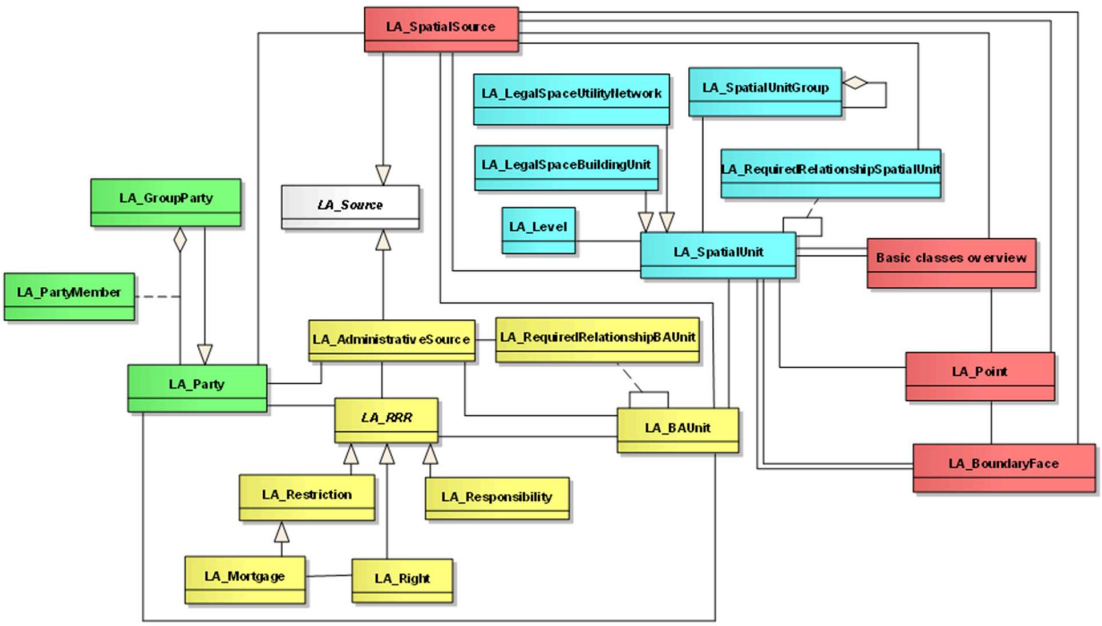
LADM in the Classroom



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Draft final version, November 2023

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Foreword

The Land Administration Domain Model (LADM) offers a comprehensive functionality that supports the representation and documentation of relationships between people and land in a land administration system. This is often organised in a distributed environment where different agencies work towards a common purpose, such as tenure security, fair taxation, sustainable land use, access to credit, peacebuilding and slum upgrading. Within the professional land administration world, the model is known and used in the development of land administration systems. Forty country profiles and ten national implementations of the LADM are known. With the Social Tenure Domain Model (STDM) there are many more.

During the Covid period we learned that there is a need for teaching materials that can be used both online and onsite. This has resulted in this LADM booklet with a set of slides. The slides refer to the figures in the booklet. The booklet explains examples of people to land relationships from the map, then their representation in a database. Finally, the LADM is explained in UML. All this is further supported by possible exercises in a real database environment.

The booklet is intended for students and educators in universities and vocational schools. It can also be used by colleagues in professional land administration organisations such as cadastres and land registries. An important user group concerns those involved in collection and maintenance of land records. ICT experts will benefit from studying this booklet for development of land administration systems. ICT experts often master UML.

1. Introduction

1.1 LADM in the Classroom

The Land Administration Domain Model (LADM) is published and visualised in Unified Modelling Language (UML). The use of UML allows experts and professionals in land administration to communicate the structure and meaning of land information with experts and professionals in information and communication technology (ICT). This means that land administration experts and professionals need to master UML to make clear to ICT experts and professionals how land administration is structured. In this booklet, we do this by providing the relevant definitions and then starting the learning and teaching process of the LADM from a cadastral map with visually linked rights and (entitled) parties. The translation of those data into a database consisting of tables is the next level of understanding. As a next step the link between a database and its tables and UML diagrams is presented. This is followed by transactions in LADM. Transactions need to be supported. This is important because people to land relationships are dynamic due to buying and selling of land rights, inheritance, establishment of new rights, etc. Formal, informal and customary rights are considered.

The figures presented in this booklet are available as slides for lectures.

A database with the data from cases in this booklet included is available. Efforts have been made to ensure that the datasets have a low entry barrier. All the datasets are distributed using open specifications. The exercises assume the use of QGIS and PostgreSQL/Postgis [1]. These are well known open software initiatives that are available, maintained, reliable and safe - attributes of software sustainability as defined by Venters et al. (2014).

1.2 A simulated environment

In this booklet we welcome you to the municipality of 'Waterriver' (Figure 1), a hypothetical location with lands and buildings where people live and work and sustain their livelihood through agriculture, industry or services.

There is tenure security through a transparent and inclusive land administration system. Property rights on land are well documented.

The municipality finances its wide range of activities from income out of property tax.

In Waterriver there is spatial planning in place, spatial plans are developed in participatory approaches.

The land administration in Waterriver was established a long time ago. The people of Waterriver understand its importance.

[1] https://www.qgis.org/
https://www.postgresql.org/
https://postgis.net/

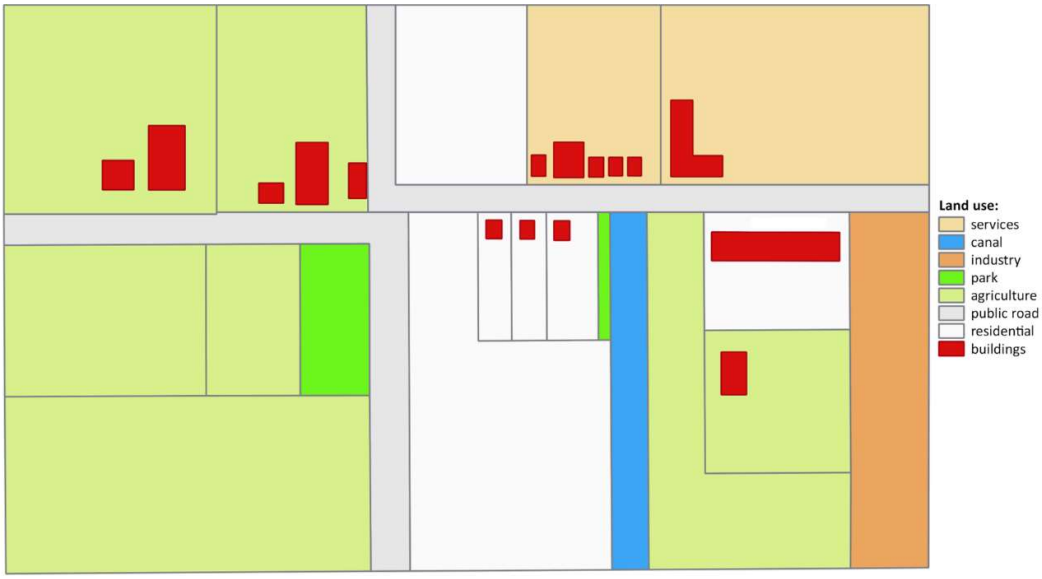


Figure 1. Municipality of Waterriver - a hypothetical location

Land administration is the process of determining, recording and disseminating information about the relationship between people and land (ISO, 2012). This relation can concern land tenure, land value and land use (UN ECE, 1996) in urban, rural and marine environments. Often land administration is implemented through a distributed set of land information systems, each supporting data maintenance activities and the provision of information. There is a Land Registry – managing the conveyancing process, a cadastre for maintenance of the cadastral map; a Planning Department – regulating land and property development and a Tax Department – gathering land tax. In the case of Waterriver the information on land tenure, land value and land use is managed by one single organisation.

2. The Land Administration Domain Model

2.1 Conceptual Model

The LADM is a conceptual data model for land administration. The development of the LADM was initiated by the International Federation of Surveyors (FIG) and the model is published by the International Standardisation Organisation (ISO) - Technical Committee on Geographic information/Geomatics. See Figure 2 with the diagram of the land administration domain model.

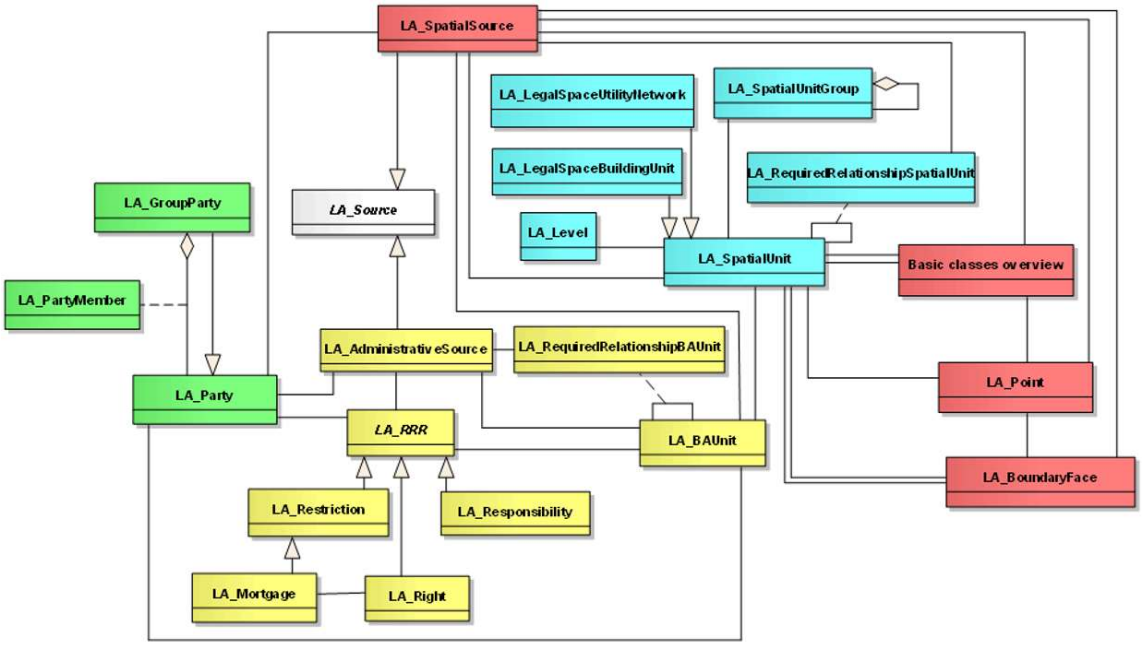


Figure 2. The land Administration Domain Model

The LADM offers a comprehensive functionality that supports the documentation of the relationships between people and land in a land administration (ISO/TC211, 2012; Lemmen et al., 2015[2]). LADM is used to support the development of land administration systems. That means developing software applications, workflows, databases and user interfaces for land administration purposes (tenure security, land tax, spatial planning etc).

LADM is about the core and essence of Land Administration (LA): the data about people, data about land and data about the relationships between people and land. This relation can concern land tenure, land value and land use. The ownership can be private or public.

People – land relationships can be expressed in terms of persons (or parties) having (social-) tenure relationships to land. A 'social tenure relation' can be seen as an 'informal right' with community legitimacy.

[2] ISO - ISO 19152:2012 - Geographic information — Land Administration Domain Model (LADM) https://www.iso.org/standard/51206.html

The spatial units are visualised in blue on maps and in UML diagrams in this booklet. Parties are presented in green in UML in LADM and rights and basic administrative units in yellow. Also restrictions and responsibilities are in yellow. Rights, restrictions and responsibilities (definitions in the next paragraph) are abbreviated to RRR in LADM. The relationships are indicated as black lines. These colours are systematically used in this booklet and also in LADM diagrams in publications and in the standard itself. See legend in Figure 3.

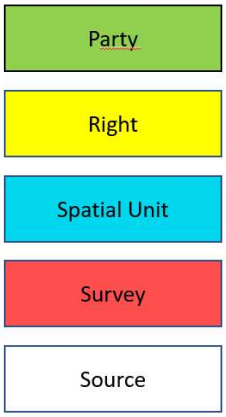


Figure 3. Legend for LADM diagrams

2.2 Party

In LADM a **'party'** is a person or organisation that plays a role in any land administration process.

A person can be a natural person that is a right holder of a right on a spatial unit (parcel). Apart from being rightholder a party can have a role in the land administration process. surveyor, conveyor, notary, registrar, grassroot surveyor, paralegal, a chief, etc. Roles depend on the context

An organisation can be a non-natural person. This may be a company, a municipality, the state, a tribe, a farmer cooperative (cooperation), or a church community (with each organisation represented by a delegate: a director, chief, CEO, etc.).

A **'party member'** is a party registered and identified as a constituent of a group party. This allows documentation of information to membership. This is not mandatory: there can be defined or undefined membership.

A **'group party'** is any number of parties, together forming a distinct entity, with each party registered

A party or group party should be assigned a unique identifier (pID) when registered or recorded. See Annex 1.

2.3 RRR

Rights, responsibilities, and restrictions are collectively referred to as RRRs.

In LADM a **'right'** is formal or informal entitlement to own or perform an action (a formal or informal entitlement to own or do something).

People to land relations or land rights may provide a formal or informal entitlement to own or do something on a specific spatial unit (land parcel). Examples of land rights are: formal ownership, usufruct, freehold or leasehold, etc. It can also be a social tenure relationship like occupation, tenancy, non formal and informal rights, customary rights, indigenous rights, and possession. A right can be an Islamic land right (e.g. miri or milk).

Note: there can be a share in a right. In LADM, fractions are used to express shares, not percentages. When using percentages, the sum of those shares does not need to be equal 1 in all cases. Compare, for example, a case with three shares: 1/3, 1/3, 1/3 and 33.3%, 33.3%, 33.3%. A share 1/1 implies it is full ownership. This could be even explicit in the database, but in this booklet that approach is not used for clarity reasons. See paragraph 6.2 for further explanation of fractions.

A **'restriction'** is a formal or informal obligation on the land owner to refrain from performing an action.

Examples of restrictions are situations where it is not allowed to build within 200 metres of a fuel station or a buffer zone along a road or highway where it is not allowed to establish buildings. And a mortgage as a restriction to an ownership right.

A **'responsibility'** is a formal or informal obligation on the land owner to allow or perform an action. Owner implies leaseholder, usufruct holder, etc.

Examples are the responsibility to clean a ditch or water canal on private land, to keep a snow-free pavement, to remove icicles from the roof during winter, or to maintain a monument.

A RRR should be assigned a unique identifier (rID) when registered or recorded, see Annex 1.

2.4 BAUnit

Apart from parties, rights and spatial units the LADM includes 'basic administrative units' (BAUnits). The term 'basic administrative units' is derived from the term 'basic property unit'[3]. Because properties require formal registration we use 'basic administrative units' because this may include informal registrations.

A **'basic administrative unit'** (BAUnit) is administrative entity, which can be 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, responsibilities or restrictions are associated to the whole entity, as included in a land administration system.

In this definition 'unique' means that a right, restriction, or responsibility is held by one or more parties (e.g., owners or users) for the whole basic administrative unit. 'Homogeneous' means that a right, restriction or responsibility (ownership, use, social tenure, lease, or

[3] https://inspire.ec.europa.eu/featureconcept/BasicPropertyUnit

easement) affects the whole basic administrative unit. For a restriction zero parties are a possibility. Ownership rights or land use rights are examples of homogeneous rights.

There are countries with a land registry but without cadastre. There is no cadastral map. Access to the registry is based on a party identifier (pID) or on BAUnit identifier (uID, optional). Spatial units are not explicitly represented in the land administration because there is no cadastral map. This means that a BAUnit can consist of zero spatial units. See figures CHRIT 01 and CHRIT 02 for examples of BAUnits in relation to spatial units. Note: those figures are not yet in LADM colours.

Restrictions and responsibilities can be associated with their own BAUnits, each with their own type of spatial unit. Note: There may be a need for extensions of the definition of BAUnits in different countries.

A BAUnit should be assigned a unique identifier (uID) when registered or recorded. See Annex 1.

Examples of BAUnits are:

- a condominium unit comprising two spatial units, this could be an apartment and a garage
- a farm lot comprising one spatial unit (one parcel of land)
- a servitude comprising one spatial unit, this can be a road representing a right- of-way
- a land consolidation area
- a right-of- use unit with several right holders and restricted objects, or:
- a windmill farm on the sea in one spatial unit combined with cable to the land as another spatial unit together form two spatial units in one BAUnit.

2.5 Spatial Unit

Spatial units are the areas of land (or water) where the people to land relationships apply. The term *land parcel* usually has a formal definition and is applicable for formal land rights. Apart from formal rights the LADM may include informal or customary rights. Or marine rights. For this reason we use 'spatial unit'. Spatial units is a neutral term.

In LADM a **'spatial unit'** is a feature type related to land administration with associated spatial and thematic attributes.

Spatial units can be represented as a text ('from this tree to that river'), as a single point, as a set of (unstructured) lines, as a surface or polygon), or as a 3D volume, see Annex 2. Surveys concern the identification of spatial units on a photograph, an image or a topographic map.

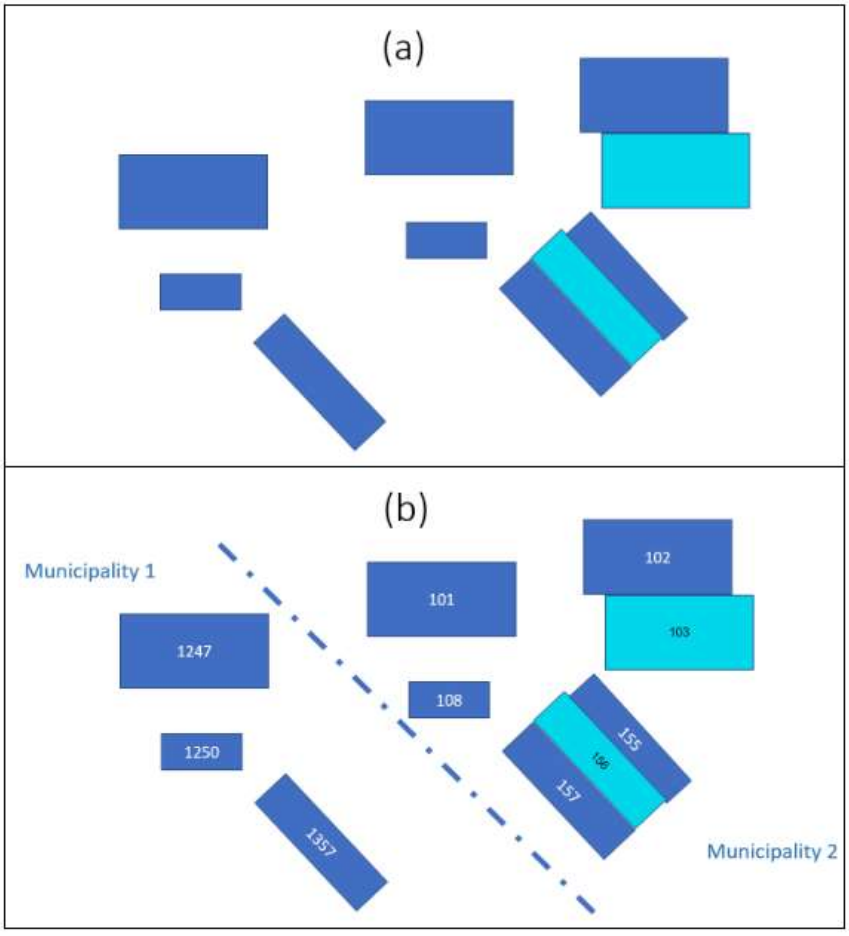
Rights may be overlapping, or may be in disagreement. Land conflicts could be visualised (using cartographic symbols) on a cadastral map. If the dispute is upheld then the cadastral map would be updated to show the new state of ownership.

A **'spatial unit group'** is any number of spatial units, considered as an entity.

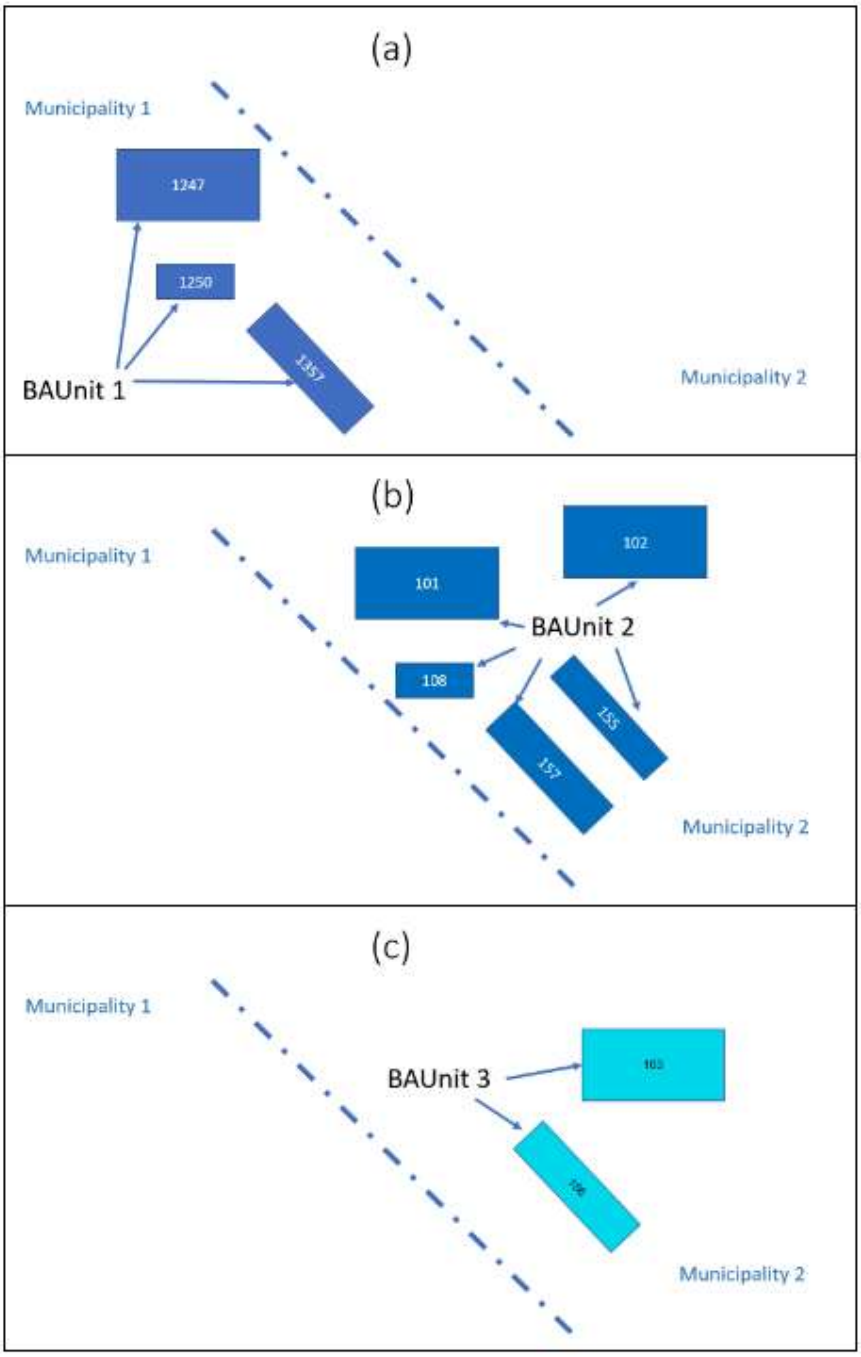
A spatial unit group can form an administrative zone such as a section, a canton, a municipality, a department, a province, or a country. A spatial unit group can concern an area where a spatial plan is under development.

A spatial unit should be assigned a unique identifier (suID) when registered or recorded. See Annex 1.

The figures CHRIT 01 and CHRIT 02 give examples of BAUnits associated with spatial units. One farmer has spatial units in ownership (freehold in dark blue) and in lease (leasehold in light blue). Three spatial units are in municipality 1, seven spatial units are in municipality 2. Five in ownership and two are leased. For taxation purposes there are three basic administrative units created for registration. BAUnit 1 in municipality 1. BAUnit 2 and BAUnit 3 are in municipality 2. For taxation the basic administrative units are considered as units that can be linked to tariffs. The leasehold has another tariff for taxation then the leasehold. Tariffs are different per municipality.



Caption figure CHRIT 01: (a) One farmer has spatial units in ownership (freehold dark bleu) and in lease (leasehold in light bleu). (b) Three spatial units are in municipality 1, seven spatial units are in municipality 2. Five in ownership and two are leased.



Caption figure CHRIT 02: For taxation purposes there are three basic administrative units created for registration. BAUnit 1 in municipality 1. BAUnit 2 and BAUnit 3 in municipality 2. For taxation the basic administrative units are considered as units that can be related to tariffs. The leasehold has another tariff for taxation then the leasehold.

2.6 Source

A **'source'** is a document providing legal and/or administrative facts on which the land administration object is based on.

A source can be administrative, for example a deed or title, a court decision or spatial, for example a field work of a surveyor, a satellite image or an orthophoto. In principle any kind of document may be added as a source.

A source should be assigned a unique identifier (sID) when registered or recorded. See Annex 1.

2.7 Transaction

People to land relationships are dynamic and subject to change. Transactions can be: buying/selling, establishment of mortgage, inheritance, valuation and taxation, land consolidation, update attributes, send confirmation, etc. Those changes require maintenance of the database. Those updates of the database are integrated in workflows. Updates should be implemented in such a way that they bring the database from a consistent state before transaction to a consistent state after the transaction. See chapter 5.

2.8 Versioned Object

All information in a LADM based database gets timestamp attributes. The date and time of insertion and deletion of all attributes is included. This allows for example reconstruction of the information at a certain moment back in time or making an overview of changes within a certain period of time.

2.9 Multilayer

LADM allows multilayers, those are called levels.

A ‘level’ is a collection of spatial units with a geometric and/or topologic and/or thematic coherence.

Examples: one level with spatial units (cadastral parcels), one level with buildings, one level with disputes.

3. People to land relationships

3.1 How is the reality represented in the database: nine cases

In order to simplify administration of land rights, the registrar of lands in Waterriver (and in other municipalities) has used the LADM model as foundation for the Land Administration System. In LADM parcels with uniform rights and the same right holder are packaged into basic administration units: that is a group of spatial units.

Figure 4 shows the starting point in presenting cases. A (or a group of) parcel(s) and their ID's are highlighted on the cadastral map with related rightholder and their names and the right type.

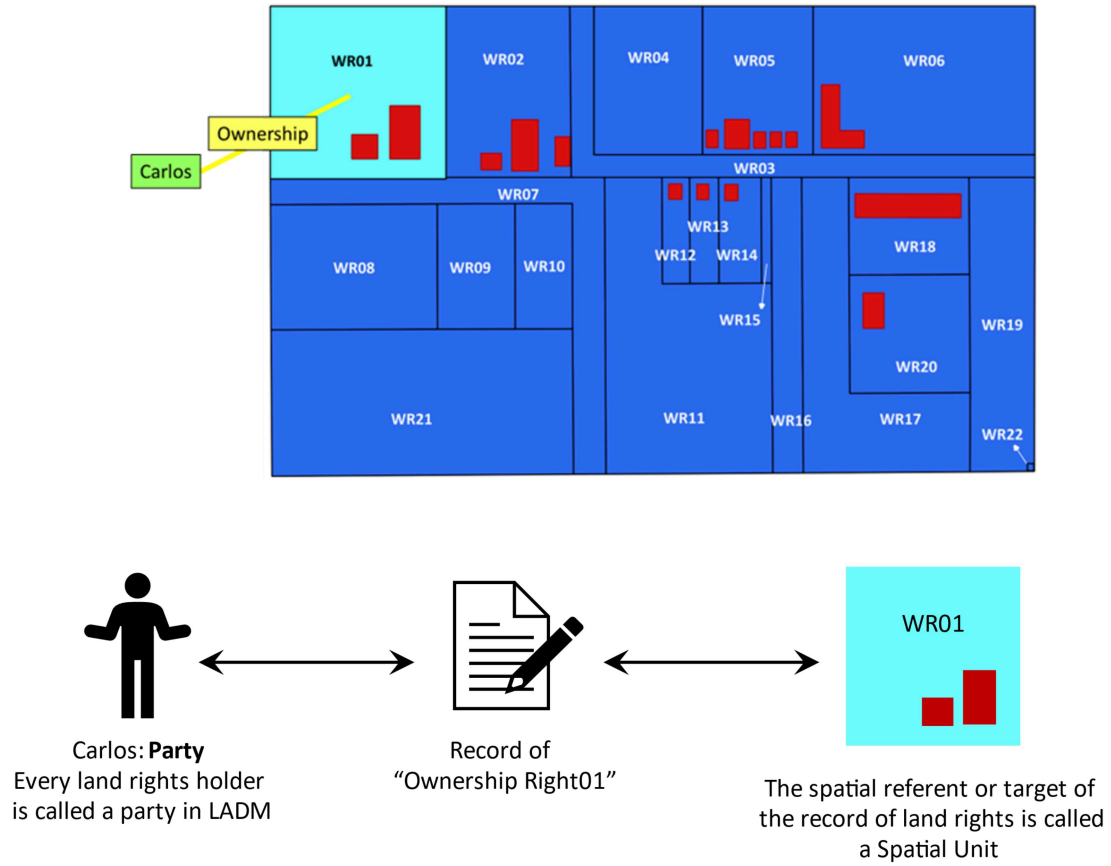


Figure 4. A spatial unit (parcel) with it's id "WR01"highlighted on the cadastral map with the related party "Carlos" and the partys name and the righttype "ownerhip right"

From the introduction of BAUs a box representation can be introduced – this representation is called an instance level diagram. These diagrams present static snapshots of instances (not classes) in the LADM. It shows exactly what points to what. See figure 8.

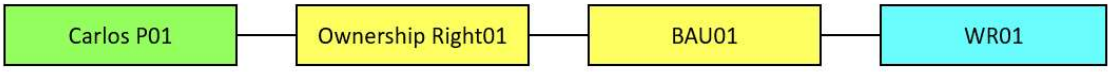
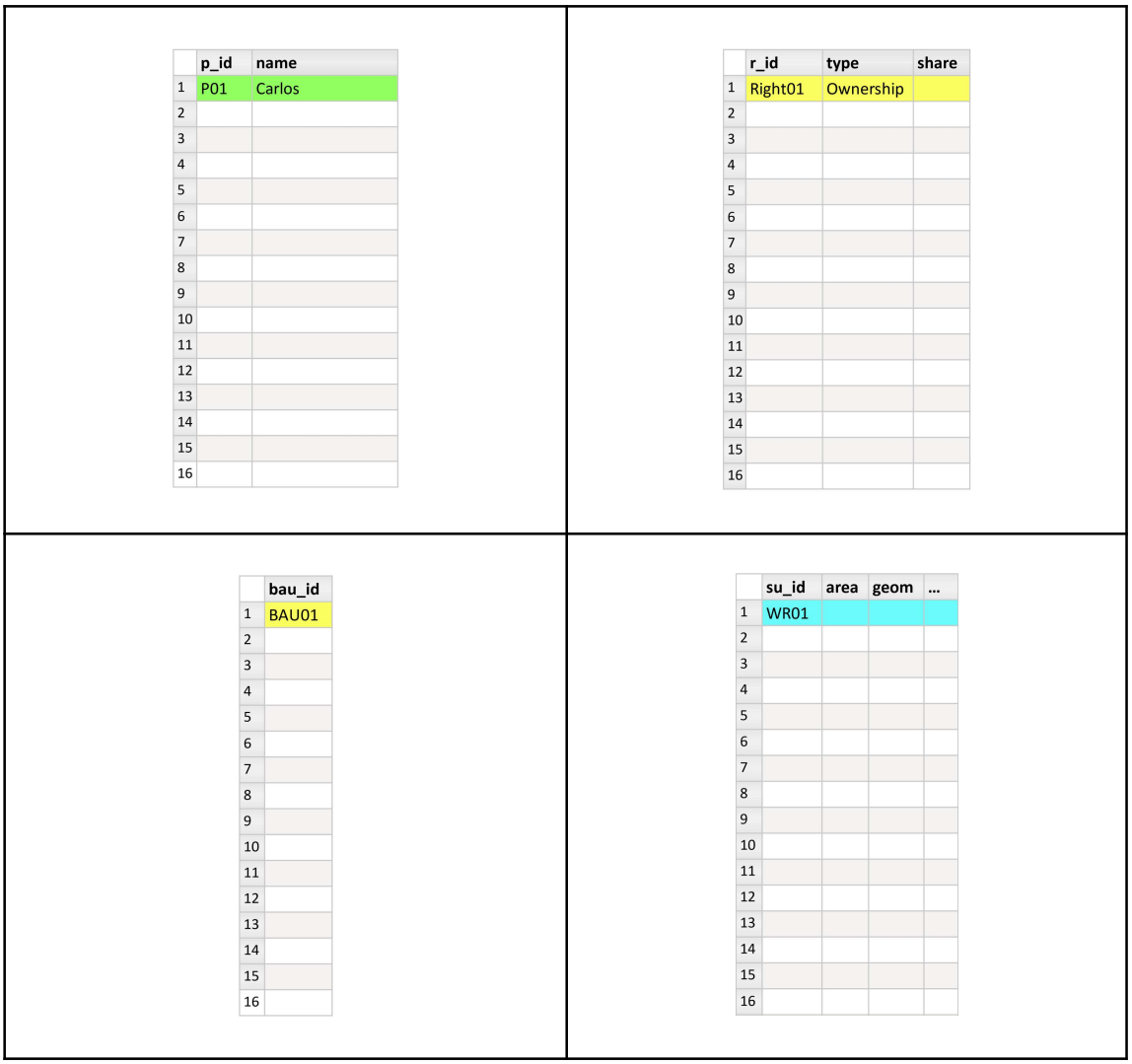


Figure 5. Instance level diagram

See figure 6.shows how all this can be represented in tables.

A party represents a person. Because different people can have the identical names, each person's record must have a unique identifier or party identifier (pID). In fact parties, rights, restrictions, basic administrative units and spatial units all have unique identifiers. Along with transactions, these are the key indexes which are used to describe state and state change.This is not meant to be the internal database identifier that is used for database management. This internal id is represented in each database table in the column to the left. See figure 6.



	p_id	name
1	P01	Carlos
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

	bau_id
1	BAU01
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

Figure 6. LADM tables in the database: (a) Party table (b) Right table (c) BAUnit table (d) Spatial unit table

Finally we put it together in tables related to each other, see figure 7.

	p_id	name
1	P01	Carlos
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

	bau_id
1	BAU01
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

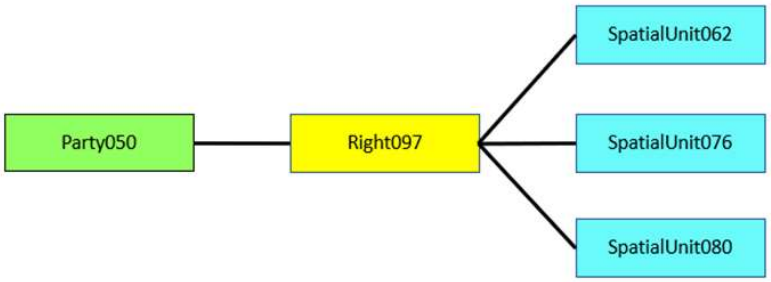
	su_id	area	geom	...
1	WR01			
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				

Figure 7. All tables combined

Examples of identifiers for parties and spatial units are in Annex 1.

3.3 Relationships without BAUnit

The BAUnits are not applied in the Social Tenure Domain Model, this a specialisation of the LADM applicable in land administration under development. In this case a right applies directly to a spatial unit. See Figure CHRIT 03 where Right097 applies to the spatial units 062, 076 and 080. Note: 'rights are called 'social tenure relationships' the Social Tenure Domain Model, in that way informal and customary rights can be included. Those social tenure relations may be converted to formal rights under LADM.

