Overview of Legal and Institutional Aspects of Croatian Cadastre and Possibilities for its Upgrading to 3D

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SUMMARY

This paper explores the laws and other legal acts related to the Croatian 3D cadastre with an emphasis on those which relate to interests in strata, spatial planning, exploitation of mineral resources, environmental protection, issuing concessions and other regulations that are valid or were valid on Croatian territory, and especially the regulations regarding the registration of buildings with several separate parts (flats, apartments, offices etc.). Current overview of the legislation, method and scope of cadastral data collection is given. Effects of the application of these regulations on the present situation of registration in cadastre and land book are considered. This paper also explores current legal, institutional and some technical solutions implemented in Croatian Land Administration System and possibilities for upgrade to 3D cadastre. Implementation of any technological option for establishment of 3D cadastre is tightly related to legislation. Hence, it is needed to consider legislation and technological options in order to find solution which will be possible to implement.

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1. INTRODUCTION

A more extensive use of land administration information began with the development of multipurpose cadastres. Their establishment has proven to be quite a demanding task, so it is hard to speak of efficient multipurpose cadastres in any country. It was only the development of information technologies that really opened up the possibilities for development of Multipurpose Land Administration Systems (MLAS). The differences between systems for registering land and systems for registering land tenure do not allow for a unified approach among countries (Roić et al, 2016).

The amount and the complexity of the information maintained according to regulations by public authorities is constantly increasing and is tightly related to the development of the technology. The possibilities of new technologies are also constantly increasing. Adopting technological accomplishments, especially in the area of information and communications technology, and their implementation in the system of registers, has enabled easier maintenance, access, and exchange of information. That opened the possibility of collecting new, additional information that were not acquired earlier due to the technical difficulties. Cadastral data are basic data for land administration system. Their availability in a digital form makes them interesting to an increasing number of new areas of human activity and they become essential for their further development. That leads to a constant increase in the demand for cadastral information. Therefore, the countries have to work on the improvement of that information in order to keep up.

The definitions and descriptions often focus on the technical and registration aspects, rather than on the legal aspects. In the legal category, most studies addressed national legislation and the practical use of (national) legislation. The authors believe that further fundamental legal research on 3D property is needed. Additional and more focused attention should be given to international matters, such as comparative studies on the use of 3D property concepts, the development of international property terminology and cooperation between 3D property unit owners (Paulson and Paasch 2013).

On the 3D Cadastre workshop in Delft, the Netherlands, 5 practical issues have been highlighted:

- Which types of 3D cadastral objects (3D properties) can be registered? Are these always related to constructions (buildings, pipelines, tunnels, etc.) as in Norway and Sweden or could it be any part of the 3D space (both airspace or in the subsurface).
- In case of infrastructure objects crossing 2D parcel boundaries, such as long tunnels, and pipelines and cables networks: should these be divided based on the surface

parcels (as in Queensland, Australia) or treated as one cadastral object (as in Sweden or the Netherlands)?

- How to deal with the fact that the legal status of such an object, does not have to be the same for all the ground parcels. E.g. one construction situated on three ground parcels, each on the basis of an other type of right (e.g. easement, restrictive covenant, lease).
- For the representation (and initial registration) of a 3D cadastral object, is the legal space specified by its own coordinates in a shared reference system (as is the practice for 2D in most countries) or is it specified by reference to existing topographic objects/boundaries.
- Should the 3D registration and visualisation reflect the actual dimensions? Or is it sufficient to have a visualisation of property units in buildings based on standard floor-to-floor heights, as in Spain? What is the legal value of these boundaries. Is an investigation of the source documents (title deed, survey plan) needed to get legal binding information? (Ploeger 2011).

In this study, among other things, answers to these questions are given.

The first section of the paper is introduction. The second deals with legal aspects of Croatian 3D cadastre, while the third section describes the link between legal and institutional aspects of 3D cadastre. The fourth section deals with upgrading and maintenance of multipurpose 3D Land Administration System. We have proposed preconditions for establishment of 3D Multipurpose Land Administration System (MLAS) also in the fourth section. The paper ends with conclusion.

2. LEGAL ASPECTS OF CROATIAN 3D CADASTRE

Business and technological systems of public administration are largely based on the registers. Introducing interoperability into the registers is one of the key drivers for optimization of public administration, starting from simple automation of existing processes to the overall transformation of the system and the construction of modern user-oriented services. An additional incentive for such a transformation is a foreseeable need for interoperability between the national system of registers and the EU registers and potentially in the future with the registers of other world countries. The current system of registers in the Republic of Croatia is significantly vertically structured (Mađer et al, 2015).

Spatial data and data about real property in Croatia are managed in multiple registers with many end users. Basic registers are Cadastre and Land book. Responsible institutions of public authority are the State Geodetic Administration (for the Cadastre) and municipal courts (for Land Book). In cadastral offices (20 regional cadastral offices with their 92 branches and the Municipal Office for Cadastre and Geodetic Works of the City of Zagreb), the real properties are registered according to their technical characteristics. The cadastral data on the real property (cadastral parcels) is the basis for the establishment, renewal, keeping and maintenance of land books that are kept in 109 land book offices. In land book, the data on cadastral parcel title holders is associated to the data on cadastral parcels defined by the cadastre. Real property in Croatian real property law is, according to the *superficies solo cedit*

principle, a land surface parcel to include everything relatively permanently associated with this parcel on or below the land surface (primarily buildings, houses, etc.). A real property, in legal terms, may consist of one or more land parcels registered in the land book in the same property sheet, as they are hence legally combined in a single body (registered land unit). Grass, trees, fruits and all valuable commodities the land provides on the surface are parts of this real property until this land is divided.

