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Key words: LADM, ISO 19152, Public Law Restrictions, 3D, Land Administration Systems

SUMMARY

Intense exploitation of land in the vertical direction has brought up complex legal relations between different types of spatial units with various characteristics (e.g., land, marine, air, underground parcels, and infrastructure objects). Therefore, the use of 3D models is required to clearly represent real property and associated Rights, Restrictions and Responsibilities (RRRs), deriving both from Private and Public Law. The latter are either not registered to cadastral systems (i.e., in The Netherlands very few have been registered like the private natural beauty areas, as they came with tax benefits), or are recorded to individual, thematic registries. Public Law Restrictions (PLRs) impose significant impact on ownership rights and land management, thus requiring to be systematically organized and registered. This brings out issues of identifying which types of PLRs need to be registered (based on land administration policies that apply in each country/ jurisdiction), selecting and "spatializing" them (in 2D/3D/nD).

Within the field of land administration, the ISO 19152:2012 Land Administration Domain Model (LADM) plays predominant role in standardizing legal relations between parties (people) and spatial units (land). LADM is currently under revision with its second edition widening its scope as a multipart standard comprising 6 Parts. The revision of LADM stimulates discussion on new concepts that could be included at the Edition II, and possibilities of refining the existing ones. In this context, the paper investigates the option to model PLRs into the multipart standard and investigates how to optimally categorize them based on the LADM Edition II Parts. The paper builds on previous work by the authors and aims to propose a flexible framework to model PLRs at conceptual level in the context of LADM Edition II. To validate the modelling proposal, two case studies of PLRs are studied. The first one relates to the restrictions imposed on land parcels crossed by the Trans Adriatic Pipeline (TAP) in Northern Greece, and they refer to the establishment of protection zones, where construction and agricultural restrictions apply. The second case study refers to land use restrictions in the vicinity of an archaeological site in the municipality of Patras, in southern Greece. Those use cases were selected because of their generic character that may apply to other countries/ jurisdictions, regardless of legal framework differences.

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1. INTRODUCTION

Legal relations applying to different types and shapes of spatial units (e.g land, marine, air, underground parcels, and infrastructure objects) are in many cases best represented in 3D and of significant importance for the Land Administration domain, and they are defined through Rights, Restrictions and Responsibilities (RRRs), deriving both from Private and Public Law. Only the former are generally registered within Cadastral Systems, while the latter are either not required to be registered, or are recorded to individual, thematic registries. Restrictions deriving from Public Law (PLRs) are gradually increasing in number and complexity, following the new fields of the vertical exploitation of land. A characteristic example is the introduction of PLRs related to UAV flights which were introduced in national legal frameworks during the last decade. PLRs impose significant impact on ownership rights and land management, esp. reducing the types of land use allowed, thus introducing the need of systematically organizing and registering them. This brings out issues of identifying which types of PLRs need to be registered (based on land administration policies that apply in each country/ jurisdiction), selecting, quantifying, and "spatializing" them (in 2D/3D/nD), according to qualitative parameters (e.g., physical, natural, or socioeconomic characteristics), and classifying them to be registered in national land registration systems (Kitsakis et al., 2019).

Registration of PLRs has been an issue of scientific research in international literature for almost 20 years (Zevenbergen and de Jong, 2002; Bennet et al., 2006; Givord, 2012; Kitsakis and Dimopoulou, 2016; Kitsakis et al., 2019). However, it faces both theoretical and technical challenges regarding its implementation. Theoretical challenges are related to the stratification of real property rights and its implementation within each national legal system, as well as to the expression of legal statute in terms of quantifiable, physical characteristics (Kitsakis, 2019). Technical challenges refer to the broad variety of restrictions imposed by public law, which brings out issues in terms of obtaining quality of 2D/3D boundaries of the PLR objects' legal spaces level of detail, cost, system architecture requirements, data accuracy and reliability (del Campo, 2012; Lai et al., 2010). Currently, the most mature approach towards registration of land-related PLRs can be traced in Switzerland, where PLR-Cadastre has been developed at cantonal level, registering 17 PLRs that are classified in 8 sectors comprising plans, legal provisions and regulations provided via geo-portals (Swisstopo, 2015, Kaul, 2019).

In parallel, standardization, as a well-known process in the field of Land Administration has strongly developed and formed new potential. Computerized land-related systems require standards to identify objects, transactions, relationships between spatial units and parties, classification of land use and value, and spatial representations of objects. In existing LAS,

standardization refers to country-level conceptual modelling approaches, data storage and exchange formats. However, open markets, globalization, and effective and efficient development and maintenance of flexible (generic) systems, require further standardization at an international level. In this scene, the ISO 19152:2012 Land Administration Domain Model (LADM) plays predominant role in standardizing the people to land relations.

Therefore, among others, the revision of LADM initiates a discussion on new concepts that could be included at the Edition II, and existing ones that could be further refined. In this context, the paper investigates the opportunity to include the Public Law Restrictions at the multipart standard and investigates how they can be best categorized to be modelled based on the LADM Edition II. The paper is based on previous research and knowledge (Kitsakis and Dimopoulou, 2016; Kitsakis, 2019; Kitsakis et al., 2018) and aims to initiate a discussion on the registration of PLRs in LAS by presenting several approaches to model at conceptual level PLRs in the context of LADM Edition II.

Therefore, initially, land-related PLRs are categorized and modelled according to LADM structure, concept, and semantics. For the purpose of this paper, the PLRs that are examined, are modelled on Part 2 of LADM Edition II. Selected categories of PLRs are modelled in UML diagrams according to LADM, the respective classes and associations are modelled, and the code list values are populated. To validate the modelling proposal, two case studies of PLRs are studied. The first one relates to the restrictions imposed on land parcels crossed by the Trans Adriatic Pipeline (TAP) in Northern Greece, and they refer to the establishment of protection environmental zones, where construction and agricultural restrictions apply. The second case study refers to land use restrictions in the vicinity of an archaeological site in the municipality of Patras, in southern Greece. Those use cases were selected mainly because of their generic character that may apply to other countries/ jurisdictions, despite the differences of the various legislative frameworks.

2. PUBLIC LAW RESTRCTIONS (PLRs)

Modelling options and registration of land-related PLRs, constitute a highly challenging research task for several reasons including (Bennett et al., 2006; Lai et al., 2010; del Campo, 2010; Kitsakis and Dimopoulou, 2018):

- The significant number of legal provisions that impose restrictions on landownership.
- The relation of PLRs to multiple (in several cases) interdependent scientific fields of different nature.
- Unclear definition of the spatial extent, the duration of the restriction and the people affected
- Legal definitions of PLRs that cannot be easily “translated” into 3D space.
- Definition of PLRs using non-geometrical or implied 3D characteristics (e.g., contaminated soil or subsurface water).
- Technical limitations (e.g., level of detail, cost, system architecture requirements, as well as data accuracy, scale consistency and completeness).
- The legal effect of PLRs on the affected/ surrounding objects.

