

# Spatial Representation of Condominium/Co-ownership: Comparison of Quebec and French Cadastral System based on LADM Specifications

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## SUMMARY

In order to progress towards a better cadastral management system that integrates the 3rd dimension the paper compares the situation of the 3D representation of vertical divided co-ownership between Quebec and French jurisdictions. Some part of the comparison analysis is made based upon the land administration data model (LADM) specifications. LADM schematizations of the spatial representation of vertical divided co-ownership adopted by both jurisdictions are consequently proposed.

The comparison first indicates that both jurisdictions propose the production of external draws to support the cadastral plan when overlapping real properties exist. These co-ownership plans are produced and managed outside the cadastral system, which could somehow reduce its access by users. Quebec proposes a systematic process to produce these co-ownership plans where a specific number showed on the cadastral plan indicates the presence of overlapping properties. From French cadastral plans there is no direct way to discern the presence of overlapping properties. French jurisdiction also proposes the production of co-ownership plans but this is not mandatory and thus the content may differ from one land-surveyor to another. Quebec jurisdiction proposes a system that allows the construction of 3D spatial representation and some 3D information are available (e.g. volume) while French system does not. Even though both systems are French speaking, some significant semantic conflicts were notified, more especially about the term "lot".

The use of LADM schematization certainly enhances and clearly expresses some of these conclusions. The advantage of having a schematization view of both systems side to side and based on the same vocabulary is obvious. The comparison is now easy and explicit and allows us to go ahead in the establishment of potential links between both jurisdictions. The use of the LADM specifications is nevertheless not evident and requires several skills in data modeling. The LADM documentation that is still in a validation process with the ISO members is somehow technical and missed official definition.

## RÉSUMÉ

Dans le but de progresser vers un meilleur système de gestion cadastral qui intégrerait la 3<sup>e</sup> dimension géométrique, cet article présente une analyse comparative entre le Québec et la France au niveau des mécanismes utilisés pour montrer spatialement les propriétés superposées. En particulier nous nous attarderons au cas de la copropriété divise verticale – les condominiums. La comparaison s'est en particulier réalisée en construisant les schémas de la norme actuellement en validation du modèle du domaine de l'administration des terres (LADM). Des profils LADM pour le Québec et la France sont ainsi proposés dans cet article.

La comparaison a d'abord permis de montrer que les deux juridictions, lorsque des cas de copropriété existent, proposent la production de plans externes mis en lien avec le plan cadastral. Ces plans de copropriété sont produits et gérés à l'extérieur du système cadastral, ce qui peut en quelque sorte réduire l'accessibilité à ces plans. Québec propose un procédé formel pour la production de ces plans. Il est possible via un texte spécifique placé sur le plan cadastral de savoir que des propriétés superposées sont présentes à cet endroit. A partir des plans cadastraux français, il n'est pas possible de savoir que des propriétés superposées sont présentes. La France propose aussi la production de plans de copropriété mais celle-ci est optionnelle et nous avons donc constaté des contenus variant d'un arpenteur à un autre. Le Québec propose une structuration qui permet la construction de représentation 3D des copropriétés verticales et certaines information géométriques sont disponibles (ex. le volume). La France ne propose pas ces éléments et la production de représentation 3D est plus problématique. Même si la langue officielle des deux juridictions est le français, nous avons constaté quelques conflits sémantiques dont celui relié au terme « lot ».

L'utilisation de la schématisation LADM a certainement contribué à formuler ces comparaisons. L'avantage d'avoir ces schémas, côte à côte, et construits à partir d'un même vocabulaire est évident. La comparaison est facile, explicite et permet d'aller au-delà d'un simple énoncé général. Par exemple, les liens de collaboration entre les deux juridictions sont clairement exprimés. L'utilisation de la spécification LADM n'est néanmoins pas simple et triviale puisqu'elle requiert une certaine expérience en modélisation de données. De plus, la documentation associée à la norme était à quelques endroits plus difficile à comprendre et manquait de définition officielle. Évidemment celle-ci est encore dans un processus de validation, et cela doit être pris en compte.

## چکیده

به منظور دست یابی به مدیریت بهینه سیستم کاداستر در به کار گیری بعد سوم، این مقاله چگونگی باز نمایش سه بعدی مالکیت های مشترک تفکیک شده را در بعد ارتفاع در حوزه قضایی استان کبک (کانادا) و کشور فرانسه در قیاس با یکدیگر مورد بررسی قرار می دهد. بخشی از تجزیه و تحلیل مرتبط با این قیاس بر اساس پیشنهادات مدل مدیریت داده های اراضی "Land Administration Data Model (LADM)" انجام پذیرفته است. به این قصد نمایش مکانی مالکیت های مشترک تفکیک شده عمودی در قلمروی کبک و فرانسه بر اساس طرحی از شمای مدل مدیریت داده های اراضی توصیف گردیده است.

این مقایسه در ابتدا مشخص می کند که هر دو حوزه قضایی یک ساز و کار یکسان را به منظور بازنمایش املاکی بر روی یکدیگر بنا شده اند به کار می برد و آن ارجاع نقشه کاداستر به نقشه هایی تکمیلی در خارج از سیستم کاداستر است. در استان کبک یک فرآیند سیستماتیک برای تولید نقشه های تکمیلی مالکیت مشترک تبیین شده است. در این فرآیند یک کد ویژه در نقشه های کاداستر وجود مالکیت های هم پوشان را (در بعد ارتفاعی) مشخص می کند. در نقشه های کاداستر فرانسه راه حلی مدون و فراگیر برای تشخیص وجود این گونه مالکیت پیش بینی نگردیده است. ساز و کارهای جاری در فرانسه به منظور ثبت مالکیت های هم پوشان (در بعد ارتفاع)

اجباری نیست و چگونگی ثبت و بازنمایش آن براساس عامل تهیه نقشه متفاوت می باشد. کبک سیستمی را به کار می گیرد که امکان ساختن بازنمایش (مدل) سه بعدی مکانی و دریافت برخی اطلاعات سه بعدی را (مثل حجم) فراهم می کند. هرچند هر دو سیستم به یک زبان (فرانسه) هستند اما در برخی از مفاهیم با یکدیگر در تقابل هستند، به طور مشخص مفهوم حقوقی قطعه (LOT).