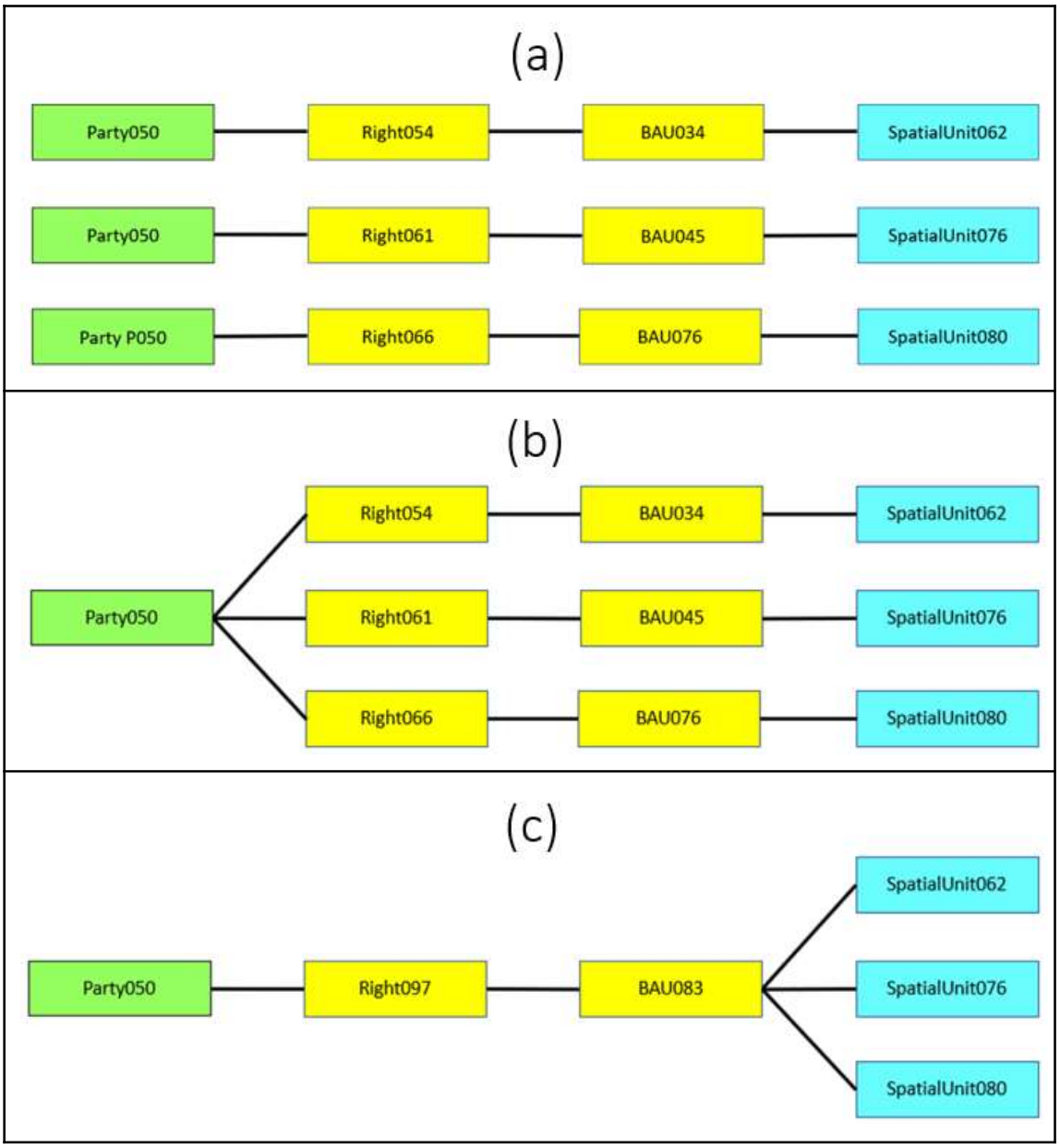


Caption Figure CHRIT 03: Right097 applies to the spatial units 062, 076 and 080. There is no BAUnit.

3.4 Relationships with BAUnit

The figure CHRIT 04 visualises people to land relations with BAUnits. The cases (a), (b) and (c) concern representations of the same situation in the field. Case (a) includes a recordation of the SpatialUnits 062, 076 and 080 with separate BAUNits and rights to the same party (Party050). In case (b) the duplication of information on the party is avoided. Case (c)

aggregates the rights to one right (Right097) to one BAUnit (BAU083) to several spatial units SpatialUnits 062, 076 and 080.



Caption Figure CHRIT 04: People to land relations represented with BAUnits. The cases (a), (b) and (c) concern representations of the same situation in the field. Case (a) includes a recordation of the SpatialUnits 062, 076 and 080 with separate BAUNits and rights to the same party (Party050). In case (b) the duplication of information on the party is avoided. Case (c) aggregates the rights to one right (Right097) to one BAUnit (BAU083) to several spatial units SpatialUnits 062, 076 and 080.

4. The Map and the Database

4.1 The cadastral map of the municipality of Waterriver

In this chapter we lay out the visualisation of the formal legal situation in Waterriver showing a total of 15 parties, 17 rights, 2 restrictions, 13 basic administrative units and 22 spatial units.

The Cadastral Map of the Municipality of Waterriver (figure 8) shows the 22 different spatial units (land parcels) representing where different parties hold ownership rights. Each parcel has a unique ID that is represented inside the parcel (where possible) on the cadastral map.

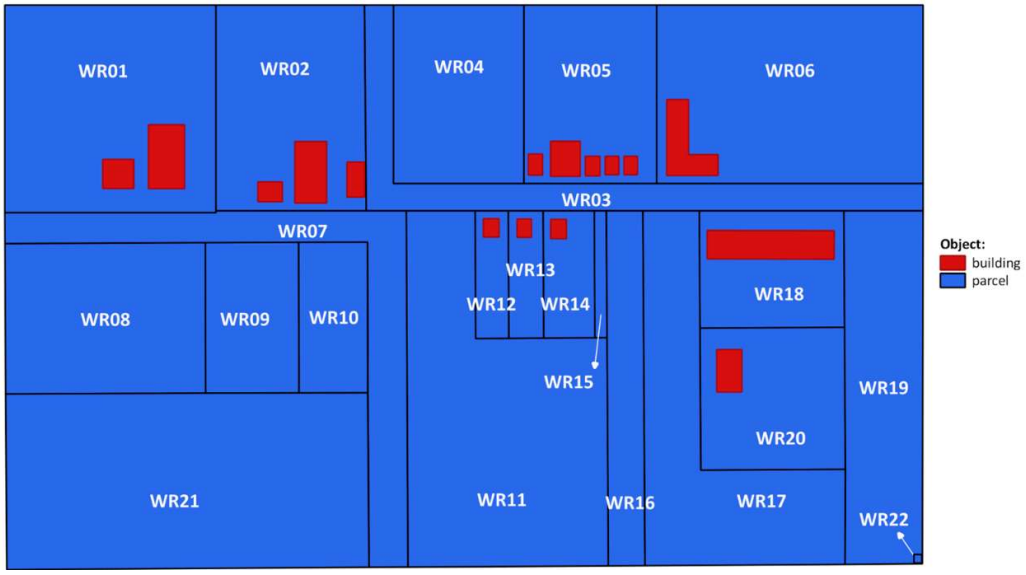


Figure 8. The cadastral map of the Municipality of Waterriver

The unique identifier contains a cadastral municipal code for the municipality ('WR' from Waterriver) and an unique parcel number per municipality. The cadastral map is digital accessible after the analogue map was converted.

Not only private owned lands can be represented and identified as parcels on the cadastral maps, also public lands (as public roads, schools and other public buildings) are identified, documented and represented (see figure 9). A school is at parcel WR06, the municipal buildings and services are at parcel WR05. And water in WR15.

The whole territory of the municipality is included, all land is represented in the Land Administration System.

As soon as all lands and related land rights of all municipalities are included in the land administration there is a nationwide seamless cadastral map.

In Waterriver land parcels cannot be represented as overlapping.

The original analogue map was at scale 1:2000.

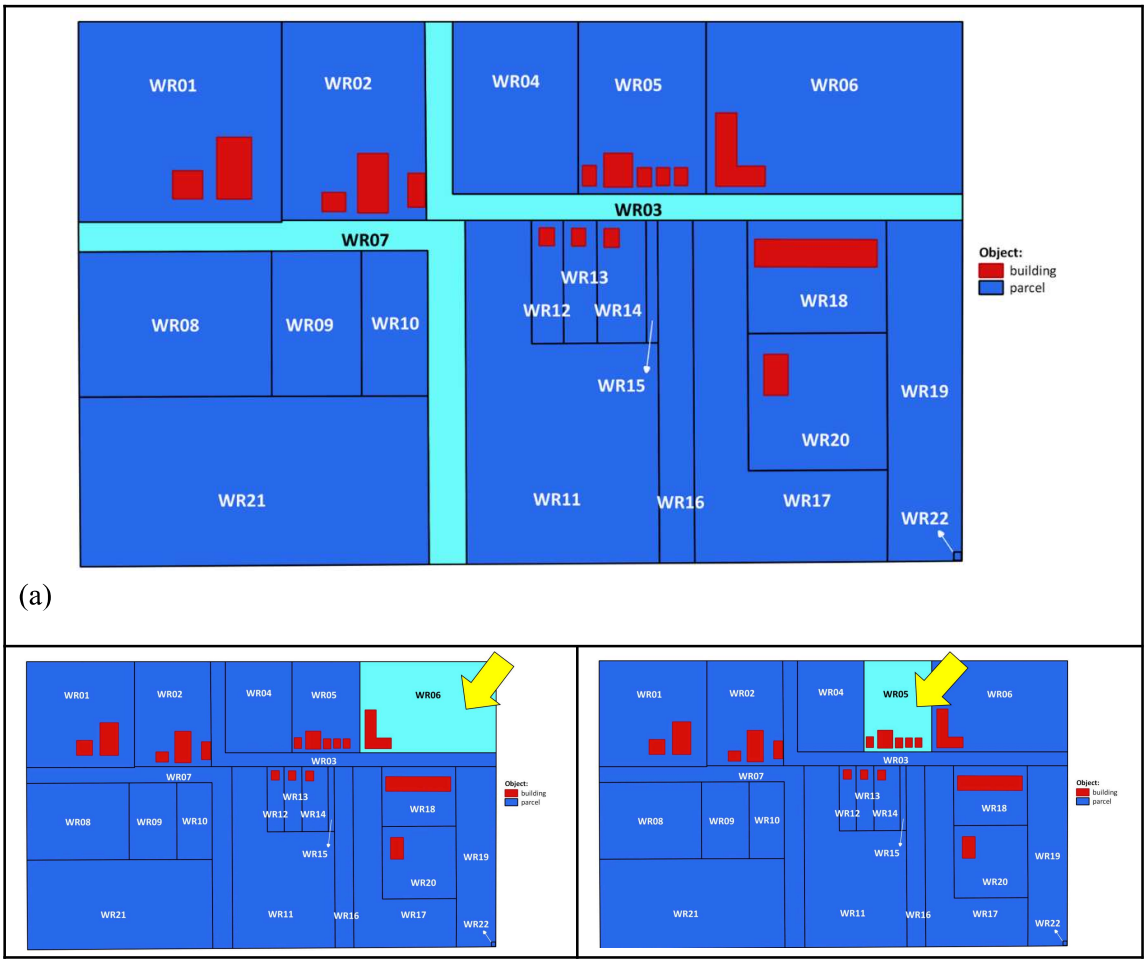


Figure 9. Public land in Waterriver: (a) Public roads (b) School (c) Municipal buildings and services

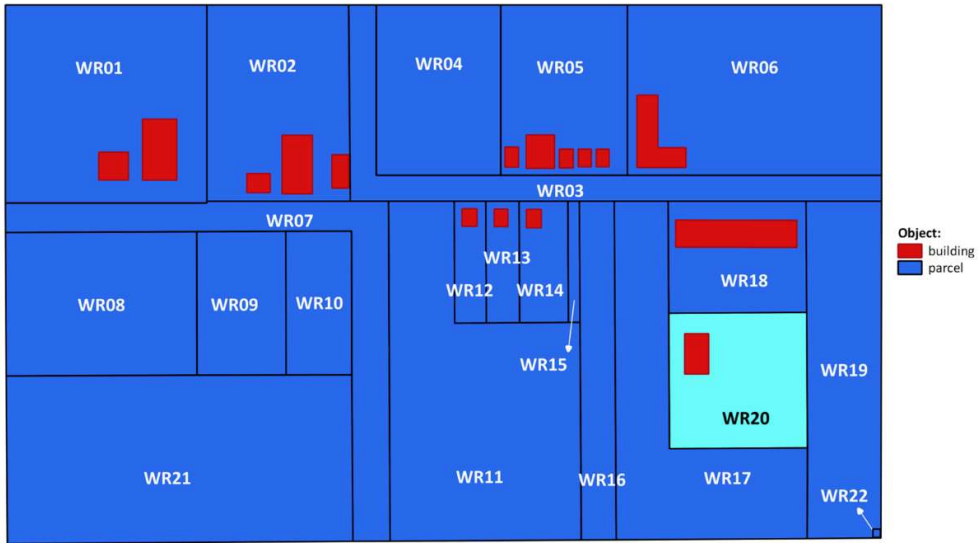


Figure 10. WR20 does not have access to a public road

The law says that all parcels should be accessible from and to public roads, those are the parcels WR03 and WR07. The parcel WR20 does not have access to the public road, see

Figure 10. This means that you have to cross another parcel to get access to a public road. This right to cross somebody's land has to be formalised in order to avoid conflicts.

Note: parcel WR22 is very small, only 1 sqm. Normally there is a minimal area for a parcel or spatial unit (defined by law or customs).

4.2 Case One: Carlos

Carlos has a right of ownership in the municipality of Waterriver. See figure 11.

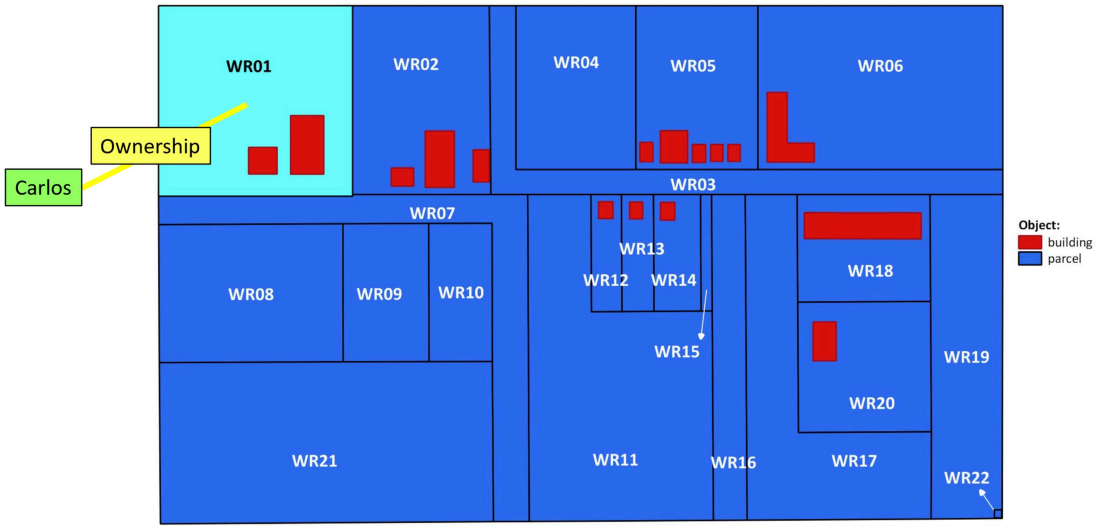


Figure 11. Carlos has a right of ownership on spatial unit

The instance level diagram related to this case is presented in Figure 12. You can see here that the right of ownership applies to a basic administrative unit and not directly to the spatial unit WR01. See figure 12.

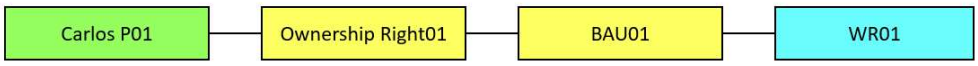


Figure 12. Instance Level Diagram of Case One.

Apart from spatial units also parties, rights and basic administrative units get a unique identifier in the land administration of the municipality of Waterriver where this case is registered.

In this case Carlos gets an id “P01”. “P” is from “Party”. The right is of type “ownership” and has as id “RIGHT01”.

The basic administrative units gets “BAU01” as id. In this case the basic administrative unit BAU01 is composed out of one spatial unit which is identified as WR01.

The database contains four tables to include attributes on parties (p_id and name), rights (r_id, type and share), basic administrative units (bau_id) and spatial units (su_id, area and geometry, see annex 2). Each table represents a class in LADM. LADM has more classes and more attributes than shown in the example cases here.

	p_id	name
1	P01	Carlos
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

	bau_id
1	BAU01
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				

Figure 13. Case 1 represented in the four database tables: party table, right table, basic administrative unit table and spatial unit table.

Each table has in its first column a database id. This id is needed to manage the data in the database management system.

In the cases below the database tables will be further filled. This will be illustrated in a straightforward way. In a real database this is more complex.

4.3 Case Two: Elisabeth and Thomas

Elisabeth and Thomas are married and together they own the basic administrative unit to which spatial units WR02, WR08 and WR10 belong - as can be seen on the cadastral map in figure 14.

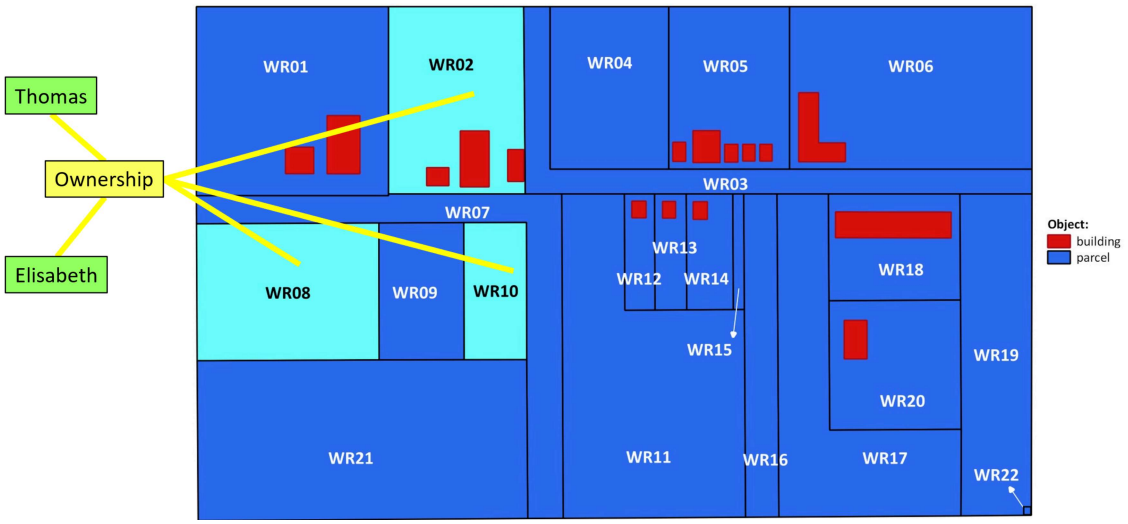


Figure 14. Thomas and Elisabeth have a property right on spatial units WR02, WR08 and WR10.

In the land administration this case is registered with both Elisabeth (P03) and Thomas (P02) owning a share ½ with an ownership right (Right02) to a basic administrative unit, in this case BAU02. See figure 14.

It is further registered that BAU02 consists of the spatial units WR02, WR08, WR10. One property, three spatial units (parcels), see figure 15.

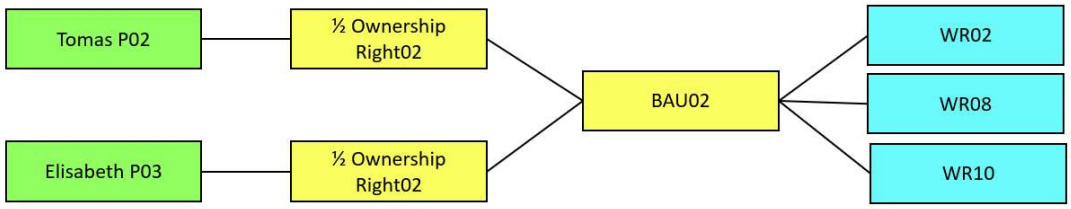


Figure 15. Thomas and Elisabeth have shares in the property right onBAU02. BAU02 consists out of spatial unitsWR02, WR08, WR10

The shares are included in the table with rights, see figure 16.

In the table below the earlier case with Carlos is still included. The actual case with Thomas and Elisabeth is highlighted in LADM colours. The database will be built up “case by case”.

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2

	bau_id
1	BAU01
2	BAU02

	su_id	area	geom	...
1	WR01			
2	WR02			
8	WR08			
10	WR10			

Figure 16. Both shares of Elisabeth and Thomas are represented on two records in the second table from the left

Note: alternative approaches in recordation and representation in the database are possible: one of the spatial units acts as a party and has rights relationships with other spatial units. By owning the 'dominant' spatial unit a party 'inherits' rights in the 'servient' spatial units. For example:

- Thomas and Elisabeth own WR02 each with a 1/2 share
- WR02 owns a 1/1 share in WR08
- WR02 owns a 1/1 share in WR10

This means that by owning WR02 Elisabeth and Thomas 'inherit' ownership of WR08 and WR10. Such an approach can be worked out in a country profile.

4.4 Case Three: the municipality Waterriver

The municipality of Waterriver (P04) is a non-natural party.

This party (P04) has a property right on the BAU03 consisting of the public roads (WR03 and WR07), the parcel of the municipal buildings (WR05), the parcel with the municipal school (WR06), the park (WR15) and the water canal in WR16.

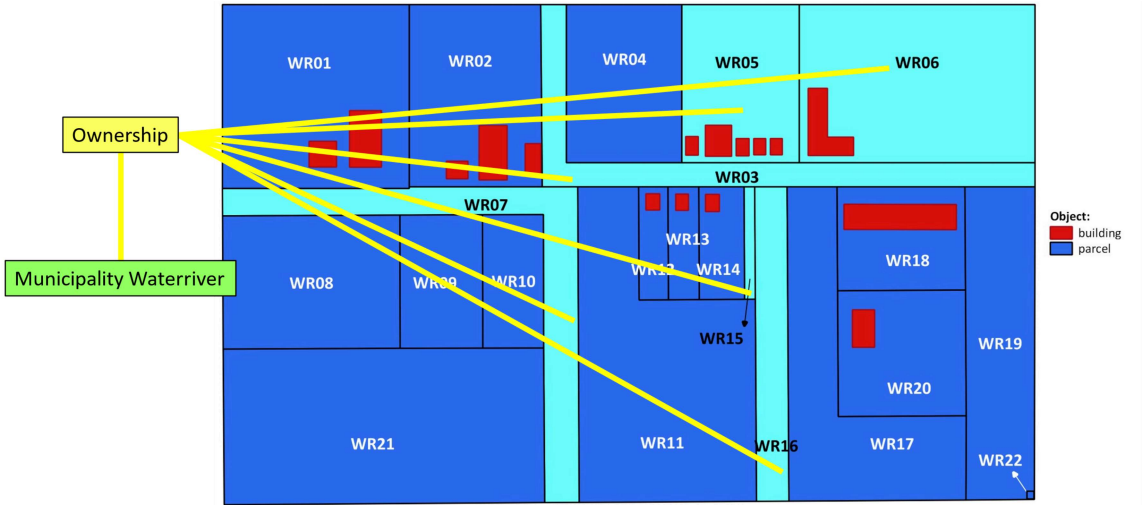


Figure 17. The Municipality of Waterriver in its role as land owner

These six spatial units (alias is parcels – because there are formal land rights) compose one basic administrative unit (BAU03) as shown in figure 18.

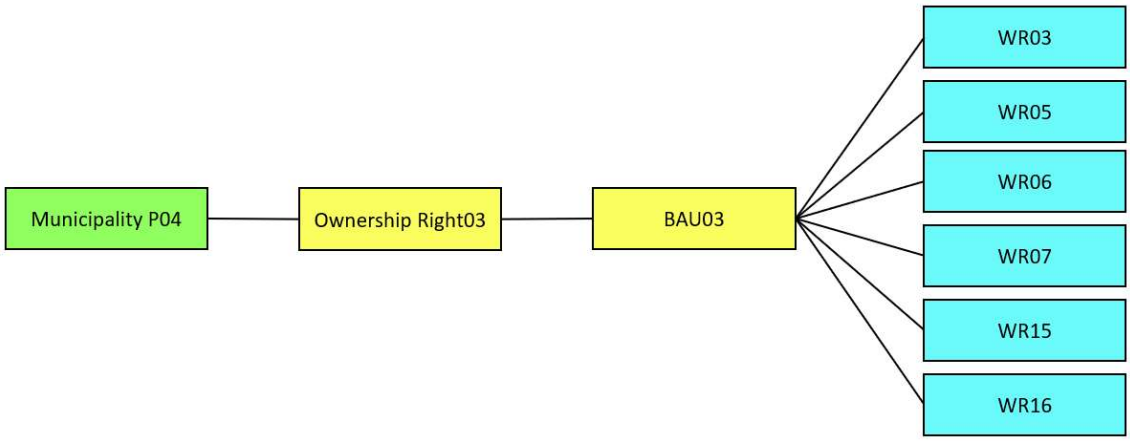
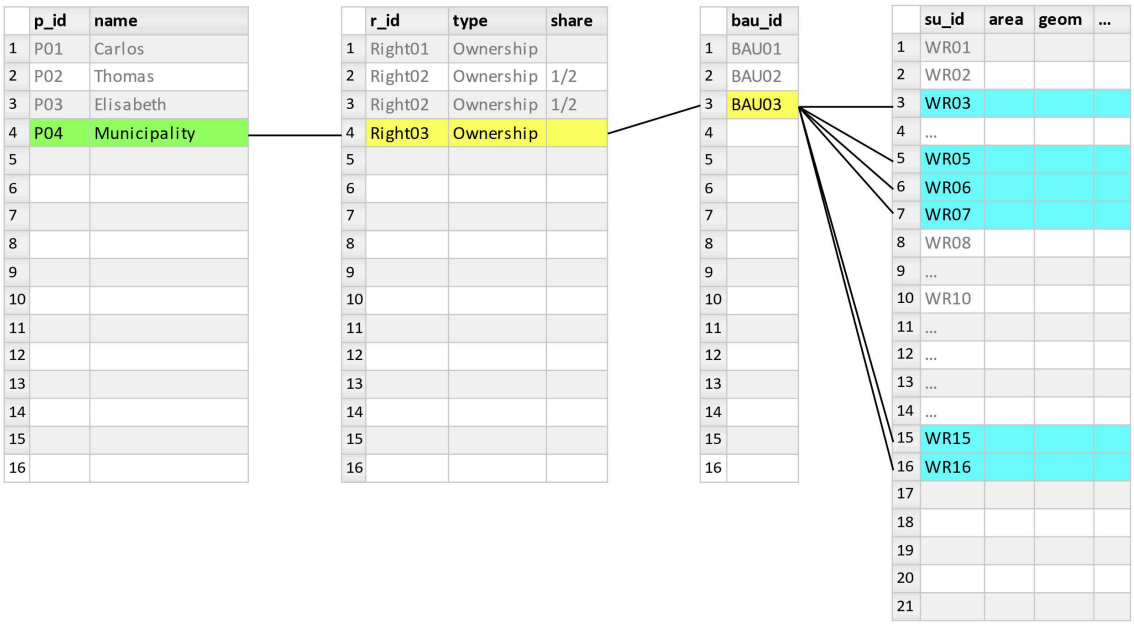


Figure 18. Instance Level representing the case of the municipality of Waterriver

In figure 18 the municipality as a party has the id P04. The municipality holds an ownership right (Right03) to a basic administrative unit (BAU03) that is composed of spatial units WR03, WR05, WR06, WR07, WR15 and WR16.

Inclusion of this case in the database results in further filled tables see figure 19. The records of earlier cases (Carlos, Elisabeth and Thomas) can be seen there as well.



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	

	bau_id
1	BAU01
2	BAU02
3	BAU03

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	...			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	...			
10	WR10			
11	...			
12	...			
13	...			
14	...			
15	WR15			
16	WR16			

Figure 19. The municipality of Waterriver as recorded in the LADM based database

4.5 Case Four: The Cooperative (Cooperation) and Anna

In Waterriver there is a farmers cooperative or cooperation. The cooperative is a legal entity which owns land that is used for agriculture. The profits of this activity are shared by the members (farmers) of the cooperative (cooperation) on an annual basis or may be used for investments in the further development of the cooperative. For WR04 there is a shared ownership with Anna. The spatial units WR09, WR11, WR17, WR20 and WR21 are fully owned by the cooperative in two basic administrative units. In total this case analysis the rights to three basic administrative units, BAU04, BAU05, BAU06.

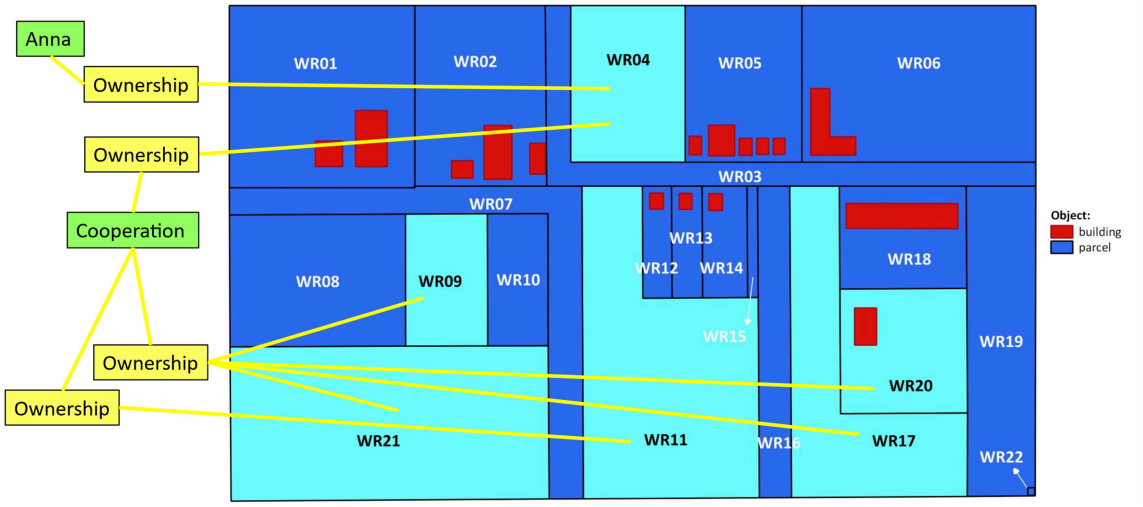


Figure 20. The cooperative owns two basic administrative units. One including WR09, WR17, WR20 and WR21 and one including WR11. Another basic administrative unit includes the spatial unit WR04 in shared ownership with Anna

The case for BAU04

The share in the ownership right of BAU04 with WR04 for 9/10th by Anna and by 1/10th by the Cooperative (Cooperation) can be modelled as in figure 21:

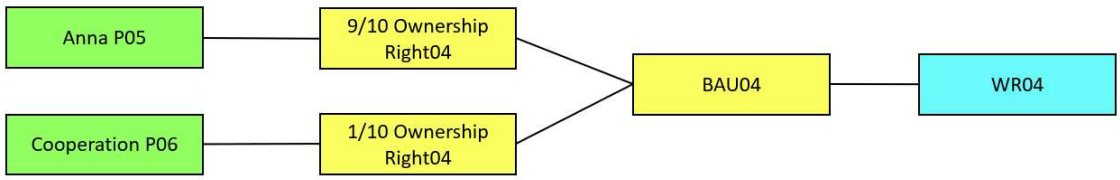


Figure 21.Share in the ownership right of BAU04 with WR04 owned by 9/10th by Anna and by 1/10 th by the Cooperative

Alternative modelling is possible. Then the parties Anna and the Cooperative are members of a group party: a Consortium consisting of Anna and the Cooperative. Anna is for 9/10th shareholder in the Consortium and the Cooperative is for 1/10th shareholder in the Consortium. It should be noted that the Consortium could have more properties.

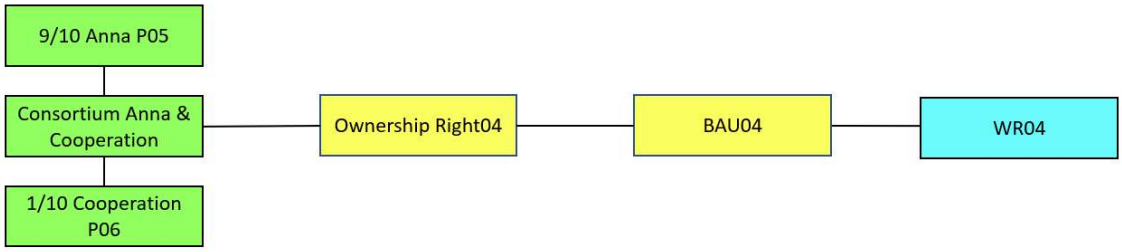


Figure 22. A Consortium between Anna (shareholder for 9/10th) and the Cooperative (1/10th)

In the database the first option (as in figure 21– joint ownership by Anna and the Cooperative) is represented now as follows:

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	...			
10	WR10			
11	...			
12	...			
13	...			
14	...			
15	WR15			
16	WR16			
17				
18				
19				
20				
21				

Figure 23. Joint ownership by Anna and the Cooperative

The case for BAU05 and BAU06

Anna does not hold further ownership rights to basic administrative units in Waterriver. The Cooperative does. The Cooperative further owns the basic administrative units BAU05 and BAU06. BAU05 is composed of WR09, WR17, WR20 and WR21. And BAU06 of WR11.All together:

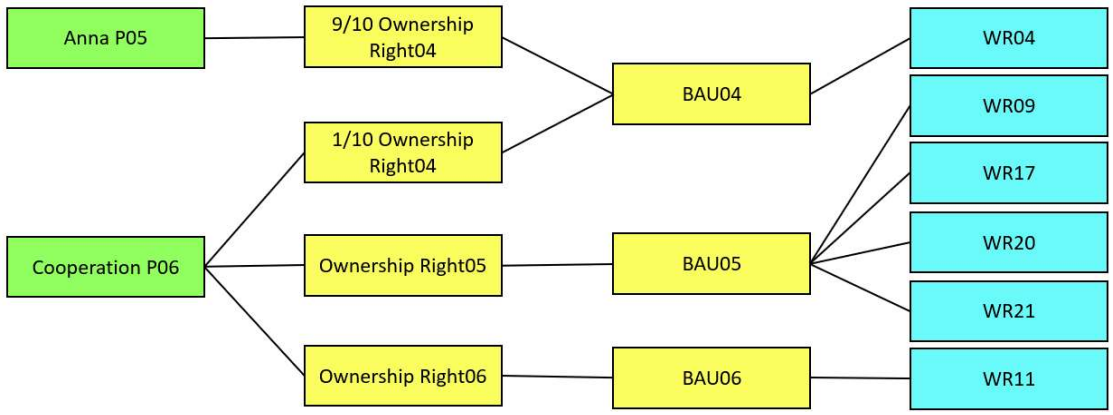


Figure 24. Joint ownership of BAU04 by Anna and the Cooperative. Ownership of BAU05 and BAU06 by the Cooperative

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9			
10			
11			
12			
13			
14			
15			
16			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	...			
13	...			
14	...			
15	...			
16	...			
17	WR17			
...	...			
...	...			
26	WR20			
27	WR21			

Figure 25. The database with the Ownership of BAU05 (with WR09, WR17, WR20 and WR21) and with BAU06 (with WR11) by the Cooperative

4.6 Case Five: The Capital Bank

In case four the spatial unit WR11 has been introduced. It is in BAU06 owned by the cooperative.

Apart from the ownership right there is also a mortgage (restriction), a usufruct and an ownership right on BAU06 (with Spatial Unit WR11). This combination of rights is presented in figure 26 in case five.

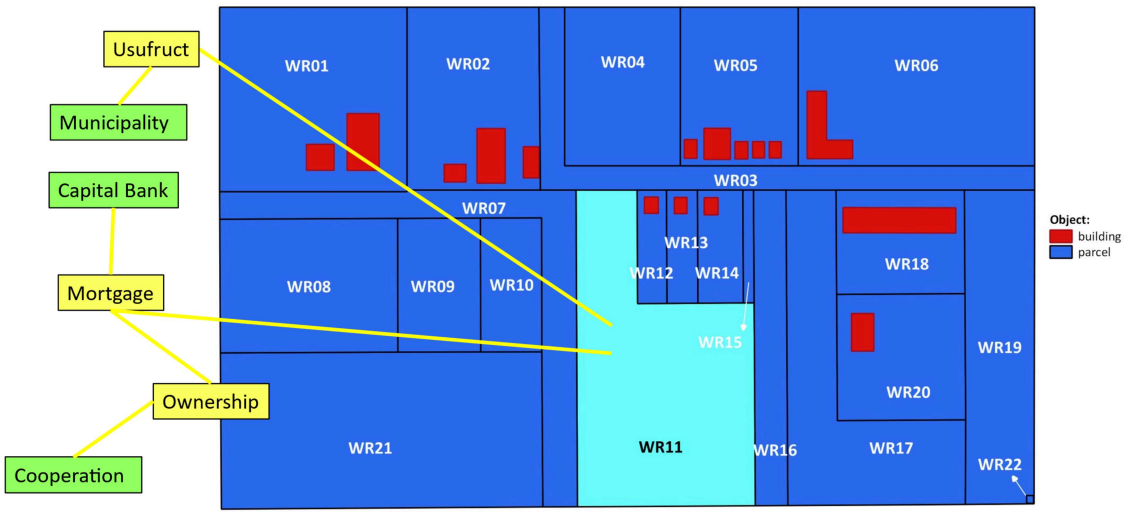


Figure 26. Apart from the ownership right on the WR11 in BAU06 (also shown in Figure 25) there is also a usufruct right and a mortgage on BAU06..

Apart from the ”Ownership Right06”, there is a ”Mortgage Restriction01, to the ownership ”OwnershipRight06”.

