Support for the Transition Process of Land Administration Systems

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SUMMARY

Croatia is currently in the process of upgrading its Land Administration system from combination of analog and digital to purely digital technology. The system's attribute data has been in digital form for many years now and is technologically well organized. On the other hand its spatial data is increasingly turning to digital technology but currently without a clear vision of its future technological orientation.

Large amount of cadastral data produced in different historical periods poses on one hand a wealth and on the other a hindrance to the development. This data is usually not standardized and not available to users.

In this paper and following internationally adopted standards, this data is classified and described presenting a fundamental condition for its efficient usage within data model and meta-database service. Can a nationwide cadastral meta-database service help and improve process of transition? Some important technological and organizational aspects of a centralized database with a distributed Web access in support of cadastral system's transition are discovered here.

1. INTRODUCTION

Metadata is the data about data. So in case of spatial data it is designed to give user some insight about where to find the data he needs, what is its positional accuracy, when was it last updated and other significant facts about it. One can say that metadata helps user find just the right data he needs or to make sure it does not exist and that he must collect it himself. Awareness of nonexistence of a particular dataset is as important as knowing some facts about it. As any other spatial dataset and especially cadastral one, primarily because it is so important, must be supported by meta-database system. Number of inquires posted to a cadastral system in a day to day manner is, especially in area of high interest and rapid update, is very large and offload accomplished by implementing meta-database system can be significant. This in turn leaves more time for cadastral office to deal with concrete inquiries and saves both the office and users at least some amount of time. Furthermore, in case the cadastral system is currently in process of transition between states, cadastral meta-database system can support and improve it.

Croatian cadastral system is currently in transition from an obsolete "Land Cadastre" to a modern "Real Estate Cadastre". Furthermore, there are a lot of cadastral renewal, and large scale update projects currently in progress in Croatia. Unfortunately no meta-database system exists to support this transition and also to improve functioning of the system itself. To make some improvements the State Geodetic Administration of Croatia (SGA) requested the Chair of Spatial Information Management of the Institute of Applied Geodesy of the Faculty of Geodesy in Zagreb to research and develop a data and a system model for a meta-database system. Such a systems was to serve its primary purpose, to serve cadastral metadata to interested users but also to support the currently ongoing transition.

In order to accomplish given tasks, analysis of the status of cadastral data was performed. Through this analysis the involved datasets were recognized and their main characteristics gathered. With a secondary objective being support for the transition, additional steps in recognition of needed analytical capabilities of the system were proposed and incorporated into the data model. Finally, the model was used to implement a test system together with its user interface and to make some preliminary test using dataset for the Croatian Island of Hvar (Roić et al .2005).

2. CADASTRAL METADATA SETS IN CROATIA

In order to build an information system one needs to know what types of data it will be managing. Metadata is data about data, so here it is first necessary to define data sets this information system will manage metadata about. Explicit cadastral data are a clear choice here, however there are also some other types of data which are not explicitly cadastral by nature but are significant for cadastre.

2.1 Explicit

The legislative as well as the actual status of cadastre in Croatia is, at the moment, a bit confusing. A contribution to the cadastre modernization is the adoption of the new "Real Estate Cadastre and State Survey Law" in 1999, which made prerequisites for the quicker and more efficient cadastre base modernization. However there is still no clear vision on how it shall be implemented neither from organizational or technological point of view. There are very few bylaws or data models that would support it.

So, the cadastral data is actually still modeled in "Land Cadastre" way making it a two aspect register. Generally, national cadastral systems is a composition of subsystems formed for the basic spatial unit, cadastral municipality. Each subsystem consists of a spatial and a descriptive (alphanumerical) component. The first one, "Cadastral Map", is in either analog (collection of map sheets), or digital form (in most cases some CAD format). The second one (alphanumerical) is today for the entire territory of Croatia in several database management systems (no standard here either). This data is available for public access via WWW service at (URL 1). To avoid further misunderstandings this part shall in the rest of the paper be called simply the "Descriptive Database". Furthermore, cadastre is constantly being updated, so all the changes that are made are archived, or more specifically all the projects that lead to the changes of the system's data. To summarize, one cadastral subsystem consists of cadastral map which is in a digital form or a collection of map sheets, digital descriptive database and a collection of update projects. One can easily recognize three basic components of any spatial information systems namely:

- Spatial,
- attribute (descriptive) and
- temporal (historic).

