

Developing a Hohfeldian Theory of Real Rights to Support LADM Modelling

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Key words: LADM, Rights, Responsibilities, Restrictions, Legal model.

SUMMARY

The Land Administration Domain Model (LADM (ISO TC/211, 2012)) is a conceptual model which supports the modelling of social relations with land articulated through *rights*. There are three principal concepts within LADM: the party (*the who*) that has a rights relationship (*the what*) with a plot of land (*the where*). A party-right-land model by definition frames rights as property interests in terms of the right holders relationship with land. In most cases this relationship is interpreted to simply mean ownership. According to Williamson et al. (2010, pp. 88-89) "*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) described rights in terms of their associated privileges, claims, powers, and immunities (see also Hjelmbloem et al. (2019, pp. 37-38)). Whilst LADM allows such relationships to be expressed, this is not clearly articulated in the standard (Hjelmbloem et al. (2019, p. 52) provide an excellent overview of these issues). This is exacerbated by *restrictions* and *responsibilities* which frame rights relationships in terms of owned land rather than relationships between parties.

This paper will present a theory of real rights to support LADM modelling. Each jurisdiction creates a set of ownership and non-ownership rights which are recognised by the state and legally formalised. This is *numerus clausus*: 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). Third parties can permanently or temporarily hold these rights through an express grant, permit, or licence. 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 affect.

The remaining rights are bundled in to 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*: 'you can not 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. A *party variation* allows an owner to transfer (sell) all or part of their property. All such transfers are *in personam* - the legal instrument which describes the variation

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specifically identifies the third party grantee who benefits from the rights transfer. A *rights variation* allows an owner to alienate rights (such as access) which can then be transferred to third parties. A *land variation* allows an owner to split their ownership in to multiple spatial parts some of which can then be transferred to third parties. These powers 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.

By considering rights, and their associated Hohfeldian attributes, we will describe how generic LADM primitives can be used to articulate the rights duality demanded by Williamson et al. (2010, pp. 88-89). Party and spatial indexing are critical in articulating such relationships. This allows *restrictions* and *responsibilities* to be modelled in terms of their Hohfeldian incidents in a generic manner that more closely aligns with legal theory.

This paper represents significant thinking that has occurred over a number of years. I would particularly like to thank Alan Howie and Jon Hodge at Registers of Scotland: our conversations on this topic have been crucial to the development of this paper.

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1. INTRODUCTION

The Land Administration Domain Model (LADM (ISO TC/211, 2012)) is a conceptual model which supports the modelling of social relations with land articulated through rights. There are three principal concepts within LADM: the party (*the who*) that has a rights relationship (*the what*) with a plot of land (*the where*). A party-right-land model by definition frames rights as property interests in terms of the right holders relationship with land. Most people interpret this relationship to simply mean ownership. According to Williamson et al. (2010, pp. 88-89):

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.

An administrative framework is robust and successful when it takes this duality into account and also identifies the appropriate managing or implementing authority.

This interpretation aligns with Hohfeldian rights theory: Hohfeld (1917) described rights in terms of their associated privileges, claims, duties, powers, and immunities (see also Hjelmbom et al. (2019, pp. 37-38)). As stated by Baron (2013, p. 62): "*Hohfeld's conceptual analysis of rights in terms of jural relations led to the development of the notions that property consists not of things, but of legal relationships.*" Whilst LADM allows such relationships to be expressed, this is not clearly articulated in the standard (Hjelmbom et al. (2019, p. 52) provide an excellent overview of these issues). This is exacerbated by restrictions and responsibilities which frame rights relationships in terms of owned land rather than relationships between parties.

This paper will present a general theory of real rights to support LADM modelling. By necessity, it will take a particular focus on formal, rather than informal, rights: this means those rights which are recognised by a jurisdiction and recorded in a Land Register. It will build on different legal rights models including the *bundle of sticks* and *law of things* dominium model (derived respectively from Hohfeld and Blackstone (Baron, 2013, p. 58)). These relationships will be modelled in a modular manner based on the *law of things* and Hohfeldian rights theory as recommended by Smith (2012).

This paper is idealised - it has been developed to support (semi-) automated registration and inference by formally describing rights and rights relationships.

2. WHAT ARE REAL RIGHTS IN LAND?

A *real right in land* describes the *nature of the things* that *parties (persons)* can do with *land* (immovable property). Ownership is the chief attribute of property. As described in the Dutch Civil Code (CC) (art. 5:1, par. 1): "*Ownership is the most comprehensive right a person can have in a thing.*" Property as a concept, depends on the idea that others are to be excluded from the thing which is owned (Penner, 2000, p. 74). This exclusivity is *in rem*, that is, it is '*good against the world*' and must be '*respected by all*', or virtually all, of the subjects of the legal system. *In rem* exclusivity is an inherent social property of owned land. This reflects the *law of things* view of property (as described by Smith (2012)). Where owned land is conventionally defined, such as being bounded by a hedge or fence, we intuitively know we are subject to certain duties of non-interference: not to enter it, use, it take it etc. This duty applies to everyone and does not require a formalised contract with the owner. There is no need to enumerate the duty owing parties for the rights to have affect (Merrill & Smith, 2001, p. 359; Merrill & Smith, 2011, p. 9).

In addition to restrictions imposed by law (see overriding interests below), an owner also has the discretionary (selective) power *not* to exclude third parties from their land. By varying their exclusivity an owner can confer rights on third parties. This is well described by Penner (2000, p. 76):

Property is like a gate, not a wall, because the owner may open the gate, selectively allowing particular persons to enter, while at the same time leaving everyone else who is outside in the same position as before.