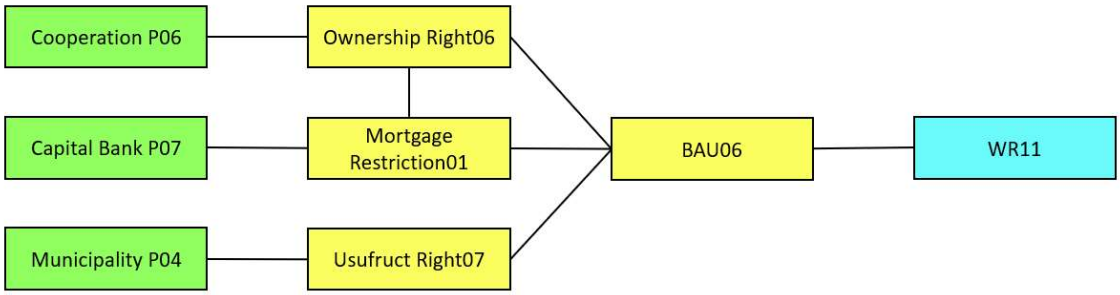
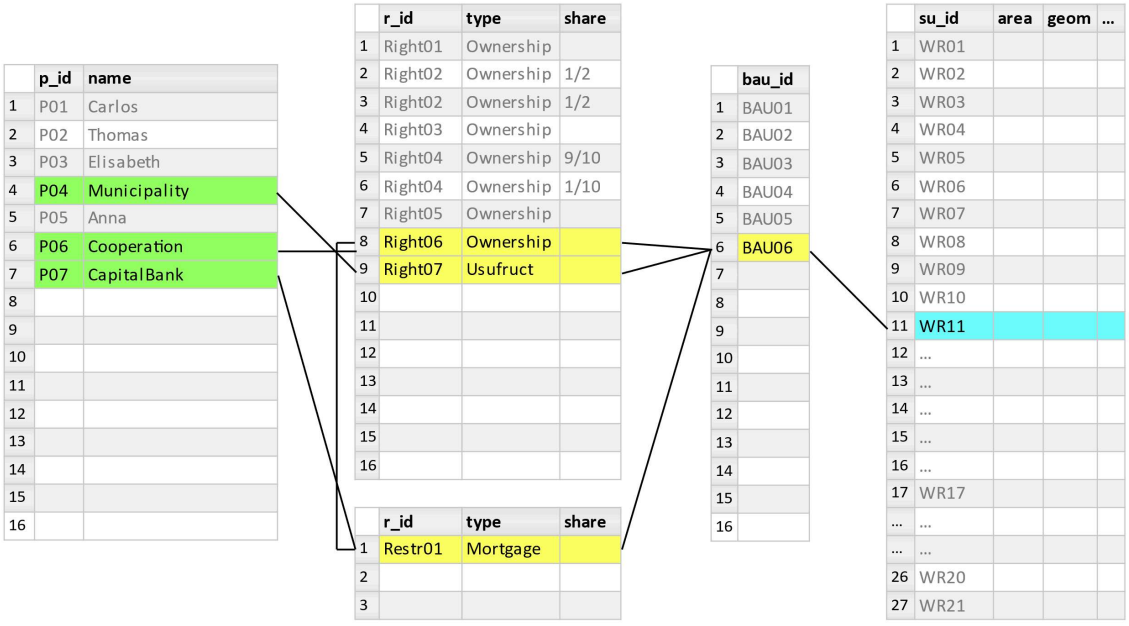


Figure 27. An ownership right, a mortgage and a usufruct right are established in BAU06

Further the municipality of Waterriver has an usufruct on BAU06 consisting of spatial unit WR11. An alternative choice in modelling could be to link the usufruct, ”Right07”, to the ownership right, ”Right 06” (same as mortgage ”Restriction01).

Note: the Capital Bank can not claim full ownership of BAU06 because it is restricted by a usufruct.

The representation in the database is reflected in figure 28:



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8		
9		
10		
11		
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10			
11			
12			
13			
14			
15			
16			

	r_id	type	share
1	Restr01	Mortgage	
2			
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	...			
13	...			
14	...			
15	...			
16	...			
17	WR17			
...	...			
...	...			
26	WR20			
27	WR21			

Figure 28. The mortgage and the usufruct on BAU06

4.7 Case Six: The Housing Company

The Housing Company supports its target group by establishing leaseholds on its parcel (spatial unit) where the houses are built on. The residents can then use it for forty years with

an option for extension. Inheritance of the leasehold is possible, the leasehold can be sold by the leaseholder – but not the ownership of the BAUnit.

In Waterriver the Housing Company owns three basic administrative units with each a parcel with houses attached, see figure 29. Note: the ownership situation is presented here in Case Six, to be continued with the leasehold in Case Seven.

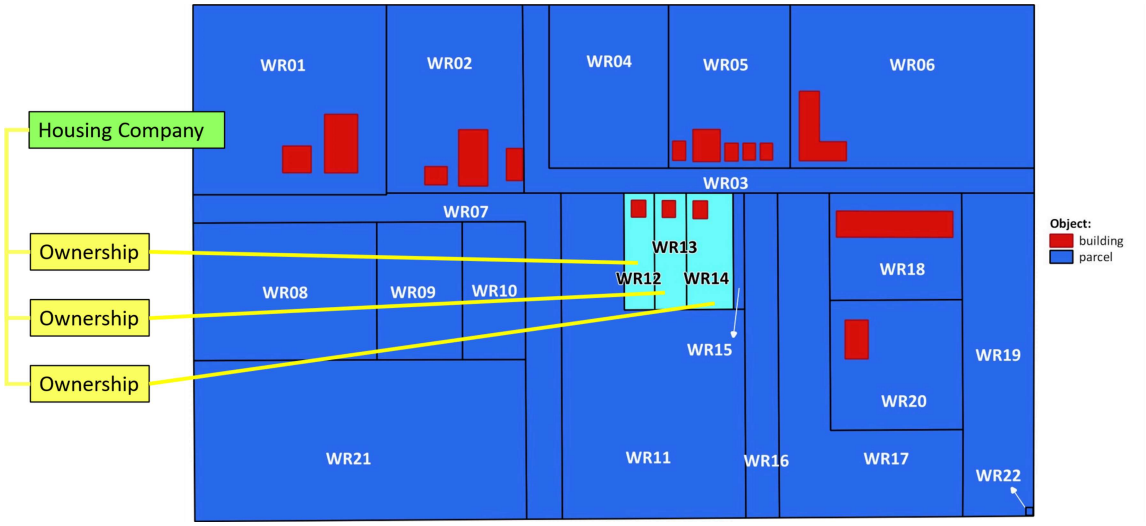


Figure 29. In Waterriver the Housing Company owns three basic administrative units. Each basic administrative unit is related to one parcel (spatial unit) with a house built on it.

The instance level in figure 30 gives a more detailed overview. Ownership Right08 of the Housing Company (which is the party with the id Party08) concerns BAU07 with spatial unit (parcel) WR12 related. Same for Right09 on BAU08 with WR13 and for Right10 on BAU09 with WR14.

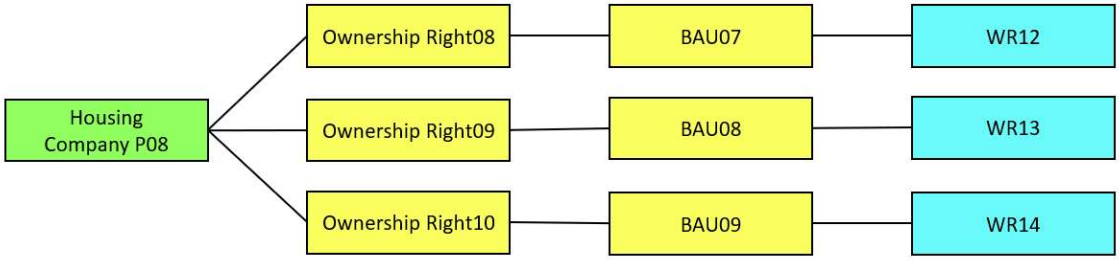
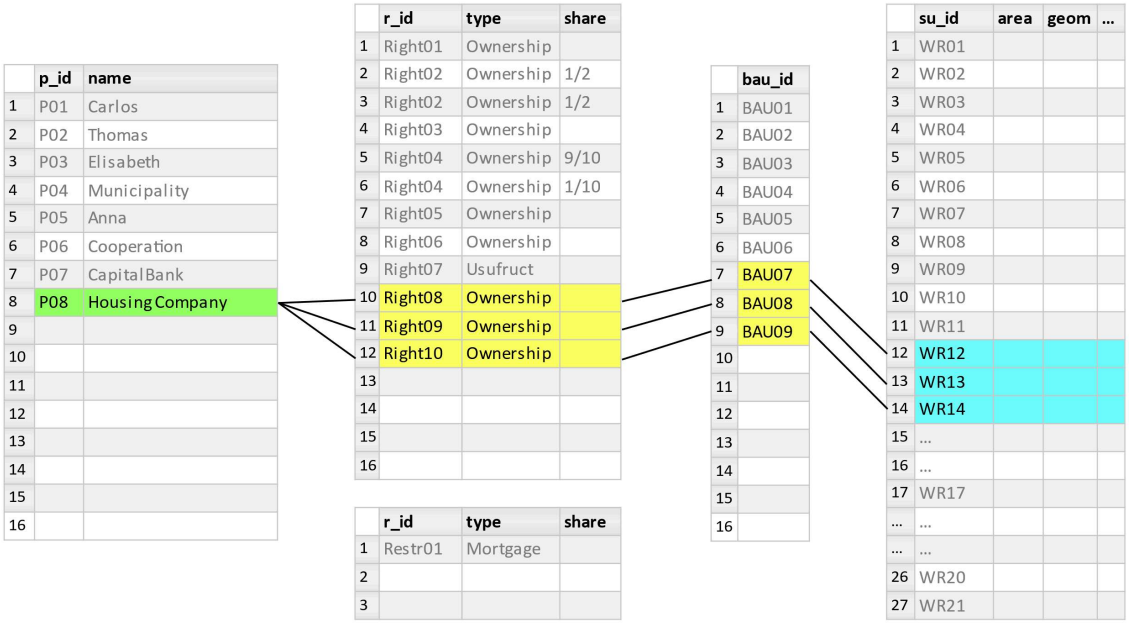


Figure 30. The Housing Company has three ownership rights each of them on a BAUnit with one single spatial unit (parcel)

The case as presented in figure 30 is included in the database as shown in figure 31.



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	HousingCompany
9		
10		
11		
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13			
14			
15			
16			

	r_id	type	share
1	Restr01	Mortgage	
2			
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
...	...			
...	...			
26	WR20			
27	WR21			

Figure 31. The ownership situation of the Housing Company

The case of the leasehold linked to the Housing Company is shown in Case Seven.

4.8 Case Seven: The Housing Company and its leaseholders

On each of the three BAUnits (BAU07, BAU08, BAU09) owned by the Housing Company there is a leasehold right established. The holders of that right are Maria and Johan; Anton and James. See figure 32.

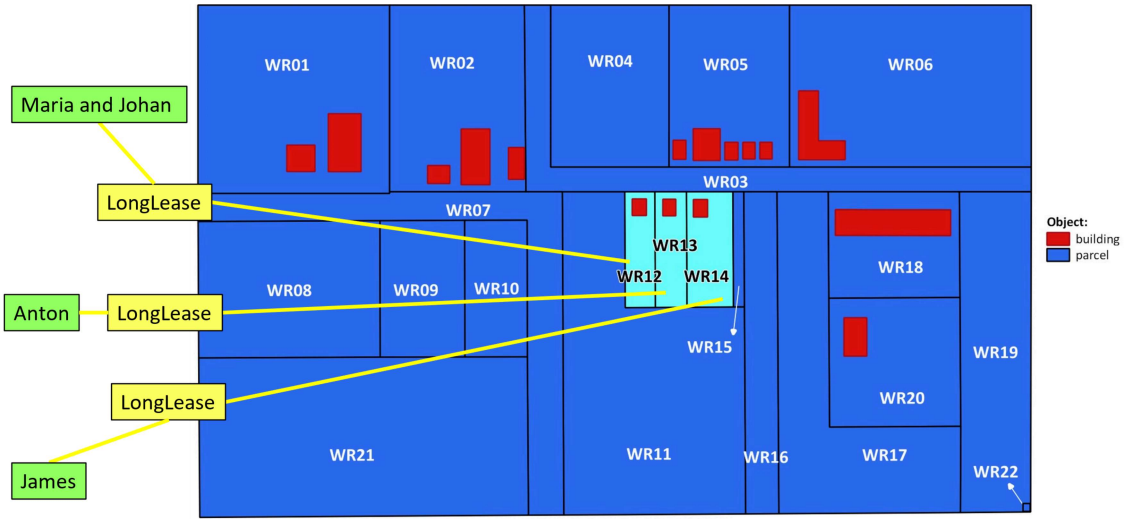


Figure 32. On each of the BAUnits of the Housing Company there is a leasehold apart from the ownershipright by the Housing Comapny itself

The three situations for:

- Maria and Johan,
- Anton and
- James

together with the Housing Company are now introduced. First Maria and Johan – they hold a long lease on the BAU07 with WR12 included.

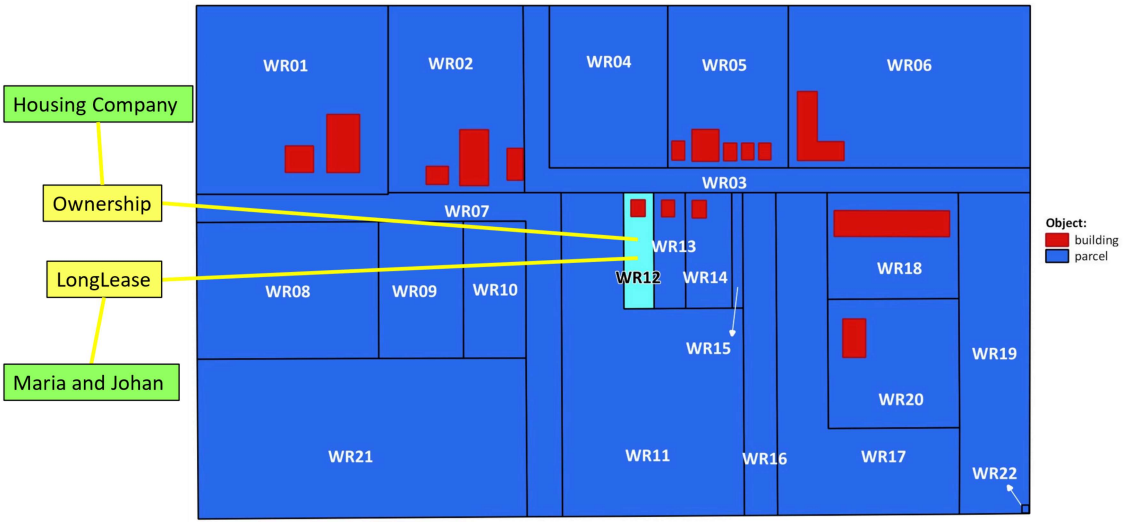


Figure 33. Maria and Johan – hold a lease on the BAU07 with WR12 included

Both Maria (P09) and Johan (P10) hold a share in the leasehold (Right 11) to BAU07 with WR12 related. The ownership is with the Housing Company (P08). See figure 34. Both have a share equal to 1/2. The sum of their shares is equal to 1.

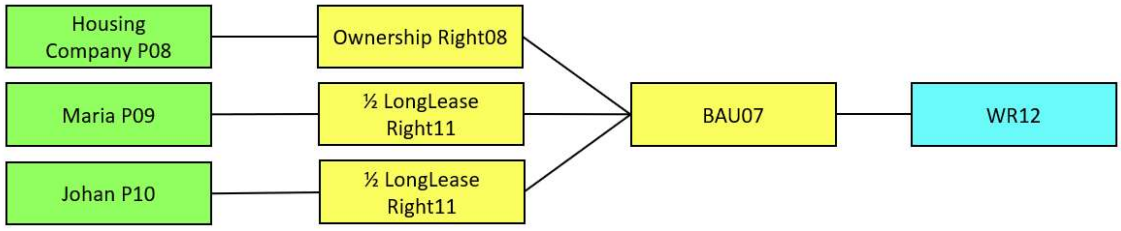


Figure 34. Both Maria, P09, and Johan, P10, hold a share in the leasehold (Right 11) to BAU07 with WR12 related

The tables below show the representation in the database. The ownership Right08 is showed once more combined with the leasehold Right11. Two records are needed for the representation of Right11 because of the shares.

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11		
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15			
16			

	r_id	type	share
1	Restr01	Mortgage	
2			
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
...	...			
...	...			
26	WR20			
27	WR21			

Figur 35. The leasehold Right11 with two records in the right table because of the two shares

The Housing Company P08 is owning the basic administrative (BAU08) unit related to the spatial unit WR13. Anton (P11) has a leasehold associated with the same basic administrative unit. See Figure 36.

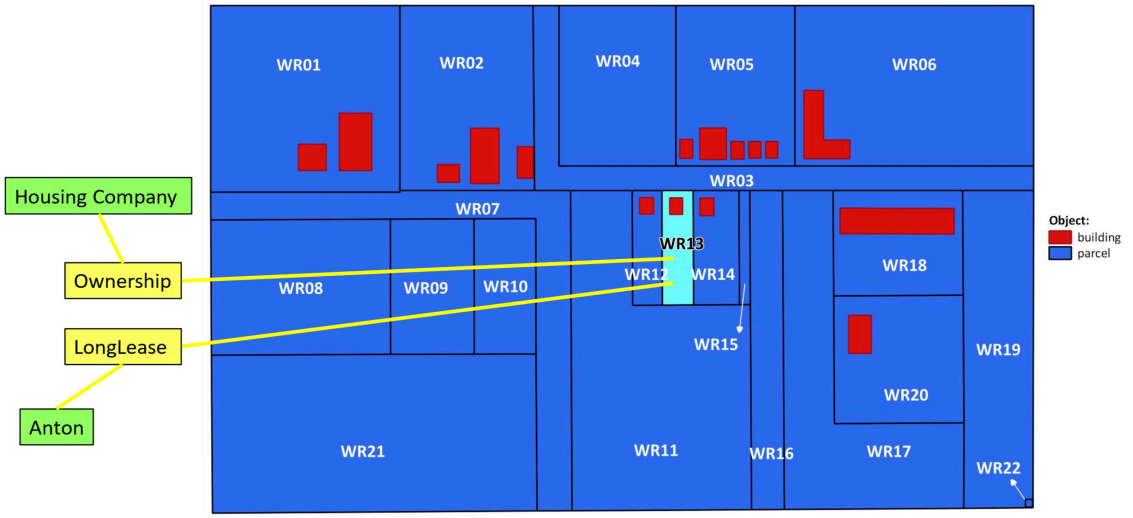


Figure 36. The Housing Company owns the basic administrative unit associated with WR13. There is a leasehold (right12) with Anton (P11). See also figure 37

Antons relationship with land and house is visualised in figure 37:

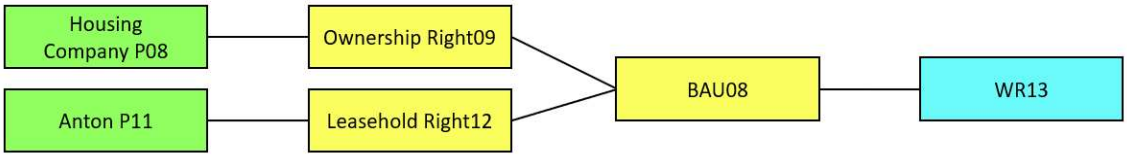


Figure 37. Anton's relationship with land: P11 has a leasehold (Right12) on BAU08 with parcel WR13

The representation Anton's leasehold in the database is represented in in figure 38:

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16			

	r_id	type	share
1	Restr01	Mortgage	
2			
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
...	...			
...	...			
26	WR20			
27	WR21			

Figure 38. Anton's land rights situation in the database

There is a mortgage on Anton's lease as can been seen in figure 39 below.

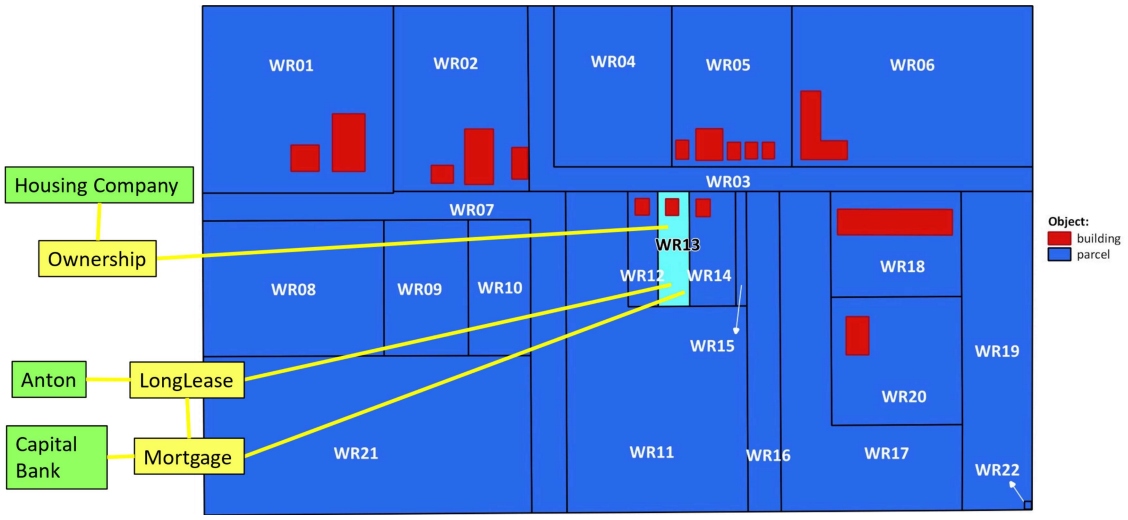


Figure 39. There is a mortgage on Anton's lease

The mortgage ("Restriction02") is explicitly associated to the concerned leasehold ("Right12") and not to the ownership right 09.

The Capital Bank is the money provider. If Anton fails to pay the interest (and redemption) on the mortgage, the Capital Bank can go to court with the mortgage agreement. The value of the leasehold right is the collateral in this situation. The bank can ask to auction off the leasehold. This approach is country specific. Figure 40 illustrates the details of the situation.

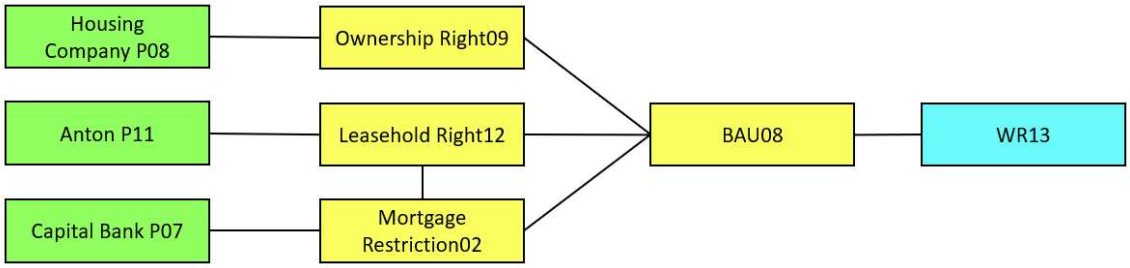


Figure 40. Anton's mortgage agreement with the Capital Bank

In the database the situation looks as shown in figure 41.

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12		
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16			

	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
...	...			
...	...			
26	WR20			
27	WR21			

Figure 41. Anton's mortgage agreement with the Capital Bank

The Capital Bank has now a mortgage (“Restriction01”) to BAU06 and a mortgage (“Restriction02”) to BAU08, see figure 42.

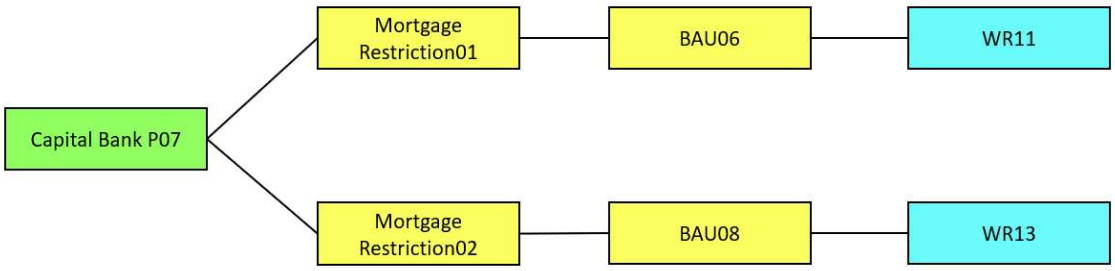


Figure 42. The Capital Bank as money provider

Finally, James (P12), holds a leasehold ("Right 13") on BAU09 with WR14 related. See the map of this situation in figure 42, the instance level diagram in figure 43 and the representation in the database in figure 44.

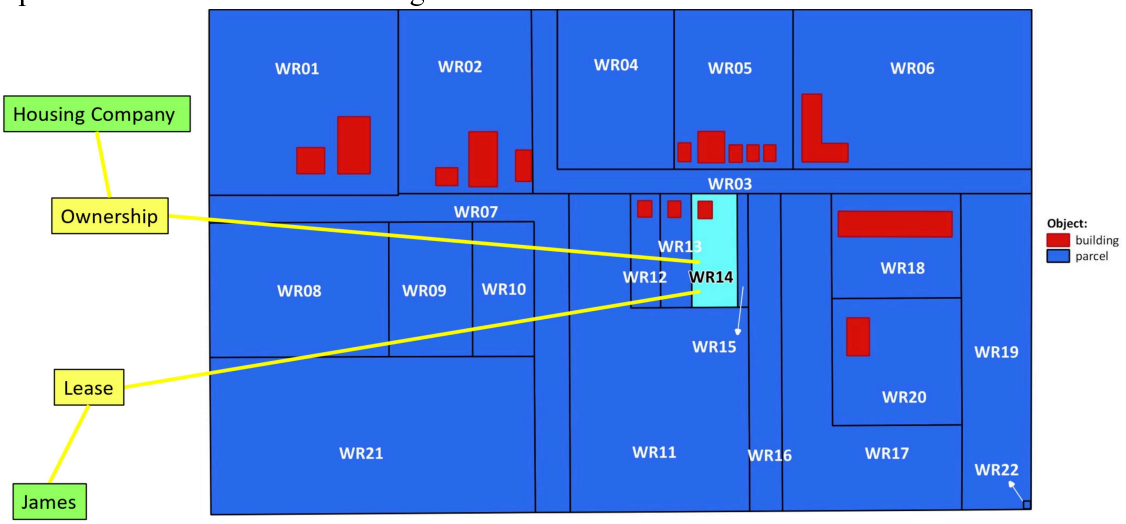


Figure 43. The leasehold of James

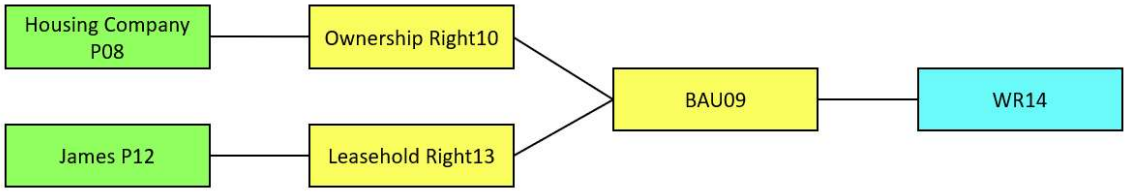
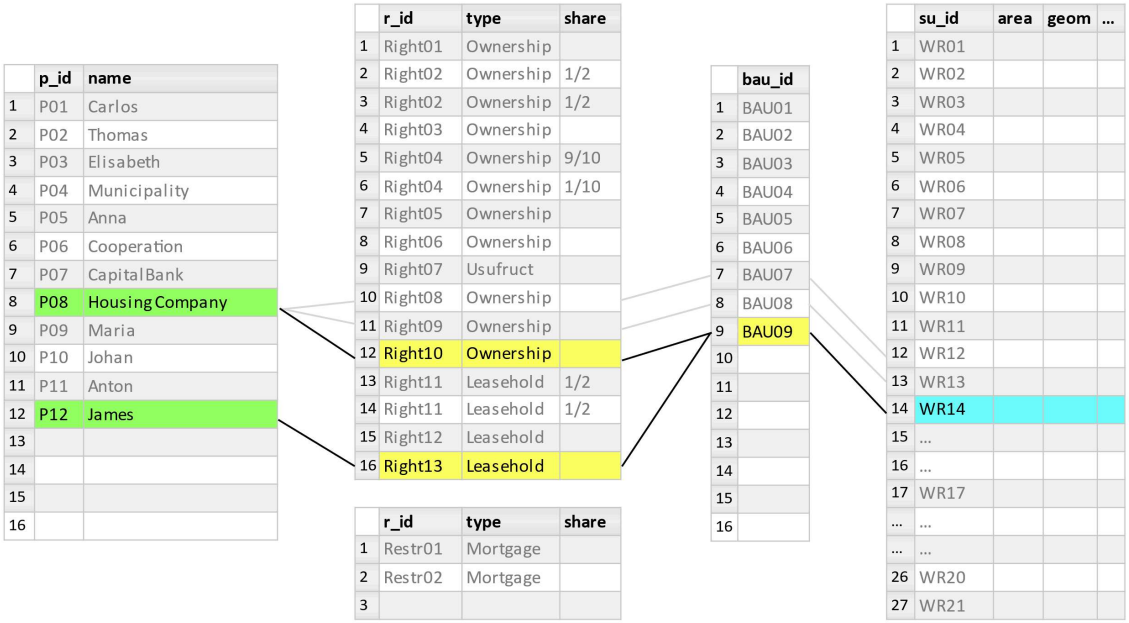


Figure 44. The leasehold (right13) of James(P12) associated to BAU09 with WR14 related



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13		
14		
15		
16		

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16	Right13	Leasehold	

	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
...	...			
...	...			
26	WR20			
27	WR21			

Figure 45. The situation of James in the database

4.9 Case Eight: The Apartment Building

There is an apartment building in Waterriver. There are different ways to register apartments, apartment buildings and the land where the building is established. One example is given here. Normally such a solution is part of the LADM country profile.

The individual owners of each apartment are members (mandatory) of the Association of Owners. This association has a board composed of members of the association: a president, a secretary and a treasurer. The board acts on behalf of the members.

The association owns all common property, for example the parcel where the apartment building is located. Separately, members own individual properties. See figure 46 where this example is illustrated.

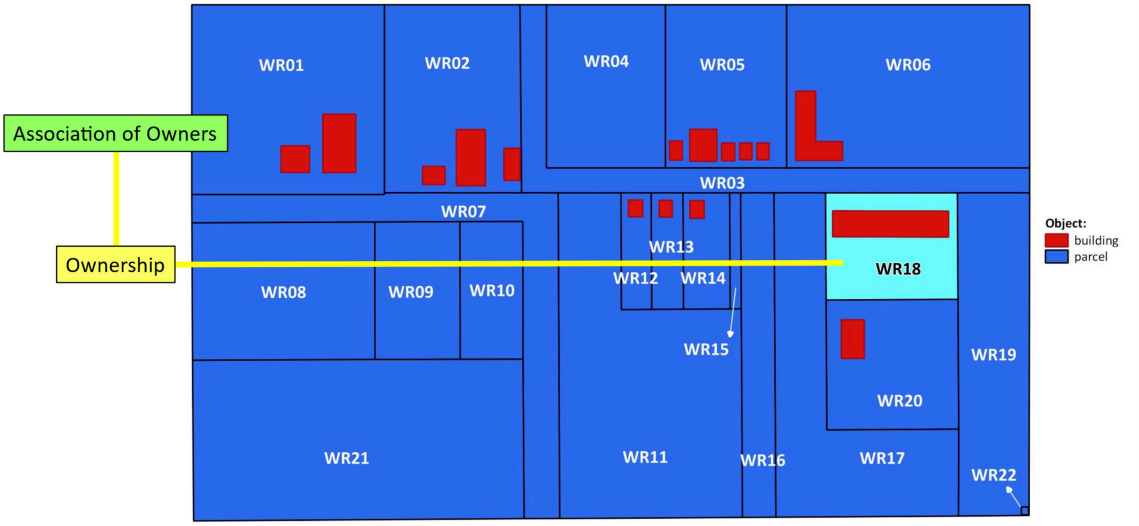


Figure 46.. The Association of Owners owns all common property, for example the parcel WR18 whith the apartment building

The Association of Owners is registered in the land administration as a party (P13) with an ownership right (Right14) to BAU10 with parcel WR18. See figure 47.

The association as such is registered in the land administration as a non-natural person.

Note: the members of the board must be retrievable, there are different ways to organise this. As said: it may be that the association is registered in the land administration itself. Then each update in the composition of the board must be included in the land administration. There can be other solutions! The board members may be in a register of associations – this may be with the Chamber of Commerce. Other options are possible, depending on the arrangements within the country, e.g. in the population register. In LADM this type of external information is included in "external classes".

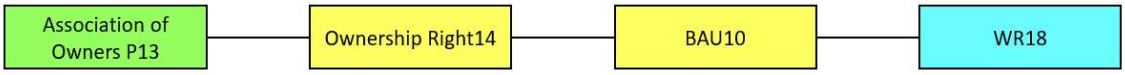


Figure 47. The Association of Owners is registered in the land administration as a party with an ownership right. The Association is a non natural person

Figure 48 shows the database with the Association of Owners and its right to BAU10 with WR18 included.

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association ofOwners
14		
15		
16		

	r_id	type	share
...	...	...	...
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16	Right13	Leasehold	
17	Right14	Ownership	

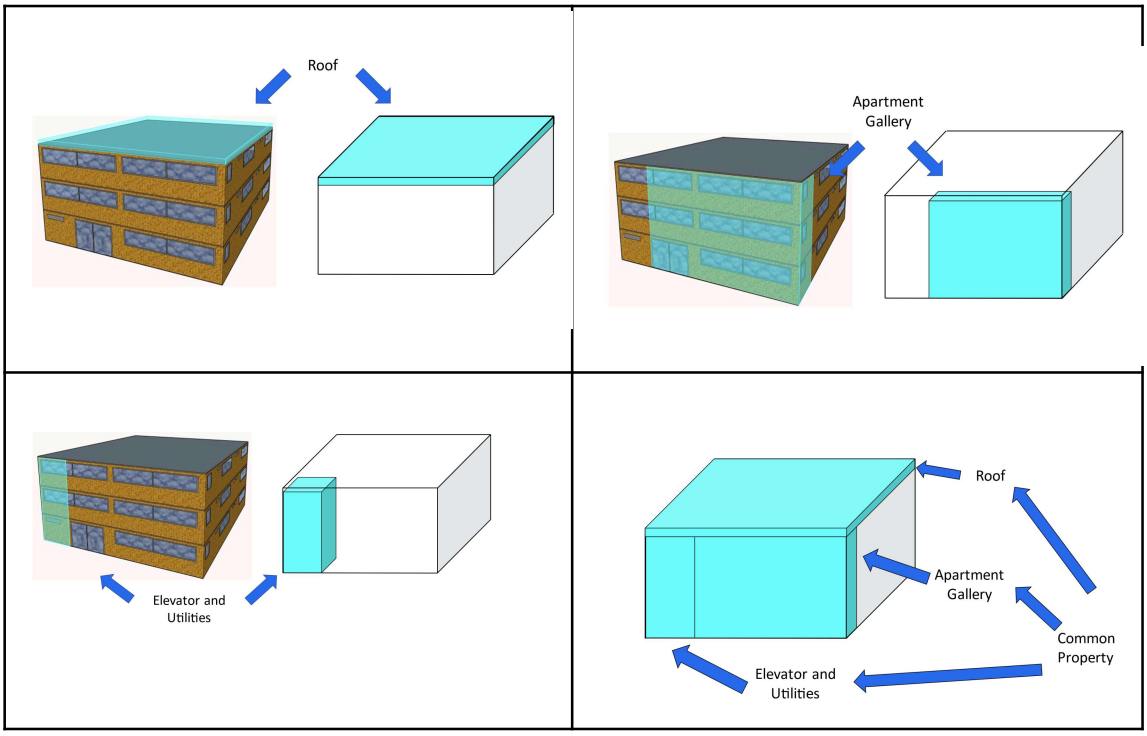
	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	BAU10
11	
12	
13	
14	
15	
16	

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
18	WR18			
...	...			
26	WR20			
27	WR21			

Figure 48. The Association of Owners in the database - with its right to BAU10

The Association of Owners also owns the common areas in an apartment building (with 3 floors). That concerns the roof, the apartment galleries and the elevator house. See figure 49.



