

The Official Topographic and Mapping System of the Republic of Croatia

Igor VILUS, Croatia

Key words: STOKIS, CROTIS, topographic database, cartographic database.

SUMMARY

The initial STOKIS project (1995) has laid out the plan to design and establish the Official Topographic and Mapping Information System of the Republic of Croatia, dealing with issues of topographic survey and the production of State maps.

The establishment of the basic topographic database was started after the standards had been defined in the CROTIS project. The goal was to define the standards for topographic data, the basic and detailed solutions for topographic information system in terms of the data model, data collection, processing, precision, terms of presentation and topological relations.

The State Geodetic Administration has succeeded, in a very short time, to organize the legal framework, contracting methodology, production, quality control and product distribution for the basic official topographic data.

The accepted system is implementing the principle: “fly once – map once”, using the methods of the production of topographic and cartographic databases that can fully comply with the requirements of even the most demanding users.

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1. INTRODUCTION

The modern digital procedures for the production of topographic maps greatly differ from the classical cartographic procedures. With the classic modes of the map production, the situation obtained by the photogrammetric or field surveying served as the original for the cartographer who, using his/her cartographic skills and relevant rules of cartographic formation and generalization, copied and transformed it into a topographic map. Thereby, the cartographer used the cartographic key as the basic system for defining the contents and manner of showing the topographic objects on the map.

Today, the collection of topographic data by modern digital tools is carried out with the view of building a complex topographic multi-purpose system. Thus, the focus of topographic surveying has shifted from the production of an analogue topographic map printed on paper to the structuring, production, capture and maintenance of an organized and regulated database of digital spatial information. In well-built systems, such a database is also the foundation for the production of analogue topographic maps. The simple forms such as points, lines and texts, through the cartographic processing procedure and with the use of a corresponding code system, are transformed into the forms enabling the map user to obtain a visual perception of the map content and to recognize the characteristics of the terrain shown and the objects associated to it.

Among a number of projects initiated with the purpose of defining the Official Topographic and Mapping Information System (STOKIS), one should certainly single out the project entitled „CROTIS – Topographic Information System of the Republic of Croatia“ produced for the SGA by the Geofoto company in 2000. CROTIS, as the crucial part of the entire system of the State map production, had as its goal the standardization of topographic data, definition of the basic and detailed solutions of the topographic information system in the fields of data models, their collection, processing, accuracy, presentation manners and topologic relations.

The project was implemented with the establishment of the object-oriented basic topographical database (BTDB) in 2002. The data contained in the BTDB is the topologically processed original data of the photogrammetric restitution, and represents the most accurate and detailed data created during the production of the topographic map in the scale of 1:25,000 (TM25).

Special attention in the development of the official Croatian mapping is also paid to quality control. Given that the outsourcing model for the topographic production is not too widespread in Europe, it has been necessary to develop the specifications and organizational models to ensure the achievement and maintenance of the stipulated product quality. At the outset of the production, the quality control was carried out by the SGA employees and an outside associate. However, that model proved to be lacking so in 2001, the Croatian Geodetic Institute (CGI) was established and took over the quality control of the produced topographic maps. With the establishment of the CGI, the foundation was laid for a high-quality control

system that was built with the technical assistance of the Kingdom of Norway. Namely, in late 2001, the first in a series of technical assistance projects was initiated in the field of geodesy, mapping and cadastre between the Norwegian Mapping Authority (Statens kartverk) on the Norwegian side, and the SGA and CGI as its Croatian counterpart, that started the implementation of the jointly funded project aimed at improving the establishment of the mapping and topographic map databases in Croatia. (Bačić, 2009)

2. LEGAL FRAMEWORK

After gaining the independence, the Republic of Croatia regulated its national geodetic and spatial system in line with its own needs, possibilities and social and economic interests. With the adoption of the Law on State Survey and Real Estate Cadastre in 1999 followed by the implementation rules, primarily the Rules and Regulations on the Manner of Topographic Survey and the Production of State Maps, the State Geodetic Administration laid down the foundations for the development of the national topographic and mapping system in line with the modern technological trends and achievements.

