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Further modelling of LADM's rights, restrictions and responsibilities (RRRs)

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ABSTRACT

This paper proposes a more detailed classification of the legal part of the Land Administration Domain Model (LADM), ISO 19152 (i.e. interests in land), than described in the current standard by further developing the LADM's 'right', 'restriction' and 'responsibility' (RRR) class and associated code lists.

Besides the more obvious formal right descriptions, this paper also deals with informal rights' descriptions as introduced in the Social Tenure Domain Model (STDM) as a foundation for further LADM development.

The authors base their research on the Legal Cadastral Domain Model, as developed by and described in the Ph.D. thesis of Paasch, which is used as a conceptual basis for adding an additional level to the LADM. Interests in land can be classified in this model as limiting or beneficial to real property ownership. The extended classification is further based on the paradigm that there are two major types of interest in land, privately agreed interests and regulations imposed by a public agency.

The incorporation of a specialized classification of RRRs in the LADM is of value for more inclusion of social tenure in (inter-)national land administration registers. The LADM allows national profiles to be added to the standard, however, such profiles are relevant within a country. These profiles are needed in cases where detailed data of interests in land have to be exchanged internationally. International data exchange requires maintenance of code tables representing the different RRRs in use within countries. OICRF has announced an initiative in support to this.

Introduction

The Land Administration Domain Model, LADM (ISO 19152:2012) (ISO, 2012), is developed by the International Standardization Organization, ISO, as a tool for structuring land administration worldwide. LADM provides a reference model for development and refinement of efficient and effective land administration systems and as enabler for communication based on the shared vocabulary. Development and maintenance of international standards are a normal procedure within ISO. This procedure includes a review at least 3 years after publication and every 5 years after the first review by all the ISO member bodies. The LADM is managed by ISO's Technical Committee 211 (TC211) on Geographic Information/Geomatics.

This paper provides input to future LADM development. The aim is to introduce an extended classification of the LADM class of rights, restrictions and responsibilities (RRRs). The research is based on proposed extended classifications of the LADM's RRR class as presented at the FIG Working Week in Nigeria (Paasch et al., 2013a) and at the LADM workshop in Kuala Lumpur, Malaysia, in 2013 (Paasch et al., 2013b). Those papers propose to add more specialized classes (respectively LA_PrivateRight, etc. and LA_CustomaryRight, etc.) to the class diagrams of LADM with base class LA_Right (and same

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for LA_Restriction and LA_Responsibility). Further, the contents of the various code lists (with types of rights, etc.) should be better defined. In LADM, Unified Modeling Language (UML) class diagrams are used, showing object classes, their attributes, operations, constraints, and the associations among the classes. Code lists are used for attribute types providing an informative open enumeration with predetermined values.

This paper initiates a discussion on possible aspects of maintenance of customary and informal rights, restrictions and responsibilities in the legal refinement of the next "development round" of the standard.

In Paasch et al. (2013a, 2013b) and Paasch (2012) further detailed modelling of the LADM's administrative package is based on the Legal Cadastral Domain Model. Paasch et al. (2013b) highlight that customary and informal rights have not been investigated in this extension, but can already be represented in the LADM. The Social Tenure Domain Model (Augustinus et al., 2006; Lemmen et al., 2007; FIG, 2010) can be used in the next LADM edition for inclusion of informal RRRs. Augustinus (2010) explains that it should be possible for all citizens (including the poor) to be included in some form of land administration system, thereby improving the land management capacity of the industry, as well as addressing upcoming challenges such as climate change. This should contribute to poverty reduction, as the land rights and claims of the poor are brought into formal systems over time.

Hespanha et al. (2013) state that flexibility is needed in relation to recordation of interests in land. This concerns the type of spatial units used, the inclusion of customary and informal rights, the data acquisition methodologies and the accuracy of boundary delineation. A more detailed alignment with the proposals as in Paasch et al. (2013a) is needed where customary and informal rights are concerned. Instead of adding more and more classes, the authors conclude that in most situations it is more appropriate to add more code list values, defining the various types of RRRs. These types can have a complicated structure, e.g. hierarchy. Semantic technology is required for modelling these types, as they form an ontology. This can be depicted in a diagram showing the relationships between the various legal concepts, i.e. types of rights, etc.

In this paper first the RRRs are discussed in a broad sense in "RRRs: formal, customary and informal in the LADM" section. Then the proposed RRR extensions of LADM are introduced in "Extensions to modelling of RRRs in LADM" section; including a discussion on informal rights in land. Section "Using, structuring and maintaining LADM code lists" describes the use, structure and maintenance of LADM code lists, provides an international outlook and introduces an ontology of interests in land. The paper closes with conclusions and a recommendation.

RRRs: formal, customary and informal in the LADM

Rights, restrictions and responsibilities are related to land ownership and other interests in land. Land tenure is the relationship, whether legally or customarily defined, among people, as individuals or groups, with respect to land (FAO, 2002, p. 7). It has been claimed that ownership is the greatest possible interest in a thing which a mature system of law recognizes (Honoré, 1987). According to the authors' knowledge an international definition of ownership does not exist. The working definition used in this paper is that the concept of ownership consists of a combination of rights: the owner's right to use the real property; the owner's right to manage and exclude others from the property; and the owner's right to add value or to receive financial income from the property and the right to transfer the property by sale or donation. The owner executes the rights until he/she decides (or is forced to, by e.g. the State or a municipality) to part with the property.

The right of ownership does not mean that the owner is forced to execute all use rights him- or herself. The rights may be individually transferred by the owner to other parties with an interest in the land for a shorter or longer period of time due to legislation, e.g. regulating the access and use of land, and thereby limiting the owner's own actual use rights on his/her property. Furthermore, ownership may be restricted by public interests in land. The State, municipality or other governments and/or administrative public institutions may apply regulations and mandate the owner or others using the land to perform certain duties, e.g. to keep buildings and other constructions in good order.