It is expected that once that the Real Estate Cadastre becomes operational its data model will be common for all of these components and will be only administratively divided into cadastral municipalities. Transition between these two cadastral systems needs to be supported by a meta-database (Figure 1).

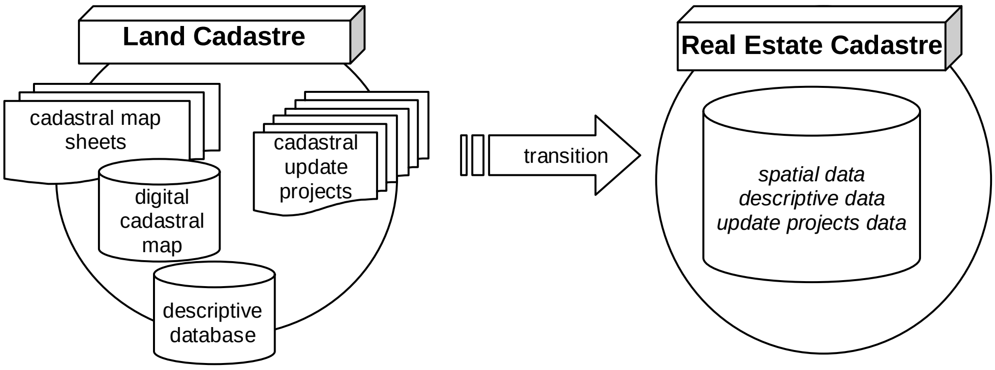

Figure 1. Data sets for both cadastral systems

There is still large amount of cadastral map sheets produced in 19-th century using the plane table and in mathematically loosely defined coordinate systems. Efficient method that could be used for transforming these maps through the process of quality improvement was developed and tested (Roić 1998) but was only applied in the area of city of Zagreb. There is also a certain amount (about 25%) of cadastral maps (mainly urban areas) produced by numerical land survey methods and in Transverse Mercator (Gauss-Krüger) projection.

2.2 Implicit

Besides those that are clearly and explicitly cadastral, several other data sets play an important role in cadastral system lifecycle. Utility Cadastre in Croatia is a public register of all underground and overhead utility lines within a community. As a spatial basis for its data, the Utility Cadastre uses cadastral data. Obviously Utility Cadastre is a dataset whose metadata can and should be managed by the meta-database. Due to the growth of interest in cadastral data in Croatia there are a lot of cadastral renewal projects in scale of a whole cadastral municipalities. In this process besides main products, being a collection of spatial and descriptive cadastral data, some "side products" also emerge. They are digital orthophoto and digital terrain model and are in nature related to a cadastral municipality. Those two data sets are the next two so called implicitly cadastral data sets.

3. CADASTRAL META-DATABASE SYSTEM

The purpose of cadastral meta-database system is to make it possible for users to find the data about the data they are interested in. Besides this main purpose, and in case that cadastral system is currently undergoing some sort of transition or improvement, the meta-database can and should support it. Considering the fact that in Croatia this is currently the case, the meta-database system was designed accordingly. Still its primary purpose is as any meta-database system, but enhanced with options that can help responsible parties in making decisions on directions of process of transition. So, after use cases were discovered and analyzed the data model for the system was developed.

3.1 Use cases

In order to correctly develop the data model, but also the model of the system, one should recognize every possible type of interaction that users could require. Although different techniques for visually modeling exist, lately UML as a visual modeling language is the preferred one (Roić et al. 2002). In UML a special diagram type, called "Use Case" is used for recognizing and modeling general interaction between users who are in this case called "Actors" and the system.

Generally several types of actors can be involved in the interaction with the meta-database system. First of all there are cadastral officers working in district cadastral offices who are in charge of maintenance of the data. So, they are using the system in order to add, update and in some cases delete the data. Deletion should of course here be taken symbolically because it only means changing state from valid to historic. Once the data is stored it can be accessed. One type of actors, here called "Ordinary user" often needs information about status, type and location of the data about their or other peoples property (parcel). It is important to notice that for "Ordinary user" only the current data is important. He should not be burdened with its previous states. So a simple inquiry to the database concerning metadata should suffice here. Chartered surveyors, who are the next actor here, may on the other hand need more specific information. For instance, when performing or preparing a subdivision or any other action on cadastral data, it is important to be aware of existence of multiple cadastral maps for the same location. So, besides simple attribute ones, Chartered Surveyor should be able to post spatial queries concerning a point or area of interest. Finally, a special type of actor using the cadastral meta-database system is the "SGA officer". When performing various analysis of work done on renewal of cadastral data, or for instance when selecting areas of special interest for some future period of system's lifecycle, he must be able to perform sophisticated and specialized spatial and non-spatial queries (Figure 2).