2.1 Historical development

In the former federal State, due to political reasons, no State institution was set up in the Republic of Croatia to take care exclusively of topographic and mapping activities, topographic and photogrammetric surveys and the production and issuance of topographic maps with the exception of the Base State Map in the scale of 1:5,000.

The topographic maps in the scales of 1: 25,000, 1:50,000, 1:100,000 and 1:200,000, and the overview maps in the scale of 1:300,000 and 1:500,000 were produced at the Military Geographic Institute in Belgrade, both for military and civil purposes. Although the aforementioned maps were of high quality at the time they were issued, their content is 15-25 years old and the army institutions procured only multicoloured printed copies on paper while the use or multiplication of reproductions was forbidden.

Understanding the need to introduce changes in the overall geodetic and spatial system of the Republic of Croatia and given that the RoC practically remained without the sources of spatial information after gaining its independence, the State Geodetic Administration has initiated a number of project aimed at defining the scope of activities of the head office and operational units in order to produce topographic maps and establish services required for the realization of such a project.

The first produced „Study on the Structure of the Official Topographic and Mapping Information System of the Republic of Croatia“ (Institute for Photogrammetry, 1992) yielded the basic guidelines about the future organizational outlook of the official cartography of the Republic of Croatia, in such a way as to have the SGA responsible for the regulations, financing, planning, quality control and system maintenance while the map production itself was conveyed to the private sector.

Furthermore, it was necessary to define the need and rationale for establishing the aerial photography services and for setting up the first standards in the production of the photogrammetric photography. The first study that was produced was the Study on the Justification for Organizing the Aerial Photography Service in Croatia (Geodetic Faculty of

the University of Zagreb, 1993) followed by the study entitled „The Development of Standards for the Aerial Photogrammetry and Photographic Survey- Phase I" (Geodetic Faculty of the University of Zagreb, 1995). After the first three studies, two more studies were produced for the purpose of developing the topographic and mapping information system in Croatia. The study entitled „Official Topographic and Mapping Information System – design project“ (Institute for Photogrammetry, 1995) defines the look and operational system framework while the Study on the Replacement of Reproduction Originals and Renewal of the Topographic Map Contents (Geofoto, 1995) was produced for the purpose of preparing the outset of the topographic survey and the production of topographic maps.

The first maps in the scale of 1:25,000 were contracted in the early 1996 and encompassed 21 sheets of the Istria County. In parallel with contracting the first sheets, the SGA initiated the production of another very important study entitled „CROTIS – Topographic Information System of the Republic of Croatia“ (Geofoto, 1996). The study created the foundations for a systematic and successive collection of topographic data and defined the parameters necessary in order for the data to be easily exchanged, processed and topologically handled.

Many years have passed between the time of the production of the first version of the conceptual CROTIS data model and today, when its application has materialized with the establishment of the BTDB.

As the result of a continuous growth of interest in the world for the current geo data and geo-spatial data, the development of services based on the location (LBS-Location Based Services) and the growing focus on the exchange of the geo data and geo-spatial data over the Internet, we have been witnessing rapid changes in the standardization in the past several years, precisely in the area of the geo-information.

In the past several years, the International Organization for Standardization (ISO) has adopted, within the framework of the 211 Technical Board responsible for the geo-information, a number of standards that directly influence the national spatial data infrastructures. At the same time, the OpenGIS consortium has published several important implementation specifications bridging the gap between the international standards and their practical application by software companies.

With regards to that, it was inevitable to harmonize the CROTIS model with the existing standards in the domain of spatial information so in 2005 a project entitled „Production of the Object-Oriented Conceptual Data Model and the Protection of the GML Application Scheme” (Geofoto, 2005) was launched with the view of improving the existing CROTIS data model, its harmonization with the cartographic and cadastral data model, results of the project of establishing the SGA topographic database and the experiences of the topographic data producers and users. The project was successfully completed in 2006 and was implemented as part of the production of the new CROTIS data model version 1.2 in 2008.

2.2 Laws, Rules and Regulations, Product Specifications

During the development of the above-mentioned projects and studies, the TM25 production has not stopped and bigger maps have been produced without any halt over the years. The very statement that the SGA and the entire geodetic operative have actually built a system, in which the real value is the topologic base while the map is only one form of its visualization,

points to the fact that it has been necessary to adjust the laws and regulations with the technological capabilities or novelties.

