Refining the Legal Land Administration-related Aspects in LADM

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SUMMARY

Among the topics that are introduced and/ or being refined in the context of the revision of the LADM 19152:2012, the legal Land Administration-related aspects are being investigated. With the knowledge and the experience from the developments of the LADM so far, and the ongoing discussion between the parties involved in the standardisation process, the need to clarify certain legal land-related aspects and to examine the alternatives for further refinement is highlighted.

Therefore, this paper presents prior work on LADM-related legal aspects since the vote of LADM as ISO standard (2012), till the time of the preparation of this paper (2021) to report the necessary background for this research. This concerns the developments related to the various legal refinements that have been proposed during this time period and specifically the refinement of the legal profiles, the LADM functional support to representation of both statutory and customary tenure and the work regarding the explicit definition of restrictions that arise from Public Law.

Moreover, this paper focuses on documenting the proposals on a refined legal model for the LADM Edition II. These include the following: (a) more detailed classification of RRRs, based on the two major types of interests in land: privately agreed interests as well as regulations imposed by a public agency and Public Law restrictions. The paper also includes (b) a discussion on the extent that LADM Edition I provides efficient support for the title and deed registration systems (as others e.g. in socialist environment), as well as (c) a discussion on how restrictions and responsibilities can be modelled as rights' relationships between an owning and a benefitting Party.

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1. INTRODUCTION

Whilst different jurisdictions organise the information related to parties, interests on land/ water (Rights, Restrictions, Responsibilities - RRRs), land/ water parcels and objects on/above/below the surface, as well as their relationships in different ways, this variability is primarily expressed through their approach to the definition and representation of legally recognised RRRs. However, there are general concepts describing the legal Land Administration-related aspects, which can be universally applied and, in this sense, the key is how a jurisdiction formally defines the set of legally recognised rights with regards to the powers that these rights provide to a right holder and, where appropriate, the responsibilities that are expected by those land holders for land encumbered by a third-party right.

The ISO Land Administration Domain Model (LADM - ISO 19152:2012), includes the top-level classification of Rights, Restrictions and Responsibilities (RRRs), embracing both formal and informal RRRs. The Annex F of the standard includes 3 legal profiles, for Rights, Restrictions and Responsibilities, respectively. However, since its vote as ISO standard in 2012, research has been carried out on enriching the standard's legal part in order to have a more detailed and refined classification and description of interests in land/ water, based on various countries' needs and the different legislative systems that operate worldwide.

The second Edition of the LADM, which is currently under development, will have a wider scope and comprises of 6 Parts, including the refinement of existing parts, where necessary, and the introduction of new ones, while being backwards compatible with the Edition I. In this context, it is investigated whether a revision shall be proposed concerning the legal part of the LADM, and specifically its classes, code lists and legal profiles, and if so, to what extent.

Therefore, considering the existing knowledge and experience from the adoption and implementation of the LADM so far, the ongoing revision process, the comments and needs that are addressed through it, as well as the need to align with other standards (such as LandInfra (OGC, 2016), VGI approaches and tools), this paper aims to initiate discussion on the perspective of the need for refinement of the legal part of the present version of the LADM.

The paper is structured as follows: Section 2 presents an overview of the developments on LADM-related legal aspects from 2012 (its vote as ISO) till the end of 2021. The next Section introduces the core aspects that are used to examine the need for refinement of the LADM legal part, namely: the support of both title and deed-based systems, a further classification of RRRs,

the option to model restrictions as rights and the refinement of code lists towards the possible update of the legal part of the standard. Lastly, Section 4 is devoted to discussion and conclusions of the research.

2. DEVELOPMENTS ON LADM-RELATED LEGAL ASPECTS

The present LADM version (ISO, 2012, clause 1) provides terminology for land administration that '*allows a shared description of different formal or informal practices'* in various jurisdictions. This terminology is about statutory and formal tenures as well as customary and informal tenures (Paasch et al., 2015).

The conceptual model of LADM Edition I consists of three packages and one subpackage. The Administrative package is related to basic administrative units (BAUnits) and RRRs (ownership and other real rights); the main classes of the Administrative Package are the LA_BAUnit and LA_RRR. The BAUnit is defined in clause 4.1.2 as '*administrative entity, subject to registration (by law), or recordation [by informal right, or customary right, or another social tenure relationship], consisting of zero or more spatial units against which (one or more) unique and homogeneous rights [e.g. ownership right or land use right], responsibilities or restrictions are associated to the whole entity, as included in a land administration system*' (ISO, 2012).