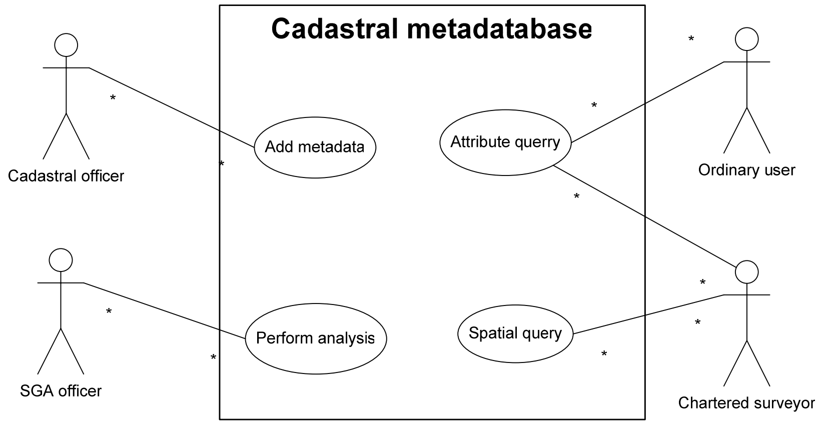

Figure 2. Use case diagram for the cadastral meta-database

Generally, two important issues are evident when analyzing the above. Firstly, the system has several quit different purposes, ranging from simple querying (Ordinary User) to performing sophisticated analysis (SGA Officer). This further emphasizes the significance of careful planning and development from the data model to the system model. Secondly, the user interface, which must be adjusted to each actor's needs, can not be one general application. Rather it has to be divided according to each actor's needs and rights within the system.

3.2 Data model

The data model developed for this purpose is largely based on ISO 19115 international standard. As relational modeling approach is used the model itself is build around two main relations (tables). Although it would be more appropriate to use a single table one of previously mentioned data sets makes it impossible. This data set is cadastral map sheet with its spatial extent being the reason that makes it so different. Unlike all the other data sets cadastral map sheet has its own spatial extent, that is it is not spatially determined by the subsystem's spatial extent (multiple sheets within a municipality). All the other data set are spatially determined by the subsystems spatial extent and all the geometry can be retrieved from the "Register of Spatial Units" (RSU). Furthermore many of cadastral map sheets exist in multiple forms. For instance there is a digital high resolution raster form of it produced by scanning the original and stored in the SGA office, then there is also a down-sampled and geocoded copy of it in a company which does the vectorization, and finally a CAD file with data produced by vectorization. So, in order to be able to store all those different kinds of metadata about map sheets a separate table had to be formed (named "LISTKP"). All this would not have been necessary if map sheets spatial extent was not important. However, because of possibility of existence of multiple sheets for any location in space (Figure 3) it was found to be necessary to be able to spatially defined each sheet.

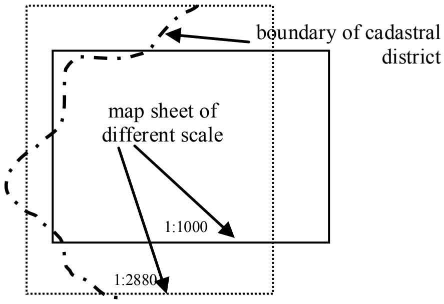

Figure 3. Multiple cadastral map sheets covering the same portion of space

Implicit and general spatial definition of map sheets can be obtained through their belonging to cadastral municipality which is explicitly spatially defined. In order to also be able to perform attribute queries, the map sheets data set an attribute designating its belonging to a cadastral district was also added. After summarizing all of the above the design of the table used to store data about map sheets is easily performed (Figure 4).

