

Official Spatial Data as the Basis for Management in Agriculture

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Key words: spatial data, land parcel identification system, national spatial data infrastructure

SUMMARY

In the European Union (EU), about 45% of all funds are allocated for agriculture and subsidies in agriculture. Consequently, the Common Agricultural Policies (CAP) is one of the most important policies in the EU. The implementation of CAP (allocation, monitoring and controlling of subsidies to the farmers) is carried out through the “Integrated Administration and Control System“ (IACS) which all EU countries are obligated to implement. The basis of the IACS is the GIS supported „Land Parcel Identification System“(LPIS).

Previously, the subsidies in the Republic of Croatia were supported by an alphanumerical database of farmers which was based on alphanumerical cadastral data. As a European Union pre-accession country, the Republic of Croatia is now in the process of implementing the IACS as well as LPIS. For this purpose, the alphanumerical data is going to be replaced with the following spatial data: digital orthophoto maps in the scale of 1:5,000 that will be used for the interpretation and measuring of agriculture areas; vectorized digital cadastral maps controlling the interpretation and connection with the alphanumerical database of farmers; register of spatial units for the information about borders of the counties, local communities and cadastral municipalities, digital terrain model for gaining additional attributes such as elevation; and topographic map in the scale of 1:25,000.

The purpose of this paper is to explain the process of building the Croatian LPIS as well as the role of the Croatian national mapping and cadastre authority, the State Geodetic Administration, which is in charge of providing the above-mentioned official spatial data as part of the Integrated Land Administration System and National Spatial Data Infrastructure.

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1. INTRODUCTION

One of the most important goals of the foreign policy of the Croatian Government is its membership of the European Union (EU) which requires that a number of points of the Croatian legislative, political and economic system be adjusted to the ones in the EU. This effort started by Croatia signing the Stabilization and Association Agreement in 2001. In the past eight years, Croatia has invested enormous efforts in order to implement the necessary adjustments and is now in the final stage of negotiations. It is expected that the negotiations will be completed by the end of 2011 and that the Republic of Croatia (RoC) will become a member of the EU in 2012, which obliges the RoC and its bodies to meet all the membership criteria. One of the remaining key conditions is the establishment of the Land Parcel Identification System (LPIS) as part of the Common Agricultural Policy of EU, which is the responsibility of the Ministry of Agriculture, Fisheries and Rural Development while the State Geodetic Administration offers key support to the implementation of this activity.

1.1 European Union Common Agricultural Policy - CAP

The EU is a unique intergovernmental community of European countries established on November 1, 1993, with the enforcement of the Treaty on the European Union (better known as the Treaty of Maastricht). Today, the European Union consists of 27 member States with over 450 million inhabitants. All the decisions and procedures in the EU are based on treaties concluded by all EU countries.

The biggest, most comprehensible EU program with the highest budgetary allocations is the Common Agricultural Policy – CAP consisting of a set of laws and practices adopted by the EU for the purpose of achieving a common policy in the agricultural sector. The rural areas of the EU cover 80% of the EU territory while about 10.4 million people (URL1) are working in agriculture. About 45% of the common European budget is allocated for the CAP. In 2009, EUR 41.1 billion were allocated for this purpose. The CAP objective, i.e. sustainable development of agriculture, has been defined by Article 39 of the Treaty of Rome from 1957:

- to increase agricultural productivity by promoting technical progress and by
- ensuring the rational development of agricultural production and the optimum
- utilization of the factors of production, in particular labor;
- thus to ensure a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture;
- to stabilize markets;
- to assure the availability of supplies;
- to ensure that supplies reach consumers at reasonable prices.

Since 2005, the new agricultural policy has been carried out in line with the reform agreed in 2003. Its main element is providing subsidies to farmers, regardless of their production: Single Payment Scheme – SPS. The amount of subsidies is directly linked to the measures taken in the field of environmental protection, food safety, application of health standards for plants and animals and the measures undertaken for the benefit of animals. The implementation of the CAP reform is regulated by Commission Regulations nos. 796/2004 of April 2004, 795/2004 of April 2004, and 2237/2003 of December 2003 (URL2).