It should be recognized that RRRs are not only about statutory tenure; customary tenure is also included. Examples showing instance level diagrams can be seen in Fig. 1, illustrating customary tenure, and Fig. 2, illustrating seasonal tribal grazing rights (servitude) on a private owned real property.

Tenure is often categorized as follows (FAO, 2002):

- *'Private: the assignment of rights to a private party who may be an individual, a married couple, a group of people, or a corporate body such as a commercial entity or non-profit organization. For example, within a community, individual families may have exclusive rights to residential parcels, agricultural parcels and certain trees. Other members of the community can be excluded from using these resources without the consent of those who hold the rights.*
- *Communal: a right of commons may exist within a community where each member has a right to use independently the holdings of the community. For example, members of a community may have the right to graze cattle on a common pasture.*
- *Open access: specific rights are not assigned to anyone and no-one can be excluded. This typically includes marine tenure where access to the high seas is generally open to anyone; it may include rangelands, forests, etc., where there may be free access to the resources for all. (An important difference between open access and communal systems is that under a communal system non-members of the community are excluded from using the common areas.)*
- *State: property rights are assigned to some authority in the public sector. For example, in some countries, forest lands may fall under the mandate of the state, whether at a central or decentralized level of government'.*

In practice, most forms of holdings may be found within a given society, for example, common grazing rights, private residential and agricultural holdings, and state ownership of forests. Customary tenure typically includes communal rights to pastures and exclusive private rights to agricultural and residential parcels. In some countries, formally recognized rights to such customary lands are vested in the nation state or the President "in trust" for the citizens (FAO, 2002). In broad terms, land tenure rights are often classified as "formal" or "informal" (FAO, 2002). Formal property rights may be regarded as those that are explicitly acknowledged by the state and which may be protected using legal means. Informal property rights are those that lack official recognition and protection. In some cases, informal property rights are illegal, i.e., held in direct violation of the law. An extreme case is when squatters occupy a site in contravention of an eviction notice (FAO, 2002). The need for inclusion of customary land tenure into land administration is underlined in many documents; e.g. in the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (FAO, 2012). In UN-Habitat (2003, 2008) the various types of land rights are viewed as existing along a continuum, with some settlements being more consistent with law than others. This view makes it possible to include the people with the weakest forms of tenures in

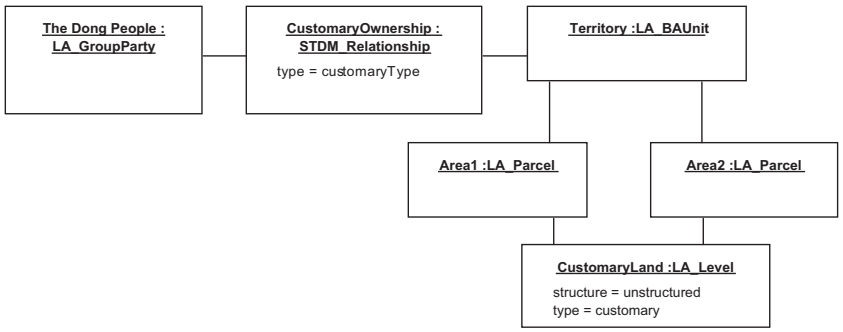

Fig. 1. Instance level diagram C.2 from ISO (2012).

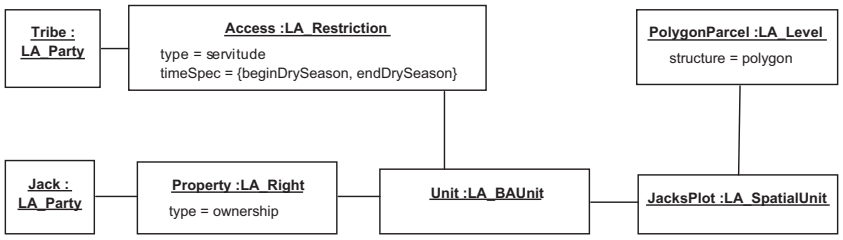

Fig. 2. Instance level diagram C.16 from ISO (2012).

the system of legal access to land. Alden Willy (2012, p. 1) provides the following definition and description of customary tenure:

> 'Customary land tenure refers to the systems that most rural African communities operate to express and order ownership, possession, and access, and to regulate use and transfer. Unlike introduced landholding regimes, the norms of customary tenure derive from and are sustained by the community itself rather than the state or state law (statutory land tenure). Although the rules which a particular local community follows are known as customary law, they are rarely binding beyond that community. Customary land tenure is as much a social system as a legal code and from the former obtains its enormous resilience, continuity, and flexibility. Of critical importance to modern customary landholders is how far national law supports the land rights it delivers and the norms operated to sustain these'.

The authors are aware that the term common is ambiguous as it can have two interpretations: "Normal, basic, standard" and "shared, joint." "Common" is an accepted term in land management for properties owned by one or more other properties, see e.g. Elinor Ostrom's Governing the Commons (Ostrom, 1990). In this paper "Common" is used for properties collectively owned by other properties (often adjacent), as described below.

In the section, Scope, of the LADM (ISO, 2012, clause 1) it is highlighted (amongst other) that the standard 'provides a terminology for land administration, based on various national and international systems, that is as simple as possible in order to be useful in practice. The terminology allows a shared description of different formal or informal practices and procedures in various jurisdictions'.

