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Towards a Land Administration Domain Model (LADM) profile for South Africa

by

Dinao Elmon Tjia

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DECLARATION

I, *Dinao Elmon Tjia*, declare that this dissertation, which I hereby submitted for the degree *MSc (Geoinformatics)* at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

SIGNATURE DATE

Towards a Land Administration Domain Model (LADM) profile for South Africa

Dinao Elmon Tjia

Supervisor: Dr. Serena Coetzee
Department: Geography, Geoinformatics and Meteorology
Faculty: Natural and Agricultural Sciences
University: University of Pretoria
Degree: MSc (Geoinformatics)

ABSTRACT

For decades, cadastral systems implemented within different countries have not provided a meaningful communication between parties involved. This problem has resulted in barriers to cadastral information exchange between different parties within and between different countries. In order to address this challenge, the land administration domain model (LADM) was developed by the International Organization for Standardization (ISO) Technical Committee 211. One of the main goals of the LADM is to enable parties involved to communicate via a shared vocabulary within the domain of land administration. In so doing, the LADM intends to improve the interoperability between cadastral and land registration systems, thus improving information exchange between local, national and international organisations. The model is not meant to be complete for any specific country. However, it serves as a shared conceptual schema upon which the existing or new systems can be refined and developed respectively, to become more efficient and effective. Various studies have been conducted based on different versions of the LADM in different countries such as Japan, Indonesia, Netherlands, Trinidad, and other European countries.

In South Africa, the research focusing on the applicability of LADM to its' unique context is solely lacking. This is a worrying factor given the potential benefits associated with the LADM implementation. Therefore, the main purpose of this research is to explore the applicability of LADM to South Africa through the analysis of the current national deeds registration and cadastral systems as well as the land information system (LIS) implemented at the City of Johannesburg metropolitan municipality. In both cases, the research scope was limited to the LADM classes required for the first level of conformance. A literature review of the South African land administration system with a specific reference to the existing property legislation that regulates both land registration and cadastral surveying was conducted. The contents of the deeds transfer data files were analyzed. A deeds property data model was derived from the sample deeds data. A cross-mapping between the attributes in this model and the attributes in the LADM conformance level classes was carried out. Similarly, a cross-mapping of the LADM conformance level classes between the City of Johannesburg LIS's core property data model was performed. The results of both cross-mappings show that there are minor semantic differences between the classes, attributes and associations in the South African data models and the LADM. However, the data models could be refined to conform to LADM conformance level one. A starting point could be to harmonize the terminology used in the national deeds registration system and CoJLIS with the internationally accepted LADM terms and definitions. The LADM provides an improved way of representing the rights and obligations encountered in the South African land registration system and CoJLIS. This research provided an initial exploration upon which further research can be conducted to examine all other aspects of the LADM.

The research has shown that the LADM can be applied to describe land information in South Africa. Moreover, the research results improve the understanding of land administration at both national and municipal level. The LADM offers an opportunity to refine the current system in the e-Cadastre initiative and in the CoJLIS upgrade project to develop an integrated cadastral or property information management model based on international standards. In general, the research results laid a foundation upon which the development of an LADM conformant municipal land information model applicable to all municipalities in South Africa can be derived. More importantly, the research contributed towards the development of a comprehensive LADM profile for South Africa.

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Agee Gosebo wa Mogale le Mahlako!

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List of Acronyms and Abbreviations

BAUnit	Basic Administrative Unit
BPU	Basic Property Unit
CLaRA	Communal Land Rights Act
CoJ	City of Johannesburg Metropolitan Municipality
DFA	Development Facilitation Act
DRS	Deeds Registration System
DRLR	Department of Rural Development and Land Reform
GIS	Geographic Information System
GLTN	Global Land Tool Network
JHB	Johannesburg
FAO	Food and Agriculture Organization of the United Nations
INSPIRE	Infrastructure for Spatial Information in the European Community
JPC	Johannesburg Property Company
LA	Land Administration
LADM	Land Administration Domain Model
LAS	Land Administration System
LIS	Land Information System
LFTE	Less Formal Township Establishment
LRS	Land Registration System
SAP	Systems Applications and Products
SOLA	Solutions for Open Land Administration
STDM	Social Tenure Domain Model
TC	Technical Committee
UAC's	Utilities, Agencies and Corporatised Entities
UML	Unified Modelling Language
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UN-HABITAT	United Nations Agency for Human Settlement
RRR	Rights, Restrictions, and Responsibilities
SDI	Spatial Data Infrastructure
MOLA	Meeting of Officials on Land Administration
OSCAR	Open Source Cadastral and Registry
PLATO	South African Council for Professional Land Surveyors and Technical Surveyors
R&T	Rates & Taxies
SG	Surveyor-General

CHAPTER 1 INTRODUCTION

1.1 Introduction

Land is a finite and an indispensable asset of any nation. It is the most important scarce resource that requires adequate management, especially with the rapid growth of the world population. In 2011, the world population reached 7 billion (United Nations Population Fund [UN-FPA] 2012). This rapid growth in population puts a tremendous pressure on the increasingly limited land resource to provide more space for food, shelter, energy, recreational space and other commodities. Research shows that about 70% of physical development occurs outside the formal processes (International Federation of Surveyors [FIG], 2010). About 30% of urban population lives in informal settlements on either vacant state or privately owned land illegally. In 2011, the population of South Africa reached 51,7 million people with a high number of people migrating to the more affluent cities in a search for better job opportunities, services or living standards (Statistics South Africa, 2012). The inward migration poses challenges to the affected areas. There are incidents where informal settlements have been developed on farm land or proclaimed townships. There are incidents whereby housing development projects have already been initiated without adhering to applicable township establishment legal processes. The growing population often results in land disputes over the rightful claimants of the land. Land grabbing is also a common phenomenon where ownership over land is unclear

The rapid growth in population has considerable consequences on the future economic growth, environmental sustainability, and human well-being (United Nations [UN], 2008). It exerts an enormous pressure on the economic, social and environmental aspects of land, especially in the urban areas. Urbanisation has been associated with positive social change, income growth and improved living standards. However, these benefits cannot occur automatically without well-devised public policies (United Nations Human Settlements Programme [UN-HABITAT], 2010). Land policies are crucial for "sustainable growth, good governance, and the well-being of and the economic opportunities of both rural and urban population, particularly poor people" (World Bank, 2003). In this view, it is crucial for any country to develop innovative and implementable approaches to support these critical policies (UN-HABITAT, 2004). How land issues are dealt with may be defined in land policies. The South African land reform programme defines the principles of how land should be restituted, redistributed and tenure reformed.

Land administration (LA) is an important activity to facilitate the implementation of land policies and management strategies (Williamson et al., 2010). LA is defined as "the process of determining, recording and disseminating information about ownership, value and use of land, when implementing land management policies" (United Nations Economic Commission for Europe [UNECE], 1996). Such common processes may include the subdivision of land, allocation of rights (ownership, use rights etc.), delineation of land parcel boundaries (either fixes or general boundaries), and transfer of rights over land from one party (i.e. person, group of people or organisation) to another (Williamson et al., 2010). This definition has featured as a guiding principle in policy documents, research and training programmes (Van Molen, 2005). Dale & McLaughlin (1999) also provided a useful definition by describing LA as dealing with processes of regulating land and property development, land conservation, revenue generation from sales, leasing and taxation, and conflict resolution over ownership and use of land as other processes. LA can be defined broadly as the "process of determining, recording and disseminating information about the relationship between people and land" (ISO 19152: 2012). The relationship may be factual as in the case of possession of a farm or legal as in the case of ownership, lease or servitude over a specific piece of land. Ownership is the most significant people-to-land relationships (Williamson et al., 2010).

Ownership is described as virtually the most complete private right a person can have as opposed to other limited real rights (i.e. rights to use and enjoy property belonging to someone else) such as leasehold, servitudes mortgage, etc. (Du Bois, 2007; Van der Walt & Pienaar, 2009). It affords the landholder with the entitlement to deal with the land as holder pleases within the limits set by law. These include powers to use, enjoy, consume, possess, dispose and resist any unlawful invasion. With the increasingly limited land resource due factor such as population growth and sustainable development, the ownership has been a subject to more and more public restrictions. Therefore, ownership as absolute and exclusive is no longer relevant within the current socio-economic context. Physical planning, land use, and environmental conservation laws restrict the power of landowners to freely use and enjoy land or property. Moreover, social and political forces have led to recognition of social obligations when dealing with land ownership. Land reform policies allow ownership to fulfil its social function by eradicating inequalities. For example, the South African land reform policy aims to address the imbalances caused by the apartheid land law which left many South African people without secure ownership rights in land.

Modern land administration systems aim to provide the complete recordation of relationship between people and land. This implies that not only formal land tenure rights in land are recorded, but also all other interests over land. Simply put, the modern LASs should provide a complete documentation of all rights, responsibilities and restrictions (RRRs) affecting land in order to support sustainable patterns of land use (Williamson et al., 2010. The LASs have a significant role in keeping information about the content of the relationship up-to-date (Ingvarsson et al., 2001). In over 4 billion cases, 75% of people-to-land relationships worldwide are not documented (Lemmen, 2012). In South Africa, 5% and 15% of parcels in urban areas and rural areas respectively, are legally occupied but not registered or surveyed. 20% and 5% of land parcels in urban and rural areas respectively are informally occupied without legal titles (Rajabifard et al., 2007). Many rural areas are without registered rights in land. In South Africa, land rights in most rural areas of the former homelands are not registerable in the current land registration system.

1.2 Land administration domain model

Research has shown that cadastral systems implemented in different countries and jurisdictions had not been able to provide a meaningful communication between involved parties within one country and across countries. The current systems are differentiated based on whether they are based on deeds or title registration approach, fixed or general boundaries approach, legal or fiscal background, multi-purpose, and so on. However, cadastral systems are, in principle, the same in that the systems are all based on people and land relationship. Such relations may be formal and informal in nature. A formal relationship is usually registered in land registration systems. On the other hand, an informal relationship is unregistered and governed by the customs and unwritten traditions. Moreover, the cadastral systems are aimed at keeping the content of the relationship up-to-date. However, to achieve this has remained a persistent challenge.

Recent developments in land administration research have heightened the need for a common vocabulary for land administration domain. A lack of shared concepts amongst various parties involved in land administration activities (e.g. land surveying, conveyancing, land use management and development of land) remains one of the key challenges faced by public and private organisations worldwide.

The *Land administration domain model* (LADM) was prepared by the International Standardization Organization (ISO), Technical Committee (TC211), *Geographic*

information/Geomatics as accepted global solution. The LADM deals with the basic information-related component of land administration, including those over water, land and material above and below the surface of the earth (ISO 19152: 2012). The LADM provides a common vocabulary for describing the *rights, restrictions and responsibilities* (RRRs) and their geospatial components. The model also provides for the description of *persons* (natural or non-natural persons) with interest in land and the spatial extent of RRRs. These representations are found in cadastral systems of land survey record systems. The RRRs are commonly found in the systems of deeds or title registration. The model aims to provide a flexible reference schema upon which cadastral systems or land administration systems in general, can be refined or new systems can be developed based on the model-driven approach, as presented by the model. The LADM model provides a shared vocabulary with which different parties within a country and amongst countries can communicate, thus making the information exchange among the parties involved easier.

The LADM is not intended to be complete for any particular country, but rather provides expandable basis upon which a country-specific model can be developed. In any country, the laws governing the land have impact on the development profile of such a country. The law, custom and established practices may permit or restrict possible inclusion or extension of some instances, attributes and other specific variables (Graffith-Charles, 2010). Hence, a number of studies in certain countries has explored or considered the adaption and extension of the LADM to their local needs. Examples of country profiles are documented in the ISO 19152: a profile of Portugal, Australia, Indonesia, Japan, Hungary, the Netherlands, the Russian Federation, and the Republic of Korea (ISO 19152: 2012). Other studies examined the possible adoption of the LADM: the Cyprus Land Information System (CLIS) in Cyprus (Lemmen, 2012); an object-oriented conceptual model based on the LADM designed for the Portuguese Cadastre and Real Easter Register. The international organisations such as the FAO and UN-HABITAT support the LADM. The FAO Solutions for Open Land Administration (SOLA) project in Samoa, Nepal and Ghana focused on applying the LADM in development of software and a data dictionary for the computerization of Land Administration Systems. The specialization of the LADM, the Social Tenure Domain Model (STDM) describes social tenure relationships as embedded in the continuum of the land rights concept supported by the UN-HABITAT and the Global Land Tool Network (GLTN).

1.3 Research problem

Research exploring the applicability of the LADM within the context South African land administration is lacking. This triggers the need to explore the adaption and extension of the LADM for South Africa. Like any other country, the South African land law may restrict or allow specific instances to be implemented. For example, the Deeds Registries Act, Sectional Title Act, Land Survey Act and regulations promulgated thereof. The Acts form the foundation of the South African land registration system. Various other Acts, Ordinances and Rules of the Courts, township planning ordinances; rules 63 of the High Court Rules, Chief Registrar's Circulars, common law (Roman-Dutch law), Registrar's Conference Resolutions also specify provisions in respect of registration procedures and information content which must be complied with in respect of land registration.

This research is an initial exploration into the applicability of the Land Administration Domain Model (LADM) to South Africa.

1.4 Research aims and objectives

The research aims to improve the understanding of the South African land administration system; to explore whether the LADM can be applied to South African land registration system (deeds registration and cadastral information systems) and municipalities, by using the City of Johannesburg Metropolitan municipality as a case study.

The objectives that guided this research were:

- to analyze the existing South African land administration elements
- to explore the applicability of the LADM to South Africa
- to explore the applicability of LADM to South African municipalities using the City of Johannesburg's Land Information System as a case study
- to identify challenges in implementing the LADM in South Africa

In order to achieve the first objective, the current South African land administration was reviewed, with a special reference given to its existing systems of deeds registration and cadastre. The second and third objectives were achieved through the cross-mappings between the LADM and South African deeds data entities and the City of Johannesburg land information system core data model, respectively. The forth objective was realized

through the analysis of the current national systems of deeds and cadastre, and analysis of the case study of the City of Johannesburg – the land information system (LIS).

1.5 Research context

This research is conducted within the context of South African land administration and the municipal land information system implemented in the City of Johannesburg. Figure 1 shows the location of South Africa in relation to its neighbouring countries and the location of the City of Johannesburg within Gauteng province, South Africa

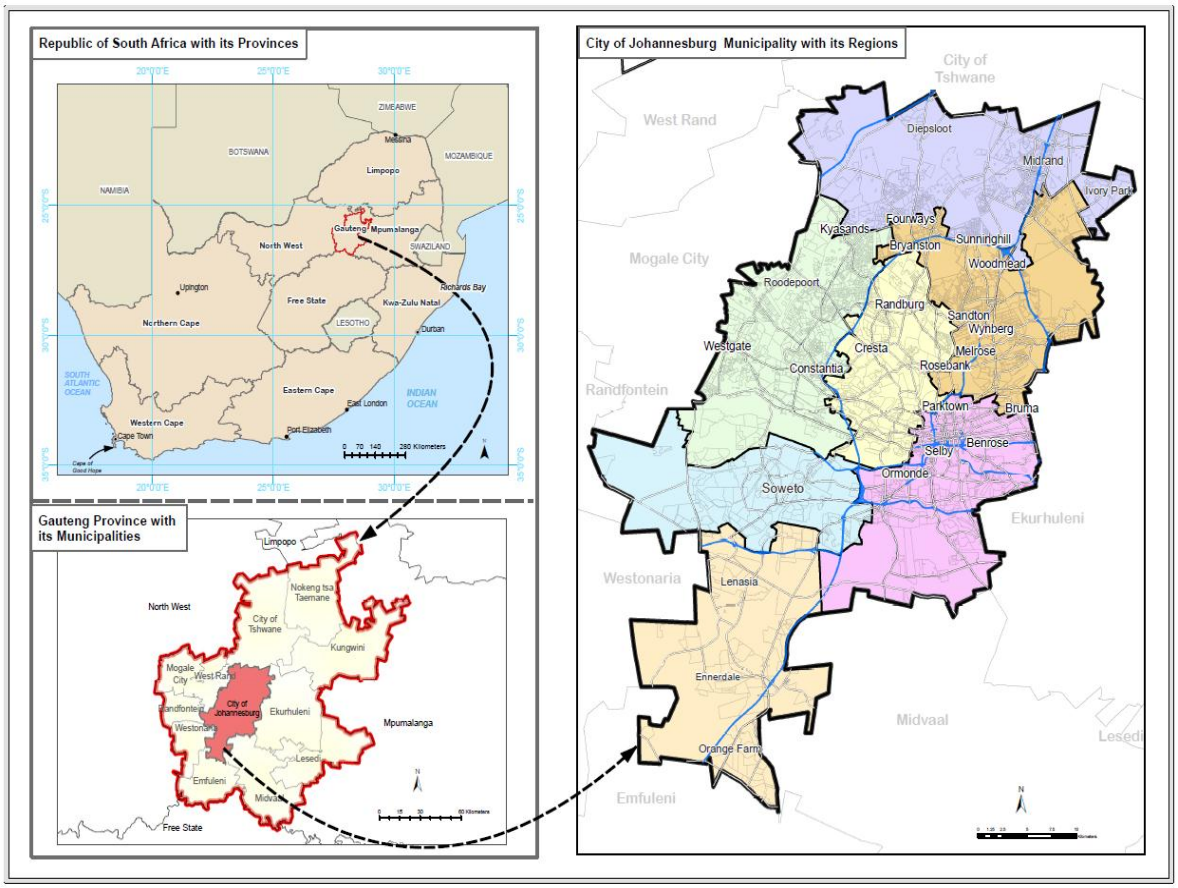

Figure 1. Study area locality map

1.6 Research method

This dissertation follows a case-study design, with in-depth analysis of literature review on land administration in general and South African land administration system in particular. This study was exploratory and interpretative in nature. The study explored the applicability of the LADM to the South African land registration system and the City of Johannesburg's land information system. The research design and stages for the study

incorporated a literature review; case study investigation; content analysis of deeds information; data model design and development. To establish the theoretical background of the research, a literature review has been undertaken. Various resources such as text books, research journal articles, organizational reports, conference papers, and other publications were used to collate a range of information from the literature review. The study reviewed the South African land administration with specific reference made to the South African land tenure system, land value, land use, and development activities.

Various pieces of legislation were reviewed in order to understand the legal requirements of the South African land registration system. This is important because the legislation influences the behaviour and the functions of land administration organisations including parties involved in land administration. It defines the roles and responsibilities of parties involved. Various laws may influence what classes, attributes and packages of the LADM that could be incorporated and possible inclusion or exclusion of some of the LADM variables. Therefore it is necessary to examine the legal framework that defines the character of the South African land registration system. The study also reviewed various pieces of legislation that govern the South African land registration system. The key Acts examined included the Deeds Registries Act, the Sectional Title Act, and the Land Survey Act. The regulations promulgated in terms of the Acts were also examined. The Acts form the foundation upon which the South African land registration system is based.

The research data in this dissertation is drawn from the following sources: The electronic deeds data sourced from the office of the Chief Registrar of Deeds. The electronic deeds sample data contained weekly transfer deeds registration records. The files contained ownership transfers, endorsements registered against properties such as servitudes, lease, notarial bonds, and mortgage bonds. The weekly deeds data sample was necessary to understand the data structures, codes, and data elements used in the South African electronic deed registration system implemented at the deeds registry offices.

In this study, a sample data structure from the ‘winDeed’ and ‘Deedsearch’ websites which host deeds information was used so as to further understand other elements of deeds data. In this research, Enterprise Architect (EA) software was used to develop the UML class diagrams of the CoJLIS and South African land administration situation.

Moreover, a sample of registered deeds documents which included deeds of transfers, certificates of registered title, deeds of lease, deeds of servitude, and notarial deeds were

acquired for this research study. A sample of survey plans and diagrams approved by the Surveyor General (SG) office approved were sourced via an official online website of the SG office. This information included general plans of township establishments, servitude diagrams, and sectional title scheme plans.

Table 1 shows the sample data and the sources of data used in this study.

Table 1. Deeds data sample and information.

Data / information elements	Sources
DeedsWeb Bulk Information Layouts (September 2009 version 1)	Chief Registrar's Office
DOT - List Files Layout (Version 5 - April 2012)	Chief Registrar's Office
DRS Weekly Transfer – Fixed Length File Layout (Version 4 April 2012)	Chief Registrar's Office
DRS – Fields (Version 3-9 November 2007)	Chief Registrar's Office
Fields in Records sent to Local Authorities (15 February 2006)	Chief Registrar's Office
Weekly deeds data sample for Local Authorities (October 2012) for CoJ and KZN	Johannesburg deed office KZN deeds office
LIS data sample for the core entities: Property; Owner; Endorsement; Application; Building; Valuation; Zoning and Land Use	City of Johannesburg
WinDeeds property search report (sample)	www.windeedsearch.co.za/DeedsOffice/Property
Deedsearch property report (sample)	www.deedsearch.co.za/lnb_sample_propertytransfers.cfm

In order to examine if the requirements provided by the South African property law are applied in real world, an empirical investigation was carried out, using the City of Johannesburg municipality Land Information System (CoJLIS) as a case study. In the case study, the City of Johannesburg's property value chain model was applied as a useful method to better understand the business requirements and processes involved from the initial stage of property creation in the LIS through various stages (i.e. land use allocation, valuation, account creation, etc.) to the last phase of value creation from revenue collection (generated from billing of accounts for property rates, taxes, and municipal services). The study examined and analysed a core data model of the CoJLIS.

1.7 Research contribution

Studies dealing with the applicability of the Land Administration Domain Model (LADM) within the South African context are lacking. This research presents an initial exploration of the applicability of the LADM to South Africa. The research improves the understanding of South African land administration system. It also provides a basis upon

which a national standard of land administration can be developed. The study derives a way for more empirical investigations in other areas, especially those areas falling outside the national system of land registration. The study is of practical significance in that it contributes to the current initiatives by the State to improve land records management system through the complete integration of the deeds registration system and the cadastral management system. At a local level, the study contributes to the creation of better understanding of how the land administration system operates in order to fulfill the legal requirements related to the collection of revenue from mainly property rates and taxes.

1.8 Overview of study

The overall structure of the study takes the form of six chapters, including this introductory chapter. **Chapter One** provides the background information to the study. The chapter starts by highlighting the importance of land as a scarce resource. The rapid population growth's pressures on an increasingly limited land resource are presented. The chapter goes further to introduce the Land Administration Domain Model (LADM) and other research studies related thereto. The research problem, research aims and objectives, the context of research, research methods, and research contribution are then presented in that particular order. The remaining chapters of this dissertation are structured as follows:

Chapter Two provides a theoretical base upon which this research is based and then provides the context of the study. The chapter presents a review of previous work in land administration in general and then places a particular emphasis on the LADM. The chapter begins with a brief overview of land administration theory. Land management paradigm is used in this chapter as a conceptual framework to improve the understanding of the role of land administration within the broader context of sustainable development. The chapter presents a literature review of the cadastral system developments and previous work on the models of people and land relationships. The marine cadastre model and the USA Cadastral standard are also presented. This chapter provides the LADM overview with a specific reference to its packages and its basic classes for the first conformance level.

Chapter Three describes the South African land administration using the land management paradigm as a guide. The chapter presents the South African land policy, land tenure (i.e. land various forms of land tenure recognized in South African law of property), land value, land use and development and the challenges affecting these systems. The chapter focuses on the formal land registration and cadastral systems. Various categories of

rights, restrictions and other interests in land that are found in the South African land registration system were presented

Chapter Four explores the applicability of the LADM to the South African national land administration. The chapter is limited to the basic classes of LADM that are required for the first basic level of conformance. The LADM provides three levels (low, medium and high levels) to which any application schema claiming conformance with the LADM must comply with any of these levels of conformance. The analysis of the conventional deed of transfer was conducted to identify information related to description of parties, rights and other restrictions and interests, and their geo-spatial representation. An analysis of an electronic deeds data sample was conducted. The literature review of current laws that govern the land rights registration, land surveying and sectional title is presented. The parties encountered in the deeds registries in South Africa were identified from available literature. The chapter presents the results of an analysis of the data samples. The comparisons between the LADM and the South African land registration system were performed. The chapter ends with a discussion of the results of the comparative analysis.

Chapter Five explores the applicability of the LADM to the City of Johannesburg Land Information System (CoJLIS). This chapter was published in the South African Journal of Geomatics, Volume 2, No. 3 June 2013. The chapter provides a background to the development of the CoJLIS. The core CoJLIS data model is presented. The cross-mappings between the LADM first conformance level and the CoJLIS entities are presented. The discussion of the results and conclusion are then presented.

Chapter Six provides the conclusion of the work presented in this dissertation. The chapter provides a summary of the research findings, study contributions, and recommendations for further research work.

CHAPTER 2 LAND ADMINISTRATION

2.1 Introduction

The chapter presents a review of previous work in land administration in general and then places a particular focus on the land administration domain model. The chapter begins with a brief overview of the modern land administration theory. The chapter discusses the changing nature of humankind to land relationship. A land management paradigm is used in this chapter as a conceptual framework to improve the understanding of the role of land administration within the broader context of sustainable development. The chapter also presents a literature review on the cadastral system developments. It provides previous work on the development of models related to people-to-land relationships: the traditional cadastral model, marine cadastre model and the USA Cadastral standard. This chapter ends with an overview of land administration domain (LADM) with specific reference to its packages and basic classes required for the first conformance level.

