Towards sustainable land administration infrastructure in Croatia

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SUMMARY

The transformation of land administration systems from traditional to modern multipurpose land administration systems (MLAS), which support all land development activities, is a goal that can be reached only by considering various aspects – legal, social, economic, technological, to name just a few. From a technological point of view, maybe the biggest shift in recent developments is perceiving the modern land administration system as being a distributed system – land administration infrastructure (LAI).

An MLAS should integrate various types of data that are kept in many official registers as public-sector information. All information from the public sector, if available, has the potential to contribute to social and economic development. The right of access to public-sector information in recent years is guaranteed by regulations in many countries. Although the regulations differ they have common objectives. Informing the population is an important task for the development of democracy, fighting against corruption and increasing the accountability of the governing structures.

Besides governments that are undergoing the process of "opening up" to the public they serve, academia is also becoming increasingly open on the wave of the open science movement. The paper describes how principles of open science in research can support the development of LAI. This approach is used for the development of the platform through the project Development of Multipurpose Land Administration System (DEMLAS) that supports the land administration needs of users from various backgrounds. The platform gives them direction on how to access data from official registers and enriches them with research data and findings, which provides users with additional value.

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1. INTRODUCTION

Land administration is defined as the process of determining registration and dissemination of tenure, value and land use information and related resources (UN-ECE 1996). This process involves identifying land interests and their properties, measuring and describing them, detailed documentation and securing relevant information in support of the real property market. A land administration system should record all rights and interests guaranteed by law, support valuation and taxation, enable pledges, support development and the monitoring of the real property market and protect private, public and state properties. It should also minimize property disputes, provide support to land reforms, improve strategic and spatial planning, support land governance taking environmental protection into account and provide statistical data on the land sector essential for monitoring.

The vision of land administration improvement is expressed as the development of its factors that facilitate the creation of effective land and property markets, protect the land rights of all people and enable long-term sustainable development (Rajabifard et al., 2013). The planning and development of a national land administration infrastructure (LAI) should fully meet the growing needs of considerably increased urban populations, resulting from the rapid expansion of cities (Bennett et al., 2012).

The development of a Multipurpose Land Administration System (DEMLAS) is a scientific project funded by the Croatian Science Foundation and is being conducted at the Faculty of Geodesy of the University of Zagreb from 2014 to 2018. The DEMLAS project aims to discover what needs to be done to transform land administration systems from traditional to modern multipurpose land administration systems (MLAS) that support all land development activities.

Existing registers are commonly established for one purpose; their interconnection is at a very low level and contains many redundant data (Mađer et al., 2015). Although there is a wealth of registers of land/real property and interests related to them, their content and structure cannot meet the needs of multipurpose land administration that will support effective land management (van Oosterom et al., 2009). Improvements are possible if they link to each other and enhance their effectiveness (Vranić et al., 2015) or establish procedures and standards for data sharing (Lemmen et al., 2015) to provide additional data.

A prerequisite for operational linking of registers is the improvement of the quality and completeness of data. The supplementation of the content is reflected in the extension of LAI on maritime domains, natural disaster prevention and management (Enemark, 2009), valuation and taxation data, public utilities infrastructure and the introduction of 3rd and 4th dimensions of property registration (Vučić, 2015). The requirements of urban, agricultural and state land management pose specific requirements to the MLAS as well as electronical available historical

data. Their inclusion in the MLAS is a special challenge and needs a specific approach supported by improved access to the registers' data (Divjak et al., 2017).

The paper analyzes the status of data from key registers and users' needs for LAI. The creation of a platform based on the principles of open science / data principles adds additional value that is emphasized in the paper.

As it is not possible to directly access data from key registers, a central repository (warehouse) was created in which part of the available data was imported. The architecture and the user interface of the DEMLAS platform and guidelines for further research are described later.

2. UTILIZATION OF LAND ADMINISTRATION INFRASTRUCTURE

Throughout the project activities, various utilizations of an LAI have been investigated. Besides the most common application of LAI in agricultural and state land management, land consolidation, valuation and taxation, several user cases of LAI utilization in spatial planning, both of inland and on sea, were also investigated. The following chapters are key findings of the research.