کاربرد طرحی مشترک از شمالی مدل مدیریت داده های اراضی "LADM" مشخصا موجب افزایش صحت و هم آهنگی نتایج می گردد. مزایای بهره گیری از دیدگاهی یگانه به منظور بررسی جزئیات هر دو سیستم بر پایه یک الگوی مدلسازی یکسان به صورت ذاتی مشخص و مبرهن می باشد. این دیدگاه یگانه قیاس مورد مطالعه را ساده و صریح می گرداند و امکان شناسایی توانمندی های بالقوه مشترک مابین این دو حوزه قضایی را فراهم می آورد. با این وجود، به کارگیری شمالی مدل مدیریت داده های اراضی "LADM" ساده نیست و نیازمند ورزیدگی و تسلط در زمینه مدلسازی مفهومی داده ها می باشد. در پایان ذکر این نکته ضروری است که مدل مدیریت داده های اراضی "LADM" همچنان در مرحله ارزیابی توسط سازمان جهانی استانداردسازی "ISO" می باشد و هنوز به عنوان یک استاندارد رسمی معرفی نگردیده است.

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## **1. INTRODUCTION**

A number of international studies about cadastral systems have been conducted to better understand and promote the value added of integrating the 3rd dimension into the land administration processes (FIG 3DCadastres web site presents several). Each jurisdiction has its own mechanism to spatially represent overlapping real estate properties ranging from 2D plan with tagged text to fully 3D representation. The questionnaire produced by the FIG working group on 3D cadastres (FIG/3D cadastres 2011, van Oosterom et al, 2011) with more than 36 specimens is an excellent source of information about this concern.

In the province of Quebec, where a hybrid solution based upon text linked to the cadastral plan is currently effective. A first experiment has demonstrated some important challenges for the automation of the migration between 2D and 3D cadastre (Pouliot et al, 2010). One experiment is certainly not enough to make clear recommendations to Quebec authority that needs support and advisements to upgrading the existing cadastral system. One way to go ahead is to survey the community and compare its own system with other jurisdictions. This is why an academic research was initiated last February to propose more rigorous and effective recommendations to the official Quebec authority (Foncier Québec). In order to achieve this task, a detailed comparative analysis between French and Quebec cadastral system is performed. Both cadastral systems are centralized, parcel based, Civil Code foundation (a Napoleonic Cadastre) and mainly used for fiscal purpose. Both civil codes indicate that ownership of the land carries with it the ownership of what is above and what is below the surface, underling the importance of the implementation of a specific regulation for overlapping real properties. We estimate that Quebec-French cadastral comparison may produce interesting and new outcomes to support decision making of a given system.

To constrain the analysis and being able to converge towards clear outcomes, the proposed analysis focuses on the technical mechanisms and documents used to illustrate the 3D geometric limits of condominium (divided co-ownership). Condominium which is the same concept in both jurisdictions usually shows building with private and common parts, and a ground parcel attached to it. Condominiums are real estate frequently reported in the literature, evident (visible) and exist in both cadastral systems. We estimate that they could be good objects to be studied by an academic research although 3D spatial representation of condominiums is probably the most straightforward. We will thus mainly focus on the diversity and the usefulness of information available about the spatial representation of the 3rd dimension of each overlapping real property.

Finally to accomplish the comparison between Quebec and French jurisdictions, the ISO 19152 Geographic information–Land Administration Domain Model (ISO/DIS 19152 LADM 2011) was used to formalize/describe each cadastral system. LADM specifications offer us a new manner to describe and compare each system. As far as we know, no such LADM comparison was done until now between Quebec and France. It also offers us the opportunity to better appreciate and experiment the application of ISO-TC19152-LADM and its associated goals. It eventually helps us to estimate its applicability to our specific context.

## 2. SPATIAL REPRESENTATION OF CONDOMINIUM

As specified by the Civil Code of Quebec (C.c.Q.), condominium or co-ownership is one mode of ownership where the same property is jointly owned by several persons.

*Civil code of Quebec (updated to 1 August 2011)*

*1009. Ownership has two principal special modes, co-ownership and superficies.*

*1010. Co-ownership is ownership of the same property, jointly and at the same time, by several persons each of whom is privately vested with a share of the right of ownership.*

*Co-ownership is called undivided where the right of ownership is not accompanied with a physical division of the property.*

*It is called divided where the right of ownership is apportioned among the co-owners in fractions, each comprising a physically divided private portion and a share of the common portions.*

This study is mainly concerned by vertical divided co-ownership with private and common portions. As indicated in the C.c.Q., the dimension of each fraction has to be specified and this fraction constitutes a distinct entity that will be registered and represented into the cadastral plan.

*C.c.Q.*

*1041. The relative value of each of the fractions of a divided coownership with reference to the value of all the fractions together is determined in consideration of the nature, destination, dimensions and location of the private portion of each fraction, but not of its use.*

...

*1047. Each fraction constitutes a distinct entity and may be alienated in whole or in part; the alienation includes, in each case, the share of the common portions appurtenant to the fraction, as well as the right to use the common portions for restricted use, where applicable.*

...

*1049. Alienation of a divided part of a private portion is without effect unless the declaration of co-ownership and the cadastral plan have been altered prior to the alienation so as to create a new fraction, describe it, give it a separate cadastral number and determine its relative value, or to record the alterations made to the boundaries between contiguous private portions.*

*1050. Each fraction forms a distinct entity for the purposes of real property assessment and taxation.*

The cadastral plan therefore plays an important role in the spatial representation of the vertical divided co-ownership. We will now have a closer view of how Quebec and French jurisdiction represent vertical divided co-ownership and the instructions attached to it.

## 2.1 Quebec situation

The current cadastral system in the province of Quebec proposes a graphical representation of the lots<sup>1</sup>; usually it corresponds to the land parcel. The limits and the official measurements of each lot are shown on a 2D cadastral plan, including a unique lot number and its dimensions (width, length and area) (see Figure 1). The cadastral plan with the index of real estate properties is part of the official land register for the publication of private land rights. The land registration infrastructure is placed under the supervision and responsibility of the ministère des Ressources naturelles et de la Faune (MRNF) also called Foncier Québec (MRNF, 2003). The cadastral plan is used to graphically show the boundaries of the properties; it does not define them.