2.2 Land administration

Land administration is about the relationship between people and land. This relationship is reflected in the manner in which land is held, the way in which is the land is used and its future uses, the manner in which it is valued and developed. The people-to-land relationship can be legal as in the case of registered ownership over a piece of land, or registered leasehold on property, registered servitude over someone else's property. The relationship can also be factual as in the case of possession of land. Williamson et al., (2010) describes ownership as the most direct relationship between a person and land. The legal relationship is in principle registered in a land registration system (i.e. deeds registration system or title registration system).

There is no uniform definition for the ownership concept. Factors such as legal, social, economic, historical, political and religious influence how societies define the ownership within their areas. In South Africa, ownership in land has largely remained the most emotionally, sensitive, historical, socio-economic and political issue; due to the past racially discriminatory land laws. These laws left majority of the South Africans without secure land tenure or ownership of land. From the South African property law perspective, Van der Walt & Pienaar (2009) defined ownership as:

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> "the most complete real right that a legal subject can have regarding a thing, or as the real right which gives the owner the most complete and absolute entitlements to a thing".

In this definition, a thing refers to either a movable and immovable thing. Immovable things are units of land and everything permanently attached to them, as well as sectional title units. Movable things are all things that cannot be classified as immovable. An owner's entitlements over a thing are distinguished as follows:

- *Entitlement to control* is the entitlement to physical control and keep a thing;
- *Entitlement to use* is the entitlement to use and benefit from a thing;
- *Entitlement to encumber* is the entitlement to grant limited real rights in respect of the thing;
- *Entitlement to alienate* is the entitlement to transfer the thing to someone else;
- *Entitlement to vindicate* is the unique entitlement of the owner to claim the thing from another person.

An owner's entitlements over a property are limited by pieces of legislation and the rights of others (e.g. limited real rights or creditor's rights). A limited real right is a right held by person in respect of a property owned by other person. Therefore, it can be said that a limited real right is a form of restriction on a specific entitlement of an owner. For example, a registered servitude of right of way creates a restriction on the owner not to use his/her entitlement in an unrestrictive manner such as erecting fence around the property so as to restrict access. An owner's right to use may be restricted by zoning restrictions imposed in terms of town planning ordinances, and other urban and rural land use policies.

This research is concerned with the relationship between people and land with a special attention directed to categories of ownership or real rights in land as well as limitations on ownership right within the South African land administration system. The following section focuses on the evolution of people to land relationships and the challenges that the modern systems of land administration need to respond to.

2.3 The evolution of humankind to land relationships

The relationship between humankind to land is dynamic (Ting & Williamson (1999). Figure 2 illustrates the evolution of humankind to land relationship within the Western countries' perspective. Within this content, four broad stages of evolution are

distinguished: Agricultural Revolution and feudalism, Industrial Revolution, Post World War II, and Information Revolution and Sustainable development. During the Agricultural Revolution and the feudalism phase, land was fundamentally a symbol and source of wealth. The role of cadastral system was to provide a public record of ownership of land for fiscal purposes. However, during the Industrial Revolution phase, land became a commodity and a primary source of capital. It was during this phase that legal and institutional changes to incorporate land markets. Cadastral systems shifted focus to support land transfer and land markets. Post World War II reconstruction and population boom, the growing awareness that land is increasingly becoming a scare resource and not enough to meet the demands of the rapid growing and world population. During this phase, physical planning, especially urban and regional planning, became a centre of focus. The role cadastre expanded to incorporate applications related to planning. From 1980s, environmental degradation, sustainable development and social equity, became one of the key challenging issues. Land use planning activities begun to incorporate community interests. This phase resulted in a need for more complex land information and land use. The role of cadastres evolved to become multi-purpose.

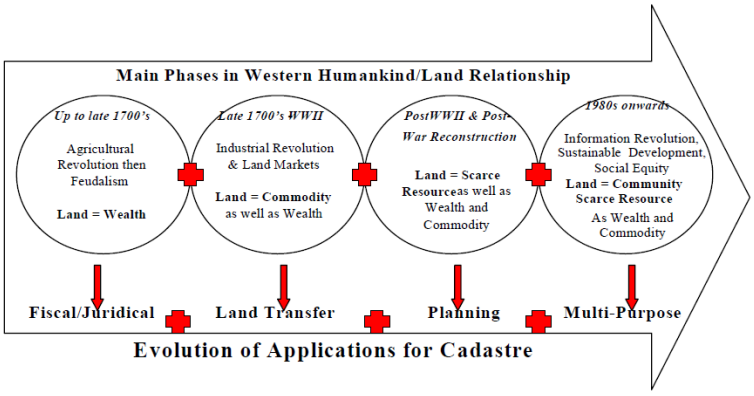

Figure 2. Main phases of Western humankind to land relationship (Ting & Williamson, 1999)

Many developed countries are moving from the third to the fourth phases, while many developing countries are encountering transition across all four phases (Williamson, 2001). There is a growing demand that all nations to take consideration on these global drivers of humankind to land relationship not just limiting their focus to country-specific, local and national structures and legal, institutional, economic and social frameworks. Ting and Williamson (1999) provide an analysis of the ever-changing humankind-to-land relationship and the response to the changes through various land or cadastral systems. Looking at the humankind to land on a more micro level, the relationship varies considerably across a country from urban areas where formal land markets with established

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system of land titling and informal settlements with no titling system, to rural areas where land is held through indigenous rights or customary rights which remain outside the formal land markets. Therefore, a single and uniform land administration response is not an ideal solution. More and more different responses are essential. These responses would change over time in response to the changes in humankind to land relationship driven by global drivers. The drivers of change are identified as sustainable development, environmental sustainability, globalisation, urbanisation, economic reform, and technology. These drivers largely influence the development of different policies in respect of land administration.

The Agenda 21 (United Nations [UN], 1992) resulting from the historic Earth Summit of the United Nations which was held in 1992 in Rio de Janeiro, highlights the importance of integrating environment and developmental concerns in fulfilling the needs of current generation without compromising the needs of the future generations. The preamble of the Agenda 21 (UN, 1992) states the most persistent global challenges that require humankind to reconsideration their relationship to land and between people themselves:

> "Humanity stands at a defining moment in history. We are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the ecosystems on which we depend for our wellbeing. However, integration of environment and development concerns and greater attention to them will lead to the fulfilment of basic needs, improved living standards for all, better protected and managed ecosystem and a safe, more prosperous future. No nation can achieve this on its own but together we can – in a global partnership for sustainable development."

The Bathurst Declaration on Land Administration for Sustainable Development (UN-FIG, 1999) identified a number of challenges related to people and land relationship. Williamson (2001) listed these serious challenges as:

- degradation of land due to unsustainable land use practices;
- lack of land for suitable urban development;
- lack of security of tenure (which in many societies impacts most severely on women and children);
- inequitable access to land by indigenous people[*sic*] and minority groups;
- access to land by women;
- destruction of bio-diversity;
- lack of adequate planning and of effective land administration;

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- tensions between environmental conservations and development; and
- impact of market forces on traditional economies and tenure.

Williamson (2001) states that the next generation of land administration systems must be developed to deal with the complex relationship between people and land. For years, the focus on land administration reform projects has been centred upon the delivery of access to land, security of land tenure and efficient land markets. It is further argued that even though these projects have, to some degree, considered environmental and sustainable development aspects, but chiefly focused on economic aspect land administration. The Bathurst Development on Land Administration for Sustainable Development (UN-FIG, 1999) established a connection between land administration and sustainable development. It is further provided in the Bathurst Declaration that "most land administration system today are not adequate to cope with the increasingly complex ranges of rights, restrictions and responsibilities in relation to land, which are influenced by such factors as water, indigenous land use, noise and pollution...". Land administration and land information systems need to be refined to deal with the ever-evolving humankind-land relationships. Williamson (2001) states that many of these systems are still based on the old limited paradigm of land administration with a sole focus on the land registration and cadastral surveying and mapping components of land administration. The new paradigm is said to be required. In response to this requirement, Enemark et al., (2005) offer the so-called '*Land Management Paradigm'* as a broad conceptual model to help improve the understanding about the manner in which land administration and sustainable development are linked.

2.4 Land management paradigm

In order to understand the role of modern land administration, one needs to place the land administration system within the context of a larger, fully integrated land information infrastructure that provides all parties involved with relevant land information to perform their duties. The land management paradigm improves the understanding about how the land administration components interact with one another to deliver sustainable development. Figure 3 illustrates the land administration paradigm.

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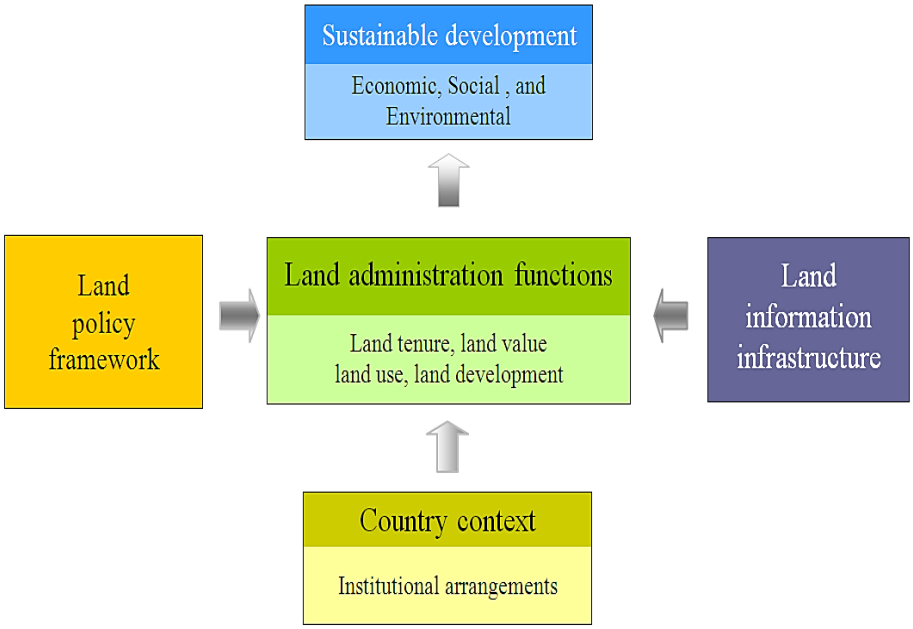

Figure 3. The Land Management Paradigm (Enemark et al., 2005)

A land policy is part of a national policy that provides objectives related to environmental sustainably, economic development, social justice, and equity. Land policy infrastructure is made up of land policies associated with security of tenure, land markets, real property taxation, management and control of land use, natural resources and environment, the provision of land for the poor, and management of land disputes.

In the land management paradigm, land tenure, land value, land use and development are described as operational functions of land administration. These functions ensure proper management of rights, restrictions and responsibilities and risks in relation to property, land and natural resources. Four functions of land administration are distinguished (Enemark et al., 2005). Williamson et al. (2010) describe each of the four functions:

- *Land tenure* deals with "securing access to land and inventing commodities in land and their allocation, recording, and security; cadastral mapping and legal surveys to determine parcel boundaries, creation of new properties or alteration of existing properties; transfer of property or use from one party to another through sales, lease or credit security, and management and adjudication of doubts and dispute regarding land rights and parcel boundaries".

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- *Land value* entails the "assessment of the value of land and properties, the calculation and gathering of revenue through taxation, and the management and adjudication of land valuation and taxation disputes".

- *Land use* deals with "the control of land use through adopting of planning policies and land-use regulations at the national, regional and local level, the enforcement of land-use regulations; and the management and adjudication of land use conflicts".

- *Land development* deals with "building new physical infrastructure and utilities: the implementation of construction planning; public acquisition of land, expropriation; change of land use through granting of planning permissions, and building and land use permits; and the distribution of development costs".

Enemark et al., (2005) provide that the four functions of land administration (as illustrated in the diagram in Figure 3) are facilitated by appropriate information infrastructures that include cadastral and topographic datasets. Such infrastructures provide access to complete and up-to-date information about the built and natural environment. Williamson et al., 2010 believe that land information should be organised in this fashion via a Spatial Data Infrastructure (SDI) at various levels, based on relevant data sharing, cost recovery, access to data policies and data models and standards. It argued that land tenure rights and land use rights, planning and land use controls are not treated as interrelated to each other. Land tenure influences the manner in which land is used, land use influences the value of land, while the latter is influenced by land use as determined via zoning schemes. Land use determines the future land development through land use planning and policies (Enemark et al., 2005; Bennett et al., 2006; Kalantari et al., 2008). These problems are said to not deliver the required services due to their poor administrative procedures. Investing in the land administration related information technological development alone would not solve these challenges. The land administration functions need to be treated as a coherent whole in order to deliver efficient services (Enemark et al., 2005).

In summary, the land management paradigm provides a useful theoretical framework usable within national and global contexts to understand the relationship between humankind and land. More specifically, the model offers a broader framework to understand the interrelationship amongst the operational functions of land administration. More importantly, the model improves the understanding of the sound connection between land administration and sustainable development as identified by the Bathurst Development on Land Administration for Sustainable Development (UN-FIG, 1999).

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The land management paradigm is "the cornerstone of the modern land administration theory". The new development or refinements of land administration systems require the adoption of this theoretical framework in order to achieve sustainable development.

2.5 Land administration systems and cadastral systems

Williamson et al., (2010) describe cadastre as 'an engine of land administration systems to implement the land management paradigm'. A cadastre provides a useful way to uniquely identify every parcel of land while maintaining spatial integrity. The parcel identification provides the link for security rights in land, controlling the use of land, connecting the ways people use land with their understanding of land. Enemark et al., (2005) describe a land parcel within a cadastre as the building block of any land administration system. There are many different definitions of a land administration system. According to the United Nations (UNECE, 1996), a land administration system encompasses the "processes of recording and disseminating information about the ownership, value and use and its associated resources". Dale & McLaughlin add the regulation of land use and collection of land tax dimensions to this particular definition. Broadly speaking, a land administration system is concerned with information related to humankind-land relationship.

In a forward of book titled "*Land Administration for Sustainable Development*" by Williamson et al., (2010), Jack Dangermond describes how geographic and land information systems are connected:

> "When people think about geography they generally think about land. So it is not a great leap to see the connection between geographic and land information systems, and how they work together to achieve effective land administration. Land administration systems (LAS) in turn drive the way towards sustainable patterns of land use across the globe".

As suggested by the above quotation, the terms '*geographic information system'* (GIS) and '*land information system*' (LIS) are connected with no distinction often made between them. Some authors regard LIS as synonymous to GIS or a subset that of (Wade & Sommer, 2006; Bolstad, 2005). The historical development of the two concepts is not similar. LIS has its roots in cadastral surveying and mapping, which have been around for over decades. GIS is relatively new and dates back to the 1960s (Obermeyer & Pinto, 2008). GIS was introduced by Roger Tomlinson and later in the 1970s number of

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organizations which the GIS technology (Peters, 2008). However, GIS has its roots from geography and cartography, which have a long history.

A GIS incorporates the basic geographic and cartographic principles that underlie the spatial analysis and modelling. It embraces the Tobler's First Law of Geography which asserts that "everything is related to everything else, but near things are more related than distant things" (Tobler, 1970 cited in Obermeyer & Pinto, 2008). Simply put, what distinguishes GIS from LIS and many other information systems is its key capability to perform complex analytic functions based on geographical principles. These principles are fundamental in explaining spatial relationships, patterns and locations of people, places and things. A LIS as "a tool for legal, administrative and economic decision-making and aid for planning and development which consists on the one hand of a data base containing spatially referenced land-related data for a defined area, and on the other hand, collection, updating, processing and distribution of data" (FIG, 1996).

A land administration system deals with information about land. Such information relates to rights, restrictions and responsibilities over land including water and their geometric and/or geospatial components. Williamson et al., (2010) describe a cadastre as an engine of land administration systems and a means to implement the land management paradigm. There is no uniform definition of cadastre. However, the International Federation of Surveyors [FIG] (1995) provides one of the most comprehensive definitions of cadastre:

> "a parcel based and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities, and risks). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, ownership or control of those interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (valuation and taxation), legal purposes (conveyancing), to assist in the management of land and land-use control (planning and administration), and enables sustainable development and environmental improvement".

The design of cadastre may differ from one country to another based the origin, history and cultural development of individual countries (Enemark et al., 2005). Simply put, a cadastre is "a record that identifies the individual land parcels or properties". Figure 4 illustrates a conventional cadastral concept. The concept consists of land parcels and textual components such as title deed documents. The mapping component is a result of property boundary surveying while the textual part is a product of ownership registration arranged

according to land parcels. The 'traditional cadastre' has land parcel as its primary focus (Kaufmann, 2004). A land parcel is defined as "a piece of land with defined boundaries, on which a property right of an individual person or a legal entity applies" (Henssen, 1995).

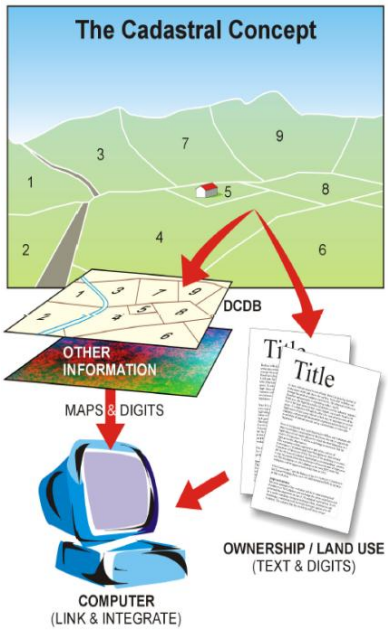

Figure 4. The Cadastral Concept (FIG, 1995)

In summary, cadastres have evolved over time in response to the changes in people-to-land relationship from merely used as registration of ownership in land for fiscal purposes through development in transfer of land and land markets, planning and land use and multiple purposes. The term 'cadastral system' is preferred instead of 'cadastre' as the cadastral system includes the interaction between the identification of land parcels and registration of land rights, the valuation and taxation of land, and the present or future use of land. Enemark et al., (2005) describe the role of cadastral systems in facilitating the administration of the three main functions of land tenure, land value, and land use.

Research has shown that the current cadastral systems implanted in different countries have not succeeded in many aspects: easy access and exchange of cadastral information within and across different countries or jurisdictions; lack of common understanding due to the difference in concepts used in different jurisdictions; lack of flexible approach to deal with non-parcel geospatial representations of ever evolving and new forms of interests in land. The global drivers of cadastral reforms such as globalization, urbanization, sustainable development, and technology require the re-engineering of the current land administration and cadastral systems in order to deliver efficient and effective land

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information services required to meet the needs of the fast-paced, increasingly complex global society. One of the key responses to the challenges of the 21st century is incorporating all humankind-to-land relationships within the modern land administration systems. This is the critical path towards responding to the objectives of sustainable development. For the property management of an increasingly limited land resource, all rights and restrictions as well as responsibilities over land require to be incorporated in these modern systems. Therefore, there is a need for development of proper models and tools that are more flexible and adaptable to the change in people-to-land relationship over time. Such models and tools should be flexible to be implementable in any country or across different countries. For example, the current cadastral models need to be expanded to deal with areas such as cadastre-less urban areas (e.g. informal settlements) and rural areas (e.g. customary areas). The implementation of the new paradigm of land management (Enemark et al., 2005) as described in the proceeding section, requires the adoption of a *toolbox approach;* instead of a *one-size-fit-all* approach.

2.5.1 Toolbox approach to land administration

There is evidence to suggest that the traditional land administration systems design models that are based on a single tool approach arranged around cadastral and land registration systems fail to deliver sustainable development objectives (Enemark et al 2010). Historically, the land administration systems (LASs) were designed to support cadastral and land registration systems in support for simple land markets. The evolution of land administration is provided in section 1.3. Modern land administration system design needs to support sustainable development. Sustainable development relies on the management of economic, social and environmental aspects of land.

Land administration systems need to move away from a single-tool approach arranged around cadastral and land registration activities to more integrated approach; as illustrated in the land management paradigm. The implementation of land management paradigm in any country should be guided by the local, regional and national circumstances of that particular country and the selection of suite of tools and options suitable in that instance. The rationale behind the toolbox approach is that the LAS design that based on a single tool approach is irrelevant in the modern LASs. The LASs need to be designed to support the complex land markets and sustainable development. The isolation of LA components from each other and reliance on single tool solution in complex situations are some of the

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major challenges related the LAS design (Williamson et al., 2010). The toolbox approach is believed to address both these challenges.

As illustrated in Table 2, the tools may be classified into three main categories: the general tools, the professional tools, and emerging tools.

Table 2. Land Administration Toolbox (Williamson et al., 2010)

General tools	• Land policy tools; land market tools • Land use, land development and valuation tools • ICT, SDI, and land information tools
Professional tools	• Tenure tools; Registration systems tools • Cadastral surveying and mapping tools • Building titles tools
Emerging tools	• Pro-poor land management tools • Non-cadastral approaches and tools

The design of any of the tools needs to reflect its integration with all the land administration functions, as described in the land management paradigm (Williamson at el., 2010). The cadastre or land information system is regarded as a number of tools within one conceptual framework. A cadastral system offers a means of integrating all administration functions using unique identifiers.

2.5.2 Incorporation of restrictions and responsibilities

The modern land administration systems need to incorporate all interests in land not just the real rights in land (e.g. real rights such as ownership, leasehold, servitudes, etc.). One of the challenges facing these systems worldwide in responding to sustainable development objectives is to move beyond the conventional practices of managing rights in property-based commodities approach to management of rights, restrictions, and responsibilities (RRRs) over land (Williamson et al., 2010). The new approach is centered upon managing people behaviors, business processes, and administration systems. These factors influence people activities in related to land. It is believed that a right is not a relationship between people and land, but a relationship between people themselves in relation to land. Such relationship in the case of legal rights is supported by the State.

Incorporating restrictions and responsibilities in LASs has become a key issue in the context of sustainable development. There is a need to incorporate all private and public restrictions and responsibilities within the LASs. A challenging question relates to how the

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records of restrictions and responsibilities should be maintained. Should the records be kept within the current land registration systems or within separate information management systems? It is argued that it is not practical to incorporate all restrictions and responsibilities within the LASs (Williamson et al., (2010). It is essential to develop flexible models and tools that allow for the registration of the RRRs within the LASs.

2.5.3 Cadastral 2014

Kaufmann & Steudler (1998) present a clear vision of the modern cadastral systems, the so called the Cadastre 2014. Cadastre 2014 provides the critical path towards the development of new cadastral models or refinement of the existing conventional models so as to enable them to effectively response to ever-changing humankind-to-land relationship. One of the primary objectives of the Cadastre 2014 is to improve information related to the legal situation of land so as to improve the security of tenure (Kaufmann, 2004). Table 3 presents the definitions of the Cadastre 2014 and the conventional cadastre.

Table 3. Evolving definition of Cadastre

Traditional Definition	**Definition of Cadastre 2014**
Cadastre: a methodically arranged public inventory of data concerning properties within a certain country or district, based on a survey of their boundaries. (UN, 1985; Henssen, 1995)	Cadastre 2014: a methodically arranged public inventory of data concerning all legal land objects in a certain country or district, based on a survey of their boundaries.(Kaufmann & Steudler, 1998)

Cadastre 2014 builds on the principles of the traditional cadastre. The traditional cadastre focused on survey based property boundaries as reflected in Hansen's (1995) definition while in the content of modern cadastre; properties are replaced by an inclusive concept of legal land objects used in the Cadastre 2014 vision. In this context, properties can correctly be considered as one part of legal land objects. The legal land objects are normally "described by boundaries which demarcate where a right or a restriction ends and where the next beings and the contents of that right". Examples of legal land objects are: the *"private property parcels, areas where traditional rights exist, administrative units such as countries, states, districts and municipalities, zones for the protection of water, nature, noise,… land use zones"*, etc.

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The future cadastre will not only comprise of the land parcels rights and other property assets, but all legal land objects with associated rights, restrictions and responsibilities (RRRs). This is presented in the first statement on Cadastre 2014 in Table 4.

Table 4. Six Statements on Cadastre 2014 (Kaufmann & Steudler, 1998)

Statement 1:	Cadastre 2014 will show the complete legal situation of land including public rights and restrictions!
Statement 2:	The separation between 'maps' and 'registers' will be abolished!
Statement 3:	Cadastral mapping will be dead! Long live modelling!
Statement 4:	The paper and pencil cadastre will be gone!
Statement 5:	Cadastre 2014 will be highly privatized! Public and private sectors are working closely together!
Statement 6:	The cost of Cadastre 2014 will be recoverable!

Kaunfmann (2004) states that the most important statement on the Cadastre 2014 is statement 1. With the rapid growth in population, the increasingly limited land resource has become restricted by public interests. It is argued that in order to provide security of land tenure, all records about land must be incorporated in the future cadastral systems. Therefore, the modern cadastral systems need to incorporate not only private rights and restrictions, but also all public rights and restrictions over land. This will improve the security of land tenure. The different legal land objects are to be arranged in accordance with the laws by which they are defined. This permits instant amendment of the cadastre to the development of legislation. New legal matters can be incorporated as additional layer of information without necessarily rearranging the information. The modern cadastral system will no longer be based on land parcel, but will consist of different land objects defined by various legislations within a given jurisdiction. Since the land objects are defined geographically using a common reference system, impacts of restrictions on a specific property may be identified through geographic overlay technique when needed.