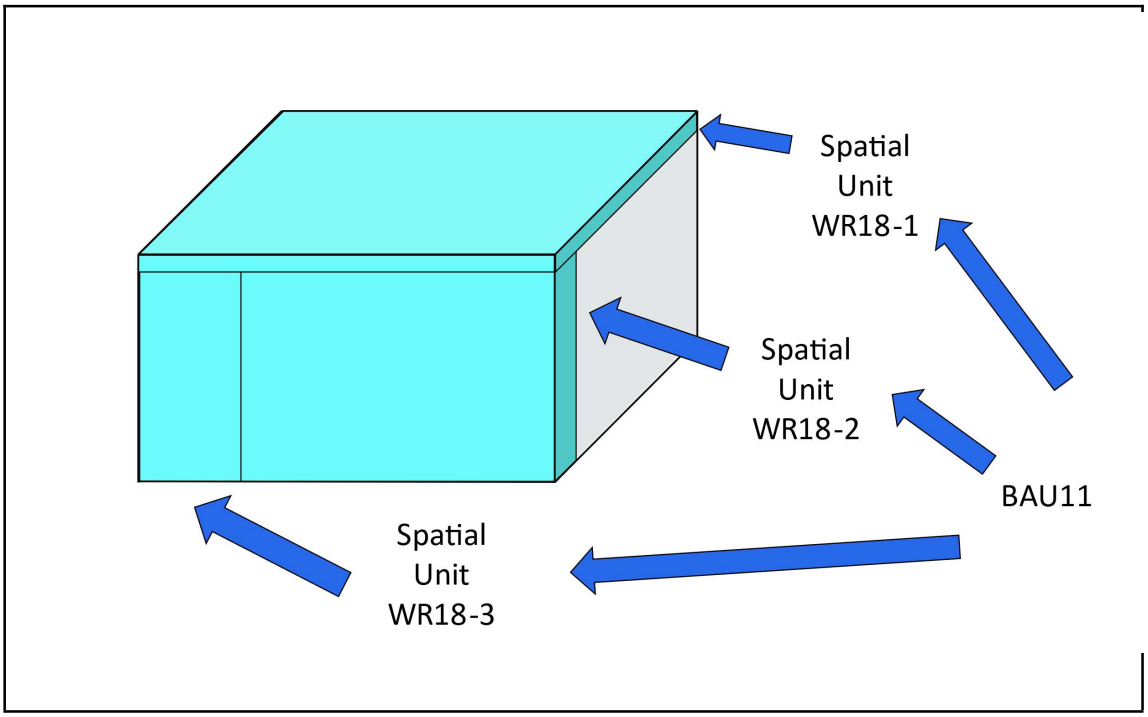


Figure 49. Apart from the parcel WR14 the Association of Owners owns the common area's in the Apartment Building. That concerns the roof WR18-1(a), the apartment galleries WR18-2(b) and the elevator house WR18-3(c)

The land administration in Waterriver supports 3D registration of cadastral objects (as parcels and apartments) apart from the 2D registration. The 2D registration is most common, but the 3D registration ..... The apartment building is registered as 3D object.

The roof, gallery and elevator houses are considered to be separate spatial units: WR18-1 represents the roof, see figure 49 (a), WR18-2 represents the gallery, see figure 49(b), and WR18-3 represents the elevator house, see figure 49 (c). The complete common property inside the building is in figure 49 (d). The spatial units get an index added to the ground parcel WR18. See figure 49 bottom.

WR18-1, WR18-2 and WR18-3 compose a separate basic administrative unit with common properties inside the apartment building: BAU11. See figure 50.

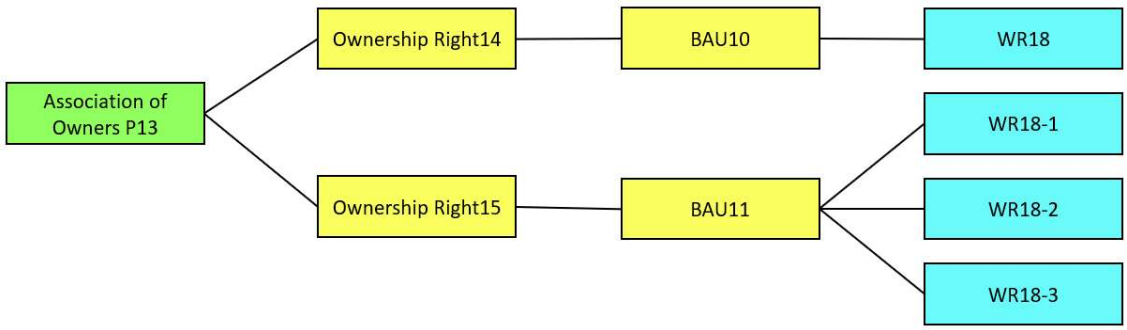
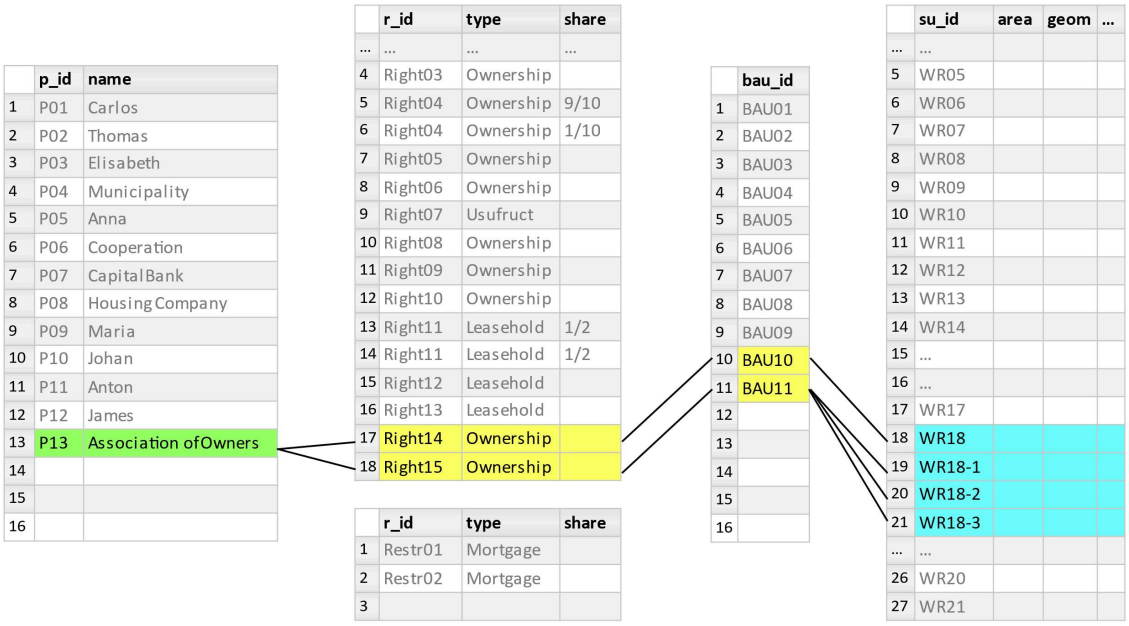


Figure 50. BAU10 (with Right14) concerns the ground parcel (WR18) of the Association of Owners(P13). BAU11with (Right15) concerns the common properties of the Association of Owners inside the apartment building: WR18-1 is the roof, WR18-2 the gallery and WR18-3 the elevator house

Note: the association of owners owns two BAUnits (BAU10 and BAU11). This can be included in one or two titles. Further aggregation is also possible:then the ownership rights are combined as well as the BAU's. One BAU may include four spatial units (WR18, WR18-1, WR18-2, WR18-3). All represented in one title.

In the database this situation looks as visualised in figure 51.



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association ofOwners
14		
15		
16		

	r_id	type	share
...	...	...	...
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16	Right13	Leasehold	
17	Right14	Ownership	
18	Right15	Ownership	

	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	BAU10
11	BAU11
12	
13	
14	
15	
16	

	su_id	area	geom	...
...	...			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
18	WR18			
19	WR18-1			
20	WR18-2			
21	WR18-3			
...	...			
26	WR20			
27	WR21			

Figure 51. The common properties of the Association of Owners visualised in the database

Monique is the owner of an apartment, a parking lot and a laundry room. See figure 52. Monique is a member of the association of owners.

The apartment, a parking lot and a laundry room concern one property.

The apartment, the parking lot and the laundry room are considered to be separate spatial units: WR18-4 represents the apartment, see figure 52 (a), WR18-5 represents the parking lot, see figure 52 (b), and WR18-6 represents the laundry room, see figure 52 (c). The complete property is shown in figure 52 (d) The spatial units get an index added to the ground parcel WR18. See figure 52 bottom.

Note: the individual spatial units can be part of a transaction. The parking lot may be sold to another party. This requires that the BAU11 needs to be subdivided.

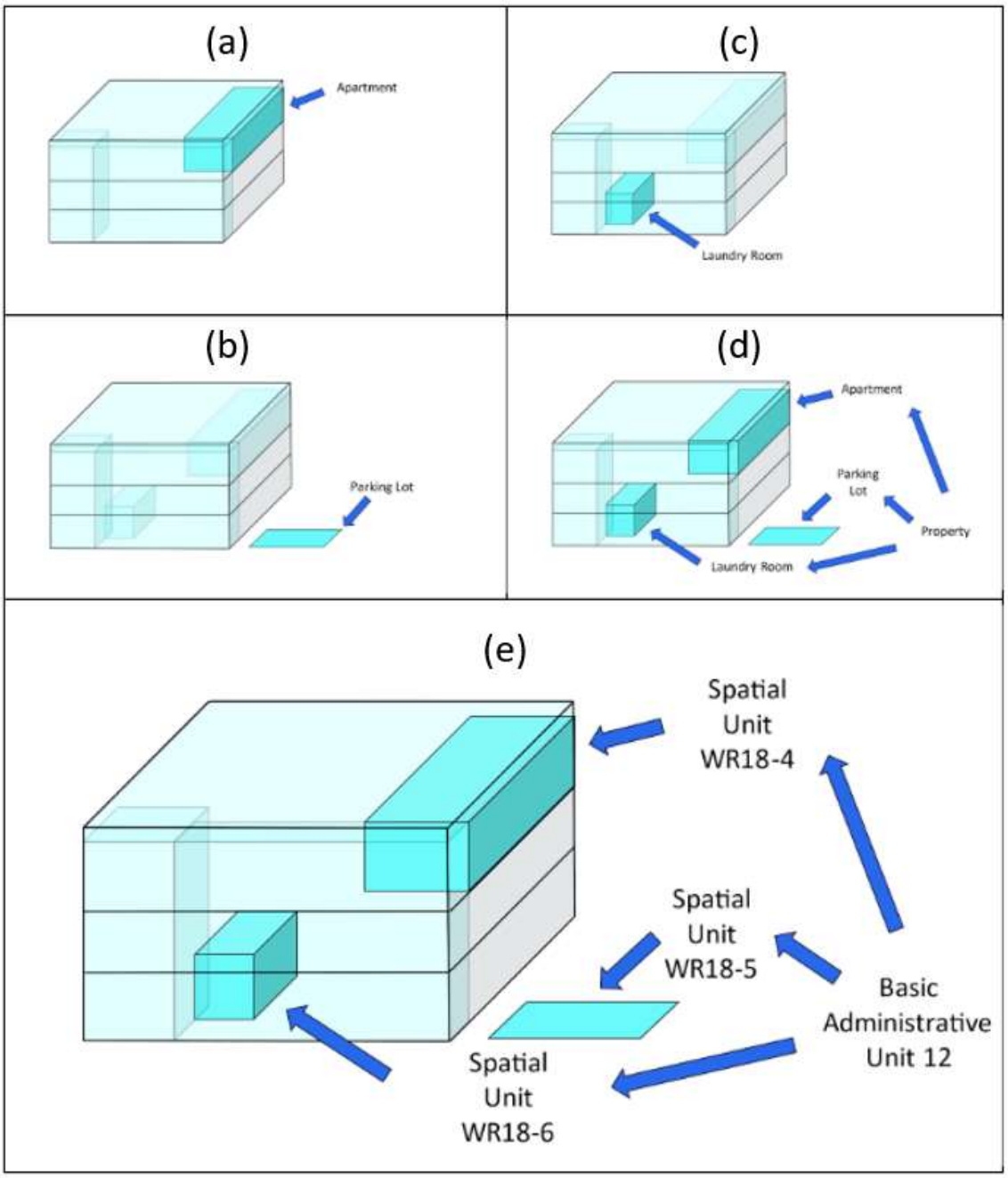


Figure 52. Monique owns BAU12. That concerns the apartment WR18-4 (a), the parking lot WR18-5 (b) and the laundry room WR18-6(c)

Figure 53 visualises the case: BAU12 (with Right16) concerns the ownership of Monique (P14). This concerns: WR18-4, Monique's apartment, WR18-5, the parking lot and WR18-6 the laundry room. The parking lot can be considered as a 3D volume, see Annex 2.

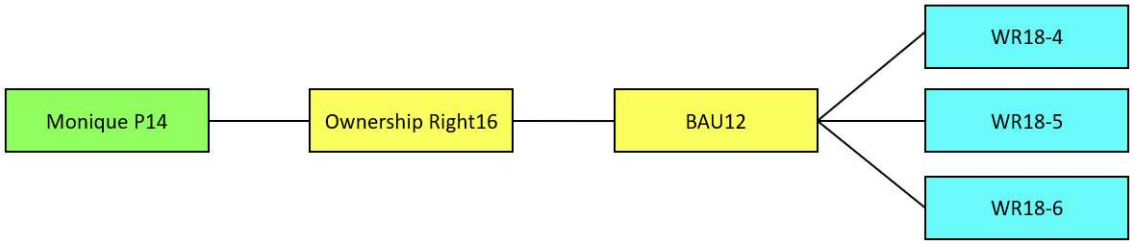


Figure 53. BAU12 (with Right16) concerns the ownership of Monique (P14). This concerns: WR18-4, Monique's apartment, WR18-5, the parking lot and WR18-6 the laundry room

Figure 54 shows the representation of Monique's (P14) ownership (Right16) to BAU12 with spatial units WR18-4, Wr18-5 and WR18-6.

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association ofOwners
14	P14	Monique
15		
16		

	r_id	type	share
...	...	...	...
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16	Right13	Leasehold	
17	Right14	Ownership	
18	Right15	Ownership	
19	Right16	Ownership	

	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	BAU10
11	BAU11
12	BAU12
13	
14	
15	
16	

	su_id	area	geom	...
...	...			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
18	WR18			
19	WR18-1			
20	WR18-2			
21	WR18-3			
19	WR18-4			
20	WR18-5			
21	WR18-6			
...	...			
26	WR20			
27	WR21			

Figure 54. Monique's property in the apartment building

Monique is a member of the Association of Owners. This association owns the common properties. Shares of members of the association are defined. Note: there can be the same situation as in case four now: Anna and the Cooperative: shares could be related to the right (see Figure 21) or to the Party (as in Figure 22).

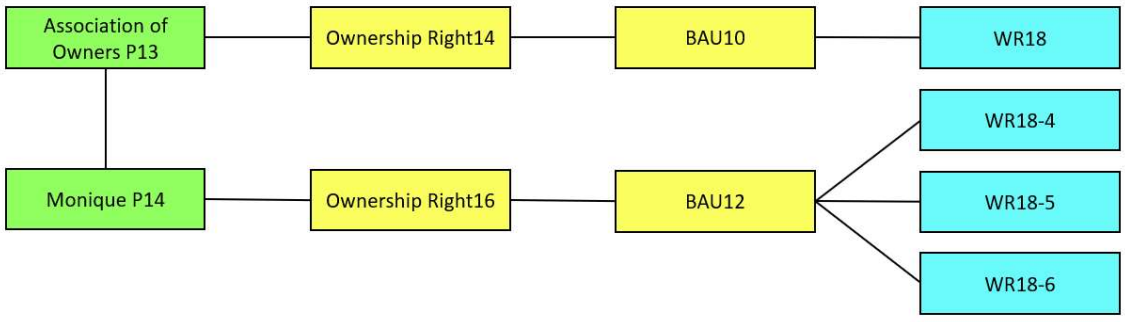


Figure 55. Monique is owner of the Association of Owners. The Association is owner of common properties

See figure 56 for the representation of Monique's situation in the database.

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	Capital Bank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association of Owners
14	P14	Monique
15		
16		

	r_id	type	share
...	...	...	...
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16	Right13	Leasehold	
17	Right14	Ownership	
18	Right15	Ownership	
19	Right16	Ownership	

	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	BAU10
11	BAU11
12	BAU12
13	
14	
15	
16	

	su_id	area	geom	...
...	...			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
18	WR18			
19	WR18-1			
20	WR18-2			
21	WR18-3			
22	WR18-4			
23	WR18-5			
24	WR18-6			
25	...			
26	WR20			
27	WR21			

Figure 56. Monique's properties. The share in the common property is not visualised. Monique owns BAU12, she has a title. The association of owners has a title as association, there is no title for the individual share.

4.10 Case Nine: Eco Investment

Eco Investment invests in sustainable development. For testing and development purposes, a site is available in Waterriver on parcel WR19. The company was also able to buy a very small parcel of land some time ago, with id WR22. This was owned by a utility company.

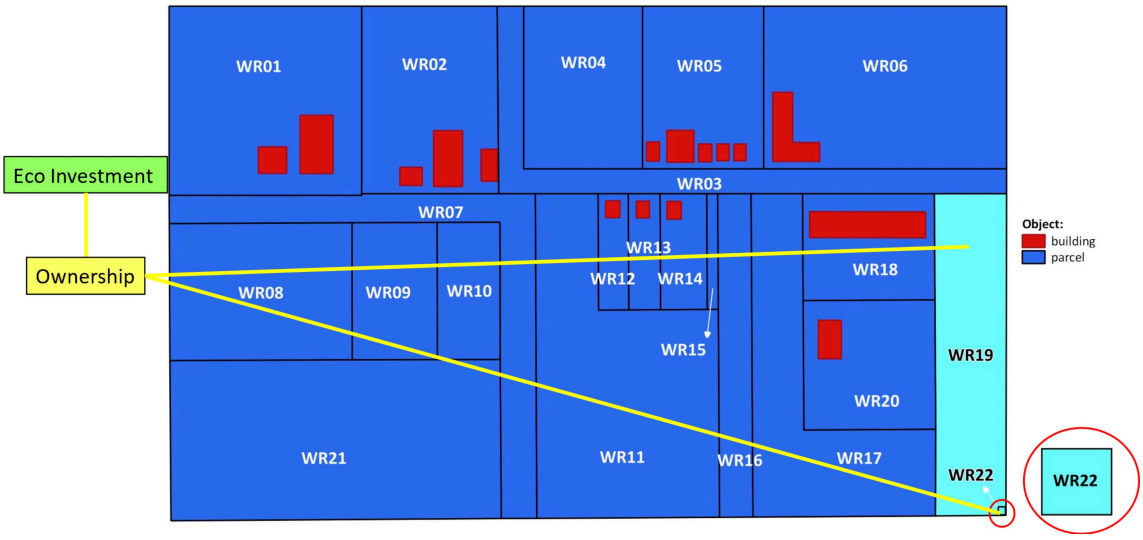


Figure 57. Eco Investment owns a BAUnit with 2 spatial units (parcels) related: WR21 and WR22

Eco Investment (P15) hold the ownership (Right17) on BAU13 with parcels WR19 and WR22. All the time it should be remembered that "parcel" is and aliase of "spatial units". This alias is used when formal property rights are concerned.

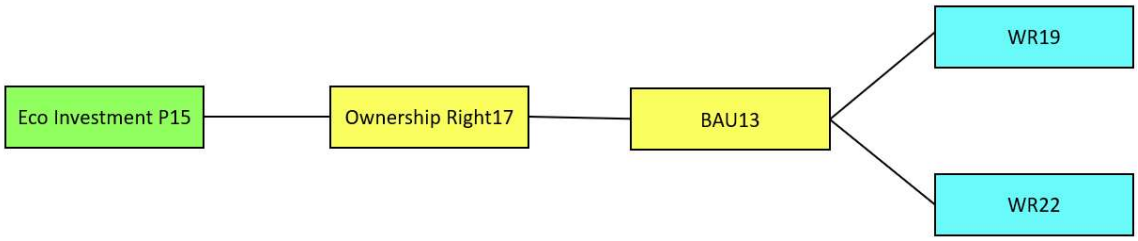
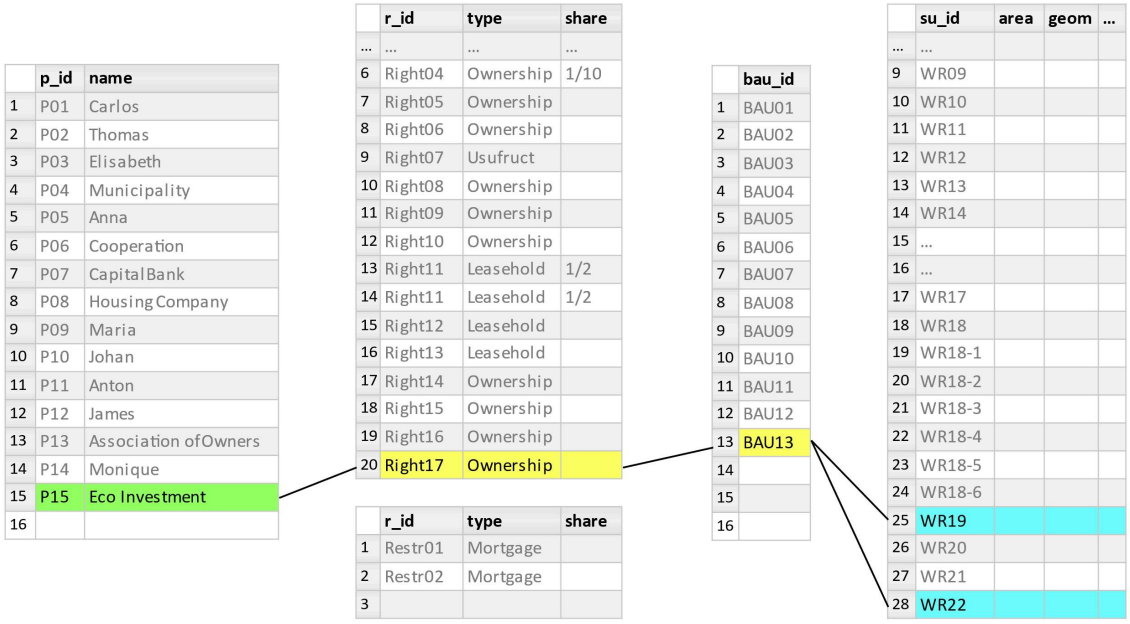


Figure 58. Eco Investment is identified as P15, the company has holds ownership (Right17) on BAU13 with spatial units WR19 and WR22

Eco Investment is identified as P15. It should be observed that the party table includes both natural and non-natural parties. An alternative approach could be to split those groups into two tables. Those tables (one for population and one for business and may be one more for different governmental institutions) could be external.



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association ofOwners
14	P14	Monique
15	P15	Eco Investment
16		

	r_id	type	share
...	...	...	...
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16	Right13	Leasehold	
17	Right14	Ownership	
18	Right15	Ownership	
19	Right16	Ownership	
20	Right17	Ownership	

	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3			

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	BAU10
11	BAU11
12	BAU12
13	BAU13
14	
15	
16	

	su_id	area	geom	...
...	...			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
18	WR18			
19	WR18-1			
20	WR18-2			
21	WR18-3			
22	WR18-4			
23	WR18-5			
24	WR18-6			
25	WR19			
26	WR20			
27	WR21			
28	WR22			

Figure 59. Eco Investment in the database for land administration

Eco Investment has a restriction (a servitude) on BAU13 (with WR19 and WR22), see figure 60. In this servitude the spatial unit WR20 is served with access to public road.

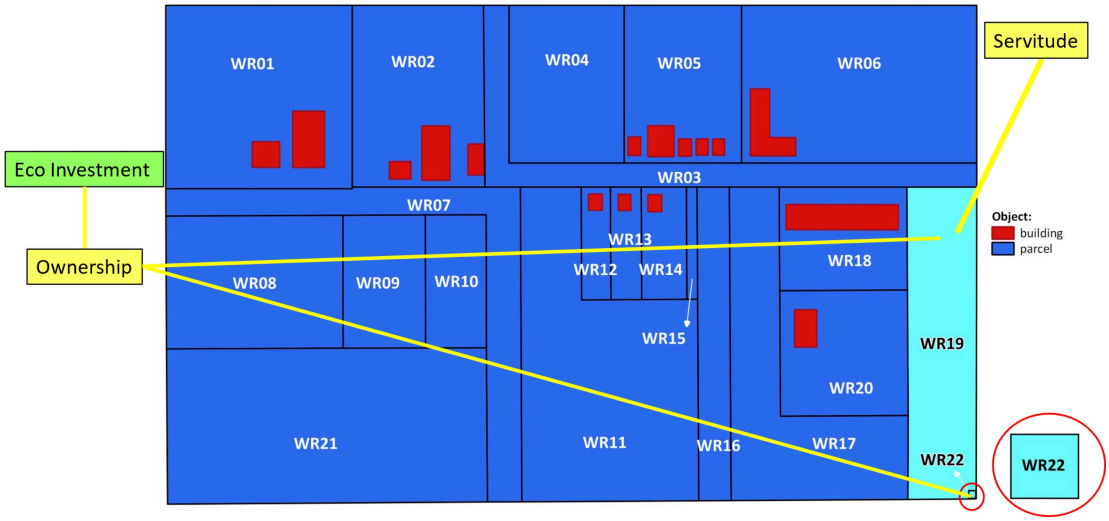


Figure 60. There is a restriction - a right of road on BAU13 (with WR19 and WR22)

The location of the access road in WR19 to WR20 is unknown. This servitude is "inherited" from the earlier spatial unit that included both WR19 and WR22.

In this example of a registration of a restriction (Restriction03) there is no party required. See figure 61. If BAU13 (or a part of it) is sold the servitude will be included – even if its location is unknown.

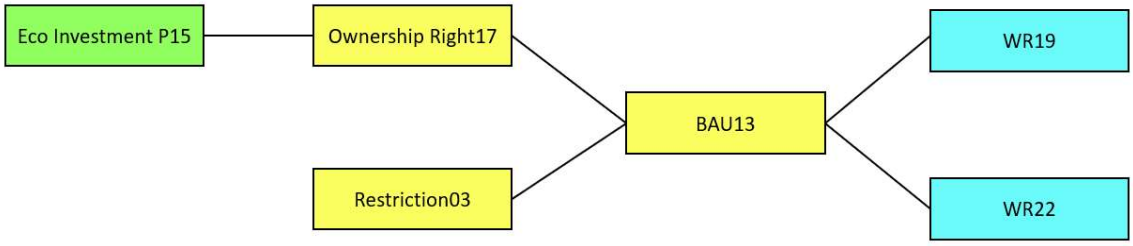
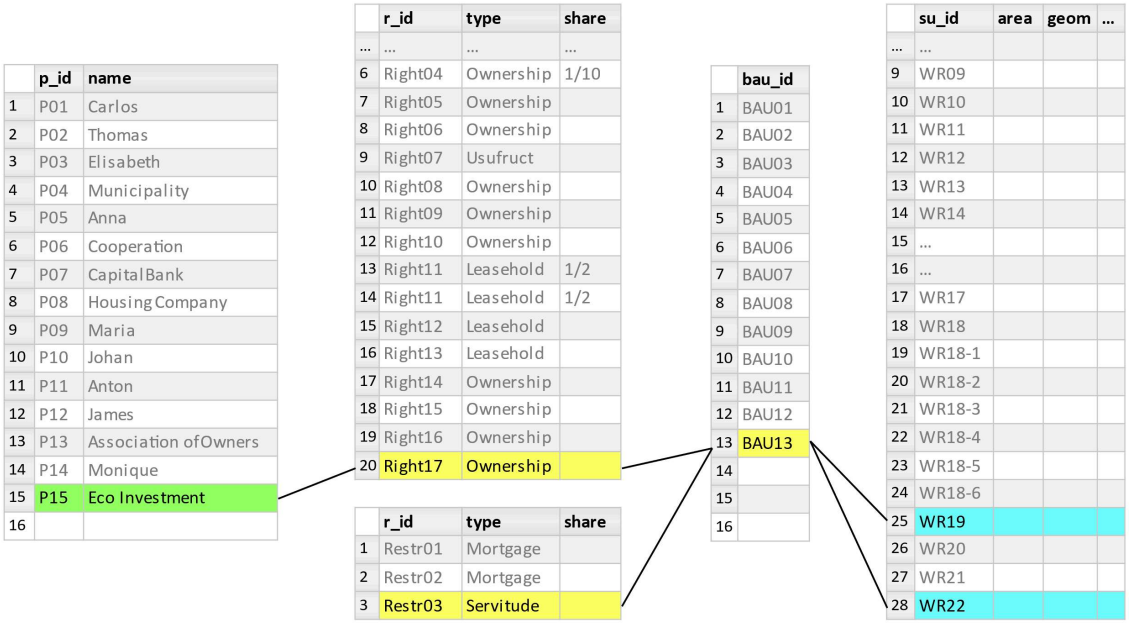


Figure 61. The right of servitude established on BAU13. The location of the servitude is unknown, it is not on that map

This situation looks as follows in the database (figure 62):



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	CapitalBank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association ofOwners
14	P14	Monique
15	P15	Eco Investment
16		

	r_id	type	share
...	...	...	...
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16	Right13	Leasehold	
17	Right14	Ownership	
18	Right15	Ownership	
19	Right16	Ownership	
20	Right17	Ownership	

	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3	Restr03	Servitude	

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	BAU10
11	BAU11
12	BAU12
13	BAU13
14	
15	
16	

	su_id	area	geom	...
...	...			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	...			
16	...			
17	WR17			
18	WR18			
19	WR18-1			
20	WR18-2			
21	WR18-3			
22	WR18-4			
23	WR18-5			
24	WR18-6			
25	WR19			
26	WR20			
27	WR21			
28	WR22			

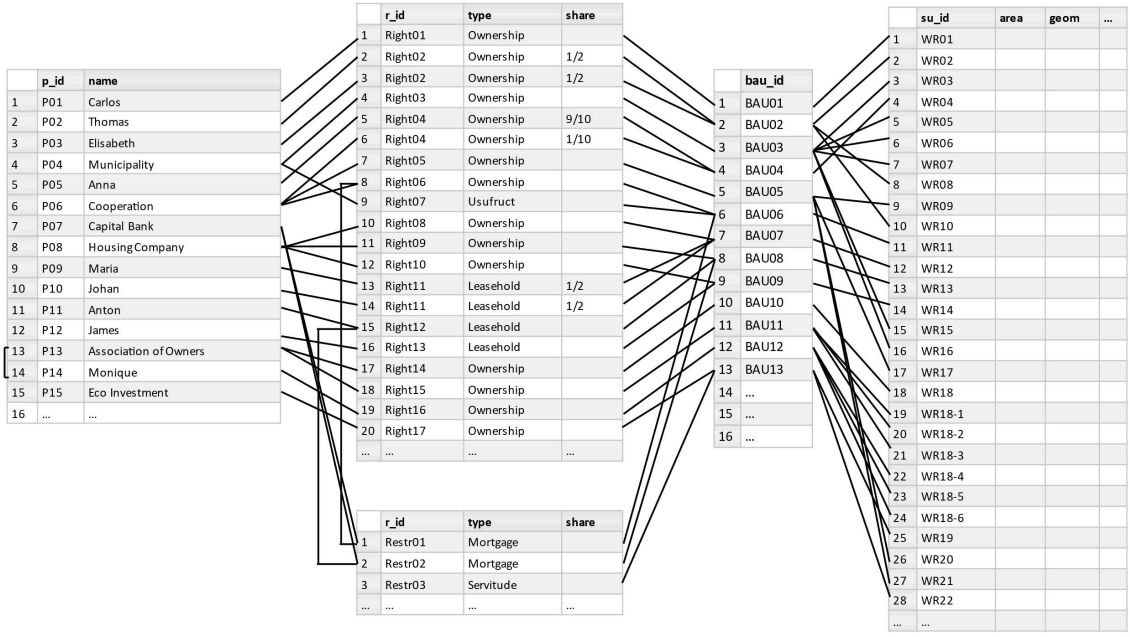
Figure 62. The restriction (Restr03) on BAU13 is not associated to a Party. It is related to the land, that is the basic administrative unit with spatial units WR19 and WR22

5. Transactions

5.1 Overview

The inclusion of Cases One through to Nine in the database results in the overview as shown in Figure 63. This includes data on parties, rights, basic administrative units and spatial units. These are called core classes in the LADM.

The complexity of the interrelationships between people and land becomes clear from the figure below. Note that not all rights and spatial units could be included in this overview of database tables, Right14 till Right17 as well as spatial units WR19 till WR22 could not be included.



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	Capital Bank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association of Owners
14	P14	Monique
15	P15	Eco Investment
16	...	...

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16	Right13	Leasehold	
17	Right14	Ownership	
18	Right15	Ownership	
19	Right16	Ownership	
20	Right17	Ownership	
...	...	...	...

	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3	Restr03	Servitude	
...	...	...	...

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	BAU10
11	BAU11
12	BAU12
13	BAU13
14	...
15	...
16	...

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	WR15			
16	WR16			
17	WR17			
18	WR18			
19	WR18-1			
20	WR18-2			
21	WR18-3			
22	WR18-4			
23	WR18-5			
24	WR18-6			
25	WR19			
26	WR20			
27	WR21			
28	WR22			
...	...			

Figure 63. Cases One till Nine represented in the database.

People to land relationships are dynamic. For example, people buy and sell property rights to land, people inherit land and divide it among children and/or other heirs, people get married and acquire joint property on which they mortgage, new rights are established when a municipality issues land for possible new construction, and rights of use can be established. And many more types of changes in the people-to-land relationships are possible.

For the data in the database to remain an accurate representation of reality, the dynamics in the relationships between people and land must be tracked in the database.

In the next paragraphs some examples will be given: buying/selling a property, merging two spatial units, establishment of a servitude and subdivision of a spatial unit. In those examples the focus will be on the transactions resulting in updates of the data in the database. Such a change is the result of a series of activities of stakeholders in an update process or workflow. See an example from Denmark in figure 64. This concerns the activities related to a sale of a

parcel (Zevenbergen and Stubkjær, 2005), The last activity is this diagram ”Final Registration” includes the transaction in the database – this database transaction is subject of the next paragraphs: a subdivision of a parcel, a merge of two parcels (one very small), an establishment of a servitude and an urban development case where land gets available for construction of houses.

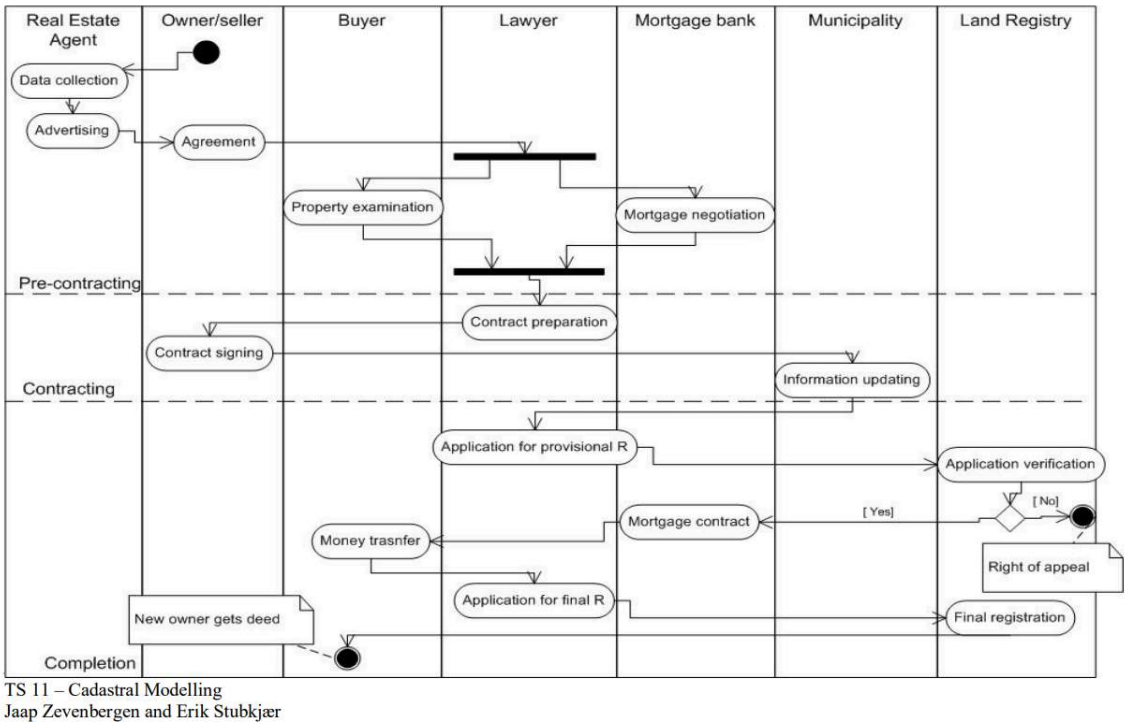


Figure 64. Activity diagramm of a sale transaction. Exanple from Denmark. Stakeholders can be seen on top of each swimming lane.

Stakeholders in this use case are: real estate agent, owner/seller, buyer, lawyer, mortgage bank, municipality, land registry. See figure 64 on top of each “swimming lane”.

5.2 Transaction01: Carlos sells WR01 to Monique

The representation of Carlos in the database is introduced in Case One.

Now Carlos sells his ownership right on BAU01 with related parcel WR01 to Monique (see figure 65).