2.1 Agricultural and state land management

Land policy measures cannot be made without knowing the position, shape and type of use for each cadastral parcel of agricultural land. This data forms the backbone of an effective land policy implementation system. Such a system should be a tool for making legal, administrative and economic decisions and the basis for planning and development.

None of the state agricultural land management programmes in Croatia since its adoption had access to reliable land and tenure information. The data needed in these programmes were an ideal opportunity to establish a land policy implementation system.

The information system supporting state land management should consist of: the subsection on the management of state-owned agricultural land, the subsystem on management of agricultural land owned by natural and legal persons and the subsystem for maintenance and protection of agricultural land (Mičević, 2016).

The system for implementing land policy depends largely on the initial state of the system and the data it comprises. Such a system must be based on the land parcel, i.e. the cadastral parcel as a basic space unit. It should be based on a unique spatial reference system, enabling data to be linked with other spatially referenced data within the system. The DEMLAS project analyzed the current condition of the available official land data records – Croatian Land Parcel Information System (ARKOD) and Cadastre and Land Book Joint information system (JIS) and possible data integration of both registers.

Data analysis of the JIS and ARKOD has shown that most of the data needed for agricultural incentives that are found in ARKOD are copied from the JIS. The problem is that the data becomes outdated (*Figure 1*, *Figure 2*), and as such cannot be used to support farmers' incentives. The consequence of outdated data is that today we have inconsistent and redundant data in two registers. Another drawback is that although it has a large amount of data, the JIS does not have any analytic capabilities to provide aggregated information.

Figure 1 Cadastral parcels in ARKOD

Figure 2 Cadastral parcels in JIS

Extracting analytical data requires deeper technical understanding of these registers and technical skills that personnel of public institutions don't possess. Hence, for most of the aggregated information they must turn to private companies that maintain information system software for managing these registers. The proposal for linking the data model of these two registers is given at the conceptual level through the adaptation of the "Land Administration Domain Model" model in Mađer et al. 2015. The model describes the relationship between the two basic properties of the enumeration of the above-mentioned registers – agricultural parcels and cadastral parcels.

2.2 Land consolidation

The fragmentation of agricultural land through many relatively small and spatially separated units causes an increase in expenses for sowing, processing, protection and generally reduces income and market competency. The average size of family farms in the Republic of Croatia is 2.7 ha (27,000 m^2), which is six times less than the European average and they are split on average into 5.3 separate parcels. Family farms so small cannot be rationally processed.

One solution to increase the productivity and competitiveness of agricultural production is land consolidation. The spatial data source analysis report for the purposes of land consolidation identified seven key registers for the process of land consolidation. It is concluded that land consolidation is an interdisciplinary measure, the implementation of which involves the geodetic, legal and agronomic professions. The geodetic profession is involved in the land consolidation process in the part related to expert geodetic work, such as marking the boundaries of the consolidation zone, assessing the value of land, making proposals for division of the consolidation area and other geodetic works. The basic information required for the co-ordination is contained in the official data records. In addition to land / property cadastre as key registers, there are other public registries of land and its parts closely related to certain areas of human activity.

Investigations on spatial data source analysis for the purposes of land consolidation analyze in detail the existing registers. As a solution to the establishment of a mass real property valuation system, the use of existing registers for which several state institutions are in charge is imposed. Although existing registers are in different degrees of completeness and up-to-dateness, considerable funds have been invested in their collection and they should be used to establish a mass real property valuation system. The results provide suggestions for the integration of existing registers based on the existing data they contain.

2.3 Valuation and taxation

A very important aspect in the land consolidation process is the process of value assessment for agricultural land. The mass assessment system is one of the basic prerequisites for quality management of land, which is the most basic and limited resource of each country. In Croatia, a system for tracking of land value data for this purpose still does not exist, unlike in most European countries. For a real property valuation system to be realized and to function normally, there is a need for up-to-date and complete spatial data registers, managed and established on the basis of the law, and managed and structured in a manner appropriate for electronic data processing (Tomić et al., 2016).