Those 'informal practises' may concern customary and informal tenures, as can be recognized in the definitions of *basic administrative unit*, *level* and *right* in clause 4 of the standard:

- The basic administrative unit (BAUnit) is defined 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, clause 4.1.2),
- The level class[4] is defined as a '*set of spatial units, with a geometric, and/or topological, and/or thematic coherence*' (ISO, 2012, clause 4.1.11). A level example given in the standard is '*one level of spatial units for an urban cadastre and another for spatial units for a rural cadastre*', another example given is '*one level with point based spatial units, a second level with line based spatial units, and a third level with polygon based spatial units*'. Many more examples of the use of levels are possible, of which two are mentioned in the standard.
- Right is defined as an '*action, activity or class of actions that a system participant may perform on or using an associated resource*' (ISO, 2012, clause 4.1.20).[5] It should be noted here that:
  - *a right may provide a formal or informal entitlement to own or do something.*
  - *the International Standard deals with real rights and personal rights. Real rights are rights over or in respect of spatial units (e.g. ownership, or usufruct). Personal rights are rights that parties have (e.g. fishing rights, grazing rights, or use rights).*
  - *rights may be overlapping, or may be in disagreement.*
  - examples of rights are: *ownership right, [. . .] apartment right, tenancy right, possessions, customary right, [. . .] or informal right.*

Further it is highlighted in the standard (ISO, 2012, clause 5.4) that the main classes of the LADM Administrative Package are the basic classes LA_RRR and LA_BAUnit. LA_RRR is an abstract class with three specialization classes:

1. *LA_Right, with rights as instances. Rights are primarily in the domain of private or customary law. Ownership rights are generally based on (national) legislation, and code lists in the LADM are in support of this (ISO, 2012, Annex J).*
2. *LA_Restriction, with restrictions as instances. Restrictions usually "run with the land", meaning that they remain valid, even when*

[4] Levels are in fact layers in GIS. The term "layer" is already in use within ISO terminology.

[5] The definition is taken from ISO 19132:2007 (ISO, 2007, clause 4.38).

the right to the land is transferred after the right was created (and registered). A mortgage, an instance of class LA_Mortgage, is a special restriction of the ownership right. It concerns the conveyance of a property[6] by a debtor to a creditor, as a security for a financial loan, with the condition that the property is returned, when the loan is paid off.

3. *LA_Responsibility, with responsibilities as instances.*

Code lists for Administrative Package in the LADM (ISO, 2012, clause 6.4.9) include a code list for *LA_RightType: the LA_RightType code list includes all the various right types, such as ownership, customary or lease, used in a specific land administration profile implementation. The LA_RightType code list is required to implement the LA_Right class. A code list shall provide a complete list of all codes with a name and description*.

In LADM based applications extended code lists are included already; see for example FAO (2014). Further there are some specific classes which are relevant for common, customary and/or communal lands. These classes are LA_GroupParty and LA_Party:

- LA_GroupParty: *any number of parties, together forming a distinct entity, with each party registered[7]. A group party may be a party member of another group party. An example is a partnership (with each partner registered as a party), or two tribes (with each tribe registered as a party).*
- LA_Party: *person or organization that plays a role in a rights transaction. In order to be registered as a party, not all members need to be identified and registered individually. A basic administrative unit may be a party because it may hold a right of e.g. easement. An organization may be: a company, a municipality, the state, a tribe, a farmer cooperation, or a church community (with each organization represented by a delegate: a director, chief, CEO, etc.).*

LA_GroupParty and LA_Party combined with LA_RRR and LA_BAUnit are only the most relevant functionalities to model customary and informal land rights based on LADM. Examples are in Annex C of ISO (2012). Some selected examples are, all from ISO (2012):

- Customary right (C.2): Spatial units (Area 1:LA_Parcel, and Area 2:LA_Parcel), with a customary right (STDM_Relationship) from the Dong people.
- Pastoralists (C.16): A group party (pastoralists) with an access right for a certain period of time.

Extensions to modelling of RRRs in LADM

Relations in land use belong to the realms of private law and public law. 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. This, basic, classification of private and public law is used as a starting point for describing land use and an input to further develop the LADM legal profiles. A legal profile is a profile with elements from the Administrative Package, and from the Party Package.

[6] Note: Not all countries see it as such; it is a limited right, not necessarily a transfer to creditor. This should be included as separate types in Edition II of the Standard.

[7] It should be noted that this means if there is a group, but no need to register the members, then this is a direct instance of a normal LA_Party (and not LA_GroupParty).

Extended legal profiles, private law

According to Paasch et al. (2013a) the top level, and abstract, classes for the realm of private law are proposed to be included in the LADM LA_PrivateRight, LA_PrivateRestriction and LA_PrivateResponsibility. Those are specializations of respectively LA_Right, LA_Restriction and LA_Responsibility, which should also be made abstract. In this section, the possible RRR model refinement is based on class diagrams. In the next section an alternative will be introduced: modelling the various types of RRRs via semantic technologies (defining the contents of the involved code lists). Interests belonging to the realm of private law can be divided into the following types of relations: *Common, Property to Property, Party (Person) to Property* and *Latent* (Paasch, 2012).

The *Common* relation is a real property to land relation executed in land legally attached to two or more (real) properties. Owners of the properties (in the LADM termed Basic Administrative Unit, LA_BAUnit) execute co-ownership rights to the land concerned (Paasch, 2012). The relation is covered in the LADM by allowing a LA_BAUnit to be a Party owning a share in another LA_BAUnit. A *Common* ownership right may also be beneficial for the real properties having a share in the common property as it allows the use and profit of the land not to be accessible to others than the shareholder properties. However, the right can also at the same time be seen as a restriction or responsibility to ownership since the "participating" real properties may have to contribute to the maintenance and management of the legally attached land. Note that this "restriction aspect" may be considered as a mirror of the beneficial side in the model. The *Common* relation can therefore execute a right, restriction or generate a responsibility, which can be termed LA_CommonRight, LA_CommonRestriction or LA_CommonResponsibility classes, depending on the actual content of the relation. See Figs. 3–5.

The *Property to property* relation is executed by the owner of a real property (#1) to another real property (#2), due to his/her ownership, i.e. the right is attached to the property #1. The relation differs from the *Common* relations described above being an (joint) ownership relation, whereas a *Property to property* relation describes other interests between real properties (Paasch, 2012). Property to property rights are beneficial to ownership for the dominant real property (#1) as they allow the use and benefits of the serving real property (#2). However, the right can also at the same time be seen as a limitation since the participating real properties (#1 and potentially also others) have to contribute to the maintenance and management of the servant real property (#2) and the facilities they use on the property (#2). This "restriction aspect" may be considered as a mirror to the beneficial side in the model. The property to property relation can execute a right, restriction or generate a responsibility, which thus exists as a *property to property right*, *property to property restriction* or *property to property responsibility*, depending on the actual content of the relation and modelled with the LA_PropertyToPropertyRight, LA_PropertyToPropertyRestriction or LA_PropertyToPropertyResponsibility relations. See Figs. 3–5.

