The Implementation of New Official Geodetic Datum and Map Projections in the Republic of Croatia

Marinko BOSILJEVAC and Željko BAČIĆ, Croatia

Key words: geodetic reference system, implementation, Croatia

SUMMARY

On the basis of the Law on State Survey and Real Estate Cadastre, on August the 4th, 2004 theGovernment of the Republic of Croatia adopted the Decree on establishing new official geodetic datum and map projections for the Republic of Croatia. The Decree determined new horizontal, vertical and gravimetric datum as well as new map projection of the Republic of Croatia.

Being aware that implementing new geodetic datum and map projections is a very complex and long-term process that implies system approach, very good organization and coordination of a multiple tasks, State Geodetic Administration adopted the Program of implementation of new official geodetic datum and map projections, for the period from 2005 to 2010. The Program has implied that new geodetic datum implementation is to be achieved by conducting chain of tasks divided in integral legislative, technological and organisational units.

As the Holder of the Program enforcement, State Geodetic Administration has put great efforts into assuring resources and other capacities which are necessary for conducting each and every Program task. The Program enforcement has also been supported by the Faculty of Geodesy, University of Zagreb and Croatian Geodetic Institute.

This paper provides the overview of the results and experiences that have so far been achieved through the Program realization. The fact that all preconditions for Program implementation in everyday practise are already achieved, fully justifies such system approach. This also implies the need that State Geodetic Administration sets the Program extension for another five year period, in order to continue the implementation process management based on a system approach.

The present five year period has assured us that the new geodetic reference system is a highly demanding, complex and long-term process. As such, it represents a great challenge but also a big chance for the entire Croatian geodetic cadastre system to prove ourselves by providing the Croatian society with the modern reference system that shall comply with all customers' requests.

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1. INTRODUCTION

On the basis of the Law on State Survey and Real Estate Cadastre (Official Gazette 116/99), on August 4, 2004 the Government of the Republic of Croatia adopted the Decree on establishing new official geodetic datum and map projections for the Republic of Croatia (Official Gazette 110/04 and 117/04). The reasons for introducing the new official geodetic reference system are the following:

- inadequate accuracy and significant errors in the existing datum which makes it inadequate in the framework of using the new measurement technology and modern requests of the users,
- the existing solutions have been adopted and adjusted to former states among which Croatia was only one constituent part,
- removal of the existing obstacles in the efficient use of modern measurement and GIS technologies, whereby the state, economy and citizens were offered an unambiguous, rational and simple reference system and framework to be implemented,
- introduce the official geodetic datum and plane map projections based on modern achievements in science and harmonized with the European recommendations and trends,
- in the part referring to spatial data, to create preconditions for the development of information society in Croatia (e-government, one-stop-shop) and enable a further development of geodetic and all other geo-related professions.

2. HORIZONTAL DATUM – HTRS96

The Decree defines the horizontal datum of the Republic of Croatia for which the European Terrestrial Reference System for the epoch 1989,0 – abbreviated ETRS89 was adopted and which the majority of European countries has adopted as their horizontal datum in compliance with the EUREF and EuroGeographics recommendations. As the mathematical model for the planet Earth, this reference system uses the GRS80 ellipsoid which is determined by its constants. The materialization of this reference system is represented by the basic horizontal made up of 78 permanently stabilized basic geodetic points whose coordinates are determined in the ETRS89 system. Our realization of ETRS89 for the Republic of Croatia was named as Croatian Terrestrial Reference System for epoch 1996,55 or abbreviated HTRS96, in relation to the time of system establishment.

3. VERTICAL DATUM - HVRS71

The vertical datum of the Republic of Croatia is determined by the geoid surface as reference surface for determining heights, and which is determined by the middle sea level for epoch 1971.5 at five tide gauges equally distributed along the Adriatic coast (Dubrovnik, Split,

Bakar, Rovinj and Kopar). Even though the vertical datum is usually defined by only one starting point, our specific approach to defining the geoid surface has given very good results, because the comparison between sea-level and geometric measurements points to the regularity of geoid surface along the Adriatic coast, and thanks to such an approach, the data of vertical system is harmonized with physical reality.
The materialization of the vertical reference system of the Republic of Croatia is made up of permanent points – benchmarks of fundamental levelling network known as II levelling of high accuracy – II NVT, whose heights are expressed in relation to the new definition of height datum, and regarding the middle epoch of sea-levelling observiations, the system was named as the Croatian Vertical Reference System for epoch 1971.5, abbreviated as HVRS71.

