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Revision of Croatian LADM Profile According to the New Regulations in Surveying Profession

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Key words: Croatia, Land Administration System, 3D cadastre, LADM, ISO 19152.

SUMMARY

The Land Administration Domain Model (LADM) provides a conceptual model for modelling of Land Administration Systems (LAS). Since its publication in 2012, a wide range of scientists and practitioners have shown interest to work on it and use it. These activities by many stakeholders resulted in recognized need for the revision of LADM. LADM Edition II has wider scope and includes additional domains such as land valuation, marine spaces and spatial plan information and introduces the modular structure in order to make it simpler and not to mix different domains in the same model.

Since the first version of Croatian LADM profile in 2013 many changes occurred in the Croatian LAS. In this paper we describe these changes and provide a proposal of revised Croatian LADM profile. While creating the revised model we focused on the Fundamental and Land Registration parts of LADM Edition II.

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1. INTRODUCTION

In recent years a significant number of changes have been introduced into the Croatian Land Administration System (LAS). The most significant changes are related to the improvement of the quality of cadastral maps by homogenising their content and by introducing digital geodetic reports, thus enabling their online submission for most of the cases. During the 2021 all LAS data have been made available without a charge.

On the other hand, LADM has gained a large community of scientists, practitioners trying to find a common language to make LAS comparable across countries. The LADM is in the process of revision. The proposed LADM Edition II has a wider scope and is divided into six parts. The first part is defining the base concepts and classes to be reused in other parts which are addressing different domains such as land registration, land valuation, marine spaces. The part 6 aims to provide implementation guidelines and examples that would underpin the implementation of LADM (Lemmen et al., 2021).

Therefore, the compliance with the LADM (ISO, 2012) would be beneficial during the process of modernization of the land administration system, since such processes are quite challenging due to complex laws and regulations, lengthy process descriptions, shared organisational responsibilities, differing information encodings and formats (Oukes et al. 2021).

Over the years a significant number of LADM country profiles have been developed. LADM country profiles integrate the legal and institutional context governing Rights, Restrictions and Responsibilities (RRRs) with the desired Land Administration Systems' (LASs) advancements. Experiences from these developments are in the direction of integrated Land Administration with vision for the future and can serve as good practices for the countries (Kalogianni et al., 2021).

The Croatian LADM profile was created and presented by Vučić et al (2013) at the 5th LADM workshop in Kuala Lumpur. The Croatian LADM profile captured the status of cadastre and land book at that time. Since then, many changes have been introduced in Croatian LAS. Updated laws on land cadastre, utility cadastre, cadastre of buildings and national spatial data infrastructure have made the path for more efficient maintenance of cadastral data but also for changes in the direction of increased and diversified usage of LAS data. This paper analyzes changes in Croatian LAS since 2013 and integrates them in LADM to create a revised version of Croatian LADM profile. Also, this paper is addressing the proposed changes in LADM Edition II while revising the LADM profile. The revised country profile is concerned only with the land registration domain while other domains (marine spaces, spatial plan information, land valuation) are outside of the scope of this paper.

This paper is organized as follows. Section 2 summarizes the content of the first version of Croatian LADM profile. Section 3 describes the currently available version of LADM Edition II. Section 4 presents the current status of LAS in the Republic of Croatia. Section 5 presents the revised Croatian LADM profile (HR_LADM_V2). The paper ends with a conclusion with main directions for the further research.

2. THE FIRST VERSION OF CROATIAN LADM PROFILE

The first version of the Croatian LADM profile (Figure 1) was developed in 2012 (Vučić et al, 2013). New classes, attributes and types were created as an extension of the base LADM classes. Code lists were extended with the values specific for Croatian LAS according to the regulations at that time (Figure 2). Classes and codelists have been prefixed with ISO country code (HR_) to distinguish them from the base LADM classes and from other LADM profiles. The class HR_SpatialUnit has attributes that use a list of values HR_UsageTypeLand and HR_UsageTypeBuilding. These codelists define the possible and allowed values for these attributes. Their content is regulated by the Regulation on Land Cadastre and according to the Regulation on the Content and Form of Real Property Cadastre Documentation. Other code lists, HR_OwnerType, HR_MonumentMaterial and HR_BoundaryType are defined in accordance with the State Survey and Real Property Cadastre Act (Figure 3).

