ANALYSIS OF USER'S RESPONSE ON 3D CARTOGRAPHIC PRESENTATIONS

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Abstract: *The paper describes the preparation and results of an internet questionnaire that was prepared to find out, how different 3D cartographic presentations (maps) can fulfil users needs. As examples three different perspective presentations have been prepared: topographic map, draped over DTM, an orthophoto image, draped over DTM and 3D symbolic presentation. Different map users have been asked, how they could use these three kinds of perspective view for similar purposes like they use 2D maps.*

Keywords: 3D cartographic presentation, map design, users' opinion

INTRODUCTION

The main task of the map is presentation of spatial information where such different cartographic presentations serve for communication between cartographer and user. This communication is successful when user is able to read and to completely recognise the map content, designed by cartographer (Rojc 1986). In general users use map in different ways: for recognition of particular presented objects, for general orientation in the surroundings and for various map measurements. All these tasks require adequate user's experiences and knowledge, but, some maps-like presentations are easier understandable than others. Today's technological development enables easier preparation of different types of cartographic presentations. Ones of them are 3D presentations – advanced way of presenting relief, which allows users appropriate recognition of landscape as third dimension (Haeberling 1999, 2005, Petrovič 2001). But, do they have any practical importance or they are only research experiments?

Let's try to find the answer in history of cartography. The very first known maps, presenting objects and phenomenon using cartographic symbols dates from 2.500 years b.c. One of well known maps is map of Mesopotamia, shown in Figure 1.

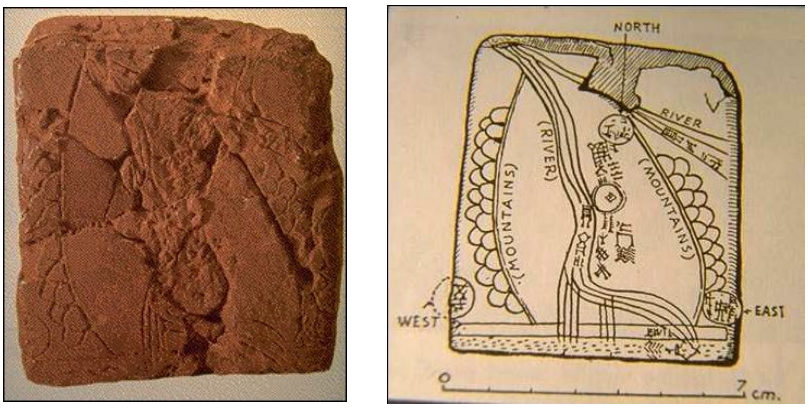


Figure 1: Perspective-like relief presentation on Map of Mesopotamia, from 5000 b.c.

This map is a combination of two different views. While majority content is mapped as ground plan view, mountains are presented in perspective way! Following the development of cartographic design through Greek and Roman era we can find out that cartographers always wanted to present the relief as realistic as possible, using mostly perspective pictures of hills and mountains. After the stagnation of development in Middle Ages, renaissance of cartography from 15th century brought the continuity of perspective presentations. Only in 18th cent., first relief presentations that presented morphological forms in ground plan view were introduced. The first method, hatching (Figure 2), indeed enabled some basic measurement tasks, like determination of slope, but the big disadvantage of the method was extreme graphical overloading. In the late 19th century contours (Figure 2) became the most common way of relief presentation at all large scale maps, since this was the only method that enabled full map measurements and exact definition of every point's height on the map.

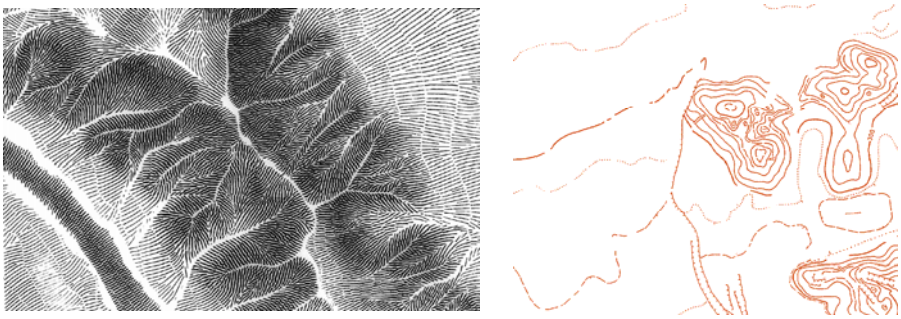


Figure 2: Hatching and contours as two ground plan methods of relief presentation

