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Pregledni znanstveni članak

Problems of the Scale and Building of Topographical Data Infrastructure

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ABSTRACT. The paper deals some problems with the scale and the possible concepts development of national topographical data infrastructure. There are two concepts in the procedure of structuring and updating of topographical data in digital (vector) form: model stars (discrete) and model steps (continuous). The discrete model consists of some basic data of framework. So, each of those data is updated separately. The continuous model concerning to the fundamental geospatial (topographical) data and all other data are generated from one level to another, in different scales and contents. There are some positive and negative characteristics in both concepts development of topographical data infrastructure. The first concept is good in this moment, but in the future the second concept will be better. However, it is very important that high level of modelling and automatization of procedures, both concepts support good possibilities for making and updating of topographical data infrastructure. Also, some experiences are presented in creating of the new topographic map by automated cartographic generalization.

Keywords: GIS, cartography, infrastructure of data, scale, generalization of data.

1. Introduction

Timeliness and utility of topographical data, or geospatial data is increasingly deteriorating. One of the main reasons is thought to be all solved by introducing information technology. It is believed that enough of the existing organizational structure to introduce modern computer equipment with appropriate programs and software, and will be easy and quick way to get to a digital presentation of objective geospatial reality. Another reason is that effective methods and procedures for the modernization of topographical data, or updating of geospatial content that would increase the quality and efficiency in the visualization of new cartographic overview, are not yet developed.

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In this difficult situation experienced cartography is under constant competition from other reasons. Therefore, the first *Google Earth* users had the geoinformation of better quality for geospatial orientation and GIS analysis free of charge. The second type of competition represents much better resolution of satellite images. And the third, it is also used more geodetic-cartographic surfaces that are scanned, but relatively outdated, too. However, all these surfaces have a serious shortcoming, and this is their limited practical value. Unfortunately, nothing in this area of geosciences is not so easy and quickly. It takes quite a knowledge, money and time. In this situation the question of the perspective of topographical data and cartography is raised.

2. Cartography and Building of Infrastructure of Geospatial Data

Alternative scanned maps or mosaics of aerophotos and satellite images are not an equivalent replacement of digital maps. Therefore, there is not interpreted on the model, but the physical pictures and recordings. Information about the area (clips, drawings, maps) must be also structured and suitable for the use and processing by computer, in addition to digital interpretations (Zeiler 2002).

Bearing all this in mind, it is necessary to define and adopt a long-term development strategy and the establishment of basic infrastructure of geospatial (topographical) data. In the first phase to generate a series of digital (vector) maps, and then in the second phase of their rounding to the level of geospatial databases and their permanent maintenance and updating (Longley et al. 2005). This will create the basic framework of topographical data for the future development of cartography and GIS at all levels (Hiroshi 2008).

On this issue, there are already some experiences and reflections. For example, Prof. Dietmar Grünreich, director of the German Bundesamt für Kartographie und Geodäsie (BKG), shows that the mapping data within the infrastructure of the area is at the beginning of a new era. In fact, speaking of geospatial data bases, such as for example German Automated Topographic-Cartographic Information System (ATKIS), is particularly important to stress that does not exist yet developed a complete process that would be one fundamental set of geospatial data can automatically notify the other sets, i.e. topographic and cartographic data models in other scales (ATKIS 2000), (Hake et al. 2002).

From the above mentioned reasons, the project ATKIS in BKG decided to digitize the first primary data sets with corresponding maps (1:25 000, 1:250 000, 1:1 000 000), which according to the scale and density of details appropriate content equivalent classical maps. After that they digitized graphical data, structured and joined them topological, semantic and temporal attributes. In this way, they created the basic digital topographic models, and from them later created cartographic models. Also, they scanned all the maps and put them available to users in raster format.

Note that digital topographic data somewhat change the philosophy of cartographic display. The aim is to find the simpler view that is released of excessive symbology and aesthetics, but the emphasis on accuracy and as much as possible updating of data. And finally, the most important is to build appropriate infrastructure of topographical data in order to provide using of geoinformation to wide range of users as simple as possible (NIMA 2000). Therefore, the classical task of cartography is the same in the information society. Namely, the faithful representation of geospatial structures of the environment in mind of topographical models is the assumption that we can create a visualization using cartographic representation of the environment.

