Bridging the Gap between LADM and Cadastres

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Key words: Cadastre, LADM, ePlan, Geodatabase, ArcGIS

SUMMARY

The LADM passed, on the 1st of November 2012, the final vote towards becoming an international standard, ISO 19152, and was formally published by ISO on 1ste of December 2012. Since then there has been a considerable move in the land administration domain towards the implementation of the model. Examples are in Australia, China, Malaysia, Indonesia, South Africa and some other countries. Most of these implementations are limited to research and development in academia. We can also observe that some of the land administration agencies are considering the adoption of the standard in various initiatives.

The above mentioned implementations often ignore that LADM is a reference model that only provides an abstract and conceptual schema for spatial and non-spatial land administration data elements. Theses implementation tends to derive a database from the conceptual model ignoring the decisive step of logical modelling. LADM describes the entire land administration domain. However, for implementation of it in a land administration system, a logical data model is needed. The logical model describes data requirements of the subject land administration system. The logical model puts terminology described in the conceptual model, LADM, into perspective for a given land administration system. More importantly, the logical modelling enables the land administration systems to assess how and to what extent LADM fits with their organisation requirements.

This paper presents two case studies in Australia and Belize where a LADM based logical model is developed, and data requirements, for a part of the cadastre in these jurisdictions, are modelled. In this process, we examine data correlation between LADM and the case studies. The paper then takes the evaluation into another level by comparing the case studies against an implementation of the LADM based logical model in an ArcGIS geodatabase.

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1. INTRODUCTION

The LADM (ISO19152 2012) passed, on the 1st of November 2012, the final vote towards becoming an international standard, ISO 19152, and was formally published by ISO on 1ste of December 2012. Since then there has been a considerable move in the land administration domain towards the implementation of the model. Examples are in Australia, China, Malaysia, Indonesia, South Africa and some other countries. Most of these implementations are limited to research and development in academia. We can also observe that some of the land administration agencies are considering the adoption of the standard in various initiatives.

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2. CASE STUDIES

2.1 Victoria

For the case study of Victoria, there are two data models that can be mapped to LADM. The first data model belongs to a product called Vicmap Property or Digital Cadastral Database of Victoria(Kalantari et al. 2008). This product consists of Victoria's land parcels and properties. Features of Vicmap Property include polygons & attributes of land parcels and properties, associated survey plan numbers, information on administrative boundaries such as parish and township, Crown description of the parcels and relevant local government identifiers. Vicmap

Property is regarded as an index, and it is only a spatial representation of the Victorian cadastre.

Another data model is called ePlan (Cumerford 2010). It is an effort to replace the paper/ PDF based subdivision plans with a digital substitute. ePlan is an Intergovernmental Committee on Surveying and Mapping (ICSM) initiative to replace the image PDF or paper based subdivision plans with a digital format so the data can be automatically validated extracted and reused. In other words, ePlan will ultimately transfer the current image based cadastre of Victoria into a high spatially accurate digital cadastre. ePlan was made available to the surveying industry in 2012 and is now operational in Victoria. ePlan maps all the elements of a subdivision plan in the data model. The ePlan data model is more comprehensive than the Vicmap property data model. It not only models the spatial definition of parcels and properties, but also includes non spatial information such as rights, obligations, surveying observations and field notes and other administrative information such as surveyors and local government boundaries. It is planned that ultimately Vicmap property to be updated using ePlan files. In this section, we briefly introduce components of the Victorian ePlan data model.

Parcels

Parcel is fundamental and multipurpose data elements in the model, and it is necessary to articulate its roles in the data model.

The Parcel element represents the continuous fabric of the cadastre together with spatial extension of land related obligations. Any parcel is defined by five elements which include Name, Class, State, Parcel type, Use of Parcel. "Class" represents the type of interest the parcel contains e.g. a lot that is owned by rightful claimants or an easement that benefits someone or lands. Using the Class attribute the Parcel element is used to categorise the rights, restrictions and responsibilities into two categories. The first category includes Primary Parcels that are base level parcels that form the continuous cadastral fabric. They consist of lots (ownership right), roads (vested in a Local Government interest), reserves (Public land), common property (communal land), crown parcels (Crown land) and staged lots (land to be subdivided in broad acre development). The second category includes Secondary Interests which provide benefits and/or pose restrictions on Primary Parcels. These include easements, restrictions and depth limitations.

At another level, Parcel is also used to define the administrative boundaries of a subdivision plan. Parcel in this example is regarded as a virtual space where the spatial extension of the administrative area does not necessarily need to be geometrically defined.

Parcel is also used to define the owners corporation schedule by which liabilities and entitlements of the member lots and common properties are defined. The parcel element is used to organise the owners corporation, but there is no need for geometrical definition of the parcel. It is called non spatial parcel.