Consequently in 20th century ground plan maps became dominant in production and use and the panoramic ones were in minority, only for some tourist purposes. To summarise, we can see, that ground plan maps with indirect way of relief presentation were dominant only in last 200 years, while perspective type maps, which are more adequate to normal people's viewing, have been used for thousands of years. Today, when digital map production and huge amount of 3D spatial data enable easier production of different 3D presentations, also ones that allow exact mathematical measurements and coordinate determination also in perspective view; such presentations after 200 years might again become prevalent ones. But, there are many different 3D presentations – 3D maps; they can be according of level of 3D sense divided into following groups:

- simply 3D maps: ground plan map or orthophoto, draped over the DTM,
- advanced 3D maps: DTM with 3D symbolization, observed still on 2D medium, and
- real 3D maps: holograms, lenticular foil (Buchroithner et al 2004).

To answer the question, which type of map view is better, the cartographer couldn't just follow theoretical principles. Only the users with their cartographic knowledge and experiences can judge and cartographers' obligation is to recognise how users see different presentations and how different 3D cartographic presentations (maps) can fulfil user's needs. Some researches have already been done (Kirchenbauer 2002, Wood et al 2005). It was realised, that results depends on users groups, user's needs, their cartographic knowledge, expectations, and preferred medium.

PROJECT METHODOLOGY

The main idea was to ask different map users, how they could use different kinds of perspective view maps of mountain region for similar purposes like they use 2D maps: about possibilities of getting numeric data, like defining distance, direction and height difference between two points or through selected track and also about possibilities of recognition of particular point, linear and area-type objects. The whole project consisted of five steps:

- definition of target user's groups,
- questionnaire design,
- internet inquiry,
- analysing the answers and
- evaluation of results.

Target users groups were defined among the population, that often use maps, but do not necessary have cartographic education. We particularly focused on surveyors, spatial planners, mountaineers, scouts and orienteering runners by asking (by mail) different users and organizations to encourage their members to take part in this questionnaire. The same appeals were published at some internet pages of organizations, like Mountain Association, Orienteering Association, and Scout Association.

Inquire was done through the internet, the questionnaire was available at the server and participants has unlimited access to it (Mašera 2004). Results were automatically summed. Such way of getting user's opinion has indeed some doubts. The questionnaire was available only for map users with internet access. We didn't know how many map users were informed about the questionnaire and furthermore how many of them would participate in it. Therefore we decided for short one, with mostly closed and half-closed questions. Of course we couldn't know who fulfilled the questionnaire.

The questionnaire started with a part, where we have asked participants to define:

- their user's group (spatial planner, mountaineer, scout, others),
- occupation (surveyor, civil engineer, geographer, architect, geologist, sportsman, other),
- which maps do they use and how often, and
- do they use maps at their job either in free time.

Introduction part was followed by some basic description of DTM, attended to those, who are not familiar with them. For easier comparison of different map use task between traditional ground plan maps and 3D presentations and also to familiarize participant with area shown in research, we first presented an insert of 2D topographic map (Figure 3) at a scale 1: 50,000.