With the adoption of the Law on State Survey and Real Property Cadastre (1999) and the subsequent adoption of

the State Survey and Real Property Cadastre Program for the 2001-2005 period (2001) adopted by the Croatian Parliament, a new momentum was gained in the production of topographic maps and the official cartography was defined in the RoC.

After the adoption of the Law on State Survey and Real Property Cadastre, the first Rules and Regulations were passed on the manner of topographic surveys and the production of State maps (Official Gazette no. 55/ 2001) stipulating the topographic survey methods as well as content and manner of the State map production. The stated rules became obligatory for all physical and legal entities performing the State survey and real estate cadastral works, i.e. all those participating in the process of the State map production.

The topographic survey, according to the afore-mentioned Rules and Regulations, encompasses the preparation, field determination of additional geodetic points, terrain surveying, mapping or rather the collection of the data on the natural and constructed objects and areas. The topographic survey data is the basis for establishing a topographic and cartographic database, the production and maintenance of maps and the production of the digital terrain model (DTM).

The basis for the production and maintenance of the CBM, TM25, the data collection (stereo surveying) for the purpose of the topographic database according to the CROTIS model is the cyclical photogrammetric surveying of the territory of the Republic of Croatia. Based on the oriented stereo pairs on the stereo instruments, the surveys map the topographic objects by associating to them the object categories, groups and types in accordance with the CROTIS data model.

Given our specific model of outsourcing the cartographic production, it has been necessary to develop the documents and organizational models to ensure the achievement of the product quality in order for the Croatian Geodetic Institute to be able perform a smoothless quality control. The SGA and CGI, in collaboration with the Statens kartverk (Norwegian Mapping Authority) as the responsible institutions of their respective countries, began in 2001 the Croatian-Norwegian Geo-Information Project (CRONO-GIP) with the aim of building the capacity for the establishment of the database of cadastral and topographic maps in Croatia.

The afore-mentioned project yielded the first product specifications that detailed the products, the manner of their production and the manner of the quality control implementation. This refers to the specifications of the aerial photography and orientation points for the scanned images, the aerial triangulation for the topographic survey data, the topographic map production itself for the production of the digital ortophoto map and the production of the digital terrain model. These specifications do not refer only to the part performed by the SGA and CGI but also to the procedures of the production and internal quality control of the companies that produce these maps.

Since 2003, the product specifications have been intensely used and all products contracted or produced by that date have to match the parameters of structure and accuracy described in them (Figure 1)

