Spatial Data Infrastructure for Topographic Maps

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SUMMARY

This article presents the geospatial data model in scale of 1:25000, which is used during the production of the new digital topographic maps in Republic of Macedonia, produced in the same scale and on the basis of the carried out aerial survey performed in 2004.

The dynamic social, political, economic, technical and global production development are in a need of bigger quantity of detail and updated geo-information regarding the condition of the events and objects surrounding us. Basic source of geospatial information are the maps and for this reason they are considered as one of the most important technical component in the process of: management, production of development studies and planning projects, economic and social development, analysis of the diffusion of the spatial events and their interconnections. The possession of information is a key element in every society and those possessing the information are one step ahead, especially if they know how to use them properly.
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1. INTRODUCTION

The use of modern technology in aerial photogrammetry and cartography opens a possibility for accumulating large number of geospatial information which can be used to define and describe the surface of the earth. This means that real conditions are created in order for the geospatial data, besides the graphic content, to be used also as a basis for creating information systems, which is not the case in analog topographic maps.

2. GEOSPATIAL DATA MODEL

Subject of presentation in the cartographic area is the real world, which by its base has a very complex nature. This is why we present the real world with a certain degree of generalization, while the generalization of the real world is his model. The model is produced through the use of the modeling procedure which is the basis for shaping the geospatial data system and is a scientific method based on: production, grading and use of the model, which can be used to illustrate a phenomenon in a much better way.

The creation of the geospatial data model in scale of 1:25000 needs to be defined in a way so the model, as organized summary of data, can act as a basic foundation for all activities connected with the space and needs to provide efficient management, processing, presentation and safeguarding cartographic information. The proposed geospatial data model on one hand will satisfy the needs of the modern management of cartographic data, while on the other hand, will respond to the level of detail and accuracy for topographic maps in scale of 1:25000, which is an imperative that needs to be achieved in the future (picture 1)
Data models can be divided into four groups: hierarchical, network, relational and object oriented data model (picture 2).

The object oriented model shows many advantages compared to the other models, including relational model. In the object oriented data model, all the instances are objects and represent specific abstraction of real objects. The object database is total of objects, i.e. the database is comprised of set of objects, where each object represents some physical entity, notion, idea or organizational concept from reality. Each object gets unique identifier that remains present all the time.

Nevertheless, the development of database management systems gravitates towards combined relational and object-oriented databases, taking the advantage of both models.

3. PHASES DURING MODELLING TOPOGRAPHIC DATA
The data model is created depending on its purpose and it should enable quick access, accuracy, completeness and updating of the data.

There are several steps i.e. phases in creation of data model with certain generalization level, which are adjusted to the needs in the process of GIS creation (picture 3). The creation of the model is conducted through the following subsequent relevant phases:

- conceptual (conceptual level of abstraction);
- logical (implementation level of abstraction); and
- physical.

The data model is developed from ther starting phase i.e. conceptual model, through logical or implementation model, all the way to the physical model whose realisation finishes the database creation.

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**Picture 3. Phases on data modeling**

The conceptual model is partly structured data model of objects, characteristics and processes that are important for successful functioning of the concrete composition. The conceptual model is based on abstraction and implements the methodology that concentrates on recognizing of similarities among objects of the real world.

The logical topographic data model represents more like an implementation oriented representation for whose realization the existence of predefined conceptual topographic data model is necessity.

The aim of digital cartographic data should not be directed only towards the graphical representation. It means that the reasoning should be focused towards spatial data analysis through creation of structures of higher level by definition of spatial relations.
The physical topographic data model is the last stage of spatial data modeling. In this phase detail description of physical organization of data is represented i.e. its distribution within the computer system. It solves the problem of translating the abstract model into the computer language, i.e. its task is determining details needed for implementation of logical model in concrete physical record.

4. ASPECT OF OBJECT BASED GEOSPATIAL DATA MODEL

The geospatial data model in scale of 1:25000 is a data model which deserves a much bigger respect because it is used to describe the structure and the content of fundamental data (picture 4) - elements comprising the digital topographic map. Also, this is a model which will provide the establishment of the geospatial data information system. Also the concept UML scheme for Topographic Data Model (TDM) in scale of 1:25000 is shown in picture 4.

**Picture 4 -** Concept scheme of geospatial data model in scale 1:25000

In the methodology used for production of digital topographic maps in R. Macedonia, the creation of the geospatial data concept model is carried out by using the object based...
modeling, due to its ability to adapt to complex structures and due to harmonization with modern world standards.