The process of agricultural land valuation can be automated by introducing mass valuation techniques. The index of land fragmentation, as a measure of land fragmentation, is one of the factors for the valuation of agricultural land. Through the project activities, automated methods of defining the fragmentation of properties were investigated – fragmentation based on several existing methods. Testing the degree of land fragmentation was carried out in the several test areas. Numerous fragmentation indexes were calculated using different methodological approaches for defining the index and the results were presented and published in the paper (Alar et al., 2014).

2.4 Spatial planning

By confronting the existing land use and urban planning in more than one period of time, it is possible to create a diagnosis of strategic development, trends and scenarios. This approach can provide very useful answers to several strategic development issues: quantification of land use, land use transformation, development potential and capacity, changes in land use policy, monitoring of planned development implementation, etc. A strategic model of urban analysis should combine knowledge from urban and geoinformation science. Several existing models of land use were examined through the project activities: theoretical urban model, INSPIRE Land Use Data Model, Urban Atlas, Land Use Classification System LUCAS, National Planning Model of Croatia, Regional Model of Land Use Île-de-France and City Model of Vienna. Each model has some advantages but also disadvantages with regard to urban land use analysis strategy. Based on the performed analysis, a new data model was developed (Šiško et al., 2016). The data model includes elements such as: purpose, temporal and spatial resolution, land use classification, land use area determination and data sources.

In the data availability report of data in maritime areas, data from existing registers that are regulated by the legislative framework are analyzed, which includes rights over the maritime areas of the Republic of Croatia. In addition to the two main registers, the Cadastre and Land Books, there are the Maritime Concession Registry (ports and docks, entertainment contents, mariculture, cables, pipelines, etc.), the Registry of Cultural Heritage (underwater archaeological sites), Registry of Protected Areas (different levels of protection according to the law on Nature Protection), Registry of authorized mineral resource exploitation areas and Registry of Existing Mineral Resource Utilization (hydrocarbons and salt), Registry of Fishing Licenses and Other Marine Organisms and Environmental Pollution Registry.

These registers are designed and function as "standalone" registers, and consequently connections between different registers, spatial coverage of registered objects, users and leases, and relevant data are weak or non-existent. The research analyzes and presents the existing conditions for the registration of sea areas in official registers in the Primorje-Gorski Kotar County examining area. Issues on integration of land and maritime administration registers have been identified and improvements proposed (Flego and Roić, 2017).

3. OPEN SCIENCE RESEARCH – DEMLAS PLATFORM

The open science principles were achieved with the concept of user cases, i.e. platform component where different usages of data accessible through DEMLAS platform are described in plain language.

Open science is an approach to scientific development based on collaborative work and information publication using advanced network technologies to create solutions based on free access and sharing (Salmi, 2015).

The advantages of open science are (Stojanovski, 2014):

- Improved research effectiveness – minimized duplication
- Accelerating pace of new discoveries
- Enabling interdisciplinary research
- Promoting scientific rigour and repeatability
- Improving the quality of scientific output
- Improving co-operation and involving a greater number of stakeholders
- Promotion of scientific activities and encouragement of the "scientific literacy" of the public
- Increasing the economic and social impact of scientific research
- Providing new opportunities for innovation

The concept of open science encompasses a series of principles aimed at stimulating scientific growth and consequently its facilitated public access. These principles are stated in following sections (URL 1).

3.1 Open access

Open access primarily refers to online access to scientific papers and research data, allowing users to freely read and reuse content with the only obligation that the author is cited. Open access is key to free flow of information between researchers and society as a whole (Stojanovski, 2014). Open access is the fundamental strategy of the European Commission to improve the circulation of knowledge and thus innovation. This is particularly illustrated by the general principle of open access to scientific publications in Horizon 2020 and the research data pilot (URL 2).

3.2 Open data

Open data are data that can be used freely without restrictions, reused and shared with anyone – with the condition of citing the author's name and sharing under equal conditions. The terms of use of open data are defined by some kind of open source license such as Creative Commons license.