Hence, ownership is conceptually a container for a bundle of other real rights which can be granted to third parties. This thinking underpins the *bundle of sticks* model where ownership is the *bundle* and granted rights are the *sticks* (see Baron, 2013; Simpson, 1976, p. 7). A formalised contract is created between the owner and other, named, third parties. In most contracts there is a granting party and a grantee party - both of whom are known. It is thus referred to as *in personam*. The grant can reflect ownership or non-ownership rights (see Figure). The process of granting such rights can restrict exclusivity (Reid et al., 1996, p. 160)¹.

Penner (2000, p. 163) states that: "*the better view of contract is that it is the law governing the power to rearrange or create rights, duties and powers by agreement.*" But what are these powers and duties associated with rights? Penner (2000, p. 13) further states that: "*a person is the bearer of a right when a duty is imposed in order to serve or protect his interest.*" If such a position is true then a right holder must invoke a duty on a third party. This means that for every party that benefits from a right, there must be a third party who holds a corresponding correlative duty to the right holder (Penner, 2000, p. 71). Hence, for *real rights in land* the right describes a relationship between two parties (a *right holding* and a *duty owing* party) framed through land. In this manner rights are given social relevance when used to describe relationships between parties framed through land. The demonstrable articulation of the

¹ is this why LADM refers to things as *restrictions*?

parties in the rights relationship is key for right holders who wish to legally enforce their *real rights in land* against an encumbered land owner.

A right holder has certain powers associated with their right. As described by Penner (2000, p. 76): "A power is a capacity, whether a natural capacity or a social capacity, which works to **change the relationships between persons**." As such a power is required in order to change a rights relationship. This means that only those parties with an appropriate power can transact on a Land Register.

In a seminal paper Hohfeld (1917) formally modelled rights, duties and powers as reciprocal implications and relationships

3. HOHFELDIAN RIGHTS RELATIONSHIPS

Hohfeld created four basic components of rights known as '*the Hohfeldian incidents*' (Hjelmbom et al., 2019, pp. 37-38). There are *first-order* elements: the *privilege* and the *claim*, that describe the right holders relationship with the *thing*. In addition there are *second-order* elements: the *power* and the *immunity*, that frame a parties ability to alter the *first-order* incidents. The relationships between the Hohfeldian incidents is described in Figure 1.

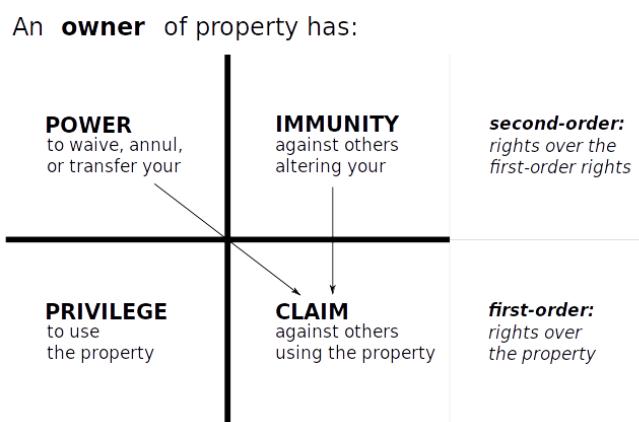


Figure 1. The relationship between the four Hohfeldian incidents of privilege, claim, power and immunity (Beck, 2022)

3.1 First-order Hohfeldian Incidents - Privileges and Claims

Privileges and claims are '*first-order*': they are rights over property.

A has a privilege to ϕ if and only if A has no duty not to ϕ .

In terms of land, privilege entitles an owner to use their property in any way which is legally permitted. The Dutch Civil Code (CC) (art. 5:1, par. 2) describes privileges associated with ownership as follows:

The owner is free to use the item to the exclusion of anyone, **provided this use does not conflict** with the rights of others and the restrictions based on statutory regulations and rules of unwritten law are observed.

As a further example, if there is:

1. no *in personam* contract that says *A* can not pick up a shell on a beach and
2. no *in rem* social agreement that *picking up shells on a beach* is not allowed.

There is no duty that *A* can not pick up a shell on a beach. Therefore, *A* has the privilege to pick up a shell on a beach.

A has a claim that *B* ϕ if and only if *B* has a duty to *A* to ϕ .

For an owner of land there is an *in rem* understanding trespass is not allowed. Everybody has a duty not to trespass on owned land. Hence, the owners right of exclusivity (i.e. not to be subject to trespass) is a claim.

As a further example, if there is

1. an *in personam* contract that grants *A* access over land which is owned by *B*.

B has a duty to *A* to provide access over their land. Therefore, *A* has the claim to right of access.

3.2 Second-order Hohfeldian Incidents - Immunities and Powers

Immunities and powers are '*second-order*': they specify how claims and privileges can be changed. A Hohfeldian power is the incident that enables agents to alter rights.

A has a **power** if and only if *A* **has the ability to alter** her own or another's Hohfeldian incidents.

When *A* has the ability to alter *B*'s rights, then *A* has a power. For general property (including things other than land) a right holder can have several powers with respect to their claim, they may:

1. waive the claim (*granting others abilities to use the property*), or
2. annul the claim (*abandoning the property*), or
3. transfer the claim (*making the property someone else's*).