The *Party (Person) to property* relation contains interests executed by a party to use, harvest the fruits/material of, rent or lease the real property in whole or in part. Party to property right types can be beneficial by the income of a rent to the property owner by allowing someone else to use one's real property or demanding some actions to be performed (Paasch, 2012). This "restriction aspect" may also be considered as a mirror to the beneficial side in the model. The party (person) to property relation can execute a right, restriction or generate a responsibility, which can be placed in the LA_PartyToPropertyRight, LA_PartyToPropertyRestriction or LA_PartyToPropertyResponsibility relations, depending on the actual content of the relation. See Figs. 3–5.

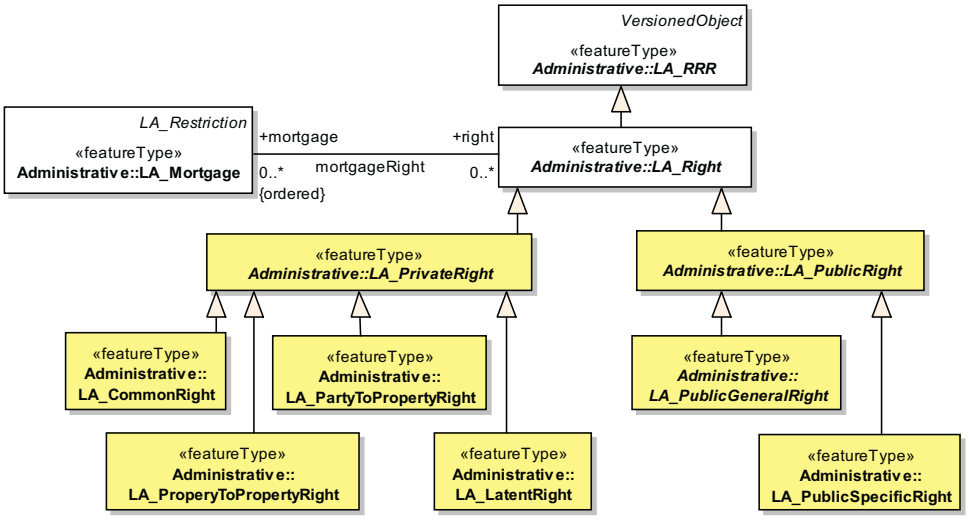

Fig. 3. Specialization of the LADM's LA_Right legal profile. Extended profile for privately and publicly imposed rights.

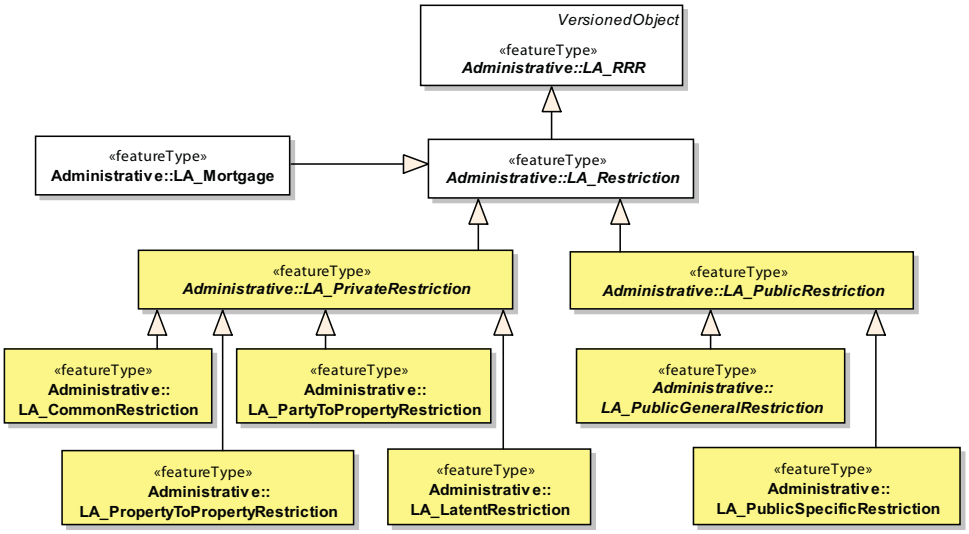

Fig. 4. Specialization of the LADM's LA_Restriction legal profile. Extended profile for privately and publicly imposed restrictions.

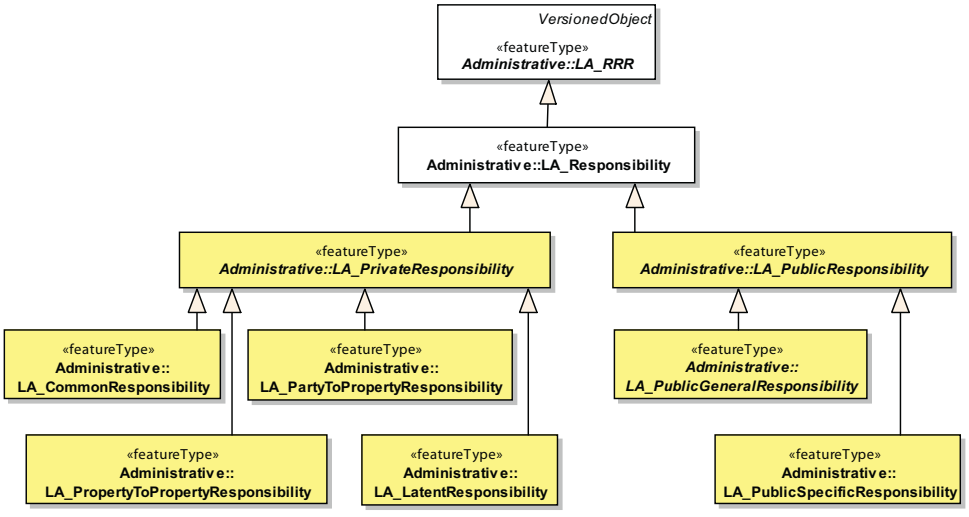

Fig. 5. Specialization of the LADM's LA_Responsibility legal profile. Extended profile for privately and publicly imposed responsibilities.