The second statement on Cadastre 2014 highlights the role of technology in integrating geometric (i.e. maps) and land registration information. In the future cadastral systems, there will be no need to operate separate business models for map production and land registration. The developments in information technology allows for the integration of land objects directly with the information required for registration models. Land objects in the future cadastral systems can be described by geometric and alphanumeric parameters.

The role of maps as analogue representations and information repositories diminish with their purpose only remaining as a representation of information. The data models and modeling languages such as the Unified Modeling Language (UML) in cadastral domain need to be implemented using appropriate information systems.

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Kaufmann (2004) developed ten principles on Cadastre 2014, of which seven apply to the Land administration Domain Model (LADM):

- *Principle of spatial units*: The land parcel of a traditional land administration system should be extended to include and administer all spatial units having some social, legal or economic relevance.

- *Principle of the documentation of private and public rights, restrictions and responsibilities*: It is provided that all other rights, restrictions and responsibilities established by different pieces of legislation having an impact on land shall be registered over and above just mere registration of ownership right.

- *Principles of legal independence:* In the development of new or refinement of land administration systems, it is necessary to investigate the laws in a jurisdiction so as to identify those laws with an effect on land.

2.5.4 3D Cadastre

In recent years, the 3-dimensional (3D) representation of cadastral information has been accepted as an effective way of dealing with administration of space. 3D cadastre intends to address the shortfall of the existing 2 dimensional (2D) cadastre. The increasingly complex urban spaces render the existing 2D registration of rights and other interests inadequate. There is an increasing number of research studies in 3D cadastre focusing on various key elements (e.g. institutional, technical, cost-benefits analysis of 3D cadastre) related to 3D cadastre implementation worldwide (Van Oosterom, 2013; Van der Molen, 2003; Griffith-Charles & Sutherland, 2003; Stoter et al., 2013; Stoter & Ploeger, 2003). Griffith-Charles & Sutherland (2003) analysed the costs and benefits of the 3D cadastre in Trinidad and Tobago. Stoter et al., (2013) studied the 3D cadastre development and application in the Netherlands. The study deals with inclusion of 3D registration of rights and restrictions based on the ISO 19152 LADM which does not require any amendments in the legal framework. The scope of work included adding 3D recordation in 3D PDF format in the property transfer deed and the actual addition of the 3D data in the registration (Van Oosterom, 2013). Stoter et al. (2013) explored the possibility of incorporating the 3D registration of rights and restrictions in the cadastral system implemented in the Netherlands. The results of the study have shown that it was possible to incorporate the 3D cadastre in the Netherlands land registration system. However, it is maintained that more

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understanding would have to be derived from analysis of the information held in the land and cadastral registers. Aien et al., (2013) examined the integration of the 3D legal and physical objects in cadastral models. Van Oosterom (2013) highlights a need for the development of a formal semantics in 3D cadastre domain to address current confusion in terms of terminology and key concepts in 3D cadastre. The ISO 19152 LADM provides a framework upon which ontology in 3D land administration should be based.

2.6 Land administration modelling

The vision of Cadastre 2014 calls for the development of cadastral models. Cadastral data modelling is an important method of sharing information amongst various organisations involved in land administration (Williamson et al., 2010). In order for a cadastral data model to be effective, the model must describe not simply what appears to be data, but also what is fundamental to a business. Most of the efforts to build a data model follow the classic cadastral concept. However, recent efforts place emphasis on the incorporation of flexible and informal land arrangements within the model more particularly social tenures. This flexible approach supports the Millennium Development Goals (MDGs) associated with securing tenure for the millions of people living under informal tenures.

2.6.1 Modelling people and land relationship

As it was already stated, land administration is basically about dealing with information related to people and land relationships. The people-to-land relationship is dynamic and continues to evolve over time in response to the changes in society. The global drivers of change are well known: sustainable development, globalisation, urbanisation, economic reform, and technology (Williamson & Ting, 2001). Tin &Williamson (1999) illustrate the evolution of people-to-land within the European context through the feudalism, the industrial revolution to the information revolution.

Henssen (1995) presents what is described as '*an object-right-subject model'* to illustrate the 'man-land' relationship, as shown in Figure 5.

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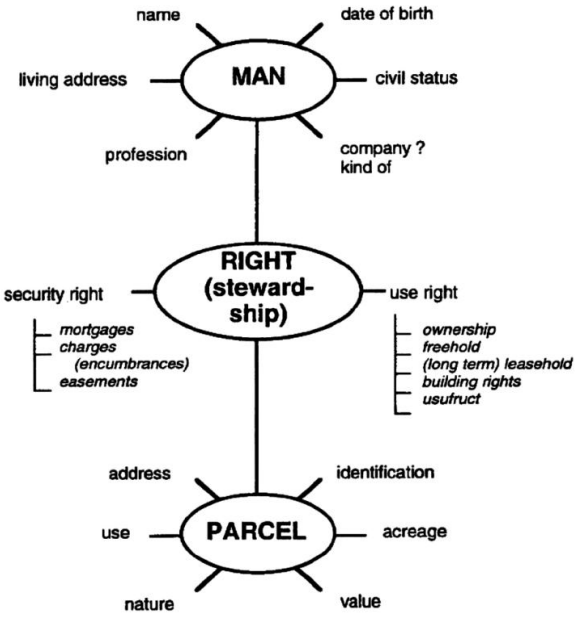

Figure 5. The Triple 'Object –Right – Subject' (Henssen, 1995).

Hessen (1995) illustrates the relation between a man and parcel via a right. The model describes information associated with a man, the categories of rights (use right, security right) and information associated with parcel (identification, address, acreage, value, nature, and use). This model illustrates simple people-to-land relations from the perspective of formal land registration system based on cadastral or parcel-based land information system. Therefore, the model illustrates land parcel as the only spatial unit that can be hold by a man through various types of rights (stewardship). Land registration and cadastre complement each other. Land registration focuses on the relation *subject-right*, while cadastre deals mainly with *right-object.* Land registration answers questions relating to '*who and how'* while cadastre answers those relating to '*where and how much'.*

Henssen (1995) uses an analogy of 'a *three-legged stool*" to describe the interrelation between land registration and cadastre: one leg representing legal data, one physical or thematic data, and one surveying data. This interrelation is dependent on the cooperation between register, notary [and conveyancers] and surveyor in order to obtain authoritativeness, completeness and (legal) validity of the system. The notary is responsible for the correctness of the documents to be presented to the register; the surveyor is responsible for a correct and workable identification of the real properties being object of the right and the registrar is responsible for land records, more precisely for

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their aim to contribute to a correct picture of (legal) situation of the real properties. Mattson (2004) presents the *object-right-subject* model as shown in Figure 6.

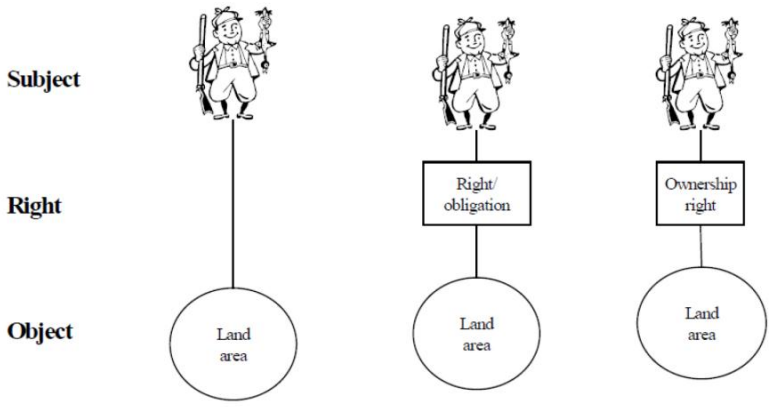

Figure 6. Subjects and object connection (Mattsson, 2004)

The model illustrates a direct link between object and subject through a right or an obligation and a connection via ownership right. Kalantari et al., (2008) acknowledge the role of land parcel as a basic building block in conventional land administration system to identify the areas related to interests in land. However, the authors argue that extent of interests in land is not necessarily equivalent to the exact extent of a particular land parcel. It may apply to a several land parcels or portion of a parcel. This implies that land parcels are not flexible enough to accommodate growing categories of interests in land that are not parcel-based. It is further argued that indexing for organising information is through the parcel identifier which does not support non-spatial identifiers. In traditional land administration systems, interests in land are associated with private rights and associated restrictions such as mortgages, servitudes, and caveats. However, the nature of interests in land has increasingly become more diverse than those held in land registries. The LASs have so far focused on more on the private interests than public interests in land.

The relation between interest and its spatial dimension is that they are a unique entity in real world. For purposes of spatial identification, any kind of interest whether a right or a restriction, has the same logical structure. This implies that RRRs are not seen as a separate entity or class. Lemmen (2012) opposes this method of modelling by arguing that the RRRs can be defined in legislation; there can be shares, and there can be different organisations with responsibilities in maintaining the attributes of a legal property unit.

2.6.2 Marine cadastre: marine property rights model

As already defined, land include also the body of water not only the dry surface of the earth, the air above and material below the surface. In this context, it is proper to examine how "the submerged lands found in relatively large bodies of water" (i.e. lakes, sea, and ocean) can be modelled. Ng'ang'a et al., (2004) present what is described as a 'marine property model' as useful model in recording of the interests in marine cadastre (Figure 7)

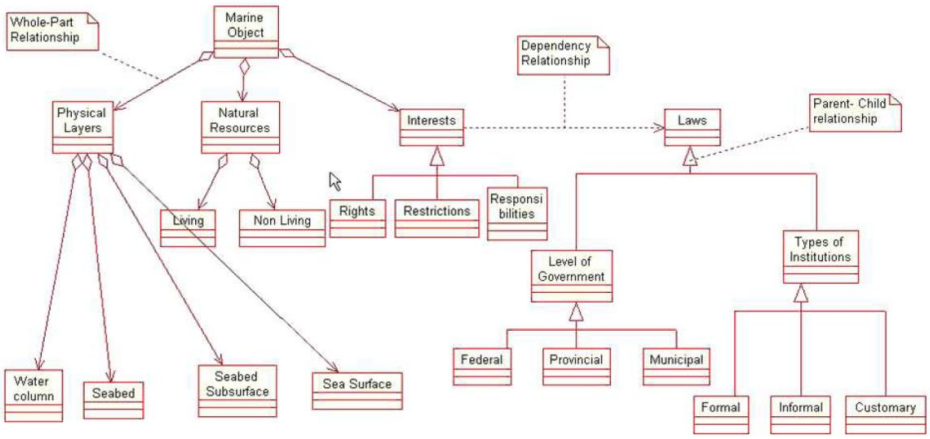

Figure 7. A marine property model (Ng'ang'a et al., 2004)

The authors defined a *marine cadastre*, in a broad sense: "an information system that allows rights in marine space to be defined, recorded, visualised and managed". The marine cadastre facilitates the recordation and visualisation of private and public rights, restrictions and responsibilities. The authors hypothesized that either the "multidimensional marine parcel that can be used as the basic reference unit in marine cadastre or a series of marine parcels that can be used as basic reference units for gathering, storing and disseminating information". As illustrated in Figure 7, the marine property rights model presents a marine parcel object dealing with the data collection, storage, and retrieval on marine interests. The core elements of marine environment are presented in the model. The marine parcel object is the core class. It consists of different layers (i.e. water surface, water column, seabed and subsurface), living and non-living resources, and interests (i.e. existing rights, restrictions or responsibilities). The categories of interests defined in law and may include the following examples: fishing rights as defined in legislation, informal (e.g. right to swim) and customary (e.g. Aboriginal fishing rights), etc. The categories of marine rights include: navigation rights, riparian rights, seabed use rights, mineral rights, development rights, and public access rights (Sutherland, 2001). Most of these rights are 3D in nature and cannot effectively be represented in 2D.

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2.6.3 Cadastral data standards

The USA Cadastral Data Content Standard is a standard for cadastral data. The standard was developed incrementally since 1990 with its initial version called the 'Cadastral Data Content Standard' (CDCS). As shown in Table 5, the standard offers the semantic definitions of objects related to land surveying, land records, and landownership information. It aim is to facilitate the exchange of information at various levels of government, including private sector organisations. The classes and attributes of the CDCS may be organised into generalised groups of classes.

Table 5. Comparison between the USA Cadastral Data Content and LADM

USA Cadastral Data Content Standard	ISO 19152, LADM
Agent	*LA_Party*
Transaction Agent	partyRole *(an attribute of LA_Party)*
Parcel Legal Area Description	LA_SpatialUnit area *(an attribute of LA_SpatialUnit)*
Record Boundary Corner	LA_BoundaryFaceString LA_Point
Rights and Interests	*LA_RRR* (LA_Right, LA_Restriction & LA_Responsibility)
Restriction	LA_Restriction
Transaction Document	*LA_AdministrativeSource*

In USA Cadastral Data Content Standard the following concepts were defined:

> *An* Agent *is an individual, organisation or public agency that holds rights, interests or restrictions in land, holds or files land records, or has established a land description, a co-ordinate value or a monument.* The LADM uses a more generic Party concept instead an agent or person, to describe people (natural and non-natural), involved in land transactions.
>
> *A Transaction Agent is any participant or party identified in a land record document or instrument. One attribute has a* role *here, e.g. grantor, grantee, leaser, lessee, trustee, mortgager, and mortgagee.* In the LADM, *roleType* which an attribute of LA_Party describes types of roles different parties can play in land transaction and maintenance of land administration information.
>
> *Rights and Interests are related to a parcel. Rights and Interests can be below ground, such as mineral rights, simple ownership on the surface, an easement for*

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hunting or grazing or an above right such as transferable development right. In LADM *LA_RRR* superclass supports the recordation of rights and Interests in land.

The Right and Interest are distinguishable from a Restriction, which is a limitation placed by a governing body and is not in the chain of title. Restriction captures information related to administrative, judicial, or other limitations or permissions for the use and enjoyment of land by the land right holder or rightful claimant. In the LADM, the LA_Restriction class captures the private and public restrictions associated with the land.

A Parcel *is a single cadastral unit, which is the spatial extend of the past, present and future rights in real property.* In the LADM, the SpatialUnit class is used to allow not only the recordation of land parcels but all other types of spatial units.

A Record Boundary is the linear feature that represents the edge of a feature, which may be a parcel or a legal area. A record boundary is the information for each boundary segment. All boundary features come from the same source and have the same units of measure. In the LADM, the LA_BoundaryFaceString is used to describe the boundary of spatial units.

A corner is a legal location. It may mark the extremity of a Parcel or a Parcel Legal Area. A Corner may have multiple Corner Points, which serve as measures of markers for the location of the Corner. A Corner Point is a point feature, which marks the ends of Record Boundaries or the extremities of a legal area. A Corner Point may or may not be monumented and any representation of a Corner. In the LADM, the LA_Point is used as opposed to 'Corner' to represents the point-based spatial units (i.e. X,Y co-ordinates).

A Legal Area Description provides the structure for assembling the components of a single legal area into one. The components of the Legal Area Description can be used to build legal descriptions based on areas.

A Transaction Document is the record of the transfers of rights in land. Transaction Documents are often recorded in instruments, but it is not a requirement in most parts of the US that transactions should be written. In the LADM, the LA_AdministrativeSource is introduced to support all documents associated with land transactions (i.e. title deed, deed of transfer, mortgage, etc.)

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2.7 Land Administration Domain Model (LADM)

Cadastral systems differ more particularly in respect of their land registration components (i.e. the deeds system and the title system). Research has shown that cadastral systems implemented in different countries and jurisdictions have not been able to provide a meaningful communication between involved parties within one country and across countries. The current systems are differenced on whether they are based on deeds or title registration approach, fixed or general boundaries approach, legal or fiscal background, multi-purpose, and so on. However, cadastral systems are in principle the same in that the systems are all based on people and land relationship. Such relations may be formal and informal in nature. The formal relationship is, in principles, registerable in land registration systems of deeds or title and they are governed by different countries' legal systems. On the other hand, the informal relationships are unregistered and governed by the customs and unwritten traditions. Moreover, the cadastral systems are aimed at keeping the content of the relationship up-to-date. One of the key challenging factors has been the lack of shared concepts between various parties in land transaction such as surveying, conveyancing, land use management and land development.

In the land administration domain, the ISO TC211 has recently published a standard for modelling basic land administration information associated with rights, restrictions and responsibilities and their (geo)-spatial or geometric components (ISO 19152, 2012). The standard is known as the Land Administration Domain Model (LADM). The LADM is an international standard data model developed by the International Standardization Organisation (ISO) under Technical Committee 211 for *Geographic information/Geomatics*. The aim of this spatial domain model is to improve communication through introducing a standard vocabulary in the land administration domain. It is intended to improve interoperability between cadastral or related information systems, thus improving the exchange of land information between local, national and international organisations, and information society at large.

The idea of developing a domain model for land administration originated from the FIG Congress in Washington, United States of America in April 2002. The earliest version of the domain model was named the Core Cadastral Domain Model (CCDM). This version was followed by a number of later versions after a number of reviews with the experts in the land administration field (Van Oosterom & Lemmen, 2003; Van Oosterom & Lemmen, 2003; Lemmen et al., 2003; Lemmen et al., 2005; van Oosterom et al., 2006a). Since its

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inception, various research efforts have been undertaken to explore the applicability of the LADM to different countries and jurisdictions. The country profiles of LADM have been created in countries like Portugal, Australia, Japan, Indonesia, and Queensland (Lemmen et al., 2011). Other work includes the integration of the LADM with the European Land Parcel Identification Systems (LPIS) and Social Tenure Domain Model (STDM) has been created by UN-HABITAT. The LADM SpatialUnit package has been used in the INSPIRE Data Specification on Cadastral Parcel. The Social Tenure Domain Model (STDM) supports areas falling outside the formal tenure and cadastral systems, such as informal settlements and rural areas governed by customary laws and traditional practices. In Japan, Portugal, Indonesia, Tanzania, Trinidad and Tobago, and other European countries, studies were carried out to investigate the use of LADM in their respective land administration systems (Augustinus et al., 2006; Ary Sucaya, 2009; Hespanh et al., 2006; Devos et al., 2010; Griffith-Charles, 2010). Several country profiles have been created some of which are included in an annex of the ISO 19152 LADM.

The Social Tenure Domain Model (STDM) can be described as a subset of the LADM. The STDM is intended to deal with the security of tenure of people in slum areas or customary areas that relies on forms of tenure different from individual freehold or other formal land rights (Lemmen, 2010). The STDM accommodates relationship between people and land that are not registerable in formal land administration systems. The STDM supports the UN-HABITAT's (2008) concept of continuum of tenure types.

The rationale behind the concept of social tenure domain and the continuum of tenures is centered on the premises that all relationships between people and land be represented and recorded. The conventional land registration systems do not deliver security of tenure for many people living in informal settlements, rural, or customary areas. The STDM aims to address this challenge through the recordation of the social tenure rights.

Figure 8 illustrates the continuum of land tenures from the informal land rights through intermediate tenures (e.g. customary, occupancy, anti-evictions, group tenure, to a formal land rights (registered freehold).

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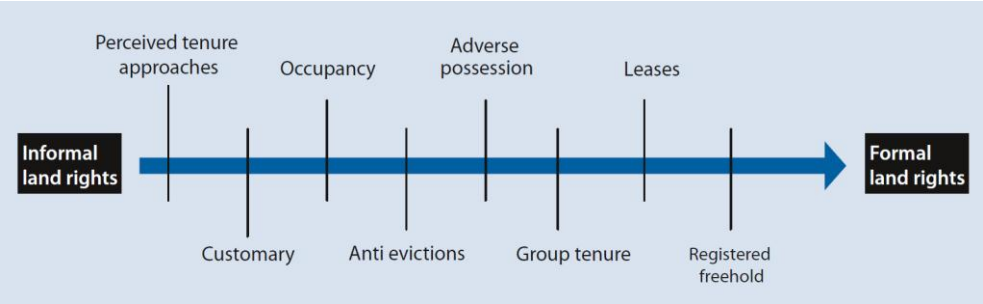

Figure 8. The continuum of tenure types (UN-HABITAT, 2008)

The STDM provides a new way of thinking that goes beyond the established conventional land administration approaches (UN-HABITAT, 2008). The STDM facilitates the recording all forms of land rights, all types of land rights holders and all kinds of spatial units. The STDM relates personal identifiers (e.g. figure-prints) to accommodate point inside a plot of land through a social tenure relation such as customary or tenancy. The STDM deals with land rights that neither registered nor registerable. For example, overlapping claims, anti-evictions in the formal legal systems. Therefore, the model supports the registration of the social tenure relationships as embedded in the continuum of the land rights concept. This concept is promoted by the Global Land Tool Network and UN-Habitat. The STDM supports a variety of spatial units. For example, a piece of land which can be represented as one point, a set of lines, as a polygon with low or high accuracy coordinates, as a 3D volume. The STDM also records all categories of right holders: individuals, groups of people such as tribes, companies, and municipalities.

The goal of Open Source Cadastral and Registry (OSCAR) is to, as outlined in the OSCAR's website (OSCAR, 2013), *"develop software that is easily deployable, maintainable, adaptable and evolvable in support of land administration and other official record keeping activities".* The project resulted in a number of related publications (Hay & Hall, 2011; 2010a; 2010b; Hay *et al.*, 2008). Figure 9 illustrates a high level design of the OSCAR conceptual data model for land administration.

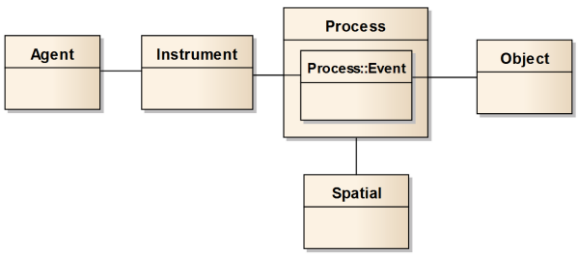

Figure 9. The OSCAR Conceptual Data Model (Hay & Hall, 2009)

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In the OSCAR model, an agent class is concerned with the description of people, banks, governments, etc. The *instrument* class (e.g. title document) records information about the state of interests (i.e. creation, state, and change in state of the interests). All instruments 'define the ontology of land administration for that country'. An *Instrument* class is the core class in the OSCAR model. An instrument is a document associated with land registration administration and land surveying. The instrument class links agents to objects such as a land parcel or building, an easement, a right of way through *events* or *processes*. The processes include the construction of land parcels and land registration workflows.

2.7.1 The packages of LADM

The LADM is abstractly organised using the Unified Modelling Language (UML) into three packages related to parties (i.e. people and organisation), rights (e.g. ownership, use rights, including customary and informal land rights), restrictions and responsibilities and spatial units (parcels, customary areas, buildings and networks) (Lemmen et al., 2011). The three packages of the LADM are: Party package, Administrative Package and Spatial Unit Package. The subpackage of the Spatial Unit package is the Surveying and Spatial Representation. The core LADM is based on the classes: LA_Party class (instances of this class are parties), LA_RRR abstract class (instances of subclasses of LA_RRR are rights, restrictions or responsibilities), LA_BAUnit class (instances of this class are basic administrative units) and class LA_SpatialUnit (instances of this class are spatial units). The packages of LADM are shown in the Figure 10.

The LADM packages facilitate the maintenance of different data sets by different organisations, each with their own responsibilities in data maintenance. For example, a land registry office (e.g. deeds or tiling office) may have with a responsibility for maintaining the formation pertinent to land ownership or other rights in land while a cadastral information office be responsible for the maintenance of spatial data related to the boundaries defining the extent of rights, restrictions and responsibilities (RRRs) registerable in the land registry office. These responsibilities can be allocated at national, regional and local levels. The packages of the LADM support the development of the Spatial Data Infrastructure (SDI) at various levels.