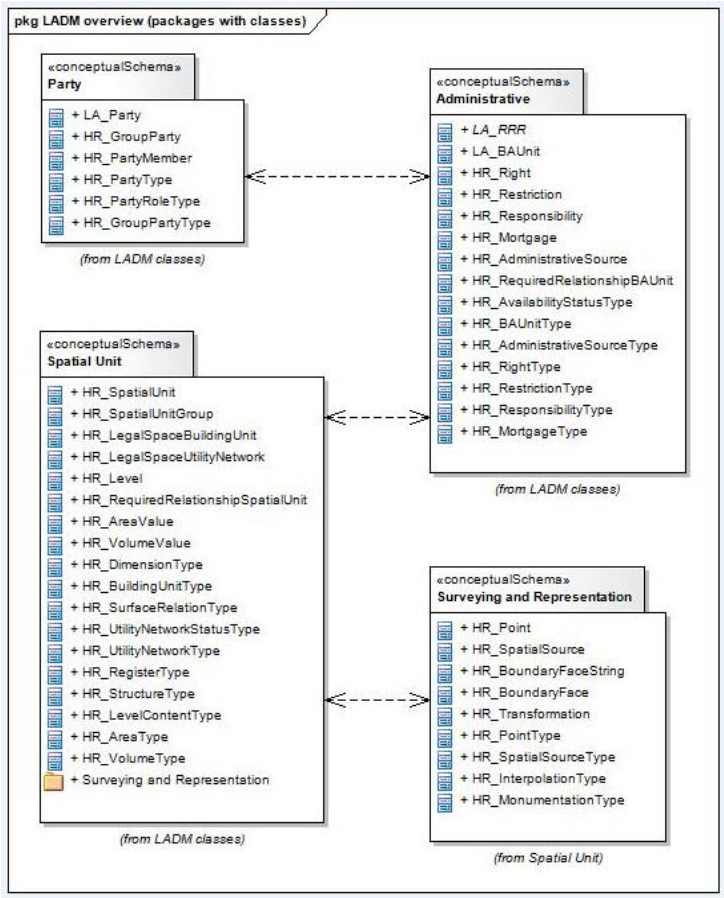

Figure 1. Croatian LADM profile overview

The first version Croatian LADM profile provided support for introducing the 3D cadastre implementation in Croatian LAS even though it was in a very early stage back then. Another important contribution to the development of the 3D Cadastre in the Republic of Croatia is the introduction of the unique identifier of separate parts of real property, proposed to be implemented in the State Survey and Real Property Cadastre Act and the Land Book Act (Vučić 2015).

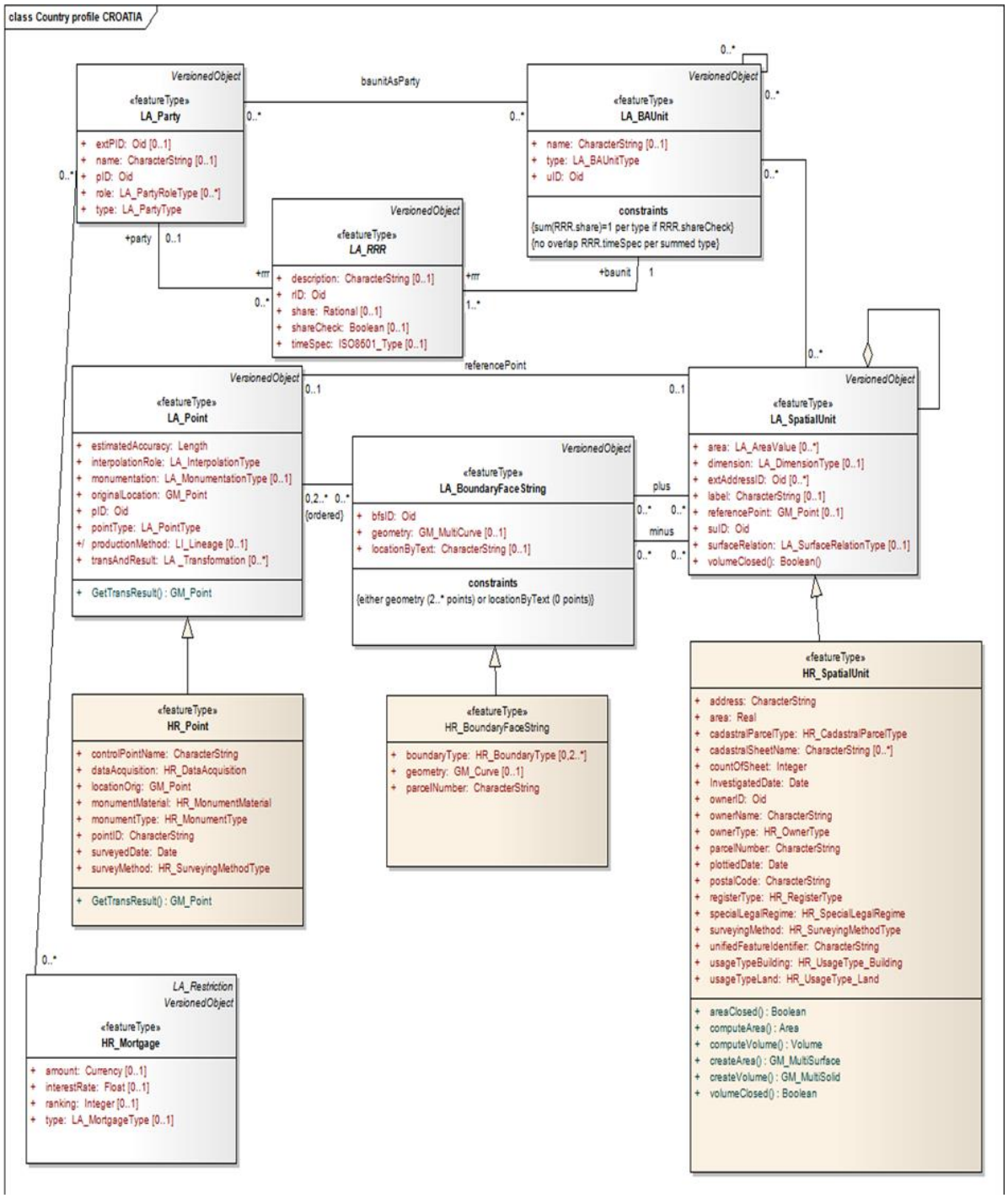

Figure 2. Croatian LADM profile - 3D cadastre model (Vučić 2015)