Land transactions tend to have their own associated registration law which extends general property law. Registration law can increase the range of powers available to a party who holds a *real right in land*. Hence, right holding party's powers for land can include: transfer, variation, alienation (creating subordinate rights), discharge (extinguishing rights), and enforcement.

Not all rights have the same powers. A holder of an ownership right in land has the power to alter their ownership right by transferring it to a third party. However, a holder of an access right over neighbouring land **does not** have the power to independently transfer this right unless their land is also transferred.

When *A* lacks the ability to alter *B*'s rights, then *B* has an immunity. Immunity prevents other parties from waiving, annulling, or transferring a claim or privilege held over property. For an owner the principal immunity is immunity from transfer - '*you can not sell what you do not own*' (*nemo dat*).

3.2 Hohfeldian Opposites and Correlates

These four incidents can be considered in terms of their opposites (in respect of the same right holder: see Table 1) or their correlatives (in respect of the a third party: see Table 2).

Duty, as the Hohfeldian correlative of a claim, are critical elements of a rights relationship. Duties reflect the duality of the rights relationships framed through land. Duties are based on the following party relationships:

- Parties holding *ownership rights in land* can expect duties from *third parties*. These *third parties* can be:
 - named (as part of an *in personam* contract)
 - not named (as part of an *in rem* relationship which is 'good against the world')
- Parties holding *real rights in land* can expect duties from *land owners*. These *land owners* can be:
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Table 1. Hohfeldian opposites - terms in respect of the same right holder.

If A has	then A lacks
a Claim	a No-claim
a Privilege	a Duty
a Power	a Disability
an Immunity	a Liability

No-claim, as the Hohfeldian opposite of a claim and correlative of a privilege, is also important. A no-claim indicates that a party has no rights associated with a plot of land. This is important when sub-ownership rights have been separated from private land (discussed below).

Table 2. Hohfeldian correlatives - terms in respect of a third party.

If A has	then some person B has
a Claim	a Duty
a Privilege	a No-claim
a Power	a Liability
an Immunity	a Disability

3.5 *in rem* and *in personam* Hohfeldian Rights Relationships

As shown above, the relationships between right holding and duty owing parties are framed by *in rem* or *in personam* characteristics. Where a right is *in rem* and therefore *good against the world* then the relationship between the *duty owing* and *right holding* party is not explicitly articulated. There is no need to enumerate the duty owing parties for the rights to have affect. Where a transaction has been described between specified parties in a contract then the right is *in personam* (such as in most conveyancing activities).

As such an *ownership right in land* can have both *in rem* and *in personam* characteristics. For example, trespass is not allowed (*in rem*) and the owner can sell the land (by necessity to a specified person (*in personam*)). In terms of land: real rights reflect relationships between parties framed through land (Baron, 2013, p. 62). As described by Smith (2012), the reality of social relationships with land is not encapsulated in a single model. We have demonstrated that, at the very least, a *bundle of sticks* and *law of things* approach is required to adequately model right relationships. However, what rights underpin these legal relationships?

3.6 Numerus Clausus - Formal Rights within a Jurisdiction

Property and law are born together, and would die together.

Before the laws property did not exist; take away the laws and property will be no more.

Bentham et al. (1914, pp. 146-147)

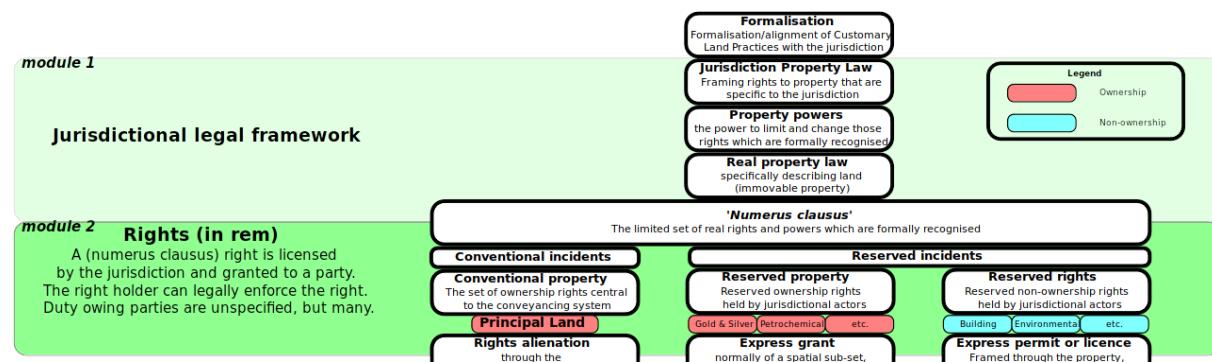


Figure 2. The legal framework for a jurisdiction determines the limited set of real rights which are formally recognised (numerus clausus). This includes conventional property (granted to parties) and rights reserved by the jurisdiction (split in to property reserved by the jurisdiction and rights restricted, *in rem* from holders of conventional property). After Beck (2021)

As described in Figure 2 and Figure 3, each jurisdiction creates a set of ownership and non-ownership rights which are recognised by the state and legally formalised. Through these rights legal protections are provided (Dale & McLaughlin, 1999, p. 26). This is *numerus clausus*: the closed number of basic land and property rights recognised by the jurisdiction. Rights within *numerus clausus* represent both the *bundle* and the *sticks* in the *bundle of sticks* model. The actual relationship between the *bundle* and the *sticks* is determined when *title* is articulated.

The property law that defines the *real rights in land* will also describe the powers and immunities associated with each right. The powers will shape the conveyancing process and define how any right can be granted, licenced, alienated, discharged, or varied. Critically, the nature of these rights can change over time based upon social, political or other needs.