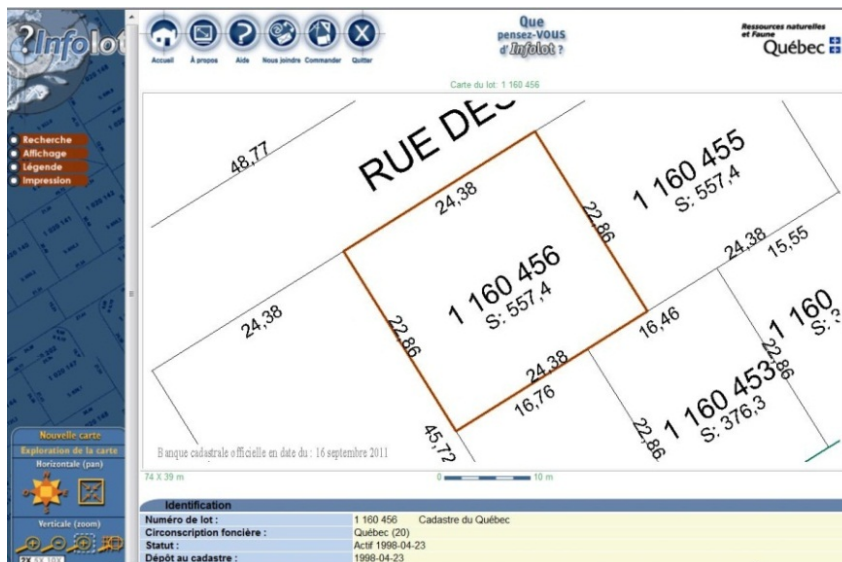


Figure 1. The Quebec cadastral plan -Extracted from Infolot<sup>2</sup>

There is one exception for which the limits of the lot are not directly represented on the cadastral plan. When overlapping real properties occurred (e.g. co-ownership, right of superficies), a specific mechanism is proposed for the spatial representation of the lots. Hence a hybrid solution is used to represent the vertical situation of overlapping real properties. Superimposed properties are pointed out on the cadastral plan by a specific text identifier called Complementary Plan (PC-Number). The PC-polygon associated with the PC-number is an arbitrary polygon with no official measurements and no lot number (see Figure 2). PC-Number could refer to one or more complementary plans which are managed independently of the cadastral plan. The PC plans are created by land surveyors and usually stored in computer-aided design (CAD) format. These CAD files are owned by private firms and currently only 2D PDF file (an image representation) is available for downloading by the end users via the Infolot interface. The PC plans show the vertical situation of the co-ownership

<sup>1</sup> A lot correspond to an immovable (i.e. a real estate property) on which the right is applied

<sup>2</sup> Web interface of Quebec cadastral plan (<http://infolot.mrnf.gouv.qc.ca>)

and are composed of horizontal plans for the ground parcel and for each floor (or apartment) and vertical profiles. The horizontal plans are used to represent the limits of the spatial units including the lot number, the official measurements (length, surface and volume) and the height (h) of various objects.

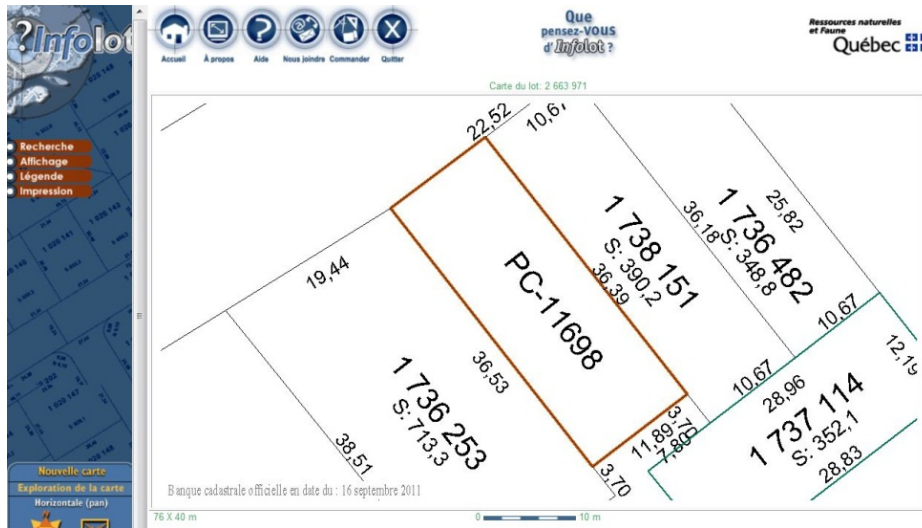


Figure 2. Presentation of superimposed properties in the Quebec cadastral plan with PC polygons - Extracted from Infolot

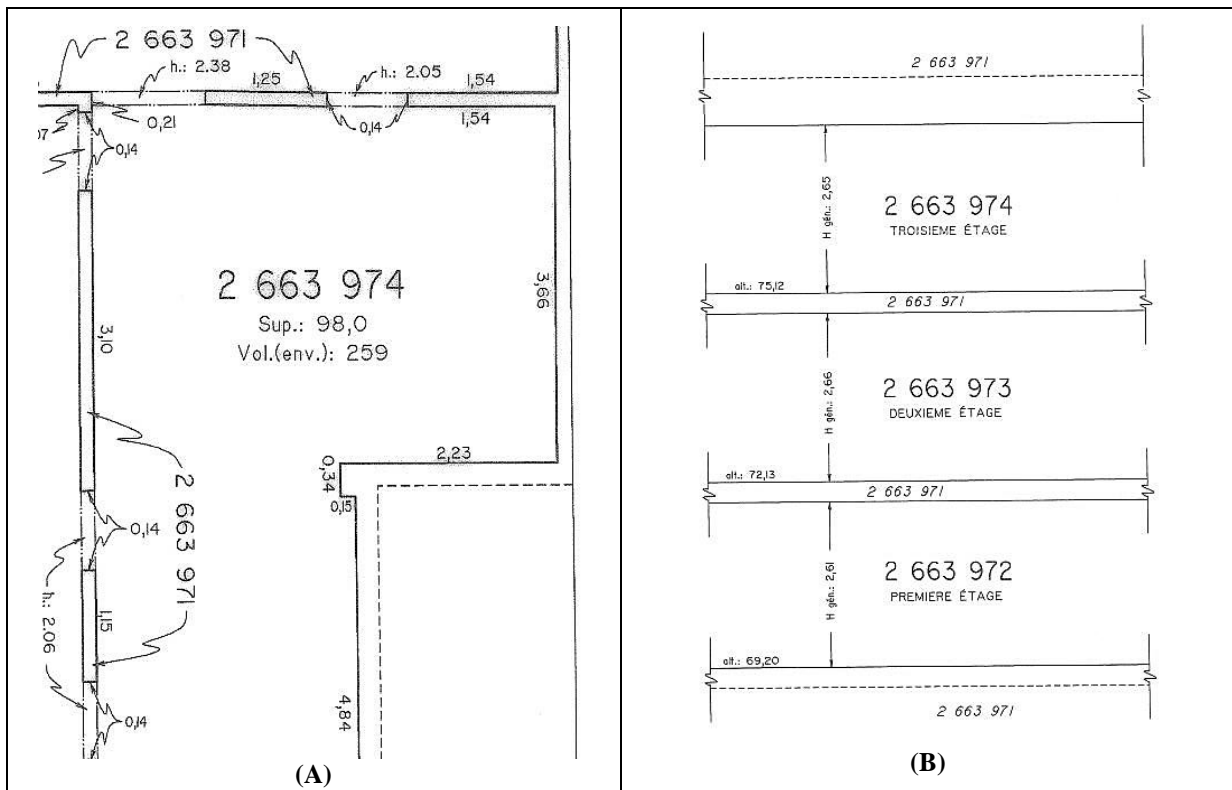


Figure 3. Horizontal plan (A) and Vertical profile (B) - Extracted from the PC file

The vertical profile corresponds to cross-sections that show the elevation (orthometric altitude) and the height of each apartment floor. Figure 3 shows (A) a horizontal plan and (B) a vertical profile extracted from the PDF file.