4. GRAVIMETRIC DATUM – HGRS03

The international gravimetric system known as IGSN71- the International Gravity Standardisation Network 1971 was adopted for the gravimetric datum, which uses the same mathematical model for the planet Earth – GRS80 ellipsoid, with additional set of corresponding physical parameters.
The materialization of gravimetric reference system is made up of fundamental gravimetric network consisting of 6 absolute gravimetric points and 36 points of the Ist order gravimetric network, and this reference system was named as the Croatian Gravimetric Reference System 2003, abbreviated as HGRS03, in relation to the year of realization.

5. MAP PROJECTION – HTRS96/TM

The Decree stipulates that the transverse aspect of Mercator's (Gauss-Krueger) projection with the mean meridian 16^0 and $30'$ and with linear scale of 0.9999 is determined to be the official map projection of the Republic of Croatia for the filed of cadastre and detailed state topography. The Lambert conformal conical projection with defined standard parallels 43° 05' and 45° 55' is determined as official map projection for the needs of general state cartography. Both projections are based on the GRS80 ellipsoid as the mathematical model, i.e. the HTRS96 reference system. For the needs of the Republic of Croatia Armed Forces and in accordance with the recommendations and obligations towards NATO, the Universal Transverse Mercator projection –UTM was adopted.

6. PROGRAM OF INTRODUCING THE OFFICIAL GEODETIC DATUMS

Aware of the fact that introducing new geodetic datums and map projections is a very complex and long lasting process requiring a very good organization and coordination of conducting a whole range of tasks, the Decree regulates its graduate introduction into the official use on the basis of the Program for introducing new official geodetic datums and map projections, which was passed on September 15, 2005 (hereinafter referred to as the Program). The purpose and objectives of the Program are the following:

- introduce new datums into practical use on the entire territory, into all official records and databases, as well as all works conducted by State Geodetic Administration (SGA)

- ensure the new geodetic reference system for the establishment of the National Spatial Data Infrastructure (NSDI),
- create the necessary preconditions and ensure support for the introduction into all official spatial records and databases of the State Administration bodies, and ensure its implementation in the economy and civil sector,
- develop the legislation and implementation of the regulations, standards and specifications necessary for the implementation of the Program,
- develop (establish) the system of education and training that will ensure the Program implementation.

For the purpose of ensuring the set objectives, the Program has defined the following:

- tasks and assignements necessary for the introduction into the official use,
- manner and deadlines of their completion,
- holders and subjects in their implementation,
- measures and activities that the State Geodetic Administration will undertake with the objective of introducing all spatial data users into official use, with a particular emphasis on the bodies of State Administration and public systems.

The Program plans to complete the implementation of new datums with the implementation of tasks divided into legal, technological and organizational units: basic geodetic works and state border survey, topographic survey and development of state maps, real property cadastre, register of spatial units, utility cadastre and geodetic works for special purposes and education and development of normative - technical regulations.

7. CURRENT PROGRAM REALIZATION

7.1. Basic geodetic works

7.1.1. Establishment of the permanent GNSS network - CROPOS

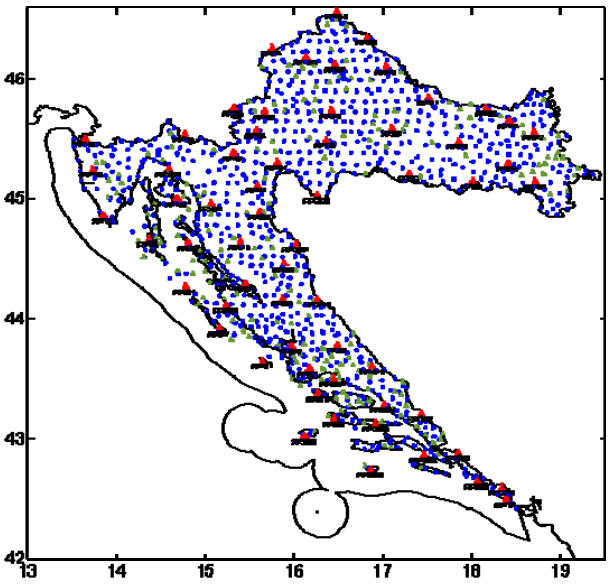

Figure 1. Croatian base horizontal network

At the moment of adopting the Decree, the HTRS96 reference framework was represented by the basic reference GNSS network of the 0 and 1st order, consisting of in total 78 basic and permanently stabilized geodetic points. That was the basis for the development of the GNSS reference network of 2nd order (10 x 10 km density) – the total of 1023 points, which represents the basis for the development of additional reference networks of 3rd order (fig.1) The additional reference networks have been developed for larger cities as well as the cadastral municipalities where the cadastral surveys are being conducted. This established reference framework has been upgraded with the state