A jurisdiction tends to ensure that they reserve a range of Hohfeldian incidents: these we have called reserved incidents. As described by Kitsakis et al. (2022, p. 3): "*the extent and the content of the right of ownership is significantly affected by regulations and restrictions deriving from Public Law (Public Law Restrictions (PLRs)). Public Law comprises the rules that regulate the relations between citizens and the state, compelling the former to conform to the regulations of the latter, in the course of exercising supreme authority of the state, or of another Public Law legal person.*" Most jurisdictions reserve powers, including the power of *eminent domain*: the power to take owned property for public use. Jurisdictions also tend to reserve both ownership and non-ownership rights. These rights are held by the jurisdiction or a nominated agent.

The remaining Hohfeldian incidents from *numerus clauses* are what we have called conventional incidents as they directly support the conveyancing process. Key to conventional incidents is what we have called conventional property: the set of ownership rights central to the conveyancing system. Conventional property, as initially granted by a jurisdiction, we call principal land (this has many names in different jurisdictions including *freehold* and *solum*). This represents the nearest thing to absolute ownership of land by individuals (subject to any *reserved incidents*: for example, see the Dutch Civil Code (CC) (art. 5:1, par. 2) discussed above for a description of ownership privileges and *reserved incidents*).

Within these reserved incidents, we have called rights of ownership reserved property. Reserved property are *separated ownership rights* over which an owner of conventional property has a Hohfeldian duty. Where a jurisdiction allows it, such reserved property can be spatially subdivided and expressly granted to parties within the conveyancing process and are therefore likely to appear on a Land Register.

Within these reserved incidents, we have called rights of non-ownership reserved rights. These rights are held exclusively by a jurisdiction (or their nominated agent) and are restrictions against conventional property. Conceptually the *stick* representing a *reserved right* can not, by default, be part of the *bundle* represented by conventional property ownership: this restricts the ability of an owner of conventional property to enjoy the right or grant it to a third party. An owner of conventional property has a Hohfeldian duty to these reserved rights. Where a jurisdiction allows it, licences or permits (normally of limited duration) can be granted that allow owners of conventional property to undertake what would otherwise be a restricted activity.

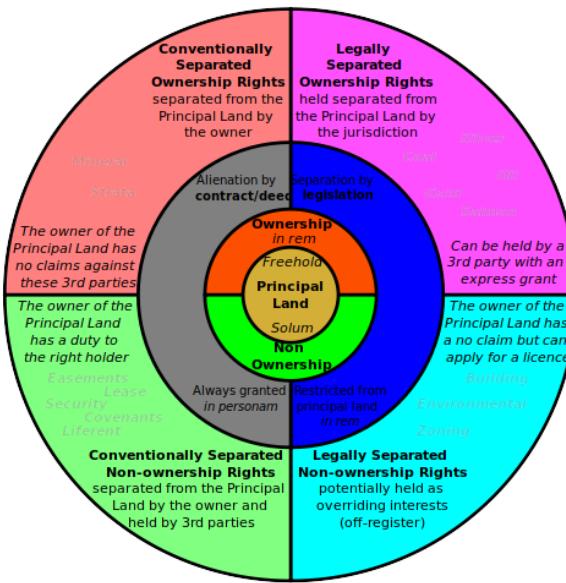


Figure 3. The rights bullseye - describing real rights in land and their relationships to principal land (Beck, 2021)

The issuing of associated licences or permits for reserved rights does not tend to appear on a Land Register. However, these rights have legal effect and therefore have the potential to *override* any rights described on the Land Register. As such these reserved rights are referred to as overriding interests. Reid et al. (1996, p. 160) state that in Scotland: "*For the owner of ordinary domestic property the most significant restriction is probably the limitation on the freedom to build imposed by planning and building legislation.*" Similar planning and building restrictions occur in many jurisdictions. Such restrictions are an important policy tool.

Conventional property, reserved property and reserved rights all have *in rem* characteristics. While ownership rights are '*good against the world*', from a practical point of view reserved rights are '*good against the set of land owners or parties in possession of land*' (Smith, 2012, p. 1706). This means that while the duty owing parties are unspecified the class of party who owe a duty can be specified (e.g. owners of land).

The conveyancing process allows the owner to alienate and grant *in personam* rights to third parties providing a richer and more nuanced approach to rights representation.

4. CONVENTIONAL INCIDENTS AND THE CONVEYANCING PROCESS

Smith (2012, pp. 1690-1691):

Thus, property defines things using an exclusion strategy of "keep off" or "don't touch" and then enriches the system of domains of owner control with interfaces using governance strategies.