Bennett (2007) identified five characteristics to distinguish "less important" interests to be registered. By applying this approach to the land-related legal statutes of Victoria in Australia, he managed to reduce their number from 620 to 66. Moreover, technical limitations on system architecture and big data management are easier to address, due to the advances in computer technology and the development of 3D modelling techniques. However, a significant number of PLRs cannot be easily expressed in spatial terms, due to its type (e.g., contaminated sites) or often because of the different existing registries which involve difficulty in collaboration between competent legal professionals, surveyors, and other specialists in this field of non-geometrically defined or implied PLRs. Specifically, in the context of 3D LAS and real property stratification, the lack of interest by legal professionals is noted by several researchers (Banut, 2011; Paasch and Paulsson, 2014; Paasch et al., 2016; Paasch and Paulsson, 202), thus resulting in ineffective implementation of land policies and constraints in Land Administration (Kitsakis et al., 2019).

The existence of a number of jurisdictions each one comprising different legal families, introduces a variety of different approaches on restricting the right of ownership and its equivalents. Therefore, standardisation of PLRs, seems to facilitate communication and interactions between the different legal systems, while ensuring interoperability amongst information systems. At the same time, searching for common ground and compromising between different legal approaches constitutes a highly challenging task and relates both to the classification of PLRs to distinct categories and to the combination of the different legal approaches for each of the distinguished categories.

Categorisation of PLRs may differ, depending on the perspective and the scope of the classification. Based on the legal perspective, PLRs are classified to the branch of Public Law where they belong, for example constitutional or administrative law. If classification aims to their purpose, PLRs can be distinguished to those serving national security, public health, urban planning, social and public policy, environment protection etc. Within a similar concept with the purpose-based classification, is the classification based on thematic fields. In this case, specific themes are defined, on which PLRs are assigned. This type of classification provides more flexibility, as themes can be adjusted to the specifications and the objectives of the research, while retaining the special characteristics of national land administration.

The latter classification option is also preferred in this work. The proposed PLRs' modelling approach is based on the classification by Kitsakis et al. (2018), mainly within the context of the Roman Law and especially the Greek legal framework, including PLRs that may apply both in 2D and 3D space (Table 1).

Table 1. Proposed classification of PLRs for Greece

Sector	Description
Mining areas	• Health and safety provisions • Restrictions on activities related to the ownership of minerals/quarry material

Cultural Heritage	• Restrictions to avoid harm of underground antiquities (e.g., in-situ preservation of antiquities; Restrictions due to construction of infrastructures or other activities) • Restrictions in constructing new buildings, alteration, restoration and use • Restrictions in maritime activities within or in the vicinity of marine antiquities
Building Regulations and Spatial Planning	• Construction regulations/ Building restrictions (e.g., restrictions on building height for landscape protection; Restrictions on materials, scale, colour, size, architectural style of constructions to match surrounding landscape, etc.) • Urban, zone and spatial planning provisions (e.g., land uses, zoning plans, Shoreline and coastal zones, forest zones etc.)
Civil Aviation	• Non-military manned air vehicles (e.g., definition of special flights' rules such as non-flight zones; Definition of general minimum flight height; Definition of Obstacle Limitation Surfaces, designating the airspace around an airport where restrictions apply to constructions or physical objects' heights) • Unmanned Air Vehicles (e.g., fly under permission above specific heights; Flight prohibition over infrastructures or correctional facilities; Definition of maximum flight height)
Environment protection	• Natural protection zones (such as restrictions on Forest protection; Natural habitats; Biodiversity and Protected areas) • Soil (restrictions regarding soil contamination (deriving from soil geological or chemical characteristics); mitigation measures on contaminated soil) • Water (restrictions regarding the protection of surface and groundwater bodies, stream buffers) • Air (such as restrictions for the protection of public health from contaminants in the air; restrictions regarding radio waves propagation to ensure efficient communication and broadcasting as well as protect public health and the natural environment from extended exposure to electromagnetic fields; restrictions regarding public exposure to electric and magnetic fields due to the installation of antennas. • Noise (such as restrictions on zones of noise propagation and vibration)
Public utility networks	• Land use restrictions • Rights of way • Servitudes of passage
Major infrastructures	• Land use restrictions • Rights of way • Servitudes of passage

Military zones	• Restricted areas • No flight zones

As shown above, this work classifies PLRs in eight sectors, each one pertaining to specific types of restrictions. Compared to the classification by Kitsakis et al. (2019), two new categories are introduced. The category "Environment protection" incorporating restrictions related to the protection of soil, water, air, noise and natural environment, and the category "Landscape and Spatial Planning" that integrates restrictions related to the protection of landscape, urban and spatial planning provisions.

3. ISO 19152 LADM REVISION

The ISO 19152:2012 LADM was published in 2012 to address basic information-related components of land administration, emphasising mainly on land registration processes and (land) parcels of real property. At the first edition of the standard, land valuation, land use and spatial planning were purposely left aside, while the marine domain was not considered as a separate field. Today, there is a need and mature ground for developing a general schema reflecting the main concepts of land administration and structuring implementation solutions. The second edition of the standard is organized into multiple parts, with the following working titles:

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

Separate New Working Item Proposals (NWIP) and Working Drafts (WD) will be submitted for each of the parts and the standardisation procedure as defined by ISO will be followed. Till today, the NWIP for Part 1 has been submitted by Standards Australia (SA) with input from the authors' team on behalf of the FIG and positively voted by the ISO Committee members, while NWIPs for Parts 2 and 4 have been submitted by FIG and they are under review from the Committee members.