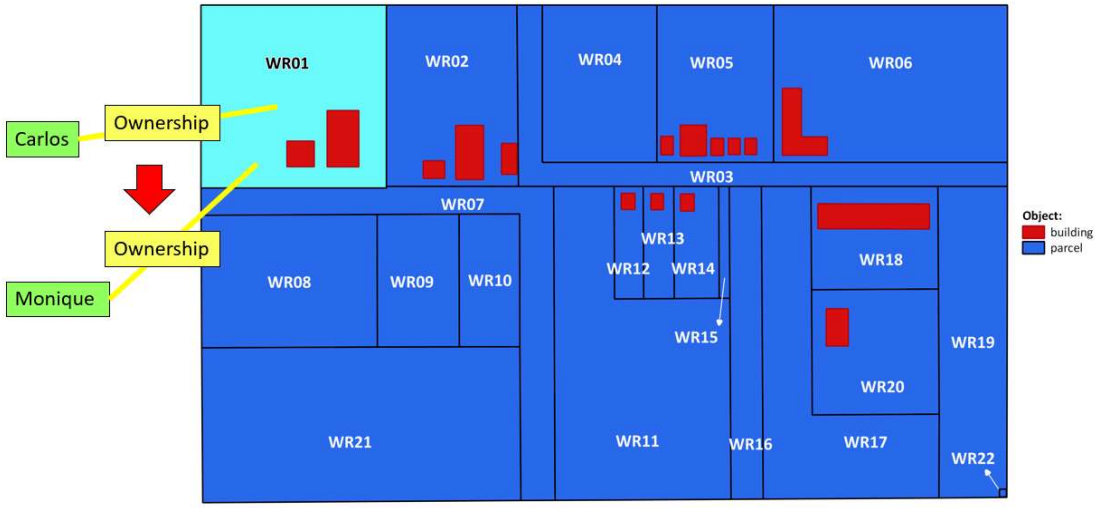


Figure 65. Carlos sells WR01 to Monique

In this paragraph the impact of this transaction in the database is illustrated using two examples of processing the transaction: one example with new identifiers for rights and basic administrative units and one example where those identifiers do not change. The approach that is used depends on implementation choices, and even other approaches are possible. This is a matter of implementation of the LADM.

Carlos (with identifier P01) sells his ownership right (Right01) on WR01 in BAU01 to Monique at 26-08-2021. The new identifier for the ownership right is Right18, the rID did change in this example, because it can be seen as a new right. Note: it is possible not to see it as a new right ans keep it to Right01, see below for this case.

For the basic administrative unit BAU14 is the new identifier. See figure 66. The arrow represents the transaction. The situation before the transaction is represented above the arrow, the situation after the transaction is represented below the arrow.

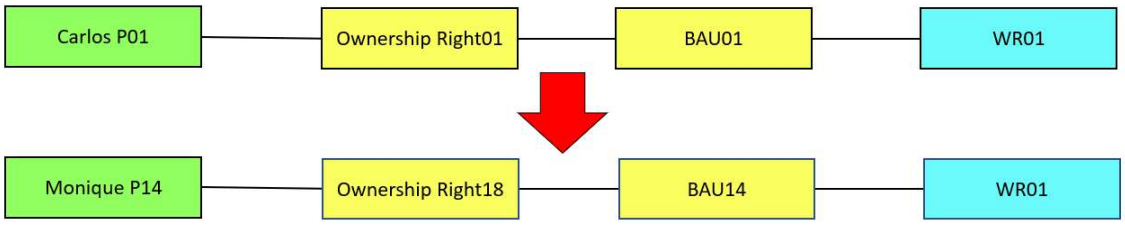


Figure 66. Transaction01. Carlos sells to Monique. In this example the right and the basic administrative unit get new id's (Righ18 and BAU14) because there is a new rightholder. In this approach the right associated to Carlos is not the same as the right associated with Monique. Same for the basic administrative unit

Carlos became right holder some time ago, his right was recorded in the land administration database at date 03-04-2015 and time 08:29. This concerns the “database transaction” with database date and time, see figure 67. Note: the “real transaction” took place in the notaries office two days earlier.

Transaction01 results in a situation where the representation of the party Carlos in the database ends at date 26-08-2021, time 14:04.

At the same moment as the representation of the party Carlos in the database ends the party Monique is created in the database. See figure 67.

This is also valid for Right01, this right is versioned in the database at 26-08-2021, time 14:04. And Right18, which is created at the same date and time: 26-08-2021, time 14:04. See figure 67.

And for BAU01, deleted at the same time in the database and BAU14, created at the same date and time: 26-08-2021, time 14:04. See figure 67.

	p_id	name	begin_lifespan	end_lifespan
1	P01	Carlos	20150403, 08:29	20210826, 14:04
2	P14	Monique	20210826, 14:04	99999999, 23:59

	r_id	la_right_type	begin_lifespan	end_lifespan
1	Right01	Ownership	20150403, 08:29	20210826, 14:04
2	Right18	Ownership	20210826, 14:04	99999999, 23:59

	u_id	la_baunit_type	begin_lifespan	end_lifespan
1	BAU01		20150403, 08:29	20210826, 14:04
2	BAU14		20210826, 14:04	99999999, 23:59

Figure 67. Transaction01: Carlos (P01) sells to Monique (P18). The database commit is at 20210826, 14:04. The right gets a new id (Righ18) as well as the BAUnit (BAU14).

Note: object identifiers p_id, r_id and u_id are not the same as database id's. Object identifiers are relevant for the land administration, database identifiers are relevant for the management of the database management system. Object identifiers are important in communication between the government and citizens and between professionals and the government, etc.

Now, after Transactio01 the complete property situation for Monique, is as in Figure 68. Compare also Figure 55.

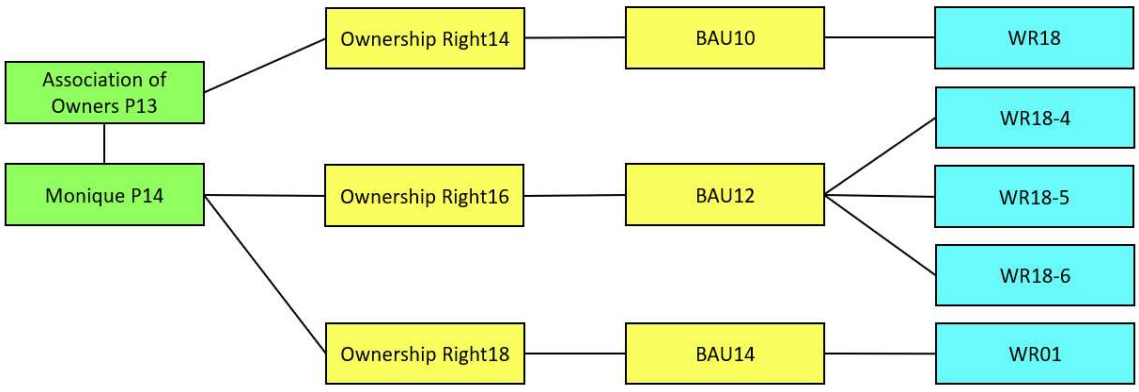


Figure 68. New situation for Monique after buying BAU14 with WR01 from Carlos

The representation of the situation before and after the Transaction01 in the database is as in figure 69. The situation before the transaction is above the arrow, the situation after the transaction is below the arrow.

After the database commit of the buying/selling transaction of BAU01 (with WR01 related) the Right01 is not valid anymore. It is deleted at 20210826, 14:04. At that moment the new Right18 is created in the database.

At the same moment (20210826, 14:04) where BAU01 is deleted and BAU14 is created. See figure 69 (begin_lifespan is called here t_min, end_lifespan is called here t_max).

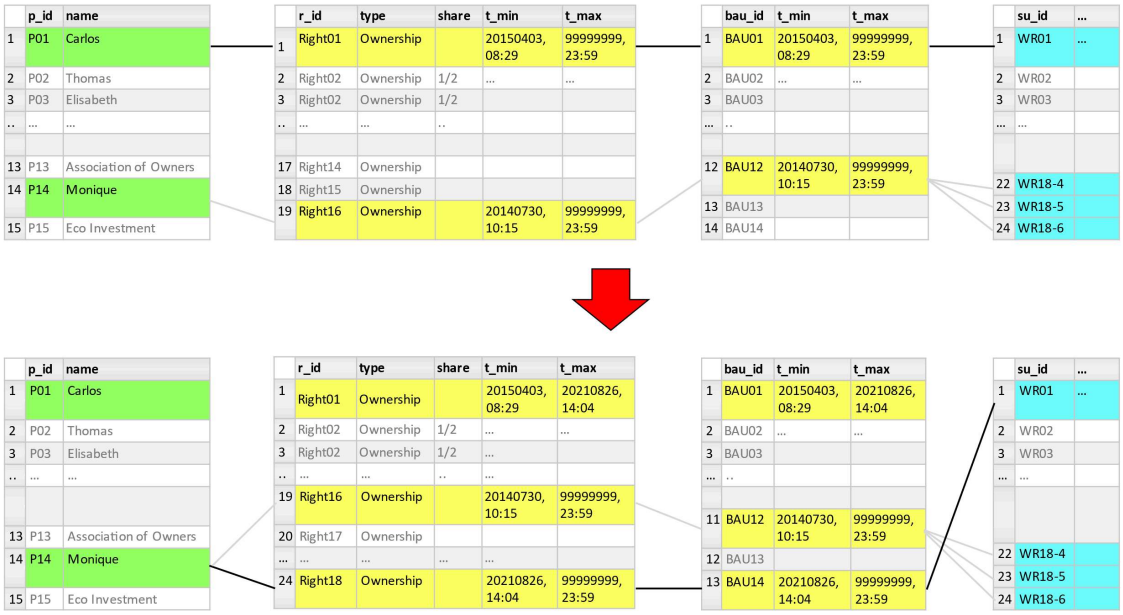


Figure 69. The situation with new record and identifiers in the database

LADM allows alternative options for identification of parties, rights etc. and for managing identifiers. This is a design choice. Identifiers as such are mandatory, not optional. Object identifiers have to be assigned by the data provider based on agreed rules.

The same buying/selling transaction between Carlos and Monique is now presented once more but with an alternative approach in identification and identifiers of rights and of basic administrative units. Now those identifiers remain the same before and after the transaction. See figure 70.

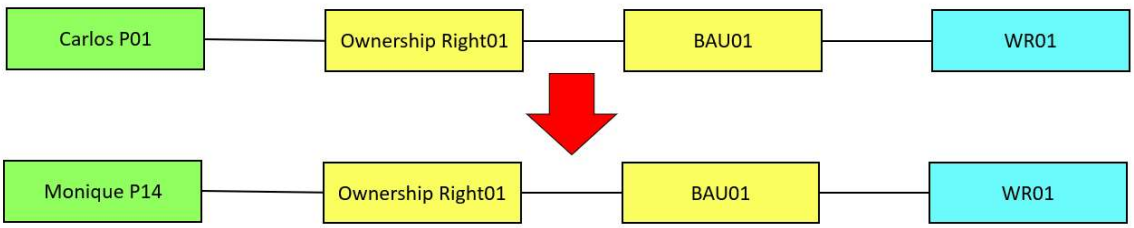


Figure 70. Transction01. Carlos sells his right on BAU01 (with parcel WR01) to Monique. The right, the basicadministrative unit and the spatial unit do not get new ids in this example

This approach in identifiers means that the transaction as such can not be recognised from the identifiers. But begin_lifespan (or: t_min) can be used in combination with the identifier of the right and or the identifier of the basic administrative unit. This makes identifiers of right and BAU is unique.

After this transaction is processed in the database there is a database commit (the updating of a record in the land administration database) of this transaction at date 26-08-2021 and time 14:04.

This commit implies that Carlos was known in the database as owner of BAU01 with parcel WR01 between 03-04-2015, 08:29 and 26-08-2021, 14:04.

In other words: 03-04-2015 08:29 is the begin_lifespan (or: t_min) and 26-08-2021 14:04 (or: t_max) is the end_lifespan of the representation of Carlos as a party in the land administration database. When the right of Carlos is deleted the right of Monique is created. See figures 71 and 72.

	r_id	la_right_type	begin_lifespan	end_lifespan
1	Right01	Ownership	20150403, 08:29	20210826, 14:04
2	Right01	Ownership	20210826, 14:04	99999999, 23:59
3				

Figure 71. Begin_lifespan. The date of creation of an attribute, in this case Right01. End_lifespan is the date of deletion. An actual attribute gets a maxtime and maxdate.

As a consequence Monique is represented in the database with identifier P14 as soon as this transaction is committed. The identifiers Right01, the BAU01 and the WR01 remain the same.

But combined with begin_lifespan the moment of the change in right holder of Right01 can be recognized: Right01 before 20210826, 14:04 is something else then Right01 after that date and time. See figures 71 and figure 72. Inclusion of time attributes as part of the rID (rightID) makes the identifier unique.

In the database this transaction looks as in figure 72. The representation of the party Carlos in the database gets end_lifespan 20210826, 14:04 (the representation of Carlos in the database did begin at begin_lifespan 20150403, 08:29).

At the same moment of the end_lifespan of the representation of the party Carlos in the database the party Monique is created for the right 01.

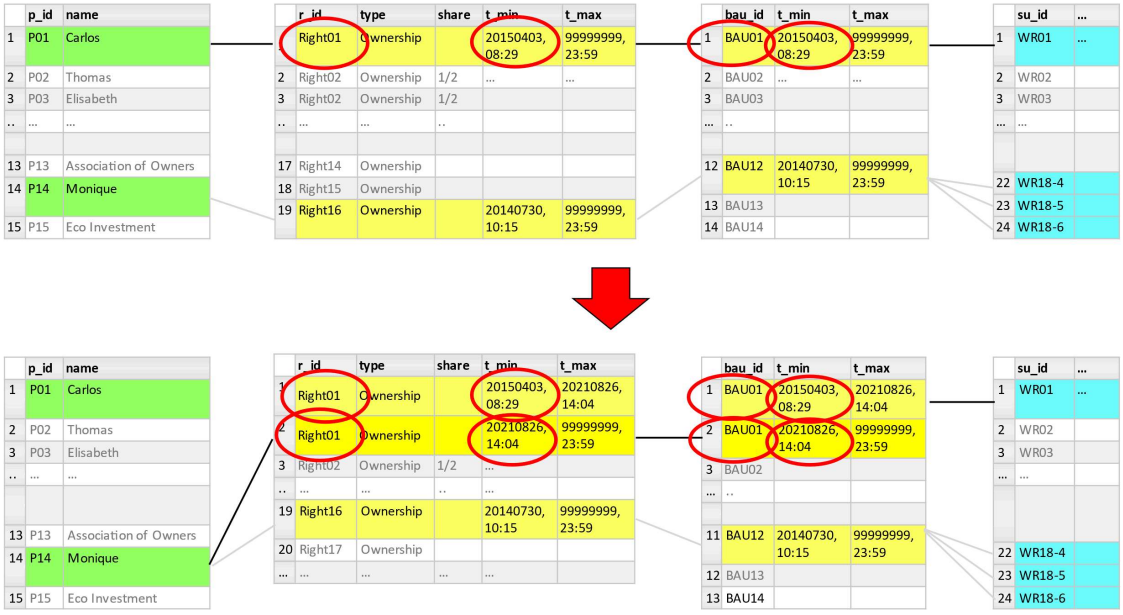


Figure 72. Transaction01 in the database. Carlos sells BAU01 with WR01 to Monique. The right identifier and the basic administrative unit identifier remains unique in combination with begin_lifespan (t_min). End_lifespan is t_max

With the attributes begin_Lifespan (t_min) and endLifespan (t_max) history can be maintained. Nothing is really deleted in the land administration database.

LADM can manage history: the actual land administration is included in the database together with historical land data.

Note: in a paper based system those historical data have to be crossed out in pen.

Management of history in summary:

- An object gets a begin_Lifespan when it is created and a endLifspan when it is deleted
- A newly created object gets maxdate and maxtime as end_lifespan
- This means that the object is “actual”, not “historical”
- A deleted object gets the date and time of deletion as end_lifespan
- In this way queries are possible that allow selection of all objects between a ‘begin date and time’ and ‘an end date and time’
- This is only possible if all objects have ‘begin_Lifespan date and time’ and ‘end_Lifespan date and time’
- That’s why newly created objects get a maximal possible date and maximal possible time as end_Lifespan, it makes the query executable

Begin_lifespan and end_Lifespan are related to (almost) all attributes in a LADM based database. This means that for each attribute it is known when it was created and when it was deleted. The period that the attribute was “actual” (the period that it was valid or “did exist”) or the period that it does exist if it is not yet deleted can be derived from this.

If it is not yet deleted the end_Lifespan is the highest possible date that the database can manage and the maximum time. Maximal time is 23:59; there could be more decimals.

5.3 Transaction02: Merge WR19 and WR22 (WR22 not more needed for utilities)

Transaction 02 concerns a merge between spatial units WR19 and WR22, WR22 is not needed for utilities. See figure 73 (and also figure 60).

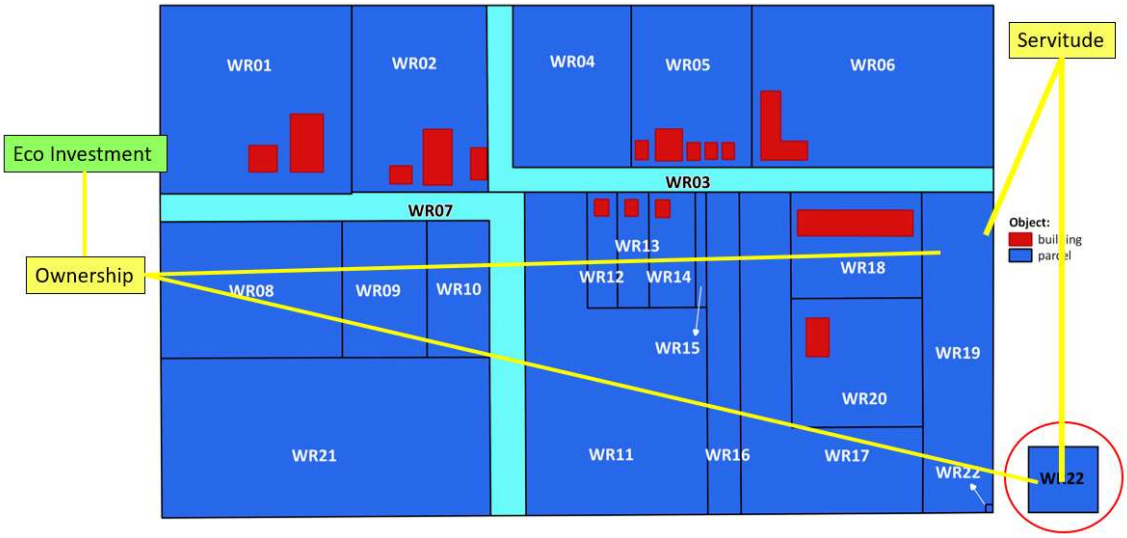


Figure 73. WR19 and WR20 will be merged. WR20 should remain accessible

Also after the merge the spatial unit WR20 needs still to be accessible: the servitude remains as a real right. The location of the servitude is within the footprint of WR19. This is the obligation that the owner of WR19 has for their neighbour in WR20. However, it is not precisely located.

After the merge of WR19 and WR22 a new Spatial Unit WR23 is created, see figure 74.

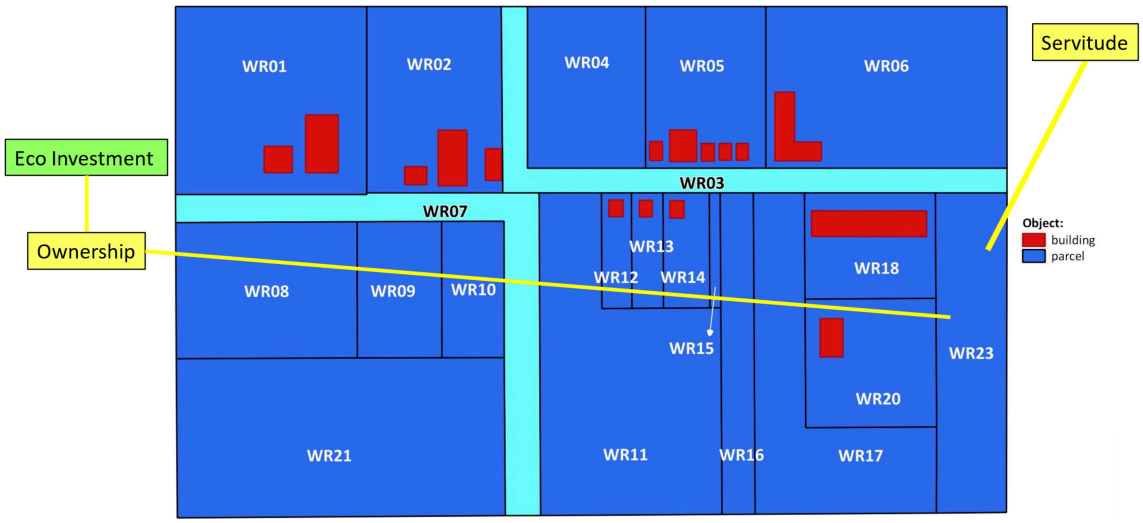


Figure 74. After mergingWR19 and WR22 the new spatial unit (or parcel) WR23 is created

The identifiers of rights, basicadminsitrative units and spatail units can be changed. Right17 becomes Right19. Restriction03 (the servitude) becomes restriction04. BAU13 becomes BAU15. WR19 and WR22 become WR23. See figure 75.

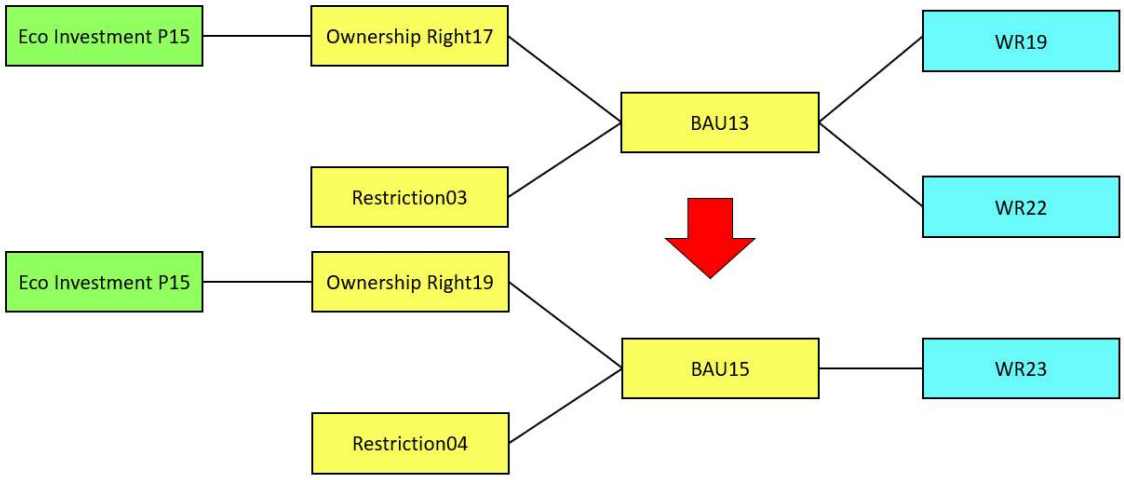
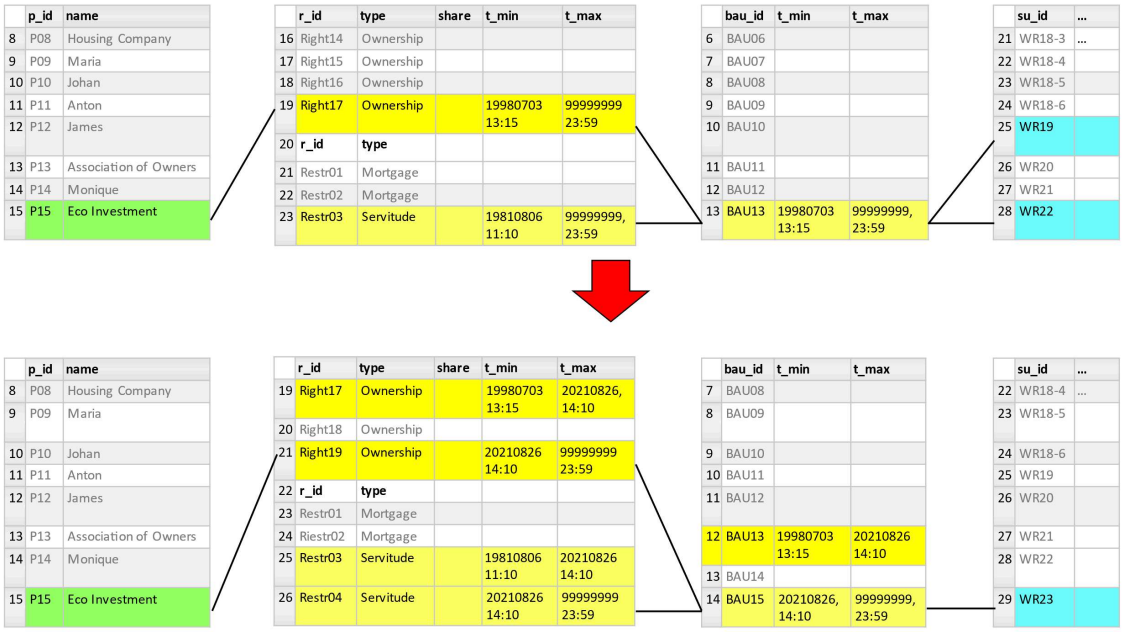


Figure 75. Transaction02, in this example with new identifiers for the ownership right, the restriction, the basic administrative unit and the spatial unit after the merge of WR19 and WR22

The Right17 was created in the database on 3th july 1998 at 13:15 together with BAU13. The Restr03 was created decades ago on 6th of August 1981. See figure 76 above the arrow that represents the transaction.



	p_id	name
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association of Owners
14	P14	Monique
15	P15	Eco Investment

	r_id	type	share	t_min	t_max
16	Right14	Ownership			
17	Right15	Ownership			
18	Right16	Ownership			
19	Right17	Ownership		19980703 13:15	99999999 23:59
20	r_id	type			
21	Restr01	Mortgage			
22	Restr02	Mortgage			
23	Restr03	Servitude		19810806 11:10	99999999, 23:59

	bau_id	t_min	t_max
6	BAU06		
7	BAU07		
8	BAU08		
9	BAU09		
10	BAU10		
11	BAU11		
12	BAU12		
13	BAU13	19980703 13:15	99999999, 23:59

	su_id	...
21	WR18-3	...
22	WR18-4	
23	WR18-5	
24	WR18-6	
25	WR19	
26	WR20	
27	WR21	
28	WR22	

	p_id	name
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association of Owners
14	P14	Monique
15	P15	Eco Investment

	r_id	type	share	t_min	t_max
19	Right17	Ownership		19980703 13:15	20210826, 14:10
20	Right18	Ownership			
21	Right19	Ownership		20210826 14:10	99999999 23:59
22	r_id	type			
23	Restr01	Mortgage			
24	Riestr02	Mortgage			
25	Restr03	Servitude		19810806 11:10	20210826 14:10
26	Restr04	Servitude		20210826 14:10	99999999 23:59

	bau_id	t_min	t_max
7	BAU08		
8	BAU09		
9	BAU10		
10	BAU11		
11	BAU12		
12	BAU13	19980703 13:15	20210826 14:10
13	BAU14		
14	BAU15	20210826, 14:10	99999999, 23:59

	su_id	...
22	WR18-4	...
23	WR18-5	
24	WR18-6	
25	WR19	
26	WR20	
27	WR21	
28	WR22	
29	WR23	

Figure 76. Transaction02: merge WR19 and WR22 to a new parcel WR23. Right17, Restr03 and BAU13 are deleted in the database at 20210826 14:10. Right19, Restr04 and BAU15 are created at the same date and time

Then the parcels WR19 and WR22 were merged to the new parcel WR23 on 26th of August 2021, this is not visible in figure 76. WR19 and WR22 were deleted and WR23 was created from the database at that day, also not visible in figure 76.

BAU13 was deleted in the database on 26th of August 2021, 11:10. BAU15, where WR23 is related to, was created at the same date and time. See figure 76 below the arrow that represents the transaction.

Right17 was deleted in the database on 26th of August 2021, 11:10 and Right19 was created at the same date and time in the database. See figure 76 below the arrow that represents the transaction.

Restr03 was deleted in the database on 26th of August 2021 and Restr04 created at the same date and time in the database. See figure 76 below the arrow that represents the transaction.

In the following example the same ”merge transaction” is discussed: WR19 and WR22 are merged into WR23. The spatial unit identifier changes, simply because it is another unit. The identifiers of the ownership right (Right17), the restriction (Restr01) and the basic administrative unit (BAU13) remain the same in this example after merging. See figure 77.

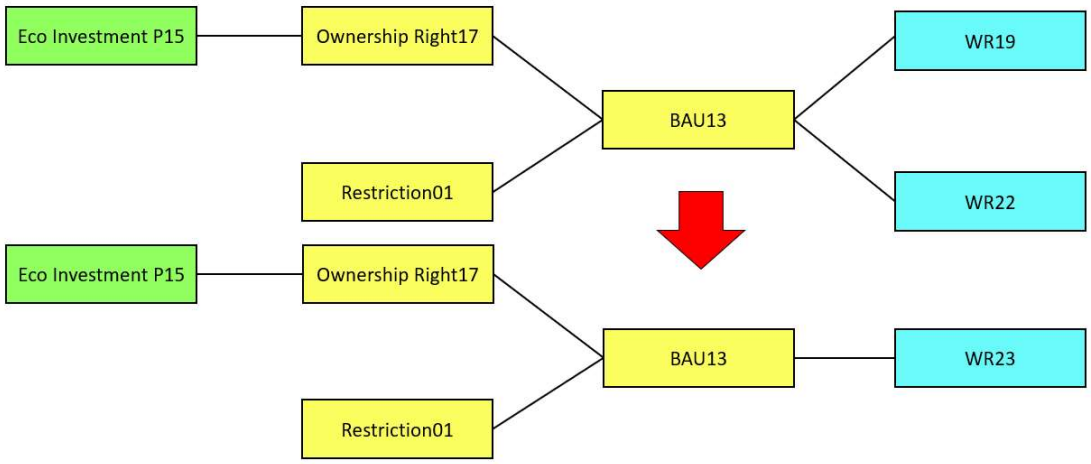


Figure 77. Transaction02. The spatial unit identifier changes in this example, simply because it is another unit. The identifiers of the ownership right (Right17), the restriction (Restr01) and the basic administrative unit (BAU13) remain the same in this example after merging

The representation in the database with timestamps is in figure 78.

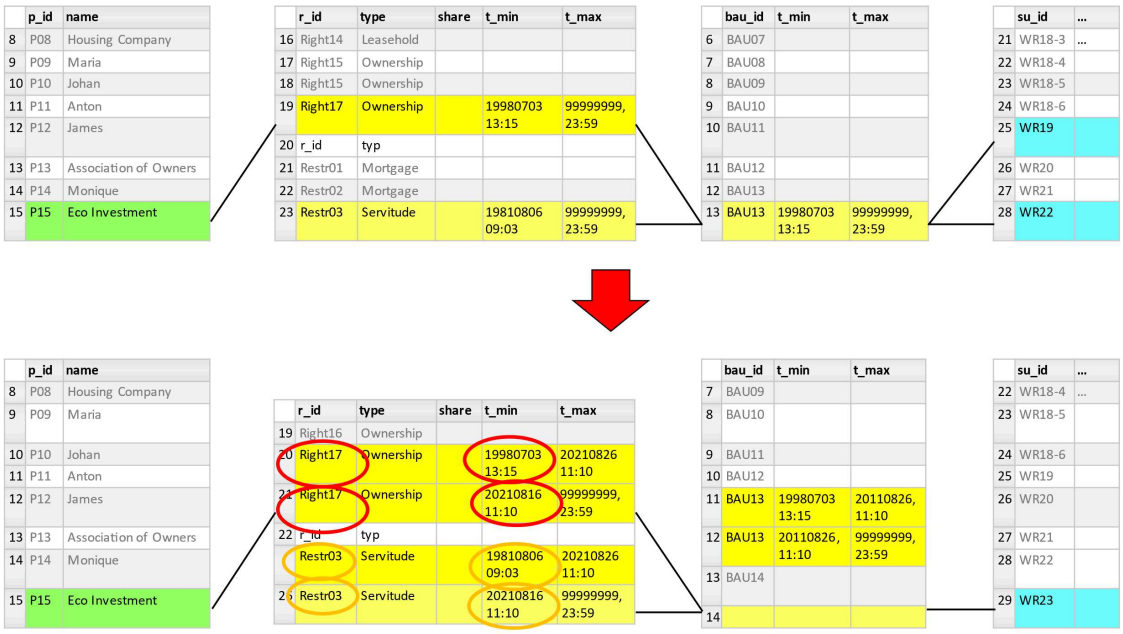


Figure 78. Merging WR19 and WR22 to WR23. Right17 appears twice, but with different t_min values. Same for Restr03 and BAU13.

The management of identifiers and the identification of rights, restrictions, basic administrative units and spatial units depends on the object identification approach as agreed for the land administration. The same is valid for parties. Here the population register is assumed to have an approach for unique party identification. The business register may have an approach for identification of non-natural persons as companies.

5.4 Transaction03: establishment of a servitude on WR17

This transaction concerns the establishment of a servitude on WR17. This servitude is needed to provide access to water for spatial unit WR20. The location of the servitude is within WR17 but not further specified.

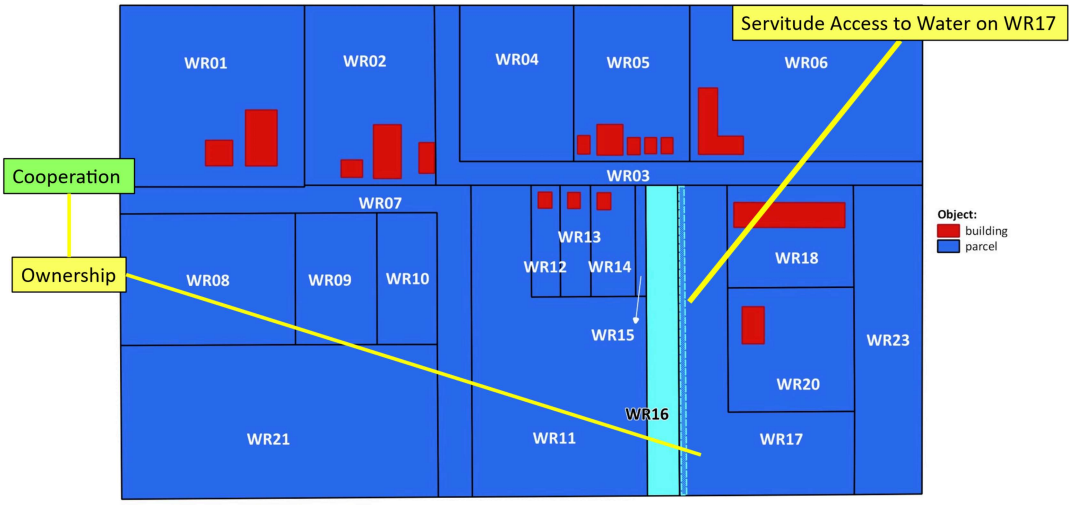


Figure 79. WR20 needs access to water. It is agreed to establish a servitude on WR17. The location of the servitude is unknown

First BAU05 is split into two new BAUs: BAU15 with WR09, WR20 and WR21 and BAU16 with WR17. The servitude can be established on the new BAU16 with WR17 (and has no relation with the other parcels in BAU05. A new title is created with Right21 on BAUNit16.