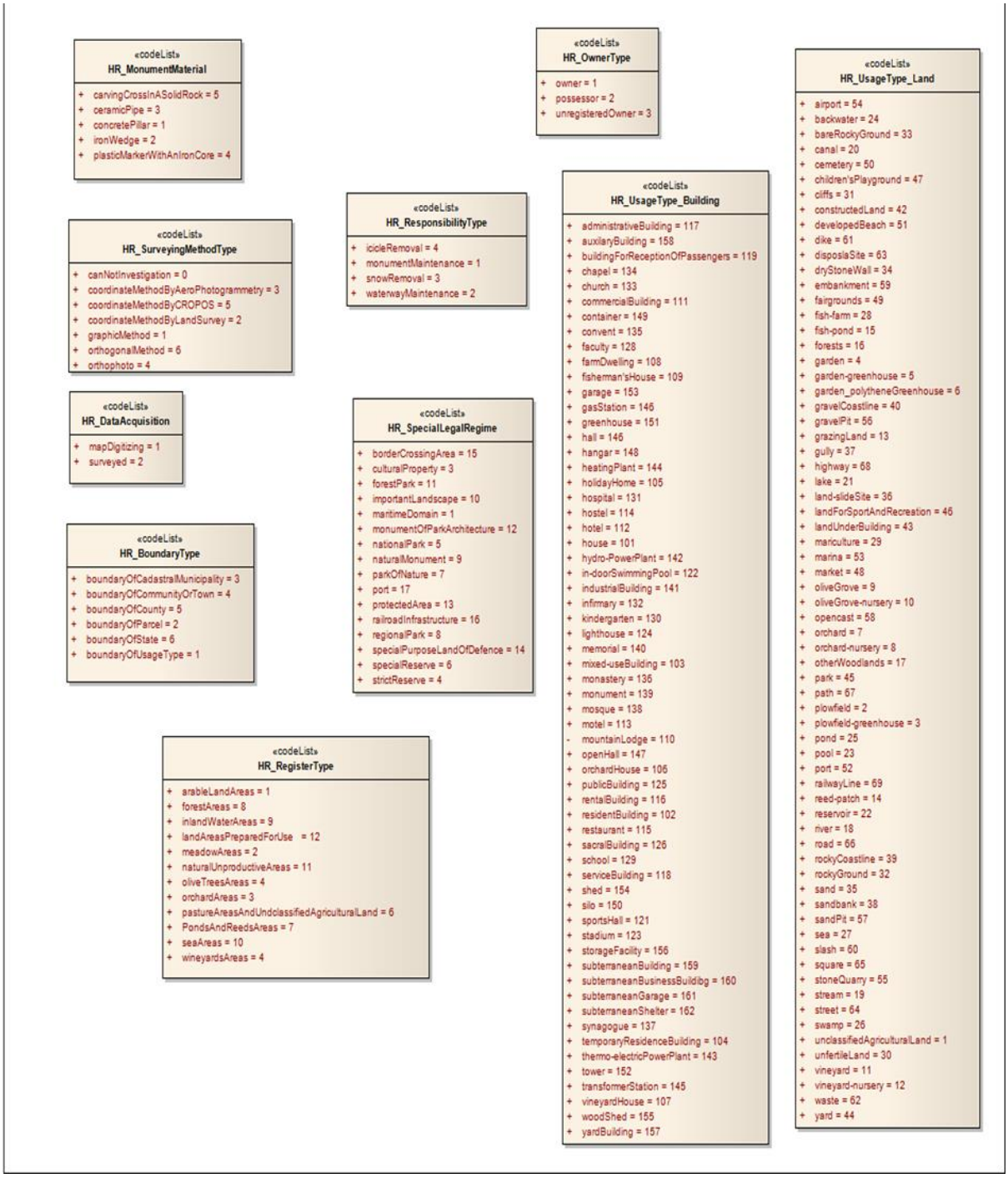

Figure 3. Croatian LADM profile - code lists (Vučić 2015)

3. THE SECOND EDITION OF LADM

The LADM is in the process of revision. It has a much wider scope and it has a modular structure where each part is covering a specific subdomain. The working titles of LADM Edition II parts are:

- Part 1 – Fundamentals
- Part 2 – Land Registration
- Part 3 – Marine Space Georegulation
- Part 4 – Valuation Information
- Part 5 – Spatial Plan Information
- Part 6 – Implementations

The package Fundamentals defines basic classes and concepts that other parts are reusing. Next figure shows the basic classes of LADM which are presented in part 1 of LADM Edition II (Figure 4). In comparison to the first version of LADM, two new classes are introduced as the base classes: VersionedObject and LA_Source. Class LA_Source represents the LAS process and it is associated with the class VersionedObject. Since all other classes of LADM are subclasses of VersionedObject they all inherit this association.