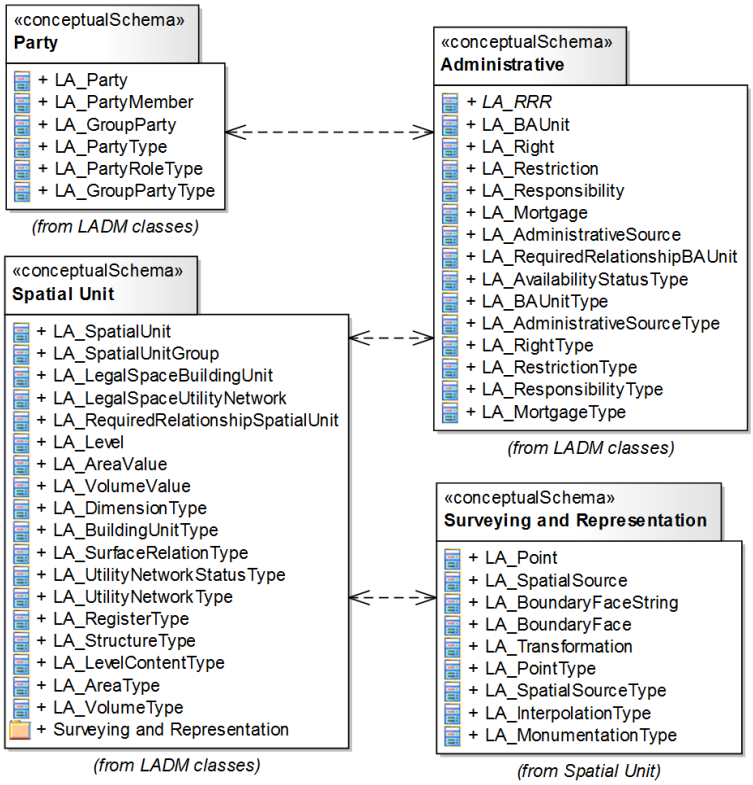

Figure 10. LADM overview (ISO 19152, 2013)

2.7.2 The basic classes of LADM

During the development of the LADM the three core classes; 'Person', 'Right' and 'Parcel' were included with terminology changing and not the actual meaning. The Person class name changed into 'Party' class. Right has been changed into '*RRR*' and the 'Parcel' into "SpatialUnit". The core classes of the LADM were derived from Henssen (1995) and from FIG's Cadastre 2014 (Kaufmann & Steudler, 1998). This means that land ownership of parcels in traditional cadastres has been extended in the LADM to include and administer all spatial units, which have some social, legal or economic relevance. This makes the LADM to be a more generic model. In the original LADM class diagram, the classes 'Person' and 'Parcel' ('RealEstateObject) were associated with class *RRR* as an association class. The association class "RightOrRestriction" was replaced by two associations: (1) between class "RightOrRestriction, and (2) between class "Person" and class "RightOrRestriction. The main reason for this design decision was to make it possible for a unique combination of a specific 'Person" with a specific "RegisterObject'. Multiple RRR instances can be associated land; for example one expressing an ownership and the other restrictions or a certain responsibility. This was not possible in the construction with association class "RightOrRestriction' (van Oosterom et al., 2006).

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The ISO Technical Commission 211 agreed that there was a need for the introduction of the so-called "Basic Administrative Unit", between the class LA_RRR and LA_SpatialUnit. This allows for the introduction of the so called a "Basic Property Unit". UNECE (1996) defines a "Basic Property Unit" as:

> "the extent of the land that is one unit of ownership is referred to as the basic property unit (BPU). It consists of one or more adjacent or geographically separate parcels. A farm, for example, may have a number of fields that are in different locations but together they constitute one BPU. Likewise, a house may have a garage on a separate piece of land".

In the LADM, the Basic Property Unit is called a Basic Administrative Unit (abbreviated as 'baunit). The Baunit is a more generic term. The LADM does not only deal with recordation of ownership and leasehold but also other types of people-land relationships. For example, customary and informal types of land use. This resulted in four core classes (LA_Party, LA_RRR, LA_BAUnit and LA_SpatialUnit).

The LADM has three conformance levels: lower, medium, and high levels. An application schema claiming conformance must comply with at least one of the levels. In this dissertation, the first conformance level will only be examined. The first conformance level consists of the basic classes of the LADM: LA_Party, LA_RRR, LA_BAUnit and LA_SpatialUnit, LA_Right which is a subclass of LA_RRR, VesionedObject class, and LA_AdministrativeSource which is a subclass of a special abstract class *LA_Source.* Figure 11 presents the basic classes of the LADM for conformance level one.

2.7.3 LA_Party class

The LADM describes information that should be provided for various types of parties in land transaction. The basic LADM party class provides the attributes: the external identification of party (extPID) in an external registration or database; the identifier of a party (pID); name of the party (name); type of a party (type), and role of the party (role). These are basic information that the party class should have in order to comply with the first level conformance requirements of the LADM party class.

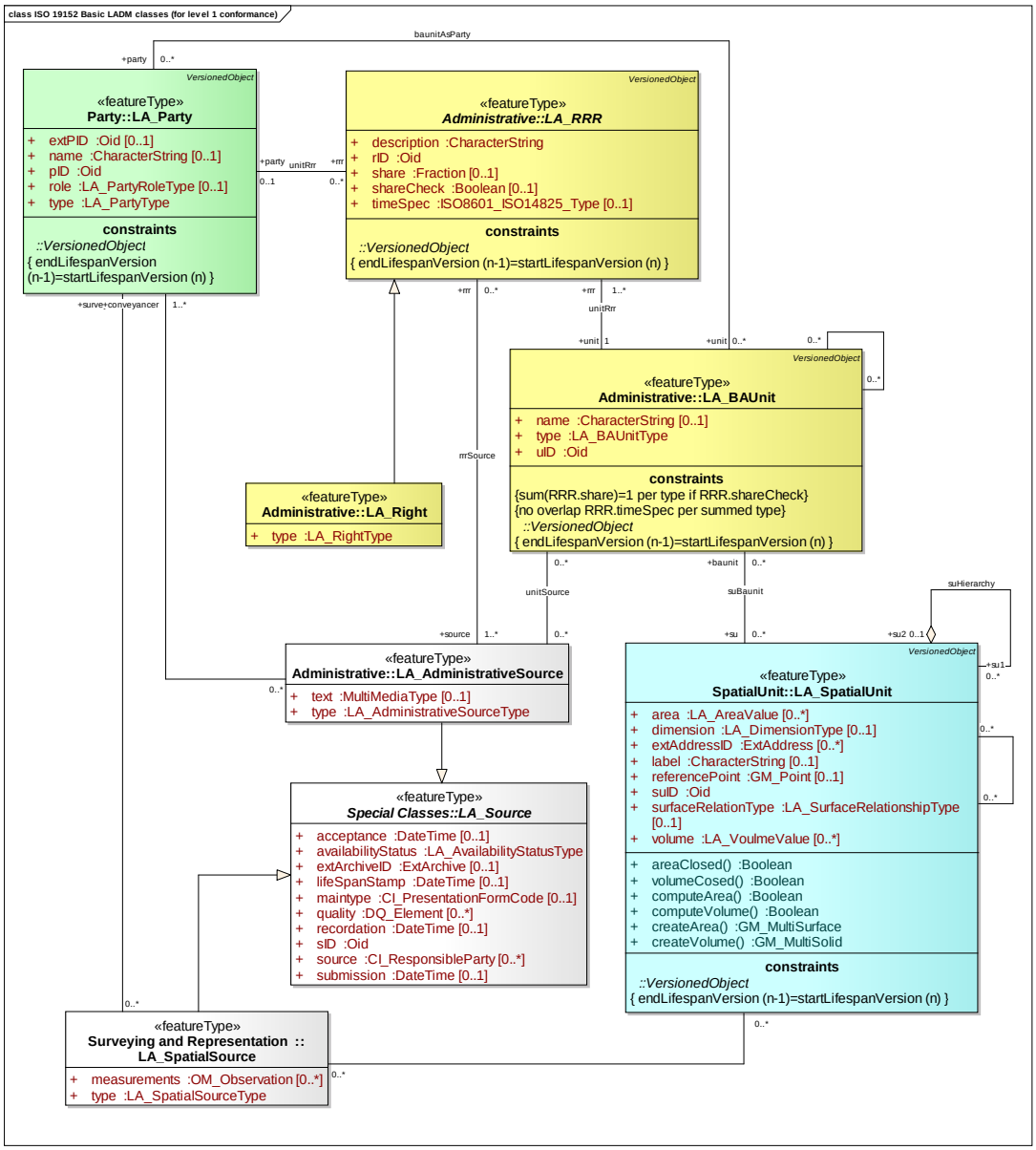

Figure 11. First Level conformance LADM classes with the SpatialSource class

2.7.4 *LA_RRR* class

The relationship between persons and land is represented in the LADM using the abstract class with its name abbreviated to *LA_RRR* (*LA_Right*, *LA_Restriction* and *LA_Responsibility*). A party may hold *RRR* over a piece of land, either formally or informally. The right is the most important and direct relationship that a party can hold over the land. The *right* is basically an entitlement that gives the holder a right to do something over a specific piece of land covered by the right. For example, a right to use,

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to enjoy the fruits of the land (e.g. rent the land), to convey the right to another party, etc. *Restriction* limits a party holding the right from doing as he/she pleases with the land. Restrictions may be imposed through both private property law and/or public property law administered by public authorities. Restrictions can be private in nature, for example servitudes. Restrictions can be public as in the form of zoning, for example land use zone permitting or not allowing a specific use on a given property land parcel. Other planning restrictions and environmental limitations can be imposed on specific land owner(s) or properties. A responsibility requires the holder of a right to perform something in relation to the land. For example, a law may make it compulsory for the erection of fence for a farmland by a farm owner as provided by the Agricultural Land Act in South Africa.

The attributes of *LA_RRR* are *description* (description regarding the right, restriction or responsibility), rID (The RRR identifier), share (a share in an instance of a subclass of *LA_RRR*), shareCheck (indicates whether the constraint in class LA_BAUnit is applicable) and timeSpec (operational use of a right in time sharing). Attribute timeSpec is capable of handling other temporal descriptions, such as recurring patterns (every week, every summer, etc.). This means that a party can hold a right to use an apartment each year in April, or that a group of pastoralists has the right to cross a field each summer. An instance of class LA_Right is a right. LA_Right is a subclass of class LA_RRR. A right may be associated to zero or more [0..1] mortgage (s) (i.e. a mortgage is associated to the affected basic administrative unit but it may also be specially associated to the right which is the object of the mortgage). The attribute of LA_Right class is type.

There is always at least one instance of LA_Right (subclass of RRR) in which the type of right represents the strongest primary right, for example, ownership, freehold or leasehold.

2.7.5 LA_BAUNIT class

The instances of LA_BAUnit are basic administrative units. Basic administrative units consist of zero or more spatial units against which (one or more) unique and homogeneous rights, responsibilities or restrictions are associated to the whole entity. The LA_BAUnit contains a constraint expressing that the sum of shares in a subclass of *LA_RRR* must be equal to 1. This implies that parties can hold a share in a right, restriction, or responsibility.

2.7.6 LA_SpatialUnit (with LA_Parcel as alias) class

The LADM supports different types of spatial representation: a ‘sketch-based (a quick drawing, sketch maps and photographs), a text-based, a point-based, a ‘line-based

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("unstructured or spaghetti), a polygon based and a topology based spatial units. The range of rights generally cannot be described in relation to a parcel; hence the LADM supports the implementation of new forms of spatial units as described. The 'Spatial Representation and Survey' subpackage allows representation of spatial units 2-dimensional (2D), 3-dimensional (3D) or mixture of 2D and 3D. The Spatial units can be grouped in two forms: as spatial units groups or as sub spatial units. The Spatial units have two specializations: building units (class LA_LegalSpaceBuildingUnit) and utility networks (class LA_LegalSpaceUtility Network).

The LADM supports the implementation of the Cadastre 2014 principle of "*legal independence*" by introducing a class level. The different spatial units may be arranged according to the laws by which they are defined. One level may represents spatial units reflecting the formal rights as described in civil code such as freehold, leasehold and servitudes. If spatial units are based on local regulations (e.g. municipal regulations) there can be another level for this. This may be valid for all municipalities within a territory. Further levels can be related to regulations developed by other government institutions.

For the conformance level 1, the LA_SpatialUnit class must be implemented from the SpatialUnit package. Therefore, the other classes of SpatialUnit package will not be dealt with, as the research is limited to the conformance level 1 of the LADM classes.

CHAPTER 3 SOUTH AFRICAN LAND ADMINISTRATION

3.1 Introduction

The purpose of this chapter is to describe the land administration in South Africa using the conceptual framework developed by Enemark (2005); the land management paradigm. The chapter examines the South African land policy framework, land administration functions, and land information infrastructure. This chapter provides an overview of the South African land administration using the land administration paradigm as conceptual framework to put the discussion into perspective. The institutional arrangement, the land policy, land tenure with particular reference to real rights and limited real right (i.e. restrictions on ownership), private and public restrictions on land, and other forms of land tenure such as customary land tenure and permission to occupy land are discussed. The chapter also presents the South African land administration functions of land value and taxation, land use and development together with the challenges facing these functions. The chapter also presents an overview of the South African land information infrastructure with a special reference to South African cadastral and land registration systems. The key challenges facing these systems are also examined.

3.2 South African land administration

3.2.1 Institutional arrangement

South Africa's Constitution established three distinctive, interdependent and interrelated spheres of government constituted as national, provincial, and local spheres of government (Constitution of South Africa, 1996). Each sphere has a defined range of functions that are either exclusive or shared with other spheres. The national sphere of government is exclusively responsible for the national defence, home and foreign affairs, the criminal justice system, water and energy resources, and tax collection. The national government is responsible for policy formulation and regulatory frameworks including norms and standards and overseeing the implementation of these functions.

South African Constitution places the deeds registration, land survey, and land reform functions as the responsibility of the national government. This includes the key elements of land reform: redistribution, restitution, and tenure reform. The Department of Rural Development and Land Reform (DRDLR) is responsible for the land tenure system (security of tenure and registration of rights). The Surveyor-Generals' offices of the DRDLR is responsible for examining and approving of all cadastral surveyors, compiling

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and maintaining of plans showing relationship of the various parcels of land to each other (Department of Rural Development and Land Reform [DRDLR], 2011). The Registrar of Deeds' offices of the DRDLR maintain public land registries. The DRDLR is responsible for the registration of real rights in land, and other documents tendered for registration and maintain records of all registered rights over land parcels. The deeds registration function is administered through the Deeds Registries Act (Act No. 47 of 1937) and the Sectional Titles Act (Act No. 95 of 1989). The Deeds Registration Regulation Board and the Sectional Titles Regulation Board are created in terms of these Acts.

The provincial sphere of government is also responsible for a number of functional areas closely related to land reform in areas where national and provincial governments have concurrent responsibility in terms of Schedule 4 of the Constitution. These areas include agriculture, environment, housing, regional planning, and urban and rural development.

The local sphere of government consists of over 280 municipalities. The municipalities deal with growing local economies and providing infrastructure and services such as water, sanitation, electricity, waste management, roads and disaster management etc. In terms of land administration, the municipalities are mandated to carry out functions such as land use planning and management, land and property rates and taxes, and regulate and control land development within their areas of administration. The key functions of municipalities include: spatial planning, land use management and land development. By law, the municipalities also required to manage and approve all buildings within their jurisdictional areas (The White Paper on Spatial Planning and Land Management, 2001). All the major municipalities are empowered to develop and manage municipal valuation rolls that are used to provide the rates assessments for properties within their administrative areas (The Local Government: Municipal Property Rates Act of 2004).

The land surveying is done by the service of private sector through the professional land surveyors who are registered with the South African Council for Professional Land Surveyors and Technical Surveyors (known as PLATO). Conveyancing is done through the use of private conveyancers and notaries. Figure 12 shows the key party role players in the South African land registration system of land administration.

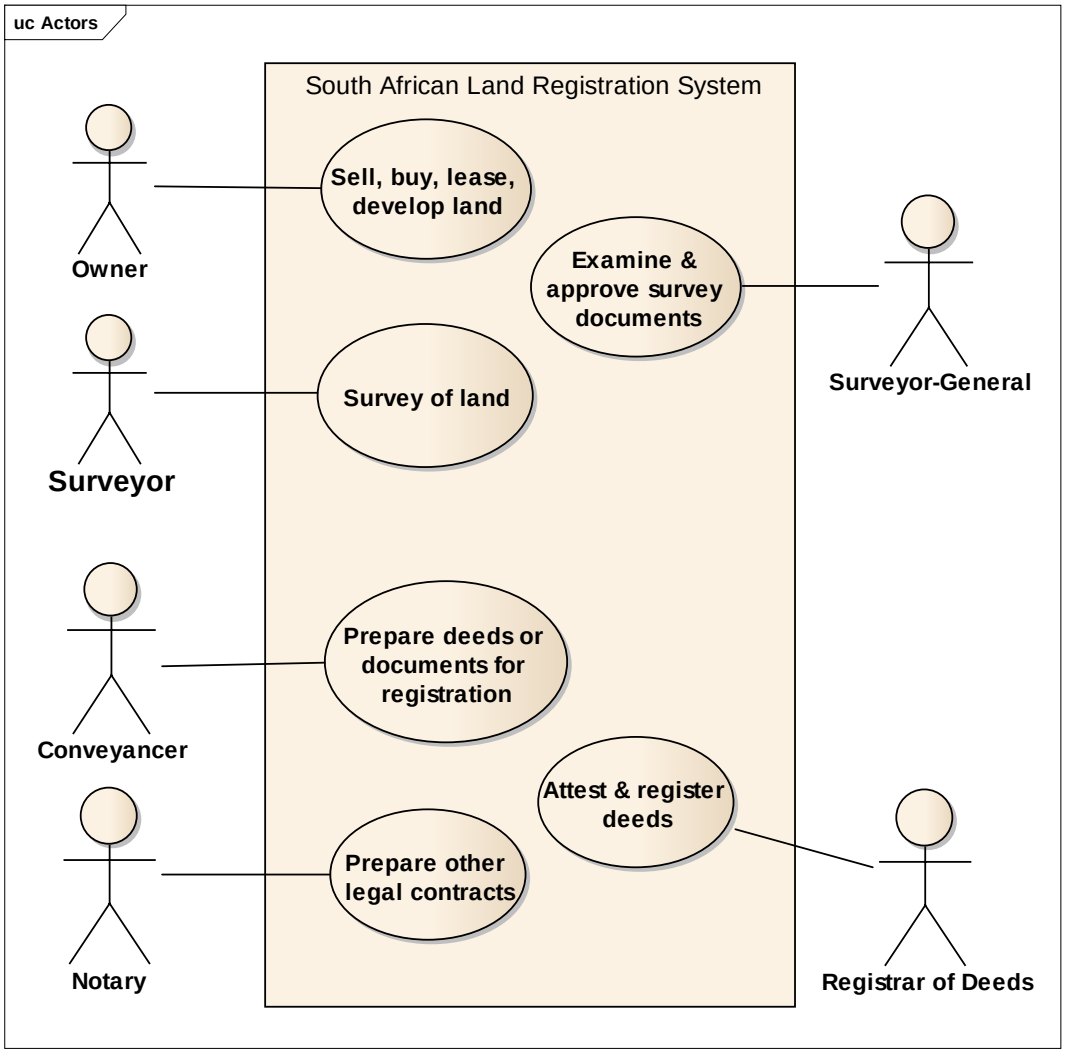

Figure 12. The key role players in land conveyancing in South Africa

The traditional authorities found in most rural areas perform functions associated with land in terms of customary law. Section 211(1) of the Constitution recognises the 'status and role of traditional leadership, according to customary law, subject to the Constitution', while section 211(2) confines them to the realm of custom, seeing them as dealing with 'matters relating to traditional leadership, the role of traditional leadership, the role of traditional leaders, customary law and customs of communities observing a system of customary law' (The Constitution of South Africa, 1996). There are seven recognised and legitimate kingships in South Africa: Abathembu, AmaXhosa, AmaMpondo, AmaZulu, AmaNdebele and VhaVenda (The National House of Traditional Leaders Act, 2009).

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3.2.2 Land policy

During the colonial and apartheid eras, over three and half million black South Africans were forcefully removed from their land (Toulmin & Quan 2000; Hall et al., 2003). More than 90% of land was designated for exclusive white ownership especially with the passing of the Native Land Act of 1913 (Harsch, 2001; Hall & Ntsebeza, 2007). The Act prohibited the black South Africans from owning, or even renting, land outside of their 13% designed areas, the so called the Bantustans. A freehold title system was introduced in the white ownership areas while in the Bantustans (homelands), a state-owned system and a landholding based on the permit-to-occupy (PTO) were implemented (Harsch, 2001; Hall 2009; Toulmin & Quan 2000). The PTO system was deliberately designed not to provide a legally secure title as compared to freehold title system. The 'pass law' restricted movement of black people and confining them to Bantustans or homelands. The Prevention of Illegal Squatting Act 52 of 1951 was passed in order to forcibly remove people who occupied land outside these black reserved areas often evicting them without prior notice. The Group Areas Act 36 of 166 introduced some form of apartheid spatial planning in urban and rural towns with white ownership of most of the urban areas and rural farmlands. The forced removals of the black people and racially skewed distribution of land resources have left the majority of the population landless and without any security of tenure. During the apartheid period, 87% of land in South Africa was generally restricted to white minority (Benjamisen & Sjaastad, 2008).

The major challenges facing the land policy makers in the contemporary South Africa are to effectively address the enduring legacies of the past colonial and apartheid eras. The challenges facing South Africa include:

> *the need to address the injustice of racially-motivated land dispossession; the need for a more equitable distribution of land ownership among various groups within society; the need for land reform to reduce poverty and contribute to economic growth; security of tenure for all, and the need for a land management system that supports sustainable land use patterns and the rapid release of land for development* (Constitution of the Republic of South Africa, 1996; White Paper on Land Policy, 1997).

To address the legacies of apartheid, South Africa's Constitution includes the following three clauses: Section 25(5) obliges the state must take reasonable legislative and other measures, within its available resources, to foster conditions which enable citizen to gain

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access to land on an equitable basis. Section 25(6) provides that "a person or community whose tenure of land is legally insecure as a result of past racially discriminatory laws or practice is entitled, to the extent provided by an Act of Parliament, either to tenure which is legally secure, or to comparable redress. Section 25(7) states that "a person or community dispossessed of property after 19 June 1913 as a result of the past racial discriminatory laws or practice is entitled, to the extent provided by an Act of Parliament, either, to restitution of the property, or to equitable redress. Section 25(6), read with section 25(9), obliges the state to enact measures that provide legally secure tenure to persons whose tenure is insecure as a result of the past discriminatory laws.

The three key elements of the land reform programme attempt to address each of the constitutional requirements outlined above: Land restitution, redistribution, and tenure reform. Land restitution is aimed to provide those who had been dispossessed of their rights to land to lodge claims either for the restoration of that land or for financial compensation. Restitution is aimed to foster improved livelihood and quality of life for the previously disadvantaged individuals and communities through acquiring commercial farms. Land tenure is aimed to address the question of insecure rights to land in the former Bantustans. Land reform is a dominant issue particularly when it relates to property rights.

Several of laws were enacted to give effect to the guarantees of secure land tenure. The Extension of Security of Tenure Act 62 of 1996 (ESTA) protects people and provides for procedures for eviction. The ESTA grants occupiers who reside on rural or peri-urban land after 4 February 1997 with the permission to the owner of the person in charge, inalienable legal rights to continue residing on the land unless there are compelling reasons for terminating these rights. The Land Reform (Labour Tenants) Act 3 of 1996 protects labour tenants to exercise their rights in land and provides for them to acquire land to work and reside on, on a permanent basis. The Interim Protection of Informal Land Rights Act 31 of 1996 is an interim measure put in place to prevent people with insecure tenure from losing their rights in land whilst the land reform programme is implemented. It specifically deals with the insecure tenure of communities in the former homelands. The Prevention of Illegal Eviction from Unlawful Occupation of Land Act 19 of 1998 repeals the Prevention of illegal Squatting Act 52 of 1951 whilst providing for the lawful occupation of land and prohibiting unlawful evictions. The Act provides for the rights of occupation for all owners and occupiers of public and private residential premises and provides for eviction procedures for all unlawful or illegal occupiers through South Africa.

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Addressing insecure land tenure in communal areas has proved to be one of the major challenges facing the land reform policy makers. The most recent failed attempt towards communal tenure reform with major objective of securing tenure has been the promulgation of the Communal Land Rights Act 11 of 2004 (CLaRA). The CLaRA applies to the ex-homelands and the former South African Development Trust (SADT) areas. The CLaRA responds to section 25(6) of the Constitution of South Africa which states that anyone whose land tenure is legally insecure as a result of the past racially discriminatory laws or practices is entitled to tenure that is legally secure. The CLaRA offers a number of ways in which the security of tenure can be achieved: firstly, by transforming the informal rights in land, whether the customary or PTO, into full ownership (i.e. freehold); secondly, rights that have been converted into freehold ownership emanating from the CLaRA can be registered in the deeds registration office. In case of land belonging to specific community, the outer boundary of the land will bear the name of the community with individuals within the community holding various rights. The Act was in 2010 declared by the Constitutional Court as unconstitutional (Cousins & Hall, 2011).

The key areas raised were that the Act did not allow rural communities to choose the nature of tenure system to be adopted or which local institution would be responsible for the land administration; failed to provide for accountability of the land administrators to right holders; and also failed to adequately address gender inequality inherent in the 'old order rights' such as PTOs, which would be upgraded to 'new order rights' in the new law. Rural women suffer severe discrimination under the current customary systems and by giving the traditional leaders power over rural land would potentially undermine the need for gender in respect of equal access to land (Cousins & Hall, 2011).

The South African government has now acknowledged that the single land tenure system is not appropriate to deal with the enduring challenges of insecure land tenure rights. In the Green Paper on Land Reform of 2011, 'a single land tenure framework' is described "as fashioned out" and proposed the integration of "current multiple forms of land ownership – communal, state, public and private into a single 4-tier tenure system":

- State and public land: Leasehold;
- Privately owned land: Freehold, with limited extent;
- Land owned by Foreigners: Freehold, but Precarious Tenure, with obligations and conditions to comply with; and,
- Communally owned land: Communal Tenure, with institutionalised use rights.