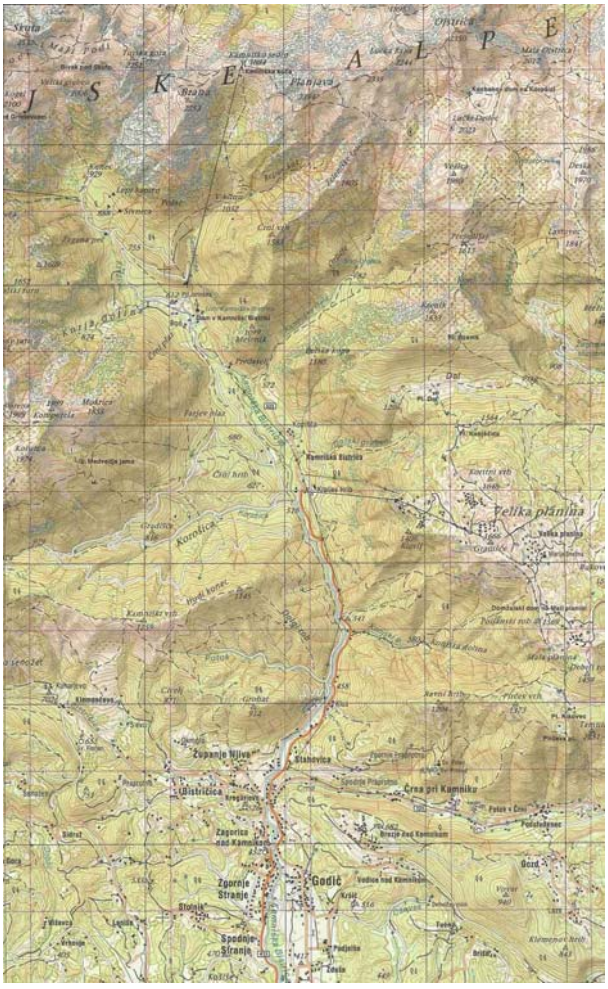


Figure 3: 2D map of selected area

Our goal was to realize, how efficient main usages of maps: recognition of presented objects, general orientation in the surroundings and map measurements, can be achieved using different types of 3D presentations. As examples three different 3D, perspective presentations have been prepared:

- topographic map, draped over DTM with added hill-shading (Figure 4),
- black/white orthophoto image, draped over DTM, again with added hill-shading (Figure 5) and
- 3D symbolic presentation, supplemented also with atmospheric phenomena (Figure 6).

DTM used for all three 3D presentations was 25 m grid, made from SAR, European space agency (ESA). Accuracy in mountain areas is 13.8 m, but it is homogenous and therefore very suitable for our research.