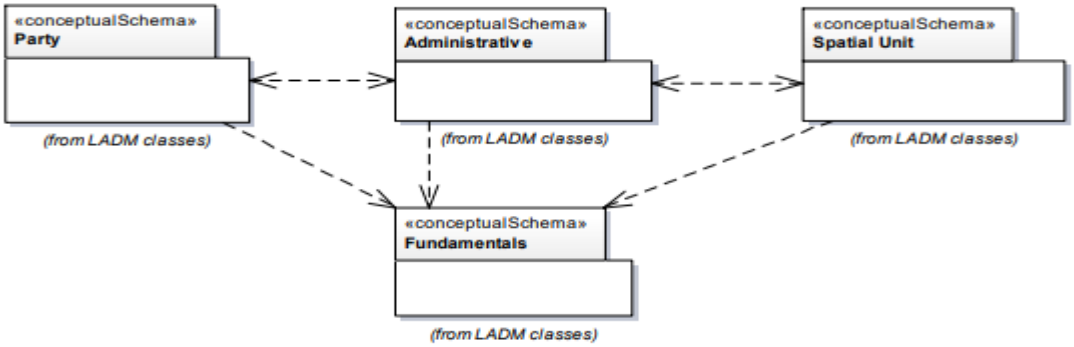

Figure 1. Packages of Part 1 - Fundamentals of LADM Edition II (Lemmen et al., 2021)

Part 1 - Fundamentals will be a high-level umbrella standard that supports all the other parts of the LADM Edition II. Part 1 presents the fundamental notions and defines the basic components and relations shared by all objects created by land administration (Figure 1), as well as provides an overview of all parts (Figure 2). This Part will not only be backward compatible with the previous version of LADM but also with the IHO S-121 Maritime Limits and Boundaries standard, which will be used as basis when developing the Part 3 of LADM Edition II (Lemmen et al., 2021).

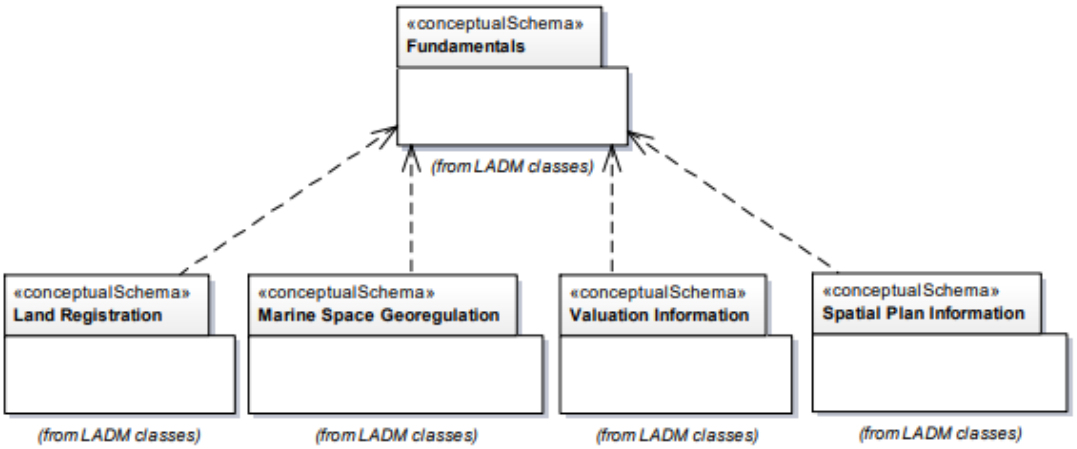

Figure 2. Packages of the extended LADM Edition II including Marine Space, Valuation and Spatial Plan Information (Lemmen et al., 2021)

Part 2 is focused on Land Administration, Land Registration and Cadastre, while some of the existing parts of LADM Edition I are being refined in Part 2 aiming to add more semantics. Representative examples of such improvements are the Survey Model and the semantically enriched, structured, and versioned code lists.

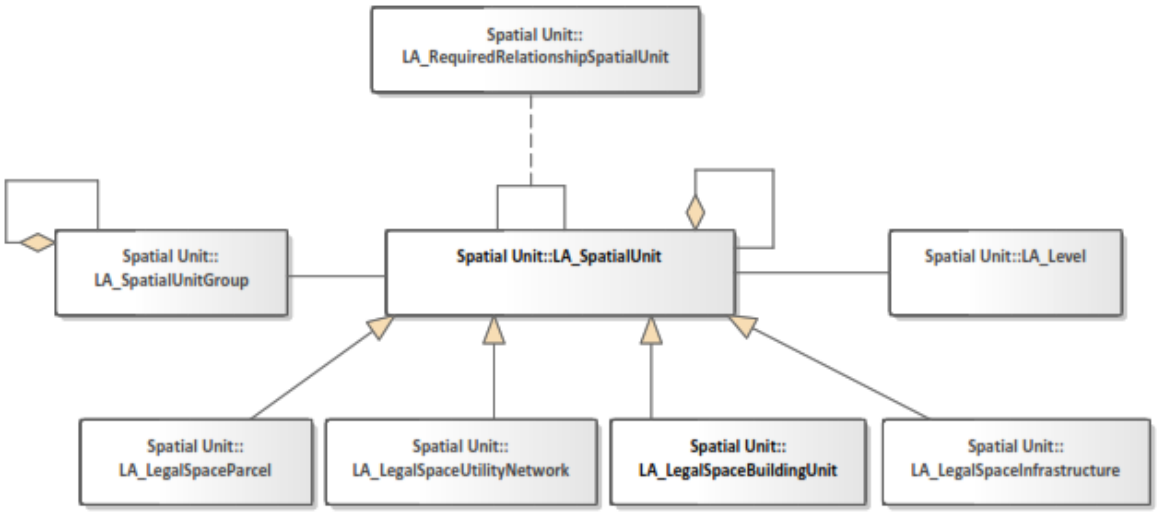

Figure 3. Proposed structure of the refined SpatialUnit Package for LADM Edition II – Part 2

What is more, the LADM Edition I allows a set of possible representations of spatial units in 2D, 3D or mixed dimension (integrated 2D and 3D), providing a framework for categorisation of spatial units. Part 2 of the LADM Edition II will include refined 3D spatial profiles to support the full lifecycle of 3D objects (Thompson et al., 2015, 2016; FIG, 2018b; Kalogianni et al., 2020). An overview of the proposed structure of the refined SpatialUnit Package (as included in the NWIP of Part 2) is presented at Figure 3.

4. PLRS ORGANISATION IN LADM EDITION II

The last decades the documentation and registration of PLRs is increasingly becoming an issue in several countries globally, as the inclusion of PLRs to the cadastral systems, makes the land market more transparent and secure. Standardization in this domain is a challenge, but at the same time an urgent need to enhance information sharing, information integration and interoperability. Kitsakis et al. (2018), provided a brief overview of the standardization approaches of PLRs, highlighting that this activity is still in its early steps, as the enactment of a PLR relates to societal changes, economic needs, demographic data, and environmental factors.