LA_RRR is an abstract class with three specialisation classes: LA_Right, LA_Restriction and LA_Responsibility. A right (clause 4.1.20) is an *'action, activity or class of actions that a system participant may perform on or using an associated resource*'. Note 1 to that definition says that a right may provide a 'formal or informal entitlement to own or do something'. This is a better definition and will be proposed for inclusion in Edition II. In this paper we will use the latter definition (ISO, 2012). It should be noted here that:

- The LADM deals with real rights that are held by parties in an '*in rem*' or '*in personam*' capacity. In rem rights are '*good against the world*' - everybody owes a corresponding duty to the right holder (i.e. no one should trespass on someone else's land). In order that people are aware of their '*in rem*' responsibilities it is argued that publication of such responsibilities through a '*public register*' is required. '*In personam*' rights are rights' relationships between named parties. The relationship between in rem and in personam rights is framed through the numerus clauses (closed number of rights) principle (see Section 3.2), defined in the legal system of each jurisdiction.
- Rights may be overlapping or may be in disagreement.

Furthermore, there are some specific classes which are relevant for common, customary and/or communal lands; LA_GroupParty and LA_Party. These two classes combined with LA_RRR and LA_BAUnit are the only most relevant functionalities to model customary and informal land rights based on LADM (Paasch et al, 2015).

The Administrative package also includes code lists, such as LA_RightType (e.g. ownership, customary type, lease, usufruct, superficies, informal occupancy, tenancy, etc.), LA_RestrictionType (e.g. servitude, noBuilding, monument, etc.) and LA_ResponsibilityType (e.g. monument maintenance, waterway maintenance). It should be noted that these code lists are just simple lists of values that do not include any definition and semantic relationship.

Existing land information systems may have limitations because of the fact that informal and customary tenures cannot be included. Land tenure types that are not based on a cadastral parcel and are not registered, require new forms of land administration systems. A social tenure approach is needed to fill the gap (Paasch et al, 2015). In LADM, this is achieved via the Social Tenure Domain Methodology (STDM) (although the acronym stands for Model, SDTM is acting as a methodology, not a model itself but a specialisation of LADM) where a range of tenures is covered, providing a land information management framework integrating formal, informal and customary land systems and administrative and spatial components by facilitating the recording of all forms of land rights (including informal land use), types of rights holders and all kinds of land and property objects/spatial units (Augustinus et al., 2006; FIG,2010; UN-Habitat, 2012).

Since the release of LADM Edition I, there has been a number of contributions on modelling legal aspects of RRRs and the LADM, such as Lemmen (2012), Hespanha (2012), Paasch (2012), Paasch et al. (2015) and Kitsakis et al. (2021a) while from the various country profiles that have been developed, the flexibility and ability of the standard to support the different needs of Land Administration Systems worldwide is demonstrated. From the literature (Kalogianni et al., 2021; Chipofya et al., 2020), it is concluded that, the majority of LADM country implementations that are developed, refer to the upgrade and modernisation of existing Land Administration Systems, following a top-down approach, demonstrating the efficient support by the LADM functionality regardless of the registration system that applies to a jurisdiction. What is more, the study of the country profiles inventory (Kalogianni et al., 2021) concludes that there have been few countries that further developed the legal profiles of the standard, with most focusing on the modelling of informal rights as well.

Among the studies refining RRR classes of the LADM, Hespanha (2012) (see Annex F of ISO 19152:2012) and Paasch (2012) are the first ones that introduce Public and Private Law specialisations of RRR classes. The relations in land use belong to the realms of Private Law and Public Law (Paasch, 2012; Paasch et al., 2015). The Private Law domain contains, in general terms, relations created between humans regarding the use and ownership of land. Public Law contains regulations within society (e.g. the State or a municipality) aiming at achieving 'the greater good' for the inhabitants and the protection of natural resources or wildlife by regulating unnatural pressure on land (Paasch et al., 2015). This basic classification of Private and Public Law is used as a starting point for describing land use and an input to further refine and develop the LADM legal profiles. In this sense, the same authors suggest specialisations of the LADM's legal profiles, namely: a) an extended profile for privately and publicly imposed rights, b) an extended profile for privately and publicly imposed restrictions and c) an extended profile for privately and publicly imposed responsibilities. Interests belonging to the realm of Private Law are further sub-categorised into the following types of

relations: Common (i.e. real property to land relation), Property to Property, Party (Person) to Property and Latent (i.e. relations not yet executed on a real property); while the realm of Public Law is extended with Specific (i.e. a limited number of properties) and General subclasses (Paasch, 2012; Paasch et al., 2015). A more detailed and thematic classification of Public Law Restrictions (PLR) based on LADM is provided by Kitsakis et al. (2021a). Restrictions deriving from Public Law (PLRs) are gradually increasing in number and complexity, and their spatial representation increasingly calls for layered and/or 3-dimensional representations. Registration and 3D modelling of PLRs is a quite laborious task, given that a significant number of them is described through qualitative or non-geometrical descriptions (e.g. by reference to chemical or geological characteristics), imposed by multiple legal documents derived from various legal fields, such as environmental protection, heritage protection, spatial and urban planning, flight of Unmanned Air Vehicles (UAV), construction and maintenance of utilities or major infrastructures (Kitsakis et al., 2021a). Given that national Land Administration Systems set different priorities on land management, different types of PLRs affect Land Administration, thus inhibiting the development of a homogenous approach regarding PLR management. From the legal perspective, deviations between different jurisdictions derive from the perception of land ownership in each jurisdiction; specifically, PLRs can be regarded as (a) external restrictions on the (unlimited) total, immediate and absolute power that derives from real property ownership; (b) restrictions inherent to the nature of ownership, or (c) restrictions that apply when exercising the powers that result from the right of ownership (Georgiadis, 2012).