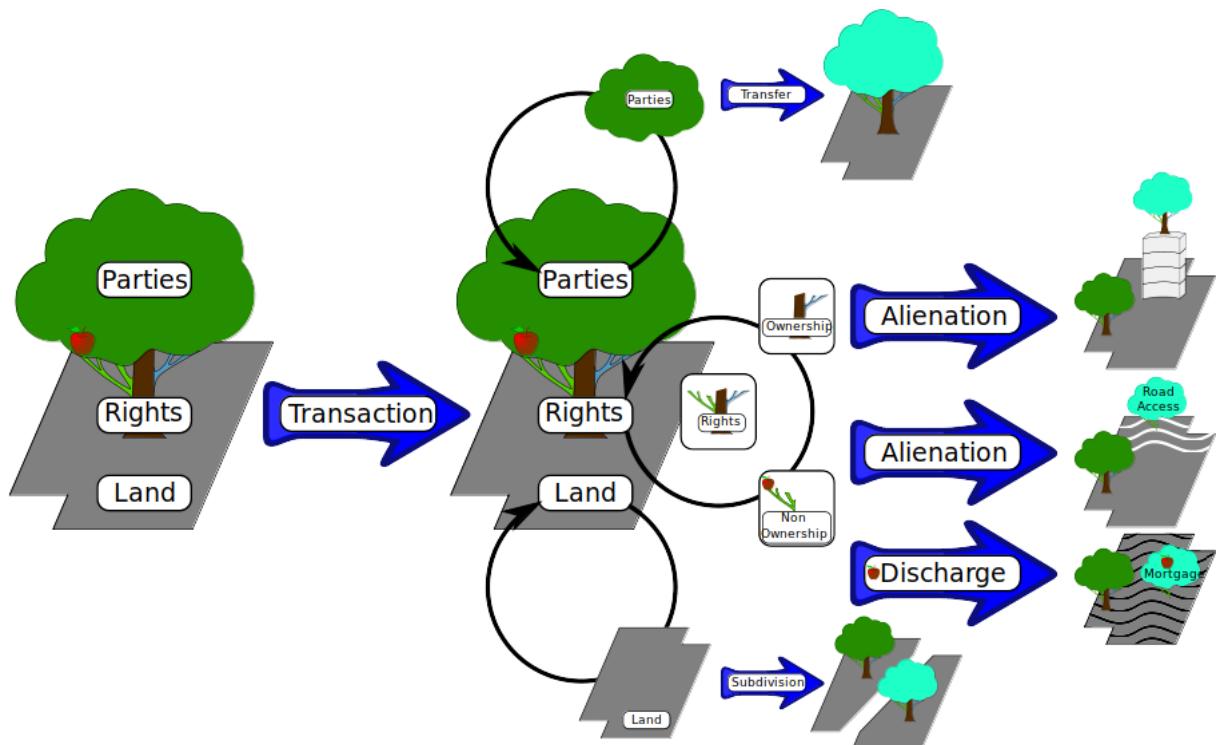


Figure 4. How in personam transactions can change Party, Rights and Land relationships (Beck, 2021). Similar thinking is seen in Figure 1 of Bennett et al. (2021) and Figure 4.8 of Zevenbergen (2002)

General conveyancing practice tends to be based on legal instruments: *in personam* contracts between a granting party (normally a right holder) and a grantee (benefitting) party. By alienating '*use and service*' rights and granting them to third parties, owners can develop nuanced governance strategies associated with land. Rights granted in this manner could be considered as the equivalent of *sticks* in the *bundle of sticks* model (see Baron, 2013; Simpson, 1976, p. 7; Merrill & Smith, 2011, p. 10)). This is essential for establishing cooperative community ownerships with complex shared ownership schemes (such as condominiums or flats).

For example, an owner might have:

- one set of rights to the dwelling,
- but a different set of rights to access the parking space (an easement)
- and different rights to the common areas of the development, such as the swimming pool (joint tenancy).

As described in Figure 4 owners can vary their ownership in terms of a party, right or land dimension. A *party variation* allows an owner to transfer (sell) all or part of their property. All such transfers are *in personam* - the legal instrument which describes the variation specifically identifies the third party grantee who benefits from the rights transfer. A *rights variation* allows an owner to alienate rights (such as access, or security) which can then be transferred to third parties. A *land variation* allows an owner to split their ownership in to multiple spatial parts some of which can then be transferred to third parties. Under certain circumstances right holders have powers to discharge the right they hold (most commonly seen with security rights).

In terms of this paper we are interested exclusively in the notion of a *rights variation*. However, the implications of *party* and *land transactions* are expressed in Figure 5.

