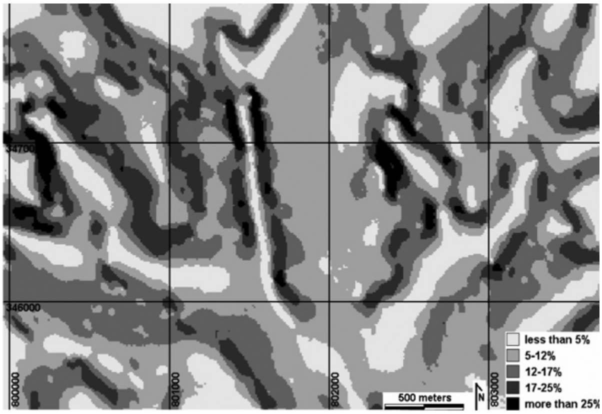
Map 3. Slope category map with a scale of 1 : 25 000 of the study area (compiled with manual method)



Map 4. Slope category map with a scale of 1 : 25 000 of the study area (compiled with digital method)



Map 5. Slope category map with a scale of 1 : 10 000 of the study area (compiled with digital method)



Map 6. Slope category map with a scale of 1 : 100 000 of the study area (compiled with digital method)

Results, conclusions

On the basis of comparing slope category maps prepared by manually and digitally using maps with a scale of 1 : 25 000 it can be stated that applying largely differing methods results in significant differences. The gained results are found in *Table 1*.

Table 1. Areas of slope categories determined by manual and software methods

Category		Manual 1 : 25 000	Digital 1 : 25 000
		area (ha)	**area (ha)**
1	less than 5%	66,8	97,6
2	5-12%	196	371,8
3	12-17%	416,3	307,5
4	17-25%	244,8	152,2
5	more than 25%	29,5	24,5

Both the Tables and the histograms prepared from the data (*Figure 1*) reveal that on the manually prepared maps the 12-17% slopes have the greatest extent, while on the digitally prepared maps the most extensive slope category is the 5-12% one. Greatest matching between the two maps is found in the steepest and least steep categories.

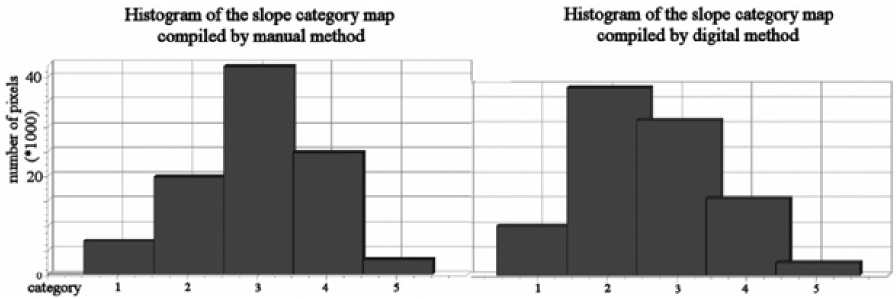


Figure 1. Histogram of the slope category maps prepared manually and digitally

The comparison of the results obtained by two different methods shows that on 52% of the 953.5 hectares area (499 hectares) the result is completely the same. In the further 385.6 hectares (40.5%) the difference was only one category. „Significant difference" was found only in the case of 68.8 hectares (7.2%). This latter value is low but we examined whether the „significant difference" is category specific or not.

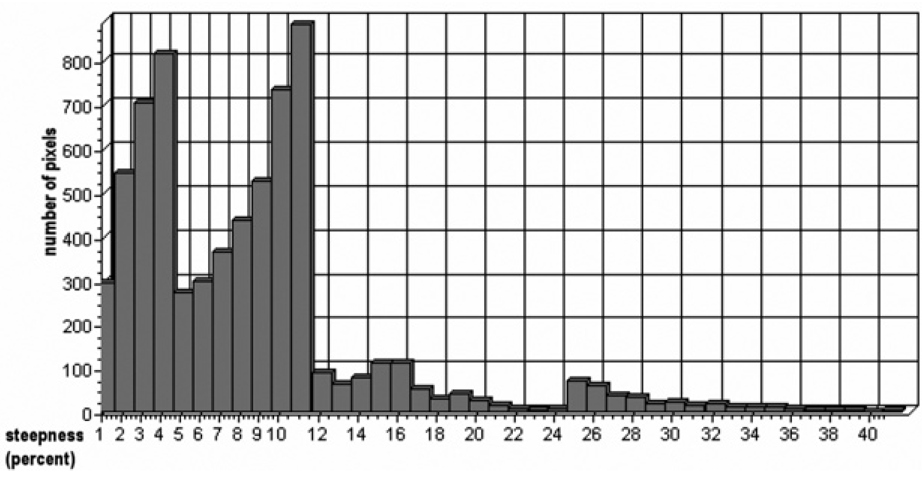


Figure 2. Distribution of „significantly differing" pixels in slope percent

Figure 2 reveals that most of the pixels with significant difference is found in the case of more gentle slopes (<12%) and the differences reach their peak near the boundary values (5, 12, etc.) of the chosen categories. This shows that in the case of manual processing classification uncertainties are accumulated near the category boundaries.