The *Latent right* relation contains relations not yet executed on a real property. One example is a mining concession which may be granted years before it is used, i.e. the right is latent until it is activated (Paasch, 2012). When executed, the relation will belong to one of the other RRR sub-classes. The latent relation may therefore execute a right, restriction or generate a responsibility, which thus is creating a LA_LatentRight, LA_LatentRestriction or LA_LatentResponsibility, depending on the actual content of the relation itself. See Figs. 3–5.

Extended legal profiles, public law

The top level, and abstract, classes for the realm of public law are LA_PublicRight, LA_PublicRestriction and LA_PublicResponsibility. They are specializations of respectively LA_Right, LA_Restriction and LA_Responsibility. Interests in land belonging to the realm of public law can be classified as belonging to three groups according to the functions they execute: (1) Public regulations creating a restriction for the real property owner to perform certain activities on his/her real property (LA_PublicRestriction); (2) Public regulations creating a responsibility for the real property owner to perform certain activities on his/her real property (LA_PublicResponsibility); (3) Public regulations creating a right (i.e. a permission/dispensation/concession) allowing the real property owner to (voluntarily) conduct certain activities on his/her property (LA_PublicRight). Any permission is an interaction with a restriction or responsibility at instance level; e.g. a permission to build within an otherwise restricted coastal non-building zone. There would be no need for any permission without one of these limiting regulations. This classification is in accordance with the LADM's RRR classification.

The public RRRs can be divided into general and specific types. Public general restrictions and responsibilities are regulations prohibiting or mandating activities on certain types of property at a general or specific level. The term specific is used for a limited number of properties, in opposition to general, which is affecting "all" real property. The public general RRRs could be modelled at class level. This implies that the corresponding classes (LA_PublicGeneralRight, LA_PublicGeneralRestriction and LA_PublicGeneralResponsibility) should be modelled as abstract classes. The code lists for these public general RRR classes are then considered as explicit representations of the relevant generic public legal items. This is in contrast to the public specific RRRs, which need to be represented at instance level, as they are RRRs on individual properties. An example of a specific RRR is the obtained building permit for building activities for a specific property located in an urban area. An example of a general RRR is the obligation to perform activities on certain types of real property, at a general level, e.g. the maintenance of production on agricultural land, which may not be withdrawn from agricultural production without prior notification/permission. The Public General RRRs are modelled in the classes LA_PublicGeneralRight, LA_PublicGeneralRestriction and LA_PublicGeneralResponsibility. See Figs. 3–5.

The *Public specific right* class contains permissions, dispensations, commissions and other public grants on land use allowing the real property owner to conduct otherwise restricted activities and thereby "reclaiming" parts of his/her (latent) real property functions limited by a restriction. The grant is creating a right in relation to other owners affected by the regulation. An example is a permission to conduct environmentally hazardous activities within a specific area. Conceptually, rights can also be affecting certain types of property. These are placed in the *Public general right* class. These are not general permits valid for specific types of property as such, but the result of changes in legislation restoring parts of the owner's original property functions for a certain type of property. An example is a change in the Swedish Planning and Building Act to allow the construction of garden sheds or cabins measuring up to 15 m^2 without applying for a building permit instead of the previous limitation of 10 m^2.[8] The change in the legislation expanded the owner's right to use the real property, i.e. to build a larger shed than before. The Public Specific RRRs are modelled in the classes LA_PublicSpecificRight, LA_PublicSpecificRestriction and LA_PublicSpecificResponsibility. See Figs. 3–5.

Customary and informal extensions to RRRs

The basis for the inclusion of customary and informal tenure in LADM is in the comprehensive analyses in Augustinus et al. (2006). Existing land information systems have limitations because of the fact that informal and customary tenures cannot be included. Generally, the systems are not designed for this purpose (Fourie et al., 2002; FIG/COST, 2004; Lemmen et al., 2005; Augustinus et al., 2006; FIG, 2010; Enemark, 2012). Land tenure types, also in terms of the continuum of land rights (UN-Habitat, 2008), which are not based on the cadastral parcel and are not registered, require new forms of land administration systems. A social tenure approach is needed to fill the gap. This is done via the Social Tenure Domain Model (of which the UML model is included as informative Annex I of ISO 19152), 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, types of rights holders and all kinds of land and property objects/spatial units. The Social Tenure Domain Model (Augustinus et al., 2006; FIG, 2010; UN-Habitat, 2012) brings all required functionality together via a new way of thinking about land records, a software package based on free, widely used and open-source systems to record information about land, a method of collecting data about land and a way of using and disseminating information about land and property. Awareness of the broader concept is relevant here. It should be recognized that this functionality is supported by the LADM and it is even possible to classify non-authorised activities such as squatter. The model, however, does not favour such practices, but only provides a semantic framework to classify all sorts of land use relations activities, legal or illegal. If illegal activities are known, the government can take appropriate action.

In LADM a representation of overlapping tenures is possible. The LADM functionality as presented in "RRRs: formal, customary and informal in the LADM" section seems to be sufficient and specific classifications/types can be added by extending the various code lists of the relevant RRRs.

