A New Vision on Cadastral Data Model

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Key words: Land administration, cadastre, land parcel, legal property object, interoperability

SUMMARY

Land administration systems are evolving towards an integrated land management paradigm designed to support sustainable development. In this paradigm, land administration delivers four functionalities: land mapping, land registration, land valuation and land development, each with specific data elements, with the cadastral data model at the core.

Cadastral data modelling potentially plays a key role in both data and business management in modern land administration systems. However, some modifications to existing data models could potentially improve their capacity to deliver sustainability.

Firstly, the existing role of land parcels and properties as core building blocks in land administration systems can be significantly extended to make the cadastral fabric available to assist management of a wider range of rights, restrictions and responsibilities by using the concept of legal property objects: an entity defined by a law or regulation which relates to a physical space on, below or above the earth. This can be interpreted as a new land related commodity, land parcel or a property.

Secondly, although land parcel and property identifiers are key elements of interoperability within land administration subsystems, the paper argues that they have not yet given appropriate emphasis in cadastral data models. Among the identifiers, spatial identifiers can potentially simplify data exchange and work flows among land administration functionalities on a much wider basis.

Finally, the paper discusses technical issues raised by changing the cadastral model: the advantages and disadvantages of spatial identifiers, possibilities for spatially presenting rights restrictions and responsibilities, and consistency between various legal property objects.

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1. INTRODUCTION

Land administration systems are evolving from a focus on core functions of regulating land and property development, land use controls, land taxation and disputes (Dale & McLaughlin, 1999) to play a greater role in an integrated land management system designed to support sustainable development (Enemark *et al.*, 2005). Sustainable development requires the management of social, environmental and economic interests on land.

Unfortunately, land administration systems have diversified services and functions to manage interests in land (
Figure 1). For example, the land registry subsystem places emphasis on the management of private rights, restrictions and responsibilities (RRRs) on land parcels. At the same time the land development subsystem is concerned with use restrictions imposed by planning authorities. The valuation subsystem focuses on the economic functions of land.

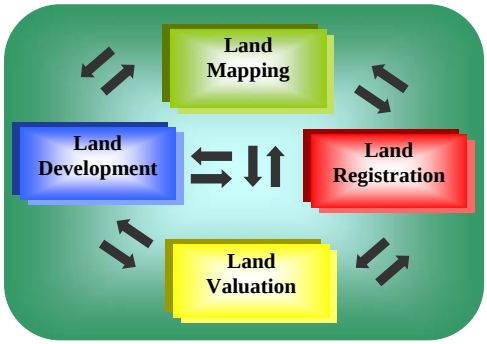

Figure 1: Data flow within the subsystems

Although these processes seem to be independent, each relies on or is related to land parcels/properties for referencing or indexing. In other words, the interests in land are generally organised through land parcels/properties data models in the cadastral information systems.

This paper encourages the land administration subsystems to take up new opportunities for better management of diverse internal approaches and overall delivery of land administration system policy through a comprehensive and interoperable cadastral data model.

2. THE ROLE OF CADASTRAL DATA MODEL

Efforts to improve land administration are focused on utilization of ICT like the electronic submission and processing of development applications, e-conveyancing, the digital lodgement of survey plans, online access to survey plan information and digital processing of title transactions as a mean of updating the database. Therefore, a comprehensive cadastral data model needs to incorporate the requirements of all these processes in all subsystems.

An effective cadastral data model must describe what is fundamental to the business, not simply what appears as data. Entities should concentrate on areas of significance to the business.

For instance, the data model for a electronic conveyancing system should be developed in conjunction with the land taxation subsystem and land registry subsystem to ensure that all land transfer requirements are met in one simple process. The tax systems rely on properties, not parcels, and they utilize a property identifier that links the title, local government and tax systems. They are interested in property price and land use. The descriptions of vacant land, residential property, industrial property, rural property and commercial property are crucial for many taxation regimes. Only some of that information can be accessed from land registries.

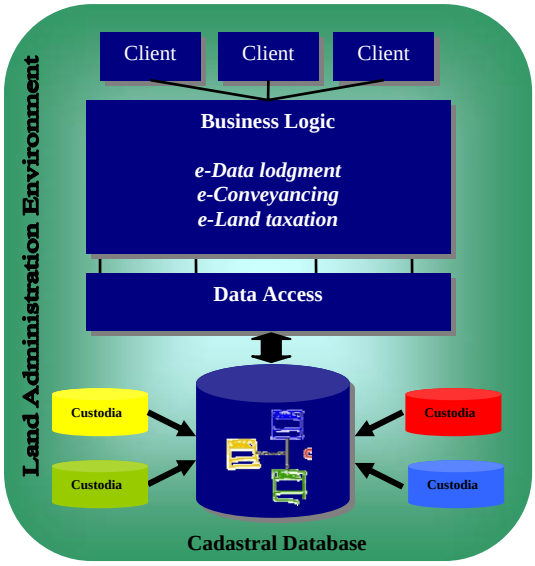

Figure 2: Role of cadastral data modeling in coordination among subsystems

Consequently, to achieve a modern land administration, cadastral data modelling is a basic step toward efficient service delivery (
Figure 2), because data are defined in the context of business processes. It allows every single process in land administration subsystems to directly influence the core cadastre model. The modelling process should recognize the business processes to mirror them in the cadastral data model.