3. Possible Concepts for Developing of Topographical Data Infrastructure

What is important to general information about the area are high quality, which means accurate and up to date, as so important that they be well structured and presented. And to do that, they must be properly organized and modelled. Today, it is usually through the modelling process and data modelling as a ubiquitous part of the national infrastructure of geospatial data. Geodesy and Cartography are the sciences which naturally belongs to the obligations of their collection and modelling. The main strategy in cartography today is how from one set of data to get to the other, and to be met the criteria of equivalence scale and density of content.

According to theory, "Organization of information about the area", there are different levels of information, which differs in quantity and content of data required for various needs of consideration, management or making decision. Therefore, there is so called information pyramid, or levels of data sets (Borisov 2006).

According to the "concept of discretization", it is necessary more basic levels of topographic data models of different degrees of detail (Figure 1). These levels are usually large, medium and small detailed. These levels can be the basis for presenting new, but relatively close to the scale and detail of content. Discretization of "information pyramid" by certain levels means that from one to the other data sets coming election or the reduction of the content, in accordance with the requirements of that level. The choice of data or generalization is the process of forming new sets, and the characteristic parameters, and sometimes simply summarize the data (Lagrange et al. 1995). The data flows from one level of detail to relatively close to (higher or lower) levels, when changing the by laws of cartographic generalization (Hake et al. 2002).

According to the "concept of continuity" for future topographic and cartographic tasks is enough only one set, or set of source of data space (Figure 2). The new derived topographic and cartographic models first applied the method model generalization and thus created the basic topographic models of structured data. Second, for the purposes of cartographic display, topographic data model has to be redesigned and shaped to the equivalent model of cartography or use symbolisation and visualization methods applied to geospatial data. The flow of data-charts upward indicates that one to the other information comes to the level of condensations of data, in accordance with the scale and needs of appropriate level of details.