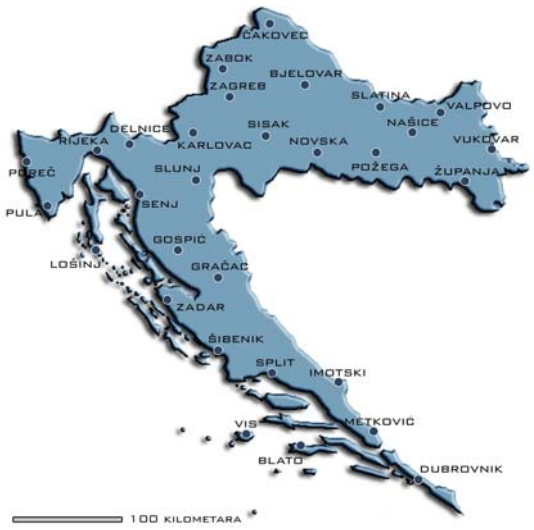

Figure 2. CROPOS network design

network of reference stations – CROPOS (fig.2). Such HTRS96 materialization enables a simpler, more precise and definitely more cost-effective determining of point coordinates directly in HTRS96 on the entire state territory. CROPOS was officially launched on December 9, 2008 and the users have access to three types of services which are charged (table 1) that mutually differ according to the method of solution, manner of data transfer, accuracy and format of data. As of December 31, 2009, 254 users (fig.3) is registered, and the average of using VPPS service in the past 6 months has been at the level of 350 000 minutes per month (fig.4). CROPOS provides the users with three types of services which are charged. As of December 31, 2009, 254 users (fig.3) is registered, and the average of

CROPOS services	METHOD SOLUTIONS	DATA TRANSFER	ACCURACY	DATA FORMAT
DSP	network solution of coded surveys in real time	Wireless Internet (GPRS, UMTS), NTRIP protocol GSM	±0.3 do ±0.5 m	RTCM 2.3
VPPS	network solution of phase surveys in real time	Wireless Internet (GPRS, UMTS), NTRIP protocol GSM	±2 cm (2D) ±4 cm (3D)	RTCM 2.3 RTCM 3.1
GPPS	*post-processing*	Internet (FTP, e-mail)	±1 cm (2D, 3D)	RINEX RINEX VRS

Table 1: **CROPOS** services and their characteristics

using VPPS service in the past 6 months has been at the level of approximatly 350 000 minutes per month (fig.4). For the purpose of increasing the quality and reliability of data in the border areas with Hungary, Slovenia and Montenegro, agreements have been signed and an exchange of border station data has been established, therefore currently 43 reference GNSS stations are involved in the network solution and calculation of correction parameters.

Figure 3. Registration of CROPOS users in 2009

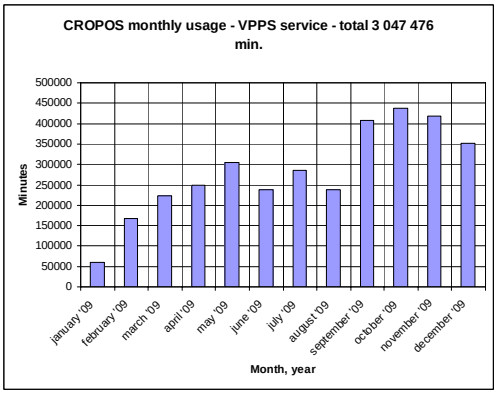

Figure 4. CROPOS VPPS service use

A high technological and technical quality of all system components, as well as its administration and maintenance ensure a reliable work and system availability of 99.9%. In the first year of system performance, the system was unavailable for 8 hours in total (Internet was disconnected or there was a power cut in the control tower), which was unplanned. These indicators tell us that in only one year, CROPOS was entirely integrated in the geodetic and cadastral system of the Republic of Croatia, and represents the most important leverage in the implementation of the new geodetic reference system.