Croatian Land Administration System (LAS) is registering 3D cadastral objects related to constructions (buildings, pipelines, tunnels). In a case of infrastructure objects which are crossing 2D parcel boundaries, such as long tunnels, pipelines and cable networks, Croatian LAS is treating them as one cadastral object. The Building law and the Law about physical planning is very strict and doesn't allow different legal status of the ground parcels on which such an object has been built, e.g. one construction situated on three ground parcels, each on the basis of an other type of right (e.g. easement, restrictive covenant, lease). For building a new construction in situation like that, the right of construction can be utilised. Right of construction is limited actual right on someone's parcel, which entitles its holder that on the surface of land or underneath it has a building, and owner of this land has to agree with that. Right of construction in legal terms is equal to the definition of real property. For the representation (and initial registration) of a 3D cadastral object its legal space is specified by reference to existing topographic objects/boundaries. For the first implementation od 3D cadastre visualisation of property units in buildings it is sufficient to use standard floor-to-floor heights. Table 1 gives current information for plans of survey - status 2014. In year 2016 status is still not changed.

Production of Surveying Designs for the construction and physical planning as well as production of Utility Cadastre Report (for the public utility infrastructure) requires the use of Technical specifications for determining coordinates in coordinate system of the Republic of Croatia. These specifications prescribe correct ways of measuring and writing/expressing *3D coordinates* in analogue and digital form for cadastral purpose (land, real property and utility cadastre) as well as detailed topographic surveying, preparation of geodetic bases and all other georeferenced views.

2.1 Buildings and separate parts of a real property

Buildings are registered in the cadastre at the obligatory request of a party. Geodetic report prepared by the authorized surveying company must be supplied with this request. Responsible cadastral office must prior review and certify the report. Since 2007 the cadastral offices have partially participated in the control of the legality of the construction of various buildings. As the condition for registering buildings into cadastre, and then taking over that data into land books, what needed to be presented along with the geodetic reports was the right documentation based on which the building could have been built. The partitioned real properties can also be registered in the non-technical part of the cadastral documentation.

Buildings and other structures are registered in the cadastre with the following attributes: location (coordinates), area, intended building use, building name, and house number. A land book takes over two-dimensional data about real property from the cadastre. Real property may be further divided into common and separate parts and registered in the land book based

on the report on partition of real property. In that way, the co-owners of a real property stay in the co-owner relationship on common parts, and each of them becomes an individual owner of a separate part (for example an apartment or an office space). Such a way of registering separate parts began in 1996, and for the majority of the real properties the partition has not yet been implemented.

Table 1. 3D Cadastre Questionnaire for 2014 (Plans of Survey)

Source: http://www.gdmc.nl/3DCadastres/participants/3D_Cadastres_Croatia2014.pdf	**Status 2014**
9.1. Do the survey plans carry 3D parcel representations?	**Yes**
9.2. If so, how are they represented?	**2.5D (2D plan with textual heights)**
9.3. Is there specific legislation (regulations) describing the requirements for Plans of Survey in 3D? If so, please give link to the relevant documents.	**No**
9.4. Is sketch level allowed (low geometric quality, but in principle enough to indicate the 3D object)?	**No**
9.5. Is it possible to define a 3D parcel by referring to other 3D real world objects/ topography (and not specifying coordinates)?	**No**
9.6. In what format are the 3D parcels submitted for registration; attached to legal document in a single pdf (which has good 3D capabilities) or in an extension of (city)GML for 3D parcels, or….?	**Paper document**
9.7. Are the 3D parcels somehow checked for spatial validity; e.g. volume is closed, does not overlap with neighbour volume (and also no unwanted 3D gaps)?	**Visually**
9.8. Do you have examples of (prototype or production) 3D survey plans available?	**No**
9.9. Are any reference objects visible on the survey plan (e.g. real buildings, roads, that is 3D topography)?	**No**
9.10. What form of 3D data acquisition is used (CAD, terrestrial surveying, sketches, stereo/oblique images, laser scanning,…)?	**Mostly terrestrial surveying.**
9.11. What software do you use for creating and processing survey plans? Any 3D capabilities included and used?	**CAD**
9.12. Can 3D parcels be subdivided, consolidated or nullified?	**No**
9.13. Is there any existing technical circular or directive to assist Surveyors in 3D data collection in the field?	**Yes. Technical specifications for determining coordinates in coordinate system of the Republic of Croatia**
9.14. Are the surveyors required to undertake a field survey for 3D cadastral data?	**No**
9.15. Are building construction plans used to compile 3D cadastral information for apartments?	**No**
9.16. Is 2D/3D field survey done by private licensed surveyors or by government surveyors?	**Private licensed surveyors**
9.17. Are plans of survey created for each new 2D/3D parcel or are they updated in an index map or a cadastral database.	**Yes**
9.18. Do you show dimensions or isometric views of 3D parcels on survey plans (do you also store this in a database)	**No**
9.19. Any other survey plan issues?	**Survey plan for 2D parcels are made exclusively licensed surveyor, for 3D also other professions**