1.2 Integrated Administration and Control System (IACS) and Land Parcel Identification System (LPIS)

A precondition for direct payments under the CAP is the establishment of the Integrated Administrative and Control System (IACS) used by member States to allocate, monitor and control direct payments to farmers. Article 21 of the EU Directive – Commission Regulation no. 3508/1992 determines the following elements of the IACS:

- a computerized data base
- an identification system for agricultural parcels
- a system for the identification and registration of payment entitlements as referred
- aid applications
- an integrated control system
- a single system to record the identity of each farmer who submits an aid application

The afore-mentioned system defines the procedures for receiving applications, administrative and inspection controls, and processing the applications and payments. Its establishment should ensure a more efficient execution of direct payments and better supervision and prevention of irregularities. The most important IACS component is the Land Parcel Identification System (LPIS) (Roc Government, 2007).

LPIS is an information system containing the real data about the agricultural land exploitation whose primary goal is to process aid applications per area size. Article 23 of the afore-mentioned Directive stipulates the LPIS elements as follows: „The identification system for agricultural parcels shall be established on the basis of maps or land registry documents or other cartographic references. Use shall be made of computerized geographical information system techniques including preferably aerial or spatial orthoimagery, with an homogenous standard guaranteeing accuracy at least equivalent to cartography at a scale of 1:10000.“ Commission Regulation no. 3887/1992 lays down detailed rules for applying the integrated administration and control system.

2. LPIS DEVELOPMENT IN THE REPUBLIC OF CROATIA

As part of the adjustments effectuated in the agricultural sector, the Croatian Government passed the National LPIS Establishment Program in the RoC in November 2007. This program defines the objectives, implementation procedure, funds, stakeholders and participants in the implementation as well as the pace of implementation. The Croatian Government has provided HRK 21.7 million (EUR 2.9 million) for its implementation.

The system is being established by the Ministry of Agriculture, Fisheries and Rural Development (MAFRD) and Agency for Payments in Agriculture, Fisheries and Rural Development (Agency) in cooperation with the State Geodetic Administration (SGA) and Croatian Geodetic Institute (CGI). According to the Law on Agriculture (Official Gazette no. 149/09), the Agency, supervised by the MAFRD, is responsible for the establishment and running of the system for administering direct payments in agriculture. According to the Law on State Survey and Real Estate Cadastre (Official Gazette no. 16/07), the SGA is a State administrative organization performing administrative and other tasks related to: geodetic and cadastral works and especially the production, renewal and maintenance of the surveys and real estate cadastre, introduction of IT into the cadastre and geo-spatial system; official mapping; keeping geodetic records; keeping statistics of the real estate and mains cadastres; geodetic and cadastral works related to the State borders; development and application of the geodetic surveying technology in the field of science, economy and other activities serving as the basis or to realize interventions in space (SGA, 2008). As part of the LPIS establishment project, the task of the SGA is to ensure the necessary spatial datasets for the LPIS establishment and maintenance. The CGI is a specialized institution performing highly expert and research papers in the field of geodesy and especially in the field of the State survey and real estate cadastre (URL3). The CGI also performs quality control of the collected and processed spatial data and SGA product development, primarily the MP TK25 and DOP which is a precondition for making them official by the SGA. The CGI performs the same role also in the process of the map production for the needs of the LPIS.

2.1 Spatial Data used for the LPIS Establishment

Before the LPIS establishment, the Ministry of Agriculture kept the Farm Register as an alphanumerical database of agricultural farms that, among other things, kept also the data on the agricultural land tenure based on the cadastral, alphanumerical data. The afore-mentioned program defines that, after the LPIS establishment, the cadastral alphanumerical data should be replaced by the spatial data based on the SGA datasets shown in the table below:

Spatial dataset	Intended to be used in the LPIS Project
Digital orthophoto map in the scale of 1:5,000 (DOP5)	Basic original and dataset for the interpretation and determination of the size of the land of agricultural farms
Digital cadastral maps (DCM)	Auxiliary original for controlling the interpretation of the land in DOP's and connect to the Farm Register containing alphanumerical data on cadastral parcels
Digital terrain model (DTM)	Auxiliary original serving to define certain terrain data attributes such as the slant determination of certain agricultural land areas, altitude determination, determination of the areas with more difficult conditions for agricultural management, etc.
Topographic map in the scale of 1:25,000 (TM25)	Additional data for the process of digitization and for a better spatial orientation on DOP's
Central Spatial Data Register (CSDR) information	Information on the borders of counties, towns, municipalities and cadastral municipalities in the RoC.