We can see in the vertical profile one common part (2 663 971) and three private parts (1st floor 2 663 972, 2nd floor 2 663 973 and 3rd floor 2 663 974). On the horizontal plan of the 3rd floor (2 663 974) we can see others objects (e.g. wall, ceiling, stair) part of the lot 2 663 971.

## 2.2 French situation

The official authority to maintain the land registration system in France is the French public land registry, under the auspices of the French tax authority, the Direction Générale des Finances Publiques (DGFIP). The French cadastral system is based upon a 2D graphical plan of land parcels on which we can see the boundaries between properties and various other information such as (AFTopo, 2000):

- The unique number (the administrative unit) of the land parcel
- Another number indicating the administrative zone
- Contextual objects such as buildings, fences, hedges, wall, ditch, etc..
- Geodetic marks
- Streets and train paths

The French cadastral plan is a representation and do not establish the official limits of the property boundary. Any title or deed will have to be consulted. Figure 4 shows an extract of a French cadastral plan where we can see the parcel number (e.g. 1004), the boundaries of the land parcel (plain line), the train path (dotted lines), building shape (filled polygons). These buildings do not necessarily refer to co-ownership.

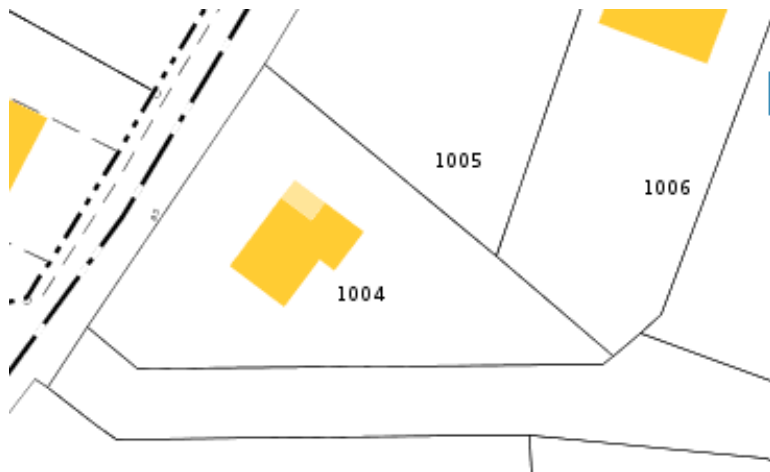


Figure 4. French cadastral plan extracted from the governmental online cadastral plan<sup>3</sup>

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<sup>3</sup> See the web site: <http://www.cadastre.gouv.fr/>



About the vertical divided co-ownership and based upon the article 1 of the law n°65-557 (July 10<sup>th</sup>, 1965) immovable divided between several ownerships is called co-ownership where each holder owns one private part and a quote part of the common parts. These subdivisions are called lot<sup>4</sup>. One unique land parcel as indicated in the cadastral plan may thus refer to one or many owners. The description of these parts with co-ownership is available in a document called “the division description”<sup>5</sup>. The document division description is important because it contents the official description of the division. Figure 5 shows an extract of this document showing one common part (PC1<sup>6</sup>). Any subdivision of the common part is described by a weighting factor. For example PC1 contains 10 lots where the weighting factor of the balcon is 0.2. We can also remark the information about the area of the PC1 (8a 96ca=896m<sup>2</sup>).

| Esquisse d'étage N°4880<br>Section 43<br>Parcelle 20  |   |  |
|---|---|--|
| <b>ETAT DESCRIPTIF DE DIVISION</b>  |   |  |
| <b>N° Partie Commune</b>  | <b>Propriétaires</b>  | <b>Situation, nature et description du local</b>   |
| PC1   | L'ensemble des propriétaires de l'immeuble sis 3, boulevard de Nancy à Strasbourg, en indivision pour un total de 10000/10000èmes (lots 8 à 15, 100 et 101).<br>Tantièmes calculés conformément aux dispositions de l'article 5 de la loi du 10 juillet 1965. | Les parties communes générales à savoir : le sol bâti et non bâti cadastré à Strasbourg, section 43, parcelle 20, d'une surface cadastrale de 8a 96ca.<br>Un accès commun, deux espaces verts et un futur local poubelles. |
| NOTA BENE :   |   |  |
| - Tantièmes calculés conformément aux instructions de juin 1998 du Conseil Supérieur de l'Ordre des Géomètres Experts.                                |   |  |
| - Tout changement dans la consistance d'un ou plusieurs lots devra faire l'objet d'une modification dans la répartition des tantièmes de copropriété. |   |  |
| - Les surfaces indiquées pour le lot 100 ont été relevées sur place par nos soins.  |   |  |
| - Les surfaces indiquées pour le lot 101 sont issues des fichiers informatiques fournis par le donneur d'ordre.                                       |   |  |
| <b>Coefficients de pondération utilisés :</b>   |   |  |
| - Appartement (> 1,80m)   | 1   |  |
| - Loggia  | 0,4   |  |
| - Parking couvert   | 0,3   |  |
| - Balcon  | 0,2   |  |
| - Grenier (> 1,80)  | 0,2   |  |
| - Grenier (< 1,80)  | 0   |  |
| - Terrasse  | 0,2   |  |
| - Parking plein air   | 0,15  |  |

**Figure 5. Example of the French division description for one lot (Graff-Kiehl, 2010)**

Sometime the division description is completed by external plans presenting the spatial arrangement of the co-ownership. The production of the co-ownership plans is nevertheless

<sup>4</sup> The term “lot” does not have the same meaning in Quebec jurisdiction. In the French system it corresponds to the subdivision parts when co-ownership property exists, while in Quebec it is the minimal administrative unit.

<sup>5</sup> Personal translation of the official French term : État descriptif de division.

<sup>6</sup> The French term PC (portion commune) has no relation with the Quebec term PC (complementary plan).

optional<sup>7</sup>, and the decision of producing such plan is made by the expert (land surveyor) who does the survey or the owner himself. Figure 6 presents an example of a co-ownership plan where we can see one common part (PC6) and one private part (#102). These French plans are very distinct from the Quebec PC-plans. The French plans are more design like an architectural plan with no measures, only indicating the name and usage of each apartment subdivision (e.g. kitchen, room, etc.). We also found on some other consulted plans the length and the height of few objects. But still, since there is no official procedure to produce these plans, the content of one plan could be distinct from one to another.