Data about buildings are transcribed into land book based on the data delivered to the land book by the cadastral office. Ownership of a separate part of property (e.g. an apartment or office space) is realized through registration in land book. These separate parts may be registered if they make independent units of use. Separate parts may include balconies, terraces, basements, and attics, under condition that they serve exclusively a single particular part and if they are clearly separated from other real property parts. Registration of particular parts of real property (**Figure 1**) in the land book is not possible without partition of real property, which in legal terms means retention of real property as a single body. The same procedure is commonly used in land book to formally unify the land which was often publicly owned with the building constructed on that land. Partition of the real property establishes ownership of a particular part of real property (apartment, office space, garage, etc.) that becomes associated with proportionally shared part on the property. Fair relationship in financing maintenance of a building is furthermore made possible by establishing ratio of each party's ownership in the real property and hence each party's proportional share in shared ownership of common parts.

Elaborate on partition of real property establishes size and shape of common and separate parts of a single real property (apartment, office space, etc.) and draws connections for reference purposes against the real property as a unit. Additionally, data about particular parts must be technically processed providing drawings of particular and common parts with required labels and areas of particular parts. These drawings are provided in analogue format. Shared ownership contract must also be provided.

According to the Regulation of connecting Land book and the Book of deposited contracts (Official Gazzette 2010) the legal obligation of the building manager is to start the procedure of connecting the Land book with the Book of deposited contracts. The regulation was brought because it has been noticed that many buildings built several decades ago have not been registered in the cadastre or the land book, and they have not been partitioned. According to the mentioned regulation, the description of the separate part of a real property contains the data on intended use (office space, apartment, and other), number of rooms, position of separate part in a building and the surface of the separate part (for example two-bedroom apartment on the first floor, right side, with the usable area of 52.00 m^2). With the description of the separate part of a real property the additions are mentioned as well (a woodshed, a garage, a parking space, a balcony, a garden, a terrace and similar), along with their area, if there is such a data.

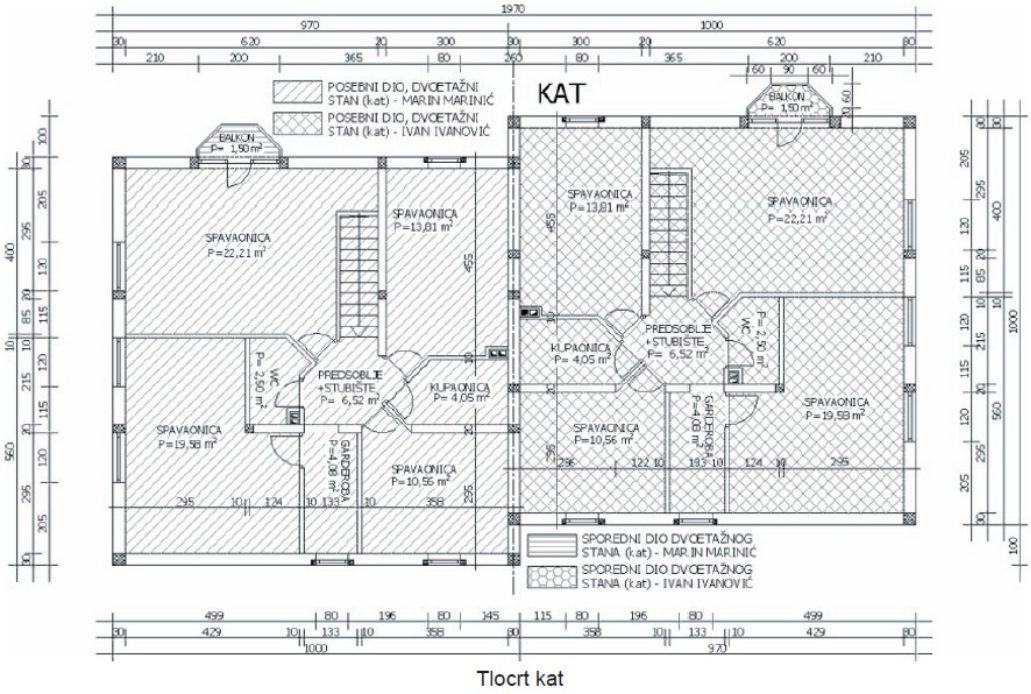

Figure 1. Elaborate on partition of real property (Tušinec 2005)

2.2 Utility cadastre

The "Law on State Survey and Real Property Cadastre" from 1999 stipulated that Utility cadastre registers are under the responsibility of future surveying offices in the bodies of local government, while the Republic of Croatia should adopt a new "Regulation on the content, method of production and Utility cadastre management". That was not made before the adoption of the current "Law on State Survey and Real Property Cadastre" (Official Gazzette 16/2007). Pursuant to the current "Law on State Survey and Real Property Cadastre" (Official Gazzette 16/2007), Utility cadastre registers remain under the jurisdiction of the bodies of local government.