Once the importance of cadastral data models is revealed, it is important to investigate the current core cadastral data models. The models depend on the functionality of land administration systems which is discussed in the following section.

3. CURRENT CORE DATA MODEL

A study of five states and jurisdiction was conducted to investigate current data models. The study reviewed three Australian states (New South Wales, Victoria and Western Australia) as well as two European countries (Netherlands and Switzerland), These wide and non specific case studies provided a broad range of data elements and their functionalities in different legislative systems.

Data elements with different functionalities contribute to land information in land administration systems. Land information is organized by land parcels which are the basic building blocks of most land administration systems. In other cases, properties play this role, specifically in the land administration systems with a fiscal background.

The results of the above case studies indicate that it is the legal component of the land administration which has prime importance. Interests on land including RRRs are kept both spatially and non-spatially in land registry databases. The case studies show interests on land or property mainly include rights rather than responsibilities or restrictions. Restrictions are usually described with land use and imposed by planning and development agencies and do not appear in cadastral databases. On the other hand, neither occupancy nor tenancy is kept in cadastral databases but they are interests in land which benefit from legal and administration support.

Additionally, even though there is a bundle of interests for each piece of land or property, that whole bundle is not normally held by one individual. It can be held by other individuals or the public. The interested person, individual or public, are mainly kept in land registry databases. However other organisations contribute to maintain the information about interested people in land tax or tenancy.

The current land administration systems maintain information about parcel, owner and ownership right as well as some obligations of the owner. Therefore, the current core data model consists of the parcel and the owner, with the ownership right linking these together (Figure 3). Indeed, the current core data model includes three main data elements: land parcel/ property, rights and some restrictions and interested persons. This model describes how a piece of land parcel or property relates to a person via the rights held.

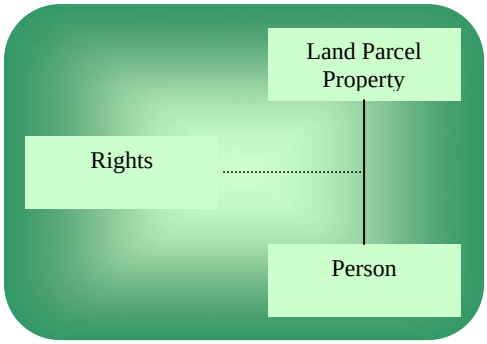

Figure 3: Current core model

However, objectives of sustainable development for holistic management of land force the cadastral and land administration systems to re-engineer the cadastral data model and incorporate other information into the model such as the third dimension, both private as well as public interests, restrictions and responsibilities on land, as well as occupancies and tenancies. The more inclusive data model described below addresses the issue.

4. A NEW VISION ON CADASTRAL DATA MODEL

In current thinking and literature on cadastral and land administration issues usually the rights are replaced by three R's of Rights, Restrictions and Responsibilities (Lemmen *et al.*, 2005). But the key question here is how or why new RRRs might be incorporated into a cadastral fabric when they are remote from physical objects or even spatial identification (Wallace & Williamson, 2004). RRRs are a result of cultural, social and political activities in each country and describing the variety of existing rights and restrictions in a common model is difficult. This detailed modeling of RRRs has been avoided when cadastral models are produced (Paasch, 2004). Authors believe RRRs are not separate entities, whereas land is treated as a legal entity. Therefore, the modelling process should recognize this strong principle: land is not a legal entity until an interest is attached to it.

Furthermore, land is a limited resource, but by creating a modern cadastre capable of recognising new commodities like biota, water, and mining, the capacity of land markets can be improved to achieve sustainable development (Wallace & Williamson, 2004). The mentioned commodities are new entities which are not physical realities but are institutional creations that may be owned by public or private sectors. Current cadastral data models are not able to handle these commodities. These new commodities cause an issue in current data models since adding new entities to current cadastral databases requires data model redesign.

Meanwhile, population growth and high demands on land lead land administration agencies to take the third dimension into account more than ever. Therefore the third dimension is becoming a more important data element in cadastral data model. While this happens, the role of third dimension in land administration will become the same as parcel or property. The third dimension can include entities like apartments over land or tunnels under ground.

Introduction of the concept of legal property objects solves the limitation: An entity defined by a law or regulation which relates to a physical space on, below or above the earth.

Further discussion is needed to better define the legal property object concept. A land parcel or property is attached to a bundle of interests and forms a legal property object. Various kinds of interest on land exist, which leads facing various legal property objects. This definition allows creating virtual information layers from intangible RRRs upon the Earth's surface. Legal property object enables incorporating RRRs into cadastral fabric and spatially represent them in a land information system.