It should be noted that different approaches in modelling are possible. For example: "a group party (pastoralists) with an access right for a certain period of time" (ISO, 2012, Annex C) can be modelled as in instance level diagrams as presented in Figures C16 and C36 in ISO (2012). The latter figure represents a pastoralist group in Kenya which has two different kinds of rights: (1) a right to migration corridors (these can pass through farmers land), and (2) a right to access grazing areas for a longer period of time. An alternative is to use restrictions. Note: this would mean a "customary" restriction to a formal right. A "formal" restriction on an informal right is also possible, for example a restriction to build/live within 100 m from a highway or close to a river with danger for inundation, or an area with risk of land slides or other danger. Responsibilities can be to mandate the construction of protections for that (or to take measures for evacuation) – as far as reasonable. More innovative responsibilities could be in capturing water during the raining seasons.

[8] Swedish Planning and Building Act of 1987, Ch. 8, on January 1st 2008.

Hespanha et al. (2013) suggest including two more subclasses to LA_RRR: LA_CustomaryRight and LA_InformalRight (apart from LA_PublicRight and LAPrivateRight as introduced here above). Customary and informal rights are introduced into separate classes for separate tenures. As a consequence all tenures would get a subclass – this would introduce a lot of complexity. An alternative is to use a hierarchy in LA_Right, LA_Restriction and LA_Responsibility as based on the models presented in Figs. 3–5.

The basic principle in this approach is that customary and informal tenures are classified under the private realm (not under public realm or state lands – or open access).

There are also good possibilities in the LADM to identify different types of customary tenures in code lists. This will be further analysed in the next section (Fig. 6).

Using, structuring and maintaining LADM code lists

Adding refined formal or informal legal classes of the LADM could be a first step in the direction of international harmonization of the administrative/legal interests in land administration. Types of tenure should be well defined and public – to support land markets, to avoid land grabbing, to protect customary and informal land users. However, adding the proposed new classes makes the UML model more complex. An alternative would be not to add this at class level, but at content level of the relevant code lists with RRR types. Our proposed modelling rule in this paper is therefore: if 'things' are structurally different, i.e. different attributes/properties and/or different relationships, then adding a new class would be appropriate, otherwise it is better to consider adding code list values.

In the current version of the ISO LADM standard, there are sample values for the code lists LA_RightType, LA_RestrictionType, LA_ResponsibilityType, and LA_MortgageType; see Fig. 7. However, the code lists are in the informative part of the standard (and not in the normative part) and the values for the various types are just indicated by a single name (label) without definitions. For the first edition of the LADM standard, it was considered to be 'a bridge too far' to standardize the legal definitions of the various types of RRRs.[9] And it is ambitious indeed – compare for example EULIS, a European portal to land register information in various European countries each with their own real estate legislation. A definition in natural text (English), based on national legislation, is given for every type of right (restriction, etc.). However, the first step in direction of better international understanding is taken by giving the option to display comparable definitions from other countries. It is not claimed that these types of rights are equal, but first links are made between the legal concepts (RRR types) from different legislations and indicated with labels from languages.

UML code lists are just lists with values without any (hierarchical) structure. A hierarchically structured code list could be organized in a simple way. This means simple hierarchical encoding based on proposed classification of RRRs in Figs. 3–5. The first level organization is proposed to be 1_private or 2_public law. The second number in the code list value is then according to the hierarchy as presented in "Extensions to modelling of RRRs in LADM" section, for private law: Common (1_2_common), Property to Property (1_3_prop2prop), Party/Person to Property (1_4_party2prop) and Latent (1_5_latent) and for public law: General (2_1_general) and Specific (2_2_specific). The next level in the code list value is then further refining the actual type; e.g. for LA_RightType this could be 1_1_1_ownership, 1_1_2_lease, etc. Of course, this has to be organized in a manageable way: both creating initially agreed code list values and a mechanism to maintain this international list. This means the identifier of the code lists is included in the hierarchy. For refinement in country profiles this should then be followed by the ISO 3166-1 country code. ISO 3166 is the International Standard for country codes and codes for their subdivisions. The existing code list values of LA_Righttype, LA_Restrictiontype, LA_Responsibility remain where they are: ordered in sequence of 'registration'.

Having broader/narrower[10] terms is one approach which might be applied in LADM administrative code lists. Having more broad terms which are internationally agreed can then be refined by more specific terms (types of rights) at national level. Therefore, the values in the code lists get a hierarchal structure, which provides some semantics as terms higher in the hierarchy are internationally defined and agreed on. Adding more content, meaning and 'structure' to the current code lists for the Administrative Package would then be another step in the development of the LADM. Adding narrower terms would mean going down the hierarchy.

The principal ontology diagram in Fig. 8 illustrates the basic types of interests in land, water and air.

The focus of the diagram is on relations in land, not the parties executing the relations nor the geometrical description/spatial extension of the interests and shown as "agent" (i.e. owner, right holder, or otherwise having a relation to land) and "land". They are illustrated with white circles in the diagram. The ontology shows that there are two types of interests in land: formal interest and informal interest. They can be divided into publicly or privately executed interests. Customary interests are a type of informal interests in land. They are illustrated with grey circles. The interests in land can be further subdivided in rights (blue circle), restrictions (orange circle) and responsibilities (purple circle). Examples from the LADM code lists in Annex J of ISO (19152:2012) (ISO, 2012) are added to the diagram as examples of RRRs.

Semantic technologies

An approach similar to the EULIS glossary described earlier in this paper is taken by the European Environment Agency (EEA) in their General Multilingual Environmental Thesaurus (GEMET) which contains a lot of terms and definitions (in different languages), but now also structured, e.g. by explicitly indicating the broader/narrower or related term.[11] This approach is thus taking international harmonization one step further and might serve as an example for how we could provide definition of the types of rights (restrictions, etc.) in the context of land administration.