State Geodetic Administration (SGA) of the Republic of Croatia considered that physical registration of the utilities must be organized at national level in the Republic of Croatia. The proposed new Croatian Utility Cadastre when incorporated in Croatian Land Administration System should streamline the provision of essential services such as water, sewerage, electricity and communication network. This normative decision, the Law on State Survey and Real Property aligned with Directive 2014/61 / EU of the European Parliament and of the Council of 15th May 2014 on impacts for reducing cost of installing electronic high-speed communications networks. The Digital Agenda is a comprehensive plan of the European Commission to stimulate economic growth through the creation of a more competitive and modern digital Europe. Member States accepting the Digital Agenda, took over the obligation to provide basic broadband to all Europeans by 2013 and ensure that by 2020 all Europeans have access to internet speeds greater than 30 Mbit / s, and that at least 50% of households in the European Union to be subscribed to Internet connection speeds above 100 Mbit / s. In order to achieve the stated objectives of the Digital Agenda adopted the Directive on measures to reduce the cost of installation of electronic communications networks at high

speed. The directive assumes that could reduce the cost of setting electronic communication networks of high speed contributed to the achievement of digitization of the public sector expanding digital leverage effect on all sectors of the economy while reducing costs for public administration and provide more efficient services to citizens (URL 1).

The mentioned changes of the current Law on State Survey and Real Property Cadastre passed all preparatory procedures. Based on the current status of the Utility Cadastre in the Republic of Croatia, the new implemented Utility Cadastre should achieve the following goals:

- obtaining information about the "occupancy of space" with regard to the underground utility and other infrastructure,
- prevention of infrastructure related negative publicity, preventing and reducing the cost of direct and indirect damages,
- management of the infrastructure, implementation of conditions for keeping records of the utility infrastructure,
- developed in such a way that infrastructure data will be merged together with land cadastre data and available in the same projected coordinate reference system - Croatian Terrestrial Reference System 96 (HTRS96) to all interested parties (Vučić et al, 2014).

3. LINK BETWEEN LEGAL AND INSTITUTIONAL ASPECTS OF 3D CADASTRE

Much of the information that public authorities collect, maintain, use and make available to others, refers to the persons, properties and interests over those properties (Roić, 2012). This information are maintained in official registers which are regulated by legislation. The high level of compliance with legislation and consistency of the data is a prerequisite for legal security that register has to provide towards the citizens, companies and other end-users of data.

3.1 General information

In Croatia at this moment there is no official records that can provide complete information about all buildings as spatial objects. Cadastre and Land Book are the only official and systematically maintained registers which contain data on real property, which also includes buildings. Condition, integrity and structure of data collected on buildings and maintained in these registers does not allow insight into the state and basic characteristics of certain buildings and overall condition of buildings in the entire country. Therefore, one of the strategic objectives of the State Geodetic Administration is establishment of multipurpose cadastre of buildings to provide such data and information. Implementation study of the cadastre of buildings should answer how to establish institutional, legislative and financial framework and propose the structure of the data model and technical standard for the information system of such cadastre. Also, this study should provide short-term and long-term strategic guidelines regarding system architecture, data model, specific needs of stakeholders, required legislation, the benefits delivered by such system and financial resources needed for its establishment and maintenance. The study should define implementation phases of the

cadastre of buildings based on experiences from EU countries which have already introduced similar systems into daily operations. The study so far, among other activities, questioned the needs of the following future key users: Ministry of Construction and Physical Planning, Tax Administration, Ministry of Justice. It is also in progress questioning the needs these key users: Ministry of the Interior, Croatian Chamber of Economy, National Protection and Rescue Directorate, Croatian Bureau of Statistics, Croatian Office for the State Property Management, and the representative sample of Croatian cities and municipalities. All of this is conducted in order to involve general public into project and consider the needs of users which will be, after the establishment of the unified multi-purpose register of buildings, an added value to more regular spatial planning, property tax collection, overall development of cities and municipalities, and the overall benefit of the state institutions and society as a whole (URL 2).

In Croatia there are number of activities aimed at improvement of data, business processes and organization of land administration, all of them running under the National Real Property Registration and Cadastre Program known as “Organized Land” - in Croatian "Uređena zemlja". One of the key objectives is the realization and implementation of Joint Information System (JIS) of Land Book and Cadastre. JIS is a unique system which, in terms of business, replaces the currently different databases, cadastral data models and associated applications in cadastral offices of the State Geodetic Administration, as well as Land Book databases and applications in offices of the municipal courts. JIS provides support for implementation of all regulated business processes and tasks, and transparent monitoring and reporting on data form the Cadastre and Land Book. Special values of this system, hosted in highly secure environment, are its’ administration and functionalities. Establishment of JIS accelerates registration of real property in both cadastral and Land Book system, raises the security level in the real property transactions, provides better management of both systems, streamlines business processes, improves customer relations, and increases the speed and quality of service. In order to provide the best speed and quality of services to key users, as well as the general public, the State Geodetic Administration and Ministry of Justice have developed and continue to develop the functionalities of public OSS (One-Stop-Shop) web application which represents the link to cadastral and Land Book data (or JIS). OSS allows all users, regardless of registration, search and overview of the basic cadastral and Land Book data, but also contains a section for registered users where they can view the data, apply for public documents, view the case status and receive issued documents into electronic mailbox. These and other additional functionalities will be soon enabled over cadastral data so that the following examples will become possible: electronic exchange of data between cadastral offices and licensed geodetic engineers, delivery of digital reports in cadastral offices which will standardize and speed up the review and confirmation of geodetic reports and accelerate the process of real property registration. It will also provide citizens with easy and quick access to public documents and data (URL 2). SGA has implemented JIS in all cadastral offices (112) on the day 27. June 2016. (Figure 2). Municipal Office for Cadastre and Geodetic Works of the City of Zagreb is not on the direct jurisdiction of SGA and that is the reason why this office will enter in the JIS a bit later.