3.3 Open source software

One of the key requirements of science is the ability to reproduce – scientists need access to the data and tools used in some research to fully reproduce and validate the findings and conclusions of this research. If the software used in scientific studies is the "black box", and the code and algorithms cannot be critically analyzed, then the results of this research will not be reproduced. Therefore, the use of open source software in science has a high priority. Certain funding programmes for scientific research set the use of free open source software as a mandatory requirement.

3.4 Open methodology, educational resources and review

Open methodology implies the openness of the research, information and data collection plan to achieve the desired outcome of the research.

Open educational resources include text, media and other digital resources used for teaching, learning and research, and are available through an open license. The distance learning trend over digital platforms has particularly contributed to the opening of educational resources.

Open review is an access to the openness of the review process in which the authors know who would review the work, and commentaries of the reviewers would be public and useful to the readers for additional information. This would make reviewers less biased, and reviews would be more constructive and could serve as an example for young researchers and future authors. Reviewers would demonstrate their expertise through open reviews and could be rewarded for their quality reviews.

The DEMLAS project is based on these underlying principles. Research results, as educational resources, are stored in the DEMLAS warehouse and can be easily found and reused by searching the metadata catalogue with spatial and attribute queries. Metadata records can be accessed and reused for future research. All data results from the research are available under the free terms of use. User cases fulfilled the principles of open methodology because the methodology of achieving results that users can easily reproduce is understandably described.

The DEMLAS data warehouse is fully developed using open source free software, and the original source code is available through the GitHub repository for reuse.

4. TECHNOLOGICAL SOLUTION FOR LAND ADMINISTRATION IMPROVEMENTS – DEMLAS PLATFORM

Transformation of a traditional system to MLAS can be achieved by improving efficiency and usability. Efficiency is concerned with the ability to quickly update the data while ensuring their consistency and accuracy. Increased usability is achieved by a technological platform that enables multipurpose use according to developed user cases (Matijević et al., 2015).

4.1 Procedures for automatic maintenance of cadastral data

Modern land administration systems must meet the new needs for faster and more efficient real property transaction processing. One of the ways to meet these needs is to outsource most of the process of updating cadastral geometry to stakeholders outside the organization responsible for managing cadastral data with the proper quality assurance procedures in place. In case the spatial component of the combined legal-spatial transactions is separated, the transaction processing system must be able to independently handle all possible cases in a safe and consistent manner. A framework that can be used to design a system based on standard database transaction concepts and guarantees the safe processing of external transactions on polygon cadastral parcels was developed in this project. To separate the process of editing from consistency control, the basic concepts for assessing the net effect of the transaction have been studied. Strict definition of what can be done in each such type of transaction provides a reference that can be used to link the legal and spatial part of a combined legal-spatial transaction. In the paper (Vranić et al., 2015), the implementation of the concept system is described as a confirmation of a developed framework.

4.2 DEMLAS platform – System architecture, storage, content and usage

Data storage was developed within the DEMLAS project as an infrastructure for research in the field of land governance (Roić et al., 2017). Access to the platform (*Figure 3*) is possible via the website of the project or directly (URL 3).

Figure 3 DEMLAS interface

Users can search for available spatial data that are described in a metadata catalogue (*Figure 4*). Various types and formats of data are available, such as: spatial sets of data, maps, measurements and accompanying spatial documents, pages, or field notes. It is possible to preview data by adding it to a map or downloading it directly to the user's device.