As LADM Edition II will explicitly model RRRs attached to land, marine and air parcels, infrastructure objects, utilities, etc., as well as processes, the current LADM legal profiles shall be able to efficiently support all the above. Moreover, modelling alternatives have been developed to explicitly define PLRs with LADM (Editions I and II) covering both the legal and the spatial aspects of them (please see Section 3.3).

3. CORE ASPECTS TO CONSIDER A REFINEMENT OF LADM EDITION I LEGAL PROFILES

This Section introduces the core aspects that have been considered by the authors in order to examine the need for refinement of the LADM legal part. The next Subsections elaborate on four main topics related to the support of the LADM Edition I on legal aspects and discuss "open questions" regarding the need for further refinement in this domain. Specifically, they provide insights and a better understanding on the registration of Rights in systems of deeds and titles based on LADM (3.1); which is followed by the need for a detailed classification of RRRs within LADM Edition II (3.2); while Sub-section 3.3 provides a view on whether a restriction is a right and if it should be modeled separately. The last Sub-section introduces the option for legal refinement via a semantically rich code list.

To start with, towards the design of the refined LADM Edition I on the legal aspects, the following aspects (both modelling and organisational) are considered:

1. Modelling aspects:
   - the new model should be backwards compatible with the first edition of the standard;
   - complexity should be avoided and the model should be kept simple;
   - apart from the refinement of the classes, the increasement of the semantic capabilities of the model via code list values shall be explored; and:
   - awarding new classes with a shadow class at both the legal and the spatial side of the LADM shall be identified.
2. Organisational aspects:
   - the refined legal model should be helpful both within and across jurisdictions and:
   - the model should be aligned with other novel governmental information systems.

3.1 Rights Registration in Various Systems

3.1.1 Requirements of the registration process that results in Registers of Deeds or Titles

Land Registers formalise the private conveyancing process and, in many cases, make the registration process public. Originally Land Registers registered deeds: the legal facts of a transaction. For example, sale of registered land (legally represented by a deed of transfer) is a transaction that transfers the whole, or part, of the ownership right associated with land from Party A to Party B. For such a transaction to be successful, the party-right-land relationship that uniquely defines the registered right-in-land should be unambiguously identified along with the nature of the associated party-right-land change so that when the register is searched the impact of the transaction on a Title can be derived. Hence, the purpose of a deed is not to describe a full party-right-land relationship; instead, a deed describes a transactional change to a party-right-land state. As stated by Zevenbergen & Ploeger (2019): (a deed) '*indicates that the parties have created a legal fact with the intention of having a certain legal consequence, and decided to have it registered*'. This means that, as stated by Simpson (1976): '*a deed in itself does not prove title; it is merely a record of an isolated transaction*'. Title is demonstrated by examining the sequence of prior deeds back to a 'good root of title'. Interpretation of the deeds is required for each Title search. The 'true' owner of the Title is the person who ought to be owner, taking stock of void deeds and other deed errors.

Titles represent the consequences of the legal facts represented in deeds. Title by registration means that the consequences of the change articulated in the deed are registered rather than the deed itself (although the deed can also be archived as part of the application process). There are many approaches to Title by registration although they are commonly referred to as Torrens' registration after Sir Robert Torrens who championed the first Title by registration legislation: the Real Property Act in South Australia in 1858. Title passes by the act of registration, rather than by conveyance between parties. This means that the transaction is only interpreted once: by the Registrar at the point of registration. This has consequences: whilst this makes the Title immediately indefeasible and therefore tradeable (eliminating the need to re-examine the validity of the title for each transaction) it does limit the ability to correct transaction errors and fraud.

Irrespective of their position on error correction, indefeasibility and the associated structure of the register, a Land Register must be able to articulate state and state change. State is required to support the transactional process and to demonstrate to any buyer (grantee) what pre-existing rights third parties may have over the land the grantee intends to purchase. State change is required to formally add, vary, or extinguish registered rights. Change to a Land Register is nominally triggered by an application (a vehicle which presents a deed for consideration by the Registrar) which, if registerable, the Registrar will either:

- record the legal instrument (e.g. deed) contained in the application that describes the fact of the legal rights change (in a Register of Deeds, Title can be derived from the Register of Deeds; and:
- register the impact of the legal change against a Title (Title by registration).