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Administrative data

The cadastre in Victoria also requires data that provide a context for the surveys undertaken. This includes information on the subdivision plan number, type the survey, surveying firm, the Act under which is survey undertaken, licensed surveyor name, administrative area of which the survey belongs, field notes and other relevant data..The significance of these elements is the role of them in the enforcement of the legislative requirements. This enables an automatics validation of the data. For example, this section determines under what legislation of Act the survey has been undertaken. Therefore in automatic validation we can validate

Survey Control

Survey control elements contain information about the integrity of the survey undertaken. These elements include information on the control traverses, survey marks and reference marks. This refers to information about the traversing between control marks and corners of the land parcels. This is about the observations that are required for reestablishment of the survey. This survey control includes elements such as instrument set up, bearing and distance.

Mapping ePlan to LADM

The first step in bridging the gap between existing cadastres and LADM is being able to map schemas, data models or data dictionaries to each other and identify corresponding elements in each data model. The technical term for this activity in the data modelling field is called crosswalk. This section presents a descriptive crosswalk. We only compare the fundamental and key elements.

LADM include LA_Spatial Unit which is the basic building block to describe a spatial dimension. This can be textual, sketch, or point, linear and polygon based. The corresponding class in ePlan is in the Parcel class that provides a basic unit to describe a spatial area. Similar to LADM, Parcel can be textual, point, linear or polygon in the Plan model.

LADM include a class called BAUNits which represent administrative entities consisting of zero or more spatial units against which one or more unique and homogenous right, responsibilities or restriction are associated. This class corresponds to the Parcel class of ePlan in which interest (e.g. ownerships, easements) can be recorded as "single" or "multipart" parcels.

The administrative package of LADM includes a class called LA_RRR with three specialisation of Rights, Restriction and Responsibilities where the RRR are described, and the shares of each party are defined. In this case, there is a considerable difference in the way ePlan handles RRRs and liabilities and entitlements of the parties. The Parcel class includes a subclass called Title element which includes all references between parcels in the ePlan to legal documents. This includes land titles but can also include any other legal document or parcel identifier that define rights or ownership of land attached to the parcel. Also, the Parcel class includes an element called Owner which is used for easement benefits and vesting where the party is an authority rather than a lot. Parcel is also used to define the owners corporation schedule by which liabilities and entitlements of the member lots and

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common properties are defined. In other words, there is no class for handling RRRs a separate entity from Parcels.

LADM, in LA_Party class models, parties that are involved in land transitions mainly in transferring the RRRs. However, the only parties that ePlan data model is concerned with are the surveying firm and the licensed surveyor. This demonstrates the surveying focus of the ePlan v.s. administrative focus of the LADM.

LADM includes a class called LA_Spatial Source which caters for inclusion of surveying measurements with field observation such as distances and bearings. The corresponding classes in ePlan are RedHorizontalPosition and RedVerticalPosition. This contains horizontal measurement information for a point on the ground. This class is used to capture survey and geodetic control information

LADM uses spatial representation classes such a LA_Point, LA_BoundaryFace, LA_BoundaryFaceString to create and manage the spatial units in 2D and 3D. In ePlan, the representation is supported by the CoordGeom and CGPonits classes which containers for points and lines. The Line class represents a line between two points from CGponits. The line may be 2D or 3D depending on the coordinates of the points that define it.

ePlan also contains a class called HeadofPower that specifies the authority that gives the approver the power to approve the plan and information contained. Generally this relates to an Act of parliament or Regulation. Multiple HeadOfPower values can be specified if required where multiple Acts or Regulation documents apply to the plan. Building on this ePlan contains a class called PurposeOfSurvey element which describes the purpose of the survey. The LADM model does not specify how to model these elements.

2.2 Belize

This case study includes data from the country of Belize. Belize has 64 categories of land ownership that make it an interesting case study for the LADM data model. Land in Belize may be "declared" or "undeclared". Declared land is registered using a Torrens system, undeclared land is titled using a deed book and volume system. The land may be government owned or privately owned, the rights may be held absolutely, or provisionally where provisional right holders may be subject to claims from other claimants. For land that is owned by the government, it may also have a leaseholder who is entitled to certain rights. And the land may be subject to a fractional ownership scheme such as a timeshare or condominium. In actual practice only 22 of these categories actually have parcels that meet all of the criteria, for instance there are no declared, freehold condominiums with a timeshare scheme where the government is the absolute right holder.

The following table compares the terminology that is used in the previous land registration model (landfolio 2.x) with the terminology for the new LADM compliant model.