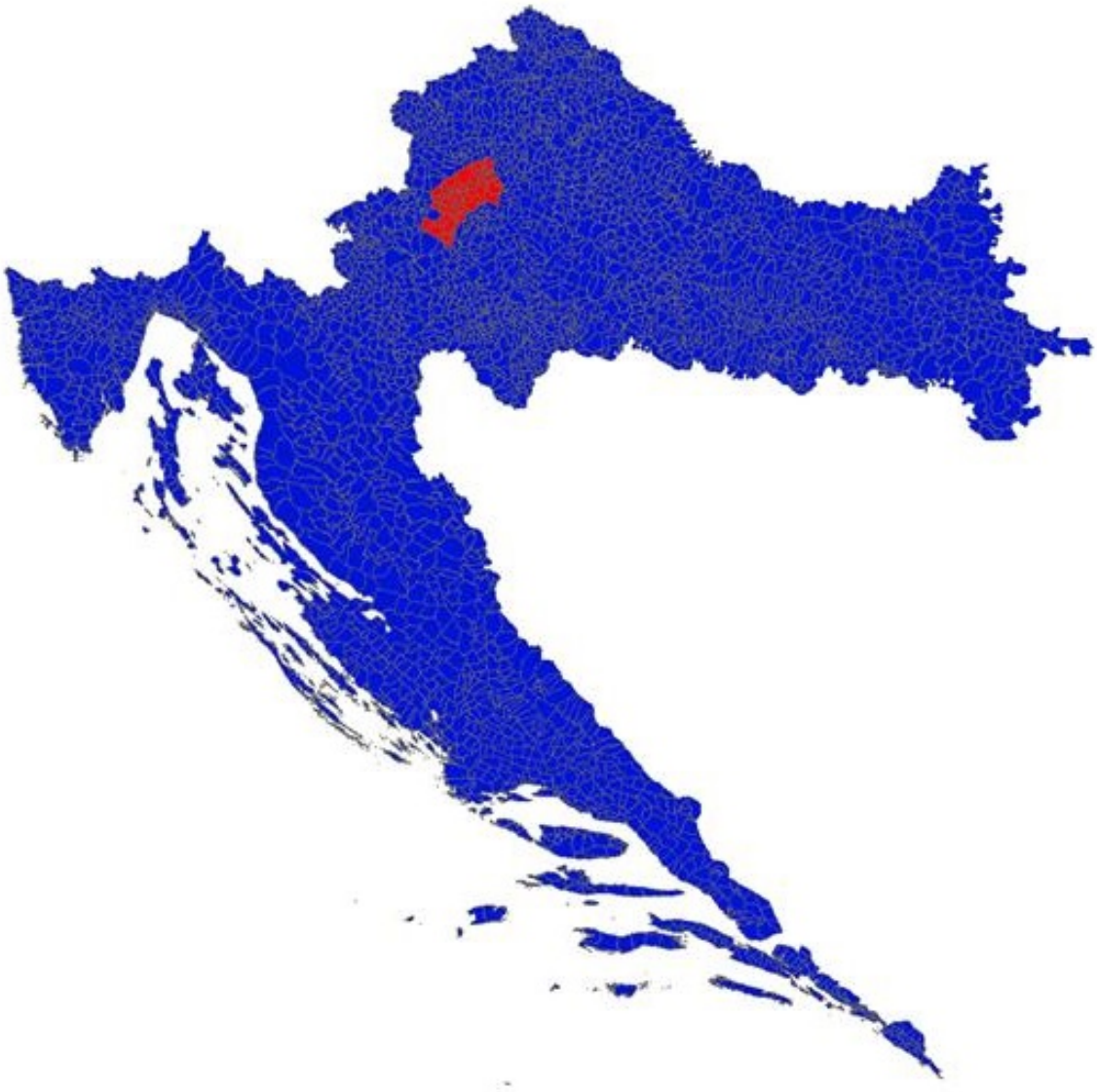

Figure 2. Status of Real Property Registration and Cadastre Joint Information System (JIS) on the day 22. August 2016. (source: URL 3)

3.2 Current state of cadastre related data

Recently conducted research (Mađer et al, 2015) included the analysis of land related registers with the purpose of overall assessment of the condition of land related data. Those registers primarily include data about land features such as cadastral parcels, buildings, utilities but also interests (rights, restrictions, responsibilities) established over those features. Registers covering this domain are: Cadastre, Land book, Register of spatial units and Utility cadastre – which are highly related registers. Analysis also included some other important registers holding the relevant data for the previously mentioned land related registers. These are Register of natural persons, Registers of non-natural persons and Register of personal identification numbers. Table 2 gives a complete list of analysed registers with information about the jurisdiction over them.