7.1.2. Renewal of the basic reference GNSS network

Figure 5. Renewed geodetic pillar

The majority of points of the current trigonometric grid of the 1st order are also points of the GNSS reference network of 0 and 1st order, as the basis of the new official Croatian Terrestrial Reference System – HTRS96, and as such they are highly important for the geodetic reference system. The majority of points have been stabilized in 1950s. Due to inadequate maintenance, the physical condition and appearance of most points is not so good. In order to prevent further deterioration of points and their complete disappearance, a restoration project was initiated within the Program to renew all 78 points of the basic positional reference network. So far, the total of 41 points have been renewed and the quality of performed works and the aesthetics of the renewed points (fig.5), clearly demonstrate the justification of the entire project and the satisfaction behind the effort invested in the realization of this project.

7.1.3. Renewal of the basic vertical network

Figure 6. Base vertical network

The vertical basis of the new vertical reference system – HVRS71 is made up of the network of benchmarks of II levelling of high accuracy (Fig.6). The main disadvantage of this network is its configuration which is adjusted to the former state (the levelling figures spread accross the territories of neighbouring countries) and the lack of gravimetric survey. Within the Program, a field review of the condition of benchmarks of all levelling network orders has been conducted. The review has determined a high percentage of benchmark deterioration in all network orders, which points to the fact that a systematic renewal is needed.

The next step is to prepare a project for an overall renewal of the basic vertical network which will include additional marking of destroyed bench marks, designing new lines for the purpose of adjusting the configuration to the state territory, the manner and method of vertical survey, and a systematic gravimetric survey of the entire network. The Croatian Geodetic Institute (CGI) is entrusted with completing this task. The project design is followed by the project implementation whose dynamics will depend on the available budgetary resources.

7.1.4. Establishment of gravimetric network

Within the Program implementation, the micro-gravimetric networks were established for all points (6) of the absolute gravimetric network, and the re-observation of absolute points is planned for 2010. With the establishment of 25 new gravimetric points of 1st order on the largest Croatian islands, the gravimetric network of 1st order has been entirely completed and it now contains the total 61 points (Fig. 8). Since 2005, the Croatian Geodetic Institute is in charge of performing all gravimetric tasks.

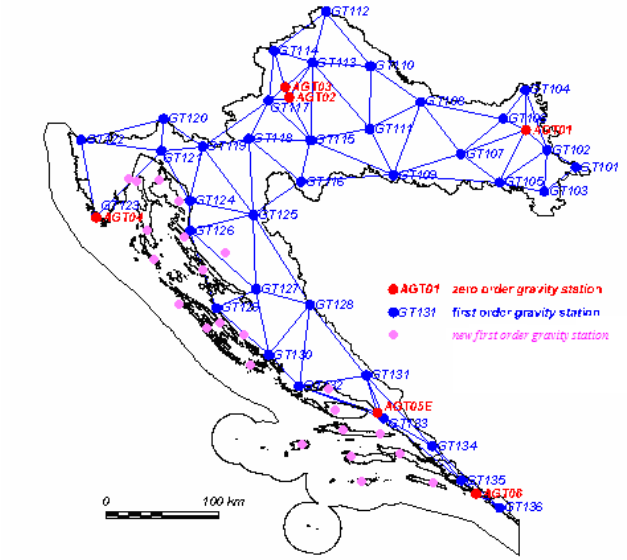

Figure 7. Gravimetric base network

At the same time as the works were being completed on the basic gravimetric network, the works started on the establishment of the gravimetric network of 2nd order within which the establishment of 250 gravimetric points of 2nd order was planned, out of which approximately 20% has been completed and the network completion is planned for the end of 2012.

7.1.5. Control measurements

In accordance with the EUREF recommendations, the CROREF2005 measurement GPS campaign was implemented in 2005 which covered 28 points of the basic reference GNSS network. To our initiative the Republic of Slovenia joined the campaign with 7 points and Bosnia and Herzegovina with 5 points. The obtained results point towards a generally good stability of the basic network since there are only a couple of points (2) showing discrepancies that exceed the expectations. The conclusion is that this is due to the relatively badly performed marking of these points. Prior to launching the CROPOS system in official use, the control measurements were conducted on 372 points of the basic GNSS reference network of 1st and 2nd order, equally distributed on the entire state territory for the purpose of examining the accuracy of determining the coordinates and system availability. The accuracy of determining the point coordinates based on odd measurements for determining the position is about ≈ +/-1 cm while the accuracy of the vertical component is: ≈+/-2 cm.