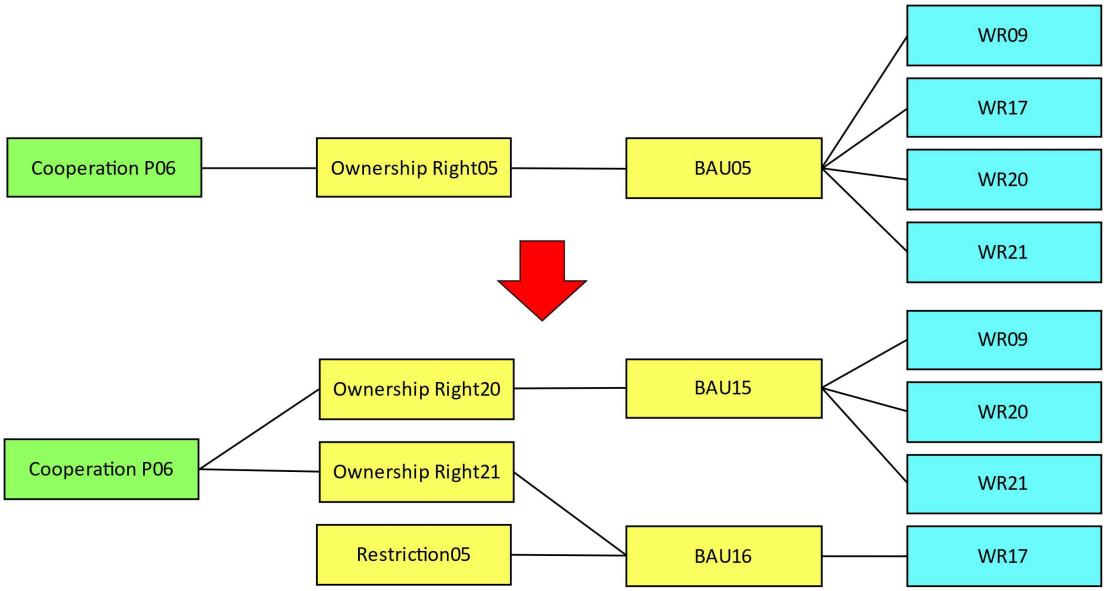
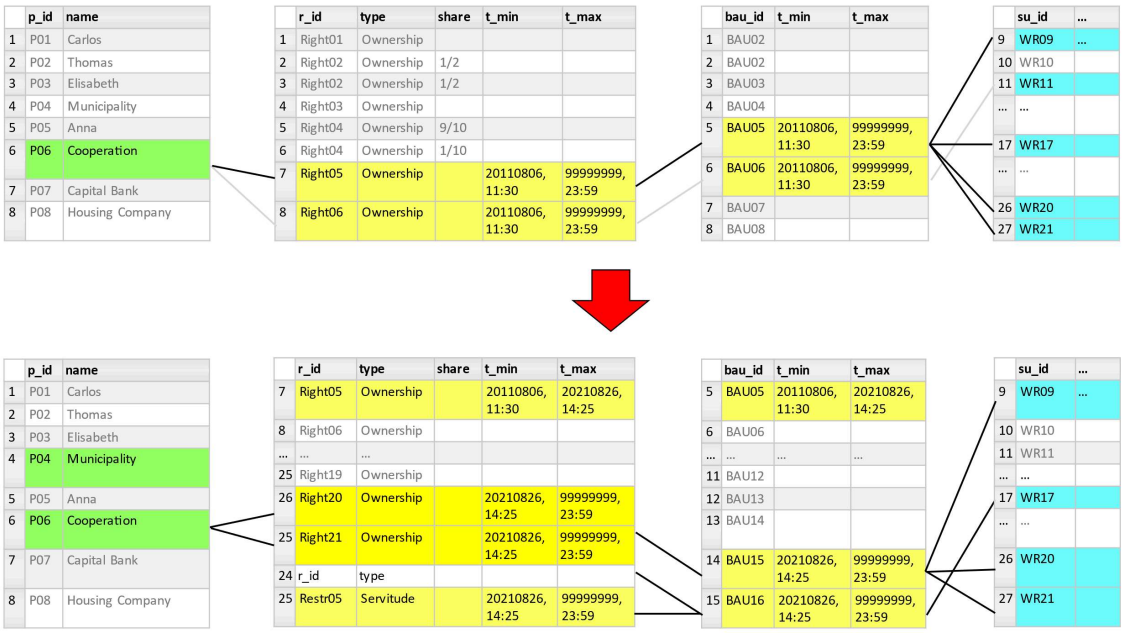


Figure 80. The new servitude is identified as Restriction 05 and applies to BAU16 with WR17. For this purpose BAU05 is split into BAU15 and BAU16. The new BAU16 is related to WR17 only. Now the new restriction is linked to Restriction05



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	Capital Bank
8	P08	Housing Company

	r_id	type	share	t_min	t_max
1	Right01	Ownership			
2	Right02	Ownership	1/2		
3	Right02	Ownership	1/2		
4	Right03	Ownership			
5	Right04	Ownership	9/10		
6	Right04	Ownership	1/10		
7	Right05	Ownership		20110806, 11:30	99999999, 23:59
8	Right06	Ownership		20110806, 11:30	99999999, 23:59

	bau_id	t_min	t_max
1	BAU02		
2	BAU02		
3	BAU03		
4	BAU04		
5	BAU05	20110806, 11:30	99999999, 23:59
6	BAU06	20110806, 11:30	99999999, 23:59
7	BAU07		
8	BAU08		

	su_id	...
9	WR09	...
10	WR10	
11	WR11	
...	...	
17	WR17	
...	...	
26	WR20	
27	WR21	

	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	Capital Bank
8	P08	Housing Company

	r_id	type	share	t_min	t_max
7	Right05	Ownership		20110806, 11:30	20210826, 14:25
8	Right06	Ownership			
...	...	...			
25	Right19	Ownership			
26	Right20	Ownership		20210826, 14:25	99999999, 23:59
25	Right21	Ownership		20210826, 14:25	99999999, 23:59
24	r_id	type			
25	Restr05	Servitude		20210826, 14:25	99999999, 23:59

	bau_id	t_min	t_max
5	BAU05	20110806, 11:30	20210826, 14:25
6	BAU06		
...	...	...	...
11	BAU12		
12	BAU13		
13	BAU14		
14	BAU15	20210826, 14:25	99999999, 23:59
15	BAU16	20210826, 14:25	99999999, 23:59

	su_id	...
9	WR09	...
10	WR10	
11	WR11	
...	...	
17	WR17	
...	...	
26	WR20	
27	WR21	

Figure 81. The new servitude is recorded in the database

BAU05 with WR09, WR17, WR20 and WR21 is split into BAU15 with WR09, WR20 and WR21 and BAU16 with WR16. The Cooperative (P06) has a right 20 to BAU15 and a Right21 to BAU16.

Restriction05 is not associated with a party, it is related to land only (WR17).

5.5 Transaction04: Implementation of a new spatial plan

Transaction04 concerns the development and implementation of a spatial plan by the Municipality of Waterriver on spatial unit WR11. Seven new houses and a small road for access will be constructed on big spatial units (parcels). Business may be developed on those spatial units under sustainability conditions. The existing parcel WR11 will be used for this development. See figure 82.

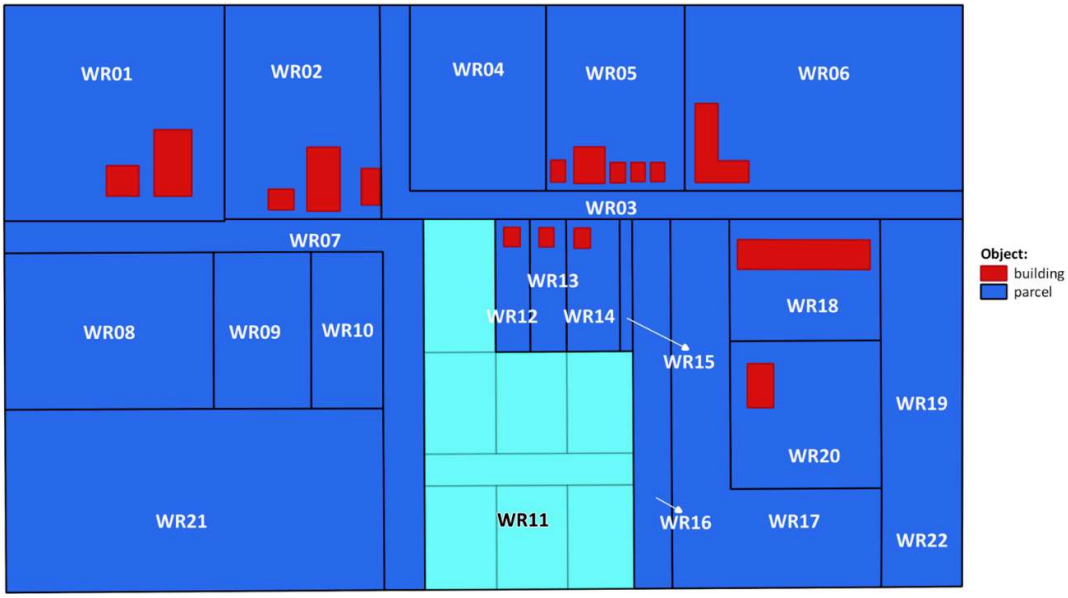


Figure 82. A Spatial Development Plan for the Municipality of Waterriver superimposed on the cadastral map. Seven new houses will be constructed on newly designed big spatial units (parcels).. Apart from construction of houses business development is possible – under sustainability conditions

In the existing situation WR11 is related to BAU06. The Cooperative has a mortgaged ownership right: Right06 with mortgage Restriction01. The Municipality has a usufruct right: Right07. See figure 26 and figure 27, and figure 83 below.

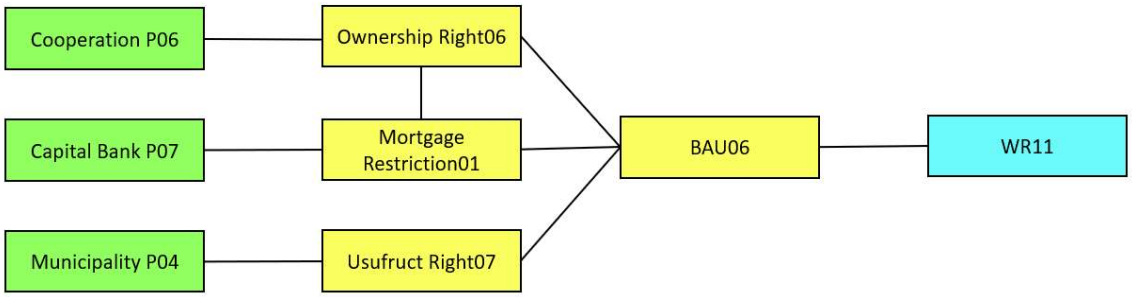


Figure 83. The Cooperative has a mortgaged ownership right and the Municipality a usufruct right on BAU06 related to WR11

The Cooperative agreed to transfer its ownership on BAU06 with WR11 to the Municipality.

Implementation of the spatial plan means a series of updates in one transaction in the land administration:

- a discharge of mortgage Restriction01 of Right06 on BAU06
- a transfer of ownership of BAU06 from the Cooperative to the Municipality
- a dissolve/discharge of usufruct (usufruct Right07 on BAU06)
- multiple subdivisions to create the new units, that is subdivision of WR11 into 8 new Spatial units

Figure 84 gives the overview of the situation before and after those transactions.

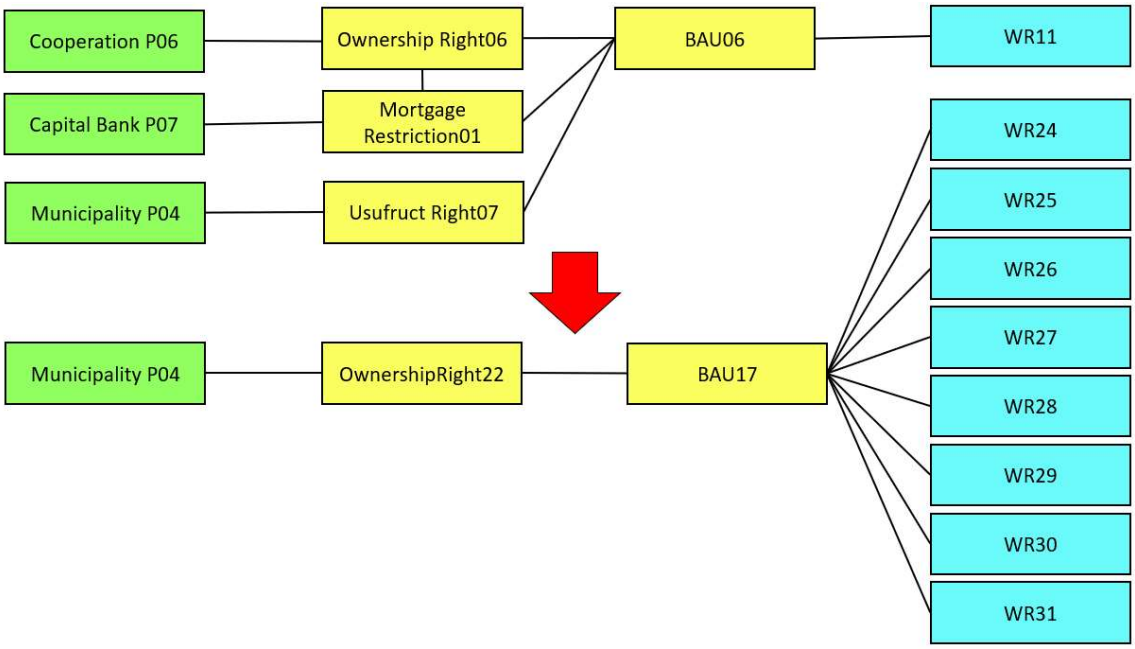


Figure 84. The usufruct on BAU06 will be ended together with the mortgage on Right06 and BAU06. Then the transfer of ownership of BAU06 from the Cooperative to the Municipality will be done. WR11 is subdivided into 7 new spatial units

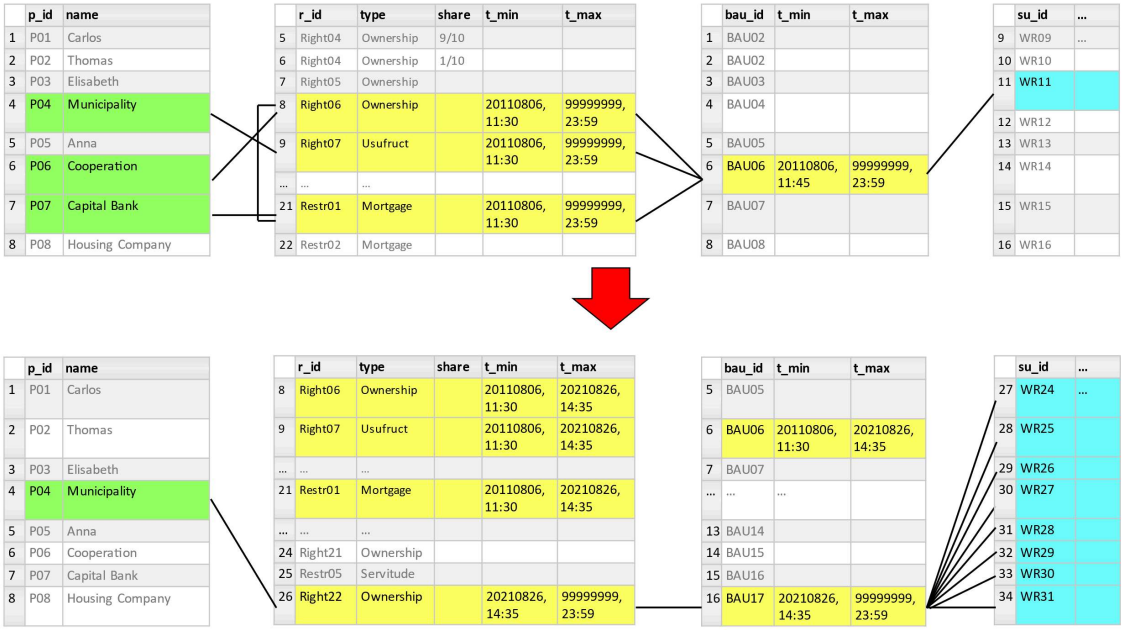


Figure 85. The transaction of figure 84 in the land administration database

The transaction takes place at 26th of August 2021 at 14:35. See the time stamps in figure 85. The transaction implies that:

- the mortgage Restriction01 on Right06 and BAU06 is ended, see t_max of Restr01 after the transaction
- the ownership of BAU06 from the Cooperative (P06) to the Municipality (P04) is transferred
- the Cooperatives' usufruct Right07 on BAU06 is ended, see t_max of Right07 after the transaction; BAU06 is deleted, see t_max of BAU06
- BAU17 is created at the same moment where BAU06 is created, see t_min of BAU17, and:
- the existing spatial unit WR11 is subdivided into 8 new Spatial units, WR24 ….. WR31, see t_min of BAU17.

See figure 86 for the subdivision.

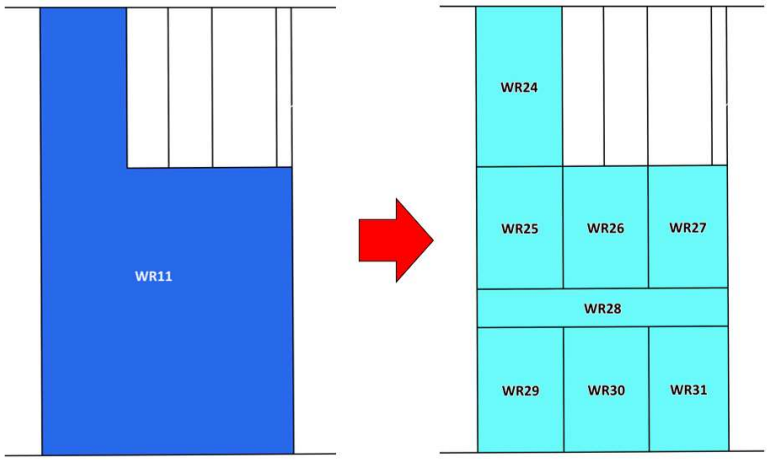


Figure 86. WR11 is subdivided into 8 new Spatial units in support to the implementation of the spatial plan

Apart from the "legal/administrative impact" in the database (see figure 85) there is also impact in the representation of the geometry of boundaries and in visualising spatial unit identifiers on the map. Figure 87 shows the boundary points. Figure 88the centroid points of the identifiers.

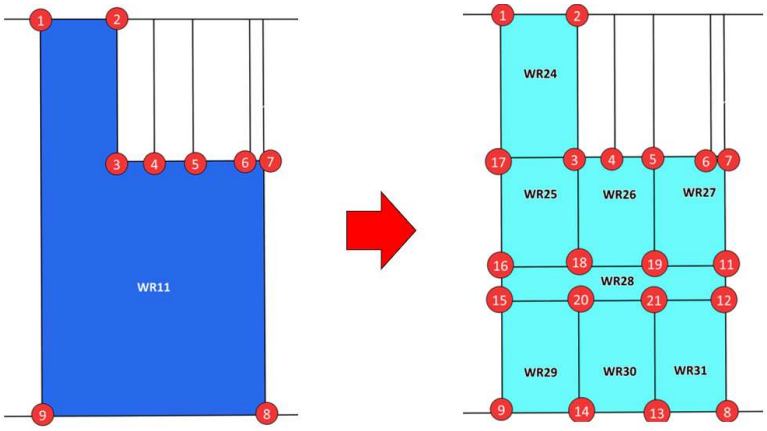


Figure 87. The subdivision means that new boundary points and boundaries are created

The boundary points in the situation before and after the transaction are visualised in figure 87 to the left (before the transaction) and to the right (after the transaction). Note: a boundary is called BoundaryFaceString (for 2D representations) and BoundaryFace (for 3D representations) in the LADM.

Coordinates of reference points (centroids) are in figure 88.

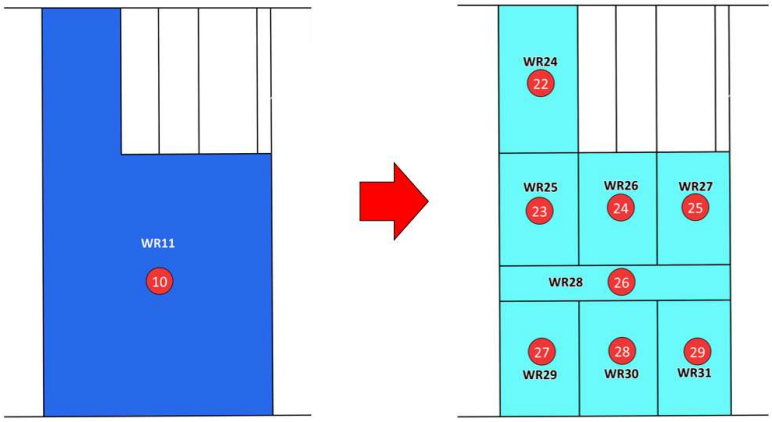


Figure 88. The centroid points of the spatial unit identifiers

The coordinates of all points are shown in figure 89.

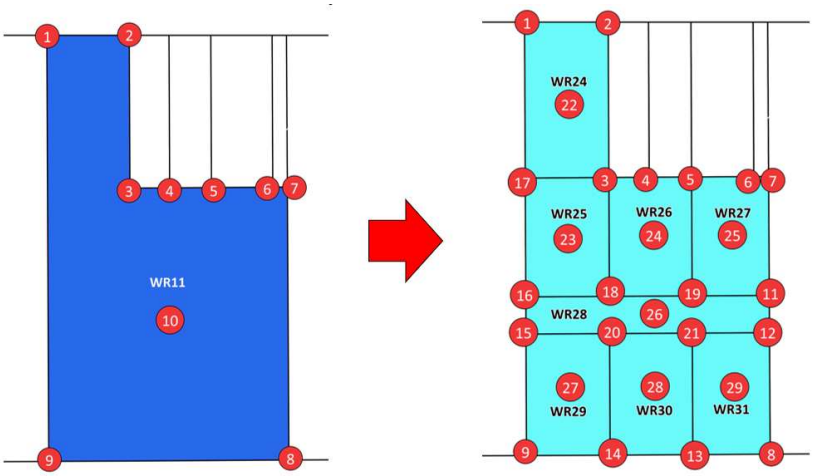


Figure 89. Coordinates of boundary points and reference points (centroid points)

The geometry of spatial unit WR11 is composed out of BoundaryFaceString (BFSs). Each BFS is defined by two or more points. See figure 90 to the right.

WR11 can be represented by BFS001, BFS002, ….. BFS008. In the example in figure 90 most face strings are composed out of two pints.

BFS002 consists of points 2, 3 and 4. Each point has coordinates X and Y. See figure 90.

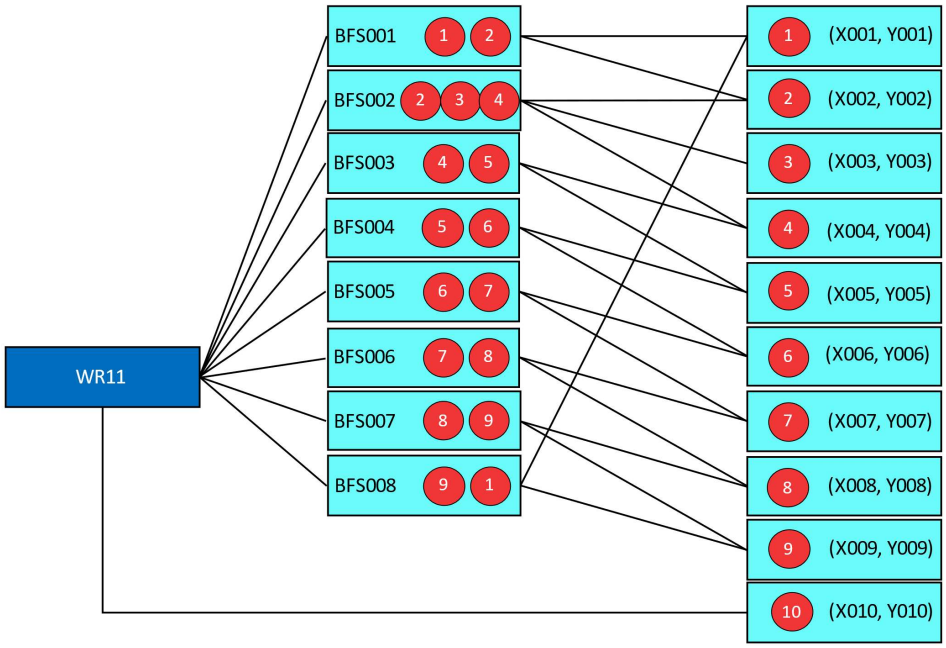


Figure 90. The geometry of spatial unit WR11 is composed of boundaryfacestraings (BFSs). Each BFS is defined by two or more points. BFS002 consists of points 2, 3 and 4. Each point has coordinates X and Y.

Note: BFS002 also appears as BFS in WR03. BFS002 appears also as boundary face string in WR12 (with references from the BFSs to the same coordinates X and Y).

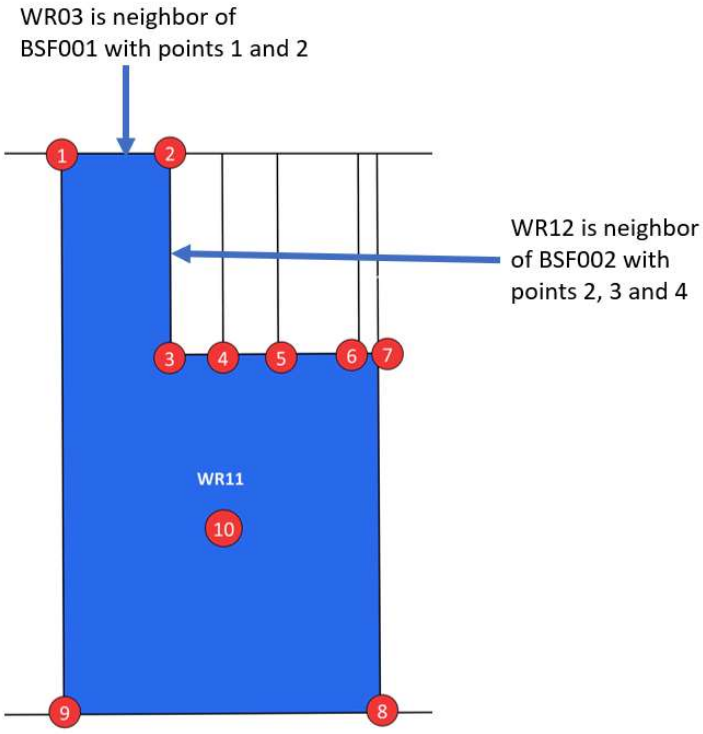
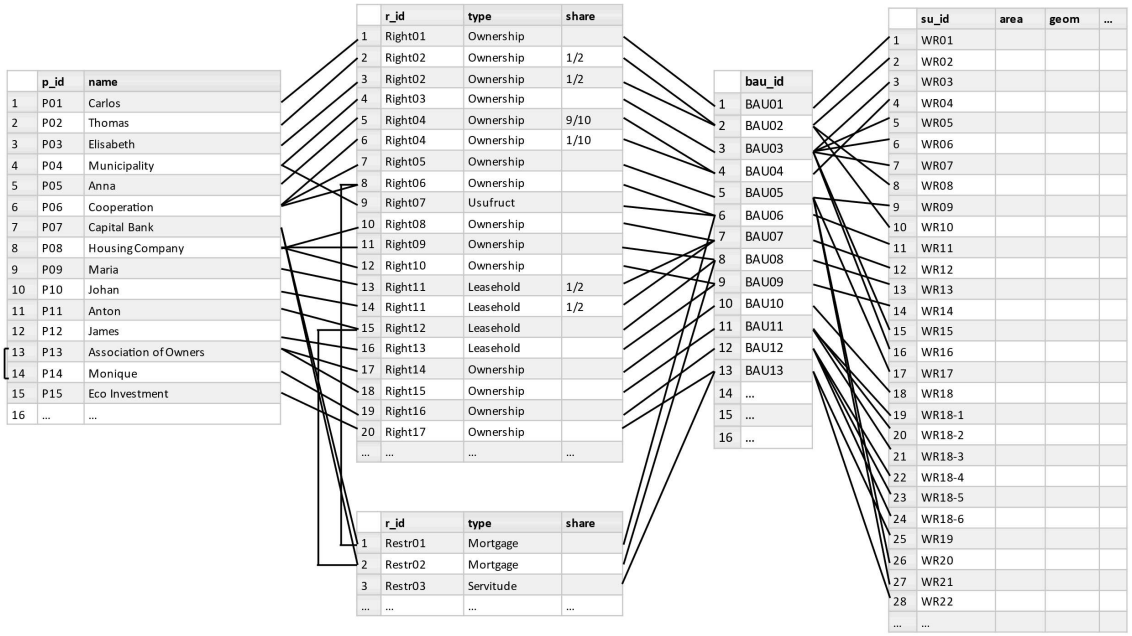


Figure 91. BFS001 also appears as BFS in spatial unit WR03. And BFS002 appears as boundary face string in WR12 (with same references to coordinates X and Y

6. LADM in UML

6.1 Core Classes

Cases One till Nine represented in the database in figure 63. This figure is repeated here without caption:



	p_id	name
1	P01	Carlos
2	P02	Thomas
3	P03	Elisabeth
4	P04	Municipality
5	P05	Anna
6	P06	Cooperation
7	P07	Capital Bank
8	P08	Housing Company
9	P09	Maria
10	P10	Johan
11	P11	Anton
12	P12	James
13	P13	Association of Owners
14	P14	Monique
15	P15	Eco Investment
16	...	...

	r_id	type	share
1	Right01	Ownership	
2	Right02	Ownership	1/2
3	Right02	Ownership	1/2
4	Right03	Ownership	
5	Right04	Ownership	9/10
6	Right04	Ownership	1/10
7	Right05	Ownership	
8	Right06	Ownership	
9	Right07	Usufruct	
10	Right08	Ownership	
11	Right09	Ownership	
12	Right10	Ownership	
13	Right11	Leasehold	1/2
14	Right11	Leasehold	1/2
15	Right12	Leasehold	
16	Right13	Leasehold	
17	Right14	Ownership	
18	Right15	Ownership	
19	Right16	Ownership	
20	Right17	Ownership	
...	...	...	...

	r_id	type	share
1	Restr01	Mortgage	
2	Restr02	Mortgage	
3	Restr03	Servitude	
...	...	...	...

	bau_id
1	BAU01
2	BAU02
3	BAU03
4	BAU04
5	BAU05
6	BAU06
7	BAU07
8	BAU08
9	BAU09
10	BAU10
11	BAU11
12	BAU12
13	BAU13
14	...
15	...
16	...

	su_id	area	geom	...
1	WR01			
2	WR02			
3	WR03			
4	WR04			
5	WR05			
6	WR06			
7	WR07			
8	WR08			
9	WR09			
10	WR10			
11	WR11			
12	WR12			
13	WR13			
14	WR14			
15	WR15			
16	WR16			
17	WR17			
18	WR18			
19	WR18-1			
20	WR18-2			
21	WR18-3			
22	WR18-4			
23	WR18-5			
24	WR18-6			
25	WR19			
26	WR20			
27	WR21			
28	WR22			
...	...			

The LADM Core classes (or Basic Classes) are: LA_Party, LA_RRR, LA_BAUnit and LA_SpatialUnit. All classes in LADM have a prefix ”LA”. This prefix makes the class name unique in the ISO standardisation system.

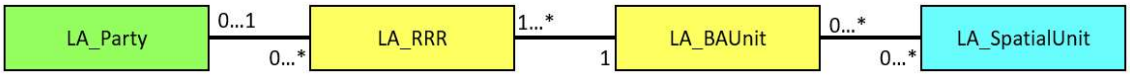


Figure 92. The LADM Core Classes - also called Basic Classes. The multiplicities between classes are represented

A LA_Party may have zero or more rights, restrictions or responsibilities: LA_RRR’s. This means there can be LA_Party(ies) without LA_RRR’s. For example: this can be a LA_Party with a role in the transactions but without property rights.

A LA_RRR may have zero or one LA_Party. If there is no LA_Party related to a LA_RRR the LA_RRR is purely related to the land. Servitude is an example. See Restr03. If there is more then one LA_Party related to a LA_RRR the LA_RRR needs to be shared over several LA_Parties. There may be a requirement that the sum of shares in a right is equal to one.

A LA_RRR applies to exactly one LA_BAU, but a LA_BAU may be composed out of zero or more LA_SpatialUnits. A LA_BAUnit must have one or more LA_RRR’s. Note: a LA_RRR must have one (and only one) BAUnit related. This allows (for example) tariffs per right type

in a taxation cadaster. Different right types means different tariffs for different BAUnits – for example per municipality. See figure CHRIT 01 and CHRIT 02 for an illustration of this.

A LA_BAUnit can have zero or more LA_SpatialUnits. There are zero spatial units (with geometry) if there is no cadastral map existing (there is no cadaster). In such a case there may be a land registry.

A LA_SpatialUnit may belong to zero or more LA_BAUnits. A spatial unit may be grouped in a property unit and at the same time (but in another way) in a taxation unit and in a spatial plan. This means there can be a land registry without a cadaster.

In the LADM standard the core classes are represented as in figure 93. ISO identifies the First Edition of the LADM as ISO 19152:2012. This edition was published at 1 December 2012.

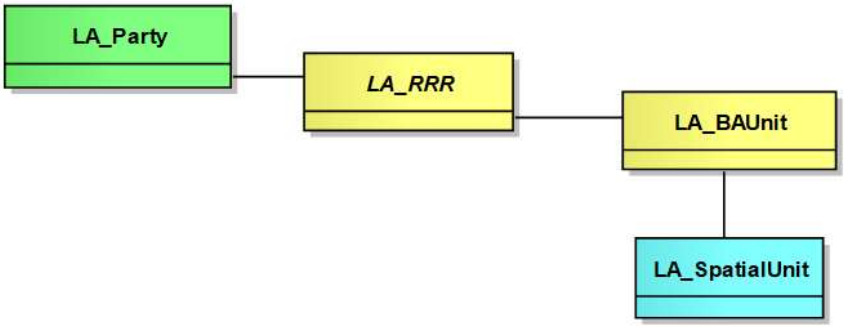


Figure 93. Core classes as represented in the ISO 19152 LADM Standard

6.2 Special Classes

There are two special classes in the LADM: VersionedObject and LA_Source. Both VersionedObject and LA_Source are abstract classes. Their attributes are inherited by their specialisation classes.

In LADM an **object** is a right, restriction, responsibility, basic administrative unit, party, or spatial unit.

All LADM classes (except LA_Source) inherit from VersionedObject. VersionedObject contains attributes for history management: beginLifespanVersion and endLifespanVersion. Those attributes contain date and time of creation of an object and date and time of deletion respectively. Those attributes are introduced in the transactions (Transactio01 til Transaction04).

Over time an object, for example a LA_Party, can have different ”versions” in the database. For example before a marriage there is no shared ownership, after marriage there is shared ownership. Note: versioning and identification are based on national or local approaches and defined in country or local LADM profiles.

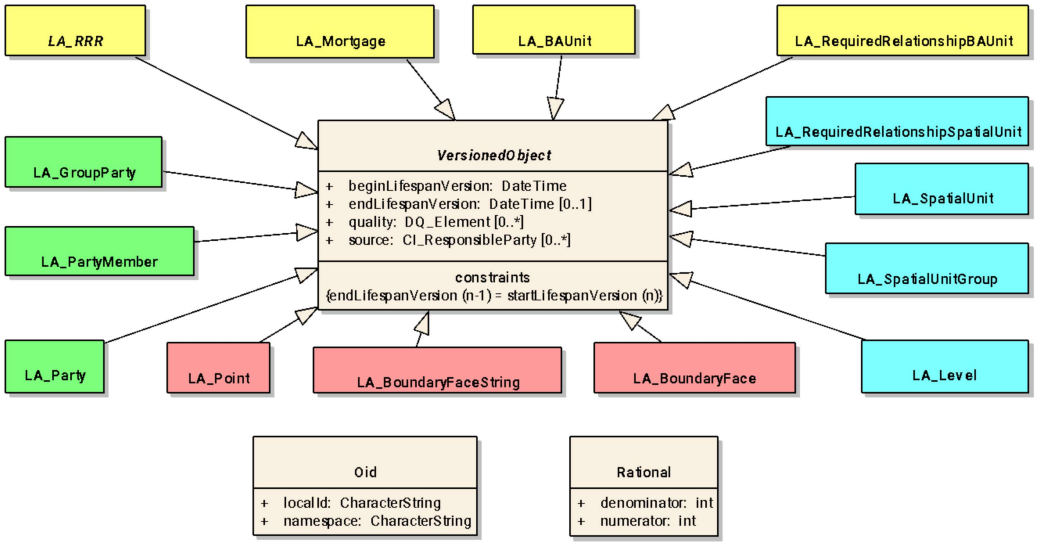


Figure 94. Class "Versioned Object" is an abstract class. Oid and Rational (fraction) are data types

For each record there are also a quality label, that is the attribute ”quality”. And there is a reference to the responsible organisation – the ”owner” of the information on the record. This attribute is called ”source”. See figure 94.

The generic data type Oid provides support in object identifiers. See Annex 1.

The generic data type fraction is introduced in the LADM to provide support for fractions, e.g. ½ or ¾. This is needed to represent shares in rights.

In the LADM, administrative sources and spatial sources are modelled, starting with an abstract class LA_Source. LA_Source has two subclasses: LA_AdministrativeSource, and LA_SpatialSource. Those classes inherit from LA_Source. See figure 95.

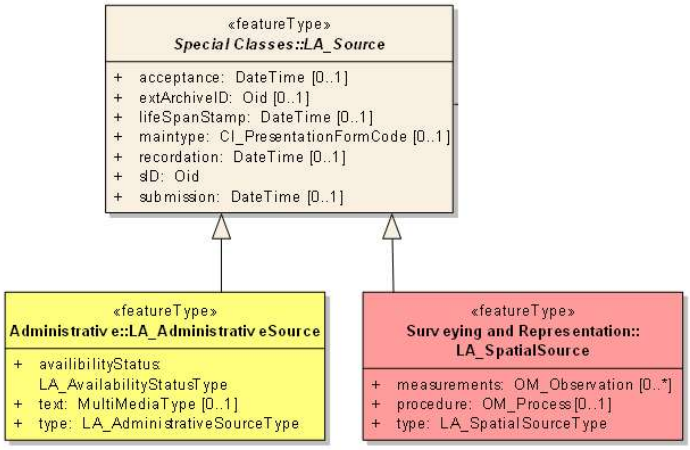


Figure 95. Class LA_Source with specialisations LA_AdministrativeSource and LA_SpatialSource

In principle there will be no changes or updates in the database if those are not documented in a source. Each transaction in the land administration database is triggered by a source document, for example a deed.

A LA_Source is authentic and does not inherit from VersionedObject. Here below the complete set of attributes of Class LA_Source and its specialisations LA_AdministrativeSource, and LA_SpatialSource is presented.

Note: attributes are columns in database tables.

A **source** is a document providing legal and/or administrative facts on which the land administration object (that is right, restriction, responsibility, basic administrative unit, party, or spatial unit) is based.