Table 2. Registers and jurisdictions

Register	Public authority
Register of natural persons	Ministry of public administration
Registers of non-natural persons	Judicial authority
Register of personal identification numbers	Tax administration
Land book	Judicial authority
Cadastre	State Geodetic Administration
Register of spatial units	State Geodetic Administration
Utility cadastre	State Geodetic Administration

One of the aims of the research was to determine the level of redundancy within the registers closely related to the domain of the land administration. The analysis has confirmed a significant amount of data redundancy (Figure 3) which is a direct consequence of non-existing linkage between the official registers. Non-existing linkage is the primary motivator for copying of data from one register to another, thus producing redundancy. The existence of redundant data in the public authorities, often leads to situation where data about some land feature in one register does not match the corresponding data in another register. Such condition is the cause of various unwanted consequences for the relevant public authorities, as well as for citizens and companies as the end-users of that data. In the time when analogue technologies were used for data maintenance such copying of data was the only available method to have additional relevant information about a recorded item originating from other registers, all in one place. Even with the most strict measures and a comprehensive controls, the analogue handling of registered data very often resulted with errors which has reduced data's consistency. Therefore registers have often been taken as unreliable which undoubtedly lessen their actual value. Unfortunately, later when electronic technologies emerged, such practice continued to be used as a result of the retained analogue logic and analogue way of thinking in the newly established electronic environment. Proper modelling of electronic data would significantly simplify the maintenance of data, increase their quality, availability and transparency, and enable more effective dissemination of information via network services.

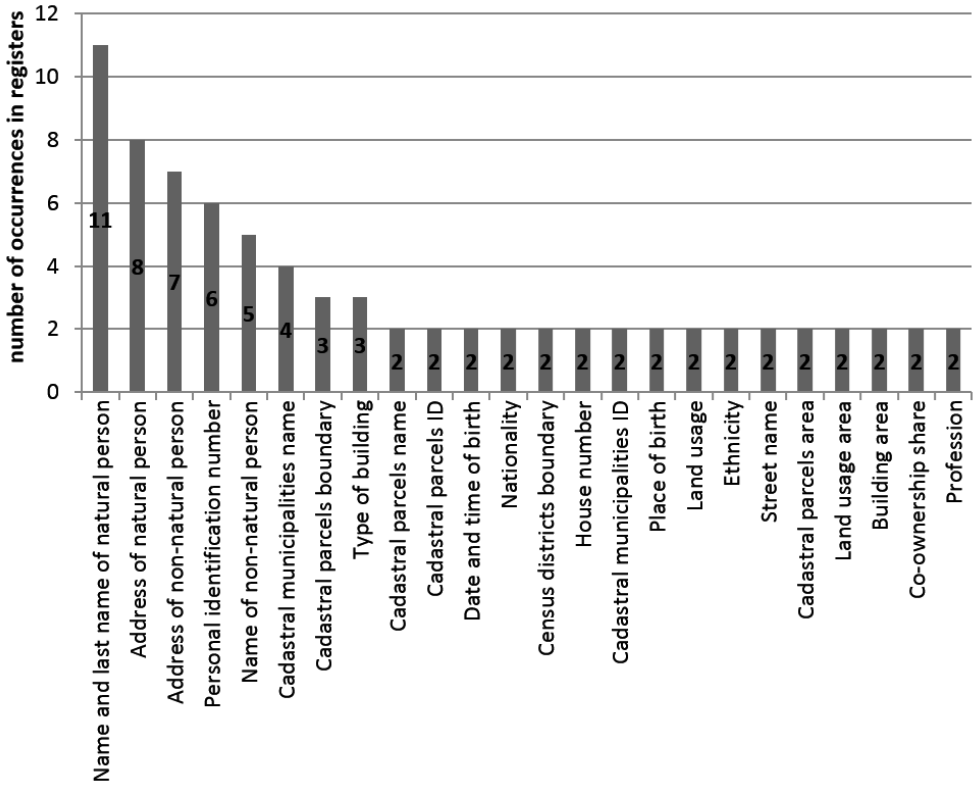

Figure 3. Redundant data in the official registers (Mađer et al, 2015)

The largest redundancy was found in data related to natural and non-natural persons. This is not surprising if one takes into account the fact that almost every other register uses those data while there is yet no systematic solution for linking registers on data level. However, in present days there cannot be any excuse for keeping such redundant data. With the introduction of e-services as a form of application of modern Information and communications technology (ICT), an environment has been created in which there are no more technological barriers for data sharing, but only those which are of administrative character.

Analysis has shown that a certain degree of redundancy exists even at the level of individual public authorities responsible for governing multiple registers (Figure 4). Especially situations like this should not occur because the public authority responsible for more than one register has an unrestricted access to all the data, is fully familiar with the underlying data models and thereby should be able to find simpler solutions for data sharing than those when data is kept under different jurisdictions.