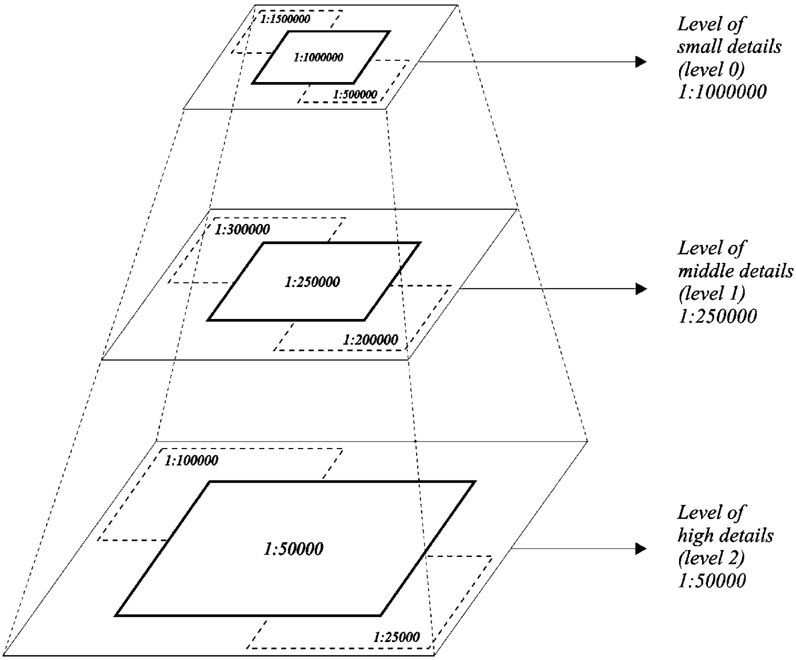

Fig. 1. *The concept of discretization topographical data.*

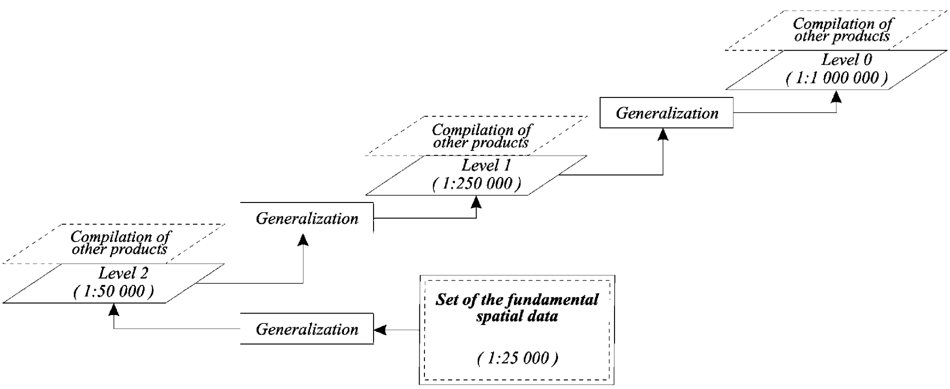

Fig. 2. *The concept of continuity of topographical data.*

One of the main tasks when it occurs is a selection of basic dimensions and resolution display in which data is collected from the field. Ideally a set of spatial data is disposed in the ratio 1:1, from which the generalization is performed for all scales and for all levels of detail content. As it is not possible, the problem is solved in practice by selecting one as the basic scale, according to which the procedures create cartographic generalization data for all other dimensions. In our state it is the cartographic scale of 1:25 000.

4. Topographic Map Production by Automated Generalization

Generalization of the topographic data in digital form, beside basic cartographic principles is influenced by other criteria that are dependant on form of digital data. In this case, digital data (map sheet) do not represent only stand alone graphical representation but visualized spatial geodatabase. Organizing data in this way allows, instead of simple vector graphic, higher level of automatization in process of cartographic generalization. Higher level of automatized generalization means that, according to our acknowledgement, up to 70% of content of different data classes can be automatically generalized directly from its supporting geodatabase. Percentage of generalization is dependent on cartographic generalization basic principles as well as on the relation between origin scale and required map scale.

Most appropriate type of cartographic generalization for automatization process is reduction of geographical data while simplified presentation with cartographic symbols and transformation of groups of elements into higher level elements are types of cartographic generalization where it is not possible to achieve greater percentage of automatization. For different data classes, generalization samples in process of creating DTM50 from DTM25 are given in Figure 3.

