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The implementation of new official geodetic datum and map projections in the Republic of Croatia

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FIG Congress, Sydney 11- 16 April 2010

Decree on establishing new official geodetic datum and map projections

- On the basis of the Law on State Survey and Real Estate Cadastre, 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).

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The reasons for introducing the new geodetic reference system

- inadequate accuracy and significant errors in the existing datum
- 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 further development of geodetic and all other geo-related professions

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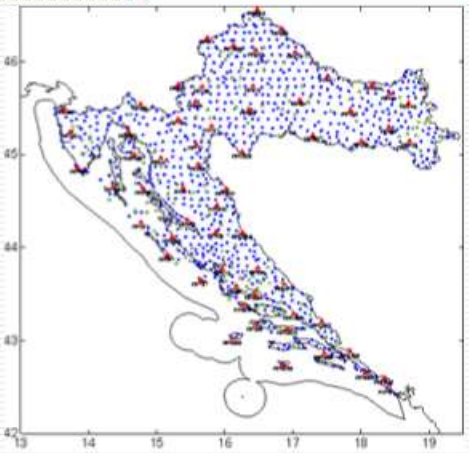
HORIZONTAL DATUM – HTRS96

- **ETRS89**
- **GRS80 ellipsoid**
  a = 6378137,00 m
  μ = 1/298,257222101

- **Basic referent GNSS network of the 0 i 1th order – 78 sites**

- **Croatian Terrestrial Referent System – HTRS96**

- **Basic referent GNSS network of the 2nd order (10x10 km) - 1023 sites**



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VERTICAL DATUM - HVRS71

- Geoid surface determinated at five tide gauges along the Adriatic coast (Dubrovnik, Split, Bakar, Rovinj i Koper) for epoch 1971.5
- Basic levelling network - permanent points – benchmarks of II. levelling of high accuracy – II. NVT
- Croatian Vertical Reference System sustav for epoch 1971.5 – HVRS71

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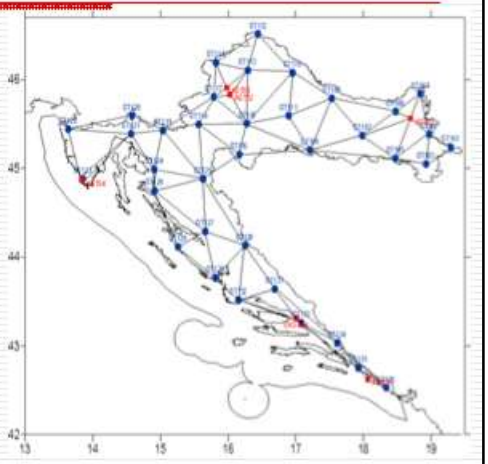
GRAVIMETRIC DATUM – HGRS03

- *International Gravity Standardisation Network 1971* – IGSN71
- Reference surface
  - GRS80 ellipsoid
  - GM = 398600,5 x 109 m^3s^{-2}
  - angular velocity of the Earth rotation
    $\omega = 7{,}292115 \times 10^{-5}$ rad s^{-1}
- Basic gravimetric network
  - Absolute gravimetric network - 6 sites
  - Gravimetric network of I. order – 36 sites
- Croatian Gravimetric Referent System – HGRS03



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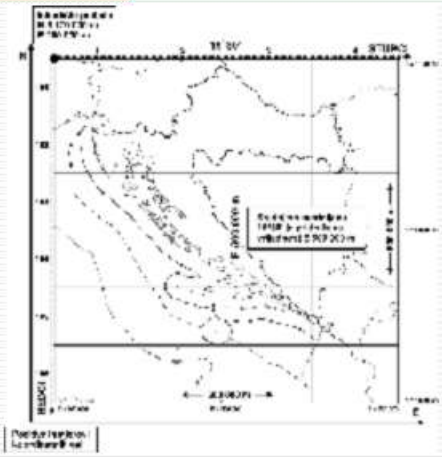
MAP PROJECTION – HTRS96/TM

- **Transverse aspect of Mercator's projection**
  - **Mean meridian 16° 30'**
  - **0,9999 linear scale**
  - **State survey and cadastre**
  - **GRS80 ellipsoid**
  - **HTRS96/TM**
- **Normal aspect of Lambert's conformal conical projection –**
  - **Standard parallels 43°05' i 45°55'**
  - **General state cartography**
  - **GRS80 ellipsoid**
  - **HTRS96/LCC**



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PROGRAM OF INTRODUCING THE OFFICIAL GEODETIC DATUMS

- 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.