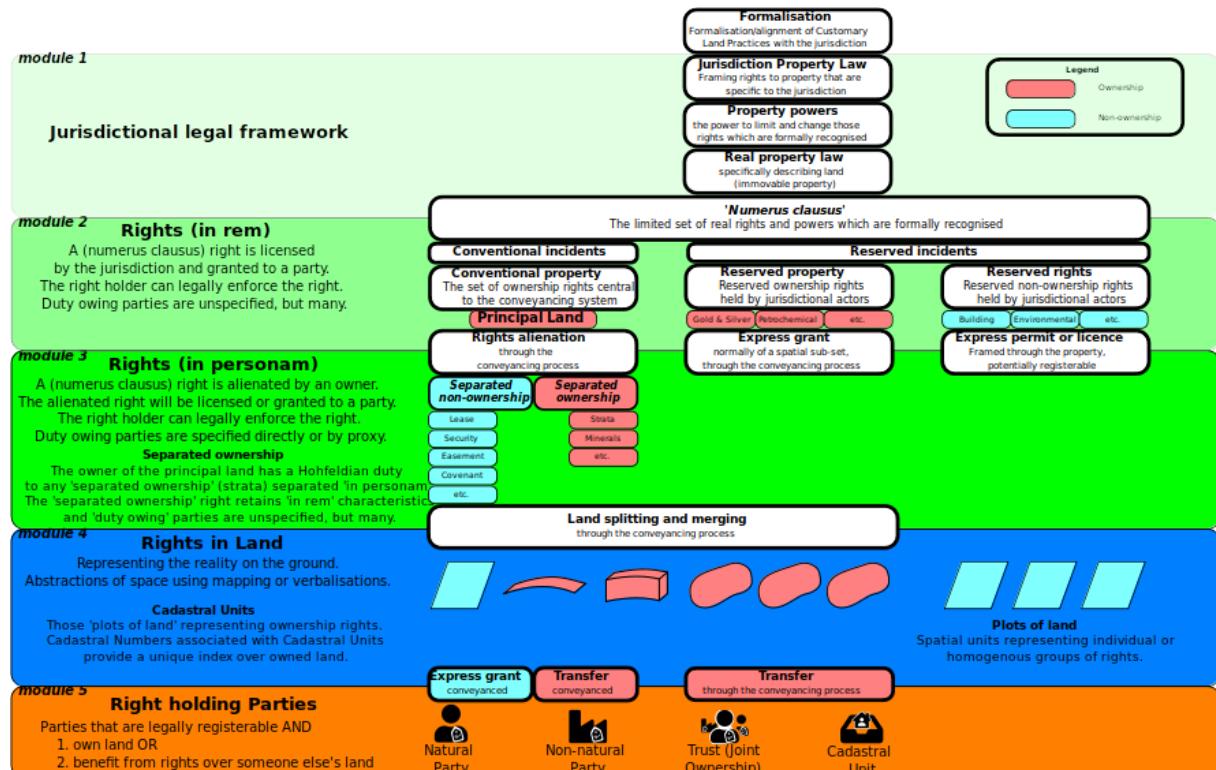


Figure 5. The modular arrangement of rights relationships. Conveyancing activities are described in modules 3-5 where respectively right, land and party variations occur (Beck, 2021)

Module 3 of Figure 5 shows how owners of conventional property can use their powers to alienate the legally permissible '*use and service*' rights (as defined in *numerus clausus*) that are inherently associated with their land and grant them (*in personam*) to third parties. These *real rights in land* can be legally separated (alienated) from the **owned land**: the separated real rights can represent *ownership* or *non-ownership* rights.

The ownership and non-ownership rights will have a spatial extent (either expressed as geometry or verbally (grounded in respect of the principal land from which the right was separated)). Land owners have a duty to non-ownership right holders to allow them to enjoy their right. Right holders have a claim over the land owner framed through the spatial extent of their right.

As outlined in Figure 6 the separation of ownership rights is more complicated. While the separated ownership right has been granted *in personam* and falls within the spatial volume implied by the principal land, the owner of the separated ownership has an exclusive right *in rem*. This means that the owner of the principal land has a duty over the separated ownership (irrespective of the spatial relationship between the rights). However, the separated ownership is an *encumbrance* on the principal land. Where ownership is expressed in 2-dimension then

the implication of this duty should be clearly articulated on any Title derivative from the Land Register.

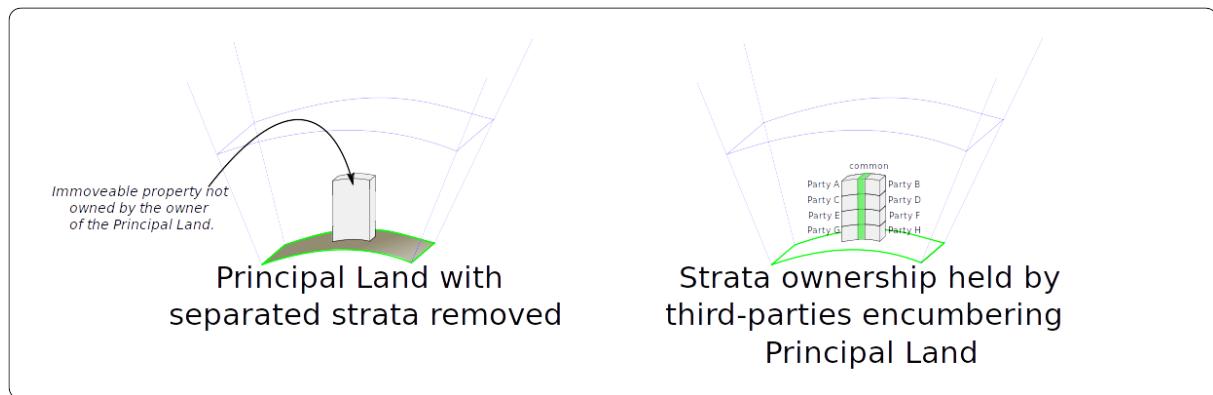


Figure 6. Separation of strata ownership rights. The illustration conceptually describes how a volume of strata (that represents, for example, a flatted property) becomes separated from the volume of ownership implied by the principal land (Beck, 2021). It describes how the new owner owns the strata and the owner of the 'principal land' is owner of the remaining implied strata

5. RESTRICTIONS, RESPONSIBILITIES AND INFERRING NEW RIGHTS RELATIONSHIPS

This paper has focussed almost exclusively on the nature of registerable rights and their Hohfeldian incidents. It has not discussed two of the core LADM concepts: *restrictions* and *responsibilities*. This is principally because *restrictions* and *responsibilities* are, in general, both rights which encumber owned land. As discussed in this paper, their implications are articulated through the duality of the rights relationships between the right holder and the land owner through land (as an owed duty). However, LADM (ISO TC/211, 2012) defines *restrictions* and *responsibilities* as follows:

- A *restriction* is a: "formal or informal obligation on the *land owner* to refrain from something"
- A *responsibility* is a: "formal or informal obligation on the *land owner* to allow or do something"

Modelling *restrictions* and *responsibilities* in this manner frames encumbrances in terms of their impact on a *land owner* rather than the benefit that the right holder has over *owned land*. The distinction is subtle but important. By exclusively considering the impact of a right through the prism of the land owner the LADM concepts of *restrictions* and *responsibilities* implicitly supports a *Title by registration* approach that articulates the impact of the right (as opposed to generic rights registration as articulated in Deeds registers). It is possible that the right holding party may be overlooked by directly modelling *restrictions* or *responsibilities* in this manner. While this may not be an issue for informal rights (and we are conscious that as a general model LADM should provide the ability to model all scenarios), there is little point registering an encumbering right without the right holder in a Land Register. The point of a Land Register is to formally register *real rights in land*, to provide evidence of these rights and where necessary to support the enforcement of the right holders registered right. If there is no registered right holder then the encumbering right can not be legally enforced and registration serves no purpose.