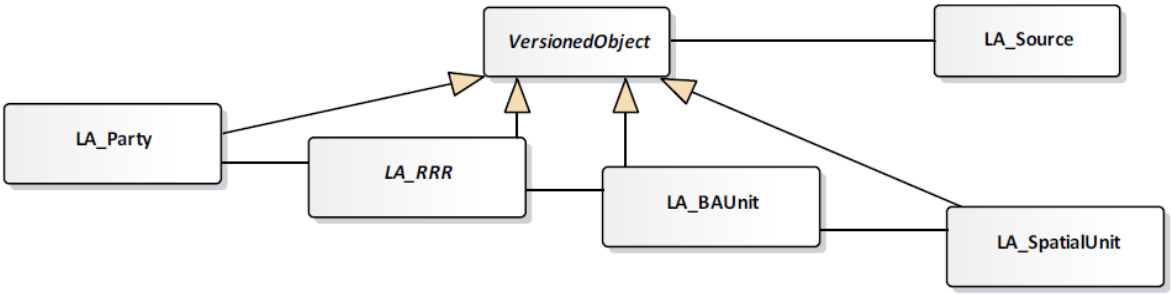

Figure 4. The basic classes of LADM (Lemmen et al, 2021)

VersionedObject is an abstract class used in the LADM to manage a temporal component. It provides optional begin and end Lifespan and Valid timestamps. This enables reconstruction of the state (database or real world) at any point in time (Thompson & van Oosterom, 2021). This was defined and discussed earlier by (Vranić et al, 2018; Vranić et al, 2021). The association between LA_Source and VersionedObject is shown in more detail on the following figure (Figure 5). LA_Source represents a process/event in LAS which caused the changes in registration. LA_Source is used to manage and maintain a temporal component of instances of LADM classes in the database.

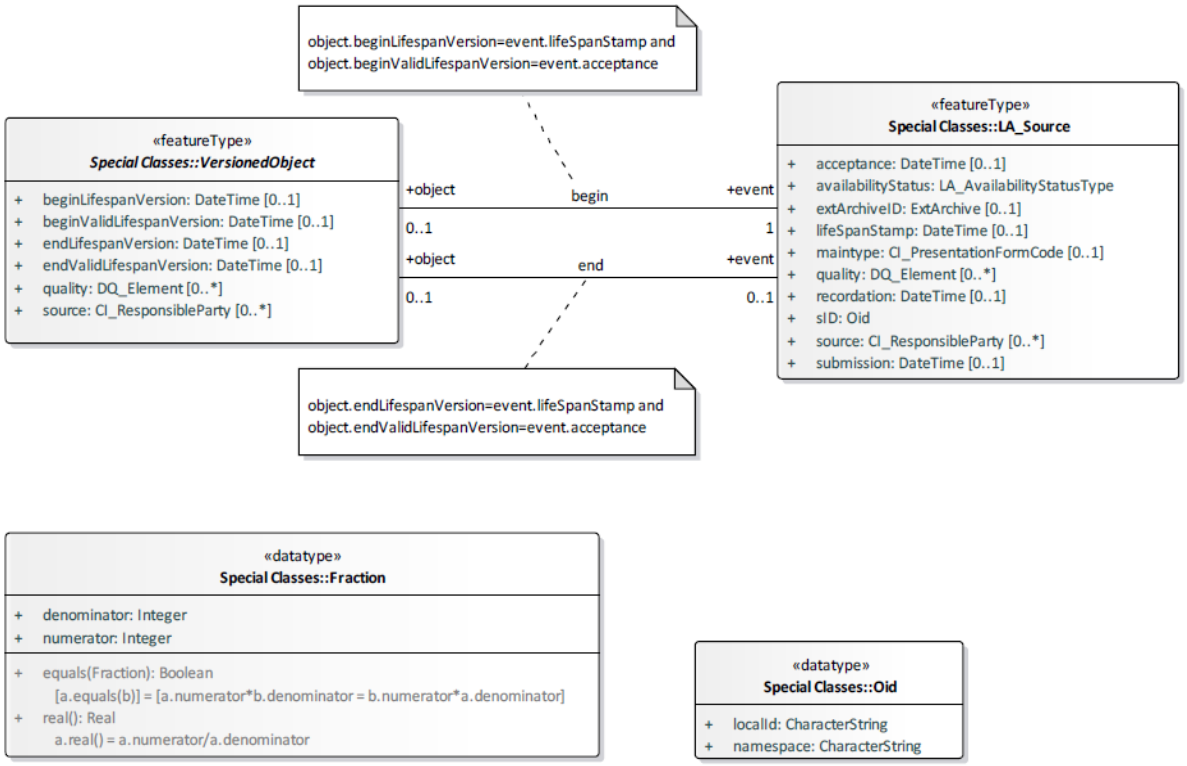

Figure 5. Newly added relationships between classes VersionedObject and LA_Source (Lemmen et al, 2021)

Lemmen et al. in 2020 produce a paper which uses developments across a global range of case countries to justify the updates and explain likely implementations. Developments across a global range of some countries (Mozambique, Indonesia, Colombia, Benin, Malaysia and Scotland) have been presented to justify the updates and extension in LADM Edition II (Lemmen et al. 2020).

4. THE CURRENT STATUS OF LAND ADMINISTRATION IN CROATIA

In December 2018 the new Law on State Survey and Real Property Cadastre was brought into the force and introduced several changes in Croatian geodetic profession. The law introduced the Register of Buildings as a transitional register towards 3D cadastre, combining datasets from several existing sources and newly collected datasets. The scope of Register of Geographical Names and Register of Spatial units have been redefined. The Cadastre of Infrastructure was returned under the jurisdiction of the State Geodetic Administration because previously it was under the jurisdiction of local government units. The process of cadastral surveys has been redefined and technical reambulation was abandoned as a methodology for partial improvement of cadastral map quality since its results were not satisfying in the past. Also this law regulates improved surveying methodology in the Republic of Croatia - this time each technical ordinance contains technical specifications that define the procedure in more detail.