The fact that PLRs may present differences per country or jurisdiction, as well as they derive from multiple authorities and registries operating under different legal provisions, is taken into consideration in the context of this paper. For that reason, a more generic categorization of PLRs, as presented in Table 1, mainly adjusts to the Hellenic reality, while at the conceptual modelling side, the criteria considered for the organization of PLRs and the UML models created are based on Part 2 of the LADM Edition II. Benefits and drawbacks of the alternative modelling approaches are discussed and validated through the use cases (Section 5). From the modelling within LADM, it is expected that the various PLRs will be organized and provide a cost and time efficient basis for their spatialization and analysis on a legal basis.

The modelling alternatives of PLRs that are being developed and examined in the context of this paper are related to their nature and complexity, as well as to the number and variety of organisations involved in their management. In all cases, the proposed modelling is based on the structure of Part 2 of the LADM Edition II, while two main questions/ criteria arise; Whether:

- PLRs should be modelled at the legal part of the LADM or at the spatial part and
- subclasses to organise the various PLR categories (Table 1) should be developed, or a structure with semantically enriched code lists with hierarchical structure should be followed.

Based on those criteria, the following UML models are developed to visualise the alternative modelling approaches for the organisation of PLRs within Part 2 of LADM Edition II.

Modelling the Spatial Part - Alternative 1

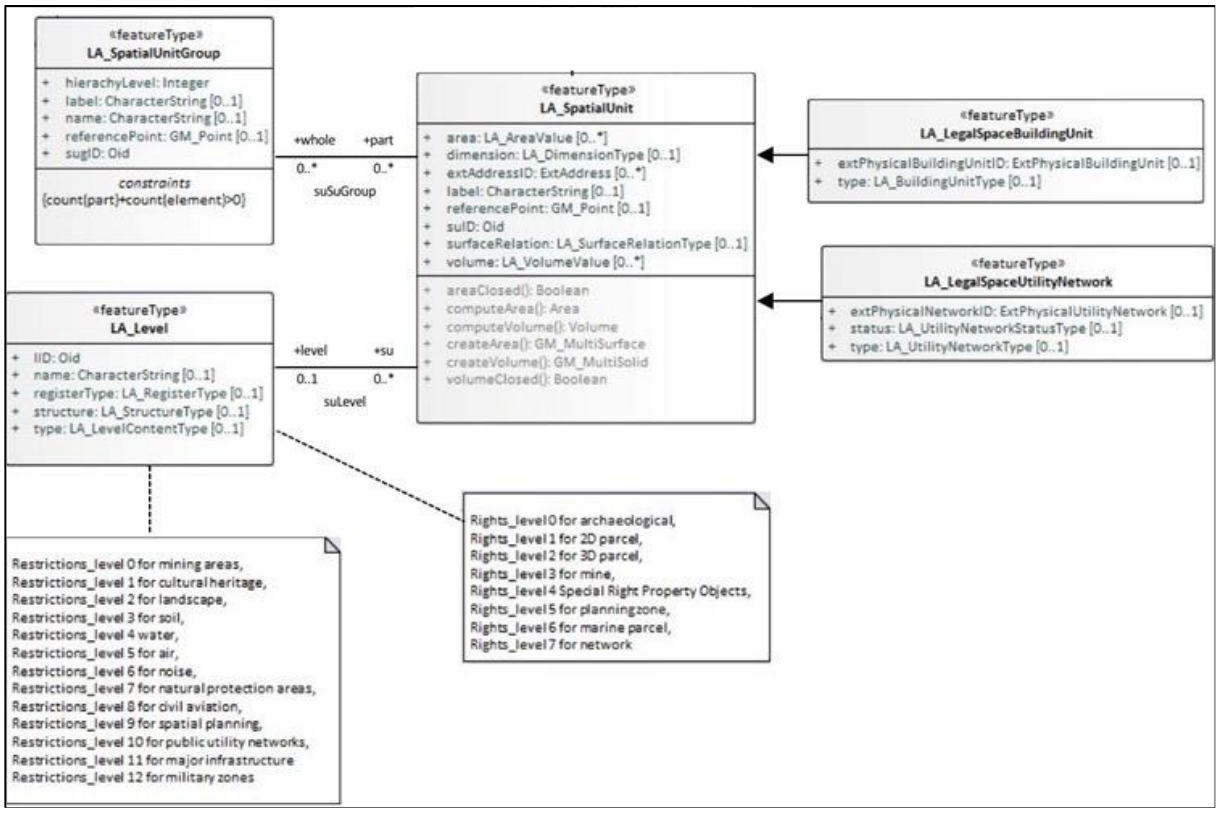

Figure 4. Alternative 1 - modelling PLRs at the spatial part of Part 2 of LADM Edition II

As proposed by Kitsakis et al. (2018), the LA_Level concept of LADM is used to connect the object/zone, on which a PLR is attached to the spatial unit and not directly to the restriction that it imposes, while the type of PLR is defined through the enriched code list values of LA_RestrictionType). A note regarding the proposed Restrictions levels is presented and contains 12 levels, according to the PLR types presented in Table 1. Apart from the restrictions' level, a corresponding note with Rights level is included based on a proposed structure for modelling different spatial units' types and their characteristics, presented by Kalogianni (2015).

Modelling the Spatial Part - Alternative 2: a new class "LA_PublicLawRestrictions" is developed and modelled with an association to the "LA_SpatialUnit" class. All the information related to PLRs is modelled through this class and the corresponding code lists are enriched with the appropriate values according to the categories of Table 1.