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We also consider the LADM concepts of *restrictions* and *responsibilities* to be constraining. Rights, claim, no-claim, privilege and duty provide more granularity (see also Hjelmbom et al. (2019, p. 39)). We can use these to flexibly define and derive new concepts based on well grounded data relations in the model. For example, *things a land owner can do*:

- the owning party, by definition, has been granted *in personam* an ownership right
 - all ownership rights have *in rem* effects
- the owning party may also have been granted *in personam* beneficial right over all, or part, of land owned by someone else either:
 - directly (held by the owner) or
 - praedially (held by the owned land (and therefore a proxy benefit to the owning party))
 - this can include ownership rights over other land (which therefore includes an inherited *in rem* effect)

Things a land owner can not do:

- where a party holds a right *in rem* over all, or part, of land owned by someone else this results in a *duty* for the land owner
 - where these are non-ownership rights owners can benefit from these rights if they hold an *express grant* or other registerable *licence*
- where a party has been granted *in personam* a non-ownership right over all, or part, of land owned by someone else this results in an *owed duty* which is exclusively reserved for the right holder (for example a right of lease or liferent)
 - such rights tend to be time limited and the rights revert back to the owner on expiration

Things a land owner has to do:

- where a party has been granted *in personam* a non-ownership right over all, or part, of land owned by someone else this results in an *owed duty*. The duty owed by the land owner can be a:
 - passive (negative) duties - allowing third parties to do things on the owned land (effectively shared use of the land for specific activities)
 - active (positive) duties - enforcing the owner to do things to or on behalf of the owned land (maintenance etc.)

Encumbrances (see Figure 7) describe nuanced rights relationships between the **owner of a cadastral unit** and a **third party** based around what rights and powers a third party has over the owned land. As such encumbrances are the union of the *things a land owner can not do* and the *things a land owner has to do*.

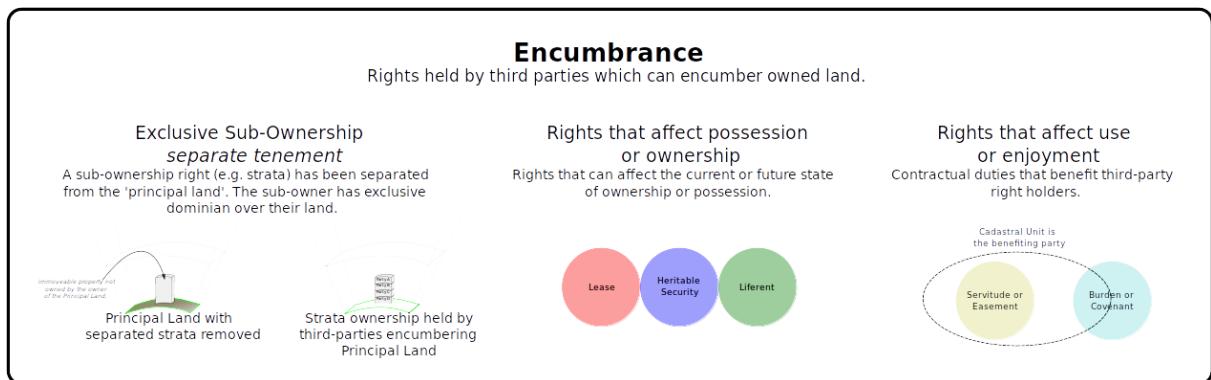


Figure 7. Encumbrances: Rights held by third parties which can encumber owned land (Beck, 2022)

6. MODELLING DUALITY IN LADM

As a party-right-land model articulates the nature of a right-holders interest, how is the duty owing duality modelled in LADM? At first glance one would use *restrictions* or *responsibilities*. However, as we have discussed above, *restrictions* and *responsibilities* frame rights relationships in terms of owned land rather than relationships between parties. Hence, an alternative modelling approach is required.