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Current realisation
GNSS permanent network

CROatian POsitioning System

- launched on December 9, 2008
- in one year full integrated in croatian geodetic sociaty
- three types of services witch are charged
- on April 1th, 2010, 254 users are registered
- average use of VPPS (RTK) servis is 350 000 minutes per month

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Current realisation
Basic geodetic works

- **Renewal of the basic reference GNSS network**
  - physical condition is bad
  - to prevent further deterioration
  - 41 (78) points have been renewed
- **Renewal of the basic vertical network**
  - network configuration was adjusted to the former state
  - lack of gravimetric survey.
  - field review of the condition of benchmarks, high percentage of benchmark deterioration
  - systematic renewal is needed and planed for next five years program

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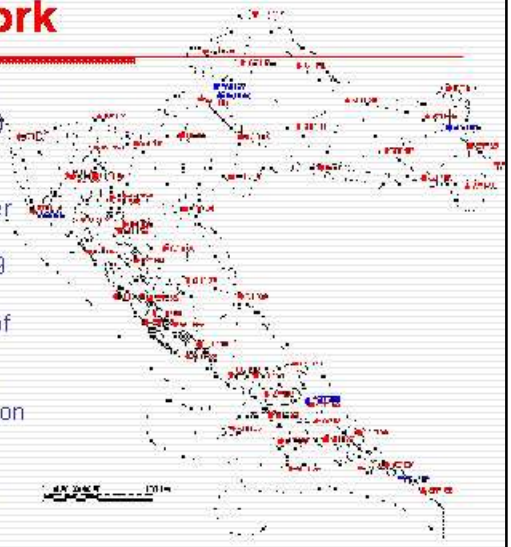
Current realisation
Gravimetric network

- the micro-gravimetric networks were established for all absolute points (8)
- re-observation of absolute points is planned for 2010
- 25 new gravimetric points of 1st order were established on islands which has been completed and contains 59 points
- 2nd order which the establishment of 250 gravimetric was started, out of which approximately 20% has been completed and the network completion is planned for the end of 2012.
- Croatian Geodetic Institute is in charge of performing all gravimetric tasks



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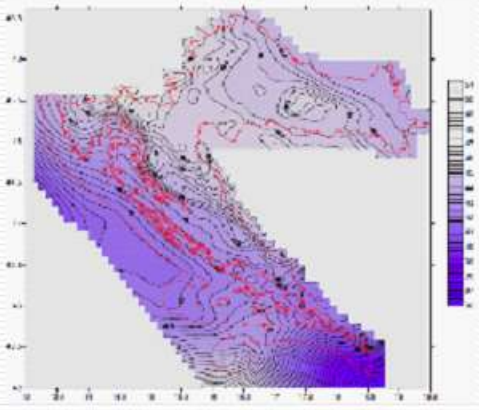
Current realisation
Development of geoid model

- for a simple and accurate transfer from ellipsoid heights into orthometric heights
- calculation of the new geoid surface was included
  - dotted free-air anomalies (more than 30000)
  - geoid undulations (for 495 points)
  - geoid undulations obtained from the satellite altimetryin the area of the Adriatic sea (400)
  - global geopotential model EGM200
- highly reliable geoid surface with high internal accuracy +/- 0.03 m
- highly external evaluation of accuracy +/- 0.04 , obtained from 59 control point



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Current realisation
Development of transformation model