Consequently it is quite difficult to get exhaustive and precise information about the geometric dimension of co-ownership properties. Some information can be found in the division description available at the French public offices and some other could be located on the co-ownership plans when they are available. The access of the co-ownership plans is also problematic since they are not public documents and stay belongings to private firms (land surveyor or architect in some cases) or the real estate property owner himself.

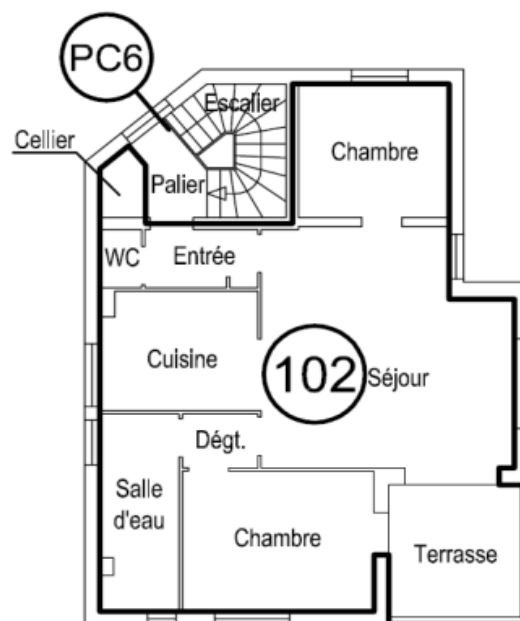


Figure 6. Example of co-ownership plan (Graff-Kiehl, 2010)

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<sup>7</sup> In the commune Alsace and Moselle, where a specific regulation exist, the production of co-ownership plan is mandatory.

### 3. LADM SPECIFICATIONS

The international organization of standardization (ISO) technical committee 211 (Geographic information/Geomatics) is leading the elaboration of a new standard called Land Administration Domain Model (LADM) and numbered 19152. In the ISO creation/validation processes, LADM is currently under a draft version not yet accepted as an international standard (ISO/DIS 19152 LADM 2011). The document used to investigate this study is consequently a draft version which has to be commented and approved by ISO member bodies. ISO 19152 –LADM proposes a conceptual schema that organizes the concepts and their relationships related to property ownership and the geometrical components. As indicated in the document ISO/DIS 19152 LADM 2011, it serves two main goals:

- Provide an extensible basis for the development and refinement of efficient and effective land administration systems, based on a Model Driven Architecture (MDA),
- Enable involved parties, both within one country and between different countries, to communicate, based on the shared vocabulary (that is, an ontology), implied by the model.

Figure 7 shows a global overview of the LADM specifications where for simplicity purpose no attributes are indicated; only the classes and the relations are revealed. LADM is organised around four packages that can be briefly presented as follow (ISO/DIS 19152 LADM 2011):

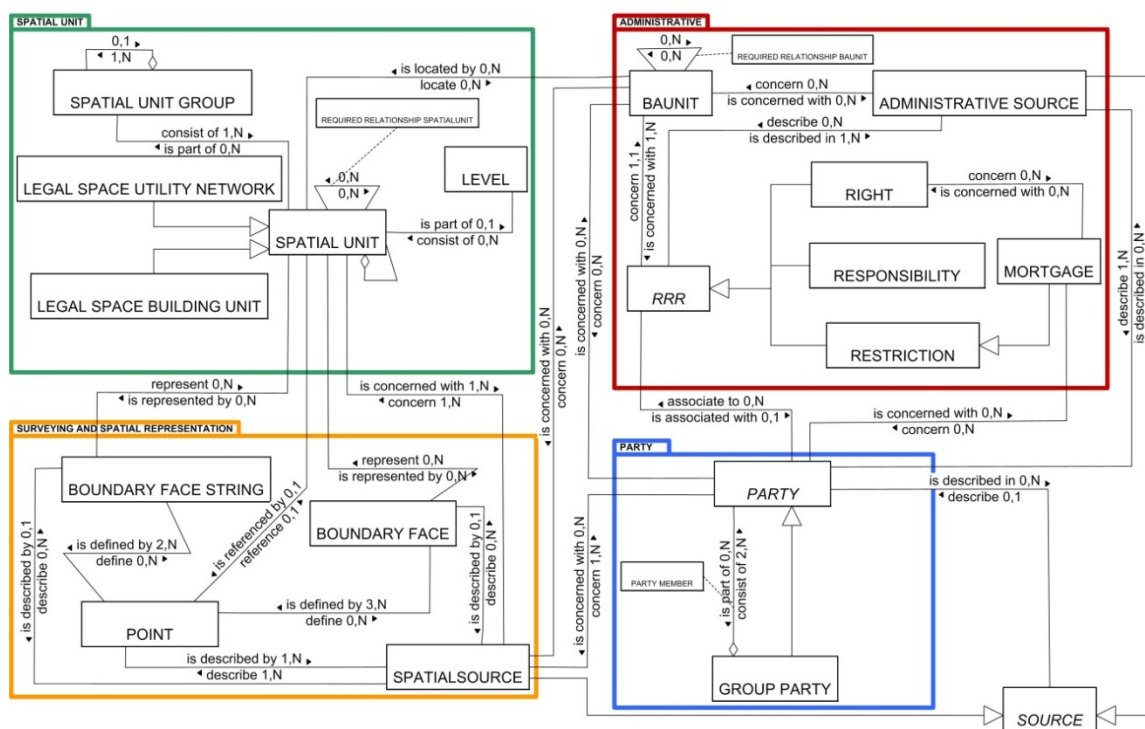


Figure 7. Global view of Land Administration Data Model (ISO/DIS 19152-LADM 2011)

The *Administrative Package* describes the administrative part of a land administration system and it consists of two main classes. The *RRR* class is an abstract class of Right, Responsibility and Restrictions (i.e. formal or informal entitlements). *BAUnit* (basic administrative unit)

allows the association of 0 to N spatial units to *Party* (e.g. owner) against which unique and homogeneous RRR is associated.

The *Party Package* consists of two classes. A *Party* can be a natural or a juridical person or a group of persons that is identified in a transaction of rights relative to a *BAUnit*. A *Party* may participate in a *Group of party* and a *Group of party* may be a *Party*.