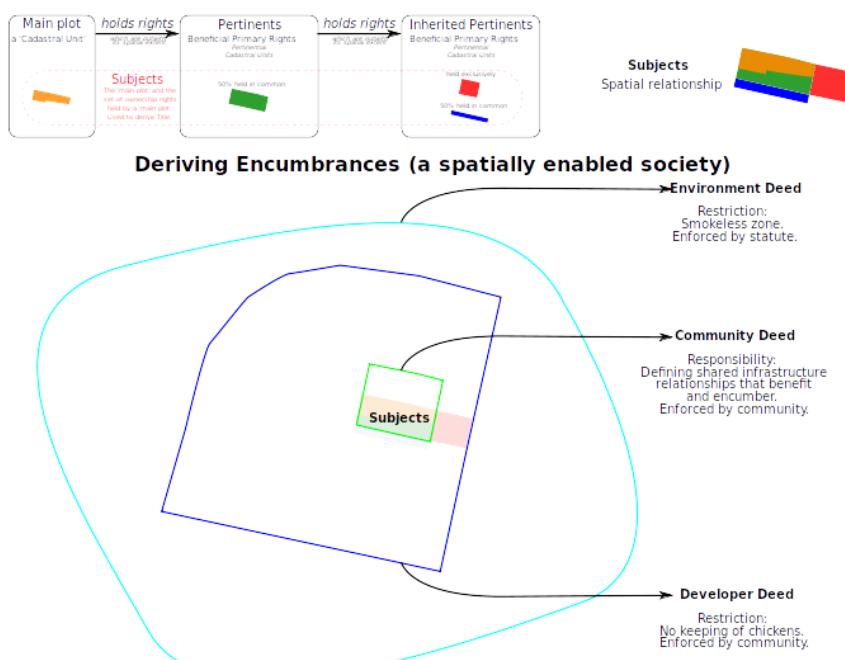


Figure 8. Deriving encumbrances (Beck, 2021). Party indexing is used to determine ownership 'subjects' and spatial indexing is used to determine encumbering non-ownership rights held by third parties

Within a Land Register, the important duality relationships are between owned land and alienated non-ownership rights held by third parties. The simplest way to model the implications of this duality is to use spatial indexing. Where the extent of an ownership right

and the encumbering right (ownership or non-ownership) is represented using spatial geometry then spatial indexing can be used to determine the duality of the relationships.

This is demonstrated in Figure 8. Initially the set of relevant ownership extents is calculated from the seeding cadastral unit. The seeding cadastral unit can act as a party and hold ownership interests in other cadastral units. A right relationship in which the right holder is owned land (a cadastral unit) is called praedial. In this example the seeding cadastral unit holds a 50% share of the ownership right in a different cadastral unit. In turn, this cadastral unit holds praedial beneficial ownership rights in two other cadastral units. This set of ownership extents derived from the seeding cadastral unit is referred to as the subjects and is calculated using party indexing. Spatial indexing (simple overlap) is used to determine which third party rights have a spatial relationship with the subjects. Third party non-ownership rights encumber the owned land as follows:

1. an owed duty not to emit smoke (a right held *in rem* and enforced by the council);
2. an owed duty to not keep chickens (a right granted *in personum* by the developer and held collectively by all affected owners) and
3. an owed duty to maintain shared infrastructure (a right granted *in personum* by the developer and held collectively by all affected owners in the block of flats. As a community deed this right also benefits every affected owner).

Using spatial and party indexing in this manner it is possible to determine what rights benefit and encumber owned land and the duality of the relationships between the individual right holders.

7. CONCLUSION

Smith (2012) argues that, in general, legal property theories are weak. This is something the legal community need to improve on. However, it has a clear impact on associated standards such as LADM. While LADM allows a right holder relationship to be clearly articulated, it is less clear about how the right holder-duty owing relationship duality is expressed. This is not helped by the *restrictions* and *responsibilities* concepts that frame rights relationships in terms of owned land rather than relationships between parties. This said, LADM is a general model and should be applicable to the widest range of circumstances. The LADM *restriction* and *responsibility* concepts will remain important modelling tools for informal, social tenure, models and for those jurisdictions which can not frame their data in the idealised manner represented in this paper.

What has been presented in this paper is idealised and as such may not be applicable in a real register. However, this paper does demonstrate that combining different Hohfeldian incidents supports the grounded derivation of new properties. One could say, the properties of property are emergent.

This paper attempts to provide a background architecture to the representation of *real rights in land*. Such an architecture must recognise that property can be modelled in different ways. While a *bundle of sticks* model is useful for representing *in personam* claims and duties between parties, a *law of things* model helps articulate what intrinsic rights a right holder has which are *good against the world*. It should be noted that nothing in this paper requires a

change to the LADM architecture. This approach is tentative, it would particularly benefit from further modularisation (as discussed by Smith (2012) in their *exclusion-governance* architecture) and consideration of automation logic (as discussed by Hjelmbom et al. (2019)). However, it is hoped that it supports new ways to conceptualise and model rights relationships based on core LADM primitives.

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BIOGRAPHICAL NOTES

Ordnance Survey is the national mapping agency for Britain, and a world-leading geospatial data and technology organisation. Accurate location data is used for smarter solutions to the world's most complex problems including resource management, urbanisation and population growth. As a trusted partner to government, business and citizens across Britain and the world, our expertise and technology helps customers in government, business and infrastructure deliver efficient services.

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Anthony BECK is a geospatial and analytics professional with a strong mix of technical, commercial, academic and policy skills. He has experience of delivering repeatable solutions using an inclusive and interdisciplinary approach, involving GI-Science, Knowledge Engineering, and Data Modelling. One of Anthony's key skills is demonstrating the link between concepts, data, policy and practice. Anthony is a Concept and Data architect. He is lead author on many academic journal publications that cover different domains: these include land administration, utilities, heritage, smart cities and addressing. He holds a PhD in heritage remote sensing applications and advises specialist, policy and standards bodies. He has won a number of industry awards including work on the integration of underground utility assets and the PAS128 utility standard. He was short-listed for the Institute of Civil Engineers entrepreneur of the year award. Anthony is fluent with ISO19152 (Land Administration Domain Model (LADM)) and is contributing to the ISO19152 version 2 revision. He is interested in approaches that improve registration automation and first-order logic modelling of the registration domain.

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