For the purpose of developing the transformation model for the positional transformation among reference systems, in 2009 a measurement campaign was conducted during which 3400 trigonometric points were measured that together with the 1800 previously measured points are incorporated in the model and they significantly contribute to its accuracy and reliability in all parts of the country.

7.1.6. Development of transformation models T7D

One of the most important Program tasks is definitely the development of the uniform transformation model that will enable a simple and equal-for-all-users procedure of the transformation of data and data sets developed in the historical reference system into the new official geodetic reference system – HTRS96. The transformation model called T7D was developed in cooperation with the Faculty of Geodesy of the University of Zagreb and is based on the uniform GRID transformation for the entire state territory. It includes the datum shift (a 7-parameter transformation) in the regular 60“ x 90“ raster of predicted values of distortion, for which 5200 identical points were used covering the entire state territory with the known coordinates in both reference systems. The new geoid model is used for the transformation of heights. The final product is a computer software T7D which ensures positional and vertical accuracy of transformation from +/- 0.06 m (in both directions) for the entire state territory. The plan is to integrate the T7D transformation model together with the Trimble Generation application into the CROPOS system in 2010, with the objective to distribute the data to the users directly in the selected map projection (or in the new HTRS96/TM) and it that way further simplify and accelerate the performance of field measurements through CROPOS.

7.1.7. Development of transformation model for the transformation of heights – HTMV08

For a mutual transformation of heights from the old vertical reference system into the new vertical reference system – HVRS71, a transformation model of heights – HTMV08 has been developed. The transformation model includes datum and distortion components which are developed in the grid form of 45“ x 30“ density on the basis of 8448 benchmarks with heights in both systems. Also, an external accuracy of the model was established with standard +/- 0.01 m discrepancy on the basis of 1589 points which were not used for the model development. The model has been incorporated in the T7D computer program and in that way it is very simply available to a large number of users.

7.1.8. Geoid model

In order to have a simple and accurate transfer from ellipsoid heights into orthometric heights, a new and significantly improved geoid model has been developed in cooperation with the Faculty of Geodesy of the University of Zagreb. In order to calculate the new geoid surface, the dotted free-air anomalies (more than 30000) were taken into consideration, toghether with geoid undulations (for 495 points), the geoid undulations obtained from the satellite altimetry

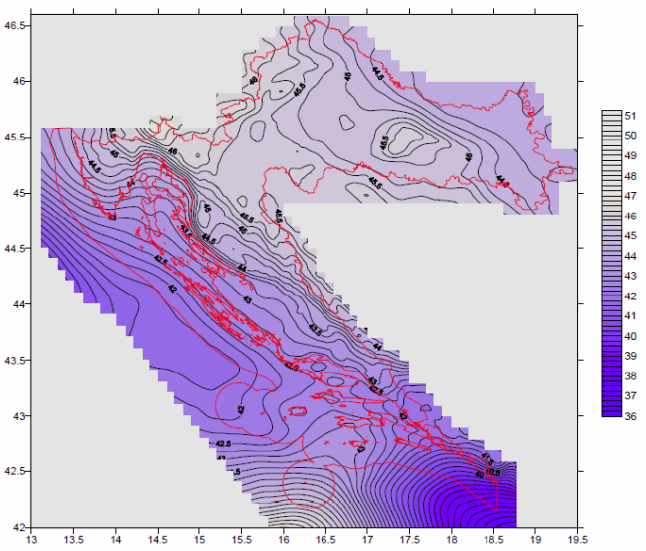

Figure 8. New geoid model

in the area of the Adriatic sea (400), and the global geopotential model EGM2008, which all resulted in a highly reliable geoid surface for the state territory (fig. A high internal accuracy with the standard discrepancy of +/- 0.03 m points to the well selected methodology and implementation of numerical calculations. The external evaluation of accuracy (standard discrepancy is +/- 0.04 m) obtained from the comparison with the control points which were not used in the model development (59 points), confirms a high absolute reliability of the new geoid model for the entire state territory.

7.2. Topographic survey and development of state maps

7.2.1. Division into official map detailed sheets in HTRS96/TM

The main characteristic of the new map projection – HTRS96/TM is a uniform coordinate system for the entire territory of Croatia with the mean meridian $16^0 30'$ and linear scale of 0,9999 along the mean meridian. The consequence of this is that in the areas more than 127 km away from the mean meridian, a deformation is introduced which is greater than it is accepted (1 dm on 1 km). In these areas, it is necessary to take into consideration the projection deformations while calculating in the projection plane. For the practical use of new mapping projection, Technical Specifications have been developed for the procedures of calculations and divisions into official map sheets and detailed cadastre map sheets developed in the map projection of the Republic of Croatia – HTRS96/TM. The main characteristic of the new division into topographic map sheets and detailed cadastre map sheets is the dimension of the map sheet, i.e. the detailed cadastre map sheet which is the same for all scales and amounts to 60 × 40 cm.