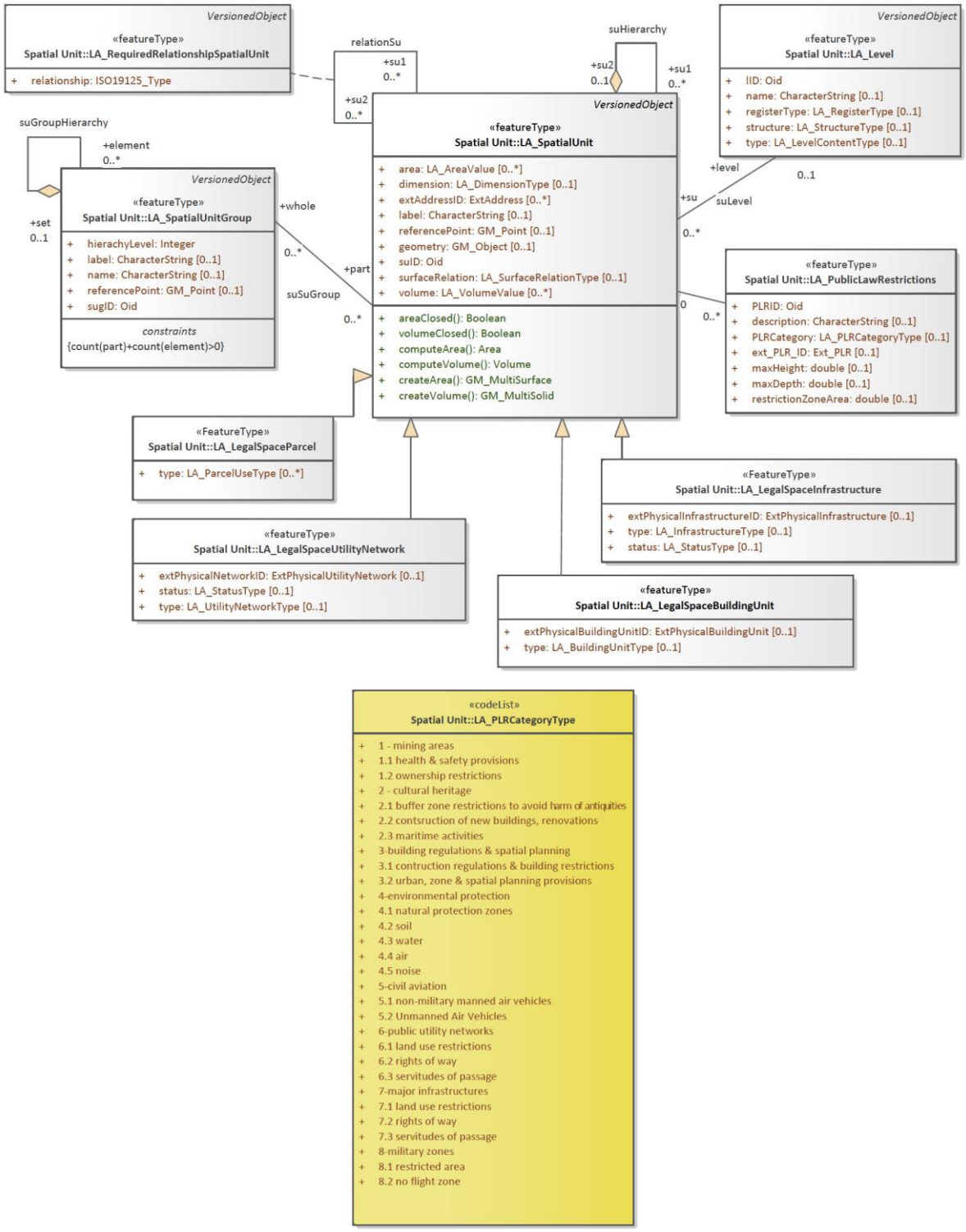

Figure 5. Alternative 2 - modelling PLRs at the spatial part of Part 2 of LADM Edition II

This alternative is further elaborated through the hierarchical code list values that are proposed to be included for the PLR_Category attribute (Figure 6). The proposed approach is

simple hierarchical encoding based on the proposed classification of Table 1, namely hierarchical numbering of values in a code list. What is more, to provide further insights for the PLR, an external link with the registry that the PLRs are (or will be) stored and maintained is proposed through the attribute "ext_PLR_ID".

Modelling the Legal Part: The alternative on modelling PLRs on the legal part of LADM is presented in Figure 6.

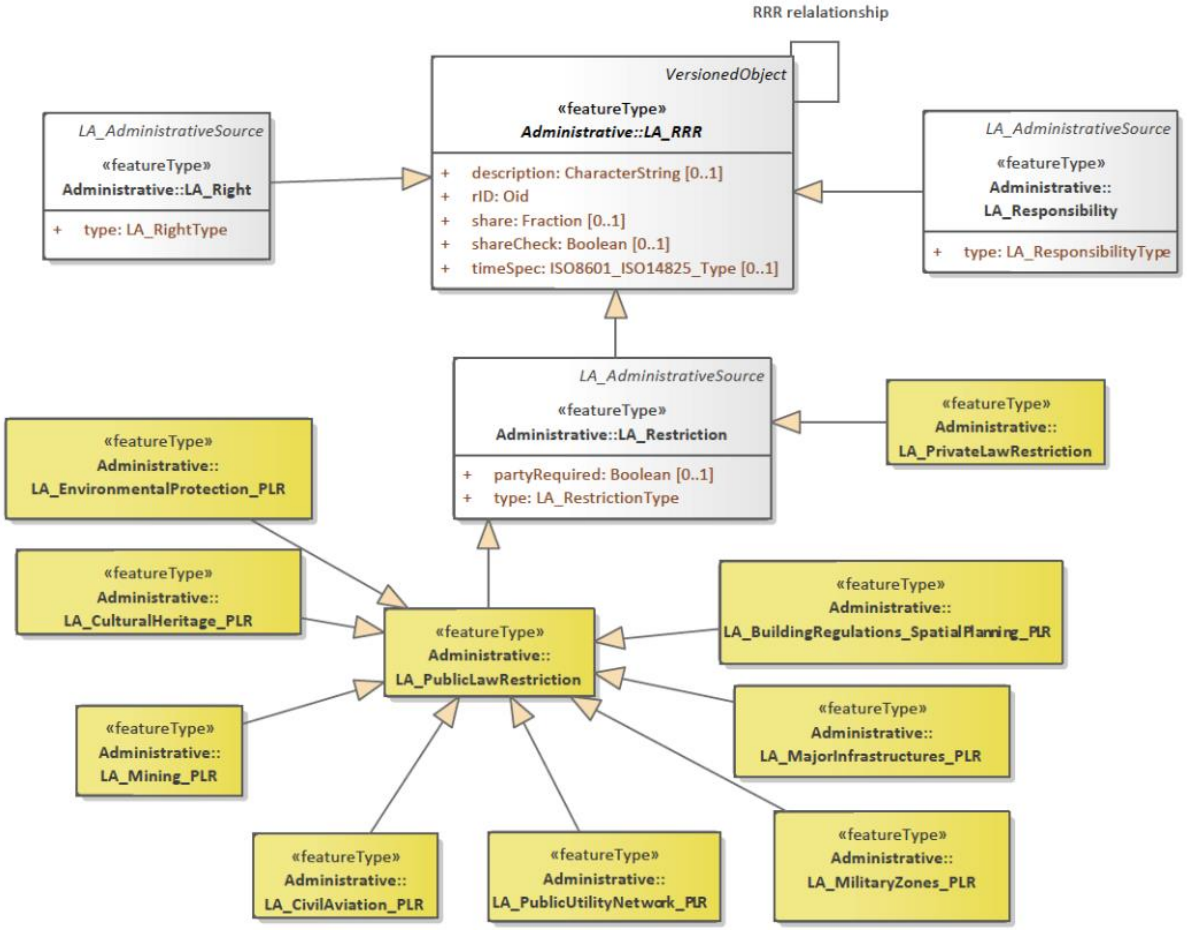

Figure 6. Modelling PLRs at the spatial part of Part 2 of LADM Edition II

Two subclasses are created at the 'LA_Restriction' class, one concerning public law restrictions and the other private law. The 'LA_PublicLawRestriction' class is further classified into 8 subclasses, according to the distinguished categories as presented in Table 1. This approach is considered beneficial when the various PLR categories have different characteristics to be modelled as attributes.