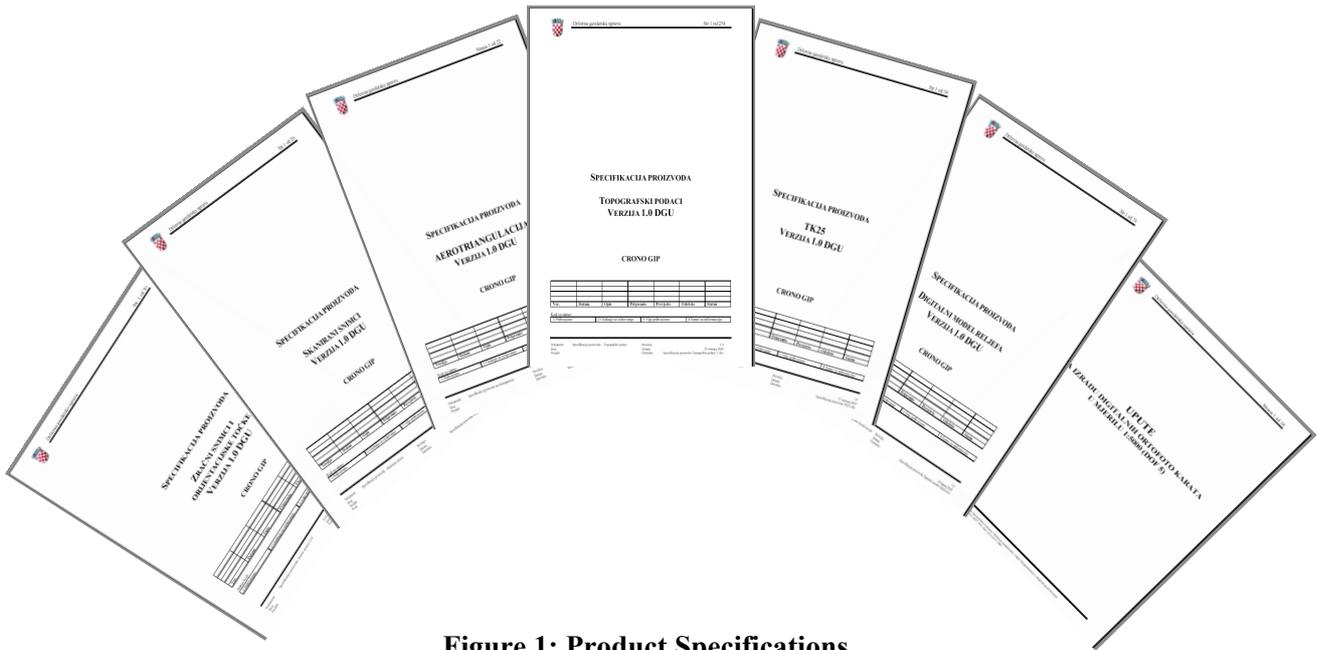


Figure 1: Product Specifications

Faced with the growing technological achievements in the domain of the topographic data production, the SGA also drafted the new Law on State Survey and Real Property Cadastre in 2007 (Official Gazette no. 16/2007), followed by the new Rules and Regulations on Topographic Survey and State Map Production (Official Gazette no. 109/2008). These Rules and Regulations introduced a number of changes as compared to the old ones from 1999. Firstly, the new Rules and Regulations define the manner of collecting, processing and storing the topographic survey data, quality control, manner of conducting and maintaining the topographic and cartographic database and the manner of producing the State maps in corresponding scales. Furthermore, in line with the Decision on the Determination of the Official Geodetic Datums and Plane Cartographic Projections of the Republic of Croatia (Official Gazette no. 110/2004) and the Erratum of the Decision (Official Gazette no. 117/2004), a new transverse Mercator projection – HTRS96/TM has been introduced for the scales of 1:300,000 and above, while the projection coordinate system of the Lambert conformal conic projection (HTRS96/LCC) was introduced for the overview topographic maps in the scale of 1:500,000 and smaller. The afore-mentioned entails also the introduction of a new division of the alphanumeric sheet codes on the official State maps and cadastral maps in the HTRS96/TM and HTRS96/LCC projection systems. Furthermore, following in the footsteps of the technological development in the field of aerial photography and photogrammetric surveys, the Rules and Regulations define the cyclical digital camera shooting with the spatial size of an illustrated element in the terrain amounting to 30 cm or with the analogue camera in the scale of 1:15,000. The photographic material of the new cyclical shooting would be, apart from the current practice of being used for the production of the orthophoto map in the scale of 1:5,000 and the basic topographic base, also used for the production of the Croatian Base Map in the scale of 1:5,000.

3. OFFICIAL STATE MAP

The official State map is a coded image of natural and constructed objects on the Earth's surface that the State Geodetic Administration is producing for the entire area of the Republic of Croatia.

The content of official State maps has been determined by the product specifications related to the map production for each map scale. For each map, the SGA produces also a collection of cartographic signs. When it comes to the content, the official State map consists of a set of data

on:
permanent geodetic points, constructions, utilities and utility-related objects, roads and objects related to transport, vegetation and the type of land, waterways and objects related to waters, altitude representation and terrain forms, State border, geographic names, so it is produced in official cartographic projections (Figure 2).