Attributes of Class LA_Source are:

- ”lifeSpanStamp”, this is the moment that the event, represented by the instance of LA_Source, is further processed in the LA system (this is the moment of endLifespanVersion of old instances. And also the moment of beginLifespanVersion of new instances. This means the data and time of a database commit – where new objects are created with a beginLifespanVersion and old objects are placed in history with a endLifeSpanVersion in class VersionedObject and all classes inheriting from there (except LA_Source which is authentic). ”lifeSpanStamp” triggers the management of history for each transaction;
- ”extArchiveID”, the identifier of a source in an external organisation;
- ”maintype”, the type of document; and:
- ”sID”, source document identifier;

Some attributes of class LA_Source are transaction related. Those attributes concern the transaction in real time, not the database time:

- ”submission”, the date of submission of the source by a party;
- ”acceptance”, this the date of force of law of the source by an authority; and:
- ”recordation”, this is the date of registration (recordation) of the source by the registering authority. Informal rights are recorded, formal rights are registered

An **administrative source** is a source with the administrative description (where applicable) of the parties involved, the rights, restrictions and responsibilities created and the basic administrative units affected.

Attributes of Class LA_AdministrativeSource are:

- ”availabilityStatus”: ”converted”, ”destroyed”, ”incomplete”, ”unknown”, ”available”;
- ”text”, text of in the document; and:
- ”type administrative source”: deed, mortgage, title, etc;

A **spatial source** is a source with the spatial representation of one (part of) or more spatial units.

Attributes of Class LA_SpatialSource are:

- ”measurements”, survey observations (from another ISO standard);
- ”procedure”, from another ISO standard; and:
- ”type spatial source”, field sketch, GNSS survey, orthophoto, video, topMap, etc

6.3 Packages and Classes

LADM has three packages and one subpackage related to:

- parties (people and organisations, classes in green)
- basic administrative units, rights, responsibilities, and restrictions (ownership rights, classes in yellow)
- spatial units (parcels, and the legal space of buildings and utility networks classes in blue), and:
- spatial sources (surveying), and spatial representations (geometry and topology, classes in red). This is a subpackage

The LADM class diagram has been presented in figure 2 and is included here once more.

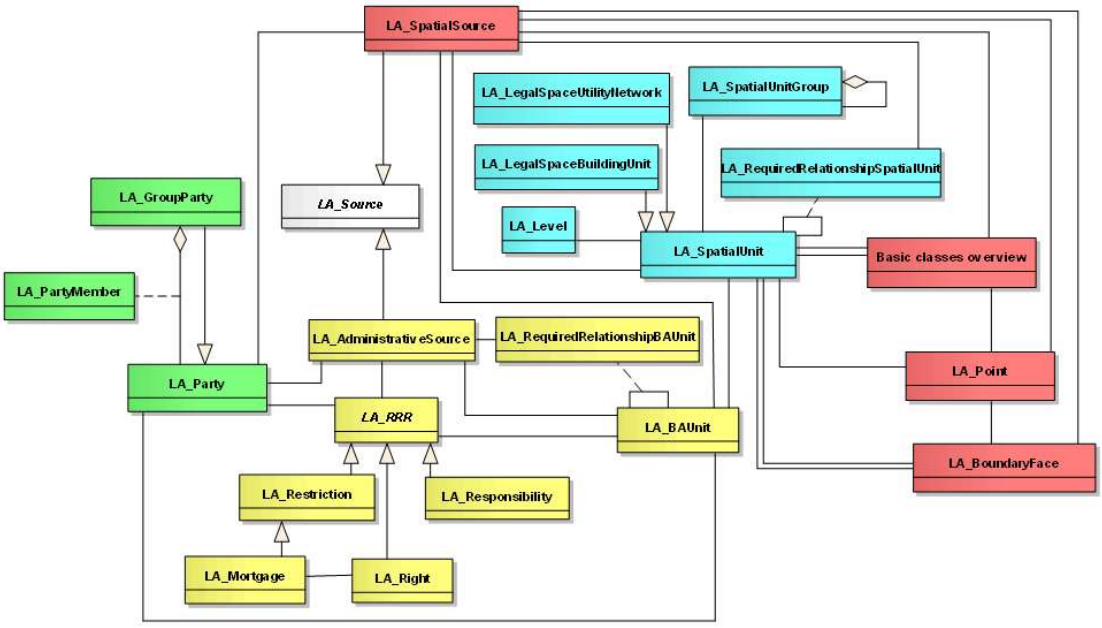


Figure 96. The Land Administration Domain Model: Class Diagram

The main class of the party package (see figure 97) of the LADM is class LA_Party with its specialisation LA_GroupParty. There is an optional association class LA_PartyMember.

A ’**party**’ is a person or organisation that plays a role in any land administration process

A **‘group party’** is any number of parties, together forming a distinct entity, with each party registered

A **‘party member’** is a party registered and identified as a constituent of a group party. This allows documentation of information to membership (holding shares in rights).

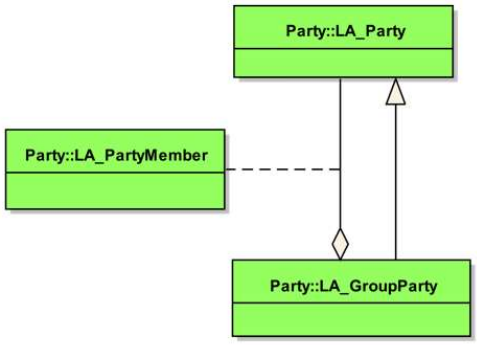


Figure 97. LADM Party Package

The administrative package (see figure 98) concerns the abstract class LA_RRR (with three subclasses LA_Right, LA_Restriction and LA_Responsibility), and class LA_BAUnit (Basic Administrative Unit).

A**'right'** is formal or informal entitlement to own or perform an action.

A **'restriction'** is a formal or informal obligation on the land owner to refrain from performing an action.

A **'responsibility'** is a formal or informal obligation on the land owner to allow or perform an action. Owner implies leaseholder, usufruct holder, etc.

A **'basic administrative unit'** is an administrative entity, which can be 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, responsibilities or restrictions are associated to the whole entity, as included in a land administration system.

A 'basic administrative unit' may play the role of a 'party' because it may hold a right of easement over another, usually neighbouring, spatial unit.

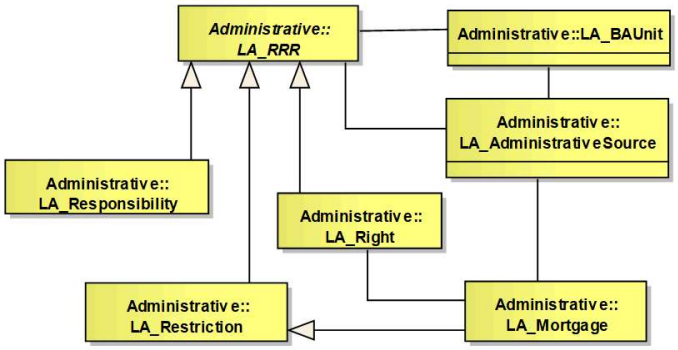


Figure 98. The LADM Administrative Package

The spatial unit package (see figure 99) concerns the classes LA_SpatialUnit, LA_SpatialUnitGroup, LA_Level, LA_AdministrativeSource, LA_LegalSpace Network,

LA_LegalSpace-BuildingUnit and LA_Required RelationshipSpatialUnit (this class is not shown in figure 99).

A **'Spatial unit'** is feature type related to land administration with associated spatial and thematic attributes

Single areas are the general case and multiple areas the exception. Spatial units are structured in a way to support the creation and management of basic administrative units.

A **'spatial unit group'** is a group of spatial units; e.g.: spatial units within an administrative zone (e.g. a section, a canton, a municipality, a department, a province or a country) or within a planning area.

A **'level'** is a collection of spatial units with a geometric and/or topologic and/or thematic coherence.

A **'utility network'** network describes the legal space of the topology of a utility. This is the legal space, not the physical cable or pipeline. To maintain the cable you need space.

A **'building unit'** is a component of a building, it is the legal, recorded or informal space of the physical entity.

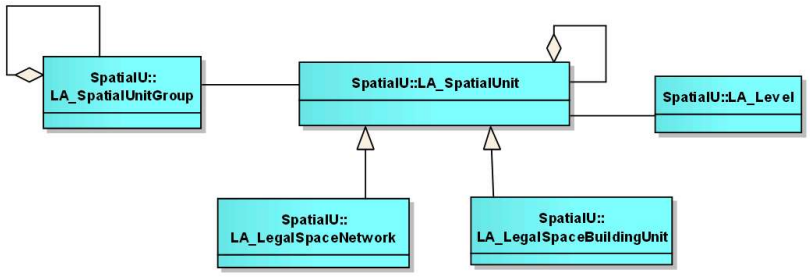


Figure 99. The LADM Spatial Unit Package

The Spatial Unit Package has one Surveying and Representation Sub-package with classes such as LA_SpatialSource, LA_Point, LA_BoundaryFaceString and LA_BoundaryFace.

A **'point'** is a 0-dimensional geometric primitive, representing a position. Points can be acquired in the field by classical surveys or with images. A survey is documented with spatial sources. A set of measurements with observations (distances, bearings, etc.) of points, is an attribute of LA_SpatialSource. LA_Point is associated to LA_SpatialSource.

2D and 3D representations of spatial units use boundary face string (2D boundaries implying vertical faces forming a part of the outside of a spatial unit) and boundary faces (faces used in 3D representation of a boundary of a spatial unit).

A **'boundary face string'** is a boundary forming part of the outside of a spatial unit.

A **'boundary face'** is a face that is used in the 3-dimensional representation of a boundary of a spatial unit.

Coordinates themselves either come from points or are captured as linear geometry.

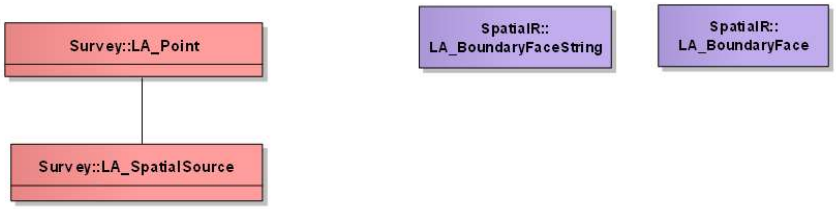


Figure 100. The Surveying and Representation Sub-Package

6.4 Party Package

The party package is shown in figure 101. The datatypes are behind the attribute name. This can be a character string, a boolean etc. If the attribute is of type "type" there is a code list.

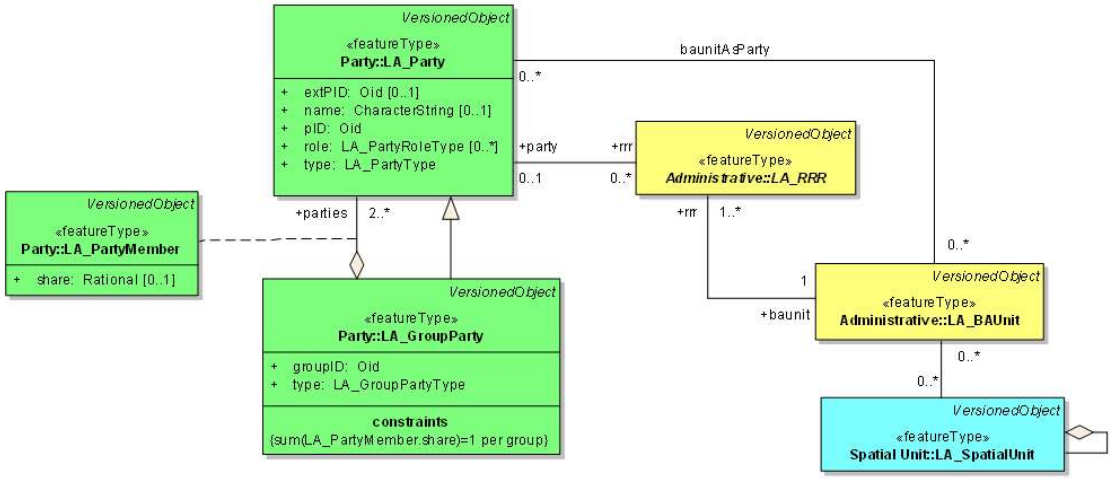


Figure 101. The PartyPackage in green, combined with the core classes LA_RRR (in yellow), LA_BAUnit (in yeloow) and LA_SpatialUnit (in bleu)

Class LA_Party is a specialisation of class VersionedObject. See figure 94 and 102.

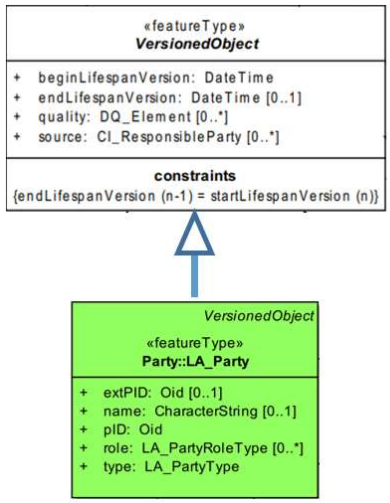


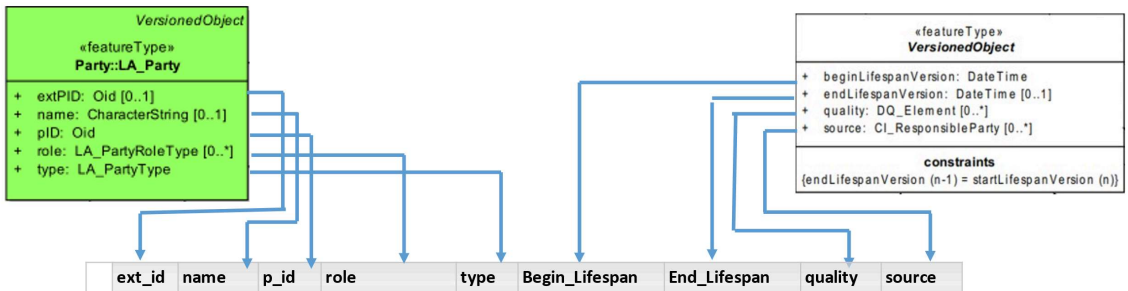
Figure 102. Class LA_Party is a specialisation of class VersionedObject

VersionedObject is an abstract class. This means that LA_Party inherits from VersionedObject.

The attributes of VersionedObject are beginLifespanVersion, endLifespanVersion, quality and source.

Attributes of LA_Party are extPID, name, pID, role and type, see figure 102.

The inheritance of attributes by LA_Party from VersionedObject means that all attributes from VersionedObject will be included in the Party table. See figure 103. There can be more attributes from local or national LADM profiles.



	ext_id	name	p_id	role	type	Begin_Lifespan	End_Lifespan	quality	source
1	1	Carlos	P01	Citizen	NP				
2	2	Thomas	P02	Citizen	NP				
3	3	Elisabeth	P03	Citizen	NP				
4	4	Muni	P04	Government	NNP				
5	5	Anna	P05	Citizen	NP				
6	6	Cooper	P06	Cooperative	NNP				
7	7	Bank	P07	Money Prov	NNP				
8	...	...	...	...	...				

Figure 103. LA_Party implemented in a party table. LA_Party inherits attributes from VersionedObjects. In the database this means that the combined sets of attributes are represented in the party table

Here below the complete set of attributes related to the classes in the party package is presented. Note: attributes are columns in database tables.

Class LA_Party:

- ”extPID”, this is the identifier of the party in an external registration, for example the population register or the business register;
- ”name”, the name of the party, in accordance to local conventions for names of natural and non natural persons;
- ”pID”, this is the ID of the party;
- “role”, this is the role in which the party appears, for example citizen, conveyor, employee, farmer, surveyor, writer, bank, notary, etc. Note: a surveyor can also be a citizen as owner. Those are two roles. And:
- “type”, the type of party: group, natural person, non natural person or a governmental organisation

Class LA_GroupParty:

- ”groupID”, the identifier of a group party; and:
- ”type”, the type of a group party, for example a tribe, an association, a family. Note: those group parties are represented by a chief, a chair, a family head

Class LA_PartyMember:

- ”share”, the fraction of the whole. A LA_GroupParty can be with defined or undefined membership. Note: there can also be a share in a right on a BAUnit

The implementation of this data package results in the of tables as in figure 104.

LA_GroupPart inherits from LA_Party, this means that a group party is a party.

Because of this inheritance the first five columns in the group party table are the same as the five columns in the party database.

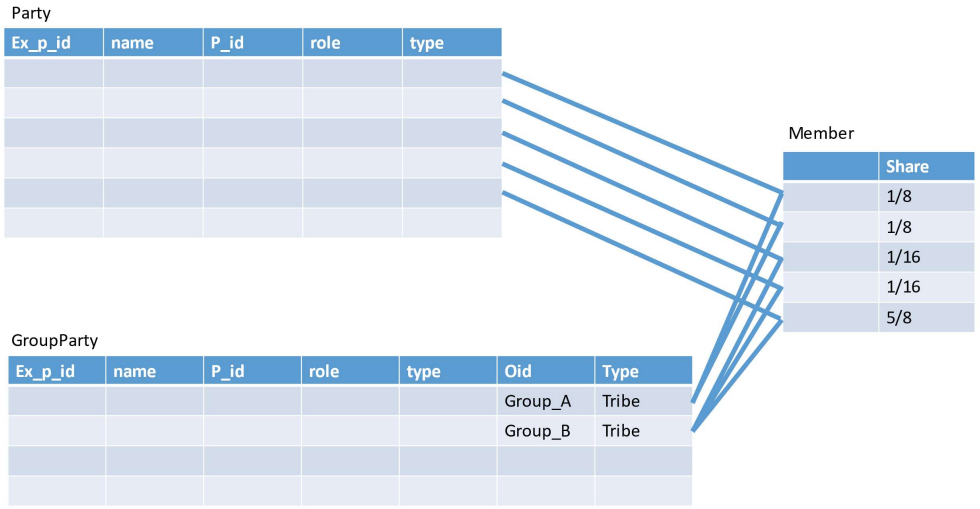


Figure 104. Implementation of the Party Package in the database

6.5 Administrative Package

The Administrative Package with its classes, attributes and multiplicities is represented in figure 105. All core classes are included, also the LA_Party class in green and the LA_SpatialUnit in blue.

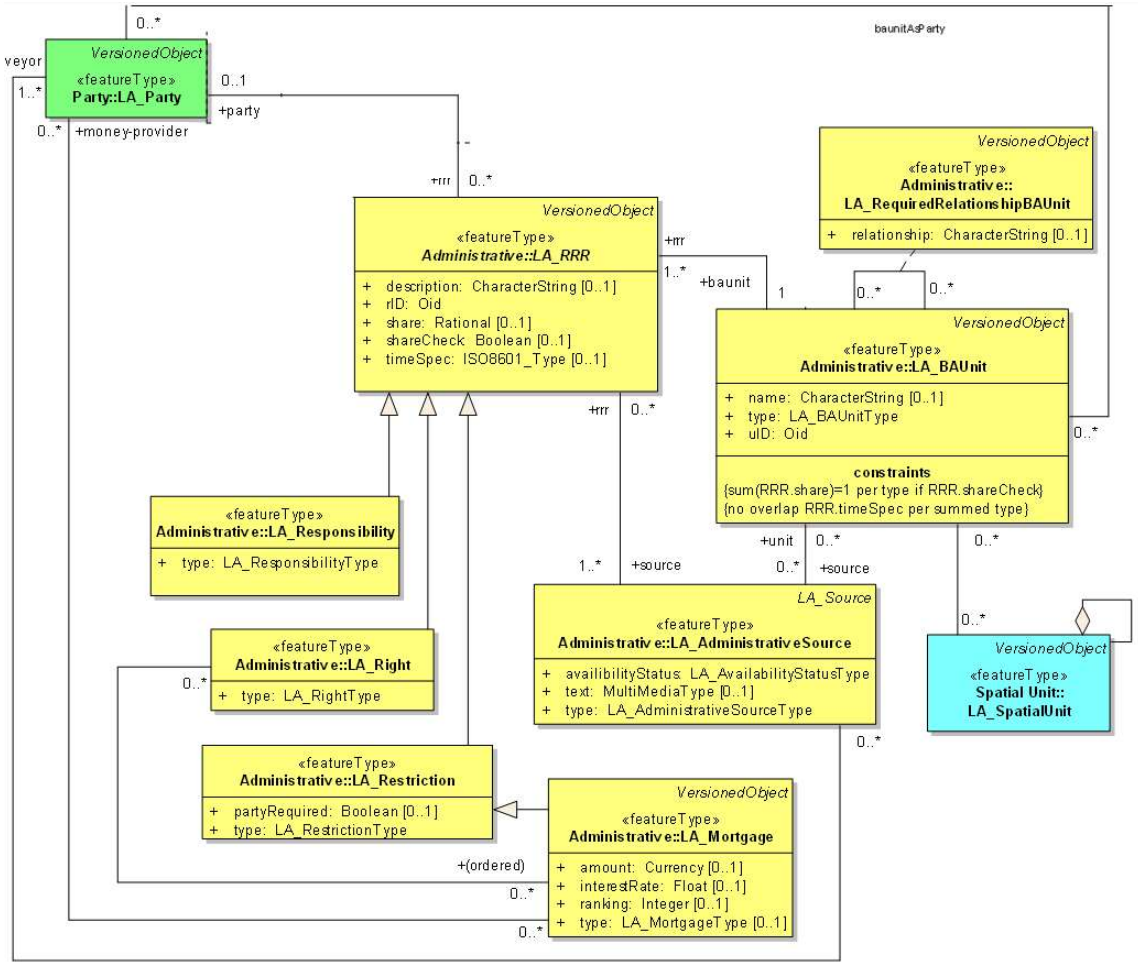


Figure 105. The LADM Administrative Package

Here below the complete set of attributes related to the classes in the administrative package is presented. Note: attributes are columns in database tables.

Class LA_RRR:

- "description", description regarding the right, restriction or responsibility;
- "rID", the RRR identifier;
- "share", a share in an instance of a subclass of a LA_RRR;
- "shareCheck", indicates that sum of shares is equal to one, this is a constraint in class LA_BAUnit, see Figure 105; and:
- "timeSpec", operational use of a right in time sharing (for example: you're user/owner in May/June, there are other users/owners during the other months

Class LA_Right:

- "type", right type, this is country specific, can be for example: ownership, lease, occupation, usufruct, tenancy, informal occupation, fishing right, etc.

Class LA_Responsibility:

- “type”, responsibility type, this is country specific, can be for example: mandatory monument maintenance or waterway maintenance. If this maintenance is not done another organisation will do it on costs of the responsibility holder

Class LA_Restriction:

- “type”, restriction type, this is country specific, for example a restriction can be a monument where are kind of changes in the building are not allowed, servitude where

Class LA_Mortgage

- “amount”, the amount of money of the mortgage;
- “interestRate”, interest rate (percentage) of the mortgage;
- “ranking”, the ranking order of the mortgage if more than one mortgage applies; there can be a first mortgage, a second mortgage etc. as a restriction to right. In case the court decides that the money provider can sell the collateral the first mortgage prevails, then the second etc. And:
- “type”, mortgage type, this is country specific, for example: linear, micro credit

Class LA_BAUnit:

- “name”, the name of the Basic Administrative Unit, for example the farm name or the name of the locality;
- “type”, BAUnit type, this is country specific, for example basic property unit, leased unit, taxation unit (see Figure 106), right of use unit, spatial plan – reallocation;
- “uID”, the identifier of the basic administrative unit; and:

Class LA_RequiredRelationshipBAUNit:

- “relationship”, the description of the required relationship. This may be needed to connect historic versions of a BAUnit in time

An example of a set of basic administrative units for tax purposes is given below.

Party A owns two basic administrative units in different municipalities: Freetown and Waterriver. Party A leases one BAU in Waterriver. For the land tax there are different tariffs per municipality per right type.

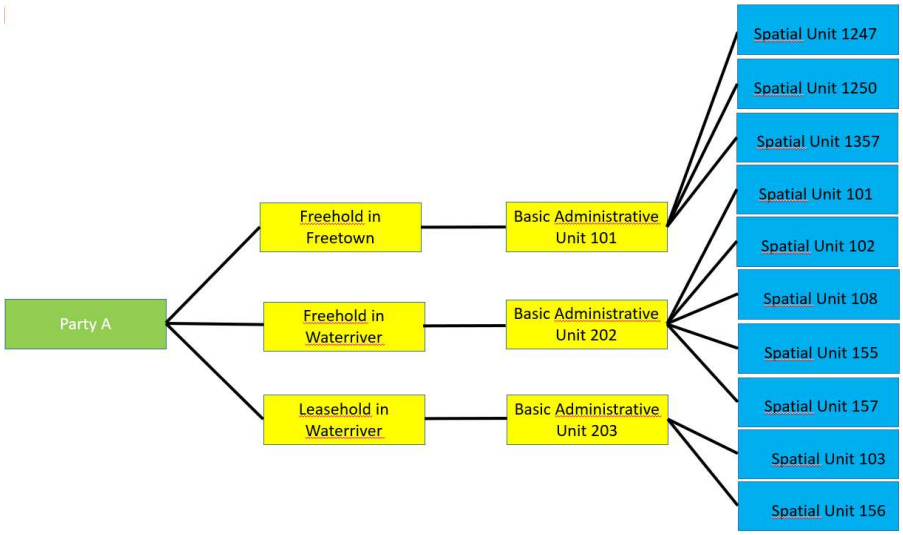


Figure 106. Three basic administrative units for taxation purposes

6.6 Spatial Unit Package

The Administrative Package with its classes, attributes and multiplicities is represented in figure 107. All core classes are included, also the LA_Party class in green, and LA_RRR and LA_BAUnit in yellow.

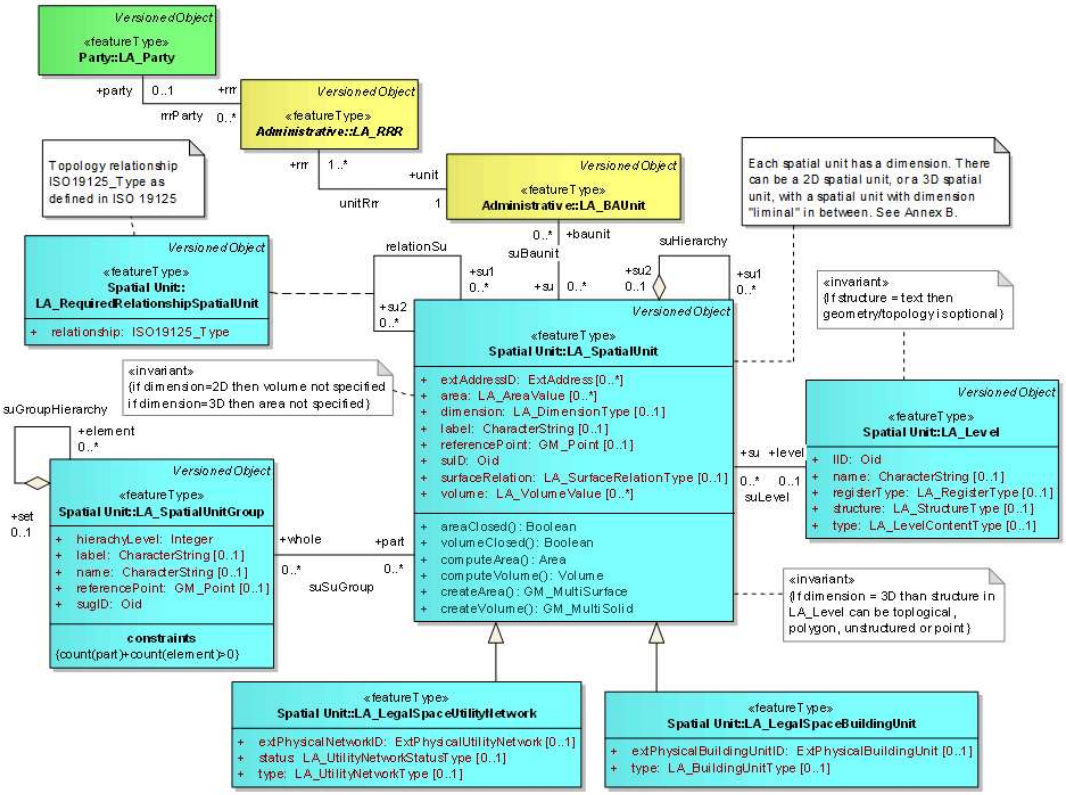


Figure 107. The LADM Spatial Unit Package

Here below the complete set of attributes related to the classes in the spatial unit package is presented.

Note: attributes are names of columns in database tables.

Class LA_SpatialUnit:

- “extAddressID”, this is the link to external address(es) of the spatial unit. Spatial units can be used as references in many applications also applications in other organisations
- “area”, the area of the 2D spatial unit. There can be more then one area, for example legal area and calculated area or calculated area after conversion
- “dimension”, the type of dimension is 0D (point), 1D (line), 2D, 3D, liminal (this is a spatial unit on the threshold between 2D and 3D representations)
- “label”, short textual description of the spatial unit
- “referencePoint”,
- “suID”, the identifier of the spatial unit,
- “surfaceRelation”, this attribute indicates whether a spatial unit is above or below surface, and:
- “volume”, the volume of the 3D spatial unit

Methods in Class LA_SpatialUnit are:

- “areaClosed” checks if associated spatial representation is closed (2D),
- “volumeClosed” checks if associated spatial representation is closed (3D),
- “computeArea” computes area of associated spatial representation (2D),
- “computeVolume” computeVolume( )’ computes volume of associated spatial representation (3D),
- “createArea” constructs geometric primitive of type GM_MultiSurface based on associated spatial representation (2D), and
- “createVolume” constructs geometric primitives of type GM_MultiSolid based on associated spatial representation (3D).

Class LA_SpatialUnitGroup:

- “hierarchyLevel”, the level in the hierarchy of an administrative or zoning subdivision. The can be a group of spatial units (for example a section) or a group of groups of spatial units (for example a municipality) or a group of groups of groups of spatial units (for example a province). Three levels is hierarchy,
- ”label” is a short textual description of the spatial unit group,
- ”name” is the name of the spatial unit group, a spatial unit can be related to more then one spatial group,
- ”referencePoint” the coordinates of a point within the spatial unit group, this is for example for GIS applications, and:
- ”sugID” is the identifier of the spatial unit group.

Class LA_LegalSpaceBuildingUnit:

- ”extPhysicalBuildingUnitID”, this is the identifier of the building unit in an external database, and:

- ”type”, the type of the building unit. This type can be ”shared” or ”individual”. Common ownership or individual ownership in an apartment building

Class LA_LegalSpaceUtilityNetwork:

- ”extPhysicalUtilityNetworkID”: A reference to the physical (technical) description of the utility network;
- ”status”: the status of the utility network, this can be ”in use”, ”out of use”, ”planned”, and:
- ”type”: the type of the utility network, can be for example: chemicals, electricity, gas, heating, oil, telecom, water, etc,

Class LA_Level:

- “lID”: the identifier of the level,
- “name”: the name of the level,
- “registerType” – for example: “urban”, “rural”, “mining”, “public space”, “forest”, “all”. Different types of cadaster’s all structured in LADM can be interoperable
- “structure” is the structure of the level geometry – this can be point, polygon, text, topological, unstructured lines, and sketch. Different types of geometry per level, there can be a development path to well structured topology,
- “type” is the type of content of the level, for example: buildings, customary, mixed, network, primaryRight, responsibility, restriction, informal, etc,

Class LA_RequiredRelationshipSpatialUnit:

- “relationship” is the description of the required relation

6.7 Surveying and Representation Subpackage

The Surveying and Representation Sub package with its classes, attributes and multiplicities is represented in figure 108. All core classes are included, also the LA_Party class in green, and LA_RRR and LA_BAUnit in yellow.

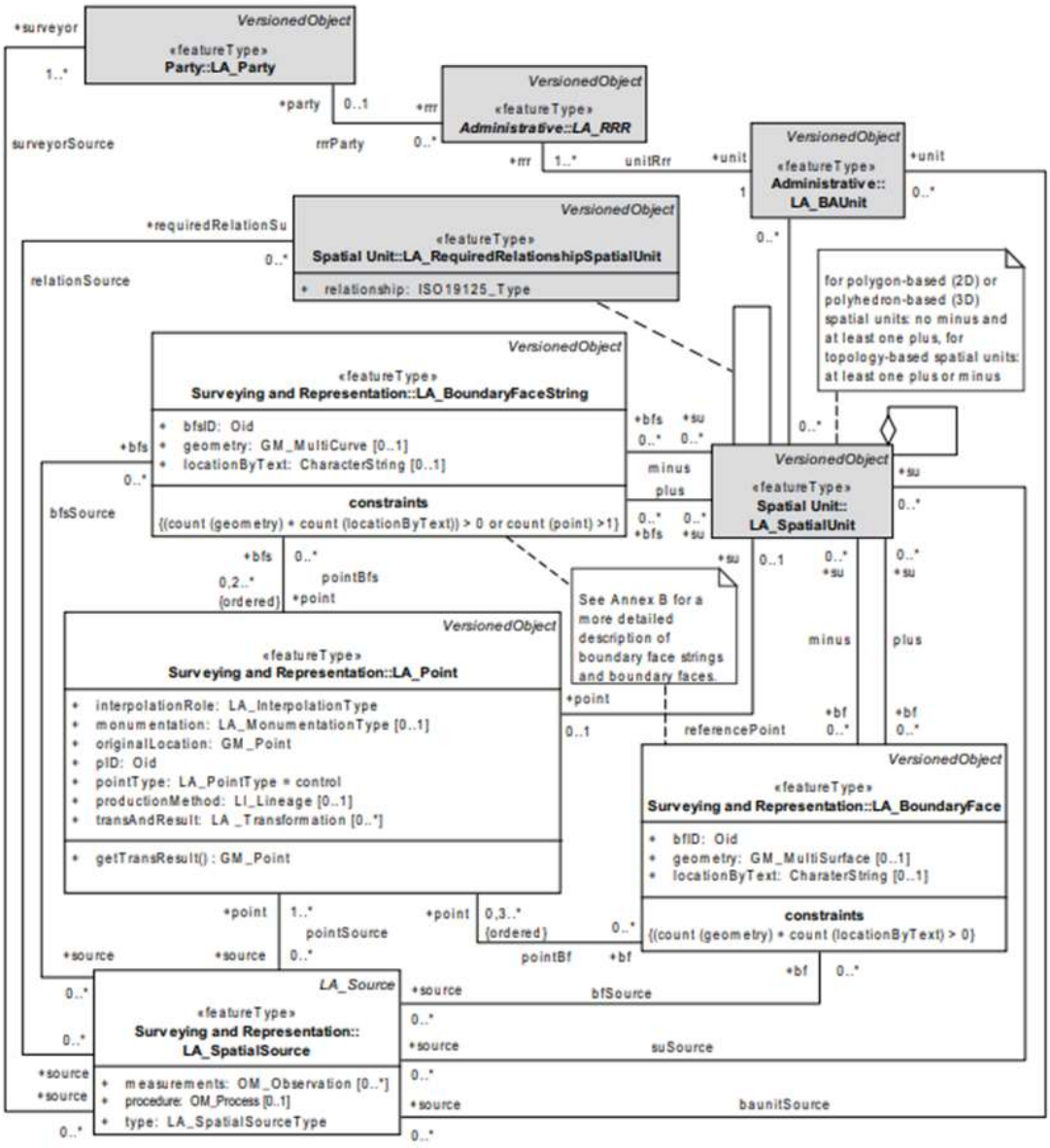


Figure 108. LADM Surveying and Representation Subpackage (not in colour) combined with LADM Core Classe

Here below the complete set of attributes related to the classes in the surveying and representation subpackage is presented. Note: attributes are columns in database tables.

Class LA_Point:

- ” estimatedAccuracy” is the estimated accuracy of the point;
- ” interpolationRole” the role of the point in the structure of a straight line or curve, this can be for example ”end”, ”isolated”, ”mid”, ”midArc”, ”start”;
- ” monumentation”, this is the type of monument of a boundary point placed in the field by the surveyor, for example: ”beacon”, ”cornerstone”, ”marker”, ”not marked”, ”chip”;

- ”originalLocation”, those are the calculated coordinates, based on measurements and observations in the field;
- ” transAndResult”: this is the transformed and adjusted version of the coordinates based on the original field observations;
- ” ID”, this is the point identifier;
- ”pointType: the type of point, e.g. control point, no source, source; and:
- ” productionMethod” Lineage – derived from another standard,

Class: LA_BoundaryFaceString:

- ” bfsID” this is the boundary face string identifier;
- ”geometry: the boundary represented via a curve at ground level; and:
- ”locationByText” this is the boundary represented in text: from the path north to the church walk twenty five steps to the oak tree,....”

Class: LA_BoundaryFace:

- ”bfID” is the boundary face identifier;
- “geometry” is the boundary represented via a surface in 3D; and:
- ”locationByText: the boundary represented in text;

6.9 Code lists

If an attribute is of a certain “type” it means there are different values possible. Those values are represented in code lists. If one value is valid for an object the other values in the code lists are not valid.