5. USE CASES

The proposed 3D PLR modelling approaches were further examined in two case studies, where restrictions apply in the three-dimensional space, concerning major infrastructures and

cultural heritage. The former case refers to restrictions imposed on land for the protection and maintenance of the Trans Adriatic Pipeline (TAP), in Northern Greece, while the latter, examines restrictions that apply on land parcels within a specific perimeter resulting from regulations related to archaeological sites.

Case Study 1. TAP

The TAP crosses about 9.189 land parcels along the regions of Macedonia and Thrace in Northern Greece, covering an area of 4277.7 Ha (TAP, 2016).

Figure 7. TAP route (TAP website, 2021)

The pipeline is constructed at a depth of 1 metre below the earth's surface. To ensure the safety and for the maintenance of the pipeline, the following restrictions are imposed on the land parcels situated in its route (TAP webpage, 2021; Livelihood Restoration Plan):

A Restricted Ownership Zone is established, 4 metres along each side of the pipeline. In this zone, landowners and users are not allowed to:

- Construct buildings of any nature
- To cultivate deep-rooted plants with roots going deeper than 60 centimetres
- Drilling or opening of trenches and/or wells
- Install underground installations at a depth more than 50 centimetres
- Make alterations to the ground morphology in any way (e.g., deep ploughing, excavating, placing of rubble, creating ponds)
- Build new roads

Furthermore, a Building Restriction Zone is established, 20 metres along each side of the pipeline, where landowners and users are not allowed to:

- Construct buildings of any nature and
- Install disposal systems altering the ground's morphology

A 400-metre zone along the pipeline's centreline is established, where restrictions to the number of buildings that can be constructed are imposed. Such restrictions are intended to ensure the security of the pipeline in case of modification of urban plans, or of elaboration of new ones.

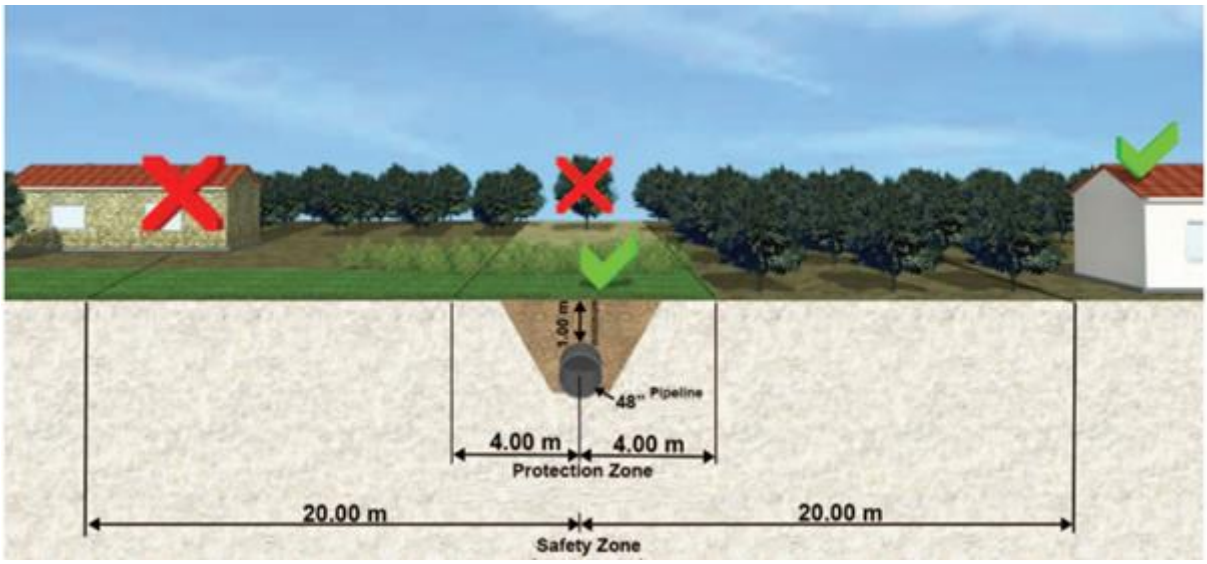

Figure 8. Protection and safety zones along TAP's route.

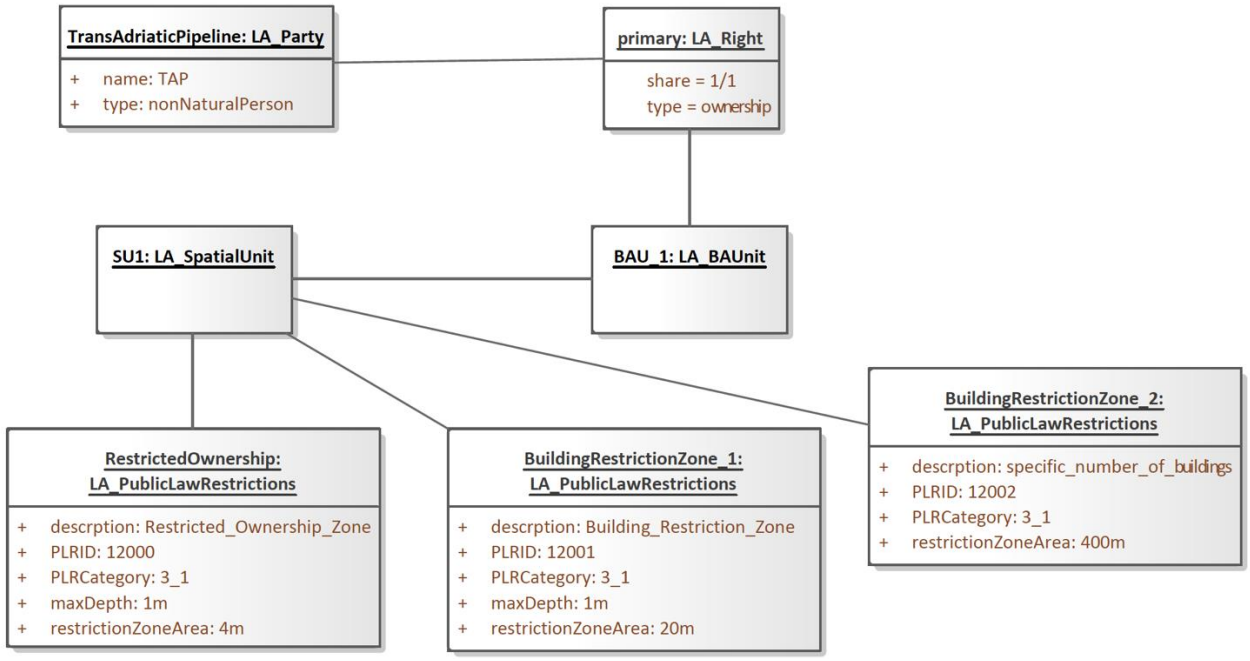

Figure 9. Instance level diagram of use case 1 modelled at the spatial part of LADM.