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The Communal Land Tenure (the 4th Tier) is urged to be complex and need widespread consultations and constitutional compliance. It is also maintained in the Green Paper that the "recent nullification of the Communal Land Rights Act (CLaRA) by the Constitutional Court, will be treated in a separate policy articulation".

In conclusion, as in any country, the implementation of South Africa's land policy relies on how access to land and land-related opportunities are undertaken. The role of the land administration system as an enabling infrastructure to facilitate land policy and land management strategies is of fundamental importance (Enemark et al., 2010). Land administration system, as described in the previous chapter, must ensure proper management of rights, restrictions, responsibilities, and risks in relation to land and other associated natural resources. Although the land use, land value, and land development components of land administration are briefly discussed in the following sections, the chapter greatly focuses on the land tenure (land rights) and systems of land registration (i.e. cadastre and deeds registration) in South Africa.

3.2.3 Land tenure

Land tenure right is defined as *any leasehold, deed of grant, quitrent or any other right to the occupation of land created by or under any law and, in relation to tribal land, includes any right to the occupation of such land under the indigenous law or customs of the tribe in question* (The Upgrading of the Tenure Rights Act, 1927 of 1991). This definition reflects two principal land tenure streams (the dual system of land rights): statutory and customary systems. The Roman-Dutch law, which is supported by documentary evidence of property, governs statutory land tenure systems or land rights such as a title deed or lease certificate and administered by the national government.

This section focuses on the identification of categories of real rights found in South Africa. The real rights or proprietary rights are those rights that a legal subject has with regard to a particular item of property (De Bois et al., 2007). Unlike personal rights, which concern the relationship between parties to a contract or delict, the real rights establish an almost direct relationship between the holder of the right and the property. The real rights with regard to land are registerable in terms of the South African Deeds Registries Act.

The current South African categories of rights traditionally developed from the Roman system of real rights which include: *dominium* (ownership), *servitutes* (servitudes), *pignus* (pledge), *hypotheca* (mortgage), *emphyteus* (perpetual quitrent), and *superficies* (a building grant). Various new restrictions on land were introduced during the feudal era: quitrent

tenure, hunting rights, salt-pans rights, metal mines right to charge an annuity on land sold, pre-emptive rights in favour of family members, etc. South African property law does not recognise a number of real rights of the feudal era. The categories of real rights that are recognised by the law are described in Figure 13.

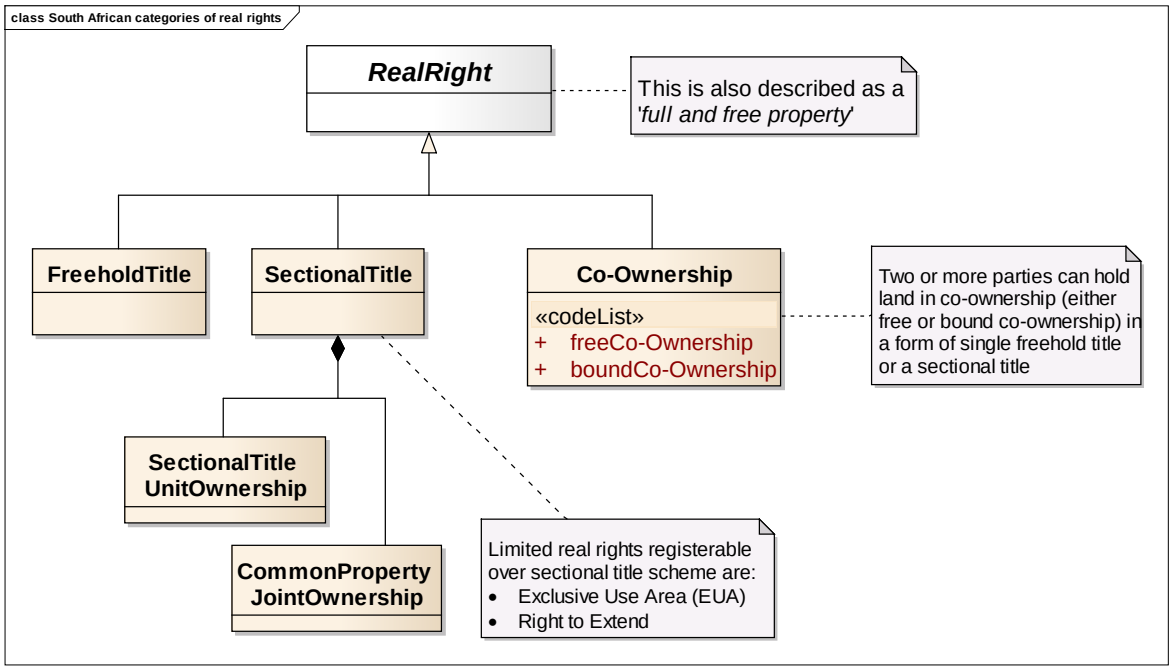

Figure 13. South African real rights in land (as described by Van der Walt & Pienaar, 2009; Du Bois et al., 2007)

Ownership is potentially the most extensive private right that a person can have with regard to property. In principle, ownership entitles the owner to deal with his or her property as he or she pleases within the limits set by the law (De Bois et al., 2007).

South Africa has introduced what is called the sectional title scheme in order to register individual ownership of portion of buildings (i.e. sectional title units). The rationale behind the sectional ownership is to allow portions of buildings to be separately owned. The sectional ownership concept consists of three important elements, namely; individual ownership of a section (e.g. flat or commercial apartment), joint ownership of the common areas of the sectional title scheme (i.e. common property), and membership of a body corporate. An owner of a section in a sectional title scheme acquires separate ownership of the section together with an undivided share in the common property. The registration of the title deed vests ownership in a section and joint ownership of the common property.

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The limited real rights that can be registered in a sectional scheme include the right to extend the scheme by either the addition of units or land and right to the exclusive use. The right to the exclusive use of an area may then be conferred on an owner of a section. The exclusive use rights can be acquired and held in terms of rules applicable to the Scheme or by way of notarial cession. A title deed is issued upon the registration of transfer of the sectional title unit as a proof of ownership. A notarial deed of cession is issued in respect of certain exclusive use areas. A developer of a sectional title scheme can reserve to himself the *right to extend* the scheme by the addition of units and/or buildings at a later stage. The plans of such a proposed extension must be drawn up and approved at the time that the Scheme is first opened and registered. If the right of extension is not exercised or reserved, the right to extend the Scheme vests in the body corporate. Appendices 6 and 7 show the class diagrams derived from a deed of transfer of a sectional title unit.

3.2.4 Restrictions on ownership

Ownership is limited by a number of other rights such as the limited real rights, creditors' rights, statutory limitation and the limitations in terms of the provisions of the neighbour law. Figure 13 shows the limitations on ownership (Van der Walt & Pienaar, 2009). A limited real right limits the entitlements of the owner of land. These are real rights registered in favour of someone else other than the owner of the land.

Figure 14 shows the broad categories of the most common limited real rights in South Africa. Servitudes can be subdivided into two main categories, namely; praedial and personal servitudes. Examples of real security rights are: the mortgage for immovable properties, and pledge for movable properties.

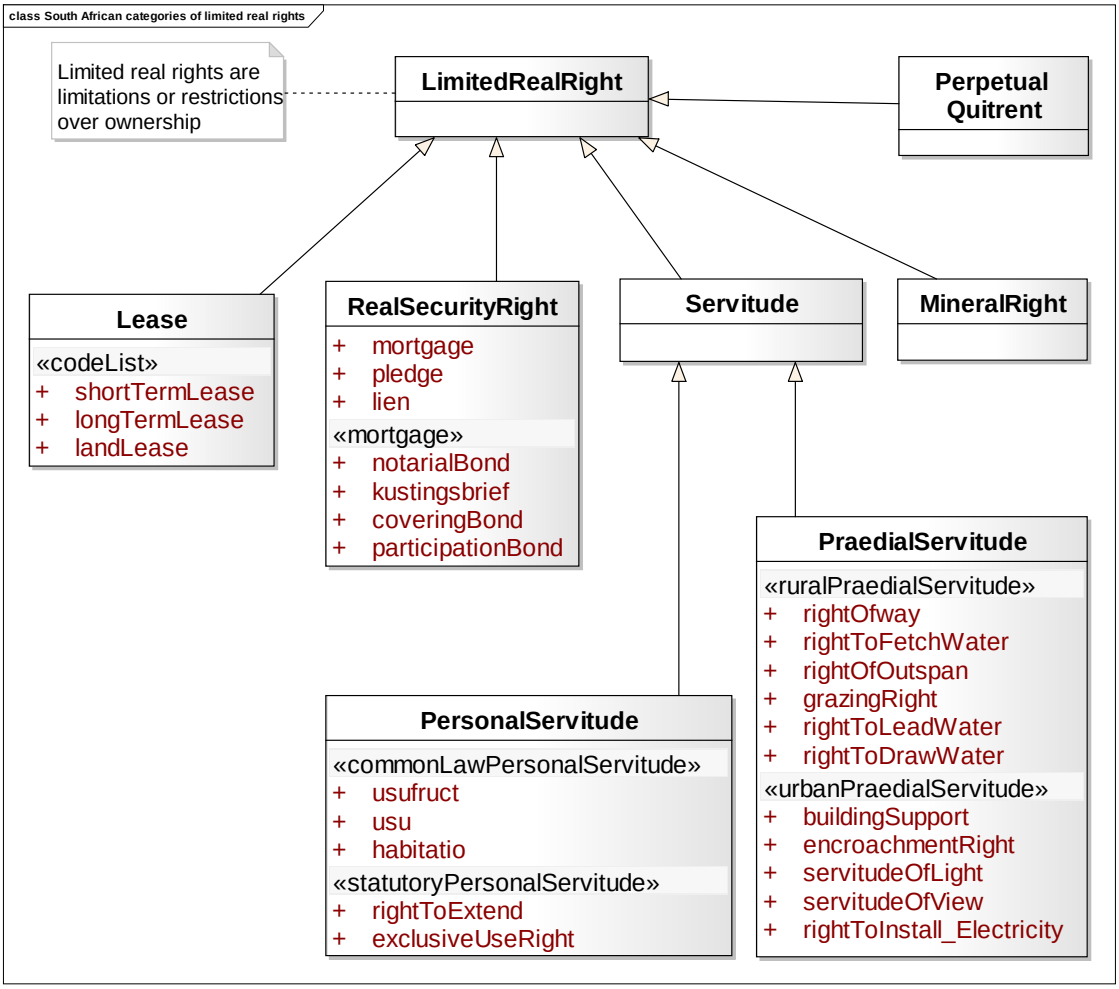

Figure 14. The South African categories of limited real rights (as described in van der Walt & Pienaar, 2009)

The class diagram in Figure 14 was developed from the textual interpretation of the South African property law, as presented by van der Walt & Pienaar (2000).

3.2.5 Restrictive title deed conditions

The restrictive conditions are registerable in the deeds registries. There are found in a number of deeds documents. The RestrictiveTitleDeedCondition codeList summarises some of the common restrictive title deeds conditions. The restrictive title deed conditions are illustrated in the *RestrictiveTitleDeedCondition codeList* (West, 2010). De Bois et al., (2007) provide useful categories of restrictive conditions: real restrictive condition, personal restrictive condition, and statutory restrictive conditions. Figure 15 incorporates both West (2010) and Van der Walt and Pienaar (2009) categories of conditions. It is not

practical to list all the types of conditions within each category. The detailed description can be found in South African property law. However, the following commonly found restrictive title deed conditions will be briefly discussed (as described by West, 2010).

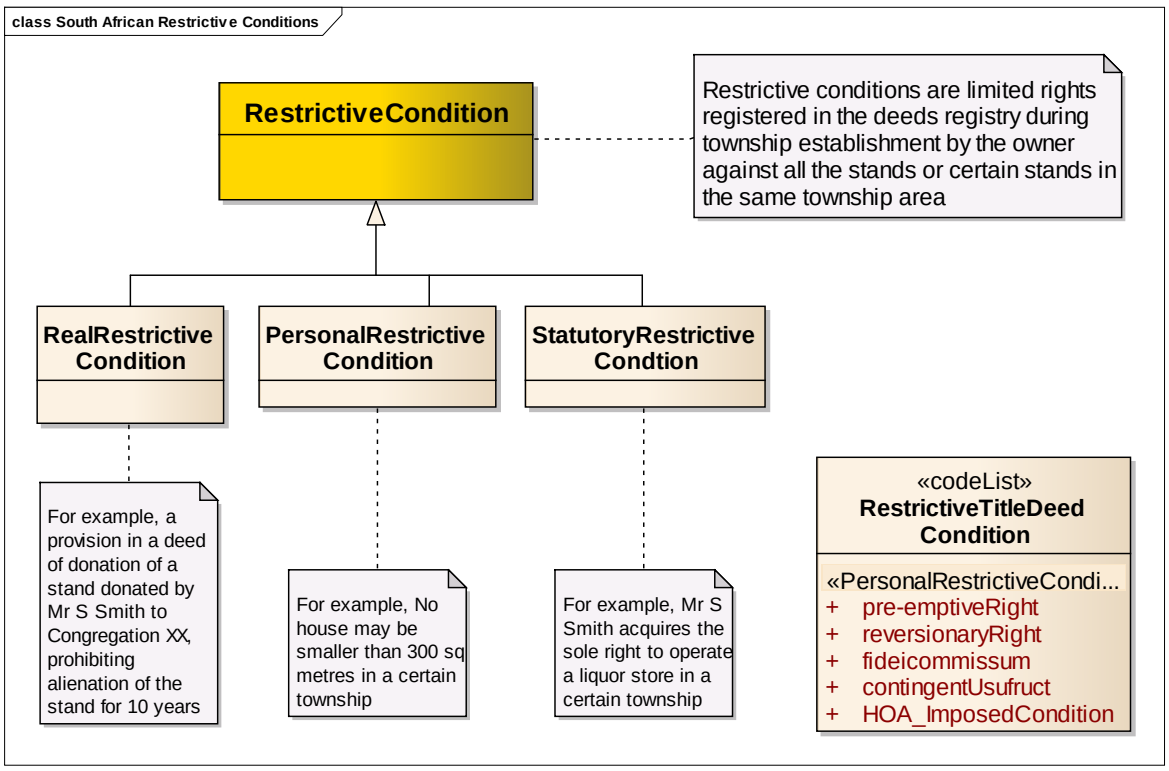

Figure 15. South African restrictive conditions (as described in Van der Walt & Pienaar,2009)

The class diagram presented in Figure 15 was developed from the textual interpretation of the South African property law, as described by van der Walt and Pienaar (2009). The common restrictive conditions of title deeds encountered in the South African deeds registries will now be briefly discussed (as described by West, 2010):

- *Pre-emptive rights*

In the deeds, a condition that grants the grantee a preference to purchase a particular piece of land should the grantor wish to sell it is encountered. This is known as a *pre-emptive right*. A pre-emptive right is a personal right and registerable in the South African deeds registry offices (West, 2010). Where the grantee refuses to buy the property, it may be sold to anyone free from restriction. The right of pre-emption does not bind the successors in title. This right will elapse where the owner or pre-emptor dies, where the property is sold in terms of a compulsory sale such as in execution or insolvency, etc. In case of pre-

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emptive right condition, the condition biding to the successor in title and takes a form of personal servitude.

- *Reversionary rights*

A condition that provides that on the occurrence or non-occurrence of some or other event, the ownership of land will revert to the previous owner is registerable in the deeds offices. This is known as reversionary right. For example, a condition often encountered which provides that should a dwelling to the value of a least R*x* not be erected on the property before a certain date, the land in question will revert to previous owner, usually a local authority. Such conditions contain no restrictions on alienation but the transfer of the land which is subject thereto, will not be permitted unless the deed is accompanied by the written consent of the holder of the reversionary right.

- *Fideicommissum*

A fideicommisium is a condition usually created by last will and in some cases as a condition in a donation (West, 2010). In terms of the fideicommissium, an immovable property shall pass to the fideicommissary heirs on the death of the fiduciary or on the happening of a certain event.

- *Personal servitudes of usufruct, usus and habitation*

The personal servitudes of *usufruct*, *habitatio* and *usus* are registerable in the deeds offices. The personal servitudes cannot extend beyond the lifetime of the holder and thus lapses upon the death of the holder of such right, after 100 years in the case of non-natural persons. Where spouses married in community of property are the holder of a personal servitude of usufruct without any indication in the deeds that they hold such right.

- *Contingent usufruct*

An example of a contingent usufruct is where the land owner bequeaths a usufruct to his son, A, who is married out of community of property to B, subject thereto that should B survive A, she will be entitled to the usufruct after the death of A. If land is subject to contingent usufruct such land cannot be transferred, mortgaged free from the contingent usufruct.

- *Home Owners Association imposed restrictive conditions*

It is often the condition of a local authority that each owner immovable property becomes a member of the Home Owners Association (HOA) and that the erven may not be transferred

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or alienated without the consent from the HOA. These conditions are often found in some deeds of transfer documents. The HOA-imposed restrictive conditions are most often created where a new township is established or small scale subdivisions approved. These conditions are often subscribed in the conditions of township establishment and published in the provincial gazette of the local authority in terms of respective town planning ordinances. These conditions are usually created in the power of attorney to pass the transfer. The conditions only become enforceable upon registration in the deeds registries.

3.2.6 Private and public law restrictions

The ownership of land is also subject to private law restrictions. The public restrictions are imposed on all owners of a particular kind of property for the benefit of society as a whole or in the interest of certain sectors of the community (De Bois et al., 2007). For example, restrictions on the use of immovable property include; amongst others, the statutory withdrawal of liquor licences, the zoning statutes that prevent a residential owner from running a business from home, and the urban planning legislation that prevents the owner of a site from erecting a multi-storey building in a residential area.

Figure 16 shows some of the statutory restrictions on the immovable properties. This is by no means a complete list of all public law restrictions**.**

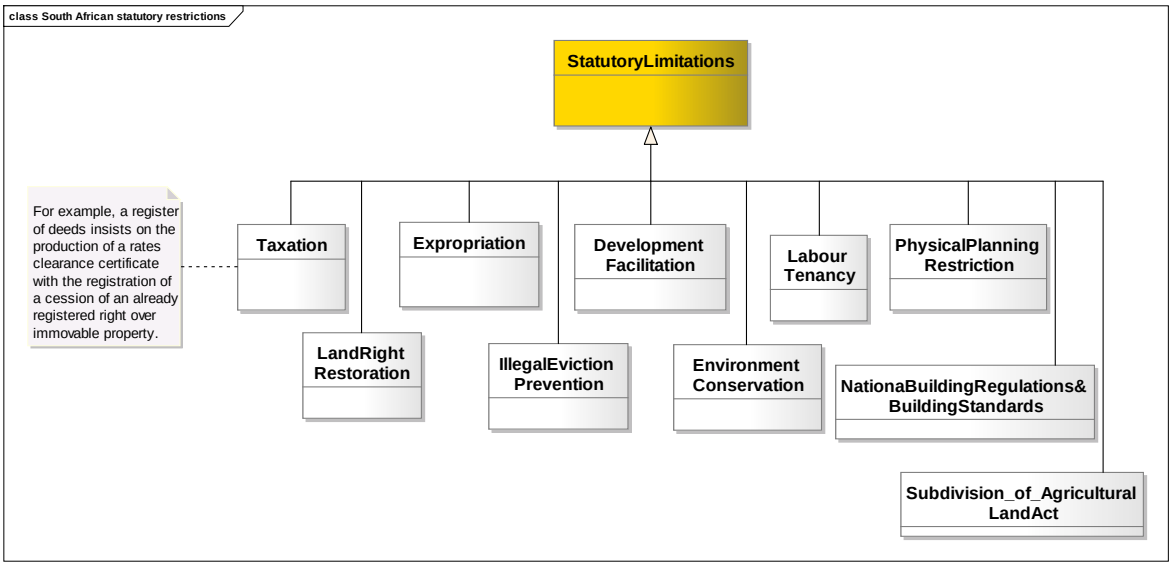

Figure 16. The South African statutory restrictions (as described by De Bois et al., 2007).

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Various town planning ordinances restrict immovable property owners' rights. The subdivision of industrial land is controlled by the Physical Planning Act. Owners' rights to build may be restricted by the provisions of the National Building Regulations and Building Standards Act which prescribes the standards for buildings. Owner's right to evict any unlawful occupation from his/her property is limited by the Prevention of Illegal Eviction from and Unlawful Occupation of Land Act which prescribes procedure for evictions. The Advertising on Roads and Ribbon Development Act restricts the display of advertisements on land visible from a public road and also the abandonment of vehicles near a main road. The Fencing Act makes the fencing of farms compulsory. The Subdivision of Agricultural Land Act prohibits the subdivision of agricultural land into uneconomic subdivisions. The National Key Points Act makes it compulsory to protect areas declared as the national key points in the interest of national security. The War Graves and National Monuments Act protects the war graves, buildings and trees declared national monuments. The Atmospheric Pollution Prevention Act promotes smoke-free zones in certain areas by restricting the level of pollution that can be allowed. The National Health Act provides for the control unhygienic premises; the Housing Act prevents the emergence of slum areas. The owners of properties are obliged to pay property assessment rates and transfer duties when transferring ownership. In terms of section 25 of the South African Constitution, an individual right holder may be derived of his or her property by means of expropriation within the limits set by the land reform policy requirements.

3.2.7 The other forms of land tenure in South Africa

3.2.7.1 Initial ownership

The type of ownership created by in terms of the Development Facilitation Act to fast track the rate of development in South Africa called 'initial ownership' (Van der Walt & Pienaar, 2009). Historically, some towns were laid out on state or municipally owned land for the black African people who worked in the cities. These people were given rights of occupation in a form of lease, which was nothing more than just a permission to occupy.

3.2.7.2 Permission to Occupy

A Permission-to-Occupy (PTO) is a type of right emanating from apartheid era. During this era, the black South Africans were not permitted to own land or immovable property. Land was held in trust by the state on behalf of communities of black people. The PTOs were not registered in the South African Deeds Registries but kept by the local authority under the

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control over the traditional black community (Department of Rural Development and Land Reform [DRDLR], 2010). In the Black Administration Act (Act 38 of 1927), a Permission to Occupy (PTO) is defined as a *"permission in writing granted or deemed to have been granted in the prescribed form to any person to occupy a specified area of trust land for a specific purpose.* The Upgrading of Land Tenure Rights Act, Act No. 112 of 1991 describes the holder of the 'PTO' as a 'putative holder' which means a person occupies an erf as if he or she is the holder of the land tenure right in respect of that erf, but who is not formally recorded in the register of land rights as the holder of the right in question.

An object level diagram in Appendix 13 illustrates an instance-level diagram of a Permission-to-Occupy that was derived from analysis of an actual PTO certificate acquired in this study. The diagram shows particulars of parties to a PTO, nature of PTO and spatial units describing the spatial extent of the right. PTO is a form of communal land tenure which provides for unregistered protected use of an unsurveyed communal land.

3.2.7.3 Customary land tenure

Customary land tenure is governed by unwritten traditional rules and administered by traditional leaders. Customary land rights can be granted at individual, family or communal group level. Van der Walt & Pienaar (2009) argue that the customary law rights in property cannot regarded as real right or nor as ownership or as limited real rights due to their character and distinctive function related to customary relationships.

The Communal Land Rights Act (CLaRA) of 2004 aimed at securing land rights in rural areas. However, CLaRA was ruled out in 2011 as unconstitutional (Cousins and Hall, 2011). It was successfully argued that the CLaRA was undemocratic, as it did not provide the rural communities a freedom of choice pertinent to the nature of the tenure system to be implemented or choice of local institutions which should be given land administration responsibility. Moreover, the Act made no provision for accountability of land administrators to rights holders, and it not adequately address inequalities inherent in the old order rights (such as PTOs) which would be upgraded to new order rights' in terms of this the CLaRA. Different types of informal tenure exist in South Africa. Customary tenure is not necessarily a land right but the rights of occupation are protected. Similarly, informal settlement tenure is not a land right but the occupants can obtain adverse possession after five years and can be evicted only in terms of specific procedures. South Africa has a numerous informal settlements in urban areas without formal land rights but protected to some extent under the anti-eviction laws (Hall 2009).

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The categories of rights in land that are recognized by various Acts, but remain illegible for registration in the Deeds Registries include:

- customary or communal tenure;
- informal settlement right;
- the rights of squatters;
- occupancy rights (such as labour tenancy);
- anti-eviction rights; and
- Permission-to-occupy (PTO) or other registered tenure rights.

The new forms of administration tools are needed to address the registration of other forms of land tenure that are currently not registerable in the South African land registration system. The modern land administration systems need to incorporate both the formal and informal land tenure systems, as supported by Cadastre 2014 vision.