The registration process represents how the Registrar implements the relationship between *state chang*e (e.g. deeds and applications) and *state* (e.g. products, such as derived searches and Title). When viewed in this manner it becomes apparent that Title by registration and the recording of Deeds are not competitive systems (see also McLaughlin & Williamson, 1985). Rather they reflect different positions on the representation of party-right-land relationships.

Land Registers have a requirement to articulate state change (the facts of change: Deeds) and state (the consequences of change: (chain of) Title). Whilst it is clear how the LADM can support the modelling of state, it is less clear how LADM can support the modelling of state change and therefore a Deeds Register. It can be argued that only deeds registration systems that provide unambiguous identification of the land affected by a transaction can be modelled using LADM (Zevenbergen & Ploeger, 2019, Palmer, 1996). We agree with Zevenbergen & Ploeger (2019) when they state that high quality deed systems need to generate an '*unambiguous identification of the subject unit of land" to support a "uniform system for identification of properties*'. We would go further and state that this is a requirement for any modelling of Deeds Registers using LADM. That said, from a conceptual perspective it is of course possible for a Deed Register to be LADM based but not LADM compliant.

Of course, LADM does not solve everything; each jurisdiction must decide their own policies associated with error correction, registration process, indexing and product derivation. Hence, with appropriate forethought a jurisdiction can use LADM to model how state and state change are represented with the Registrar taking responsibility for the mechanics of the transaction process and any associated error correction procedures.

3.1.2 State change representation in LADM

A right holder's powers frame how a right can be changed. Changes include such transactions as rights creation, transfer, variation or discharge. Through these transactions parties can change the state of registered party-right-land relationships using the conveyancing system. Such activities frame the state and state-change relationships that are critical for both Title and Deed (and other) registration systems. As several concerns related to Deeds Registers and LADM

have been raised under LADM Edition I, the issue of representation of state change in LADM using deeds or applications will be given some more attention here.

A deed registrable in a Land Register is a legal instrument that describes real right transactions that result in the creation, variation or discharge of party-right-land relationships. Henssen (1995) describes four general principles that underpin transactions within Land Registers. Two are critical here:

- The consent principle: that the granter on the deed gives their consent and has the legal power to authorise the transaction.
- The specificity (originally speciality) principle: that the transactional party-right-land components must be unambiguously identified (these component parts support indexing).

We described a Title as being framed by three key elements:

1. the party (the *who*) that benefits from
2. the ownership right (the *what*) over and
3. a plot of land (the *where*).

Party verification and designation during registration allows us to uniquely identify the '*who*'. The Registrar can confirm that the granter actually is the registered right holder (satisfying the consent principle). The legislative framework allows us to identify '*what*'. What is missing is a mechanism to uniquely identify the '*where*'. The '*where*' is the cadastral unit that uniquely identifies each owned plot of land and its associated spatial representation in the cadastral map. The specificity principle means that the Registrar can unambiguously identify the party-right-land relationship which is to change either explicitly or by reference to the corresponding deed in the deed chain. Zevenbergen & Ploeger (2019); Palmer (1996) both argue for the explicit inclusion of parcel-based (cadastral) registers to improve the rigor of Deeds based registration systems. France, South Africa and the Netherlands all have deed-based registers supported by formalised parcel-based (cadastral) systems. Once the party-right-land relationship has been unambiguously identified, then the nature of the transactional change can be articulated.

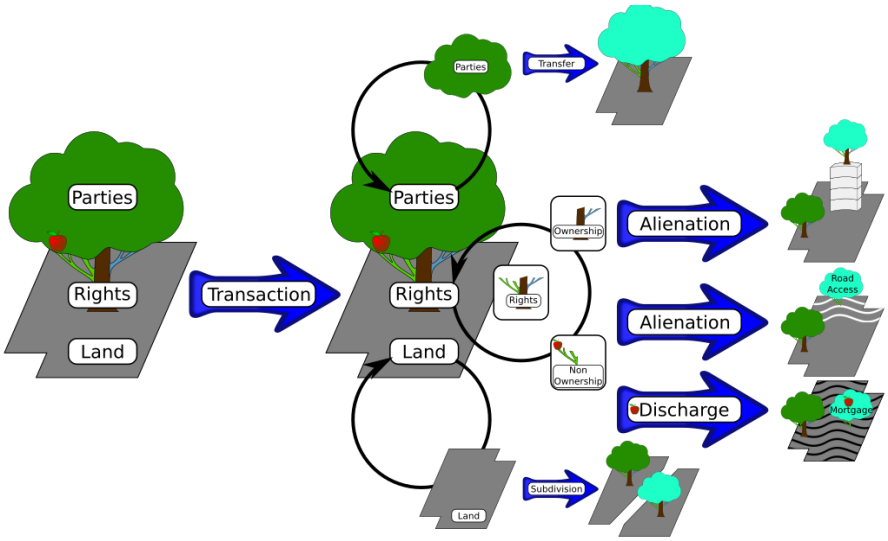

Figure 1. How transactions affect Land Registers by changing Party, Rights and Land relationships. (This images is re-used under a CC-BY licence: https://commons.wikimedia.org/wiki/File:Ownership_Transactions_-_parties,_rights_and_land.svg)