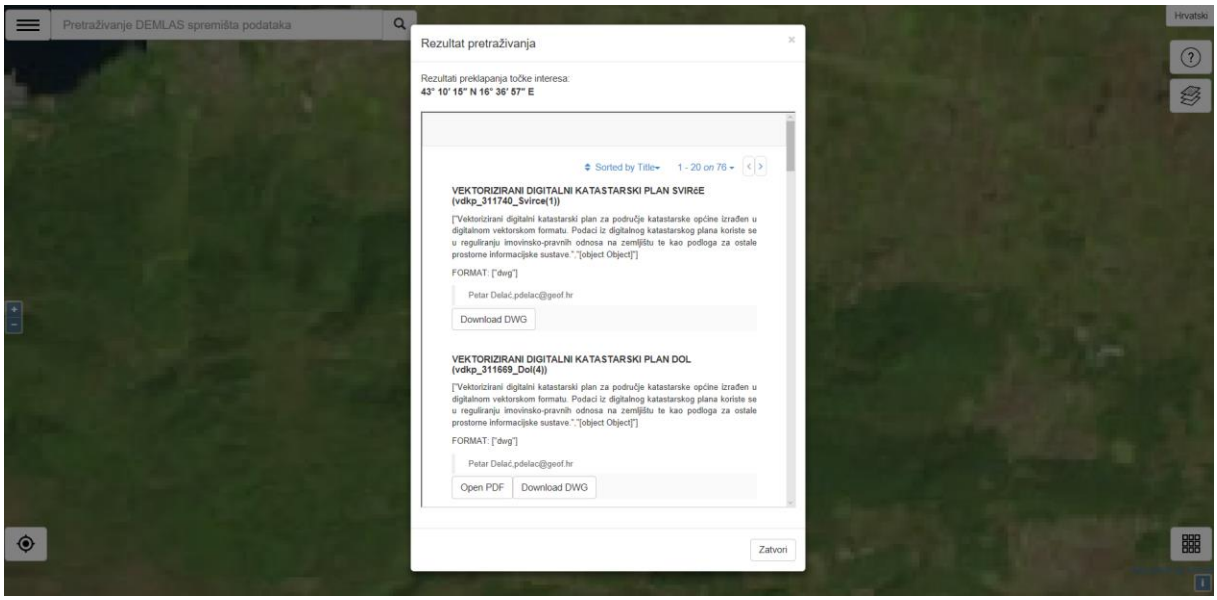

Figure 4 Preview of metadata records

The portal has been developed so that it can be used in the field through various mobile devices. While carrying out project activities, a case was made to find the purpose of the land on which the user is located. Steps that a user needs to make to reach identical results are described in the DEMLAS project pages.

The DEMLAS portal architecture consists of three layers – a presentation, a business logic layer and data layer (*Figure 5*).