3.2.8 Land value and taxation

In South Africa, land valuation function faces a number of challenges. The South African Green Paper on Land Reform clearly outlined these challenges (Department of Rural Development and Land Reform [DRLR], 2011). At the national level, there is no comprehensive, reliable and collated database of property values. The South African cadastral system focuses on the creation of surveyed property boundaries for the purpose of registration of various real rights over properties. Therefore, there is a need to establish national depository of property values. The Green Paper outlined the key challenges that needed to be addressed. These challenges are quoted below:

- *absence of legislative framework to determine when 'market value' is one of the variable in determining values as opposed to being the only criterion;*
- *the integrity of some of the valuation is questionable;*
- *conflict of interest and malpractices;*
- *improper or hurried valuations in order to meet deadlines or compliance; and*
- *an historical or mechanical approach to valuation.*

The Green Paper on Land Reform proposes the establishment of an office of the Valuer-General (CVG) with the responsibilities to, *inter alia*; provide of fair and consistent land values for rating and taxing; determine financial compensation in cases of land expropriation; set guidelines, norms and standards required to validate the integrity of the valuation data, creating, and maintaining a database of valuation information.

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At the local government level, South African municipalities are empowered to conduct land and property valuation within their respective jurisdictional areas within the framework set by law. The Local Government Municipal Property Act of 2004 provides a more uniform approach to collect revenue for the municipalities. Historically, the local authorities levied the property rates and taxes in accordance with the provisions of provincial ordinances. The Act introduced some of the key changes that include the rating of property based on the market value of the property. The payable amount of rates is directly connected to the value of the property or right. In terms of the Act, a register of all property rights from which a valuation roll is frequently compiled and updated is required to be established and maintained. In terms of the Act, a property means:

- *immovable property registered in the name of a person, including, in the case of a sectional title scheme, a sectional title unit registered in the name of a person;*
- *a right registered against immovable property in the name of a person, excluding a mortgage bond registered against the property;*
- *a land tenure right registered in the name of a person or granted to a person in terms of legislation, or*
- *public service infrastructure (e.g. provincial or other public roads; water or sewer pipes, dams, water supply reservoirs, communication towers, power station, etc.).*

As informed by what is referred to as property by the Municipal Property Act, it is clear that the Act is applicable to all registered land in the name of a person, a sectional title unit, and rights registered against immovable properties. The registered rights include; *inter alia*, servitudes, lease agreements, exclusive use areas, and real rights of extension.

According to the Act, the council of a municipality must adopt a policy consistent with this Act on levying a rate on rateable property in the municipality. This policy must determine the criteria to be applied by the municipality if it levies different rates for different categories of properties, exempts specific categories of owners of properties, or the owners of a specific category of properties from payment of a rate on their properties. The Act specifies the categories of rateable properties which include the residential; industrial; business, and commercial properties. The properties in respect of which it is impossible or unreasonably difficult to establish a market value as a result of legally insecure tenure resulting from past racially discriminatory laws or practices are exempted. These areas are mostly found in the rural areas of the former homelands.

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In order to levy a rate on property, a municipality must, in accordance with the Local Government Municipal Property Rates Act (No. 6 of 2004), establish a general valuation on all properties within its jurisdictional area. During the valuation process, all rateable properties must be valued, including fully or partially excluded from rates. All properties valued must be included in the valuation roll which takes effect from the start of the financial year and remain valid for that financial year or for one or more subsequent financial years as the municipality may decide, but not for more than four financial year. The contents of valuation rolls as stated in section 48 of the Act, must list all properties in the municipality. The municipal valuation roll must reflect the following information in respect of each property: the registered or other description of the property; the category in which the property falls; the physical address of the property; the extent of the property; the market value of the property, if the property was value; the name of the owner, etc.

In respect of land taxation, as in many other countries, land taxation is a complex system and needs the depth of knowledge of an expert. In this research, an overview of the key forms of immovable property taxes is briefly provided. The acquisition of land is taxed by either one of the two national government taxes, namely the Value-Added Tax (VAT) or Transfer Duty. The Value-added Tax Act, Act 89 of 1991 provides that a levy be paid where a registered vendor supplies any goods (including immovable property) or service in the course or furtherance of any enterprise. The taxable value is the consideration a payable (contract price) and the standard rate of VAT is 14 per cent. Transfer Duty is a tax levied under the Transfer Duty Act, Act 40 of 1949, on any acquisition of the immovable property where VAT is not payable. A transfer duty receipt/exemption certificate must be obtained and produced to a registrar of deeds for each acquisition of property (West, 2010). These two taxes are administered by the South African Revenue Services (SARS).

In summary, South African property valuation and taxation activities are dependent on the formal system of land registration. These activities require the identification of registered property owners and, registered property rights and the legal property description.

3.2.9 Land use

The lack of national standards leads to disparate and confusing practices in land use, particularly at local government level. Prior to the introduction of town planning schemes, land use in South Africa was governed by means of restrictions written into the title deeds of each and every property and registered in the deed office (City of Johannesburg, 2009).

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With the promulgation of various land ordinances in 1931, 1965 and 1986, this system of land use control transformed drastically. Land ordinances allowed each municipality to develop its own town planning schemes prescribing the conditions for how each property can be used. There is a considerable variation in the land use management systems presently applied across and within South African cities. For example, there are over 12 different town-planning schemes in the City of Johannesburg, each of which is based on the old principles and assumptions. In many of the townships that were established prior to the ordinances, restrictions inserted in the title deeds may still be found. The land related information is inserted in the conditional clause of a deed. The following text was extracted from a condition clause of deed of transfer dated 1984.

SUBJECT to the following conditions:-

1. SUBJECT to the provisions of the Townships Amendment Act, 1908 (Act No. 34 of 1908 of the Transvaal).

2. On this lot no place of business of any description shall be erected or opened, and not more than one house with the necessary outbuildings and accessories thereto may be built thereon, unless the consent in writing of the township owner has first been had and obtained.

The Land Use Management Bill is intended to be the main legal framework for land use management. The Bill empowers municipalities to develop 'land use schemes' to regulate how land is used and managed within their respective areas. The Bill provides for the intergovernmental support for the development and coordination of land use and spatial development plans of municipalities, and for dispute resolution between municipalities and local communities connected to development and use of land (Hall, 2009).

3.2.10 Land development

The Development Facilitation Act (67 of 1995) defines land development as: "any procedure aimed at changing the use of land for the purpose of using the land mainly for residential, industrial, business, small-scale farming, community or similar purposes, including such a procedure in terms of other laws relating exclusively to prospecting or mining". Land development is about change of land use from one type to another. There are different types of developments, namely; township establishment by subdivision of land parcel. Various Acts and Ordinances govern the subdivision of land. In rural areas the following Acts govern the subdivision of land: the Advertising of Roads and Ribbon

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Development Act, 21 of 1940; the South African National Roads Agency Limited and National Roads Act, 7 of 1998; and the Subdivision of Agricultural Land Act, 70 of 1970; the subdivision of agricultural holdings and agricultural land situated with the jurisdiction of a local authority in terms of Ordinance 20 of 1986 in the former Transvaal. Consent to the subdivision of agricultural holdings and farmland of which is not agricultural land, is granted by the Premier by virtue of Division of Land Ordinance 20 of 1986. The Ordinance only controls the division of land and not the acquisition of shares in the ownership of land as well. The division of land includes the surveying and registration of a lease over a portion of the land. Section 5 of Ordinance 20 of 1986 determines that the Surveyor General may not approve a general plan or diagram pertaining to the division of land, and the registrar of deeds may not register the transfer or lease of any portion of land which has been subdivided, unless the Premier or authorised local authority.

The National Building Regulations and Building Standards Act (103 of 1977) provides a basic and uniform system of building control for all towns and urban centres in South Africa. The Act, together with associated standards contained in the National Building Regulations (SABS 0400), provides a national legislative framework for building control in the country. The Act prohibits the construction of buildings without prior written approval of the local authority. It also requires that applicants obtain a certificate of occupancy from the local authority when a building is complete. A local authority has the power to issue prohibitions for building schemes that are already underway which are considered to infringe on the building standards and requirements of the Act and its regulations (City of Johannesburg, 2008). At the national level, there is no national register or a database of buildings. However, South African deeds offices maintain registers of portions of buildings (i.e. sectional title units) for the purpose of allocating individual ownership of sections of buildings and the creation of other limited real rights.

In summary, there is no national standard for land use and valuation of land in South Africa. The current policy initiatives focus on the development of national land valuation and land use management. The land use management bill aims to provide uniformity in land management. However, this legislation has not yet been fully implemented. In terms of land tenure, South Africa still faces challenges related to the security of tenure for those people whom their tenure rights where forcibly taken away from them during the apartheid regime. Many of these communities hold land in customary and informal arrangements.

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3.3 South African land information infrastructure

3.3.1 South African cadastral concept

In the South African Cadastral Template, the South African cadastral system is described as a system of high accuracy based on a national control survey system (Department of Rural Developed and Land Reform, 2010). The survey records highly accurate up to a centimetre accuracy level. It is a legal requirement that all South African cadastral surveys have to be connected to a network of control namely; the trigonometric stations and towns survey marks. In so doing, the positions of every beacon and boundaries can be accurately derived and that land parcel boundaries do not overlap. The system is based on 2 dimensional representations of land parcel or cadastral property boundaries. The property boundaries are defined geometrically using a numerical figure (i.e. lists of co-ordinates) and verbally representation of land parcels.

The primary objective of the South African cadastral system is to define and delineate boundaries of properties for the purpose of registration of real rights in property. It is a legal requirement that all registration of land rights (real rights) be done only after the cadastral survey have been done. The cadastral survey forms the basis for registration of real rights in property (i.e. freehold, leasehold, servitudes, etc.).

The current South African cadastral model is based on a similar traditional cadastral concept presented by the International Federation of Surveyors (FIG, 1995). The South African cadastral model captures ([DRDLR], 2010):

- *The unique designation of the property;*
- *An illustration depicting the property;*
- *Details of any curvilinear boundary*
- *Descriptions of the corner beacons*
- *A table listing the numerical data of the boundaries*
- *The area of the property*
- *Details of any registered real rights over or under the property (e.g. servitudes or mineral rights)*
  A unique reference number supplied by the Surveyor-General

Figure 17 illustrates the South African cadastral records.

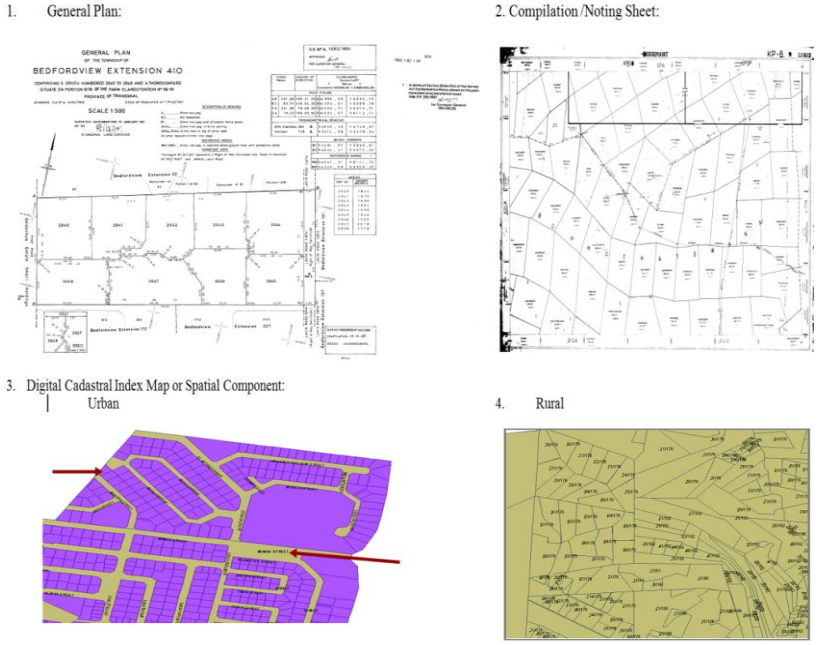

Figure 17. South African Cadastral information (Department of Rural Development & Land Reform, 2010)

Like many other formal cadastral systems found in many other countries, the South African cadastral model was not designed to incorporate the registration of all other real rights and informal or social land tenure arrangements that fall outside the formal system of land registration. The new tools are necessary to be developed to cater for registration of all rights for all people as described conceptually by the continuum of land tenure concept.

3.4 Land administration challenges in South Africa

The South African cadastral system is described as one of the best in the world (Simpson, 1976). The system is known for its' highly accurate land surveying that is based on geodetic network of co-ordinates and conveyancing. Although, the system provides secure property rights for those who can afford it, like many in the world, it has not been unsuccessful in securing the rights of many poor communities who are the victims of the past racially motivated land tenure arrangements. Most of these communities live in informal and customary land. One of the challenges of the South African land reform policy is to address these inferior land tenure rights by upgrading them into legally registerable rights in the national land registries. The South African cadastral system fails to incorporate all new categories of rights and informal rights such as permission to occupy. The different legal processes complicate receiving of consents for land surveying as these processes are regulated by different ordinances found in different provinces. The

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processes even vary from a municipality to a municipality. For example, a permission to subdivide land in both rural and urban areas has to be obtained from a number of different local authorities. There is a vast difference in ordinances between the various provinces. This results in different procedures of land surveying throughout the different offices of surveyor-general. This often causes confusion for the land surveyors, conveyancers and general public. For example, the Free State ordinance empowers the township board concerning consents of subdivision that results in power given to the municipalities and people on the ground. The Northern Cape Ordinances gives power to the individual local authorities to approve subdivision. In Johannesburg, the City of Johannesburg has been given powers to approve applications of township development, subdivision, and consolidation of land parcels, etc.

From the technological perspective, the South African land registration system is not fully integrated. The Surveyor-General and Registrar of Deeds offices operate separate land information systems (LIS) that are independent of each other, with the legal conveyancing predominantly manual process. The South African deeds registration system (SADRS) deals with the security of land title through a registration process beginning from the conveyancers' preparation of deeds and documents tendered for registration or execution and ending with the security of private immovable property rights (e.g. freehold, leasehold, servitudes, etc.). The SADRS deals with the maintenance of the registrar of deeds 'electronic register of real immovable property rights and associated restrictions or conditions while the South African Cadastral Information System (CIS) deals with recording, processes and stores land parcel data within the Cadastral Surveys Management (CSM) branch of the office of the Surveyor-General (SG). The CSM branch examines and approves survey plans (i.e. general plans, sectional title plans and diagrams).

The challenge facing cadastral system is the lack of integration of the two traditional business and database models. These models are outdated and are inefficient in dealing with the current demands: The Deeds Registration branch is said to be under-resourced, thus it cannot accommodate the envisaged high volume of requests for land registration (about 20 million land parcels and more) from the Land reform programme (Riba, 2012). Hence, the need to link the DRS to the CIS so as to improve "land parcel management of current and evolving forms of land tenure" which are not registerable in the current system despite their recognised legal status in the land reform programme. This need supports the international Cadastre 2014 vision which promotes the complete recordation of all land rights including restrictions and responsibilities (RRRs) in the future cadastral systems

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(Kaufmann & Steudler, 1998). The consolidation of the DRS and CSMs databases into an integrated land information system that provides a single unified view of all land parcels and ownership (deeds) data is identified as a sound solution. Riba (2012) described the e-Cadastre as "the high profile electronic solution aimed at automating and optimising the organisational performance of the CSM and Deeds Registration branches of the Department of Rural Development and Land Reform (DRLR) through provision of a solution that enables interoperability and Service Oriented Architecture (SOA) - based integration which presents one unified view of scoped constituencies".

In 2010, a project titled *Vulindlela* was started with an aim at addressing the two major land issues in the DRDLR: security of tenure, management and maintenance of the national cadastral data (Riba, 2012). The project is intended to improve land and rights information management that supports land administration efforts. Moreover, it aims to improve the turnaround times for examination and approval of survey plans and registration of land rights, thus enhancing the land development value chain. The scope of the Vulindlela project entails the consolidation of the DRS and CSMs databases into an integrated land information system designed to provide a unified view of land parcels and ownership data. The *Vulindlela* project coincides with the newly adopted ISO 19152 LADM. The project provides the opportunity to adopt an international standard for modeling cadastral and ownership information in South Africa.

It is impossible to register land without considering the rules and regulations associated with planning, zoning, surveying, adjudication, conveyancing, valuing, taxation, etc. The requirements for maintaining the land information system (LIS) are interrelated. Despite the fact that some parts are centralised, as in the case of South African land registration system of deeds and cadastre, others are decentralized, as in the case of land use (including zoning), valuation (including assessment rates) and development applications (e.g. township establishments, subdivision, consolidation, etc.). These functions are conducted by different organisations. Private sector professionals (i.e. registered land surveyors, conveyancers, notaries, planners) are responsible for a significant part of the land administration service delivery. The activities of these professionals are regulated by the State (i.e. the offices of surveyor-general and registrar of deeds, the local government authorities). They are all implicated in the state's formal land registration system. Therefore, it is logical to consider the significant role of municipalities in land administration functions, particularly in land development, land use and valuation.

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It is a legislative requirement for all the municipalities to adopt a system of collecting revenue from property assessment rates and taxes for services so as to ensure that the municipalities remain financially viable and sustainable. The Supreme law of South Africa guarantees rates on property as an autonomous source of revenue for the municipalities (Constitution, 108 of 1996). The Constitution states that the power of a municipality to impose rates on property may be regulated by national legislation. A municipality is mandated to levy rates and taxes in terms of municipal property rates law. It is mandated to regulate the land use via various town planning ordinances (i.e. town planning schemes) and development control, etc. These functions are dependent on the accurate, current and timely land parcels and ownership data. The ability to secure revenue from assessments rates depends on accurate and current land parcel information, their valuation and prompt transfer of the information to the municipal billing system. This implies that the proper management of land information is critical. However, this can be a daunting task especially where different organizational business units, departments and/or other government agencies involved in the maintenance and supply certain of information. This can be complicated by a lack of data standard to allow seamless data integration; thus making the sharing of data across various involved organizations more difficult and cumbersome.

A complete documentation of various interests in land is important. Therefore, there is a need to address land tenure issues of people who have no secure land tenure. It is accepted world widely that new land tenure tools required in order to address the tenure security. The LADM and STDM aim to address the recordation of people-land relationship in formal land administration systems. While the LADM provides a common conceptual framework for the basic administration information in formal registration systems, the STDM focuses on the recordation of information in respect of social tenure relationships such as customary land tenure arrangements and informal settlements/slums, etc. However, it is possible to incorporate both informal and customary rights in the LADM.

In summary, this chapter described the people-to-land relationship from the South African perspective. The land management paradigm was used as a framework to discuss the South African land administration systems of cadastral information management and land registration. The chapter examined the different categories of real rights in land that are registerable in terms of the provisions of the Deeds Registries Act, and those rights identified as valid yet not registerable in their current form. There are number of challenges facing the South African land policy makers. These challenges relate to the delivery of secure land tenure for all, more particularly the majority of people who their rights to land were removed through the past-racial discriminatory laws.

CHAPTER 4 TOWARDS A PROFILE OF THE LAND ADMINISTRATION DOMAIN MODEL (LADM) FOR SOUTH AFRICA

This chapter builds on the initial work presented as a peer-reviewed paper in the Proceedings of the Global Geospatial Conference 2012, 14-17 May 2012 in Quebec City, Canada, as a paper by Dinao Elmon Tjia and Serena Coetzee, under the same title.

4.1 Introduction

This chapter builds on the international conference paper that was presented in Canada under the same heading (Tjia & Coetzee, 2012). The purpose of this chapter is to explore the applicability of Land Administration Domain Model (LADM) to the South African land administration system. The chapter is limited to the basic classes of LADM that are required for first basic level of conformance. The LADM provides three levels (low, medium and high levels) under which any application schema claiming conformance with the LADM must comply with any of these levels of conformance. In order to achieve the said purpose, the analysis of current deeds registration system and cadastral systems is essential. A literature review of current laws that govern the land rights registration, land surveying and sectional title provided insight into the South African land administration system, especially the land registration system.

The research approach also included the analysis of the conventional deed of transfer documents, deed of servitudes, notarial deed of servitudes, deeds of leasehold, and other legal documents were analyzed to establish the kind of information that is registered in these documents. This is was conducted so as to determine what land information related to parties involved in land transactions, the nature of rights, restrictions and responsibilities (RRRs) and how they are represented in the South African deed registration system. The main focus was on the basic relationship between the people and land in South Africa - the real rights in land (e.g. land ownership and other registerable limited real rights).

The chapter presents the overview of the South African land registration system and then followed by the analysis of a content of conventional deed of transfer. This was followed by the examination of the data content (i.e. tables and attributes) from the sample of deeds of transfer text file database. The sample data was acquired from both the South African

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Registrar of Deeds office. Additional information included the DeedsWeb Bulk Information Layouts, the DOTS – List files layout, DRS Weekly Transfer, the DRS Fields, and the Fields in Records sent to Local Authorities. This information was essential in order to enhance understanding the structure of the data presented the acquired deed of transfer text file data. The surveyor-general plans and diagrams were also obtained.

4.2 South African land registration system

The purpose of the South African land registration system is to keep a complete catalogue of real rights (i.e. full and free ownership) and lesser real rights (e.g. mortgage, leasehold, and servitude.) in all land, presenting ownership of each piece of land and any restrictions or obligations affecting ownership of each and every land parcel. This ensured that no double sales are recorded and that the holders of these rights are properly protected. With the advent of the new constitutional dispensation, the role of the system expanded. The new land law through the programme of land restitution, redistribution and tenure reform shifted away from the discriminatory tenure system of permits and licenses.

South African land registration system consists of elements of title registration system and not just deeds registration system as the Act dealing with land registration may suggest, the Deeds Registries Act. The system compiles with most of the requirements of a title registration system: West (2010) describes these requirement as follows:

- *there is a scientifically prepared diagram of each parcel of land in order to eradicate any uncertainty as to the identity thereof, there is security and an indisputable title;*
- *there is continuity and completeness of records;*
- *the deeds are meticulous and accurate because all deeds and documents are thoroughly examined (as prescribed by section 3(1)(b));*
- *there is simplicity as far as the complexity of law allows it; there is effectively and suitability as it has developed over the years.*

Given this background, the South African land registration system is unique in that it contains both elements of title registration and deeds registration. The only reason why the system is not officially regarded as title registration system is because the Deeds Registries Act provides for the registration of deeds documents such as antenuptial contracts, general powers of attorney and notarial bonds and other related documents.

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The South African land registration system is based on the following pieces of legislation: The Deeds Registries Act 47 of 1937 which provides for registration of real rights by the Deeds Registries, the Sectional Title Act 95 of 1986 which provides for the registration of sectional title schemes and units and regulations promulgated in terms of thereof. Various other Acts provide specific provisions pertinent to the registration procedures to be adhere to. These include, amongst others, the Ordinances (e.g. the Town Planning Ordinances) and Rules of the Courts (e.g. the Rule 63 of the High Courts). Chief Registrar's Circulars and internal circulars issued with regard to the registration or execution of deeds. There are also court decisions that influence or amend practice in deeds registry offices. The practical or application problems are clarified through the conference resolutions of all deeds registrars (known as Registrars' Conference Resolutions as well as the Chief Registrar of Deeds circulars and internal circulars. Other sources of the South African registration system include common law, law reports, and Deeds Practice Manuals, etc. The system is founded on the common law principles of immovable property transfer.

The Deeds Registries Act and regulations promulgated lay down the basic practice for the lodgement and preparation of deeds and documents lodged at a deeds registry for execution or registration. However, the Act does not suffice for all the requirements and further rulings must be made to provide for a uniform practice. The CRS are issued in order to establish a uniform deeds practice in all deed registries through the entire country. However, each registrar of deeds may lay down standard practice in his own/her own deeds registry by issuing Registrars Circulars (RC). The RCs are issued for the deeds registry staff/examiners and conveyances in respective registries.

The South African land law does not explicitly guarantee the security of title or other real rights. The system records the rights in land without a state warranty as to the accuracy of the deeds registry. This 'negative' system of land registration in South Africa was adopted its Roman-Dutch precedent. Unlike in a 'positive' system of registration with State warranty of the accuracy of the register, in the negative system, the State does not guarantee that the information held it the registries is accurate. Therefore, system does not assure that the registers reflect a factual picture of the state pertinent to land ownership. Ownership can be acquired by other modes that are not reflected in the deeds office such as by limited to, acquisition by expropriation where notice has been issued on the registered owner but the transfer had not yet been registered in favour of the expropriating authority, ownership transfer in respect of marriage in community of property where such marriage is not reflected in the deeds. Other modes include by transfer by in in fulfilment of the

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fideicommissary condition, by prescription or by statue. The termination of ownership or other real rights by abandonment, merger or termination of principal debt secured by a mortgage bond, are not instantly replicated in the South African deeds registries. It is highly probably to have incorrect entry in the deeds registry.

4.3 The analysis of the conventional deed of transfer

The alienation of vacant State land is done by registration of deed of grant in the deeds registry office which the land is situated. There are a number of deeds offices across South Africa. The subsequent transfer of land ownership is through deed of transfer. A deed of transfer is drawn up in accordance with the provisions of section 20 of the Deeds Registries Act 47 of 1937. Several forms are set out to which deeds of transfer must conform in various circumstances. The general form of a conventional deed of transfer include the following clauses (van der Walt & Pienaar, 2009; West 2010): the preparation certificate; the heading, recital, vesting clause, description of property, extending clause, conditional clause, consideration clause, exclusion clause, registration clause. This section deals with the analysis of a conventional deed of transfer using these clauses.