As described in Figure 1, a transaction can be based on the following primitives:

1. Party based transaction primitive: the transfer of all or a proportion of the ownership to a third- party(ies);
2. Land based transaction primitive: a subdivision of owned land to create two parcels of owned land; and:
3. Rights' based transaction primitive: where rights can be separated from the body of ownership and granted to third-parties:
   i. ownership: alienation of sub-ownership rights (e.g. strata)
      - these rights can be reincorporated into the body of the parent land when both the parent ownership and sub-ownership are owned by the same party.
   ii. non-ownership: alienation of non-ownership rights (e.g. lease, security (mortgage), easement/servitude, etc.)
      - the alienated rights are equivalent to sticks in the '*bundle of sticks*' model of land;
      - non-ownership rights can be discharged by the new rights' holder; and:
      - right holding parties may have limited powers associated with these rights.

Land based and Rights' based transactional primitives tend to be conflated with a Party based transaction primitive in a deed. For example, when land is split using a Land based transaction primitive it is common for one of the cadastral units to be transferred (sold) to a new party using the Party based transaction primitive. In addition, executive powers are commonly held by the jurisdiction which enables them to grant duty imposing rights (Public Law Restrictions). These tend to be overriding interests which are recorded off-register and held (enforced) by functionaries of the jurisdiction.

3.2 Detailed Classification of Rights, Restrictions and Responsibilities (RRRs)

Rights to land take many forms and shapes between different jurisdictions. When we limit ourselves first to Private Law we can identify jurisdictions where one land holder has the full array of private rights; constituting a very strong right that is often called ownership or freehold. According to the Roman Law three distinguishable components are presented that make up this right:

1. Usus (use) - Right to use a property including its transformation and even destruction;
2. Fructus (enjoy) - Right to receive income by contracting with non-owners;
3. Abusus (dispose) - Right to permanently transfer the ownership right to another.

The owner or freeholder can choose to use the land herself or let another use it but enjoy income from it. The right that the other then receives can be a short-lived use agreement (rent) or constitute another rather strong right like long lease or leasehold (often with a set period of e.g. 40 or 99 years). The latter type of land right in most jurisdictions is also registrable. In such a case we already see that two land holders each have a land right pertaining to the same land parcel; a situation that the model incorporated from the start.

When the holder of rights in land (normally an owner but often also leaseholder) chooses to transfer those rights to a third party the land registry will be updated by replacing the name(s) of the original land holder with the one(s) that acquired the land right. In most jurisdictions special cases of '*abusus*' are to put one's land right up as collateral, e.g. a mortgage or hypothec. Here the original land holder retains possession, but the money lender will also be registered as holding the mortgage. This can effectively block the original land holder from further disposal of the land until the landowner has fulfilled their financial obligations to the money lender.

The complexity of the array of private rights linked to the same land parcel in many jurisdictions is much larger than the three mentioned above. In traditional or customary law-based systems, land rights (such as grazing, picking fruit, cutting down trees) are often split between different people or groups. Also, seasonal access rights are not uncommon. These rights are commonly called '*secondary rights*' and may not be required to be included in the land registry. This means that after formal registration, enforcement of these rights declines and then usually disappears altogether.

In no jurisdiction are the Private Law land rights absolute, not even for owners or freeholders. In the general interest the government always has or retains several powers. This includes 'to take for public use' (eminent domain, compulsory purchase, expropriation) which is key for ongoing development in the public interest. Powers 'to control use' are also reserved. However, the extent to which the government can limit, guide, or forbid certain kinds of use differs significantly (see below on the section describing Public Law Restrictions). Land taxation is another near universal set of powers that a jurisdiction reserves.

So far, we have primarily described how parties can hold rights that relate to land. This is the implicit relationship conveyed by a LADM party-right-land triple. However, there is also the implied relationship between an owner of land and a party who holds a secondary right over

the same land. According to Williamson et al. (2010) '*A right is not a relationship between an owner and land. It is a relationship between an owner and others in relation to land, backed up by the state in the case of legal rights. This duality of owners and others is also present in restrictions and responsibilities affecting landowners and users. Each restriction/responsibility involves a duality that imposes obligations on owners in relation to the land for the benefit of others.*' This aligns with Hohfeldian rights theory (Hohfeld, 1917) who described rights in terms of their associated privileges, claims, powers, and immunities. Hence, relationships between owning and non-owning parties are framed through the land itself.