4.1 Real Property Cadastre

The new Law on State Survey and Real Property Cadastre introduces the real property cadastre as a reliable and high quality product. Cadastral parcels which are registered in a real property cadastre were measured accurately, by aligning the actual situation in reality with cadastre and land book. Real property cadastre guarantees real property security. The cadastral parcel registered in the real property cadastre guarantees the same protection of trust such as land book data. One of the biggest novelties in abovementioned new law is the obligation that quality of field measurement data for boundaries of cadastral parcels and buildings must be determined by the level of confidence for horizontal coordinates with 95% probability standard positional accuracy up to 0.1 meter (Official Gazette 2018).

In the past five years, cadastre and land book made substantial efforts in the digitalization of their procedures. This means that today it is possible to retrieve the majority of cadastral and land book data digitally. Also, it is possible for licensed surveyors to submit digital geodetic reports in most cases.

4.1.1 System of Digital Geodetic Reports (SDGR)

The System of Digital Geodetic Reports (SDGR) is a comprehensive web application developed following the most recent web technologies and principles of interoperability and openness, that provides full support to licensed surveyors in preparing the Digital Geodetic Report (DGR). It supports the entire process with downloading of initial state of data in digital GML format and preparation and development of geodetic data in digital form in order to submit the geodetic report to the cadastral office for the electronic review and confirmation. The SDGR is an advanced solution associated with the Real Property Registration and Cadastre Joint Information System (JIS) and One the Stop Shop (OSS) system (URL 1).
The graphical part of DGR is made in accordance with technical specifications for the creation of digital cadastral maps and the graphical part of digital geodetic elaborate, as well as technical specifications for geodetic elaborates. It consists of a survey plan, and in case of non-homogenous cadastral map, of a cadastral map for the maintenance of digital cadastral map. The SDGR has a large number of implemented automated controls that ensure integrity and validity of the graphical part of DGR (Tomić et al. 2018).

The SDGR provides support to surveyors in creating and checking digital geodetic reports. Due to the complexity of cadastral data in Croatia some types of changes are not supported by the SDGR and have to be created in an analogue manner. The SDGR is connected to external systems by web services that provide data, official documents and processes in the creation of DGRs. Interoperability and attainability of the SDGR also refer to the SDGE REST API module that enables external systems via web services to use SDGR functionalities, such as quality control and data conversion (Grđan et al. 2018).

4.1.2 Cadastral maps homogenisation

From the historical point of view, the cadastral system in Croatia was established in the 19th century by the land surveying and land regulation systems of the Austrian Empire and later of

the Austro-Hungarian Monarchy. The largest percentage of generated cadastral maps were by graphical methods in the period between 1869 and 1916, and the data digitized from those maps are still in use. An improvement of these old cadastral maps was necessary and SGA selected an optimal solution, cadastral map homogenisation – a technical procedure for geometric improvement of cadastral parcels in graphical survey, which takes care not to break the best parts of the digital cadastral map. This technical action does not change the legal status of graphical cadastral data and cannot substitute the cadastral survey, but enables the changes based on the measured individual geodetic surveys in the official records by the overlapping method and properly represent the actual position on the field (Moharić et al. 2018).

4.2 Utility Cadastre

In the previous period, from 2000 till 2018, utility registration was under the jurisdiction of local government (cities and municipalities) which did not produce any positive effect because cities and municipalities did not even establish it, even though they were required to by the law. The State Geodetic Administration has therefore implemented a unique database and information system required for the development and management of a centralized registry of the utility infrastructure at the state level. The system will contain digital data on infrastructure and on notifications on planned construction works (Figure 6).