In this context it is relevant to consider the approach taken in the European INSPIRE directive (Lutz, 2010), both with respect to modelling (hierarchical structuring) the code list values and how to manage these. INSPIRE applies ISO 19135 'Procedures for item registration' (ISO, 2005) for managing and disseminating code lists. Beside definitions of code list (values) also identifiers of code list (values) are relevant. In order to be referenceable the identifiers in INSPIRE are all unique resource identifiers (URIs). This is true for the INSPIRE register itself,[12] for a specific code list; e.g. land use classification,[13] and for a specific code list value; e.g. 'farming infrastructure'.[14] The INSPIRE code list register contains besides a referenceable identifier and label (name) also the definition of the code list values; e.g. for 'farming infrastructure' the definition

[9] Personal experience from participating in the ISO drafting team producing the LADM.

[10] Narrow would mean going down the hierarchy.

[11] See www.eionet.europa.eu/gemet with concepts defined in natural language and terms (concept names) given in many languages, but also linking to broader or related terms.

[12] http://inspire.ec.europa.eu/codelist.

[13] http://inspire.ec.europa.eu/codelist/HILUCSValue.

[14] http://inspire.ec.europa.eu/codelist/HILUCSValue/1_1_2_FarmingInfrastructure/.

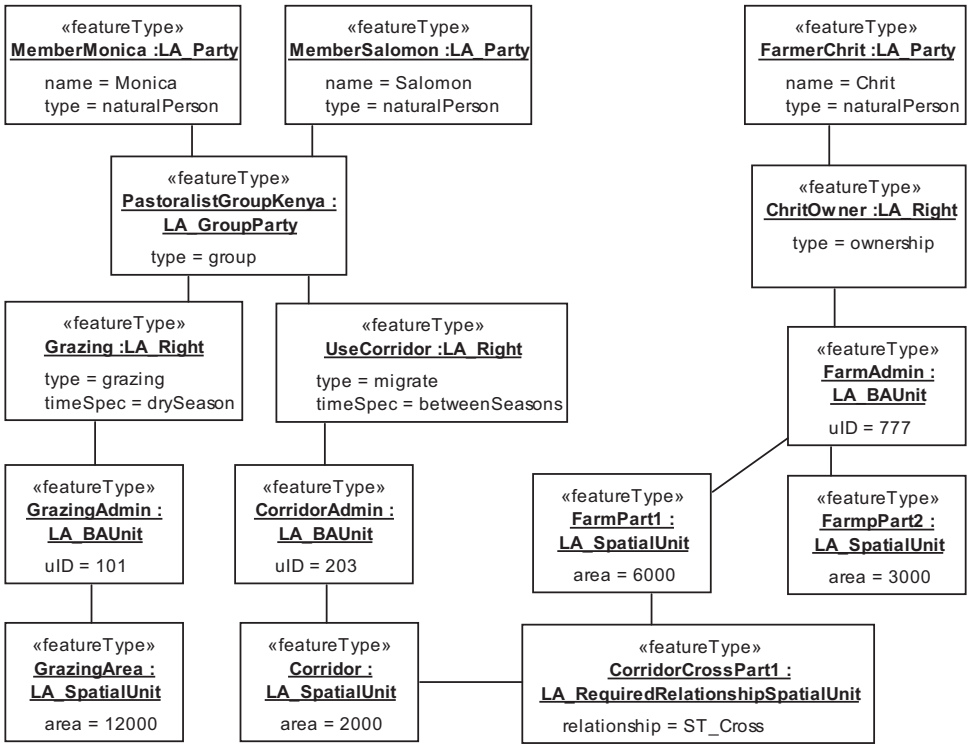

Fig. 6. Instance level diagram C.36 from ISO (2012).

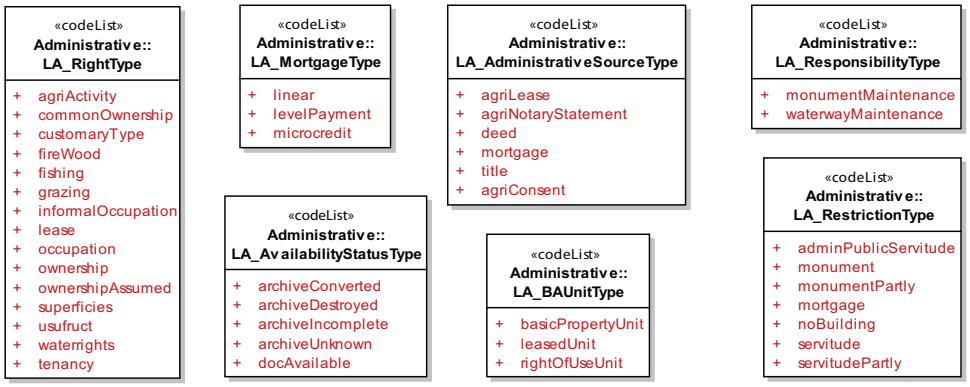

Fig. 7. LADM's current code lists for Administrative Package (ISO, 2012, Annex J.2).

is: 'Farm dwellings, animal husbandry infrastructure (animal dwellings and processing infrastructure linked to farms), manure storage and other farming infrastructure (e.g. buildings linked to plant handling and processing in farms).'

The above INSPIRE example of the code list for land use classification was not chosen by accident. To the code list value, e.g. 'farming infrastructure', an identifier is associated, of which the numbers in the last part of the identifier contains an encoding of the hierarchy; e.g. 1_1_2_FarmingInfrastructure (three levels deep because of the number hierarchy prefix). So, the parent is a code list value with identifier (last part), which is two levels deep: 1_1_Agriculture. This code list value in turn has parent with identifier (last part), which is one deep 1_PrimaryProduction. This is clearly a root value where any numbers in the identifier (last part) cannot be removed anymore. For LADM a similar pragmatic approach is proposed.

