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How the ISO 19152 Land Administration Domain Model performs in the comparison of cadastral systems: A case study of condominium/co-ownership in Quebec (Canada) and Alsace Moselle (France)

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ABSTRACT

This paper proposes an original approach for comparing cadastral management systems, more specifically, the conceptual modeling used to spatially represent vertical divided co-ownership (usually equivalent to the condominium). The comparison is based on the ISO 19152 Land Administration Domain Model (LADM) specification, an international standard recently adopted by ISO. The LADM comparison is applied between Quebec (Canada) and Alsace Moselle (France) condominium units. Specific attention is paid to the third geometric dimension of the spatial representation used in each jurisdiction. The study includes the creation of LADM layouts for condominium units in Quebec and Alsace Moselle and a comparative analysis. The paper discusses the advantages and limitations of using LADM layouts to undertake such comparisons and gives advices to produce similar analysis for others cadastral systems.

LADM schematization certainly made the comparison between Quebec and French condominium units easier, more concise and clearer. The formal description of common set of concepts and terms such as proposed by LADM allows us to quantify the similarities and differences, and potentially move towards the "automatic" creation of a matching file between both systems. One of the main advantages is the graphical views resulting from the schematization process that permit visual comparison where both systems can now be compared side by side, class by class, attribute by attribute. The use of the LADM specification is, however, not evident and requires quite a few skills in data modeling. The LADM documentation is somewhat technical and lacking in official definition. It required time to comprehend the documentation, and some LADM classes, attributes or relationships are ambiguous and still difficult to match with both systems.

1. Introduction

The ISO 19152 Land Administration Domain Model (LADM) specification, recently adopted by the International Organization for Standardization (ISO), proposes a reference model to "formalize" (i.e., rendering concepts in a graphic language) common aspects of land administration systems and, in particular, their central cadastral components (ISO/DIS 19152 LADM, 2011). LADM 19152 recommends a conceptual model that organizes the concepts and the relationships related to rights, responsibilities and restrictions (RRR), governing matters such as the ownership of real property (land or water) and the geometrical components associated with its spatial representation. One of the stated goals of LADM is "to enable involved parties, both within one country and between different countries, to communicate, based on the shared vocabulary (i.e., an ontology) implied by the model." Based on this, the LADM could be used to document common aspects of land administration systems all over the world and contribute to sharing experiences and promoting good spatial data modeling practices.

Information sharing and comparative analysis are appropriate approaches for improving a land administration system. For instance, the International Federation of Surveyor's Cadastral 2014 proposal was developed on the basis of a questionnaire which provided insight into current cadastral systems around the world (Kaufmann & Steudler, 1998). The same approach was used by van Oosterom, Stoter, Ploeger, Thompson, and Karki (2011) in order to establish a framework for 3D cadastres. A number of comparative analyses have also been conducted on 3D cadastres (Döner et al., 2010; Paulsson, 2007; Stoter & van Oosterom, 2006; Stoter, van Oosterom, Ploeger, & Aalders, 2004). Nevertheless, none of them used graphical formalism or a formal semantic reference model to assess and enumerate the similarities and differences between systems. Compared to pure text, graphical formalisms such as concept maps (Sowa, 1984), graphs (Gross & Yellen, 2004) and Unified Modeling Language (OMG-UML, 2011)

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are simple and intuitive visual forms of knowledge representation. They support system design, decision-making, modeling and comparative analysis (da Silva & de Paula, 2002; Nosek & Roth, 1990; Urban & Dietrich, 2003). In using graphical representation such as proposed by LADM with the Unified Modeling Language, we can more easily quantify and indicate specific classes, attributes and relationships that are either missing or are inconsistent between systems. In addition, the use of a common vocabulary and formal description may facilitate the future establishment of a data exchange framework, since assembling a matching classification schema would become obvious.

In this paper, the LADM specification (specifically, its graphical illustration features and formal description of cadastral systems), is used as a new tool to conduct comparative analyses. The study compares the Quebec (Canada) and Alsace Moselle (France) cadastral systems, in particular, the conceptual modeling that is used to spatially represent condominium ownership of superimposed units, which is termed "vertical divided co-ownership" in Quebec law (Civil Code of Québec, 2012). Conceptual modeling refers to the organization of concepts and their relationships which are used to store and manage information contained in the cadastral plan and the associated co-ownership plans. The French and Quebec jurisdictions were selected because the authors are already in contact with authorities there and have access to documentation. Since the production of co-ownership plans is mandatory in Quebec and Alsace Moselle, content is easier to model. The comparison is based on the hypothesis that both jurisdictions want a better cadastral management system, one that will integrate the third geometric dimension and enable data-sharing and communication between organizations and their information technology systems. The advantage of using 3D cadastre is now largely recognized and several references discuss the challenges that must be addressed (Döner et al., 2010; Pouliot, Roy, Fouquet-Asselin, & Desgroseillers, 2010; Stoter, 2004). The International Federation of Surveyors (FIG) has created a 3D Cadastre working group (FIG/3D cadastres, 2012) that allows information and documentation sharing among experts and practitioners.