Each jurisdiction creates a set of ownership and non-ownership rights which are recognised by the state and are legally formalised. This is numerus clauses: the limited number of basic land and property rights recognised by the jurisdiction. The jurisdiction can reserve some of these rights either directly as alienated ownership (reserved property: e.g. minerals and petrochemicals) or indirectly by providing itself with powers to alienate non-ownership rights (which become a Hohfeldian 'duty' and a restrictive overriding interest to all affected owners). These reserved rights, in common with ownership in general, are rights in rem - the rights are good against the world; there is no need to enumerate the duty owing parties for the rights to have effect.

The remaining rights are bundled into a conventional property ownership concept. This concept provides immunities and powers to a right holder. The most important immunity for an owner is 'nemo dat quod non habet' (you cannot sell what you do not own). Powers allow the holder to vary or discharge rights. Owners can vary their ownership in terms of a party, right or land dimension, as shown and explained above in and under Figure 1. These changes that owners can initiate, are undertaken through the national conveyancing process supported by legal instruments (such as deeds) which legally frame the transactional change. The transactional legal instruments will be submitted for registration in the national Land Register.

This has resulted in a number of different models to represent rights and the relationship between rights. Some jurisdictions start from looking at full ownership of land by the landowner, with other rights and powers being chopped away from that 'solid block'. Another way of looking at this sees these different rights and powers as sticks that make up the full bundle; with different (sets of) sticks being held by different land holders. Whatever approach is followed, the LADM implementation should be able to allow meaningful registration to occur. Any model needs to ensure that new rights can be added to the framework. With the increasing impact of climate change and measures taken to mitigate carbon emissions, the number of fragments chopped off or sticks defined that are not with the landowner are increasing.

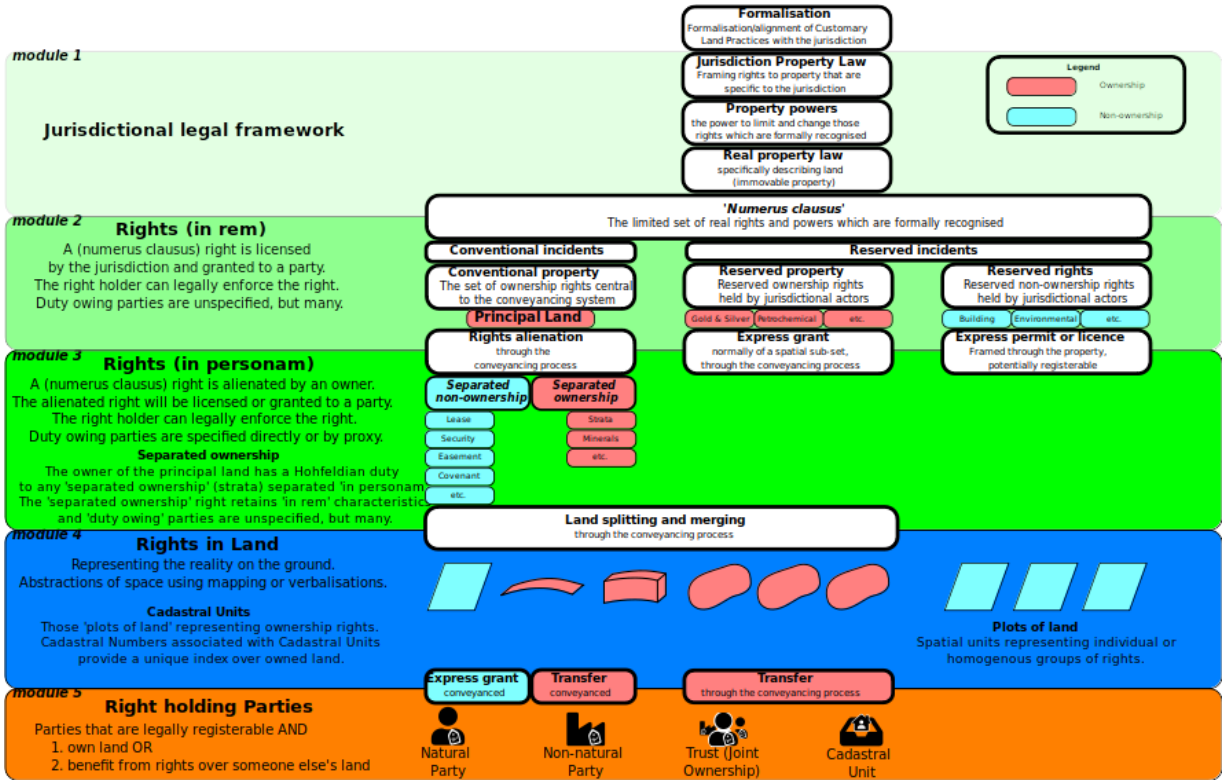

Figure 2. The formalisation of immovable real rights (https://commons.wikimedia.org/wiki/File:The_formalisation_of_immovable_real_rights.svg)