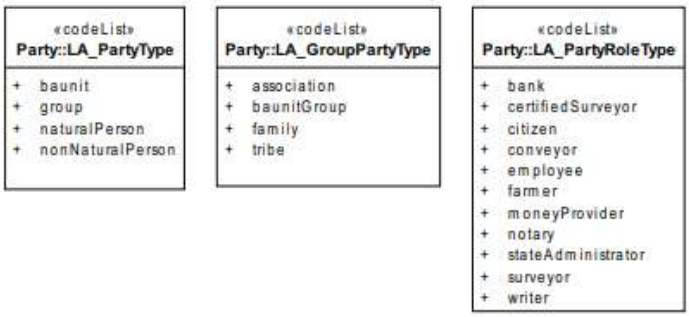


Figure 109. Code lists for Party Package

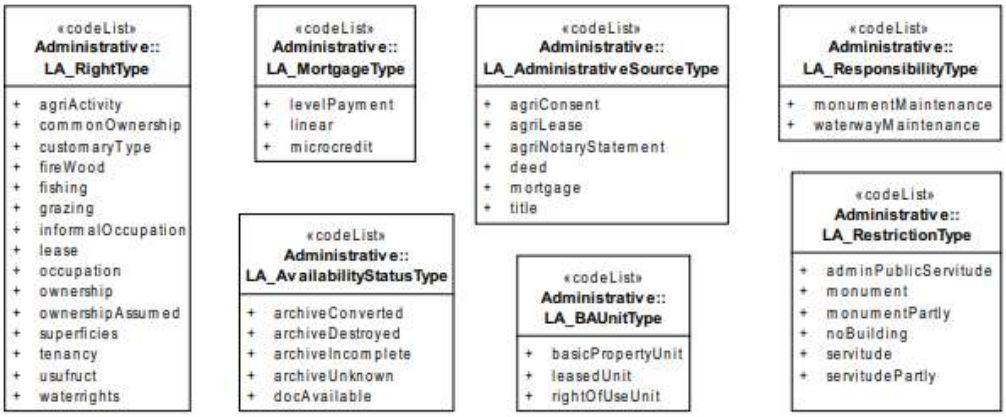


Figure 110. Code lists for Administrative Package

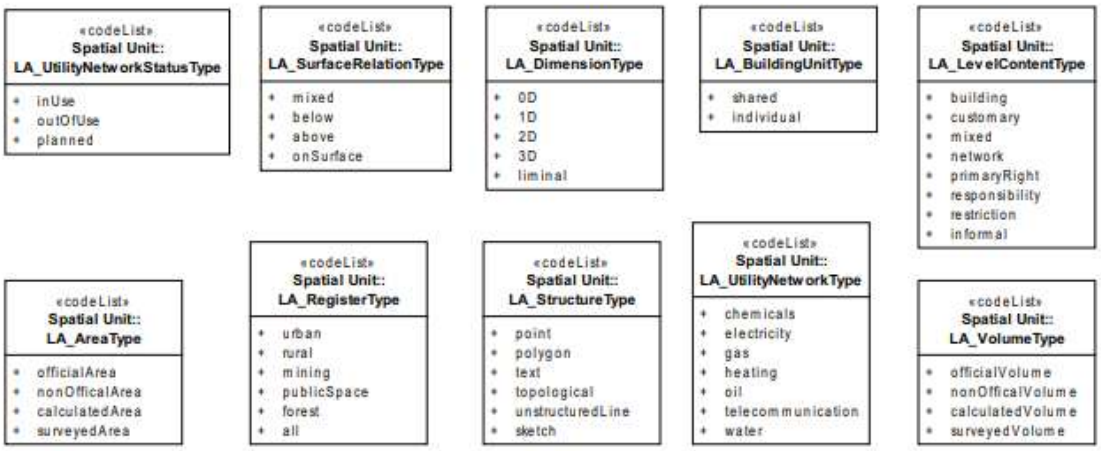


Figure 111. Code lists for Spatial Unit Package

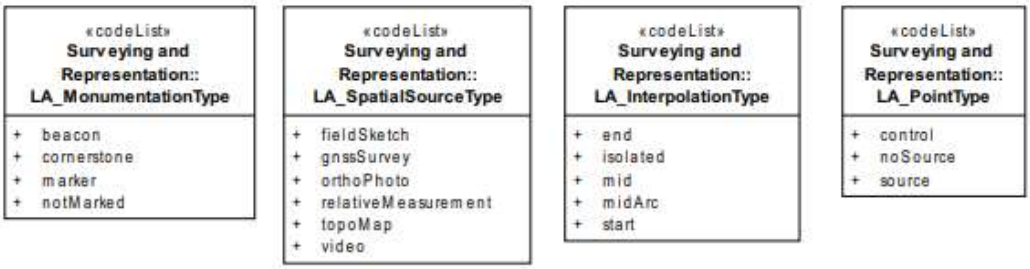


Figure 112. Code lists for Surveying and Representation Subpackage

6.10 External links (databases)

The construction of external databases with party data, address data, taxation data, land use data, land cover data, valuation data, physical utility network data, and archive data, is outside the scope of the LADM.

However, the LADM provides stereotype classes for these data sets, which indicate what data set elements the LADM expects from these external sources, if available.

See figure 113. External classes may be included in other ISO standards available or under development. Valuation and land use information are under LADM Edition II which is under development.

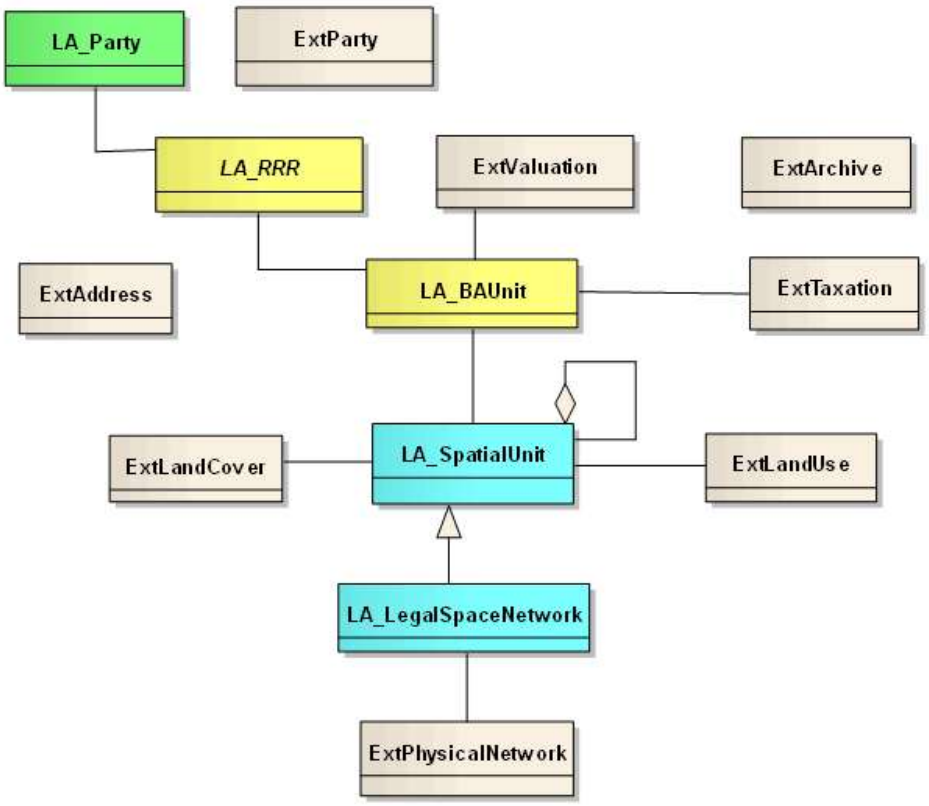


Figure 113. External links

6.11 Multiplicities

Class 1[a]	Class 2[a]	Association name	Role name End 1	Multi-plicity	Role name End 2	Multi-plicity
AdministrativeSource	BAUnit	unitSource	source	0..*	unit	0..*
AdministrativeSource	Party	conveyancerSource	source	0..*	conveyancer	1..*
AdministrativeSource	RRR	rrrSource	source	1..*	rrr	0..*
AdministrativeSource	RequiredRelationship-BAUnit	relationSource	source	0..*	required RelationBaunit	0..*
BAUnit	BAUnit	relationBaunit	unit1	0..*	unit2	0..*
BAUnit	RRR	baunitRrr	unit	1	rrr	1..*
BoundaryFace	SpatialSource	bfSource	bf	0..*	source	0..*
BoundaryFace	SpatialUnit	minus	bf	0..*	su	0..*
BoundaryFace	SpatialUnit	plus	bf	0..*	su	0..*
BoundaryFaceString	SpatialSource	bfsSource	bfs	0..*	source	0..*
BoundaryFaceString	SpatialUnit	minus	bfs	0..*	su	0..*
BoundaryFaceString	SpatialUnit	plus	bfs	0..*	su	0..*
Mortgage	Right	mortgageRight	mortgage	0..*	right	0..*
Party	BAUnit	baunitAsParty	party	0..*	unit	0..*
Party	GroupParty	members	parties	2..*	group	0..1
Point	BoundaryFace	pointBf	point	0,3..*	bf	0..*
Point	BoundaryFaceString	pointBfs	point	0,2..*	bfs	0..*
RRR	Party	rrrParty	rrr	0..*	party	0..1
SpatialSource	BAUnit	baunitSource	source	0..*	unit	0..*
SpatialSource	Party	surveyorSource	source	0..*	surveyor	1..*
SpatialSource	RequiredRelationship-SpatialUnit	relationSource	source	0..*	required RelationshipSu	0..*
SpatialSource	Point	pointSource	source	0..*	point	1..*
SpatialUnit	BAUnit	suBaunit	su	0..*	baunit	0..*
SpatialUnit	Level	suLevel	su	0..*	level	0..1
SpatialUnit	Point	referencePoint	su	0..1	point	0..1
SpatialUnit	SpatialSource	suSource	su	0..*	source	0..*
SpatialUnit	SpatialUnit	relationSu	su1	0..*	su2	0..*
SpatialUnit	SpatialUnit	suHierarchy	su1	0..*	su2	0..1
SpatialUnit	SpatialUnitGroup	suSuGroup	part	0..*	whole	0..*
SpatialUnitGroup	SpatialUnitGroup	suGroupHierarchy	element	0..*	set	0..1

[a] The LA prefix of class names has been omitted due to space reasons.

Figure 114. Associations and multiplicities between LADM classes

7. Valuation Information (TBD)

7.1 ….

7.2 ….

8. Customary Areas (TBD)

8.1 ….

8.2

9. LADM Editions

LADM Edition I was published in 2012 (ISO, 2012).

ISO TC211 on Geographic information/Geomatics has decided to revise the LADM. This is an opportunity to further develop LADM with new, additional functionalities, such as: a refined (3D) survey and legal model, semantically rich code lists, marine space geo-regulations, valuation information, spatial plan information. Combined with land registration this forms the backbone of a nations land information infrastructure.

In Edition II there will be attention to LADM implementation aspects, which can be done in various ways, and various platforms and encodings can be used.
The TC 211 is developing this new edition of the LADM as multipart. This was agreed in a Stage 0 document. The general title of the new edition will be 'Geographic information — Land Administration Domain Model (LADM)', consisting of the following six parts:

- Part 1 – Generic Conceptual Model. This part provides the scope and definitions, a general overview of the model, its core classes and its individual packages and a more detailed overview of the LA_Source and VersionedObject classes,
- Part 2 – Land Registration. This part introduces the Land Registration Standard including a refined Survey and Representation package with a range of measurement techniques. It further includes updates around the functionality published in Edition 1 of the LADM,
- Part 3 – Marine Space Georegulation. This part is based on IHO's S121 standard: Maritime Limits and Boundaries,
- Part 4 – Valuation Information. This part specifies the characteristics and semantics of data in valuation registries maintained by public authorities,
- Part 5 – Spatial Plan Information. This includes planned land use (zoning) to be converted into rights, restrictions and responsibilities (RRR), and:
- Part 6 – Implementations. This part will address a range of topics needed for implementations of LADM: developing a country profile, modelling processes/ workflows, and encodings.

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Finlised by Chrit

Beck

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Annex 1: Identifiers

In LADM all information is versioned and identifier. The generic data type Oid provides support in object identifiers. Note: this is not about internal database identifiers. The following attributes are data types with value Oid:

- sID: the identifier of the source
- pID: the identifier of the party
- groupID: the identifier of the group party
- uID: the identifier of the basic administrative unit
- rID: the RRR identifier
- suID: the spatial unit identifier
- lID: the identifier of the level
- pID: the point identifier
- bfsID: the boundary face string identifier
- bfID: the boundary face identifier

In the country profile there needs to be attention for identification. In most cases the identifiers can be generated automatically.

For parties a national identification number or national identity numbers can be used. There are many options.

Every basic administrative unit and spatial unit (parcel) recorded within a cadastre or land registry must have an identifier.

The establishment of nationwide unique identifiers for basic administrative units and spatial units is an effort and is usually based on the advice of a national committee of experts.

UNECE (2004) provides a comprehensive set of guidelines. Note: this Annex is based on (UNECE, 2004). See also (IAAO, 2015). See figure CHRIT 05.

Parcel identifiers need to be (UNECE, 2004):

- unique so that no two properties or parcels have the same reference. There must be a one-to-one correspondence between what is on the ground and what is on the registers and vice versa
- easy to understand so that there is little confusion and little likelihood of making mistakes. It is, for example, easy to misread numbers that are otherwise meaningless
- easy to remember so that landowners can correctly recall the identity of their properties
- easy to use both by the general public and by the cadastral and land book administration. They should also be easy to use by computer although how the computer handles any digital records internally is of no concern to the landowner and will depend on the database structure that has been adopted
- permanent so that the reference does not change unless the real property is to be subdivided
- capable of being updated when subdivision arises or when adjoining properties are amalgamated
- suitable for referencing plots within parcels
- flexible so that they can be used for a variety of purposes within and outside land administration, for example within local government
- economic to introduce and cheap and easy to maintain.

- able to support archiving and permit historical review so that it is possible to determine who was the owner of a certain real property on a certain date in the past.
- maintained by one responsible legal authority
- independent of parcel attributes that can be changed by other responsible authorities (such as postcodes)

Caption Figure CHRIT 05: Guidelines for the development of identifiers for BAUnit's and Spatial Units (UNECE, 2004)

In many cases the parcel identification is related to the administrative subdivision of a country with nationwide unique codes for states, provinces, departments, municipalities. This is followed by codes for cadastral units as sections, cantons or blocks and then a sequential number inside. See examples in figure CHRIT 06. This concerns country examples for identification of BAUnits and spatial units (UNECE, 2004). See also figure CHRIT 07.

Note: if the numbering is organised per project or per municipality then a unique project code or municipality code should be included. It is also possible to use a generated meaningless code that is nationally unique.

AUSTRIA (and similarly in CROATIA)
Parcel ID: 20018-123/23 (Cadastral unit identifier plus the number of the parcel. The Cadastral unit identifier consists of five digits: provincial code (first digit); competent district court (second and third digit); and cadastral unit (last 2 digits). The codes remain unique keys in the sense of a database system even when mergers of administrative offices occur.)

DENMARK
The Danish cadastral identifier is a compound of a number and small letters, like 2df. Each parcel has a unique number within a specific defined area. Prior to April 2001, the same number could be attached to several parcels within the same area, but now each parcel must have a unique number within a specific defined area. The numbering system does not apply to all parts of Denmark for historical reasons.

FINLAND
BAUnit ID: 123-223-3-44 (Municipal code, location code, group code (block or house), unit code (lot or register unit.)

GREECE
Parcel ID: 22-333-22-22-333 (Prefecture (2 digits)-municipality (3)-cadastral sector (2)-cadastral section (2)- parcel (3).)

LATVIA
Parcel ID: 01000030002 (0100 = code of cadastral territory; 003 = code of cadastral group; 0002 = unique number in cadastral group (from 0001 - 9999).)

LITHUANIA
Parcel ID: 4400-0004-4230 (the unique code) (Each land parcel has a unique number consisting of 12 digits including 1 control number. The digits have no special significance.)

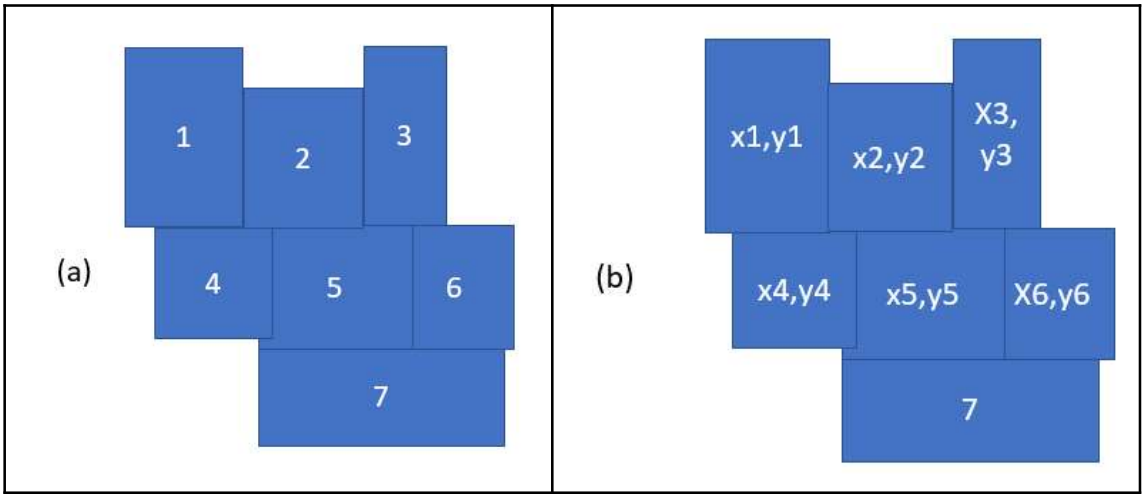
Cadastral address: 5203/0003:4 (5203 = code of cadastral unit; 0003 = code of block; 4 = parcel number in the block (unique within the block).)

RUSSIAN FEDERATION
Parcel ID: 50:13:03:001 is the first parcel in cadastre block 3 in Chimki rayon (13 = the number of the cadastre rayon) in Moscow region (50 = number of cadastre okrug).

SWEDEN
Parcel ID: Haninge Svartsö 3:49 where the municipality, township or village is named, followed by the block number and BAUnit number

Caption CHRIT 06: country examples for identification of BAUnits and spatial units (UNECE, 2004)

Identifiers can be numbered sequentially per cadastral unit as a section, canton or block. See CHRIT 07 to the left. Another approach is to use the X,Y of the centroid, see CHRIT 07 to the right.



Caption CHRIT 07: Different ways of parcel (spatial unit) identification: (a) numbering per cadastral unit, for example a section, canton or block. (b) Use of geographic coordinates of the centroid as unique identifier.

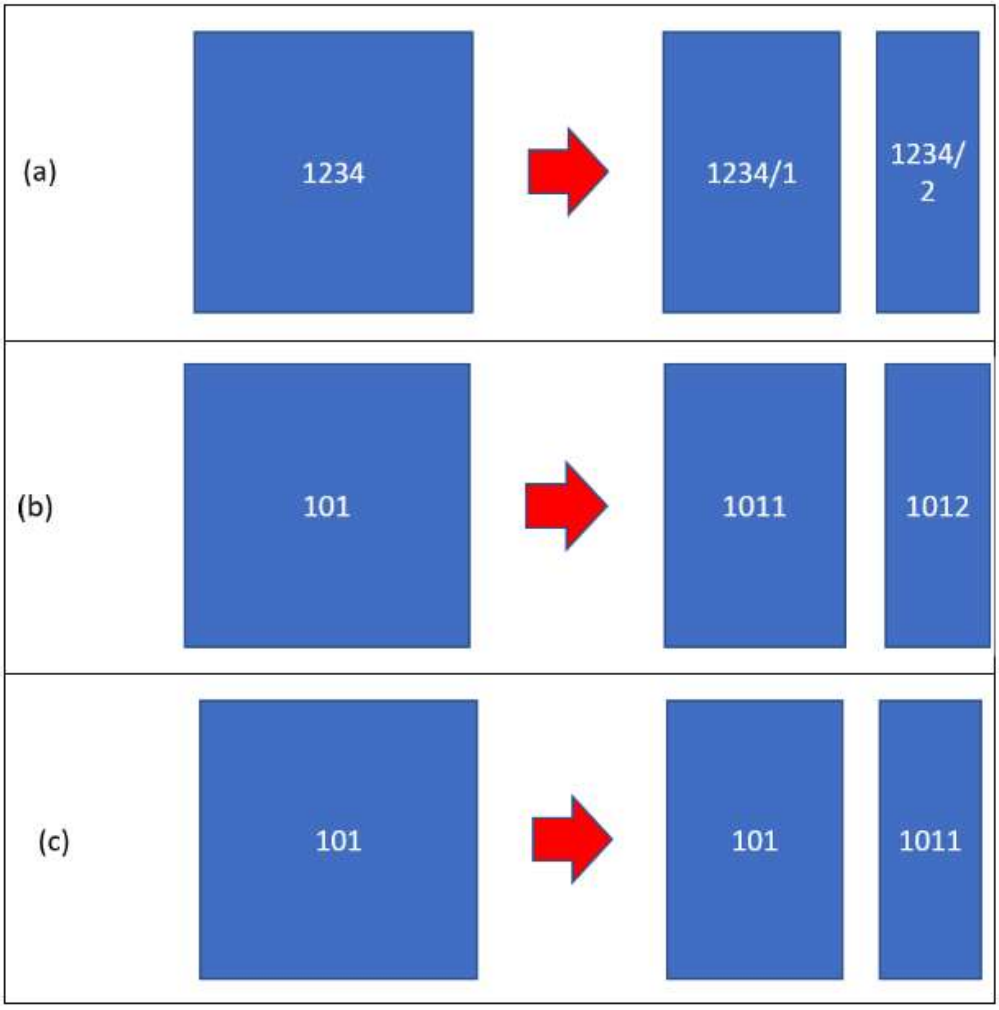
It is possible to use meaningless IDs with (for example) 12 digits including a control digit.

And, another approach, unique numbers can be related to a geographic name.

It is very well possible to use postal addresses There may be complications because addresses are street based and not area based. And not all streets have names or zip codes.

Subdivision of spatial units requires special attention in relation to spatial unit identifiers. Three examples are give in figure CHRIT 08. Under (a) new parcels get a sub index to the mother parcel 1234: 1234/1 and 1234/2. Similar in (b) where 1011 and 1012 are created out of

101. In (c) the part that remains to the seller remains the same identifier 101. That means that 101 is related to different parcels over time.



Caption figure CHRIT 08: Under (a) new parcels get a sub index to the mother parcel 1234: 1234/1 and 1234/2. Similar in (b) where 1011 and 1012 are created out of 101. In (c) the part that remains to the seller remains the same identifier 101. That means that 101 is related to different parcels over time.

Annex 2: Spatial Units

In LADM spatial units can be text based, point based, line based, line based (with or without topology), polygon based or volume based.

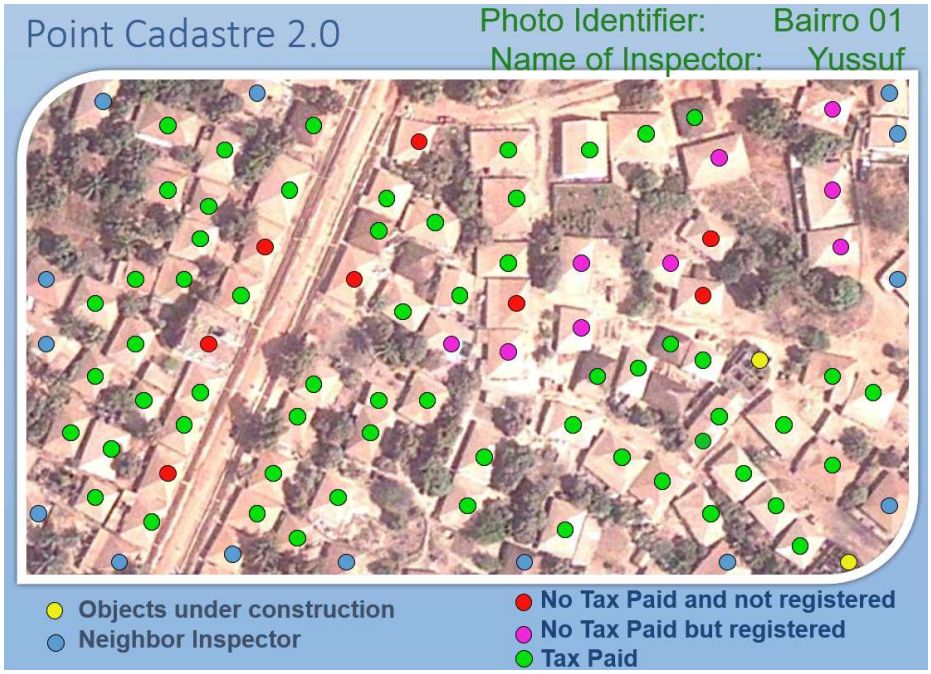
Text based

Text based spatial units don't have coordinates, the geo referencing is done by using names of areas and regions. For example: *'beginning with a corner at the intersection of two stone walls near an apple tree on the north side of Muddy Creek road one mile above the junction of Muddy and Indian Creeks, north for 150 rods to the end of the stone wall bordering the road, then northwest along a line to a large standing rock on the corner of John Smith's place, thence west 150 rods to the corner of a barn near a large oak tree, thence south to Muddy Creek road, thence down the side of the creek road to the starting point.' (quoted from: http://en.wikipedia.org/wiki/Metes_and_bounds).*

Point based

Point based spatial units identify a spatial unit, usually the centroid. There is no delineation, there are no boundaries represented in the land administration system. The centroids can be on top of an image.

It is assumed that a single coordinate of the centre of the dwelling unit could positively identify that unit, and this may be sufficient for basic recording purposes where the limits of the landholding are for the time being unimportant. This can be applied at an early stage in a system of progressive title improvement, ending in a standard freehold system. Note: this approach provides an address reference point. See figure CHRIT 09.

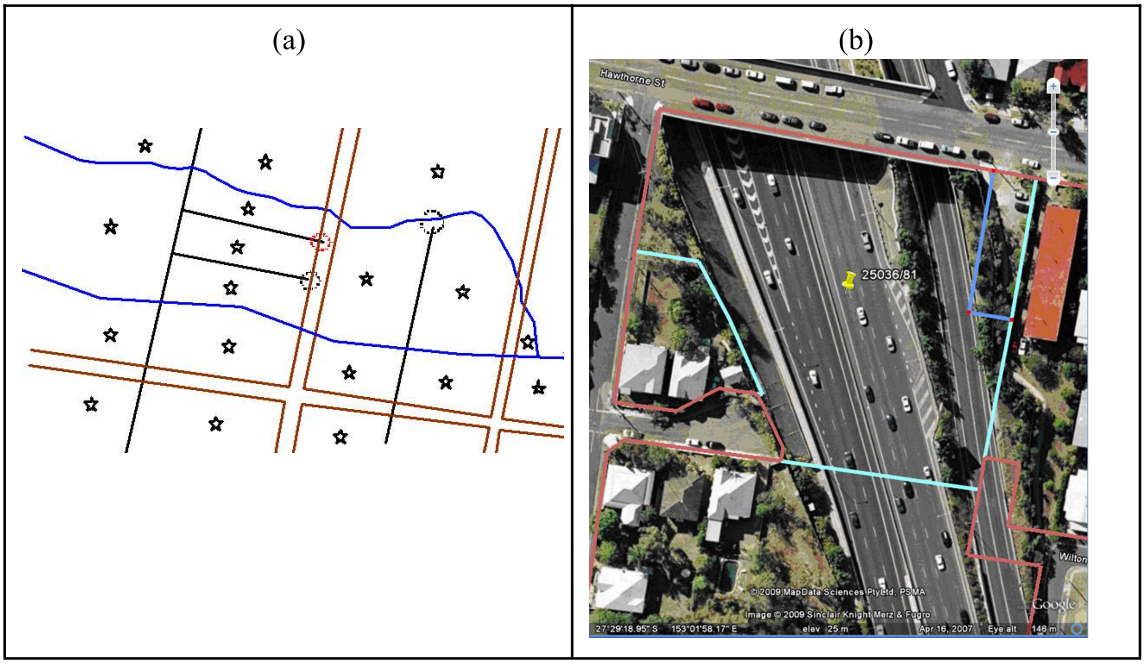


Caption figure CHRIT 09: Example of a point cadastre

Line based (no topology)

Line based spatial units can, likewise as point based spatial units, be used at an early stage in development. There is no topology, the boundaries are represented as lines and are not linked. Boundaries of one spatial unit may be collected from different sources, as existing cadastral maps and imagery. Overshoots are allowed, and then it still provides a useable "cadastral map" base, see figure CHRIT 10.

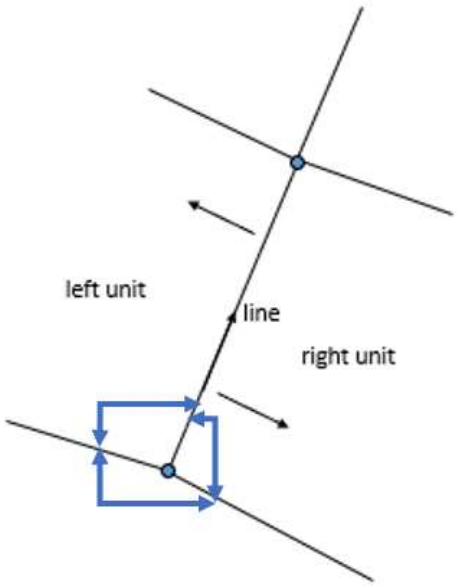
Subdivision is difficult, this should also be line based. Area calculation can be done manually.



Caption figure CHRIT 10: Line based spatial units: (a) over and undershoots are allowed in this approach. (b) Original boundaries from different sources are used. Attributes, as the name of the surveyor, can be linked to individual boundaries.

Line based (with topology)

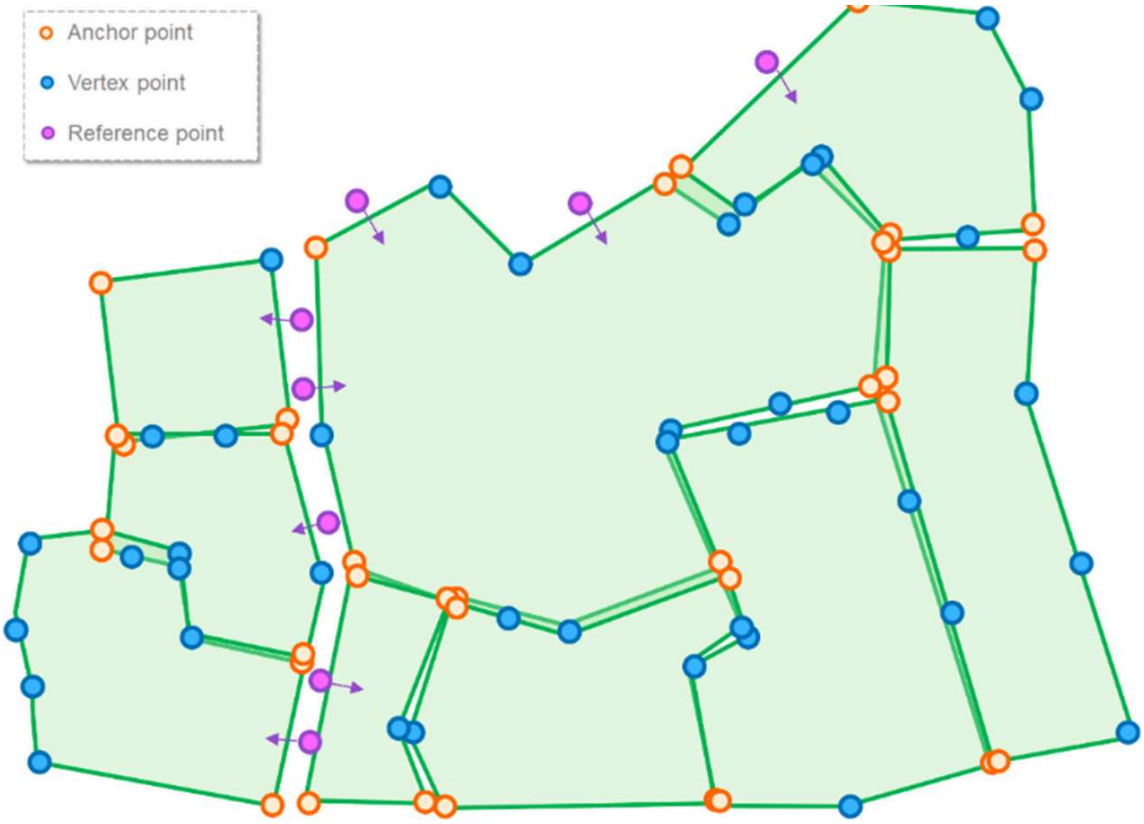
Now the lines are linked and form the boundaries of a spatial units. Lines are stored once only and are broken at points. Topology is built into the database. Attributes can be linked to individual lines (boundaries), See figure CHRIT 11.



Caption figure CHRIT 11: Line based spatial units with topology: there may be attributes per line (boundaries) and there are links between lines based on the boundary face string identifier or the bfID: the boundary face identifier. An example of linking is given in blue.

Polygon based

In case of polygon based spatial units aach spatial unit is recorded as a separate entity (a polygon in 2D). There is no topological connection between neighbouring spatial units (and no boundaries shared), All lines are represented twice (at least). *See figure CHRIT 12,* caption: polygon based approach. Note this approach can be used where grassroot surveyors collect the boundary data together with citizens under supervision of professional surveyors, see Morales et al. (2021): '*the process starts from the field data collection stage up-to the post-processing to identify and properly position the property boundaries. Perimeters of spatial units are walked in the field and observed as polygons, this means that each boundary is observed from two sides. Topology is calculated during post processing of the observations. A field survey module is developed, in collaboration with Esri, to adhere to the stated requirements. The field survey module is based on the ArcGIS Collector app (Morgenthaler, 2020) and, consequently, the module takes advantage of the cloud infrastructure on which Collector operates. It is important to note that the fit-for-purpose approach that is proposed has been tested through several case studies in regions of Colombia with different land rights structures, ranging from formal to indigenous or social. See Morales (2021)*'.

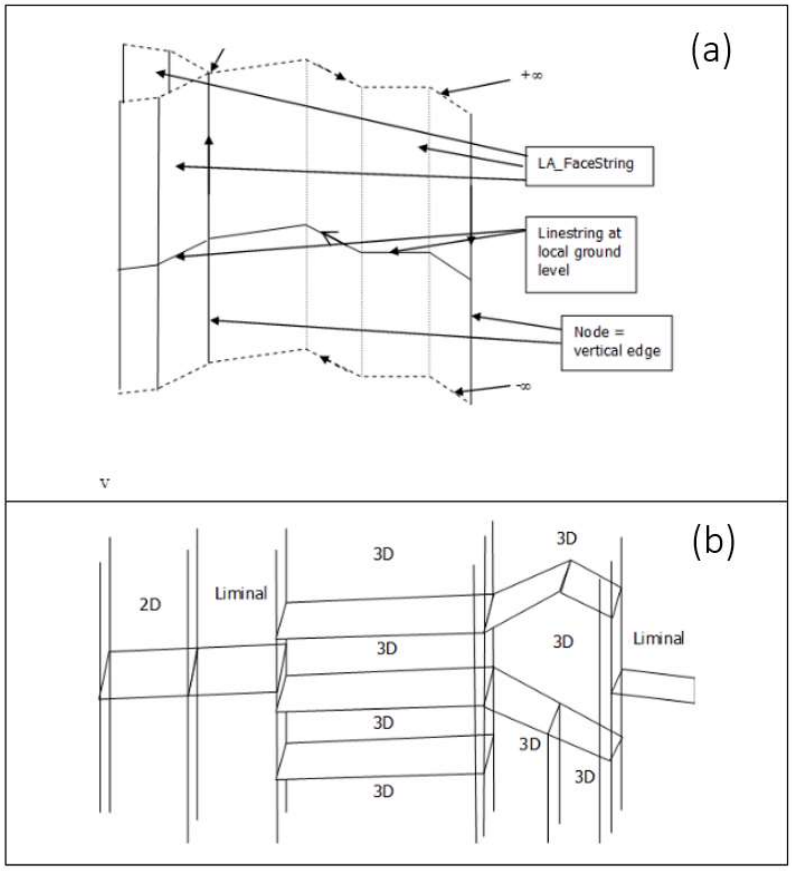


Caption CHRIT 12. Polygon based approach. Example from Colombia where grassroot surveyors walked perimeters of spatial units with presumed owners Anchor points are points where several boundaries come together. Vertex points are intermediate points. Reference points refer to roads and water courses. Source: Morales et al.(2021).

3D spatial units

In lADM 3D representations are possible. Facestrings are 3D linestrings. Facestrings can be seen as invisible curtains on top of line strings representing boundaries. See CHRIT 12 (a).

2d and 3d integration between 2D and 3D spatial units is possible via liminal spatial units. Liminal spatial units are 2D parcels, but are stored as 3D parcels. Liminal spatial units are delimited by a combination of LA_BoundaryFace and LA_BoundaryFaceString objects. See CHRIT 12 (b).



Caption CHRIT 12. (a) 3D representations can use facestrings. Facestrings can be seen as invisible curtains on top of line strings representing boundaries. (b) 2d and 3d integration between 2D and 3D spatial units is possible via liminal spatial units. Liminal spatial units are 2D parcels, but are stored as 3D parcels. Liminal spatial units are delimited by a combination of LA_BoundaryFace and LA_BoundaryFaceString objects.

Annex 3: Country Profiles (TBD)

Table Eftychia

Annex 4: Guiding Materials (TBD)

This booklet is accessible at:

The figures in this booklet are in a set of slides available….

Access to the dataset

Exercises