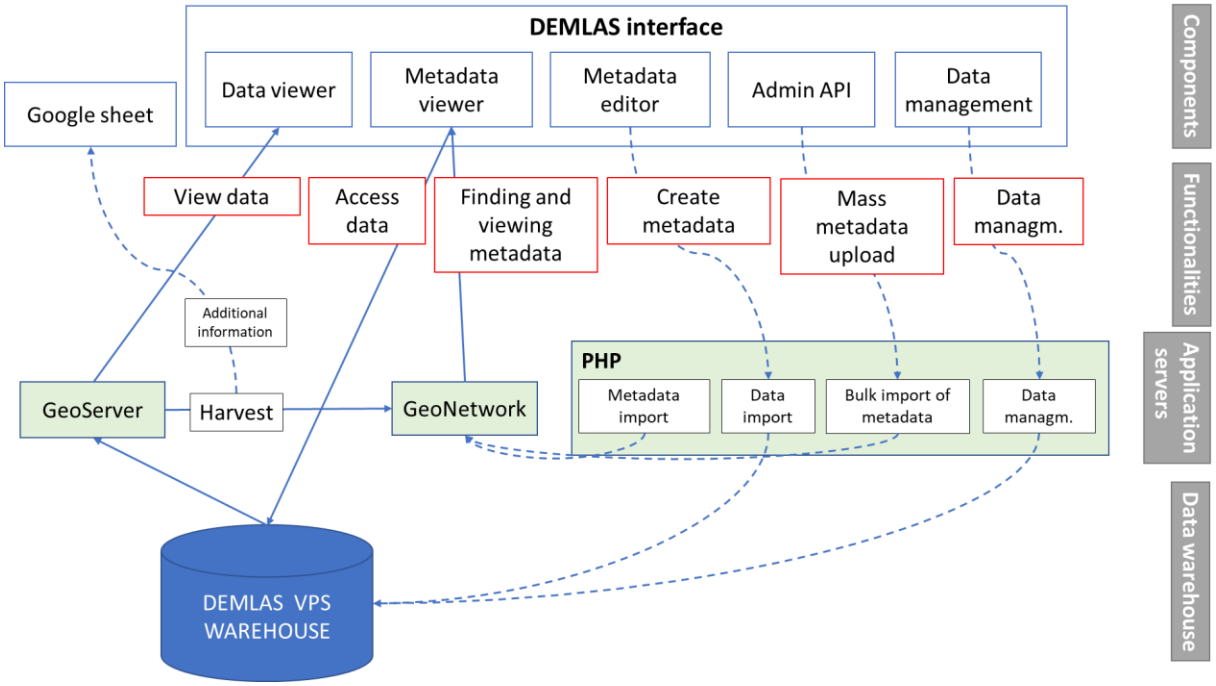

Figure 5 DEMLAS platform architecture

All data are located on the DEMLAS virtual servers. Data are stored in document-oriented, relational and object-relational databases.

The business logic layer is implemented in the PHP programming language and by using spatial data server applications, GeoServer and GeoNetwork, for each of the six basic logical functionalities.

A separate component was created in the DEMLAS warehouse interface that forms the presentation layer. The presentation layer is made as a responsive web application. It is therefore possible to use it on mobile devices, which further increases the usability of DEMLAS in the field operations.

4.3 Future developments

In the further development of the DEMLAS repository, we aim to make the spatial sources that are currently stored in a proprietary format of the records available through open network-based services. It primarily relates to open standards of the OGC consortium WMS, WFS and WCS, which will achieve an even higher degree of interoperability.

The second direction of further DEMLAS development is the research of possibilities for the integration of key resources that would make DEMLAS a service for evidence-based policy making in land governance. Functionalities of the DEMLAS platform will be extended to

enable automatically collecting, storing and publishing the data and indicators on the state of land governance. A planned system will follow recommendations of the World Bank Land Governance Assessment Framework and will be consistent with the principles recommended by the FAO Voluntary Guidelines on the Governance of Tenure. It will use best practices in quantifiable monitoring based on indicators and prediction systems.

In the next phase of the project, it is necessary to supplement the repository with data addressed in the project research carried out so far. This will be a step forward for multi-purpose LAI. It is planned that in the future it will provide information to users on the existence of data through links to external resources (registers).

Besides these technical aspects of DEMLAS future development, several new topic areas need to be addressed as well. Those are impact on legal issues that would such LAI have and legal regulation that would support it as well as position of the land owner and citizen in the process. Furthermore, quality of data collected from different sources and the financial sustainability of the system,

5. CONCLUSION

As part of the current research activities within the DEMLAS project, key user cases have been identified for the establishment of an MLAS. These user cases proved to be valuable framework for further research of different topics and aspect of MLAS usage. An analysis of the existing data of official registers was carried out and recommendations for their harmonization and improvement were given. Results of the ongoing projects on state level that are directly related to MLAS will have impact on future developments of DEMLAS and help steer further research in LAI domain.

When proposing new data models that would merge data from multiple existing registers, valid standards from the spatial information domain (19115 Metadata and 19152 LADM) were considered and improved. It has been noticed that existing standards do not fully support the needs of users, and there are proposals for their further development and supplementation.

The predominant purpose of the warehouse at this stage of the project, to store and easily find the data, is fulfilled.

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REFERENCES

Alar, T., Tomić, H. & Mastelić Ivić, S. (2014) Fragmentacija zemljišta kao čimbenik vrednovanja u postupku komasacije. U: Racetin, I. (ed.) Proceedings from 7th Symposium of charted engineers, Osijek, Croatia

Bennett, R, Rajabifard, A., Williamson, I., and Wallace, J., 2013, 'On recognizing land administration as critical, public good infrastructure' Land Use Policy, Vol. 30 (1), pp. 84–93.

Divjak, D., Roić, M., Tutić, D. (2017): Open Science in DEMLAS project, U: Racetin, I. (ed.) Proceedings from 10th Symposium of charted engineers, Opatija, Croatia

Enemark, S. (2009) Sustainable land Administration infrastructure to support natural disaster prevention and management, paper presented in the UN regional Cartographic conference for the Americas, New York, 10-14 Aug 2009: 2-9.