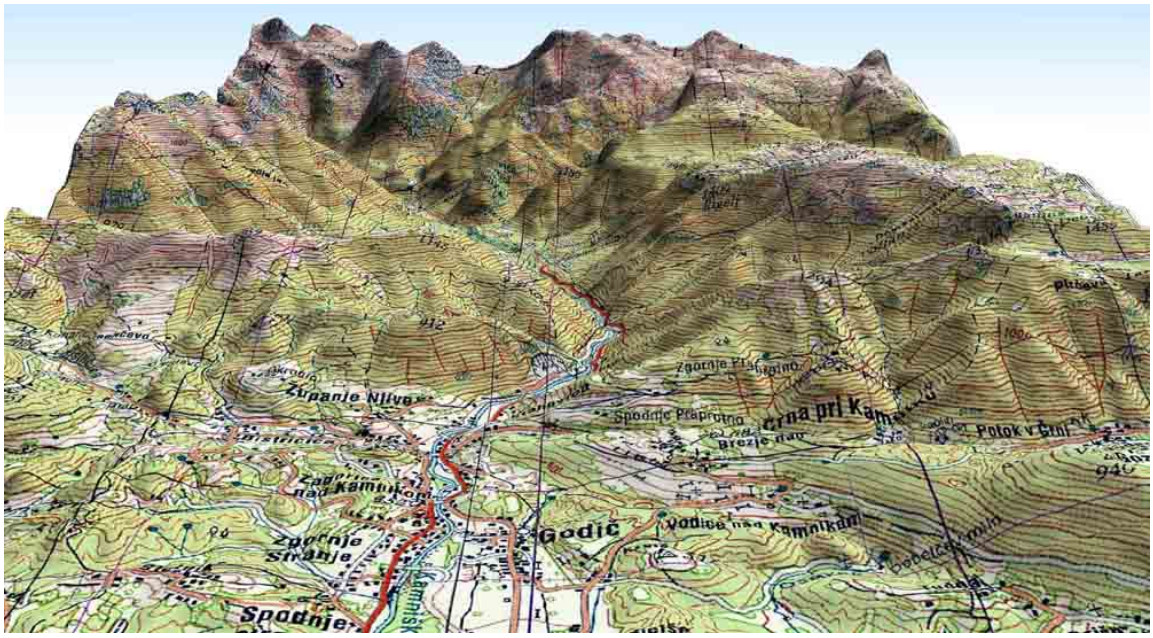


Figure 4: Topographic map, draped over DTM with added hill-shading

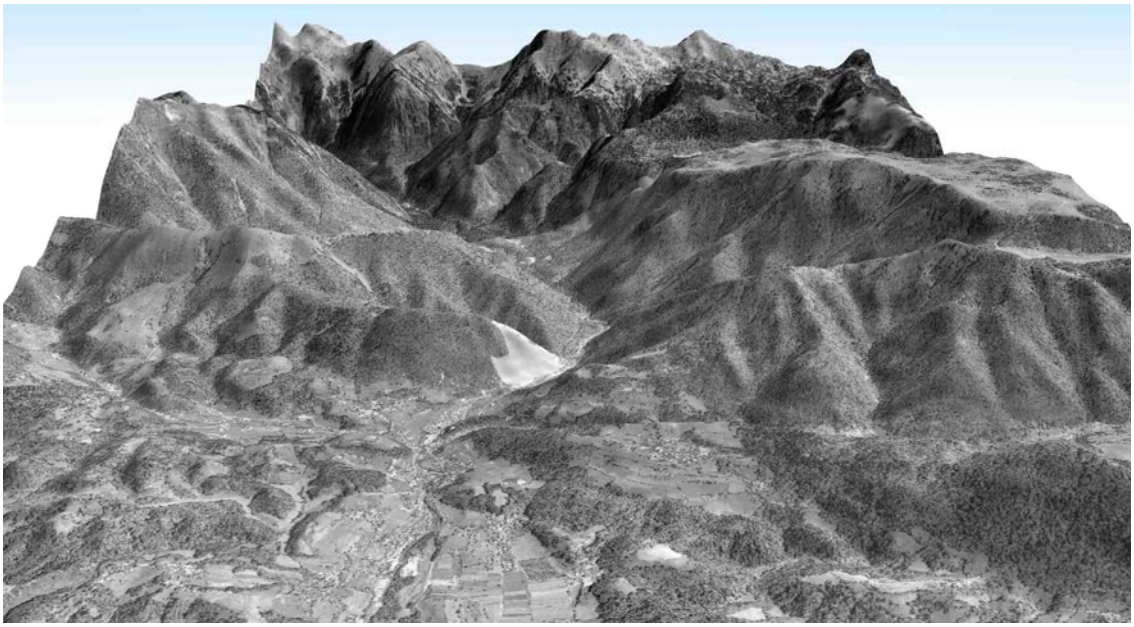


Figure 5: Black/white orthophoto image, draped over DTM with added hill-shading

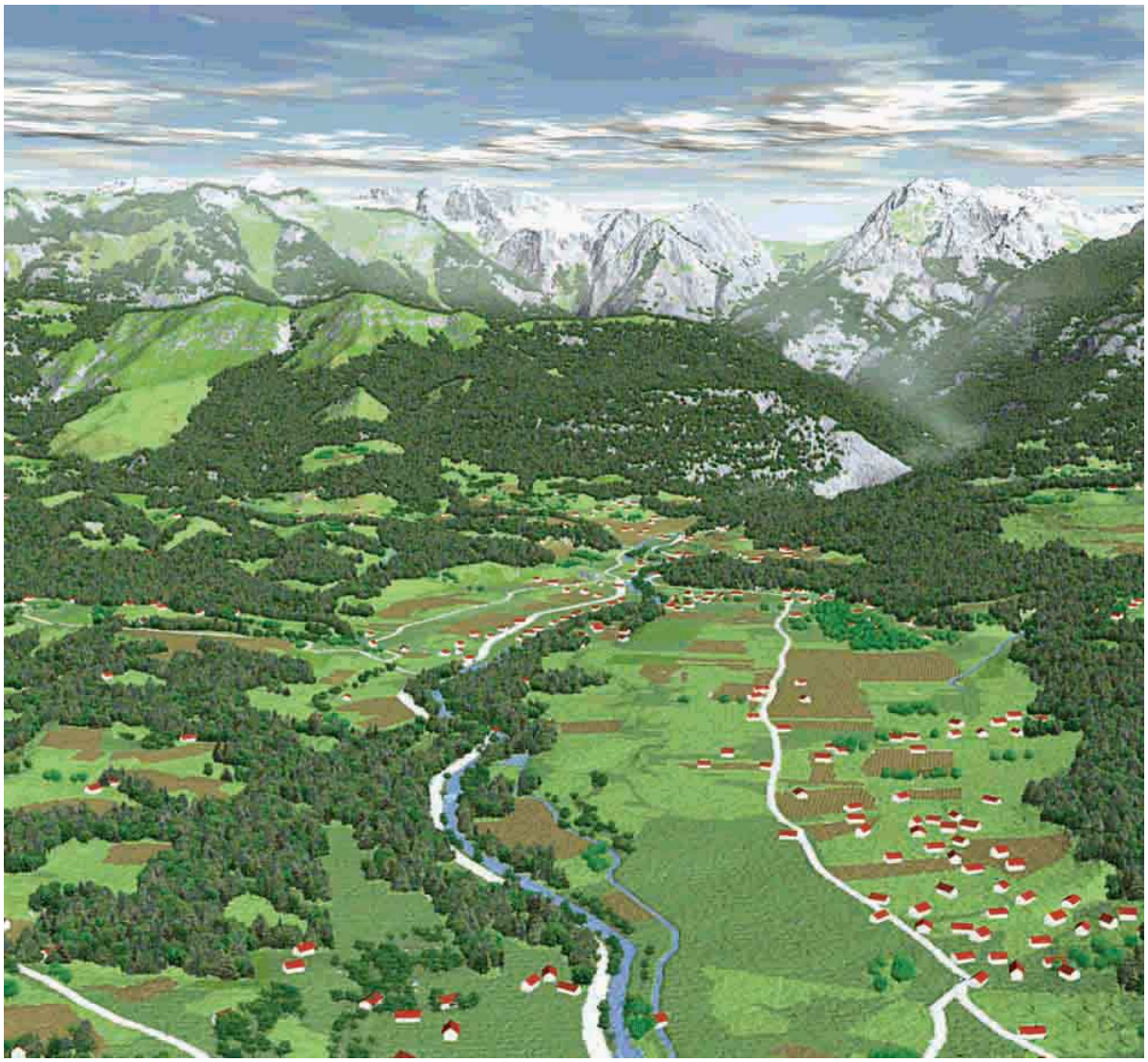


Figure 6: 3D symbolic presentation, supplemented with atmospheric phenomena.

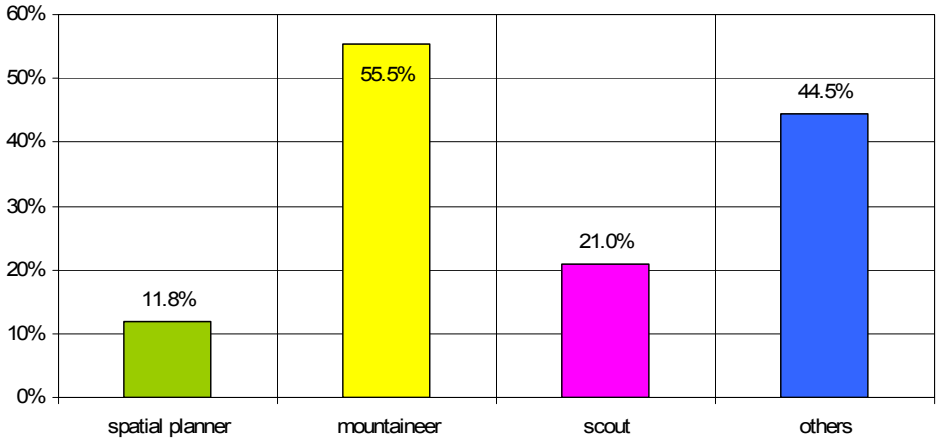
With main part of questionnaire we wanted to know how the users would use these three different types of perspective views for similar purposes like they regularly use 2D maps. First group of questions asked about the possibilities of getting numeric data (defining distance, defining north direction, and defining height difference between two points or through selected track). In the second part we have asked about possibilities of recognition of particular point, linear and area-type objects (building, church, forest, rocks, road, and stream). Finally, some general questions, as follows, were added:

- which 3D presented map would they prefer for their use and why,
- point out the advantages and the disadvantages of 3D presentations,
- which geographic elements, presented over the DTM are for they the most important, and
- would they prefer 3D map on paper or on digital media.