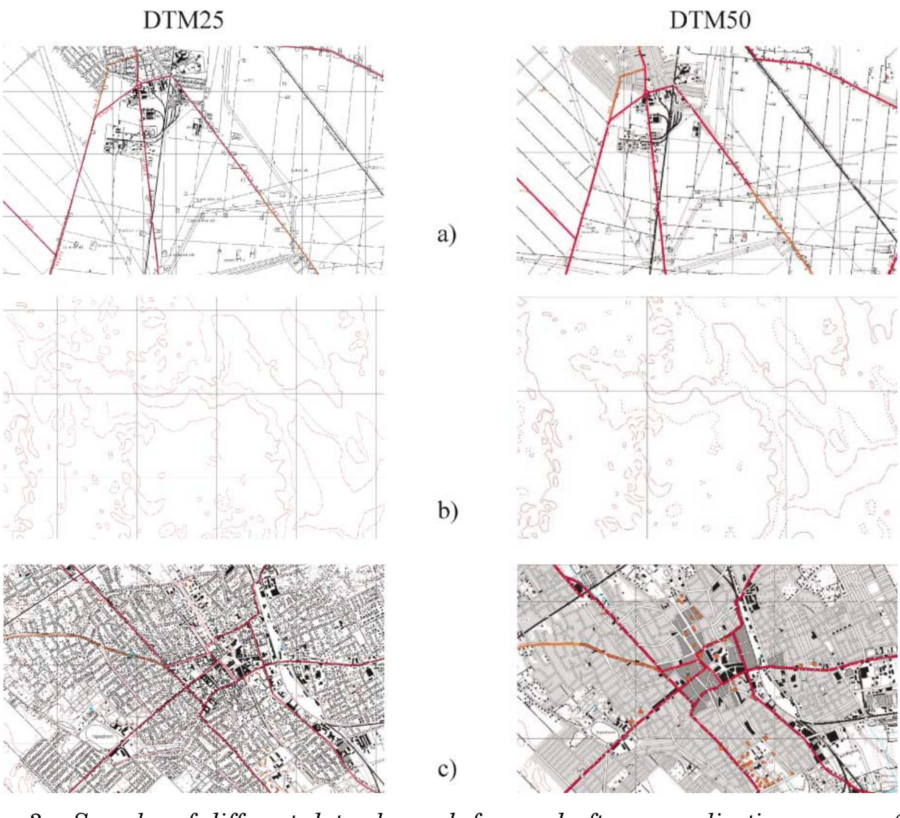

Fig. 3. *Samples of different data classes before and after generalization process: (a) Transportation (b) Relief (c) Population.*

The fundamental spatial data produced and added to the library at scale 1:25 000 is used for new project. The objective of this project was to design 1:50 000 scale digital topographic model (DTM) and cartographic production system. According to statistics, 70% of cartographic processes are carried out automatically and the rest are made interactively. On the other hand, time spent for production decreased to 35%.

In process of generalization from DTM25 to DTM50, creation is based on minor changes which mean reduction of topographical data. Some problems related to change of graphic primitives for mass elements are still present so we did not manage to achieve greater percentage of automatized generalization without harming relations between other elements of the map sheet. Achieved percentage of automatization varies between 0 and 70%.

Development of procedures for automatized generalization of content of DTM25 in purpose of creating DTM50 is still in progress. The main goal is to achieve automatization of generalization process in about 80% of cases for each element class. As mentioned above, our project group has created a semi-automatic production line by developing intelligent and sophisticated generalization tools using ArcGIS and its customization environment (ArcObjects, Visual Basic and C++ Programming languages).

5. Conclusion

Emergence of new technologies for collecting, displaying and analyzing geospatial data is also affected in our state to review and upgrade so far achieved results in the field of digital cartography and GIS. Generating of a national infrastructure of topographical data represents just a step in that direction, and a very important step.

This paper analyzed the two concepts. The concept is based on the generated vector data as large, medium and small details, and relatively close to the scale (detail) to create new products from existing ones. The second concept is based on a primary set of vector data, and all other datasets are derived from this set, regardless of the scale and detail. The state basic topographic map at 1:25 000 scale is selected as the basic set of topographic data, a good basis for creating models of the primary topographical model of data.

At the end it is very important to say that the second concept (primary) is more useful and practice, especially in the case when all topographical data are in the same database and they are displayed on unique way. It is better solution than forming and using framework of data at different scales and density. When we need information of quality, it is very important to use international standards, (Moellering and Hogan 1997), (DMA 2000).

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Problemi mjerila i izgradnje infrastrukture topografskih podataka

SAŽETAK. U radu se iznose neki problemi s mjerilom i mogući koncepti razvoja nacionalne infrastrukture topografskih podataka. U konceptu strukturiranja i održavanja topografskih podataka u digitalnom (vektorskom) obliku postoje dva osnovna koncepta: model zvjezdica (diskretni) i model ljestvica (kontinuirani) podataka. Diskretni model podrazumijeva kreiranje više osnovnih skupova geoprostornih (topografskih) podataka i njihovo održavanje. Kontinuirani model odnosi se na jedan osnovni (bazični) skup topografskih podataka i na osnovu njega izvođenje i održavanje (ažuriranje) svih ostalih nivoa ili skupova topografskih podataka, odnosno kreiranje skupova podataka različitih mjerila i sadržaja. Oba koncepta razvoja infrastrukture topografskih podataka imaju svoje prednosti i mane. Smatra se da je prvi koncept trenutno prihvatljiviji, a da je drugi koncept složeniji i ima veću perspektivu. Međutim, ono što je vrlo važno, a to je da uz veliki stupanj automatizacije i modeliranja pojedinih procesa, i jedan i drugi koncept pružaju mogućnosti novih kreiranja i održavanja podataka, odnosno izgradnju infrastrukture topografskih podataka. Također, prikazana su neka iskustva prilikom izrade nove topografske karte automatiziranom kartografskom generalizacijom.

Ključne riječi: *GIS, kartografija, infrastruktura podataka, mjerilo, generalizacija podataka.*

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