Figure *6*

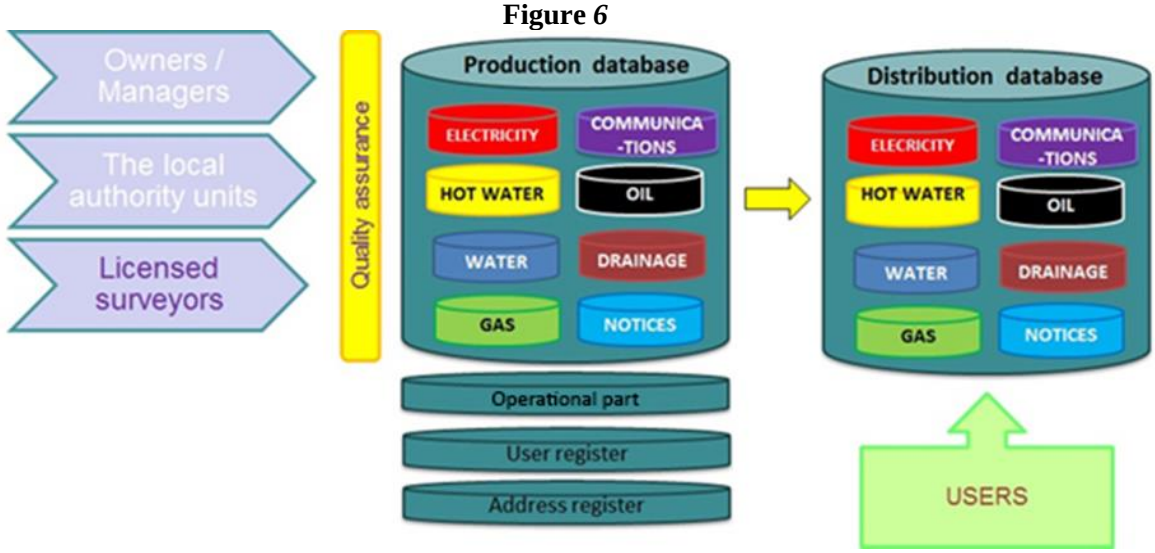

Figure 6. Croatian Utility lines system schema

Implementation of Directive 2014/61/EU of the European Parliament and of the Council from 15 May 2014 on measures to reduce the cost of deploying high-speed electronic communications networks in Croatian legislation, enabled the State Geodetic Administration (SGA) to become the competent body for the establishment of the single information point.

In 2016, there were amendments to the Law on State Survey and Real Property Cadastre. Following these amendments, the State Geodetic Administration became the Single Information Point for the utility infrastructure cadastre (). Ordinance on infrastructure (utility

lines) cadastre was brought into the force in 2017 followed by the second Ordinance on infrastructure cadastre which was brought into the force on 1st January 2022. This ordinance introduces digital geodetic reports for utility infrastructure.

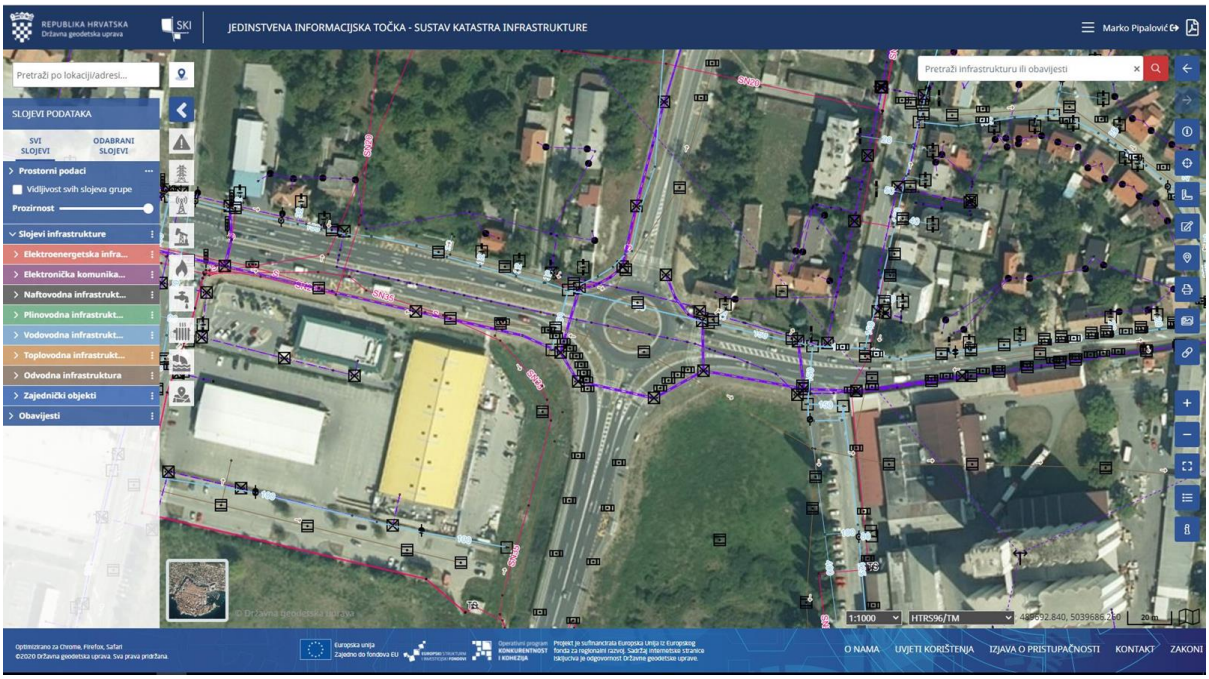

Figure 7. Utility infrastructure application of State Geodetic Administration

Since December 2018 the new Law on State Survey and Real Property Cadastre introduces that cadastral offices as being responsible for the maintenance of utility lines cadastre for the entire territory of the Republic of Croatia except the three cities (Osijek, Velika Gorica and Zagreb) because those cities have previously established systems to manage their data about utility infrastructure.

4.3 Building Register

Implementation of the Building Register project in the Republic of Croatia, as a new part of the real property register, is essential for the establishment of a unique register of buildings. This register will serve as a platform for developing a good, complete and fair basis on which property tax can be established, for improving management of real property and resolving legal issues in multi-residential buildings, for better management of spatial and construction planning and housing policy, for promoting the development of community and infrastructure planning, for providing a better overview of apartments and office spaces, as well as for providing a systematic statistical census (Vučić and Šantek 2020).