Case Study 2. Protection zones of the archaeological site of Voundeni

In this case study, restrictions imposed for the protection of the archaeological site of the Mycenaean settlement of Voundeni in the municipality of Patras in Western Greece are examined.

Figure 10. Left: General view of the archaeological site
Right: Zones defined by the restrictions of the archaeological site (red: Zone A, yellow: Zone B)

For the protection of the archaeological site, two zones of protection were established, where specific restrictions apply regarding construction and land exploitation, as stipulated by the relative Ministerial Decision (Greek Government Gazette, Vol. B, Issue 985, 30/12/1994).

- **Zone A:** This zone includes the citadel along with its walls, the remnants of the ancient settlement, as well as the ancient cemetery. Within this zone, only agricultural activities are allowed, opening of rural roads to ensure access to land parcels. A specific region within Zone A, defined in the (2D) survey plan accompanying the Ministerial Decision, is excluded from the non-construction restriction.
- **Zone B:** In this zone, construction is allowed under conditions. Such conditions are defined by Presidential Decree (Greek Government Gazette, Vol. D, Issue 416, 22/5/2002) that sets minimum land parcel area to 4.000 sq.m. Moreover, it defines specific regulations regarding the construction of buildings. Specifically, apart from a minimum land parcel area, it defines the minimum land parcel depth at 50 metres and the minimum façade length on roads to 45 metres. It also sets land parcels' building coefficient to 0.20.

This use case is modelled within the alternative modelling approach for the legal part of LADM, as proposed in Section 4 and the instance level diagram is presented in Figure 11.

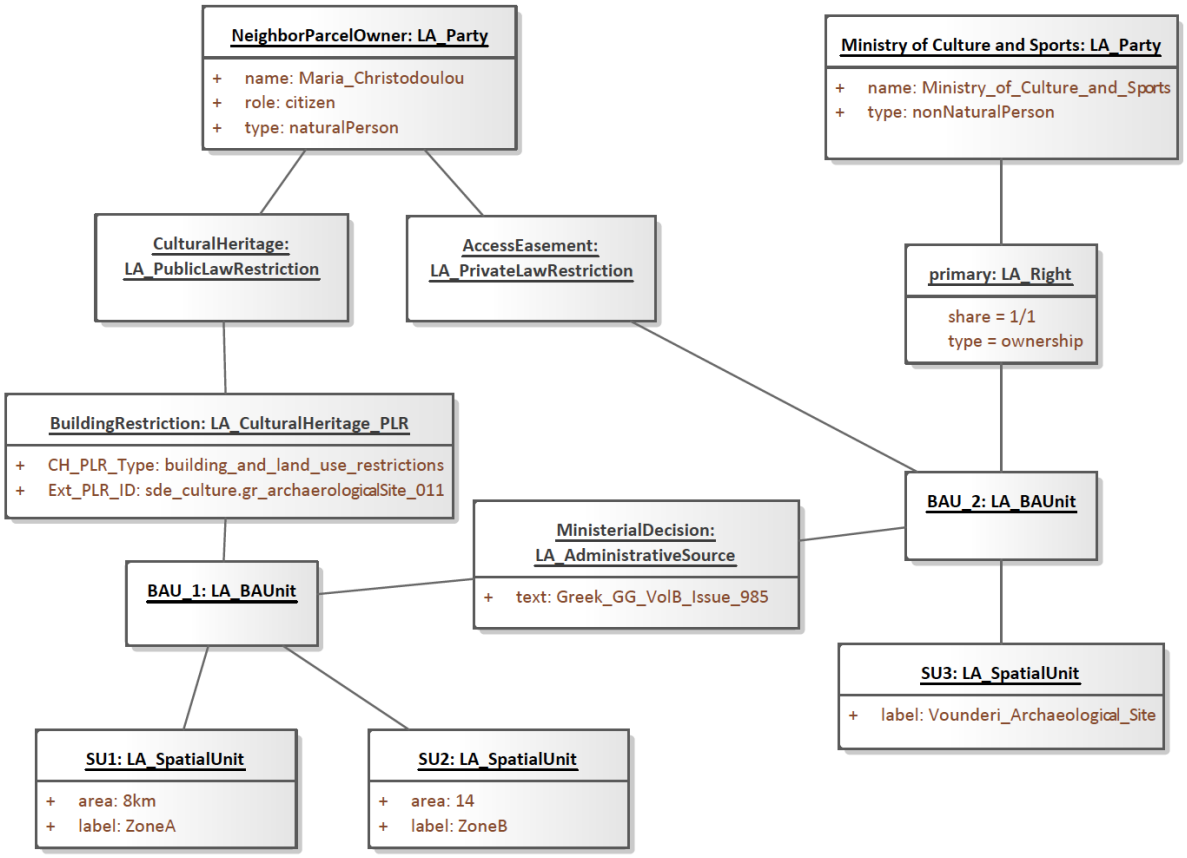

Figure 11. Instance level diagram of use case 2 modelled at the legal part of LADM.

6. DISCUSSION & CONCLUSIONS

Multipurpose and intense exploitation of land in the vertical direction has introduced numerous complexities in LAS, in the form of modelling and registering complex, overlapping private rights, as well as private and public law restrictions in 3D space. Within this context, to secure public benefit, each State imposes PL restrictions on landownership and land-use, concerning the dimensions and characteristics of the buildings, their construction options, as well as specific actions in plot sections.