3.3 Modelling restrictions as rights?

So far, the paper focused almost exclusively on the nature of rights and right holders, while the other two core LADM concepts, were not discussed: restrictions and responsibilities. This is principally because restrictions and responsibilities are, in general, rights. They are rights which encumber owned land. As discussed above, their implications are articulated through the duality of the rights relationships between the right holder and the landowner through land (as an owed duty). Hence, when viewed from the perspective of the landowner the encumbering rights held by third parties are either a responsibility or a restriction. LADM (ISO, 2012) defines restrictions and responsibilities as follows:

1. A restriction (clause 4.1.19) is defined as '*formal or informal obligation to refrain from doing something*'.
2. A responsibility (clause 4.1.18) is defined as '*formal or informal obligation to do something*'.

A restriction can conceptually be represented as a right which is exclusively held by a third-party and therefore cannot be enjoyed by the landowner (or in the bundle of rights approach, as one of the sticks not allocated to the landowner but held by another right holder). In order to enjoy the right, the landowner must seek the permission of the right holder. When such rights are reserved by a jurisdiction and enforced by a public body, they are not normally recorded on

the Land Register. However, they still have legal effect and are, therefore, described as overriding interests. The public body may allow a landowner to enjoy the right by granting a time limited permit.

A responsibility can conceptually be represented as a right which is granted to a third-party in a non-exclusive manner. Negative rights allow a third party to enjoy rights over land owned by someone else. Positive rights obligate the landowner to perform some activity to benefit a third party (e.g. pay rent) or the property itself (e.g. maintain drainage).

Restrictions and responsibilities can both be between two private landowners (one's land is benefitting from it, the other's land is burdened by it), but there is an increasing amount of such restrictions or responsibilities that serve the public interest (incl. nature and climate). Also, their impact on the land market is increasing and such PLRs are 'registered', often in separate registers, which can be (and in some jurisdictions are) linked or integrated with the Land Registers. LADM is designed to support adding such RRs into the system. Although conceptually one could define an explicit right holder (e.g. the government, society, nature) of many of these types of restrictions and responsibilities, this is rarely done in the laws assigning the powers to establish these. LADM does allow for such 'party'-less RRRs.

Due to the gradual increase of PLRs in number and complexity, their spatial representation calls for layered and/or 3-dimensional representations. Following the new fields of the vertical exploitation of land, PLRs impose significant impact on ownership rights and land management, 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 socio-economic characteristics), and classifying them to be registered in national land registration systems (Kitsakis et al., 2019). Following the trend of the vertical exploitation of land, their modelling and registration has been investigated by a wide spectrum of researchers world-wide (Zevenbergen and de Jong, 2002; Givord, 2012; Kitsakis and Dimopoulou, 2016; Kitsakis et al., 2019; Kitsakis et al., 2021a; Kitsakis et al., 2021b) as it is expected that many jurisdictions will implement real right restrictions as part of a suite of approaches to reduce the impacts of climate change and other types of State-imposed restrictions on land exploitation. Hence, as LADM Edition II will explicitly model RRRs attached on land, marine and air parcels, infrastructure objects, utilities, etc., as well as processes, the current LADM legal profiles shall be able to efficiently support all the above.

3.4 Refinement via Semantically Rich Code List

In order to provide the refined legal support in LADM, valuable contribution can be provided by structured code lists (e.g. LA_RightType, LA_RestrictionType, etc.). This was already concluded in an initial analysis by Paasch et al. 2015. In the context of an INTERLIS prototype the code lists were further explored by Kalogianni et al. (2017). This included the provision for hierarchical code list values (parent-child relationships between values), short code list values

and longer descriptions of code list values, and versioned code list values in order to support possible changes.

In a more general OGC context the importance of code lists, managing their values, providing semantic support, and several other related aspects was further described by Stubkjær et al. 2018. The next step is to include a more explicit proposal for the formalisation of code lists and their values in the revision of ISO 19152 Land Administration Domain Model. Kara et al. 2022 propose a metamodel for the semantic description of code list values. The metamodel makes primary use of the Simple Knowledge Organisation System (SKOS) notation which serves to represent LADM code lists. In this metamodel for code list values a skos:Concept is used with a name for each code list value, represented by a skos:prefLabel and a unique skos:identifier. In order to provide more functionality, this metamodel is extended with the earlier mentioned support for versioning (dct:hasVersion, dct:created and dct:modified for the value definition), other than hierarchical relationships between concepts (e.g. skos:CloseMatch, skos:RelatedMatch,...), code list textual definition with source reference (skos:definition). This approach also supports relating country profile code list values to the LADM code list values. As describing an approach by a metamodel is rather abstract, the metamodel is illustrated with a few examples'code lists; therefore at the Annex one small example to define two code list values for LA_MortgageType (more details in Kara et al. 2022) is presented.