These datasets must be available for the entire territory of Croatia and cannot be older than 5 years, in accordance with the EU legislative requirements (URL4). The availability of data (DOF, TK-25 and DKP), their homogeneous quality and metadata are essential for successful LPIS implementation in Croatia (Tušek i dr., 2008).

2.1.1 Digital orthophoto maps in the scale of 1:5,000 (DOP5)

In 2004, the decision on the determination of the official geodetic datum and plane cartographic projections of the RoC defined the new positional (European Terrestrial Reference System 1989,0 - ETRS89 and GRS80 ellipsoids) and vertical datum (defined on the basis of the mean sea level at five tide gauges) as well as the new mapping projection of the RoC (transverse aspect of Mercator's projection - abbreviated HTRS96/TM with the mean meridian 16° 30' and the linear scale of the meridian set at 0.9999).

Although the SGA has systematically produced DOP5 since 2001, DOP5 are produced for the first time in the new system (6,859 sheets) as part of the LPIS Project. The DOP production is based on the new aerial photogrammetric survey (determining the projection central coordinates for each photography by using the GPS/IMU system), determination of orientation points (reduced number of points determined by using the CROPOS system of the SGA), leveling the aerial triangulation blocks, and supplementing and producing the new digital terrain model (Lemaić et al., 2009). The DOP's are being produced in color with the resolution of 0.5 m. Under earlier contracts, the DOP5 was produced on the basis of cyclic aerial photography in the scale of 1:20,000 shot by analogue cameras and, more recently, by digital cameras. The primary service aim in the production of digital orthophoto maps in the scale of 1:5,000 is to develop a multi-purpose spatial information system that will serve as the basis for the broader National Spatial Data Infrastructure (NSDI) for Croatia. A section of the DOP5 is shown in Figure 1.



Figure 1: DOP5 section

2.1.2 Digital cadastral maps

The territory of the Republic of Croatia encompasses 3,330 cadastral municipalities and 56,000 sheets of cadastral maps produced in various scales (1:1,000, 1:2,000, 1:2,880 and 1:2,904). The average cadastral municipality is displayed over 17 cadastral map sheets. In 2005, the State Geodetic Administration started a project of vectorizing the RoC cadastral maps and of transforming the maps vectorized earlier in their standard format (the so-called „standardisation“). The vektorization is implemented in the following stages: scanning of cadastral maps (raster), geo-referencing, first quality control and correction of rough errors, vectorization (vectorized cadastral map), second quality control (the graphical and alphanumerical data is harmonized in the SGA cadastral offices and branch offices) and uploading in the cadastral map database of the SGA. Under the LPIS Project, the Ministry of Agriculture has, in cooperation with the State Geodetic Administration, contracted the vectorization/standardization of the last 960 cadastral municipalities (CM) in the Republic of Croatia (Croatian Government, 2007). A section of the DCM is shown in Figure 2.