The other conclusion drawn from the comparisons is that the manual constructor in the extensive areas of relatively uniform sloping not separated always the patches that have sloping differing only slightly from the given category. In the case of the software method, however, even the smallest areas (even those occupying only one pixel) are counted in the statistics.

Next we examined the differences resulted from the comparison of the slope category maps digitised from topographic maps with different scales and derived from the SRTM elevation model. Areas measured in the given maps in slope category separation are found in *Table 2*.

Table 2. Comparison of slope category areas derived from data of different scales

Category	1 : 10 000	1 : 25 000	1 : 100 000	SRTM
	area (ha)	area (ha)	area (ha)	area (ha)
less than 5%	74,5	97,6	175,3	6,2
5-12%	367,3	371,8	378	117
12-17%	321,8	307,5	269,4	507,9
17-25%	159,7	152,2	113,8	281,8
more than 25%	30,3	24,5	17	40,7

Topographic maps with a scale of 1 : 10 000 presented the control. It can be observed in the diagram *(Figure 3)* prepared on the basis of the data that the study area similarly to the Hungarian hilly areas consists of 5-17% category slopes according to all of the topographic maps.

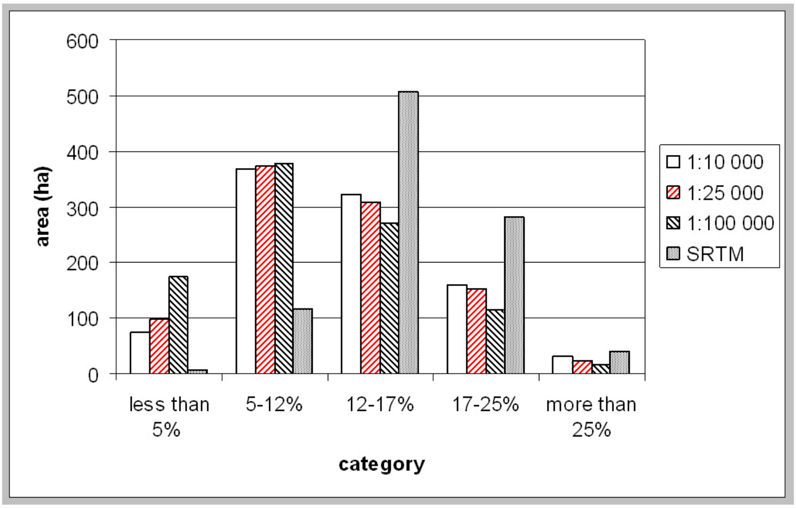
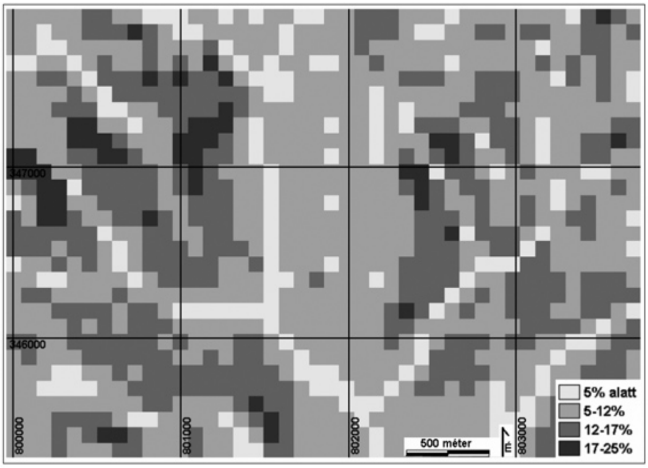


Figure 3. Comparison of slope category areas derived from databases of different scales

It is well traceable that with decreasing scale, the rate of the areas belonging to the 12% category also continually decreases while the area of the gentler slopes increases. Increase in the grade of generalisation of the maps induces opposing trends in the change of the steeper and the gentler slopes. The only exception for this is the STRM data series as this does not follow this trend. Considering its accuracy, the original resolution of 90 metres is comparable (more-or-less) to a map with a scale of 1 : 200 000 therefore it is situated in the „right position" in *Figure 3*. Based on the above, its application to smaller study areas can be suggested only with great caution.



Map 7. Slope category map of the study area made by using SRTM

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SRTM database and manuals: ftp://e0srp01u.ecs.nasa.gov/srtm/