ANALYZE AND RESULTS

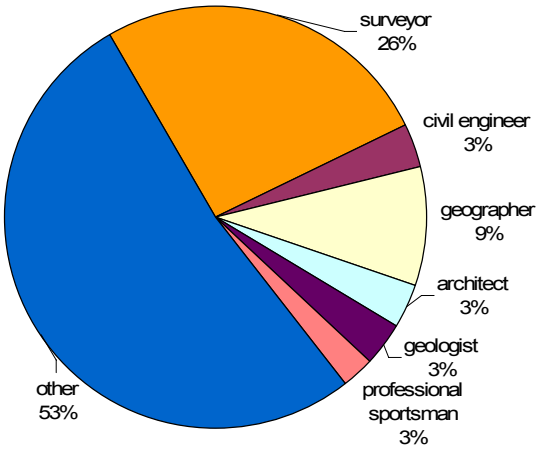
In twenty days in autumn 2004 all together 420 visits of web page have been recorded, while 119 different map users answered to questions (Mašera 2004). An average time for answering it was 6 minutes. All answers have been automatically written in txt file and therefore an automated analyse was performed. In generally participant gave quite positive evaluation of presented 3D presentations. Detailed results follow.

The participants classified themselves according to proposed user groups (Graph 1). More than half classified themselves to be mountaineers, what indeed is not surprised in Slovene, where mountaineering is for sure the most popular recreational activity.



Graph 1: Participants according to proposed users' groups

The occupation of participants was really heterogeneous (Graph 2), with exception of surveyors, who made one fourth of the participants. The result again was quite expected one, since map use is nowadays widely distributed and therefore cartographers, surveyors and geographers are not the only users.



Graph 2: Participants according to occupation

In next answer participants explained which maps do they use and how often. 95% of participants use maps in spare time and 57% at job, what gave us the confirmation that participants are regular map users. But the most favourite maps they use are:

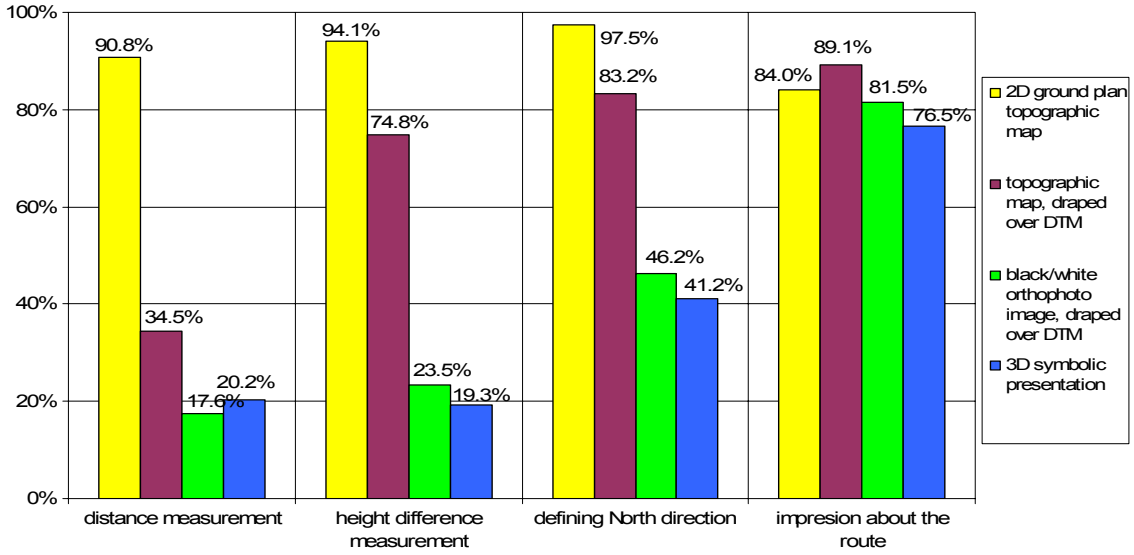
- National Topographic Map 1: 25.000,
- mountain maps,
- road maps,
- city maps,
- general maps,
- meteorological maps,
- National and Military Topographic Map 1: 50,000;

while less users indicated also tourist maps, Basic Topographic Map 1: 5000, orthophoto maps, orienteering maps, panoramic maps, and satellite image maps.