The *Spatial Unit Package* illustrates the physical entities of a land administration system. The *Spatial unit* class corresponds to the boundaries of a single area/volume of land or water. It is used to support creation and management of the *BAUnit* and can be specialized as a *Legal space building unit* and *Legal space utility network*. The *Spatial unit group* class forms a collection of spatial units (e.g. an urban planning zone) and the *Level* class regroups the *Spatial unit* with the same geometric, topologic, and/or thematic coherence.

The *Surveying and Spatial Representation package* describes the spatial representation of a land administration system. The *Boundary face string* class is a set of lines which allows representing 2D boundaries of the spatial units. The *Boundary face* class is used to show 3D spatial units. The spatial representation of the spatial units could be referenced using *Point* class which can be used to define *Boundary face string* or *Boundary face*. Boundary faces are employed to form a closed /bounded volume in height and depth. The class *Spatial source* helps to complete the description of the others classes (such as field survey notes).

### 3.1 LADM layout of Quebec vertical divided co-ownership

Based on our comprehension of the LADM specifications, we now propose the schematization of Quebec jurisdiction for vertical divided co-ownership. We mainly focus on the LADM packages *Spatial units* and *Survey and Spatial representation*. We also founded our analysis on the current procedure which take into consideration the production of numerical plans (not paper plans). No attention has been paid to *Party* package and only the base administrative unit (*BAUnit*) of the administrative package has been taken into account, since it represents the link with a unique and homogeneous RRR, ownership in our case. Figure 8 introduces this schema where classes in grey are those explicitly added or modified from LADM schema in order to fulfill our requirements.

First and because we focus on the vertical divided co-ownership we added the distinction between private and common parts. These instances occur in the Administrative and the Spatial Unit packages. In the Administrative package, *BAUnit* that corresponds to the Lot in Quebec is refined into two specializations Private Parts and Common Part. These two classes are connected with a relation explained in the declaration of co-ownership. In the Spatial Unit package two legal space building unit classes exist; one for the private parts and another for the common parts. The cardinalities of the relations between legal space building unit classes and administrative units are important since they express the fact that it exist possibly many private parts each having one unique lot number but the common part only have one lot number for many spatial units common parts. The *BAUnit* common part also has a relation with the spatial unit ground parcel. The legal space building unit private has some geometric information (area and volume) while the common parts do not. The dimension of the whole building is 3D while the dimension of the ground parcel is 2D. We added the ground parcel

since this feature is distinctive in the concept of vertical cadastre. The super class Spatial Unit only possess the PC-number, an important text (label) element to manage the relation with the raster spatial representation associated to it.

About the Survey and Spatial representation package, we first took the decision to distinguish elements related to survey compare to those related to spatial representation. Even though this is not the recommendation of the LADM version used, we detected in previous version this possibility and we estimated this solution more appropriate and explicit for our purpose. Accordingly, we first identified point as being observation derived from field survey. Two categories of points are surveyed planimetric (X,Y) and altimetric (Z) (surveyed separately or simultaneously).