7.2.2. Development of official topographic maps TK25 and establishment of topographic database

The project of developing topographic maps in the scale 1:25000 – TK25 started in 1996 and so far 90% out of 594 sheets in total has been developed, and the remaining unfinished sheets are being developed. Their completion is planned for 2010 when the complete topographic and map database should be established. The entire project of TK25 development is being conducted in the old reference system and in accordance with the current division into sheets. After the development of all sheets and the establishment of complete topographic and map databases, they will be transformed into the system of new map projection.

7.2.3. Development of digital ortophoto map DOP5 in HTRS96/TM

Within the Land Parcel Information System Project which is being implemented in cooperation with the Ministry of Agriculture and Rural Development, in 2008 the development of DOP5 was contracted for 6089 sheets out of 9756 sheets in total (cca 60%), directly in the new reference system – HTRS96/TM. The completion is planned for the end of 2010. For the remaining sheets developed in the 2006 – 2007 period, the procedure of transformation into the reference system – HTRS96 is ongoing and the procedure to complete this has been developed by the Croatian Geodetic Institute. This will ensure a complete establishment of the DOP5 databases in the reference system HTRS96/TM.

7.2.4. Vectorization of Croatian base map HOK5 and the transformation in HTRS96/TM

The State Geodetic Administration has begun with the vectorization project of Croatian base maps in scale 1.5000 – HOK5. All of the developed HOK5 sheets have been scanned and georeferenced in the current reference system, and so far cca 10% has been vectorized out of the total number of sheets – 9756. After the vectorization of the contents of all HOK5 sheets and after the HOK5 database is formed, its transformation into HTRS96/TM will be conducted implementing the T7D transformation model, i.e. the model of height transformation HTMV08 for the transformation of height data.

7.3. Real Property Cadastre.

7.3.1. Cadastral map vectorization

In order to ensure the basic precondition for the transformation of cadastral maps, the project of cadastral map vectorization for the entire state territory was initiated in 2005. The state territory of the Republic of Croatia is divided into over 3300 cadastral municipalities with the total of more than 54.000 cadastral map sheets. The cadastral surveys for certain cadastral municipalities have been conducted using various surveying methods and in different time periods. In that respect, we distinguish the cadastral maps from the times of Austro-Hungarian Monarchy developed using the method of graphic survey (cca. 75%), from the cadastral maps developed in the period from 1950 onwards in the projection system of Gauss-Kruger projection (Bessel ellipsoid). In order to implement the vectorization, technical specifications have been developed as well as the program application called Vectoria, and also a database of digital cadastral map has been established whose completion is planned for the end of 2010.

7.3.3. Cadastral map homogenization

The state of cadastral maps produced in the historic projection systems (old Austro-Hugarian graphic survey – for approx. 75% of the state territory), even after the implemented vectorization, underlines their very poor quality of geometry and the lack of homogeneity as well as the lacking accuracy that is not adequate for recording highly accurate data determined by modern surveying methods (CROPOS). For this reason, it is necessary to carry

out the homogenization process, i.e. its proper insertion into the new geodetic reference system under which the existing lack of homogeneity is being removed and the geometry and accuracy are being improved. For that purpose, in cooperation with the Faculty of Geodesy, the procedure of „cadastral map homogenization“ has been developed as well as the technical specifiactions and the procedure for quality control of the conducted homogenization. The project completion, supported by the Croatian Geodetic Institute, is planned for the next program period.

7.3.3. Implementation of cadastral surveys directly in HTRS96/TM

For the purpose of analyzing the proposals and implementing in practice the new map projections, the State Geodetic Administration contracted in 2007 the survey of cadastral municipality Požari in the HTRS96/TM reference system as a pilot project. The experience obtained points out to the fact that the implementation of the new reference system will simplify the performance of cadastral surveys and will increase the homogeneity and accuracy of the survey itself. With the enforcement of "Technical Specifications for the procedures of calculations and divisions into official map sheets and detailed cadastre map sheets developed in the map projection of Republic of Croatia – HTRS96/TM" and with the establishment of CROPOS, all conditions have been met to conduct the new cadastral surveys from 2009 directly in the new reference system.