Comparing Quebec and French jurisdictions is appropriate since they share a similar societal relationship regarding rights to land. Both cadastral systems are centralized, parcel based, built on a Civil Code foundation (a Napoleonic Cadastre) and are used for property tax assessment. To limit the analysis and to allow for the development of recommendations regarding possible 3D improvements of the cadastral systems, the proposed analysis focuses on the concepts/rules used to illustrate the 3D geometric limits of condominiums (referred to as vertical divided co-ownerships). The condominium usually indicates a property including land and one or several buildings whose ownership is divided among owned by different individuals. Condominiums are common real estate arrangements in both jurisdictions, the use of 3D is highly beneficial because it provides optimal legal and spatial representation. Cadastral and co-ownership plans exist and are accessible by all users in both jurisdictions. This makes condominiums the most straightforward type of property to investigate for this first experiment based on the new formalization. As indicated, the innovative part of our approach lies in using the new ISO 19152 LADM specification, which provides a common set of concepts and terms and supports the use of 3D representations of objects. To our knowledge, this is the first attempt in either jurisdiction to progress toward LADM schematization of the cadastral system. This research also offers the opportunity to better appreciate and experiment with application of the ISO 19152 LADM. We were not involved in the production, nor the validation of the LADM specification. We used the LADM specification and documentation as a potential model for spatial data managers who would like to use this standard to improve their own systems.

The paper is structured as follows. Section 2 briefly presents the LADM specifications. Section 3 explains the two contexts in which the study took place and the conceptual modeling of vertical divided co-ownership (condominium). Section 4 presents the LADM modeling of vertical divided co-ownership of Quebec and Alsace Moselle, and our comparative analysis. Section 5 discusses the advantages and limitations of such an approach. The concluding section proposes a comparative framework based on our experiment.

2. LADM specification

LADM 19152 proposes a conceptual schema that organizes the concepts and the relationships related to RRR and the geometrical components associated with spatial representation of RRR. Fig. 1 shows a global overview of the LADM specification. For purposes of clarity, no attributes are indicated, only the classes and relationships are showed. The documentation used to understand the LADM specification was a draft version of the Land Administration Domain Model (ISO/DIS 19152 LADM, 2011). The LADM comprises four packages:

The *Administrative Package* describes the administrative part of a land administration system and 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–*N* spatial units to *Party* (i.e., owner) against which a unique and homogeneous RRR is associated.

The *Party Package* consists of two classes. A *Party* can be a person, whether natural or juridical (i.e., a legal entity), or a group of persons identified in a transaction of rights relative to a *BAUnit*. A *Party* may be part of a *Group Party* and a *Group 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 the creation and management of the *BAUnit* and can be further subdivided into 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 groups 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 and the survey techniques used. LADM geometry is based on the ISO/TC 211 conceptual model (spatial and topological schemas) that offers *GM_point*, *GM_curve* and *GM_surface*. No GM_solid is allowed. The *Boundary Face String* class is a set of lines that allows representation of 2D boundaries of the spatial units. The *Boundary Face* class is used to show 3D spatial units. The representation of the spatial units can be referenced by using the *Point* class to define the *Boundary Face String* or the *Boundary Face*. *Boundary Faces* are employed to form a closed/bounded volume in height and depth. Finally, the class *Spatial Source* indicates where the information is gathered such as field survey notes.

The *Spatial units* and *Survey and Spatial representation* packages are the main items of interest here because the focus of this paper is a comparison of the concepts used to spatially represent vertical divided co-ownership in the cadastral and co-ownership plans. No attention was paid to the class *Spatial Source* since we determined that this aspect has no direct impact on the content of the cadastral plan itself. We do recognize that the *Spatial Source* could have an impact on the procedure employed to build these plans but not the plans currently in use, themselves. Similarly, for the *Party* and *Administrative* packages, we only consider the *Base Administrative Unit* (BAUnit) class since it represents the link with a unique and homogeneous RRR. Note that only ownership properties in the RRR class were taken into consideration for this investigation.