At the part where we asked about the possibilities of getting numeric data participants answered to four questions regarding all four different maps - ground plan map and three perspective maps:

- could they measure the distance between two points?
- could they measure the height difference between two points?
- could they define North direction?
- could they get adequate impression about the route between two points?

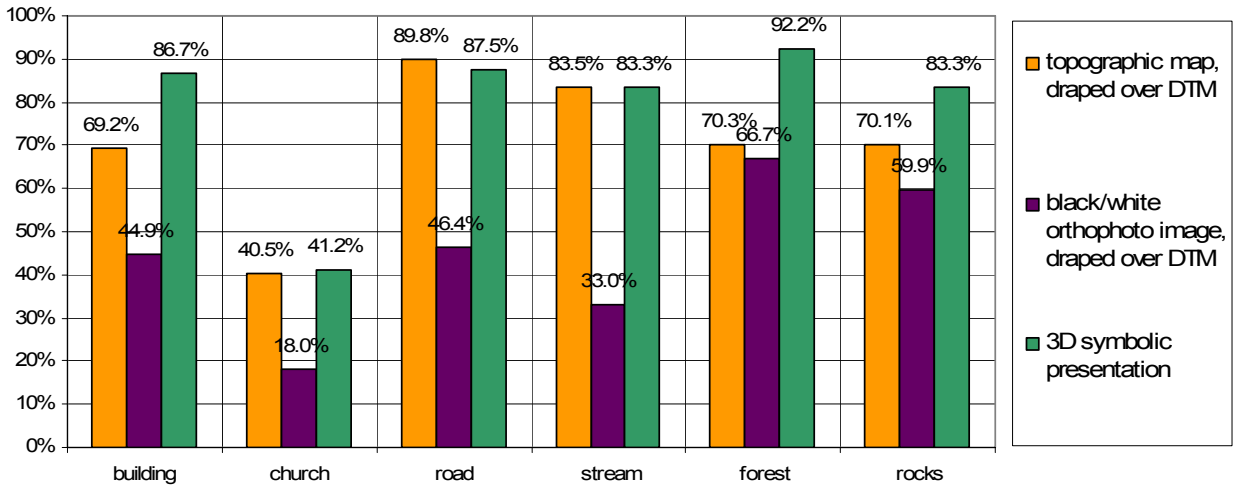
Results are shown in Graph 3.



Graph 3: Map measurements possibilities on different maps

Since the majority of participants regular use maps they had almost no doubts about getting numerical data from topographical ground plan map. Between orthophoto and 3D symbolic presentation there were mainly no difference, but users favoured draped topographic map, especially due to contours and grids that were draped over the DTM together with other map content.

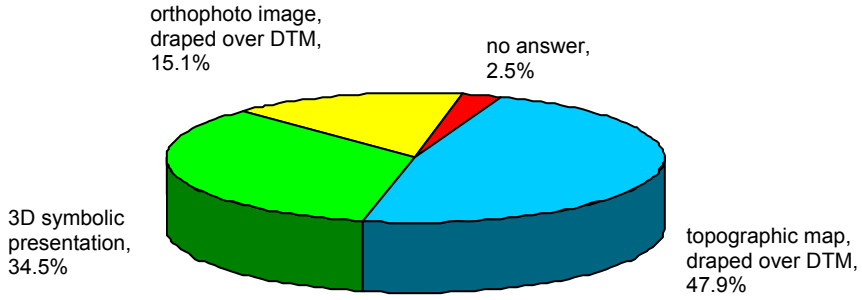
In the second part we proposed a set of point objects (building, church), linear objects (road, stream) and area-type objects (forest, rocks) and we asked participants to recognise them at all three 3D maps. The legend at draped topographic map was not available, so recognition based under familiarity with topographic map. Results are presented in Graph 4.