7.3.4. Transformation of cadastral maps in HTRS96/TM

The new systematic cadastral surveys have so far covered 7% of the state territory. The implementation of new systematic cadastral surveys is a long (approx. 2 years) and very complex task. It requires significant human and financial resources and this is the reason why the surveys are conducted in those areas (city centers, coastal belt) where there is a high level of real property transactions and where the value of real property is high, which justifies the procedure and guarantees the return of resources invested in the surveys. For the remaining part of the country (approx. 90%) the existing cadastral survey will continue to be available. The maintenance of cadastral maps at this moment is conducted in the reference systems used so far, whereas with the establishment of CROPOS it is possible to conduct all types of geodetic tasks in HTRS96/TM. The consequence of this is that good-quality and highly accurate data directly determined by the survey is transformed into the old reference systems and in that way their accuracy and homogeneity is significantly reduced.
In order to avoid that, it is necessary to transform the existing cadastral maps into the HTRS96/TM reference system. In relation to the original reference systems in which these plans were developed, it will be necessary to develop two transformation procedures – for the plans developed in Gauss-Krueger projection of meridian zones (approx 20%) and for the plans developed using the method of graphical survey (approx. 70%), and which include the afore-described homogenization procedure. Basic preconditions for a successful transformation of cadastral maps have been established and these include the implementation of cadastral map vectorization (completion in 2010) and a uniform transformation model – T7D (in use). For both transformation procedures, it is necessary to develop detailed procedure steps and technical specifications in order to have uniform procedures, since we

have more than 54 000 sheets available. After the transformation is completed, these plans will be maintained exclusively in the new system.

7.4. Register of spatial units

The State Geodetic Administration is responsible for managing the central register of spatial units. The data on the borders of all spatial units is kept in vector format in the central database, and the topographic maps in the scale 1:25000 in raster format are used as mapping data set. The entire database is established in the old reference system. With the completion of the topographic map in the scale 1:25000 and with the establishment of a new mapping database (2010), conditions will be created to replace the raster maps used so far with the new up-dated data sets in the new reference system into which the vector data on the borders of spatial units will also be transformed.

7.5. Utility cadastre and geodetic works for special purposes

The public companies, state bodies and institutions, cities and municipalities have developed for their purposes the utility cadastre, i.e. the geographic and information systems of different contents. All this data has been collected and processed in the coordinate system used so far. The introduction of new datums also assumes the transformation of these geoinformation systems and data sets into the new geodetic reference system. In the framework of cooperation with the Faculty of Geodesy, the State Geodetic Administration through an educational program will provide the necessary scientific and expert assistance to all state institutions, as well as other public systems in the transformation of their GIS systems into the new geodetic referece system, and the employees of these institutions will able to participate in the training program. We expect to intensify these activities this year, after the adoption of transformation models and the completion of all necessary normative and technical regulations.

7.6. Providing information, training and developing normative and technical regulations

7.6.1. Organization of regional CROPOS workshops and the 1st CROPOS conference

A well managed and scheduled information campaign directed towards potential CROPOS users (November 2008) has greatly contributed to the fact that six months after it was officially launched, the CROPOS system was entirely integrated into our geodetic and cadastral system. Through four informative workshops attended by more than 800 participants, the geodetic and cadastral public was informed about the manner and conditions of using CROPOS which was the key factor in its fast integration into the system. This was also helped by the development of CROPOS Manual which is distributed to the users at the moment they register, and it can be downloaded from the CROPOS web site - **www.cropos.hr**. A good functioning from the very beginning and a respectable number of users (254) after only one year, was the main reason to organize the 1st CROPOS conference (Zagreb, June 8 – 9, 2009). The main conference objective was to exchange domestic and international experience related to the work and use of permanent GNSS networks, as well as

to improve the implementation of CROPOS in the performance of a growing number of daily practical assignements, and to expand the implementation in other state administration bodies, public companies, economic and public sector. The conference gathered more than 300 users, experts, scientists and professionals whereby the expectations and predictions of the conference organizer were entirely achieved.