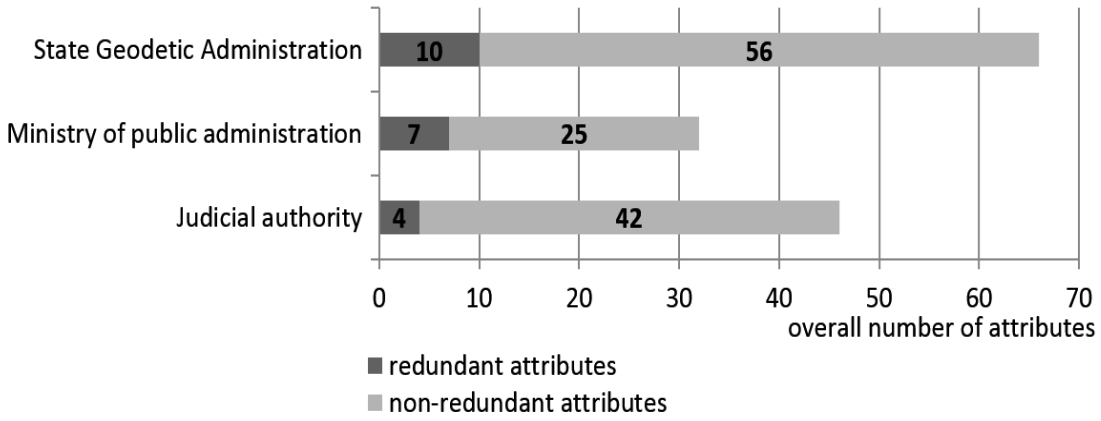

Figure 4. Redundancy at individual public authorities (Mađer et al, 2015)

In the registers which are under the jurisdiction of State Geodetic Administration a total of 66 attributes was discovered. Analysis revealed 10 attributes that appear in 2 or more occasions which is a significant redundancy of 15%. In the registers which are under the jurisdiction of Ministry of public administration the total of 32 attributes was discovered. Analysis revealed 7 attributes that appear in 2 or more occasions which is a significant redundancy of 22%. In the registers which are under the jurisdiction of judicial authority the total of 46 attributes was discovered. Analysis revealed 4 attributes that appear in 2 or more occasions which is also a significant redundancy of 9%.

Additional analysis of the results presented by the previous figure shows that a significant amount of this redundant data is natively maintained by the individual public authority, thus confirming the problem is not only caused by non-existing linkage at the level of different jurisdictions but also at the level of individual public authorities. Appropriate linking of registers would eliminate data redundancy and achieve significant savings in time, people and financial resources used for redundant and unnecessary multiple recording of the same data in different registers. This would lead to overall rationalization of the system of registers, enhancement of its legal security and the availability of high quality and always up to date data.

4. PRECONDITIONS FOR ESTABLISHMENT OF 3D MLAS

Urbanisation, the development of high-rise apartments and the advent of complex building structures creates unique challenges that cannot be met by 2D land and property information. These include inter-related titles and complex plans relating to:

- cadastral parcel
- building, both internal - indoor plans and external attributes -roof and facade (Jazayeri et al, 2014).

The primary purpose of a land administration system (LAS) is the registration of legal or other formal relations of persons to land. Besides its primary purpose, land administration system can and should also serve as a basis for land management. Different to the land administration, land management is a set of processes ensuring that the land is used in an

efficient and sustainable manner. Unfortunately, land administration systems are rarely able to fulfill such additional requirements, even in the developed countries.

Therefore, it is required to increase efficiency and usability of LAS. Under efficiency we consider the ability of LAS to update its data quickly whilst ensuring the consistency and correctness thereof. Usability of LAS is also very important. Besides the mere registration of the land, multipurpose LAS must be able to efficiently support processes of land valuation, urban planning and various rearrangements aiming to increase agricultural productivity of the land. By increasing its efficiency and its usability a land administration system can be transformed into a multipurpose land administration system (MLAS) (Figure 5).