Graph 4: Object recognition on different maps

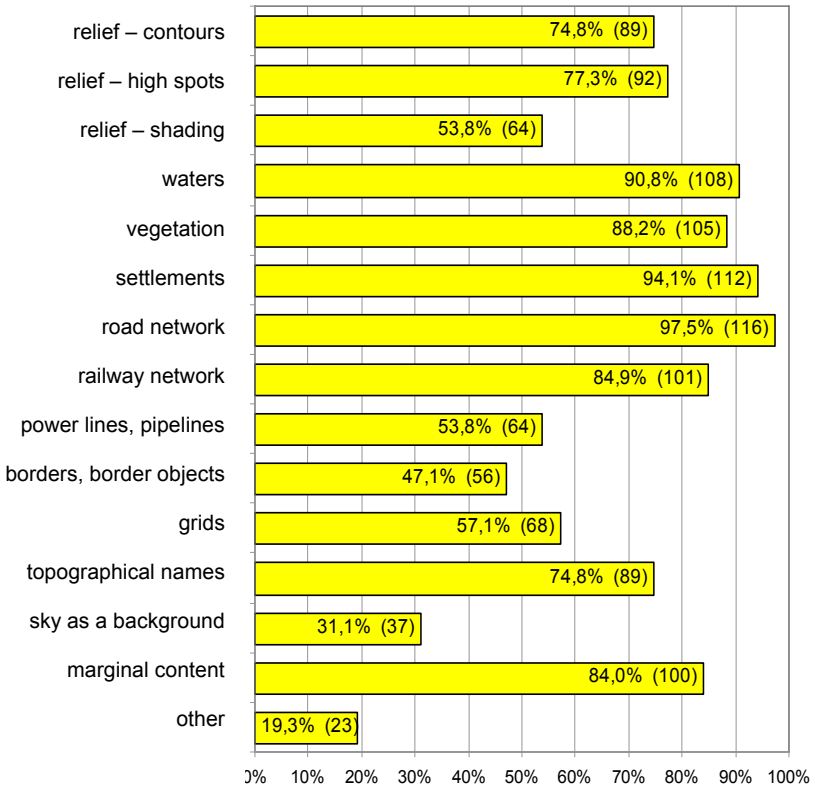
The results are partly surprised! Since the majority of participants were regular map users it was expectable that recognition of particular objects on draped topographic map shouldn't be problem even in absence of the legend. It is also natural, that recognition on draped orthophoto at a scale smaller than 1: 20,000 (even at larger computer screens) was poor. But the results show that 3D cartographic symbols on third presentation, again in absence of legend, have been recognised as even better than on topographic map. Obviously, 3D symbols are very associative and without previous knowing of symbols participant had no problem to recognise them.

But finally, when participants answered the question "Which 3D presented map would you prefer for your use?" the result was as it is shown in Graph 5.



Graph 5: Users preference on different 3D maps

Although participants found 3D symbolic maps as the most useful for object recognition they preferred draped topographical map. Were the map measurement possibilities that are indeed better in draped topographic map, so important for participants? The remained questions helped us to answer this question. When participants were asked to define, which map contents according to their opinion have to be presented in 3D maps, they decided as follows at Graph 6.



Graph 6: The importance of 3D maps content

Obviously, since the grid is not very important to be presented on 3D maps, also map measurements is less important then object recognition. So we analysed the answers where participants freely indicated, why they prefer one of three 3D maps. The most frequent answer regarding draped topographic maps was habit, familiarity with topographic map and then also good spatial impression and presence of topographic names. As advantages of symbolic 3D map users indicated realistic view, simple object recognition, especially vegetation. General advantages of 3D maps by participants' opinion are improved spatial impression, better terrain recognition, especially for unskilled users, and further possibilities with interactivity. As disadvantages, perspective projection, worse map measurement possibilities and some area covered behind mountains and hills.

The very last question asked whether they prefer 3D maps in hard copy version (e.g. on the paper) or in soft copy, digital version, observed at the computer screen. As expected they preferred both if they are available.

CONCLUSIONS

Draped topographic map has been recognized almost as adequate for height or direction measurements as traditional 2D topographic map, while distance measurements bring more problems. The other two examples were evaluated nearly equally, they gave only limited accessibility for proposed measurements. Possibilities of recognition particular objects gave different order. Although the users are familiar with 2D topographic maps and therefore they know symbols presenting particular objects in draped topographic map, users found 3D symbolic presentation as much suitable for recognition majority of proposed objects. But, in spite of that, users favourite 3D draped topographic maps, since they are used of them, while 3D symbolic maps are something new for them. These results showed us that cartographers can't always just trust to users' opinion. Cartographers have to follow user needs, but also, based on theoretical principles in cartography, partly teach the users about advanced, new maps and their possible use.

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