4. CONCLUSIONS AND DISCUSSION

The legal package of LADM Edition I was not without confusion. Taking advantage of the initial work regarding the legal aspects of the LADM Edition I and the questions that has been raised regarding the level of support that provides to various land registration systems, this paper discusses and tries to resolve issues such as modelling of deed/title registration, relation between rights and restrictions, as well as Public Law Restrictions.

Aiming at keeping the LADM class diagrams as simple as possible, generic terms of (optional) links between (sub) classes are used, allowing for exchange between systems. This does also allow flexibility to deal with a large diversity of jurisdictional choices on the exact numerus clauses of land rights and other land relationships. However, it also makes the implementation in certain jurisdictions not always appearing complete and natural, as sometimes the dominant party-right-land combinations are not directly visible in the class diagram. But adding such cases into the overall standard makes that more biased to the jurisdictions included and may cause even more concern in other jurisdictions.

As described in the previous sections, indexing is critical: the ability to unambiguously identify the party-right-land triples which are to change are critical in deeds' register. LADM could be extended to recognise the relationship between state and change elements and how these are articulated within a single deed. Hence, while it is recognised that party-right-land indexing is important, deed and title indexing is of equal importance.

To increase and make explicit the support of LADM at the various land registration systems, it is proposed to add an extra attribute at the Administrative Package of the standard to supporting the need to go back to the 'good root of title; in deed systems. What is more, in order to include explicit links between deeds (chain of source documents), another attribute will be added to provide the link between their IDs. This chain is now implicit and can be obtained by query or in view at a database table (i.e. select for one parcel over time all attached RRRs and their admin sources, and sort by time of admin source).

Furthermore, with respect to refining options of LADM Edition II legal functionality and including cross country/jurisdiction specific support and interoperability, the use of an extensible code list is proposed with more explicit meaning attached to the code list values via semantic technologies. This is also adding supplementary structure between the concepts of code list values in the model.

Lastly, the increasing amount and importance of Public Law Restrictions (PLRs) in the context of being tools for social change, also addressing climate change, calls for attention. Therefore, modelling alternatives have been proposed at the literature to explicitly define PLRs with LADM (Editions I and II) covering both their legal and spatial aspects, as a part of an ongoing interest and research work, as presented in the previous sections.

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ANNEX Code list values for LA_MortgageType, example from (Kara et al. 2022)

```
prefix con: <http://www.isoladm.org/model/con/>
prefix country: <http://www.isoladm.org/model/country/>
prefix dct: <http://purl.org/dc/terms/>
prefix ladm: <http://www.isoladm.org/>
prefix prov: <http://www.w3.org/ns/prov#>
prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
prefix skos: <http://www.w3.org/2004/02/skos/core#>
prefix scheme: <http://www.isoladm.org/model/scheme/>
prefix xsd: <http://www.w3.org/2001/XMLSchema#>

## LADM 'Core' Code List Values for LA_MortgageType
con:LA_linear
  a skos:Concept;
  skos:inScheme scheme:LA_MortgageType;
  skos:identifier "http://www.isoladm.org/model/con/la_linear"^^xsd:anyURI;
  prov:wasAttributedTo country:LA;
  skos:prefLabel "linear"@en;
  dct:created "01-01-2022"^^xsd:date;
  dct:hasVersion "1";
  skos:definition "The type of  mortgage with the gradually decreasing
periodic payment"@en;
  rdfs:isDefinedBy
"http://www.examplesource.com/mortgagedefinition/linear"^^xsd:anyURI .

con:LA_levelPayment
  a skos:Concept;
  skos:inScheme scheme:LA_MortgageType;
  skos:identifier
"http://www.isoladm.org/model/con/la_levelPayment"^^xsd:anyURI;
  prov:wasAttributedTo country:LA;
  skos:prefLabel "level payment"@en;
  dct:created "01-01-2022"^^xsd:date;
  dct:hasVersion "1";
  skos:definition "A level payment mortgage is a type of mortgage that
requires the same payment each month or payment period"@en;
  rdfs:isDefinedBy
"http://www.examplesource.com/mortgagedefinition/levelpayment"^^xsd:anyURI
.

con:LA_microcredit
  a skos:Concept;
  skos:inScheme scheme:LA_MortgageType;
  skos:identifier
"http://www.isoladm.org/model/con/la_microcredit"^^xsd:anyURI;
  prov:wasAttributedTo country:LA;
  skos:prefLabel "microcredit"@en;
  dct:created "01-01-2022"^^xsd:date;
  dct:hasVersion "1";
  skos:definition "Microcredit, a means of extending credit, usually in the
form of small loans with no collateral"@en;
  rdfs:isDefinedBy
"http://www.examplesource.com/mortgagedefinition/microcredit"^^xsd:anyURI.
```