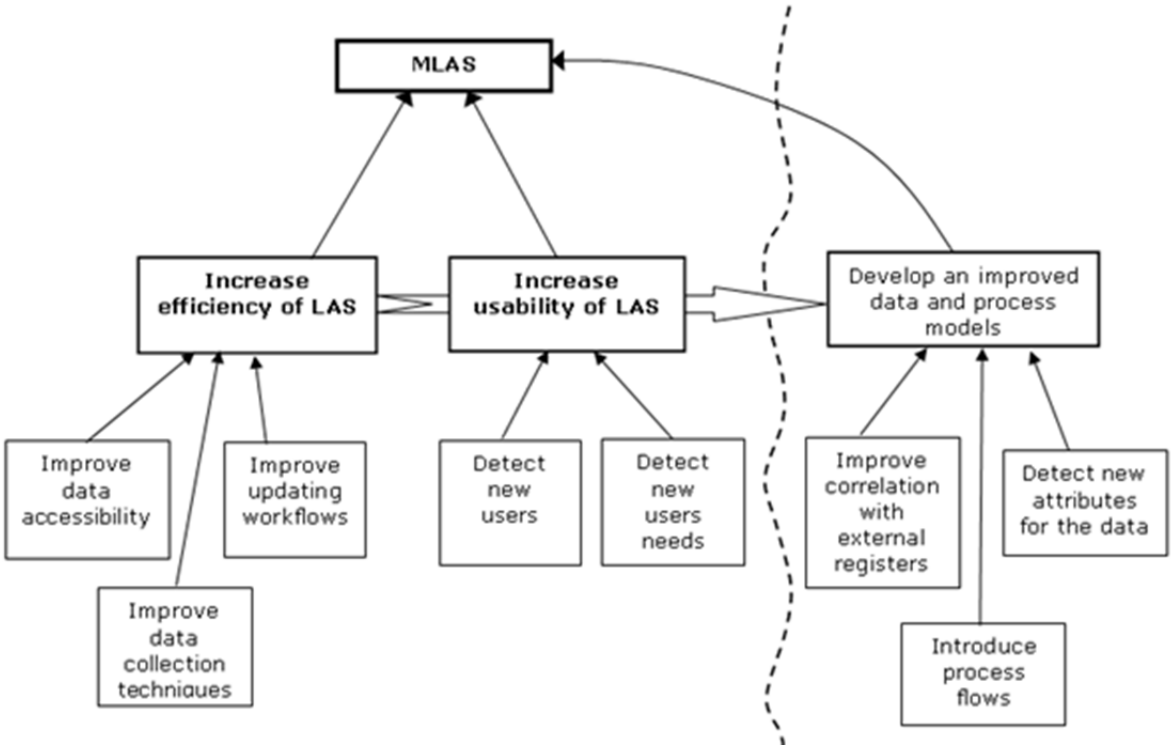

Figure 5. Transformation of LAS to MLAS

Bennet et al (2005) recognized which criteria future cadastre should satisfy in order to serve as a background for quality land administration and the same can be applied to 3D LAS:

- Improving the integration between field data collection and execution of transactions on the data
- Defining and formalization of types of transactions on the data
- Describing and formalizing the transaction processes for various types of transactions in order to make as large as possible part of the updating process outsourceable.

In order to have good background for all products and services of MLAS improvement of efficiency has to start at lowest layer of MLAS, i.e. data collection and maintenance within

controlled real property transactions. Current procedures in land surveying are adapted to paper based cadastres. There is a lot of work to transform survey results in a form which would be easily imported into information system. Similar research made (Duc et al, 2009) on a Vietnam cadastral data case study. (Spaziani 2010) in his work explained process of converting historic survey data for the construction of survey-accurate digital cadastre. Van Oosterom and Lemmen (van Oosterom et al, 2011) explored possibilities for modelling land survey data based on ISO standard 19156 (Observations and Measurements - O&M). Vranić et al (2015a) went step beyond developed conceptual model based on ISO 19156 for GNSS observations which could be used for efficient storage and retrieval of land survey data.

In order to enable outsourceable transactions it is necessary to recognize transaction types and their correctness conditions. In their work (Matijević et al, 2008) made basic analysis of transactions in cadastre and planar partition since traditional European parcel-based cadastres use planar partition to manage their geometry. In later work (Matijević et al 2011) made initial research on correctness of cadastral parcels represented by ISO simple polygons. The authors defined which general criteria should be satisfied in order to planar partition of working area should be correct. Later, Vranić et al (2015b) defined complete list of transaction types on cadastral parcels and defined preconditions and postconditions for each of transaction types. Developed conceptual model shows direction towards definitions of correctness criteria of 3D data. Initial research on the correctness of 3D data was already conducted by Karki et al (2010). The authors use as basis ISO standard 19152 (Land Administration Domain Model - LADM) which defines several encoding strategies for 3D data in order to ensure the level which is achievable. Depending on the level of maturity of system validation criteria can be defined.

In Croatia there are some initiatives towards establishment of 3D LAS, such as the Cadastre of Buildings. Idea of that project is to define conceptual model for the data on buildings with minimal redundancy. Several stakeholders are involved in the project. Each stakeholder is responsible of update for their share of the data, and the data are aggregated into one place in the cadastre of building. However, further efforts should be invested in order to define complete workflow for gradually improvement of 3D data about buildings and other 3D objects from existing sources since establishment of 3D LAS from the scratch doesn't seem to be feasible in some reasonable time.

Institutions that could and should participate in establishing 3D cadastre are the National Mapping and Cadastral Agencies (NMCA) or depends of country Ministry of Finance. Financial resources to establish a 3D cadastre should be prescribed by law in a way that citizens, entrepreneurs and investors have benefits directly from the 3D cadastre. It should take into account the real limits of performance and find the way how to motivate citizens and legal persons to register their property in the 3D cadastre, using past experience in the field of land administration.

5. CONCLUSION

On the way to establish a complete 3D cadastre the important step is to register all buildings and structures (especially bridges, tunnels, overpasses, underpasses, traffic infrastructure, underground buildings etc.) as well as underground and over-ground public utility infrastructure. It is especially important to improve legal and institutional framework that will enable registration of properties in 3D form and adequately describe its separate parts. 3D property models suitable for implementation in a complete 3D cadastre can be made out of 2D geodetic data (mostly geodetic reports) or out of plans of separate parts of the properties.

It is not imperative that the 3D cadastre be made as soon as possible, but it is better that he was making gradual and well prioritization (it is indisputable that larger cities with more complex 3D situations from real life, a lot of public utility infrastructure, more underground structures and a large number of buildings with two or more floors have a greater need for the creation of 3D cadastre of small towns, especially from the village). To determine these priorities cost-benefit analysis of establishing 3D cadastre in a certain area is necessary.

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