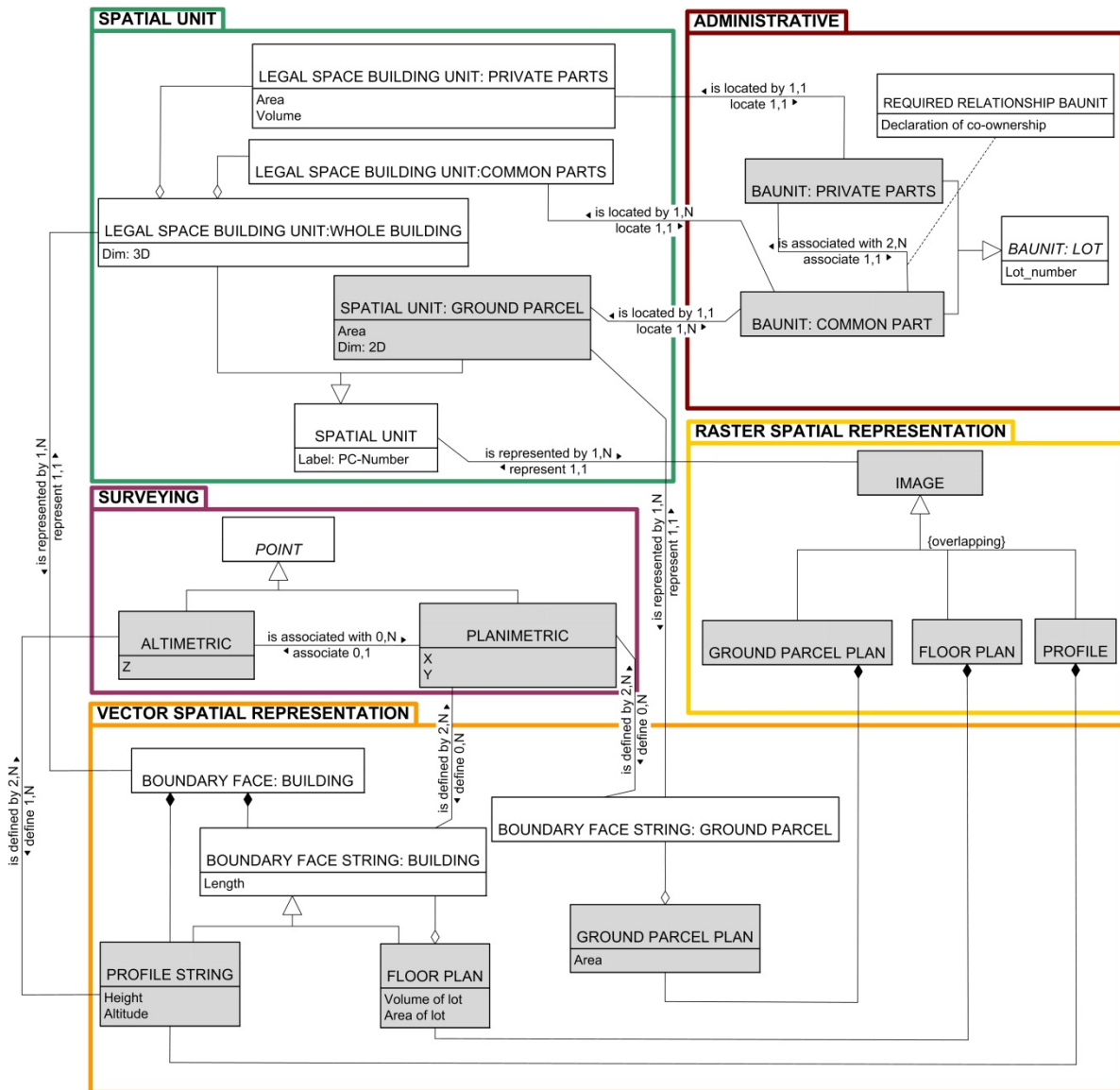


Figure 8. LADM profile for Quebec condominium units

Finally and in order to integrate the specific mechanisms used by Quebec jurisdiction to represent the vertical divided ownership the LADM *Spatial representation* package was split into two packages (raster and vector). The complementary plans (PC) are currently built/stored in vector format (file available by the land-surveyor firms who did the survey) but delivered to the end users in image format (PDF or TIFF file). Image format contains a set of values associated to a regular array of cells (called pixels). This kind of format does not fully fit with the classes available in the LADM based on the spatial schema of ISO 19107 (point, line, polygon). Even though lines are included in the PC PDF file, the user does not have a direct access, in the sense of querying or manipulating the feature. For example, with PDF format the coordinates system is not rooted to the points as it is proposed by LADM specifications. For this reason and because two different spatial representations exist in the Quebec jurisdictions, one for the vector format and the other for the image format, we have suggested to add a new package. Motivated by ISO 19123 Schema for coverage, we propose to call this package *Raster Spatial representation* in which we included the features that are enclosed in the PDF image file. The *Image*<sup>8</sup> corresponds to the whole PC PDF file from which we can extract the *ground parcel plan*, the *floor plan* and the *vertical profile*.

As mentioned the PC-plans are also available in vector format and this has been symbolized in the *Vector Spatial representation* package. Buildings are first represented by line strings extracted from the floor plans and secondly by faces extracted from the profile. Ground parcel is extracted through the ground parcel plan. The attributes height, altitude, length, area and volume are official measurements founded in the PC-plan not the intrinsic geometric properties of the geometric primitives. Obviously these two sources of information should be equal but because of the graphic tolerance used to produce de Quebec cadastre, we can notify some differences. Compare to the original LADM diagram we added in the *Vector Spatial representation* package an aggregation between *Building boundary face string* and *Building boundary face* since this is correspond to the modeling approach used.

### 3.2 LADM layout of French vertical divided co-ownership

We adopted the same approach to produce the LADM profile of the French condominium units<sup>9</sup> (Figure 9). BAUnit now correspond to Parcel and it is also specialized with private and common parts. The division description is indicated in the administrative package as a recursive relation between BAUnit private parts and BAUnit common parts. The spatial unit package shows almost the same content of Quebec except for the dimension of the building which is now 2D. Co-ownership plans when they are available are produced in CAD files. So only the Vector spatial representation package is proposed. Buildings and the ground parcel are represented by line strings and no information exists about the volume. Survey points are collected with X,Y coordinates.

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<sup>8</sup> We prefer not to use the term « coverage » as it is proposed in ISO 19123 since this is a first draft that needs to be discussed and validated. Based upon ISO 19123, the PC PDF file should correspond to a discrete coverage.

<sup>9</sup> This schematization is not valid for volumetric plans; another category of vertical subdivision not studied.

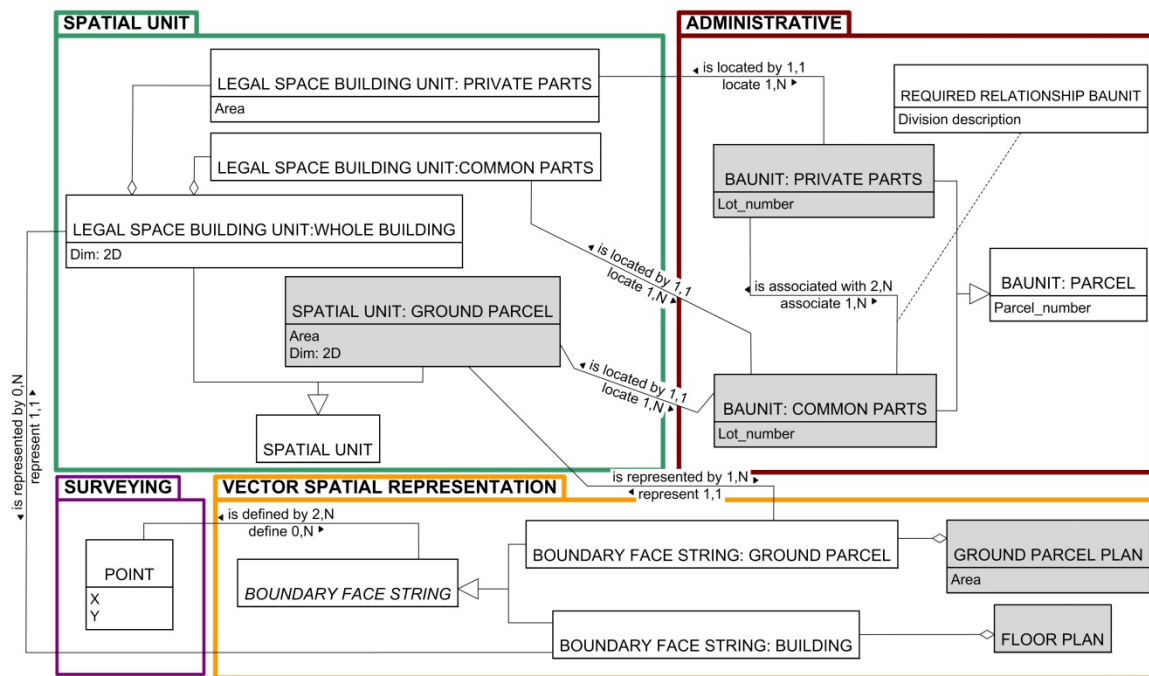


Figure 9. LADM profile for French condominium units

#### 4. DISCUSSION AND COMPARE ANALYSIS

The comparison at first indicates that Quebec and French jurisdictions propose the use of cadastral plans corresponding to 2D graphical representation. For both systems, the cadastral plan does not define the limits of the real properties; as a result they are not a definitive statement of the legal boundaries of a property which can only be established by a land survey or found in the title. This is a direct heritage of the Napoleonic code where the cadastre was used to calculate taxes.

When overlapping real properties exist they both not integrate volumetric representation and recommend the production of external draws to support the cadastral plan. These draws are produced and managed outside the cadastral system, which may somehow reduce their accessibility by users. France does not request a systematic and obligatory<sup>10</sup> procedure to build this draws while Quebec does. On the cadastral plan, Quebec jurisdiction proposes the use of a specific number (PC-number) distinct from the cadastre number which directly indicates the presence of overlapping properties. In France, there is no direct sign on the cadastral plan to detect if overlapping properties exists. The only way is to consult the division description or the co-ownership plans when available.

<sup>10</sup> Except in the commune Alsace and Moselle, where a specific regulation exist, the production of plan of co-ownership is then mandatory.