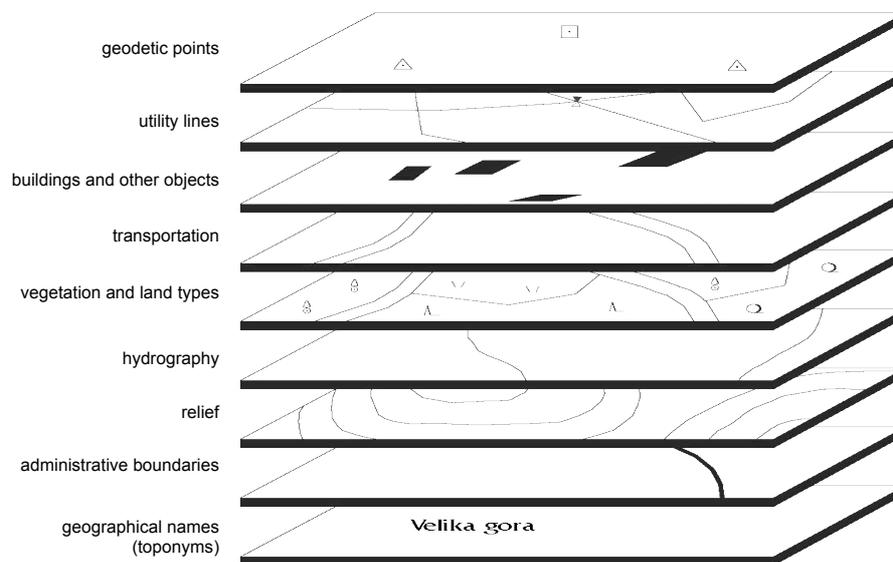


Figure 2: Content of the official State maps

The basic official State maps are: Croatian Base Map in the scale of 1:5,000, or exceptionally in the scale of 1:10,000 for the areas of lesser economic importance (CBM 5/10), Orthophoto Map in the scale of 1:5,000 (DOP 5) and Detailed Topographic Map in the scale of 1:25,000 (TM25).

The other official detailed and overview topographic maps are produced as needed on the basis of the topographic and official cartographic databases for a specific scale or based on the basic official State map.

All maps produced as part of the SGA activities are being made on the basis of the topographic and cartographic databases for a specific scale starting from the BTDB.

Since the BTDB data, due to their high accuracy and attention to details, are not suitable to be visualized in their original form as topographic maps of different scales, it has been necessary to develop the methodology that would link the existing basic topographic databases with the databases of different scales.

The key to it all is the categorization of the term „object generalization“ into two types of generalization: model and cartographic.

The model generalization in short means the automation of certain processes in order to obtain for a specific accuracy the result that is the most acceptable, e.g. the model generalization refers to the generalization of the initial data model and, as opposed to the cartographic generalization, is not burdened with the illustration (symbolization) on the map by distancing certain data and is limited to the map space.

The primary goal of the model generalization is the reduction of the scope of data as adjusted to the targeted abstraction level or: the reduction of the scope of data, removal of the details not important for the targeted abstraction level, data harmonization. In general, the model generalization consists of: selection/elimination of objects, modifications of the geometry type, integration and geometric simplification.

With the model generalization, none of these operations encompasses the distancing of objects i.e. the position of objects remains the same and that is the crucial difference as compared to the cartographic generalization.

The non-distancing of objects leads to the preservation of the planned and required accuracy of a spatial data with all the benefits offered by the object-oriented spatial database.

Therefore, the result of implementing the model generalization boils down to „step by step“ as follows:

- The topographic database in the scale of 1:25,000 (TDB25) is derived from the BTDB
- The topographic database in the scale of 1:50,000 (TDB50) is deduced from the TDB25
- The topographic database in the scale of 1:100,000 (TDB100) is deduced from the TDB50
- The topographic database in the scale of 1:250,000 (TDB250) is deduced from the TDB100

The topographic databases satisfy all the needs of the users who need to perform spatial analyses of great or reduced accuracy.

When we speak about the maps, we need to comment on the very definition of the topographic map: „The general geographic map with a large number of information on the local circumstances of the area shown, as related to the settlements, roadways, waterways, land formations, vegetation and a number of other occurrences required for the overall orientation, all enhanced by a map description. All the objects stated are illustrated as equally important.“ (Geodetic Dictionary, Francula, Lapaine, 2008).

When producing a map, the expert (cartographer) tries to describe and illustrate all the aforementioned information which means that, during the process of transforming the cartographic generalization, he/she strives to locate all objects in the illustration of a certain area but with a certain level of abstraction that greatly depends on the expert her/himself and not on the strictly written technical rules. By developing the above-mentioned, it can be further deduced that the real situation in a certain area is actually adulterated in order to located all the necessary objects on the map.