LADM	Original Model
BA Unit: The Basic Administrative Unit replaces the land register. The BA Unit represents an administrative entity that may be a parcel, timeshare, condominium or other unit of homogeneous **rights responsibilities** or **restrictions**.	**Land Register**: The land register represents the registerable object. This is the parcel, condominium, timeshare or lease. It contains data elements to allow for the recordation of Parcel related features such as the legal description, location, and status flags.
BA Unit Entry: Similar to the Land Register Entry, this is a textual description of a right, responsibility or restriction as well as other identifying information about the entry such as the section of the register that the entry applies to, the link to the source document, the date and user who entered it and is termination status.	**Land Register Entry:** The Entry contains a textual description of a right, responsibility or restriction as well as other identifying information about the entry such as the section of the register that the entry applies to, the link to the source document, the date and user who entered it and is termination status.
BA Unit Related: or any BAUnit that is mutated (split or amalgamated), the related BAUnits are the children of the primary BAUnit.	**Land Register Related**: For any land register that is mutated (split or amalgamated), the related land registers are the children of the primary land register.
Building Unit: A building or component of a building.	**Building**: This element is optional in this model. There are no rules or relationships to link the building to the parcel or to the Land Register.
Control Point: Contains control points in the parcel fabric.	No Equivalent
Folio Item: The folio item is the source with the administrative description (where applicable) of the parties involved, the rights, restrictions and responsibilities created and the basic administrative units affected.	**Instrument**: The instrument is the source document that provides the legal basis for modifying the rights to a land register. It describes the Land Register(s), party(s) and right(s), restriction(s) and responsibility(s) to create or transfer.
Folio Item Attachment: The Folio Item Attachment is the electronic representation of the source document. This is usually a scanned image that is retained for archival purposes. Each folio item may have one or more attachments which may be a supporting document such as an affidavit or an image of an ID card.	**Document**: The document is the electronic representation of the source document. This is usually a scanned image that is retained for archival purposes. Each Instrument may have one or more documents attached and the document may be a supporting document such as an affidavit or an image of an ID card.
Fractional Plan: This is a description of the fractional ownership plan.	**Condominium Timeshare Plan**: This is a description of the timeshare scheme or condominium plan.
Line: Contains parcel boundary, dependent, precise connection, connection, radial, road	**Parcel Line**: This is an option element in this model. If this element exists, it participates in

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frontage, origin connection and part connector lines.	the Parcel topology with the following rules: Parcel Lines must cover parcel boundaries and parcel boundaries must be covered by parcel lines. Parcel lines must not self-intersect.
Line Point: Line points are those parcel points that sit on the boundary lines of adjacent parcels without splitting the boundary lines.	No Equivalent
Parcel: This is the geographic representation of the parcel.	**Parcel**: This is the geographic representation of the parcel. Parcels are related to other parcels and parcel lines through a topology with the following rules: Parcels must not overlap or have gaps.
Party: A person or organization that plays a role in a **rights** transaction.	**Party**: A person or organization that plays a role in a **rights** transaction.
Party Member: A party registered and identified as a constituent of a group party**.**	In this model, the Party may be related to a "Parent Party" where the parent party is the group party. Each "Child Party" has the same role and share in the group party.
Point: Contains parcel points in the parcel fabric.	No Equivalent
Responsibility 1..n: One layer exists for each registerable responsibility where the responsibility does not necessarily coincide with the boundaries of a Parcel.	No Equivalent
Restriction 1..n: One layer exists for each registerable restriction where the restriction does not necessarily coincide with the boundaries of a Parcel.	No Equivalent
RRR: This is the relationship between the BAUnit, the RRR holder and the BAUnit Entry that conveys the RRR. It includes the share numerator and denominator rather than a percentage and a time specification in ISO 8601 format for fractional ownership such as timeshares. The commencement and termination dates of the RRR as well as the link to the administrative source come from the related BAUnit Entry.	**Land Register Proprietor Relationship**: This is the relationship between the Land Register the proprietorship right holder and the instrument that conveyed the proprietorship right to the party. It includes the share percent, the nature of proprietorship and the date range for the proprietorship right.
Separated Right 1..n: One layer exists for each registerable right where the right does not necessarily coincide with the boundaries of a Parcel.	No Equivalent

The previous system explicitly models proprietorship rights, taxation responsibilities, and to a limited extent mortgage and easement restrictions, but it does not explicitly model other types

of rights, restrictions or responsibilities. The textual information in the Torrens register entries allows for the recordation of the RRRs that are not explicitly modeled. This capability satisfies the legal requirements for recordation, but due to the free-form nature of the text entries, from a technical standpoint it is not possible to programmatically determine the complete legal status of a given parcel. Since both data models share the Torrens capabilities, the new system retains the implicit RRRs from the entries, however, the data conversion process should include a manual review of each "land register" to find RRRs that are implied in the entries and explicitly create the appropriate objects in the LAMD model.

3. REALISATION OF THE MAPPING IN GEODATABASE

3.1 Victoria
This data model has been realized in the ArcGIS geo-database using five main classes and relationships. This includes point, line and polygon classes that represent the spatial unit package. We also used two non-spatial classes to represent RRRs and Party packages in LADM. The model was successfully implemented in Enterprise Architect and was imported to ArcGIS environment.

3.2 Belize
This data model has been realized in the geo-database using a set of SDE-Registered tables and relationships for non-spatial classes, the ESRI Parcel Fabric for the Parcel, parcel line and point feature classes and additional supplemental feature classes for RRRs that are not coincident with Parcel boundaries. Registering the non-spatial tables with the geodatabase allows them to be versioned in accordance with the LADM standard.

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BIOGRAPHICAL NOTES

Mohsen Kalantari is a lecturer in Geomatics at the Department of Infrastructure Engineering and Associate Director at the CSDILA. Dr. Kalantari teaches Land Administration Systems (LAS) and his area of research involves the use of technologies in LAS and SDI. He has also worked as a technical manager at the Department of Sustainability and Environment (DSE), Victoria, Australia.

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