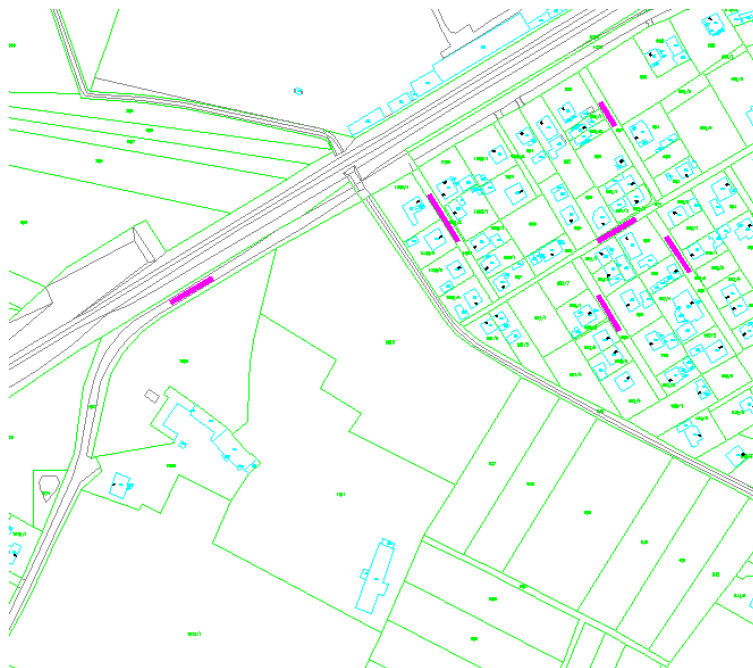


Figure 2: DCM section

2.1.3 Digital Terrain Model production (DTM)

DTM is a set of individual markers, rasters of altitude points, breakpoints and contours required for displaying the Earth's surface (SGA, 2003). It has been produced for the entire territory of the RoC. The existing DTM data has been produced in the process of the previous DOP or topographic data production, created by the photogrammetric mapping or created by vectorizing the Croatian Base Map (CBM) sheets. The DTM data is contained in the historical

reference systems and map projections (Gauss Krueger projection of the 5th and 6th zone, Bessel ellipsoid 1841) and for the purpose of producing the new DOP 5. It is transformed into new HTRS96/TM and HVRS71 systems.

2.1.4 Topographic map in the scale of 1:25,000 (TM25)

The basic original for the topographic survey in the Republic of Croatia is the aerial photography in the approximate scale of 1:20,000. The photographs produced by aerial photography are subjected to aerial triangulation followed by the restitution performed by analogue and digital stereo instruments. The mapping is defined by the RoC Topographic Information System – CROTIS data model. Since 1996, all 594 sheets of TM25 have been reproduced for the entire RoC territory. A section of the TM25 is shown in Figure 3.



Figure 3: TM25 section

2.1.5 Central Spatial Data Register (CSDR)

CSDR is a digital, geographic database of the administrative spatial units produced for the entire RoC territory. It consists of the alphanumeric and the graphical part. The alphanumeric part contains the lists of towns and municipalities, spatial units of the local governments, cadastral spatial units, settlements, census and population lists, addresses and house numbers. The graphical part of the database encompasses the data up to the census level.

2.2 **Inter-institutional cooperation in the LPIS establishment**

In order to implement the national program, the SGA and MAFRD signed in November 2008 a protocol on forwarding the spatial data aimed at defining the procedure for the smooth flow

of data exchange used as the basis for the establishment of the LPIS database. The protocol provides a specification of the spatial data required for the LPIS (DCM, DOP5, DTM, TM25, CSPR), the structure of the tables of the required spatial data specifications, manner of forwarding the spatial data for the LPIS and the pace of the data delivery.

In order to implement the national program in a timely manner, the SGA and CGI passed in May 2008 the Action Plan for the production and quality control of the spatial datasets and the capacity building in the SGA and CGI. This Plan specifies the necessary activities and financial framework required for the production of spatial datasets, provision of human capacities, working condition and necessary equipment as well as management of the LPIS establishment activities under the authority of the SGA and CGI.

In December 2008, the SGA Director-General passed a decision on the appointment of a joint commission of the State Geodetic Administration and Croatian Geodetic Institute for the support of the LPIS Establishment National Program. The commission is tasked to organize the implementation of the activities envisaged by the National and Action Programs, take care that the resources obtained are used appropriately and for the purpose of the LPIS realization, monitor and administer the implementation of the LPIS-related activities, cooperate with the MAFRD project team in the implementation of the National Program and report to the LPIC Board, Director-General and other authorized persons about the program implementation. In order to be able to carry out the tasks defined by the Action Plan and ensure the necessary human resources for the program implementation, the SGA and CGI started promptly to recruit and gave fixed-term contracts to the additional 116 employees.

In order to improve the methods and procedures for controlling the quality of the products used in the LPIS establishment and in line with international standards, international cooperation has been initiated between the CGI and the Norwegian company called PMM that has been financed by the Kingdom of Norway through the National Mapping Agency (Statens kartverk) in order to implement the project more efficiently (Lemaić et al., 2009).