- T7D was developed in order for simple and equal-for-all-users procedure of the data transformation
- based on the uniform GRID transformation T7D includes:
  - datum shift (a 7-parameter transformation)
  - predicted values of distortion in the regular 60" x 90" raster calculated from 5200 identical points
  - new geoid model is used for the transformation of heights
- T7D ensures positional and vertical accuracy of transformation from +/- 0.06 m (in both directions)
- Integration T7D transformation model with the Trimble Generation application into the CROPOS system
- more simplify and accelerate the performance of field measurements through CROPOS.
- Transformation model of heights – HTMV08 includes datum and distortion components calculated in regular 45" x 30" raster from 8448 indentical benchmarks
- external accuracy of the model +/- 0.01 m obtained on 1589 control points
- HTMV08 incorporated in the T7D computer software

Current realisation
Topographic survey and state maps

- new division into topographic map sheets and detailed cadastre map sheets (National Grid) was developed
- dimensions of the map sheet and detailed cadastre map sheet are the same for all scales and amounts to 60 × 40 cm

Current realisation
State topography

- **Topographic map in the scale 1:25000 – TK25**
  - The project started 1996, 594 sheets, full completion is planned for 2010
  - in old reference system and in accordance with the current division into sheets,
  - transformation into the system of new map projection.
- **Digital ortophoto map DOP5 in HTRS96/TM**
  - Total number of sheets - 9756, 6089 sheets completed in HTRS96/TM (60%)
  - remaining sheets (40%) produced in the 2006 – 2007 period, will transformed HTRS96/TM

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Current realisation
Real property cadastre

Cadastral map vectorization

- basic precondition for the transformation of cadastral maps, started in 2005
- 3300 cadastral municipalities with the total of more than 54.000 cadastral map sheets
- The cadastral survey have been conducted using various surveying methods and in different time periods
  - cadastral maps from the times of Austro-Hungarian Monarchy developed using the method of graphic survey (cca. 75%)
  - cadastral maps developed in the period from 1950 onwards in the projection system of Gauss-Kruger projection (Bessel ellipsoid)
- for vectorization process the technical specifications and procedures have been developed
- for maintanance of vector cadastral maps program application Vectoria have been developed
- database of digital cadastral map has been established whose completion is planned for the end of 2010

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Current realisation
Real property cadastre

Cadastral map homogenization

- **The state of cadastral maps produced in the old Austro-Hugarian graphic survey underlines**
  - very poor quality of geometry,
  - lack of homogeneity ,
  - lack of accuracy
  - is not adequate for recording highly accurate data determined by modern surveying methods (CROPOS)
- **The homogenization process was developed, proper insertion of cadastral maps into HTRS96/TM under which the existing lack of homogeneity is being removed and the geometry and accuracy are being improved**

Current realisation
Real property cadastre

Transformation of cadastral maps in HTRS96/TM

- new systematic cadastral surveys have so far covered 7% of the state territory
- for the remaining part of the country (more than 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
- with the establishment of CROPOS it is possible to conduct all types of geodetic tasks in HTRS96/TM
- consequence 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
- it is necessary to transform the existing cadastral maps into the HTRS96/TM, two transformation procedures:
  - for the plans developed in Gauss-Krueger projection of meridian zones (approx 20%)
  - 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
  - cadastral map vectorization (completion in 2010)
  - uniform transformation model – T7D (in use)
  - detailed procedure steps and technical specifications in order to have uniform procedures

Current realisation
Providing information and training

Organization of regional CROPOS workshops and the 1st CROPOS Conference

- four informative regional CROPOS workshops (november 2008) with more than 800 participants
- CROPOS Manual, distributed to the users at the moment they register, and it can be downloaded foom the CROPOS web site - www.cropos.hr
- Organization of the 1st CROPOS conference (Zagreb, June 8 – 9, 2009, exchange domestic and international experience related to the work and use of permanent GNSS networks, more than 300 users, experts, scientists and professionals

Development of normative and technical regulations and training

- The new Rules and Regulations in the area of basic geodetic works 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 their conducting
- "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

Conclusion

- New geodetic datums and their realization have been determined for the Republic of Croatia. The State Geodetic Administration 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.