From the field of semantic technologies, a similar approach can be detected in RDF (resource description format) in an attempt to create more formal semantics. Specifically appropriate is the RDF vocabulary[15] SKOS (Simple Knowledge Organization System). SKOS Core (W3C, 2004a) has semantic relations between concepts (such as: broader, narrower, related) and mapping properties (such as: closeMatch, exactMatch, broadMatch narrowMatch, relatedMatch). In addition, SKOS Extensions (W3C, 2004b) are a set of terms extending the SKOS Core vocabulary to support some common features of knowledge organization systems, especially thesauri. Instead of just modelling a hierarchy SKOS has some more refined ways to describe relationship between terms: broaderGeneric, broaderInstantive, broaderPartitive, narrowerGeneric, narrowerInstantive, narrowerPartitive, relatedHasPart and relatedPartOf. An example of the use of SKOS is the 'Cadastre and Land Administration Thesaurus' (CaLAThe)[16] which is also LADM related/inspired. The content of this thesaurus covers the complete LADM, so not only code list values, but also the LADM classes which

[15] http://www.w3.org/2004/02/skos/extensions.rdf.
[16] http://cadastralvocabulary.org/.

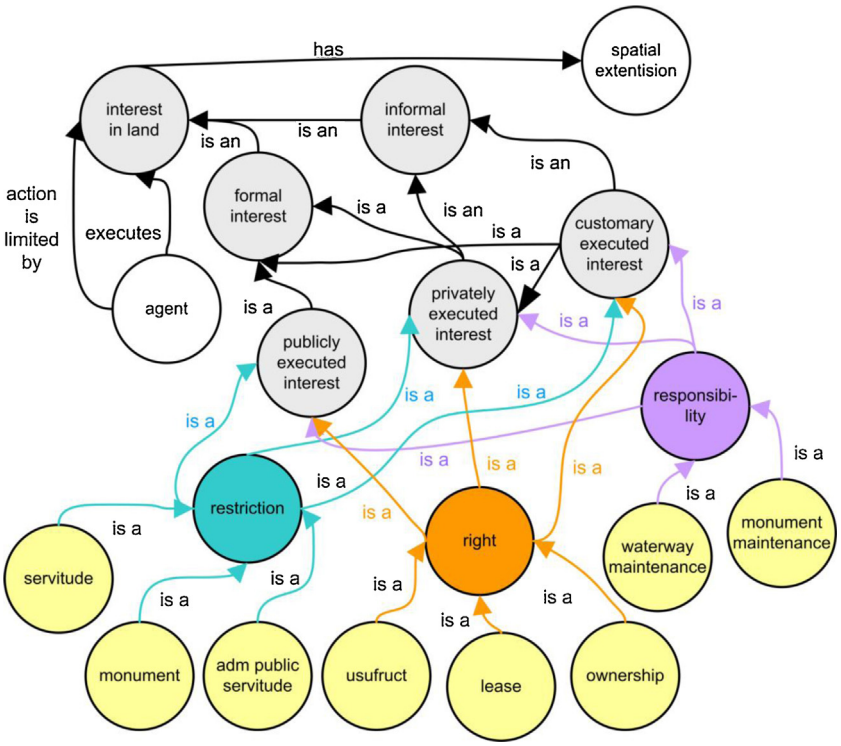

Fig. 8. Ontology diagram showing land use relations, exemplified with RRRs listed in LADM Annex J of ISO (19152:2012) (ISO, 2012). (For interpretation of the references to color in text, the reader is referred to the web version of the article.)

might be considered as a drawback: 'semantic soup', with classes, attributes, enumeration, and code list terms in one environment.

There is also an initiative to represent land administration data as Linked Data via the 'Core Immovable Property' in RDF (again LADM based). This should fit into the e-Government Core Vocabularies[17] by the European Commission, ISA Programme: Interoperability Solutions for European Public Administration (EC, 2009). The semantic technologies (RDF, SKOS, linked data) provide tools which could be very useful. However, from modelling perspective UML class diagrams already have generalization (broader–narrower) and also aggregation (part-whole) associations between classes (concepts) to create hierarchies. Note that this is at class level and not at code list value level.

Organizational and technical aspects of updating LADM code lists

The question arises, who will be responsible for managing the register: maintaining the content and disseminating this content? Some options are: ISO/TC211, OGC FIG (with register on e.g. http://isoladm.org),[18] or OICRF[19] as a permanent institution within FIG?

OICRF reported in their annual report for 2013 at the FIG's General Assembly during its meeting (first session) in Kuala Lumpur, Monday, 16 June 2014 an initiative to investigate the organization of the maintenance of code tables (OICRF, 2014).

However, there are many countries in the world and several of them with more jurisdictions (provinces, states), who might all want to extend the basis code list values. Perhaps, it is not good to have a single 'authority', but apply a kind of open linked data approach. The usefulness of identifiers that are referenceable has been demonstrated by INSPIRE.

Two aspects of updating LADM code lists can be identified: (1) organizational (who is responsible, involved, roles) and (2) technical (systems for the code list registers/database, web services to access and update code list values, etc.).

Conclusion and recommendations

The research presented in this paper shows that it is possible to extend the Land Administration domain Model, LADM, and its code lists, using the Legal Cadastral Domain Model and the Social Tenure Domain Model, to make it possible to represent RRRs on a more detailed level, including informal rights, restrictions and responsibilities.

The incorporation of a specialized description of RRRs in the LADM may be of future value when (if) more detailed information on social tenure land use has to be stored in national or international land administration registers. The LADM allows national profiles to be added to the standard, however, such profiles are relevant within a country. These profiles are needed in cases where detailed data of interests in land have to be exchanged internationally. International data exchange would, however, require international maintenance of code tables representing the different RRRs in use within countries.

We recommend further research into the organization and required institutional arrangements of LADM code tables and the related approach in publication of code lists, such as to explore the use of semantic technologies to define the various types of rights (RRRs).

[17] https://joinup.ec.europa.eu/elibrary/document/egovernment-core-vocabularies.

[18] ISO/TC2011: ISOs technical committee on standardization of Geographic information/geomatics. OGC: Open Geospatial Consortium. FIG: International Federation of Surveyors.

[19] OICRF is the Office International du Cadastre et du Régime Foncier (International Office of Cadastre and Land Records), a permanent body of FIG, located in Apeldoorn, The Netherlands. www.oicrf.org.

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