Despite the difficulties that this and every other project must face, all the afore-mentioned activities contribute to the successful LPIS implementation and establishment in the RoC. All spatial data has been delivered, the parameters for transforming the old into the new system have been determined where the project task so required while the production of the newly contracted datasets are being carried out as planned.

2.3 ARKOD

The Land Parcel Identification System in the Republic of Croatia was published under the acronym of „ARKOD” at www.arkod.hr in the summer of 2009. The farmers can register in ARKOD free of charge and the registration is performed in the regional offices of the Agency for Payments in Agriculture, Fisheries and Rural Development as well as in local offices of the Croatian Agricultural Agency. ARKOD is based on the existing, alphanumerical Farm Register. During the registration, the farmers themselves will, with the help of the Agency

staff, identify all the parcels that they cultivate on the digital orthophoto maps (URL2). The use of ARKOD can be divided into three stages:

Step 1: Photointerpretation of digital orthophoto maps and production of initial ARKOD layer

Step 2: Consultations with farmers supported with digital cadastre maps, TK 25 and Farm Register and the production of the final ARKOD layer containing verified and attributed farmer blocks as the basic unit for subsidies as well as remaining physical blocks + indicated landscape features

Step 3: Processing and finalization of obtained data (generation of unique block ID, analyses with DTM – calculation of average altitude and slope, digitalization of selected landscape features, database and topology checks) (Tušek et al., 2008).



Figure 4: ARKOD (Tušek et al., 2008)

2.4 Future Cooperation related to the ARKOD system maintenance

Apart from completing all the activities of the LPIS establishment, a new challenge to the cooperation of the State institutions involved in the LPIS Project represents the structuring of the LPIS maintenance system by systematic renewal of all necessary mapping products (especially DOP5), submission of the changes to the DCM to the Agency, establishment of the GPS-supported quality control system for the collected data and including this activity in the RoC National Spatial Data Infrastructure.

2.4.1 Croatian Positioning System (CROPOS)

According to the rules, the minimum of 5% of the parcels has to be controlled by the GPS field measurements (or by the satellite imagery) in order to determine the de facto situation of the crops. For that purpose EU countries have a possibility to use EGNOS system. Since in late 2008, the SGA launched Croatian Positioning System (CROPOS) there is a possibility for further collaboration of SGA and Agency in using CROPOS for the purpose of quality checks because of its higher precision and reliability in determination of coordinates.

CROPOS is a network of 30 reference GNSS stations, available to its users 24/7. The reference stations are 70 km apart and are distributed in such a way as to cover the entire Croatian territory for the purpose of collecting the data of satellite measurements and calculating the correction parameters. The purpose of the CROPOS system is to enable the point determination in real time with the horizontal accuracy of 2 cm and the vertical accuracy of 4 cm in the entire country. The correction parameters are available to the users in the field via wireless Internet -GPRS/GSM (URL5).



Figure 5: CROPOS network (URL5)

2.4.2 National Spatial Data Infrastructure – NSDI in the Republic of Croatia

The Directive 2007/2/EC of the European Parliament and of the Council of March 2007 established an Infrastructure for Spatial Information in the European Community (INSPIRE). The objective of the INSPIRE Directive is to make the spatial data as available as possible in order to create and implement the Community policy in its members States at all levels. The Directive requires that common Implementing Rules are adopted in a number of specific areas (Metadata, Data Specifications, Network Services, Data and Service Sharing and Monitoring and Reporting) and they are binding for Member States (URL6). INSPIRE is focused on the environmental policy but is open to be used and supplemented by other sectors such as agriculture, transport and energy and, as such, constitutes the framework for the NSDI (National Spatial Data Infrastructure) within the EU members States. Therefore, the INSPIRE guidelines can be considered obligatory for any further NSDI activities.

The legislative framework for the establishment of the National Spatial Data Infrastructure (NSDI) in the Republic of Croatia is provided by the Law on State Survey and Real Estate Cadastre (Official Gazette no. 16/07) whose Article 84 defines the NSDI as a set of measures, standards, specifications and services aimed at enabling, as part of the e-Government establishment, the efficient collection, keeping, exchange and use of the geo-referenced spatial data under the jurisdiction of the State administrative bodies, regional and local governments and public systems. The activity that preceded the adoption of the Law is the production of the RoC NSDI Study developed by a group of international experts for the SGA in 2005. In line with the Law, the services of the NSDI stakeholders' spatial data need to be linked to a common IT network in order to enable the search of the spatial data sets and services in an easy and widely accessible way.