Figure 18 presents information derived from a conventional deed of transfer prepared in terms of the prescribed Form E of the Deeds of Registries Act.

According to section 20 of the Deeds Registries Act, a deed of transfer shall be prepared in the form prescribed by law or by the regulations promulgated under the Act. Form E is a prescribed form for the conventional deed of transfer. If the form is analysed, the various components can be identified as presented in Figure 18. The analysis of the obtained sample of registered conventional deeds of transfers will now be discussed using these various components. The attributes information presented in Figure 18 were derived from the analysis of the content of the transfer deeds documents.

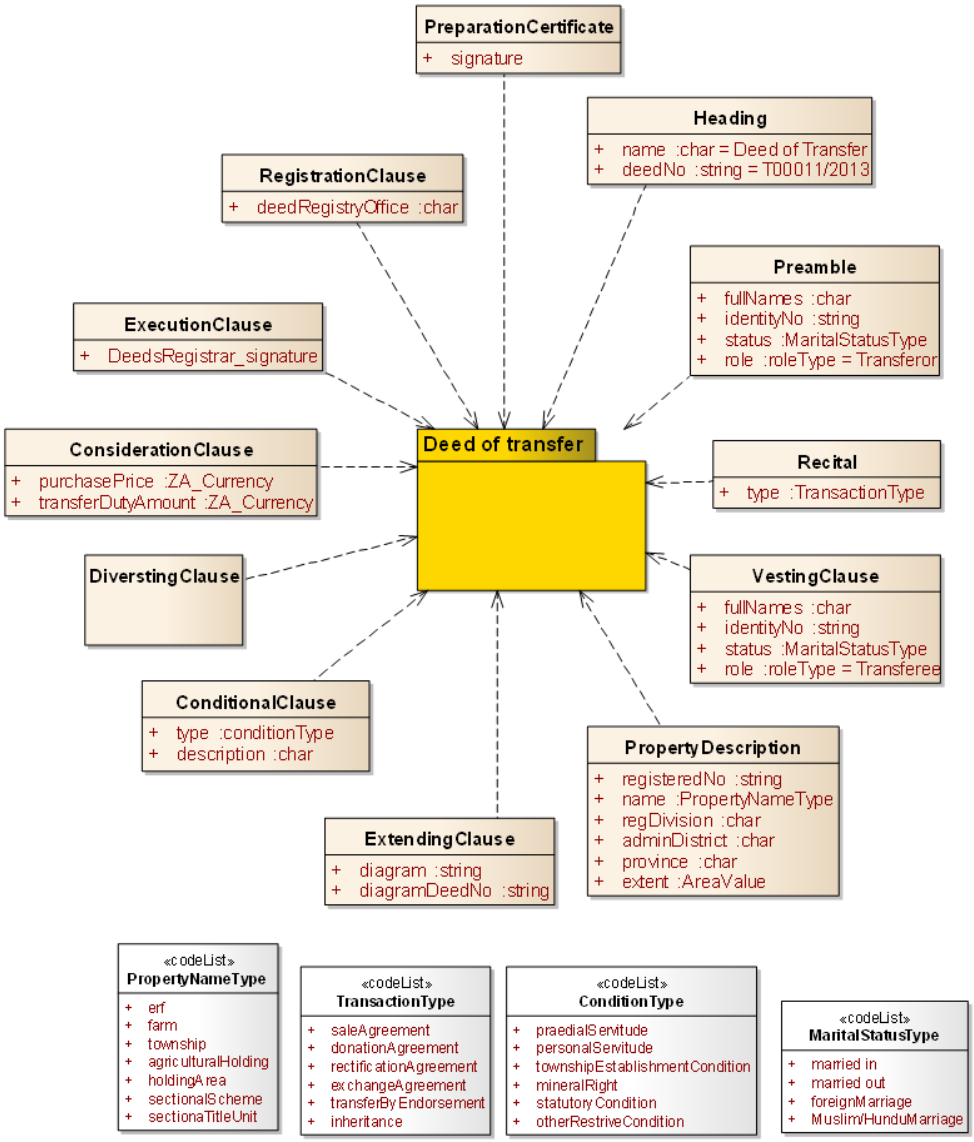

Figure 18. Conventional Deed of Transfer data elements

Figure 18 shows a class diagram of classes and attribute information derived from the Form E which is prescribed for a conventional deed of transfer. The attributes were developed from the actual analysis of registered deed of transfer documents. The different classes presented in Figure 18 are discussed in the following subsections.

4.3.1 The preparation certificate

Section 15 of the Deeds Registries Act provides that only a conveyancer practising in the province in which the deeds office is situated may sign the preparation certificate. The only the surname name and initials of conveyancer are provided in the preparation certificate.

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4.3.2 The heading of a deed of transfer

The nature of deed is disclosed in a deeds registry by means of a *heading* so as to describe the nature of a deed without having to examine it. The heading in this case is usually the "Deed of Transfer". The registrar upon the registration allocates a unique deed of transfer number. Each deed of transfer (including any other deed or document) lodged for execution, registration or filling is filed and recorded under a unique code, for example T 17182/1984, ST 16252/2004, SB 171617/2911. No code descriptions are provided in the deeds of transfer documents. In order to understand what the different codes mean, an additional piece of information had to be acquired. The Chief Registrar's Circular No. 2 of 2009 provided the description of various codes currently used in the deed registries. Table 6 shows the land title lodgement codes used.

Table 6. Land titles lodgement code and description (Chief Registrar of Deeds, 2009)

Land titles – code before the serial number	
Code	**Description**
T	All title deeds of land (inclusive of transfer deeds, deed of grants, certificate of title, all other titles to land, transfer of land by endorsement)
TL	Certificate of leasehold title, all leasehold transfers, transfers by endorsement, and other leasehold titles
TG	Deeds of Grant in terms of the Proclamation 293/1962 and the Proclamation 16/1992
ST	Certificate of Sectional title and all sectional title transfers

In the deed of transfer document, the lodgment code 'T' is used to refer to all title deeds of land (i.e. transfer deeds, certificate of title, deeds of grant registered post 1/11974 and transfers by endorsement). The codes allocated before and after the serial number and year provide clarity on the nature of the deed documents.

4.3.3 The preamble and the vesting clause of a deed of transfer

In the *preamble* of a conventional deed of transfer, the full names, identity numbers, and marital status of the transferor (in case of national persons) or the prescribed particulars of legal persons in order to identify such persons adequately, are contained in the preamble, which also indicates the transferor gives the conveyancer a power of attorney to handle the transfer. The vesting clause of a deed of transfer contains the description of the transferee (full names, identity numbers and marital status of national persons and prescribed particulars of legal persons necessary to identify such persons).

The manner in which various parties (natural and non-natural persons) are prescribed in the Regulations promulgated in terms of the Deeds Registries Act. In terms of the Regulation

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24(1)(a) of the said Act, natural persons must be identified by reference to their full names and official identity numbers (as reflected in the identity document issued by the responsible government authority in the Republic) and or date of birth. This excludes persons acting in representative capacity. No *alias* is permitted in describing any person in any deed or document lodged. The title of person is not allowed to form part of the name of the person involved. The abbreviation of the identity number (i.e. ID Number) in deeds and documents is unacceptable. In case of identification of any non-natural person (i.e. juristic person), full names and registered number (where applicable) must be furnished (Regulation 24(1)(b)). There are a number of non-natural persons that are encountered in deed of transfer documents. These include, not limited to; companies (which are further distinguishable based on types); close corporations, trusts, statutory bodies, non-profit organisations, associations (incorporated or not), tribe, churches, partnerships, etc. In the Deeds Registries Act, a number of parties involved in the land transaction are identifiable.

Table 7 describes some of the various types of parties that are encountered in the South African deeds registration system (as described by West, 2010):

Table 7. Description of parties/persons (as described by West, 2010)

Parties	Description
Natural persons	*Identified* by their full names, either the official identity number and/or date of birth (regulation 24(1)(a))
Companies	*Registered name* and *registration number* (section 50(c) of the Companies Act 61 of 1973 read with regulation 24(1)(b) of the Act))
Close corporations	The above applies to close corporations
Trusts	The Trust Property Control Act 57 of 1988 provides registration of trusts by the Master of the High Court, which allocate a number to such trust.
Bodies incorporated by statute (excluding companies)	These bodies are identified by their names as reflected in the Act in terms of which body was incorporated, for example: *The University of Pretoria, (incorporated in terms of section 3 of the Act 13 of 1930)*
Partnership	Where two or more persons carrying out business in partnership, the names of individual partners, their identity number, and status together with a reference to the name of the partnership or business must be disclosed.
Land of National or Provincial Government	The Constitution of South Africa provides that assets shall vest in the "natural government" or relevant "provincial government"
Joint venture	A joint venture is not a legal persona where the parties are not trading as a partnership. Therefore it is not permissible to vest immovable property in this case.

In summary, the purpose of the preamble of deed of transfer is to reflect the transferor or the person conveying the right to land. The transferor is the most important person in a

deed of transfer. In a deed of transfer, a conveyancer prepares and executes a deed of transfer before the registrar of deeds within which the property being transferred is situated. The name of a conveyancer is disclosed and no reference made to any identity number of the conveyancer. The full names and identity numbers of the owner (transferor) and the person to whom the property is being transferred are provided. Figure 19 presents an instance-level diagram of an example of information content of the preamble and vesting clause of the conventional deed of transfer. This diagram was developed from the real data derived from a registered deed of transfer document. For protection of personal information purposes, the name and identity numbers of the parties are fictitious.

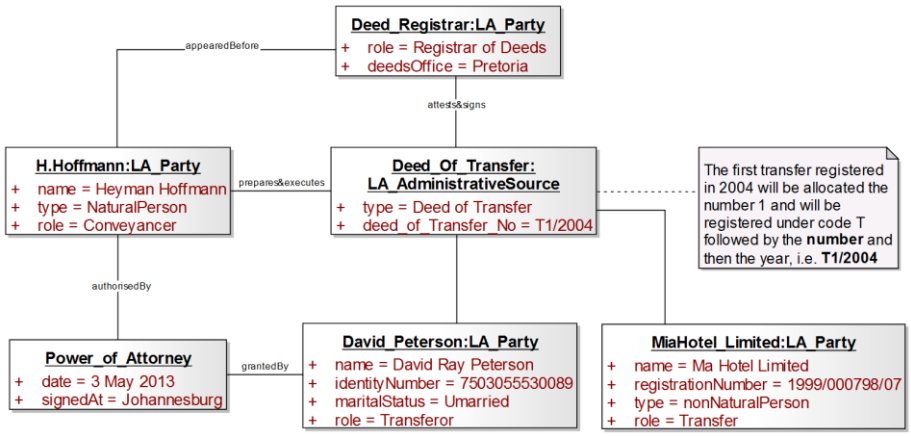

Figure 19. Parties in deeds of transfer permeable and vesting clause

The instance level-diagram in Figure 19, illustrates a conventional deed of transfer by sale agreement. The LADM LA_Party and LA_AdministrativeSource concepts were used. In the Figure, Heyman Hoffmann, plays a role of a conveyancer who is authorized by a power of attorney granted by the transferor (owner), David Peterson, to prepare and executes a deed of transfer. In the deed of transfer the first name and the surname of the conveyancer are furnished. There is no reference made of the identity number (or any professional registration identity number) of conveyancer inserted in the deed of transfer. The registrar of deeds attests and signs the deed. The information related to the registrar of deeds is his/her signature and his/her registrar's office. The full particulars of both the transferor and transferee are inserted in the deed of transfer. In this instance, the transferor is a natural person and the transferee is a non-natural person (i.e. a company). Both the descriptions of the natural person and non-natural person in this instance-level diagram conform to the Regulation 24(1) of the Deeds Registries Act. Natural persons are described by reference to their full names, identity number (as registered in the national population register) and the marital status. As shown in Figure 19, the transferee is identified by making a reference to

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its registered name "ABC Hotel Limited" and registration number as registered in the company register. In South Africa, companies are registered in the company register in terms of the Company Act. The extPID (identifier of party in the external register/database) attribute of the LADM supports the registration of identity numbers of both the natural and non-natural persons. In the deed of transfer documents, a reference is made to a power of attorney (which can rightfully be regarded as an administrative source document) permitting a conveyancer to prepare and execute a deed of transfer on behalf of the owner or the transferor. In summary, the instance-level diagram illustrated the nature of party information encountered in a conventional deed of transfer.

4.3.4 The recital clause of a deed of transfer

The *recital* clause of a deed of transfer provides the reasons initiating the transfer of property from one party to other. The prescribed Form E to the regulations of the Deeds Registries Act requires that an appropriate recital of the nature of the transaction or the circumstance initiating the transfer be inserted in a deed of transfer. However, there is no standard form for a recital of a deed of transfer. The recital follows immediately after preamble in a deed of transfer. The aim of the recital is to disclose the reason of the transfer. This is important in order to determine as whether the deed of transfer is permissible and/or registerable in the deed registry. For example, Section 91 of the Deeds Registries Act states that no transfer of land that is passed as security for a debt or other obligation shall be attested by any Registrar or registered in any deeds registry.

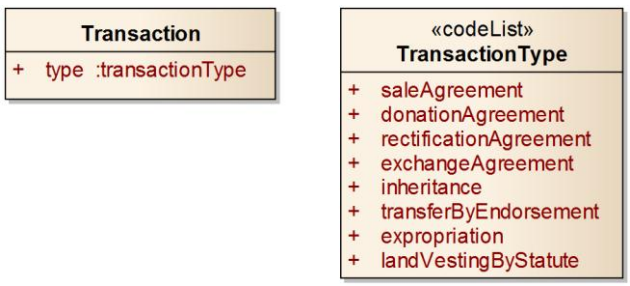

Figure 20. The land transaction types encountered in the deeds of transfer

Figure 20 shows a class diagram of the most common types of land transactions encountered in the deed of transfer. As a general rule, the land may be transferred from one party to another by sale agreement, donation, rectification, inheritance, by endorsement, expropriation, etc. The nature of transaction can be identified in the recital clause of deeds of transfer documents. Appendix 7 shows a deed of transfer for sale of property.

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4.3.5 The property description clause of deed of transfer

The Regulation 28(1) of the Deeds Registries Act describes the information that need to be furnished when describing land in any deed: the *name of registration division, administrative district* and *province* in which the land is situated, or in the case of land situated in a *township*, the *registration division* concerned, *administrative district*, the name of such a township and the province; (b) the *registered number* (if any) of such land. The land description in the deed of transfer or any deed can be worded along the following:

> "Erf 159" or "Portion 103" of "Erf 200" or "Holding 55", if it is agricultural land "The farm Braamfontein" or "Portion 12 of the farm Schnoord " or "Portion 200 (a portion of 12) of the farm Chloorkop", etc.

In describing land, no reference shall be made in a deed conferring title to land or any interest therein, or in a mortgage bond, to any building or other property, movable or immovable, which may be on or attached to the land (Regulation 28(2). It is not necessary to repeat the description of (if any) of the boundaries mentioned in a diagram, provided that a suitable reference to such diagram is made in the relevant deed. In describing immovable property, the term *'share' shall be employed* when an undivided share in a piece of immovable property is dealt with, and such share shall be expressed in one fraction in its lowest term, the method of arriving at the result being also given in complicated cases: Provided that when the denominator of the fraction exceeds two figures, the fraction shall be expressed as a six figure decimal (Regulation 30).

The extent of the land and not the surface thereof must be furnished in a deed. Regulation 29 refers to the 'extent' of land and prescribes that it must be expressed in words and figures. Where the extent of the land is expressed in a title deed in the old measure (i.e. sq. ft.) must be converted to the metric.

In the case of a sectional title scheme, the property description must be described by referring to the *number of the section, name of the scheme,* and the *sectional plan number*. No reference needs be made to the undivided share in the common property. The exclusive use area must be described by referring to the exclusive use area. For instance, G 10, name of the scheme, and the sectional plan number. Figure 21 illustrates information derived from land and sectional title scheme descriptions, as described by the Regulation 28 of Deeds Registries Act, and Sectional Title Registries Act and its regulations, respectfully. The information presented in Figure 20 was also derived from the analysis of the real data.

The class diagrams presented in Figure 21 was developed from the analysis of a real data derived from a registered deed of transfer documents. A deed of transfer of land and a deed of transfer for a sectional title unit were both examined; using the LADM conceptual framework. Appendix 4 shows an instance-level diagram of a sectional unit (i.e. an apartment) while appendix 5 illustrates an instance-level diagram of a deed of transfer of an erf (i.e. land parcel). All these diagrams were developed from the sample data.

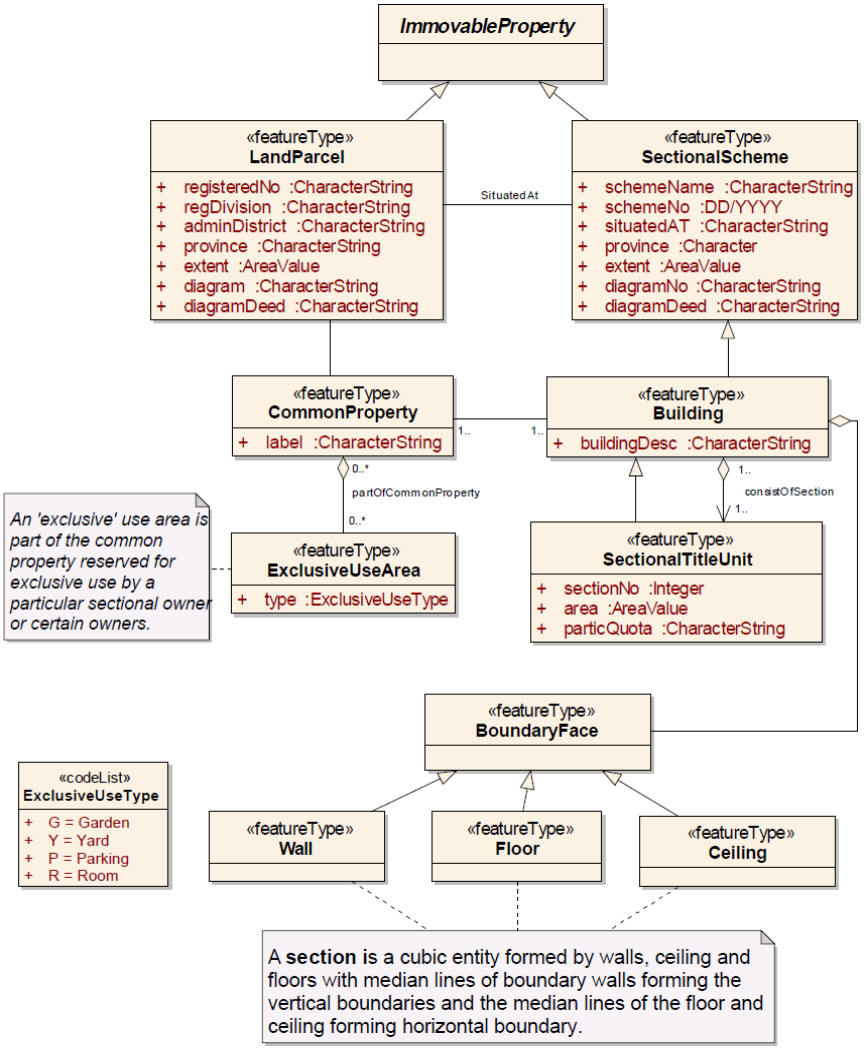

Figure 21. The South African Cadastral Property Model

4.3.6 The extending clause of a deed of transfer

In the extending clause of a deed of transfer, the reference is made to the original deed to which the map of the land is attached and also the deed of transfer of the transferor. The purpose of the extending clause is to give a reference to the diagram that was approved by the Surveyor General for the land as well as the *diagram deed*. The purpose of the diagram is used to determine the location of the land; that is the boundaries of the land, its width

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and length. It also shows the title land under which the land was lastly held. There are two forms of extending clauses encountered in the deed of transfer: the first form is diagram deed or original deed in respect of land that was not previously registered. The second form of an extending clause is the one that appears in a title deed in respect of a portion of land that is already held under a title deed. The following examples were derived from the analysis of a conventional deed of transfer document:

In respect of land not previous registered, the extending clause found to be worded as: *"As will appear from the annexed diagram (or general plan) S.G. No A 101/1994 and held by Deed of Transfer (grant or certificate of title) No. T3578/2004".*

In the case of a portion of land that is already held under a title deed, the extending clause found to be worded as: *"First transferred and still held by deed of transfer T12345/1967 with diagram S.G. No A8910/1967 annexed thereto".*

4.3.7 The conditions clause of a deed of transfer

In the conditions clause of a deed of transfer, various types of restrictions and responsibilities were encountered. The conditions clause of deed of transfer contains the conditions and limitations registered in respect of the land. For example, praedial servitudes, personal servitudes (e.g. *usufruct, habitatio and usus*), conditions of township establishment, reservation of mineral rights, statutory conditions, and other restrictive conditions are included. For example, the following condition was encountered in the registered deed of transfer document:

> *"A dwelling to the value of a least R500 000 not be erected on the property before a certain date, the land in question will revert to previous owner".*

This is called a reversionary *right* as the condition provides that on the occurrence or non-occurrence of some or other event, the ownership of land will revert to the previous owner (usually a local authority). The following restrictive conditions were encountered the in condition clause of a conventional deed of transfer document registered in a deed office:

- **Servitude of right of way and use**: *By Notarial Deed of Servitude dated the 8th November 1949 registered on the 15th December 1949 under Contract Ni. F 351/49 a perpetual right of way and use over certain portion of the Building erected on this Lot and Lots No. 164 and 166 Berea Township, has been granted to the City of Johannesburg, for the purpose of an Electricity Transformer Camber.*

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- **Servitude of access***: The right to enter and be upon the servitude area at any time in exercise of the aforesaid rights whether it be to construct, erect, use, maintain, repair, relay, alter or inspect the structures, works, conductors or appliances there present or whether it be in the course of gaining access to any adjacent property in the exercise of similar rights held in respect of that property or properties.*

- **Right to lease a servitude area by servitude holder***: ESKOM shall have the right to lease any portion of the servitude area and/or any of the installations and apparatus thereon to any third party on such conditions and use as ESKOM may deem fit.*

A restrictive condition can be endorsed against the property and inserted in the deed of transfer which provides that specific properties (Erven) are notarially tied and that none of them shall be disposed of separately from others except with the consent of a specific person in whose favour the condition is registered. The condition is created by a means of a notarial deed which is registered in the deeds and endorsed against the deed of transfer of the affected property. An example of such a condition was encountered in the conditional clause of a deed transfer document was quoted as:

> *"By Notarial Deed No. F100/61 dated 25th August, 1960, this Erf and Erven Nos. 160, 162 and 166 Berea and Erven Nos 168 and 170 Berea shall be tied and none of them shall be disposed of separately from others except with the consent of ABC Limited, as will more fully appear from the said Notarial Deed registered on 13th April, 1961."*

A real restrictive condition can be registered which prohibit the building of a house of specified extent on a property. For example, *no house of smaller then 250 square metres may be erected on the property*. A restrictive condition in respect of buildings encountered in the examination of the deed of transfer included one that prohibits the construction of buildings prior to submitting and approval of building plans to relevant person:

> *On this erf no buildings shall be erected until the plans have been submitted and approved by the township owner, and no buildings shall be built thereon at a distance of less than 3,55 metres from the street boundary; provided, however, that it shall be in the discretion of the township owner where such provision cannot be applied to remove this restriction either wholly or in part.*

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The LADM supports not only the recordation of the rights and restrictions over land, but also the responsibility over land. In the condition clause of a deed of transfer, various responsibility conditions were encountered. For example, the following condition was extracted from a conditional clause of a deed of transfer document:

> *"This erf shall be neatly and properly fenced by the purchaser with wood and iron railings or good wire fence (or with any suitable material). The fence shall always be kept in good and through repair by the owner of the said lot for the time being".*

It must be noted that the conditions encountered in a deed of transfer do not necessarily reflect all applicable conditions. It only covers those conditions that have already been registered against the land when it was transferred. As a common practice, other conditions are usually endorsed against a deed of transfer after registration. For example, a condition declaring a marriage out of community of property is usually endorsed against the title deed of the property. Many other conditions related to the zoning can be found in the municipal land use management schemes prepared in accordance with various provincial town planning ordinances and other related land use management policies. There is no uniform standard prescription of inserting conditions.

4.3.8 The diverting and consideration clauses of deed of transfer

The diverting clause immediately follows the conditions clause of the deed of transfer. In this diverting clause, the transferor divests himself of his ownership in favour of the transferee. For example, a diverting clause may read as follows:

> *"Wherefore the appear, renouncing all the rights and title (the name of the transferor) heretofore had to the premises, did, in consequence also acknowledge it to be entirely disposed of and disentitled to the same, and that by virtue of these presents, the said (the name of the transferee) its successors in title or assigns, now is and henceforth shall be entitled thereto conformably to local custom, the State, however, reserving its rights, and fully acknowledging the* ***purchase price*** *to be the sum of (R 2 790 000, 00 (TWO MILLION SEVEN HUNDRED AND NINETY THOUSAND RAND) and the date of sale to be the* ***11th day April, 1984****.*

In the consideration clause, the *purchase price* or amount on which transfer duties have been paid is mentioned. In case where the reason for the transfer is not sale, the property value that was used to for the transfer duty purposes is inserted in the deed of transfer.