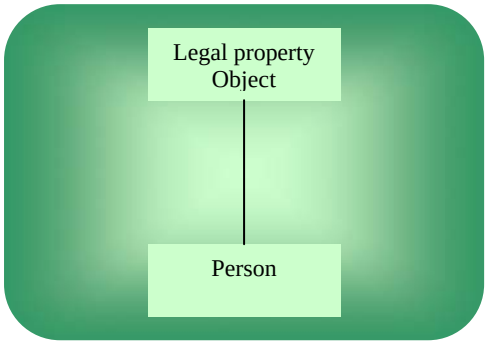

Figure 4: New core cadastral data model

The concept of legal property object changes the current core data model from three components into two components: legal property object and the person (
Figure 4). The legal property object includes physical land related entities as well as legislative RRRs in the form of virtual information layers. The legal property object will be the basic building block and is the centre of the model to support the title based approach. The person includes all the private, natural and non natural individuals as well as the public.

5. REGULATING LEGAL PROPERTY OBJECTS

Incorporation of legal property objects into a cadastral data model faces some practical challenges. The first is the conversion of the attributed RRRs into a spatial dimension; this involves difference between spatial characteristics of RRRs. The legal property object might be a polygon or not. It can be a line or a point. The easement on a land parcel for a right of way is an example. The right can be represented by a line with associated attribute or as a polygon. The second challenge is the relation between land parcel and property with the other legal land object layers. In other words, how can they be connected together in a spatial database? The use of spatial referencing system in the data model helps meet these challenges.

Spatial referencing systems are generally not used as identifiers for matching various databases together. The most common identifiers are volume–folio in land registration subsystems, parcel identifiers in land mapping subsystems and property identifiers in valuation and development subsystems. Use of relational or object oriented databases is the

common way for integrating various databases, but a spatial referencing system could simplify land administration database management. The new model therefore requires the coordinates of all legal property objects to be linked via geocodes.

There are many advantages to having a spatial referencing system for legal property objects that includes some form of geographic reference. This facilitates the management of various layers of information related to legal property and facilitates spatially presentation of rights, restrictions and responsibilities. Finally, setting the related legal property objects on top of each other facilitates the institutional data exchange process between those of responsible and optimises the interoperability among organisations.

Introduction of legal property objects and use of spatial identifiers require far-reaching change in cadastral information systems.

6. CONCLUSION

This paper describes cadastral data modelling based on the modern land administration concept with four functionalities: land mapping, land registration, land valuation and land development to support sustainable development.

The paper investigates current core cadastral data models and reveals that current core cadastral data models include three main data elements: land parcel/ property, rights and interested person. These parcel based models are not able to accommodate the growing number of interests in land and new commodities out of land. More importantly, it does not facilitate interoperability among land administration subsystems.

To address these issues, two changes in current core cadastral data models are proposed. The first changes the building block for land administration from physical land parcels into legal property objects. This facilitates the incorporation of rights, restrictions and responsibilities into the cadastral fabric. The second is to make the spatial referencing systems the centre of the cadastral information system as the legal property object identifier. The second change can promote interoperability and simplicity in data exchange processes, particularly upgrading and updating cadastral databases.

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BIOGRAPHICAL NOTES

Mohsen Kalantari is a PhD candidate in the University of Melbourne working on cadastral data modeling and ICT enabled land administration. He was awarded a Bachelor of Surveying Engineering and Master of GIS by KNT University of Technology in Tehran, Iran. During his M.Sc. studies, he was involved in various research projects in the Geodesy and Geomatics Research Centre at KNT University of Technology. During his final year of M.Sc. Mohsen worked as a teaching assistant in the GIS department and was involved in tutoring GIS students. After finishing his Masters degree in Dec 2003, he became R&D director in GlobeArray (Geomatics Private Research and Development Company) in Tehran.

Abbas Rajabifard is Deputy Director of the Centre for Spatial Data Infrastructures and Land Administration and a Senior Research Fellow in the Department of Geomatics at the University of Melbourne. He holds BSurv (Tehran), Postgrad-Dipl (ITC), MSc (ITC), and has PhD from the University of Melbourne. He has been an Executive Board member and National representative to Permanent Committee on GIS Infrastructure for Asia and the Pacific 1994-1999, and member of International Steering Committee for Global Mapping 1997-2001. His current research and interest are spatial data management, SDI development models and SDI capacity building.

Jude Wallace is a land policy lawyer who works in international land administration. She is a former Law Reform Commissioner of Victoria, familiar with land transactions, development and resource law. She deals in system to deliver social, environmental and

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Ian Williamson is Head, Department of Geomatics, University of Melbourne, Australia, where he is Professor in Surveying and Land Information, and Director of the Centre for Spatial Data Infrastructures and Land Administration. He is Chair, Working Group 3 (Cadastre) of the United Nations sponsored Permanent Committee for GIS Infrastructure for Asia and Pacific (PCGIAP). He was Chairman of Commission 7 (Cadastre and Land Management) of the International Federation of Surveyors (FIG) 1994-98 and Director, United Nations Liaison 1998-2002. His teaching and research interests are concerned with designing, building and managing land administration, cadastral, and land and geographic information systems in both developed and developing countries. He has consulted and published widely within these areas.

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