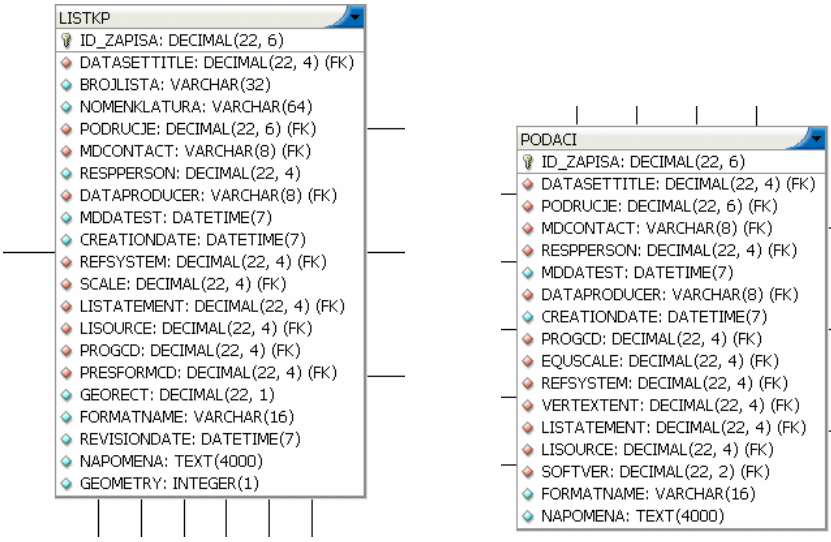

Figure 4. Design of tables used for storing metadata about map sheets and all the other data sets

The other table, used for storing metadata about all the other data sets (called "PODACI") consists of less attributes and is spatially defined using foreign key mechanism on the RSU. Most of the attributes in both tables are foreign keys pointing to other tables which are holding predefined data. The temporal component of the data model is incorporated in a number of instants in a lifecycle of each dataset (creation, revision of a dataset, ...).

4. TEST IMPLEMENTATION

In order to test the model implementation of a system based on the developed model was implemented using Oracle10g spatial database. The choice for a spatial database as a technological basis was made based on their good integration with WWW technologies, and the need for simultaneous remote access from multiple cadastral offices throughout the country. Good support for spatial data types was a requirement also because the spatial component of the metadata was to be integrated into the system. The data model from previous chapter was simply coded into Oracle's data model and the tables were created.

One of the technical issues concerned transformation of spatial data between different coordinate systems. As mentioned before, Croatian cadastral data lies in several different coordinate systems based on Bessel 1841 ellipsoid. The new official ellipsoid (GRS80) and a unique projected coordinate system for cadastral data "HTRS96/TM" was designated in august 2004, but as of yet there are no official parameters for transformation of cadastral data from old to the current one. The data for the RSU was in one of the "old" systems and we wanted to base the test system on the new coordinate system. In order to be able to perform data transformations between the old coordinate systems and the new one, transformation parameters from (Bašić and Bačić 2000) were used.

The user interface was fully developed by the staff of the Institute using JSP (Java Server Pages) and partially (for the spatial visualization part) Oracle's "Mapviewer". All parts of the user interface are fully WWW oriented and thus platform independent. The user interface was divided into several parts depending on the type of actors that is meant for. According to Use Cases described earlier in the paper there are generally three kinds of user interfaces needed for functioning of the system. The first one is used for updating of the database and enables the actor (Cadastral Officer) to choose from available items in majority of the fields requiring less manual input (Figure 5). In our current test implementation only insertion of the data was allowed through this interface, but updating and deletion are simply a matter of coding it into the interface. Besides ease of use, using predefined selection list minimizes possibility of faulty input.