The content of the external draws are quite different when we compare Quebec and France. The Quebec PC plans proposed vertical profiles while France does not. This information is significant since it allows the construction of 3D representation of the properties for the Quebec jurisdiction. Second the Quebec PC plans contain the official measurements (surface and volume). The French co-ownership plans, when they are available, contain architecture drawings with the name and usage of each subdivision of the apartment (e.g. kitchen, room), some signs of neighbouring property and no measures are indicated. We have to refer to the division description to understand the boundaries of each property. This situation can be explained by the original goal of each cadastral system. The one in Quebec is to delimit the properties, thus its spatial representation in all dimension has to be explicit. In France, the cadastral system is mainly done for fiscal purpose, the spatial representation even important is secondary as far as the important information can be retrieve somewhere. Descriptive text as it is currently proposed could then be sufficient.

From LADM profile comparison we can easily notice that Quebec and French jurisdictions propose some similar process to manage and represent vertical divided co-ownership (12 over 22 classes are identical). One of the differences comes from the solution which has been used to assign a unique number, clearly showed in the *BAUnit* class. In France the *BAUnit* corresponds to the parcel number while in Quebec the *BAUnit* is the lot. Furthermore *BAUnit privates parts* and *BAUnit common parts* of the French system have a second ID, the *lot\_number*. Accordingly there exists a semantic conflict about the term “lot” since the term “lot” in French system is used to represent the division when vertical divided properties exist. This is clearly expressed in the attributes of the *BAUnit* classes. We can also easily notice with the presence of classes *Profile* and the content of the classes *Legal Space Building units* and *Point* that Quebec system gives a cartographic access to 3D information (e.g. volume, xyz coordinates) while French system does not. The class *Spatial unit* confirms a significant difference with the use of an important label (the PC-number) for the Quebec jurisdiction. This label first indicates the presence of overlapping properties and secondly allows the link with the PC-Plans. A clear distinction between both jurisdictions is certainly visible about the spatial representation package since the French system does not have a specific mechanism to produce images of the co-ownership plans. Obviously, since the production of the co-ownership plans in the French jurisdiction is not mandatory the exact content of the spatial representation could vary depending on some personal initiative. We were however not able to integrate this possibility in our diagram. Finally, in the Quebec jurisdictions, the class *Boundary Face* (i.e. means unbounded volumes) appears while in France this class does not exist. This is also a clear indication of the enlarge capability of the Quebec system to produce volumetric representation of the lot.

The use of LADM specifications was ultimately a valuable tool to compare both jurisdictions. It first constrains us to transpose and clarify several concepts in order to schematize both jurisdictions. Even though both jurisdictions use the same language (French), the terms used could be leading to semantic conflicts. We now have a clear, explicit and comparable view of all features and relations of each system. This is a strong advantage although the production of these diagrams is not trivial. The task of schematization required many efforts but the ultimate diagrams graphically expose certain differences. The LADM profiles are now a good source of information to formally describe each system and these schemas are somehow



universal. No matter is the language, the materials are understandable and the communication is straightforward.

The LADM documentation indicates “the norm should be as simple as possible, in order to be useful in practice”. We have to admit that we had few problems to fully understand some concepts. The documentation is sometime not clear even with examples; the implementation still requires some guessing decisions. The diagrams proposed in this paper must be taken as a first experiment. Some validations were undertaken since several discussions took place and many versions were produced but much more validation is still required.

## 5. CONCLUSION

This study has argued that comparing Quebec and French mechanisms used to spatially represent the vertical divided co-ownership is a valuable approach to identify better practices and eventually propose advisements for upgrading cadastral system. Among other, the study establishes its comparison on the exploitation of LADM ISO 19152 schematization (version that still has to be validated by ISO members). The results of the compare analysis are previously presented; we will not repeat them in the conclusion. But what have we learned from this experience (LADM uses among) and based on the results which recommendations can we propose and to who?

First, the creation of LADM profile for a country certainly provides a new manner to see and comprehend its own system; a clear outcome to user who is interested to create them. Regardless our good knowledge of the two cadastral systems, the use of conceptual schema and its associated modeling rules force us to revise or reread almost all documentations associated to each system. Some challenges were specially tackled with the use of LADM specifications. For example, the LADM terminology was not always clear to us and furthermore we had to match it with the vocabulary used in each jurisdiction. In that sense LADM certainly constrains us to use a shared vocabulary while sometime we were a bit confuse about the sense of certain terms. For instance, we still have concern about the exact meaning of spatial units, level or spatial unit group. We faced major difficulties in order to integrate the concept of label number (the Quebec PC-Number) which has an arbitrary geometry. We finally placed it as a spatial unit with an attribute label but still we are not sure about this proposal. Many relationships have no name in the LADM documentation, this amplify the confusion.

The use of LADM also requires few skills in data modeling. Even though we have some experiences in data modeling, we found the implementation of LADM not obvious. Lot of decisions made by LADM designers were obscure to us. For example, why not having an explicit spatial unit ground parcel, why these is no relationships between string and faces, why not allowing solids representation, why no raster representation is allowed? We obviously understand that LADM is still in a validation process and it was not especially design to represent vertical cadastre. At the end, LADM was an adequate reference model which helps us to make a clearer comparison. Thanks to LADM diagrams we are now able to go ahead of a general assessment as it is usually the case. We can somehow quantity and point out specific features, attributes and relationships and subsequently propose adjustments for

creating standardized land administration system. This information could be the foundation of the establishment of data exchange specifications between France and Quebec, although this was not a target in the study. We surely recommend countries to do the exercise of conceptually schematize their cadastral system. The proposed profiles could be seen as a first draft from which Quebec, France and others jurisdictions can take advantage of.

If we are able to formulate a number of recommendations about the use and design of LADM; what about advisements to upgrading each cadastral system, the overall aspiration of this study? The study confirms previous analysis suggesting that Quebec jurisdictions compares to French proposed a more elaborate system for the visualization of the 3<sup>rd</sup> dimension when overlapping properties exist. Few suggestions can be addressed to the French authorities although this was not the initial intention (the target was Quebec authority). The main is certainly the definite need of having a mandatory process to produce co-ownership plans. Changing the name of the *BAUnit* (parcel for regular cadastre to lot when condominium exists) is maybe not a good solution from a data management and administrative system point of view. We thus ended with no specific recommendations to Quebec authority even though the Quebec profile is now available and could contribute to further planning or decision making about the system. We could compare it with others jurisdictions that proposed enhanced solutions about 3D representation (e.g. Spain or Australia).

Finally, the current investigation was limited to vertical divided co-ownership, one of the next questions is certainly what about other kinds of overlapping properties such as the presence of subway, or others right such as right of superficies. Is it possible to generalize our experiment to these objects? For now the answer is no and further investigation is strongly recommended.

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