The topographic data concept model in scale of 1:25000 grasps organization of the data and a manner of their presentation. According the theory of object based modeling and the standard for object based modeling ISO 19100 as well as the steps during the creation of the spatial data model, the concept model is formed for the needs of creating the digital topographic map in scale of 1:25000.

5. CONTENTS OF THE GEOSPATIAL DATA CONCEPT MODEL

One part of the contents of the geospatial data model in scale of 1:25000 applies to the current contents of the topographic map in analog form in the same scale. The classification of the data has emerged as a result of the logic grouping of objects contained in the cartography, depending on the geometry, category, type and characteristics of each object.

As we can see from the concept scheme of the data model (picture 2) during the production phase, the model is consisted of ten packages, and they are:

- administrative areas
- land classification
- roads
- railways
- waters
- small objects
- topographic characteristics
- text (textual note)
- reference raster
- spatial scheme

Each of the packages represents one totality which is comprised of classes, described by certain information i.e. data related to their characteristics and specific elements - so called attributes. The actual implemented object analysis during the creation of the model is based on the use of diagrams where the design of the packages is executed one package at a time with UML, using the graphic image of the class diagram. Using analytical processing of the diagram we can differentiate the class of the object and we can exploit the class diagram. The behavior of the classes is described with operations which are conveyed on the objects.

The main characteristic of each class is its name, while the attributes of each class are the following:

- **History**: is the date when the class is created. That date needs to match the time period of forming the model. There are six fields for assigning the date, out of which the first four fields are intended for writing the year, while the remaining two are used to write the month.
Type of element: during the creation of the topographic data logic model, each object needs to have exactly defined type of element. The element of the object will appear during the editing process, when according the data model in scale of 1:25000, the element shall be realized completely. The type of element for all objects in the model, during the acquisition process, has geometric character and can be presented with:

- geometric point defined with its rectangle coordinates
- geometric line i.e. opened contour comprised of geometric points
- geometric polygon i.e. closed contour comprised of geometric lines.

Usually, the points are used to present discrete objects with very small dimensions which are the reason why the object can not be presented with lines or surfaces in the assigned scale. Lines are used to show stretched objects, which have small width that can not be presented as surface in the adequate scale, while polygons are used to present objects which are substantially big and can be shown in the given scale.

Item: is the name of the class which is comprised of similar objects having mutual characteristics, giving us the opportunity to unite the object under this name.

Macedonian name: is a text for the title of the Macedonian language.

English name: is a text for the title of the English speaking area.

Code: is the code in form of number summary which is unique for each type of object of the model. The code, through the graphic symbol library of topographic signs (digital topographic key) is connected with adequate graphic symbol whose attributes are created through selection of its parameters: level, thickness of the line, type of line, color, type of sign and other. The attributes of the object connected through his adequate numeric code are easy to be processed by computer. Within the scope of one data base, the codes can be repeated depending from the spatial diffusion of the field contents. The numeration of the codes can be executed in the best manner if we increase it by one, starting according the following proposed schedule:

- administrative areas from 1001
- land classification from 2001
- roads from 3001
- railways from 4001
- waters from 5001
- small objects from 6001
- topographic characteristics from 7001
- text (textual notes) from 8001

This wide spread of numbers is made in order to create large quantity of free codes in the data base. The above stated is useful during management of the data from the model, especially in
the future when the model eventually will be supplemented with other characteristics. The colors of classes are selected in a way to act according their nature, where the water signs are created in blue color, the vegetation signs are in green color, the railway is in black color, contours are in sepia color and similar.

Note: is a marking element and contains textual descriptions and comments related to the class which additionally elaborates the note.

Each of the packages is divided in classes, while the classes are built from objects. The total number of objects in the geospatial data base is two hundred and the quantitative diffusion in each package is:

- administrative areas – two objects
- land classification – thirty nine objects
- roads – twenty six objects
- railways – nineteen objects
- waters – twenty eight objects
- small objects – forty six objects
- topographic characteristics – twenty one object
- text (textual note) – eighteen objects
- reference raster – one object (orthophoto)

The basic idea behind the creation of the presented geospatial data model was how to design one topographic model which will be complete, accurate and adjustable to all eventual needs of the different possible users. During this process, the observations that resulted from the analysis of the contents of the current topographic maps in scale of 1:25000 had played a considerable role, taking into account the new technology to be used for production of the maps.

For easier orientation in this multitude of data, the object approach is applied by which we have selected the relevant objects and we have assigned names so we can make a categorization of specific or abstract groups into certain classes. The concept model has made possible for us to create the model of the real world and to illustrate it through graphic form. This is the manner used to produce the geospatial data model in line of creating the digital topographic map in scale of 1:25000.

REFERENCES:

BIOGRAPHICAL NOTES

Academic experience:
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