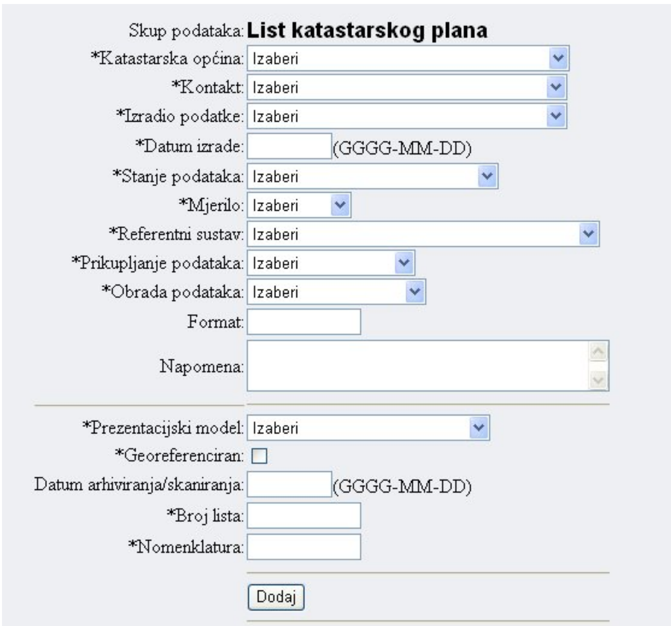

Figure 5. User interface for updating of meta-database

The second part of the user interface is intended for "Ordinary Users" and "Chartered Surveyors". It enables them to post spatial and attribute queries to the system. Spatial queries are formulated using the interface on the left side. Besides by clicking on the map user can directly input coordinates for the desired location. Although in our case no distinction was made between those two types of actors right in access, this option could (or should) be limited only for "advanced" ones like for instance Chartered Surveyors. List of metadata for the desired location is displayed on the right side of the interface, with hyperlinks to short and detailed information about each one. In order to immediately display the distinction between metadata about official and all the other sets, the official ones are displayed in black color while others are displayed in red (Figure 6).

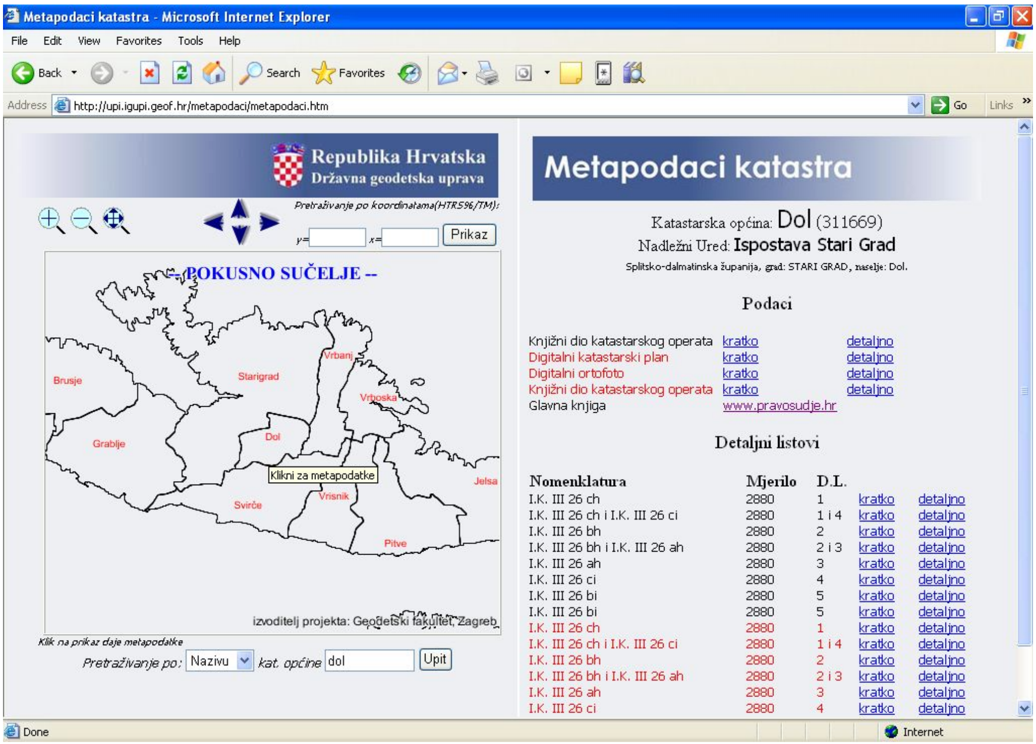

Figure 6. The "public" part of the user interface

Finally, the third part of the interface serves the support of the process of transition of cadastre. It enables only registered users (SGA Officer) to perform sophisticated analysis of all the available metadata. Results of queries are displayed as a list of records (hyperlinks) and also as a visual representation of their spatial characteristics (Figure 7).