4.4 National Spatial Data Infrastructure

In 2018, the National Spatial Data Infrastructure Act was amended. Spatial Data Infrastructure (SDI) is a set of technological and non-technological settings established within and between

organizations to facilitate access, exchange and use of spatial data and thus facilitate implementation of business processes, policy making and service delivery. The basic components of SDI are: spatial data, technologies, policies, standards and human capacity. Together, these components enable interoperability using the same technologies, standards and policies. The most important component without which SDI cannot exist is spatial data. The aim of this component is to establish a unique framework for spatial data in order to reduce redundancy of data and minimize the effort needed for data collection and management. Spatial data comes from a variety of sources and manufacturers, each with its own requirements and needs. In order to be able to combine data from different sources and from different manufacturers without additional effort, it is necessary to use standards that will serve many users and facilitate the use of data (URL 2).

4.5 Regulation of Surveying Profession

The new Law on Geodetic Activity came into force in 2018. This law regulates surveying profession on territory of the Republic of Croatia. The basic novelty of this law is new division of professional geodetic works into two basic types:

- works which affect the quality of official state records on the territory of the State Geodetic Administration and which serve for the management and maintenance of the land cadastre and real estate cadastre and thus affect the safety of legal transactions
- works for technical and other purposes.

4.6 Communal Economy

In the meantime, the Law on Communal Economy came into force, which regulates the principles of communal economy, performing and financing communal activities, building and maintaining communal infrastructure, paying communal contributions and communal fees, maintaining communal order and other issues important for communal economy (Official Gazette 2018a).

4.7 Multi-year Program of Cadastral Surveys of Construction Areas for the Period 2021-2030

On the 1st October 2021 Croatian Parliament adopted the Multi-year program of cadastral surveys of construction areas for the period 2021-2030. The implementation of activities from this Program will provide up-to-date data on real property in construction areas in the Republic of Croatia and areas around construction areas that are important for the development of cities and municipalities, counties and countries and in which more than 80% of economic activities. Distribution of real estate property data through online services will enable citizens, public and private sector access to the data in real-time. The program aims to measure 600,000 hectares of land, mostly in the construction area (Official Gazette 2021).

5. PROPOSAL OF REVISED CROATIAN LADM PROFILE (HR_LADM_V2)

Based on the analysis of the current state presented in section 4, we give an update of Croatian LADM profile. The main focus of this revision is on the SpatialUnit (**Figure *8***). We added a new class *HR_LegalSpaceInfrastructure* in order to support changes occured by adopting the Law on Communal Economy which recognizes different comunal objects that should be registered in cadastre.