During 2008 and 2009, the NSDI establishment activities encompassed the establishment of the NSDI bodies i.e. Council carrying out the establishment and coordination of the NSDI stakeholders' activities, Board as an independent NSDI implementation body and the following NSDI working groups: for technical standards, for joint usage of spatial data, for linking the NSDI and Croatian Government programs, for developing the RoC business model and for building the NSDI capacities.

In accordance with the Law, the SGA acts as the Secretariat of the NSDI Council, coordinates all NSDI bodies and provides technical support. Furthermore, one of the SGA tasks is to create preconditions for the NSDI establishment by establishing and maintaining a public metadata service on the Internet (via the Geo-Portal) in a way that will enable the NSDI subjects to maintain the information interactively.

The LPIS system development based on the SGA data is one of the first, more significant examples in Croatia of linking the State administrative bodies in a common network, following the basic principles of the INSPIRE Directive being that the data is produced and maintained at one, most appropriate place and then used for various purposes.

2.4.3 SGA Geoportal

In May 2009, the SGA launched the SGA Geoportal that, in this initial phase of establishment, contains five databases: orthophoto maps in the scale of 1:5,000, Croatian Base Map in the scale of 1:5,000, raster cadastral maps, Central Spatial Data Register and the permanent geodetic point database including the www sale component (URL7). The Geoportal will be extended in the next stage, that is being prepared, with additional SGA spatial datasets and supporting services, and will be upgraded in order to take over the function of the INSPIRE national access point. This will enable to access the geo-spatial information (metadata, spatial data and cartographic displays) of the RoC NSDI at one place. The upgraded Geoportal would also create preconditions for automatically uploading up-to-date spatial information for the needs of the LPIS.

2.4.4 Real Property Registration and Cadastre Joint Information System (JIS)

The Croatian Government, through the Ministry of Justice and SGA, has been implementing the Real Property Registration and Cadastre National Program since 2003. The Program aims at providing a faster and simpler process of registering the real properties and appertaining titles to the RoC citizens. One of the greatest challenges in this process is the development of the Real Property Registration and Cadastre Joint Information System (JIS), i.e. a unique database of the cadastre and land registries and a unique application for keeping and maintaining the afore-mentioned data. The JIS establishment will accelerate the real property registration in both the cadastral as well as the land registration system, raise the level of legal security of the real property transactions, streamline both systems and simplify business processes, ensure that the data of both systems is harmonized, improve the customer relations as well as the speed and quality of service provision (URL8). The establishment of such system will provide online data exchange with all interested subjects as well as with ARKOD.

3. CONCLUSION

In line with the set requirements, the Republic of Croatia will establish the LPIS and create preconditions for its further successful functioning by the end of 2010 as part of a chapter related to the EU accession negotiations. The LPIS itself or rather its applicative solution called “ARKOD” have been realized in an extremely short span of time due to the intense cooperation between the Ministry of Agriculture, Agency, SGA and CGI as well as numerous contractors. In order to establish the LPIS, the SGA and CGI had to obtain a number of new datasets and adjust them to the new reference system. This has been successfully performed but the processes of the data exchange have not been automated so the SGA is working on the establishment of a new Geoportal and the JIS, not just in the context of the LPIS but also in the context of the entire land administration reform, whereby all the data required for the LPIS will be available to the users and the MoJ in accordance with the NSDI and INSPIRE concepts.

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BIOGRAPHICAL NOTES

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Academic experience: graduate geodetic engineer, Faculty of Geodesy, University of Zagreb, Republic of Croatia in 1993. Since 1994, employee of Department for Geodetic and Cadastral Works in the Ministry of Construction and Environmental Protection,

since 1995 employee of the State Geodetic Administration. In the period 2001-2008 worked on the World Bank-funded Real Property Registration and Cadastre Project. Current position is Head of EU-funded project and Head of joint working group of SGA and CGI for support of the implementation of LPIS project.

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. Interests: SDI, cartography, satellite positioning, GNSS permanent networks, capacity building in surveying, ...

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