Flego, V and Roić, M. (2017) Land tenure registration on the marine areas in Croatia, International Conference. U: Maritime Spatial Planning, Ecosystem Approach and Supporting Information Systems (MaPSIS). Las Palmas de Gran Canaria.

Lemmen, C.H.J., Van Oosterom, P. and Bennett, R. (2015): The Land Administration Domain

Model. Land Use Policy, 49:535-545

Mađer, M., Matijević, H. & Roić, M. (2015) Analysis of possibilities for linking Land Registers and Other Official Registers in the Republic of Croatia based on LADM. Land use policy, 49, 606-616.

Matijević, H., Roić, M. & Tomić, H. (2015) Development of Multipurpose Land Administration Systems. Proceedings from FIG Working Week 2015: "From the Wisdom of the Ages to the Challenges of the Modern World". Sofija, Bugarska, pag. 1-15

Mičević, B (2016) Development of agricultural land administration system within the agricultural policy context in the Republic of Croatia, Doctoral Thesis, Faculty of Geodesy, University in Zagreb

Rajabifard, A., Kalantari, M. & Williamson, I., 2013. Spatially Enabled Land Administration; Paragidm - Shift in Land Information Management, Washington DC: Annual World Bank Conference on Land and Poverty.

Roić, M., Vranić, S., Kliment, T., Stančić, B. and Tomić, H. (2017) Development of Multipurpose Land Administration Warehouse. Proceedings from FIG Working Week 2017: "Surveying the world of tomorrow - From digitalisation to augmented reality". Helsinki, International Federation of Surveyors, 1-12.

Salmi, J. (2015) Study on Open Science - European Commission, EUR 27390EN

Stojanovski, J. (2014) Open science. Open Science conference – possibilities and perspectives, Zagreb, Croatia

Šiško, D., Jukić, T. & Cetl, V. (2016) Development of Strategic Urban Land Use Analysis Model. INSPIRE Conference 2016. Barcelona, Spain.

Tomić, H., Mastelić Ivić, S., Mičević, B. & Jurakić, G. (2016) Use of Multi-Criteria Analysis for the Ranking of Land Consolidation Areas. U: Symposium on Land Consolidation. Apeldoorn, The Netherlands, 9.-11.11.2016.

United Nations. Economic Commission for Europe - UN–ECE (1996): Land administration guidelines. New York/Geneva

van Oosterom, P.J.M., Groothedde, A., Lemmen, C.H.J., van der Molen, P. and Uitermark, H.T. (2009) Land administration as a cornerstone in the global spatial information infrastructure. In: International journal of spatial data infrastructures research: IJSDIR, 4 (2009) 34 p

Vranić, S., Matijević, H. & Roić, M. (2015) Modelling outsourceable transactions on polygon based cadastral parcels. International journal of geographical information science, 29 (3), 454-474.

Vučić, N. (2015) Support to the Transition from 2D to 3D Cadastre in the Republic of Croatia, Doctoral Thesis, Faculty of Geodesy, University in Zagreb

URL 1: http://openscienceasap.org/open-science/ Was ist Open Science? from OpenScience ASAP, accessesed 27.07.2017

URL 2: https://ec.europa.eu/digital-single-market/en/news/open-access-scientific-publications-horizon-2020-projects Open access to scientific publications Horizon 2020 projects, accessesed 21.09.2017

URL 3: https://demlas.geof.unizg.hr/ Demlas portal interface, accessesed 17.07.2017

BIOGRAPHICAL NOTES

Dragan Divjak graduated in Geodesy from the University of Zagreb, Faculty of Geodesy. In 2011, he received a MsC from the same Faculty. His professional career started in State Geodetic Administration and continued in private sector as an SDI consultant working for various public administrations, EC JRC, UN and WB. The topics that he specializes in are Spatial data infrastructures, Open data and Geoinformatics. He is currently Research Assistant at Faculty of Geodesy and PhD student.

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