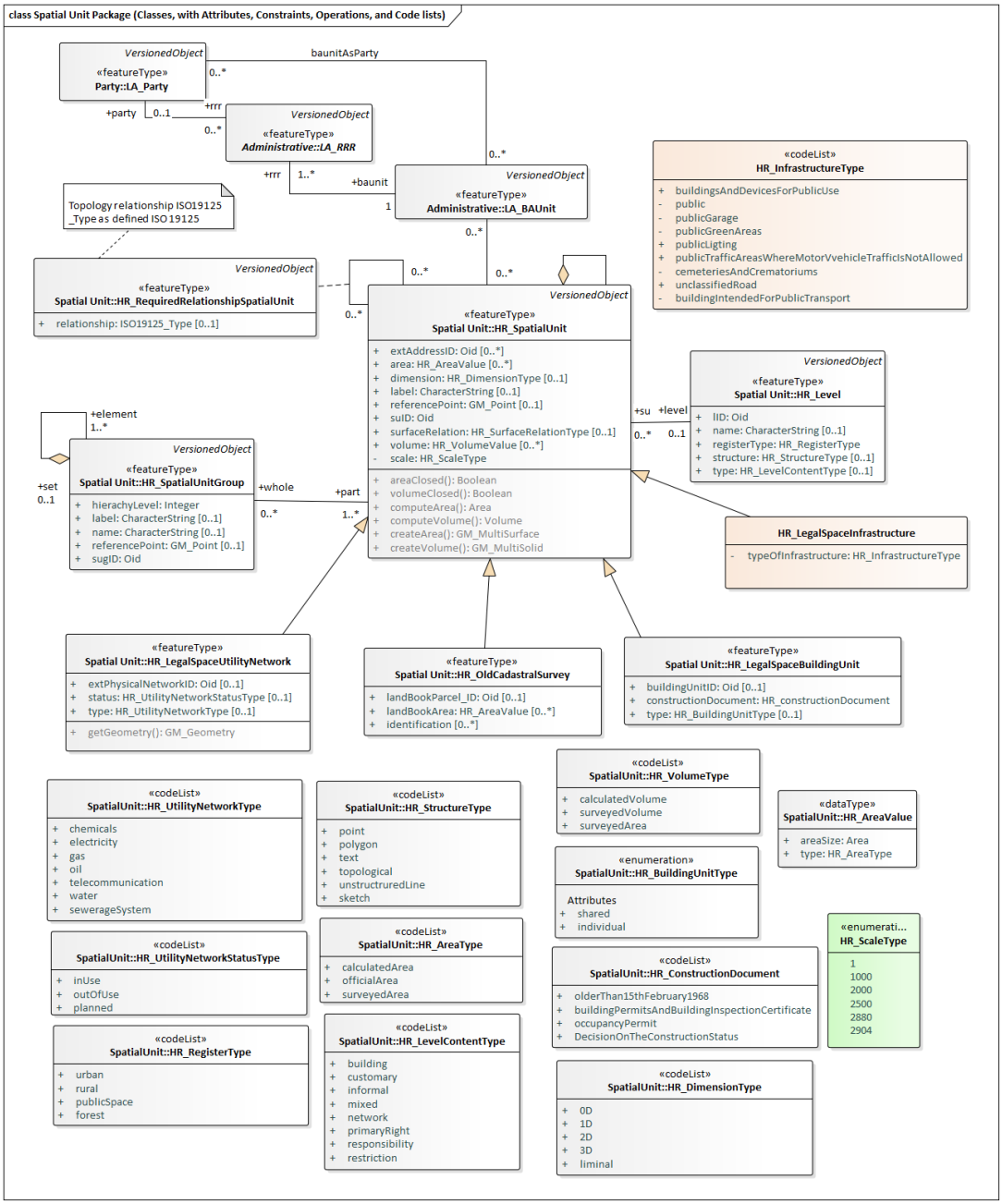

Figure 8. Revised Spatial Unit package of Croatian LADM profile

Another important, though maybe not noticeable at first sight in the diagram is the introduction of the attribute *scale* to class *HR_SpatialUnit*. This diagram is mandatory and has a list of possible values defined by *HR_ScaleType*. This attribute is introduced in Croatian LAS to manage the accuracy issue of parcel boundaries. For instance, if the parcel boundaries are measured after 2018 with the standard positional accuracy up to 0.1 meter, a parcel will have the value of *scale=1*. This means that other surveyors cannot change these boundaries without a valid reason and formal explanation. Also, when changing newly registered boundaries a surveyor has to include neighbouring parcels in order to update the official area as well so that it matches to the area calculated from the coordinates. For parcels that don't have *scale=1*, a surveyor can change the position of a parcel's boundary without changing the official area of neighbouring parcels.

Since the Cadastre of infrastructure and Register of Buildings are in very early stages we didn't make any detailed modelling of these parts but it will be addressed in subsequent research.

6. CONCLUSION AND FURTHER RESEARCH

This paper described authors' initial efforts to address changes in Croatian LAS since 2013. We described the changes mainly in the LADM package SpatialUnit since other changes are quite recent and are in early stages of implementation.

Although ISO 19152 (LADM) is an excellent basis for modelling the land administration system in the Republic of Croatia, it is not commonly used. One of the reasons might be that LADM usage is not mandatory. Recently developed databases based on new technologies are operating with old data (typically older than 50 years). Data from different time periods might have different legal weight. Hence, changing attributes and entries in order to improve data models or enhance the queries can be challenging.

The following research will include a more systematic analysis of other LADM packages in relation with Croatian LAS changes. Once LADM Edition II will be made available another revision of the Croatian profile would be needed.

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BIOGRAPHICAL NOTES

Nikola Vučić graduated in geodesy from the University of Zagreb, Faculty of Geodesy. In 2015, he received a PhD from the University of Zagreb for the thesis "Support the Transition from 2D to 3D Cadastre in the Republic of Croatia". He was employed at the cadastral office in Glina from 1999 to 2004. He was the Head of the Department for Administrative and Professional Supervision at the State Geodetic Administration of the Republic of Croatia. He was the Head of Sector for Cadastral Programs and Special Registers at the State Geodetic Administration of the Republic of Croatia. He was the Head of Division for Special Registers at the State Geodetic Administration of the Republic of Croatia. Currently he is the Head of Sector for cadastral surveys and infrastructure at the State Geodetic Administration of the Republic of Croatia. His main research interests are land administration systems, 3D cadastres and geoinformatics. He is a member of the Croatian Geodetic Society and the Croatian Chamber of Chartered Geodetic Engineers.

Saša Vranić graduated at University of Zagreb, Faculty of Geodesy in 2009th with a diploma thesis "Interface of cadastral database". In 2018, received a PhD from the University of Zagreb for the thesis "Modeling transactional workflow management system over spatial component of cadastral parcels". After graduation he worked in Croatian geoinformatics company Geofoto LLC for several years as GIS Consultant on projects of implementing spatial information systems. From 2012 to 2018, he was employed at the University of Zagreb, Faculty of Geodesy as University Assistant on Chair for land surveying. Since 2018 he is a freelance GIS consultant/programmer, working mainly as a project manager for a Slovak based company KAJO on several European H2020 projects. His main research interests are geospatial web applications, spatial databases, geospatial standards, and land administration systems.

Miodrag Roić graduated in Geodesy from the University of Zagreb, Faculty of Geodesy. In 1994 he received a Ph.D. from the Technical University Vienna. Since 1996, he has been a professor at the University of Zagreb, Faculty of Geodesy. He was the Dean of the Faculty 2011-2015. The topics that he specializes in are land governance, land administration systems, engineering geodesy, cadastres and geoinformatics. He is a corresponding member of the German Geodetic Commission (DGK) and many other national and international scientific and professional institutions.

Hrvoje Matijević is currently working as project manager at the Croatian geoinformation company IGEA L.L.C. Prior to this Hrvoje has worked in another Croatian geoinformation company, Geofoto L.L.C. as Senior Consultant, and at the Faculty of Geodesy in Zagreb as University Assistant. He received master's degree in 2004 with thesis "Cadastral Data Modeling" and defended in 2006 his Ph.D. thesis "Modeling Changes in Cadastre" at the same university. His main research interests were and still are GIS and Spatial DBMS technology in service of cadastral data management.

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