The registration and 3D modelling of PLRs is a challenging task associated with their characteristics and often with their descriptive character, which in many cases does not refer to a 3D space counterpart. In addition, because of the large number of laws and regulations that govern PLRs, the different time of their creation and the duration of their validity, there is a need to clarify their status and systematically organize them, selecting those that need to be modelled and registered in terms of significance and feasibility. Therefore, different approaches can be identified nationally, depending on the priorities set for national Land Administration System and the technical capacities of national spatial data infrastructures, as stated in the paper. Apart from the previously mentioned factors, significant differences also relate to the legal status of each country/jurisdiction, which is particularly relevant to land

ownership issues: PLRs can be regarded as external restrictions on the (unlimited) total, immediate and absolute power deriving from real property ownership, or as restrictions inherent to the nature of ownership, or as restrictions that apply when exercising the powers that result from the right of ownership. Based on those aspects, a classification of PLRs specially to serve the Greek context is proposed in this paper, also considering international experience and knowledge. Following, the umbrella of the various modelling approaches of the PLRs within the LADM revision is proposed, elaborated on the two basic criteria set out above. Advantages and disadvantages are in both approaches, being verified by the implementation of the two use cases through the instance level diagrams. Specifically, the alternatives proposed on the spatial part of the LADM show that the spatial extent of PLRs is emphasized more, while the legal extend is being referred as a code list value or attribute in the level approach. On the other side, the legal proposal is beneficial when the various PLR categories have different characteristics to be modelled as attributes. Therefore, it is considered that the ground is not mature to propose a single solution to model PLRs within Part 2 LADM Edition II.

This paper opens the possibilities and creates the preconditions for a generic model, which will result from the extension of the study to other systems. More use cases from various jurisdictions are needed to validate the proposed solutions and allow for revision iterations at the conceptual level. Having these in mind, different approaches need to be examined, and potential interchanges between different concepts. For example, the bundle of rights concept, best fitting to Common Law based jurisdictions, can be revisited, and investigate its potential application on PLRs, by examining how PLRs "carve away" powers that can be exercised by an owner, deriving from the right of ownership. Therefore, the next step of this ongoing research is to extend on other types of PLRs and on different jurisdictions, so that practical implementation of the investigated case studies can be further examined on real world situations. Moreover, comparative analysis of different jurisdictions will provide feedback on the model's replicability and provide identification of best practices and drawbacks for its further refinement. The PLRs thus modelled, may results in benefits including transparency in land development and innovative products and services in Land Administration practices.

REFERENCES

Banut, R. (2011), "Overview Working Sessions." In 2nd International Workshop on 3D Cadastres, Delft, The Netherlands, 1–10.

Bennett, R., Wallace J., and Williamson, I. (2006), Managing Rights, Restrictions and Responsibilities affecting land. In: Combined 5th Trans Tasman Survey Conference & 2nd Queensland Spatial Industry Conference 2006, Cairns, Tasmania, 1–12.

Bennett, R. (2007), Property Rights, Restrictions and Responsibilities : Their Nature, Design and Management, PhD Thesis, The University of Melbourne.

del Campo, Ainhoa González. (2012) "Gis in Environmental Assessment: A Review of Current Issues and Future Needs." Journal of Environmental Assessment Policy and

Management 14(01): 1250007. http://www.worldscientific.com/doi/abs/10.1142/S146433321250007X.

Givord, G. (2012), Cadastre 3D des Restrictions de Droit Public à la Propriété Foncière, Conservatoire National des Arts et Métiers.

Kaul, C. (2019), 10 Years of "Law on Geoinformation" in Switzerland - Current Situation and Outlook, In FIG Working Week 2019, Hanoi, Vietnam

Kitsakis, D. and Dimopoulou, E. (2016), Possibilities of Integrating Public Law Restrictions to 3D Cadastres, In 5th International FIG 3D Cadastre Workshop, eds. Peter van Oosterom, Efi Dimopoulou, and Elfriede M. Fendel. Athens, Greece, 25–46.

Kitsakis, D., Dimopoulou, E., 2018. Determining the "true" three-dimensional environmental impact of public law restrictions. In 6th International FIG 3D Cadastre Workshop, ed. Peter van Oosterom. Delft, The Netherlands, 291–308.

Kitsakis, D., Kalogianni, E., Dimopoulou, E., van Oosterom, P.J.M. (2018), Requirements for Standardised Representation of Public Law Restrictions based on LADM. In FIG Commission 3 Workshop and Annual Meeting - Spatial Information in the Era of Data Science: Challenges and Practical Solutions, Naples, 3-6 December 2018.

Kitsakis, D., Kalantari, M., Rajabifard, A., Atazadeh, B., Dimopoulou, E. (2019), Exploring the 3rd Dimension within Public Law Restrictions: A Case Study of Victoria, Australia, Land Use Policy 85: 195–206.

Kitsakis, D. (2019), Legal Requirements for Real Property Stratification, PhD Thesis, National Technical University of Athens.

Lai, Poh C., Kim Hung Kwong, and Ann S.H. Mak. (2010), "Assessing the Applicability and Effectiveness of 3D Visualisation in Environmental Impact Assessment." Environment and Planning B: Planning and Design 37(2): 221–33.

Lemmen, C., Alattas, A., Indrajit, A., Kalogianni, E., Kara, A., Oukes, P., van Oosterom, P.J.M. (2021), The Foundation of Edition II of the Land Administration Domain Model. In: 9th FIG Workshop on the Land Administration Domain Model / 3D Land Administration.

Navratil, G. (2012), Combining 3D Cadastre and Public Law – An Austrian Perspective. In 3rd International Workshop on 3D Cadastres, Shenzhen, China, 61–72.

Paasch, J., and Paulsson, J. (2011), "Terminological Aspects Concerning Three-Dimensional Real Property." Nordic Journal of Surveying and Real Estate Research 8(1): 65–80.

Paasch, J., Paulsson, J., Navratil, G., Vučić, N., Kitsakis, D., Karabin, M., El-Mekawy, M. (2016), "Building a Modern Cadastre: Legal Issues in Describing Real Property In 3D." Geodetski Vestnik 60(2): 256–68.

Paasch, J., & Paulsson, J. (2021). 3D Property Research from a Legal Perspective Revisited. Land, 10(5), 494. MDPI AG. Retrieved from http://dx.doi.org/10.3390/land10050494

TransAdriatic Pipeline (2021), About TAP, Retrieved from: https://www.tap-ag.com/about-tap.

TransAdriatic Pipeline (2021), Safety near the pipeline, Retrieved from: https://www.tap-ag.com/land-and-local-residents/safety-near-the-pipeline.

TransAdriatic Pipeline (2021), Guide on Land Easement and Acquisition, Retrieved from: https://www.tap-ag.com/land-and-local-residents/local-landowners-and-users/land-access-documents/$2781/$2782/$2788.

Zevenbergen, J., & de Jong, J. (2002), Public Law Information Regarding Land; Dutch proposal for registration, In FIG XXII International Congress, Washington D.C., USA.

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