7.6.2. Development of normative and technical regulations and training

Procedure rules, i.e. the standardization of technical procedures (especially the transformation, use of geoid model) are highly important for the establishment of mutual trust and cooperation among the producers of geodetic data (authorized entities) and state bodies that officially verify and record this data (SGA, CGI). The regulations in the area of basic geodetic works were out-dated and in some parts they are no longer implemented. The new Rules and Regulations on the manner of conducting basic geodetic works (Official Gazette no.87/2009) support the new geodetic reference system together with the new acceptable and efficient methods of conducting basic geodetic works. The Rules and Regulations have covered the new categorization of geodetic networks (positional, vertical, gravimetric and magnetometric) and technical criteria for certain network orders, as well as standards for expressing the assessment of accuracy and final results. Apart from that, the Rules and Regulations have covered the measuring methods using GNSS technology including here also the implementation of CROPOS while establishing basic geodetic networks. Also, in 2009, the ”Technical Specifications for the procedures of calculations and divisions into official map sheets and detailed cadastre map sheets in the map projection of the Republic of Croatia – HTRS96/TM” were put in official use and they contain the description and algorithms for the resolution of basic tasks, the division into detailed sheets and names of official topographic map sheets in the projection system HTRS96/TM. This year, the State Geodetic Administration plans to start the process of educating and training geodetic experts to perform geodetic tasks in the new geodetic reference system.

8. CONCLUSION

New geodetic datums and their realization have been determined for the Republic of Croatia. The State Geodetic Administration as the Program implementation holder invests great efforts in order to ensure adequate funds and other capacities necessary to conduct the Program tasks, in the framework of executing annual programs. In that, SGA has the support from all partners in the Program implementation, primarily from the Faculty of Geodesy of the University of Zagreb and the Croatian Geodetic Institute.
Until the end 2009, through the Program implementation all preconditions were entirely established for further implementation in daily practice which is the end goal of the Program. In order to ensure that, it is necessary to continue with the program approach, on the basis of achieved results, and in that way systematically manage the implementation process.
From the previous five-year period, we can all conclude that the implementation of the new geodetic reference system is a highly demanding, complex and long-lasting process and as such presents a great challenge. Equally, it is an opportunity for our entire geodetic and

cadastral system to prove itself and to present to the Croatian society a modern geodetic and reference system which will be able to meet the users' requests.

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BIOGRAPHICAL NOTE

Marinko Bosiljevac, graduate geodetic engineer
Academic experience: graduate geodetic engineer, Faculty of Geodesy, University of Zagreb in 1985. He started his professional career as a surveyor at the local cadastre office in Ozalj. In 2001, he was appointed Assistant Director in State Geodetic Administration of the Republic of Croatia, responsible for development and maintanance of geodetic refererence system and state border. He has a big professional experiece in cadastre surveying, land registry, planning and development of GNSS permanent network and new reference systems introducing.Member of Croatian Chamber of Licensed Surveyors.

Prof. Željko Bačić, Ph.D., graduate geodetic engineer
Graduated in 1986 from the Faculty of Geodesy, University of Zagreb, and obtained his Ph.D. at the Institute for Applied Geodesy and Photogrammetry at the Technical University in Graz in 1997. He started his professional career as a teaching assistant at the Faculty of Geodesy in Zagreb. In 2002, he was elected Professor at the Satellite Positioning and Navigation Chair of the same Faculty. In 1999, he was appointed Deputy Director and in 2000 Director-General of the State Geodetic Administration of the Republic of Croatia. In period 2002-2009, he was member of the EuroGeographics Management Board and served as President in 2005-2007 period. Since 2008, appointed by Croatian Government as a member in the Croatian National Spatial Data Infrastructure Council and President of the NSDI Committee. Member of Croatian Chamber of Licensed Surveyors. Honorary member of Croatian Cartographic Society and Geodetic Association of Herceg-Bosna. Member of Cambridge Conference Advisory Board since 2005. He authored or co-authored more than 50 papers in various fields of geodesy and geoinformatics.

CONTACTS

Title, given name and family name:Marinko Bosiljevac
Institution: State Geodetic Administration of republic of Croatia
Address: Horvatova 82
City: 10 000 Zagreb
COUNTRY: CROATIA
Phone + 385 1 6165 412
Fax + 385 1 6165 430
Email: marinko.bosiljevac@dgu.hr
Web site: http://www.dgu.hr

Title, given name and family name: Prof. Željko Bačić
Institution: State Geodetic Administration of Republic of Croatia
Address: Gruška 20
City: 10 000 Zagreb
COUNTRY: CROATIA
Phone + 385 1 6165-444
Fax + 385 1 6157-389
Email: zeljko.bacic@dgu.hr
Web site: http://www.dgu.hr