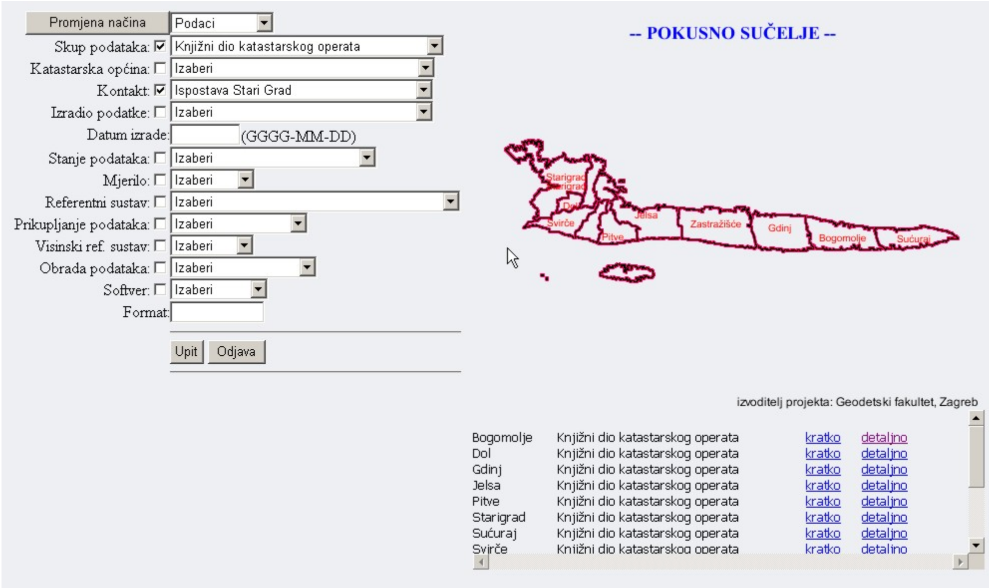

Figure 7. The analytical part of the user interface

With combination of described user interfaces, constant and efficient updating and querying of the meta-database are ensured. Furthermore, analytical capabilities are at the disposal of a limited number of actors, giving them a wider insight in the overall status of the whole system.

5. CONCLUSIONS

Cadastral meta-database plays an important role in land administration systems lifecycle, so proper planning with an accent on the development of the data model is crucial here. Its primary purpose is to serve metadata to all interested users and this it must do with maximum efficiency. With Internet playing a crucial role in a modern society, it presents the only reasonable choice for the general scope of the system. Technologies that support such an approach are numerous, and the one that is used in this case (JSP) is just one of them.

Through combination of careful planning and with the right choice of technological basis a versatile and flexible user interface for the meta-database system was developed. Besides its primary purpose, to serve metadata to users, it also offers a number analytical capabilities. Using those capabilities significantly improves key responsible parties view of the current situation in the process of transition of cadastre, enabling them to make the right decisions regarding its further development.

REFERENCES

Bašić, T., Bačić, Ž. (2000): Transformation between the Local and Global Geodetic Datum in Croatia, Proceed. of IAG Sub-commission for Europe (EUREF) Symposium held in Tromso, 22-24 June 2000.

Roić M. (1997): Obnova listova katastarskih planova (Renewal of Cadastral Map Sheets), Izvješće o projektu (Project Report), Sveučilište u Zagrebu, Geodetski fakultet, Zagreb.

Roić, M. (1998): Improvement of Cadastre in Croatia. In "Proceedings of the XXI. International FIG Congress", Commision 7 - Cadastre and Land Management, pp. 505-516, July 19.-25., Brighton.

Roić, M., Matijević, H.. Cetl, V. (2002): Objektnoorijentirano modeliranje katastra, Zbornik Geodetskog fakulteta Sveučilišta u Zagrebu povodom 40. obljetnice samostalnog djelovanja 1962.-2002. / Bašić, T. (ur.), Zagreb.

Roić, M., Mastelić Ivić, S., Cetl, V., Matijević, H., Tomić, H., Mađer M. (2005): Podrška evidenciji i upravljanju preobrazbe Katastra zemljišta u Katastar nekretnina (Support for Register and Management of Transformation of Land Cadastre to Real Estate Cadastre), Izvješće o projektu (Project Report), Sveučilište u Zagrebu, Geodetski fakultet, Zagreb.

URL 1: Preglednik katastarskih podataka, http://www.katastar.hr

BIOGRAPHICAL NOTES

Miodrag Roić is a professor at Spatial Information Management/Cadastre at the Faculty of Geodesy in Zagreb and a national delegate to FIG Commission 3. Currently he is Vice Dean of the Faculty and Head of the Chair of Spatial Information Management of the Institute of Applied Geodesy. He leads and participates actively in numerous projects at international and national level. In 1996 he received his Ph.D. from the Vienna University of Technology. He was an Editor-in-Chief of “Geodetski list”, an internationally recognized Croatian scientific geodetic magazine. Miodrag Roić has published more than 20 scientific papers.

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