Therefore, the new Rules and Regulations define that the „cartographic databases“ are derived from the topographic databases and that they are used exclusively for the visualization of topographic maps according to certain layers. (Figure 3).

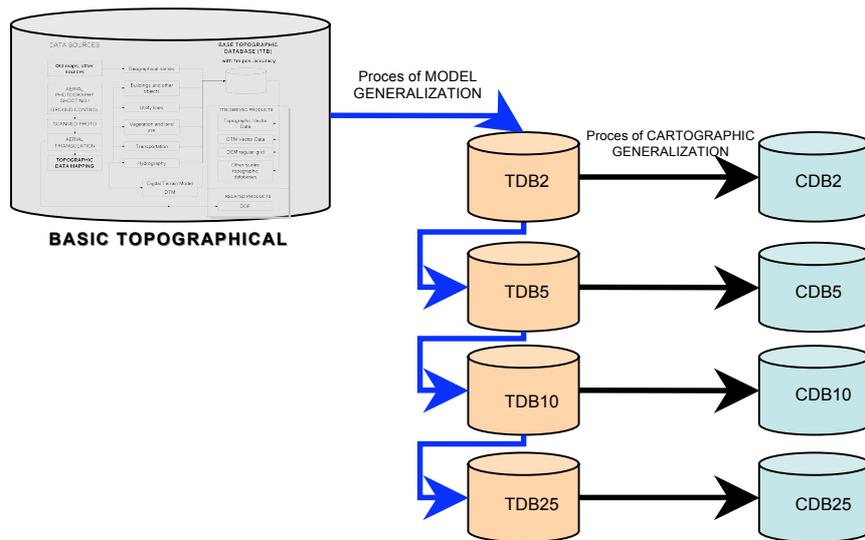


Figure 3: Model/cartographic generalization principle

The cartographic databases are established on the basis of the topographic databases for a certain scale by using the cartographic generalization methods as follows:

- The cartographic database in the scale of 1:25,000 (CDB25) is deduced from the TDB25
- The cartographic database in the scale of 1:50,000 (CDB50) is deduced from the TDB50
- The cartographic database in the scale of 1:100,000 (CDB100) is deduced from the TDB100
- The cartographic database in the scale of 1:250,000 (CDB250) is deduced from the TDB250

After homogenizing and linking into a continuum all the above-mentioned sets, we obtain a cartographic database without the object-oriented approach to data but serving exclusively as a means to define the exit of any layer or map without taking into account the framework but the space for illustration.

4. CONCLUSION

The basic principle of the *e-Croatia* concept determined by the Croatian Government is based on a single collection of information and its multi-purpose use.

Since the importance of the spatial information is growing in today's global world, today's users looking for adequate products may obtain an accurate and updated information on the space.

The SGA is tasked and legally bound to promote the spatial information and must inevitably do everything in its power to form the products demanded by prospective users by, naturally, adequately communicating with them.

By realizing the afore-mentioned, the SGA acts towards increasing the level of knowledge on the spatial information and the knowledge and use of the spatial information is directly correlated with the economic growth of a society and the level of its efficiency. Therefore, the SGA will continue to implement these projects and develop new ones that will serve to achieve the afore-mentioned goals.

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BIOGRAPHICAL NOTES

Igor Vilus was born on April 8, 1967, in Sisak, Croatia. He graduated geodesy at the University of Zagreb in 1995.

His professional career began in 1997 when he started working for a construction company as a geodetic engineer. Since 2000, he has been employed at the State Geodetic Administration of the Republic of Croatia (SGA). He has been the head of the Department for Topographic Survey and Cartography since 2004.

Member of the working group for ISO/TC 211 Geographic information/Geomatics; author and coauthor of many papers in the spatial data domain and active member of several projects in the SGA.

CONTACTS

Mr. Igor Vilus
State geodetic administration of the Republic of Croatia
Gruska 20
HR-10000 Zagreb
CROATIA
Tel. +385 1 6165 426
Fax + 385 1 6165 430
Email: igor.vilus@dgu.hr
Web site: www.dgu.hr