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4.3.9 The execution and registration clauses of a deed of transfer

The execution date is the date on which a deed of transfer is executed before the registrar of deeds is recorded in the execution clause. The signatures of the registrar of deeds and the transferor or his empowered conveyancer are encountered in the execution clause. The date of execution (also referred to as registration date) is inserted in the execution clause. In the registration clause, a reference is made to the register in which the information is to be filed. The registration clause is not necessary where records are computerized.

4.4 The results of the analysis of the conventional deed of transfer

The analysis of the conventional deed of transfer provided an insight into understanding information contents pertinent to the description of parties, the nature of rights and restrictions encountered as well as the legal description of land. It was not practical to examine and discuss all the deeds documents tendered for registration or execution in the deeds registries due to time constraints. However, other documents such as deed of lease, deed of servitude, notarial deed of route descriptions, deed of transfer of sectional title, were only modelled into various instance-level diagrams presented in the appendices. The conventional deed of transfer was fully discussed in this section, with a particular reference to the information contents and the legal prescriptions that define how the information must be presented in the deed of transfer or any other deed.

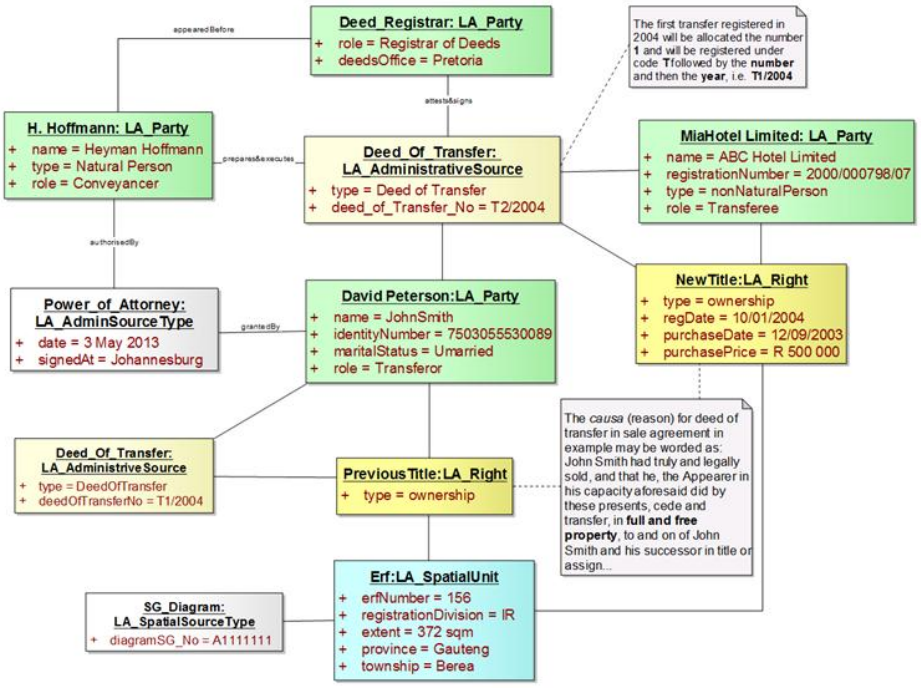

Figure 22. An instance diagram of a conventional deed of transfer by sale agreement

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Figure 22 illustrates an instance-level diagram of a deed of transfer derived from a conventional deed of transfer document registered in the Pretoria deeds registry office. The names of parties where substituted by fictitious ones for the purpose of protecting of sensitive personal details. The LADM was used in order to generate the instance-level diagram presented in the figure 22. The diagram shows parties involved in the sale transaction of property: the registrar of deeds, conveyancer, the party acting as transferor and the party acting transferee of the property right in land. The reference is made of the previous title deed within which the land was lastly held. The new title deed is referred to in the new deed of transfer document. The information presented in the object classes were derived from the analysis of the conventional deed of transfer.

It can be concluded that in the South African land registration system, different parties, rights, restrictions and responsibilities (RRRs) over immovable property are encountered in the deeds of transfer documents. Although, these RRRs relate mainly to the private real rights and limited real rights, other public rights created in terms of other laws such as those related to the town planning ordinances and other provincial ordinances are also encountered. The analysis of the conventional deed of transfer was based on the registered documents that were acquired from the deeds office. The deed of transfer conforms to the prescription of the Form E prepared in terms of the Deeds Registries Act. South Africa has introduced an electronic system of capturing the deeds of transfer, other deeds and documents tendered for registration or execution in the deeds offices. Therefore, it is important to examine the South African electronic deeds registration system so as to ascertain the contents of data captured from the conventional deeds of transfer and any other deed documents. The registered deeds and/or documents (e.g. deeds of transfer, registered title deed certificates, mortgage bonds, deeds of lease, deeds of servitude, notarial deeds, antenuptial contracts, etc.) tendered for registration or execution may rightfully be described as the primary sources of the South African land registration data. The data is captured through legal processes of conveyancing and recordation of land administration information related to parties involved in land transaction and their interests over land. The information captured from these administrative or legal source documents is then captured into the electronic land registration system.

The following section deals with the electronic deeds information derived from the South African deeds registration system. The sample data from the system was acquired and examined so as to understand the contents of the deeds data.

4.5 The analysis of the electronic deeds registry information

The preceding section presented the analysis of the conventional deeds of transfer in order to establish the information contents related to parties, RRRs and spatial descriptions of land. The section examined the registered deeds of transfers as a primary data source. In order to conduct the comparison analysis between the South African land registration system and the LADM conformant levels one classes, the following deed data sample was obtained as presented in Figure 23.

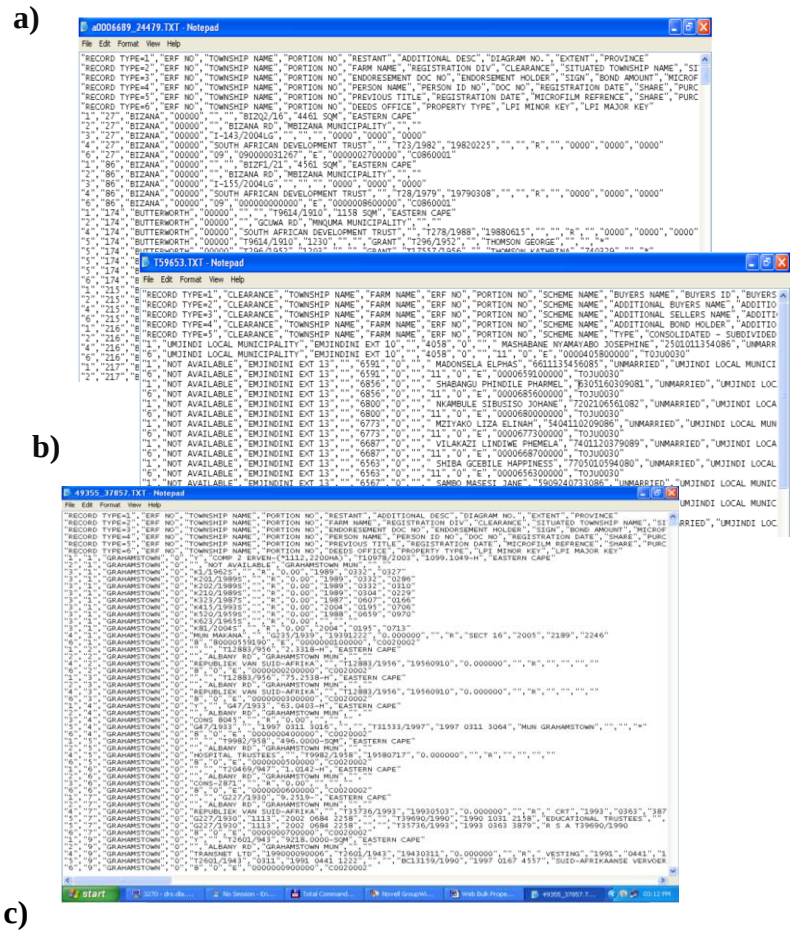

Figure 23. The text files of deeds data showing the Record types with associated attributes for the (a) bulk Property, (b) Person, & (c) Transfer records

The deeds sample data contained five types' record types which represented different attribute information: *Record type* 1 contained all property description information; *Record type* 2 contained information related to local authority; *Record type* 3 contained information related to endorsements, bond, encumbrance or restrictions endorsed against the properties in the deed registries. *Record type 4* contained the person information registered as property owners in the deed registry office. *Record type* 5 contained historical

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information about the properties, previous property owners' and the new title, etc. The *Record type* 6 contains the tracking information. The digital deeds records files of the bulk property, persons and weekly deed transfers were examined.

The South African Deeds Registration Data Model (SADRDM) was derived from the digital deeds records presented in Figure 23. The SADRDM is presented in Figure 24. The class diagrams and attribute information were derived from the deeds transfer data supplied in a text file format (see Figure 23). The metadata describing the codes used in the *record type*, *person types*, *property type* and *deeds office* was acquired from the office of Chief Registrar of Deeds. Figure 24 presents the South African deeds registration model derived from the electronic deeds information sample. As shown in the Figure 24, four main classes were derived: Person, property, endorsement, clearance, historical, and tracking classes. The attributes of each class are shown. The codes and their descriptions are showed in the enumeration classes in Figure 24.

The following section provides an analysis of the South African deeds registration data model derived from the electronic deeds transfer data, as presented in Figure 23 and 24. The cross-mapping of classes and attributes of the derived South African data model against the LADM basic classes is presented in tabular format.

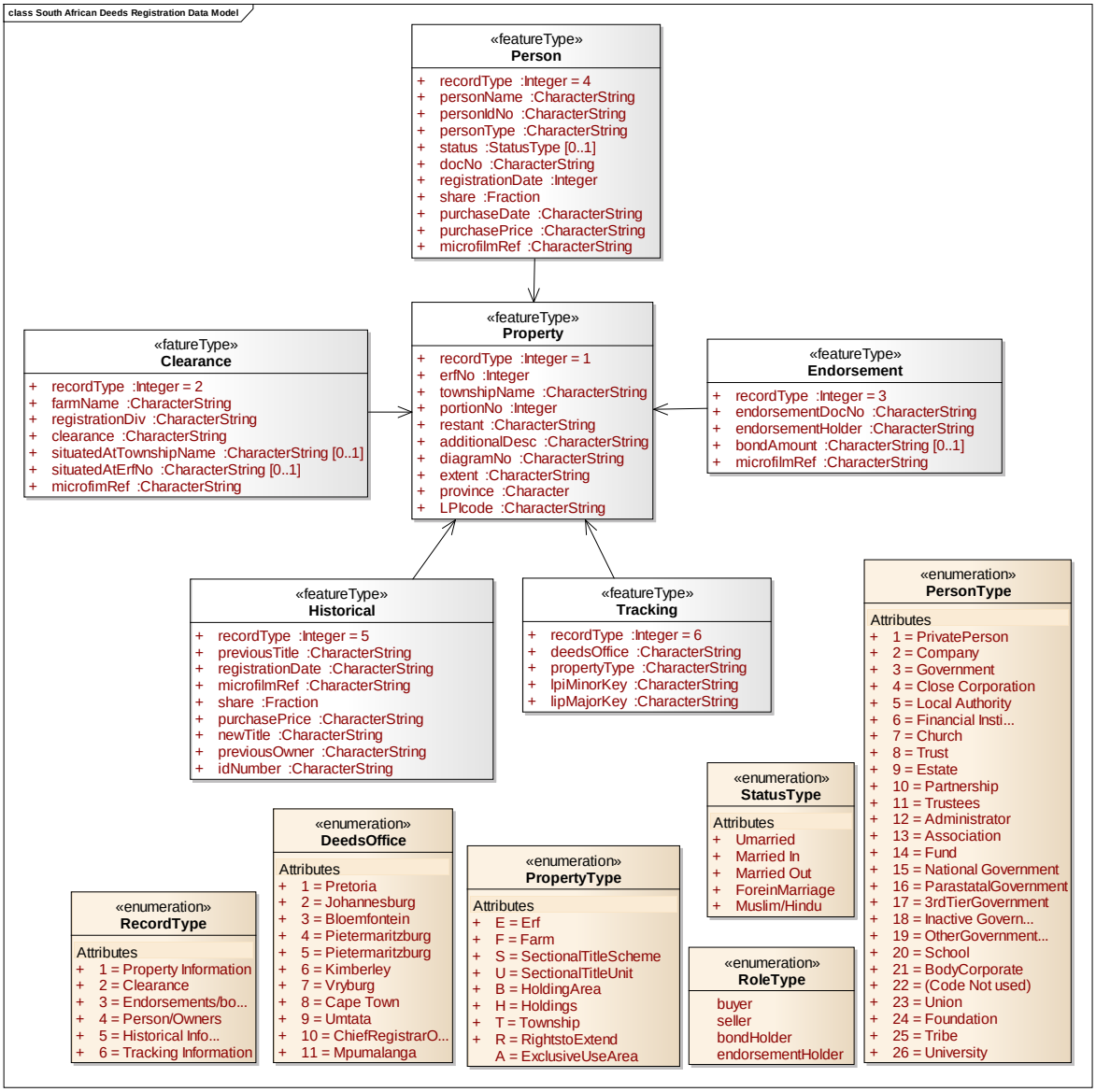

Figure 24. South African deeds registration data model derived from the deeds data

The *property class* is the core class in the South African deeds registration data model. The property class contains descriptive property information (i.e. the registered number of property, property name, portions, extent, unique property identifier, etc.). The *clearance class* contains additional information related to property (i.e. farm name, registration division, clearance or local authority within which the property is situated, in case of sectional tile scheme, situated at township name and situated at erf number are also provided, etc. The *endorsement class* contains information related to other limited real rights endorsed against property (e.g. bonds, servitudes, leasehold and other limited real rights). The *person class* contains of information related to persons and other information

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related to the type of deeds document, registration date, shares, purchase price, purchase date and microfilm reference information. The *historical class* contains historical deeds transfer information (e.g. previous title to land, previous owners, etc.). The *tracking class* contains information for the purpose of tracking the deeds information (i.e. deeds office name, type of property, reference number, etc.). Table 8 shows the cross-mappings of the LADM basic classes against the South African corresponding data records.

Table 8. The LADM basic classes and their corresponding record types

LADM basic class	Person	Record Type description
LA_Party	**Person**	This contains person/owners information
LA_Right (LA_RRR)	**Person**	This *record type 1* also contains title deed numbers which one can make up the nature of rights from the codes and descriptions.
LA_Restriction*	**Endorsement** *(Record type = 3)*	This *record type 3* contains endorsements registered against the property. These are basically restrictions or encumbrances registered within the deeds office. For example; servitudes, mortgage bonds, notarial bonds, interdicts, etc.
LA_Responsibility*	-	
LA_BAUnit	-	
LA_SpatialUnit	**Property** *(RecordType = 1)* **Clearance** *(RecordType = 2)* **Tracking** *(RecordType = 6)*	This *record type 1* contains property descriptions: registered property numbers (e.g. erf no, townshipName, portionNo, additional description. *RecordType = 2* contains other information related to property: clearance (localAuthority), situated TownshipName (for Sectional schemes); situatedErfNo (for sectional scheme only); RecordType = 6 contains the propertyType, lpiMinorKey and lpiMajorKey (all together make up unique Land Parcel Identifier (LPI) code.
LA_AdministrativeSource (LA_Source)	**Person** (RecordType = 4)	This record contains information related to the legal deed documents (i.e. diagramNo (**T**10978/2008), and microfilm references
LA_SpatialSource	-	
VersionedObject	**Tracking** *(RecordType = 6)*	This record contains historical information of the previous property transactions. Information about the previous parties, property descriptions, deeds title documents numbers, and endorsement.

4.5.1 LADM LA_Party and South Africa LA Party comparison

The *record type 4* contains the information about the particulars of the parties and other information related to deed documents involved in the land transaction. Only attributes related to the parties (persons, buyers and sellers, owners) were taken and modelled into a

UML class diagram so as to easy the cross-mappings of the LA_Party and the derived South African LA Party (Person). Table 9 shows the attribute comparison between the LADM LA_Party class and South African LA Person. The term person is used in the deeds registry to refer to the natural (also referred to as private person in the data presented by deed registry) and non-natural persons (also known as legal or juridical persons).

Table 9. LA_Party and Person attribute comparison

LA_Party	Person (RecordType 4)	RecordType 4 attribute description
extPID*	personIdNo	This is the unique identity number (or registration number in the case of a trust, the trust number, etc.) of the person from the external register. In the case of a natural person a (natural) population register and in the case of a company or close corporation, in the registrar of companies, etc.
name*	personName	The full names of person (both natural and non-natural persons)
pID	*personIdNo*	Natural persons are identified by their identity number and full names whereas the companies, close corporation, trust are identified by their registration numbers. In some instance, the person's name with reference to Section of the Act that gives provision for such persons must be provided.
role*	-	The person attributes name reflects the two type of role; namely; the seller (sellersName, sellersID, etc) and buyer (BuyersName, BuyersID, etc).
type	personType	This contains person type codes (**1**= private person; **2=** company; **3=** government, etc.)
-	status	This is the marital status of a natural person. For example, unmarried, married in community of property, etc.

*optional attribute

The *personIdNo* attribute contains the identity numbers or registration numbers (where applicable) of the parties involved in the land transaction. The identity numbers contained in the *personIdNo* are not allocated by the deed registry but by the authority that created the identity of parties. In terms of a natural person, the full names and identity numbers or birth day (where necessary) must be inserted, while registration number is used for non-natural persons such as companies, close corporations, trusts, etc. In some cases, only the name of the party is used as the identity of the party.

Figure 25 illustrates a basic person classes derived from the South African deeds registration information and the LADM Party class. The *personType* enumeration class contains the *personType* code and description. The data sample of the deeds transfers acquired from the deeds office only contained the person codes, thus making it difficult to

understand them without the code descriptions. The metadata document that describes the different person codes was acquired from the deeds registry office. The role types presented in this class diagram were derived from the record names presented.

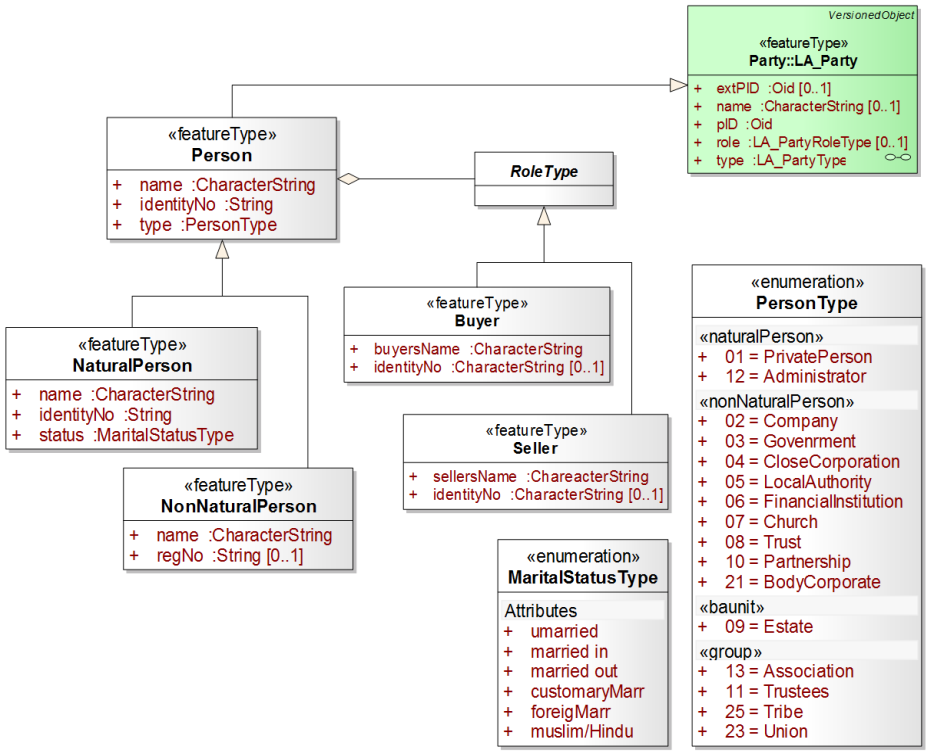

Figure 25. The LA_Party and the South African Person (Party) classes

It is an established practice that the marital statuses of natural persons are furnished in the deeds documents. This information is essential for both a registrar of deeds and practitioners in establishing as whether the party has the legal capacity to effect any action to transfer any immovable property registered in such a party's name. For example, a party whose is married in community of property has limited contractual capacity, hence may no alienate any immovable property forming part of the joint estate without the written consent of the other spouse (section 15(2)(a) of the Matrimonial Property Act, 1984). There are different types of marriages that are encountered in the deeds and documents: married; married in community of property, married out of community of property, foreign marriage (marriage of which legal consequences is governed by another country); marriage concluded in accordance with Muslim and Hindu rites, indigenous customary marriage, etc. The LADM party class does not require the marital status of natural parties to be furnished. Therefore, the South African party class would need to incorporate the marital statuses of natural parties, excluding those serving in representative capacity.

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4.5.2 LA_Right and ZA_Right comparisons

Table 10 shows the *LA_Right* class and the South African rights classes created from the sample data received from deeds office.

Table 10. LA_Right and ZA_Right attribute comparisons

LA_Right	ZA_Person	ZA_Person attribute description
description*		
rID	deedNo	This is title deed number for the title deed document that is registered in the deeds registry office
share*	share	The percentage share of ownership. If a person owns 50% of the property then it will be shown as 0.5.
shareCheck*	-	
timeSpec*	-	
type	deedNo	The deedNo represents the different categories of ownership rights (for example all the ownership rights starts with a code T followed by serial number. **T**1/2013, In the case of sectional title code **ST** (ST2/2013).
-	purchaseDate	This implies the date on which an offer to purchase was signed and accepted.
-	purchasePrice	This is the amount or price paid for the property. The following are encountered: T/T; TBE, Endorsement, TransferByEndorsement, Vesting, SECT 35, ESTATE, Rectification, Unknown, SGDT, CRST, etc.
-	registrationDate	This is the registration date of the property in the deed registry office. This is also known as the transfer date
-	microfilmRef	This is the unique microfilm reference number for the document used for retrieval purposes. The title deed documents are microfilmed for archival purposes in the deeds registry offices. The microfilm may be available and in some cases not available.

*optional attribute

The *Endorsement class* stores restrictions endorsed against the properties. For examples, mortgage bonds, notarial servitudes, mineral rights, sequestrations, deed of lease, sectional bond, notarial bond, court orders, caveat, general interdicts, surveyor-general interdicts, antenuptial contract, or court order declaring marriage in community of property, leasehold bond, etc. The *endorsementDocNo* attribute stores codes and serial numbers allocated by the relevant deeds registry offices for various types of endorsements. The *endorsementDocNo* reflects the nature of endorsement, for example, B123/2013, SB 2910/2007, SK123/2013S, and K234/1983RM. In order to understand the description of the nature of endorsement registered against properties, one needs to refer to additional documentation outside of the sample data. The Chief Registrar of Circular (2009) provides

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for the codes and descriptions used in the deeds registries. Table 11 shows the cross-mappings of LA_Restriction and the corresponding South African Endorsement entity.

Table 11. LA_Right and Endorsement attribute comparison

LA_Restriction	ZA_Endorsement	ZA_Endorsement attribute description
description*		
rID	endorsementDocNo	This is title deed number for the title deed document that is registered in the deeds registry office
share*	-	
shareCheck*	-	
timeSpec*	-	
partyRequired*	*endorsementHolder*	This is the holder of endorsement. In the case of a bond this will generally be the bank
type (LA_Restriction)	*endorsementDocNo*	The *endorsmentDocN*o represents the different categories of restrictions registered or endorsed against the ownership rights. For example, bonds, servitudes, interdicts and other restrictive conditions such as notarial tied together properties,
amount*	amount	The *amount* of endorsement. In the case of a bond this will be registered bond amount and not necessarily the outstanding amount. The bank can be contacted to find the outstanding amount.
interestRate*	-	
ranking*	-	

*optional attribute

There are no records or attributes in the sample data and structure that reflects the *share*, *shareCheck*, *timeSpec*, *interestRat*e and *ranking*. These are optional attributes and it suffices to just describe them briefly. Information regarding the *interest rates* is reflected in the mortgage bond document and is not inserted in the deed of transfer, or title deeds. The interests in the mortgage bond at the time of the transaction or approval of the bank are recorded. The financial institution can be contacted to obtain the actual interest rates and the outstanding amount. The amount in the case of a mortgage bond is the amount registered in the bond not necessarily the outstanding amount.

The holder of endorsement is reflected in the endorsement attribute, *endorsementHolder* which stores the name of the party holding the endorsement (Table 11). Most of the records encountered in the deeds sample data relate to financial institution, for example, First Rand Ltd, ABSA Bank Ltd, etc. The *endorsementHolder* can be represented in the Party class of LADM. The *partyRequired* attribute can then be implemented to indicate if

the party is required. Figure 26 shows the integration of the South African rights and restriction classes derived from the sample deeds data and the *LA_RRR* classes.

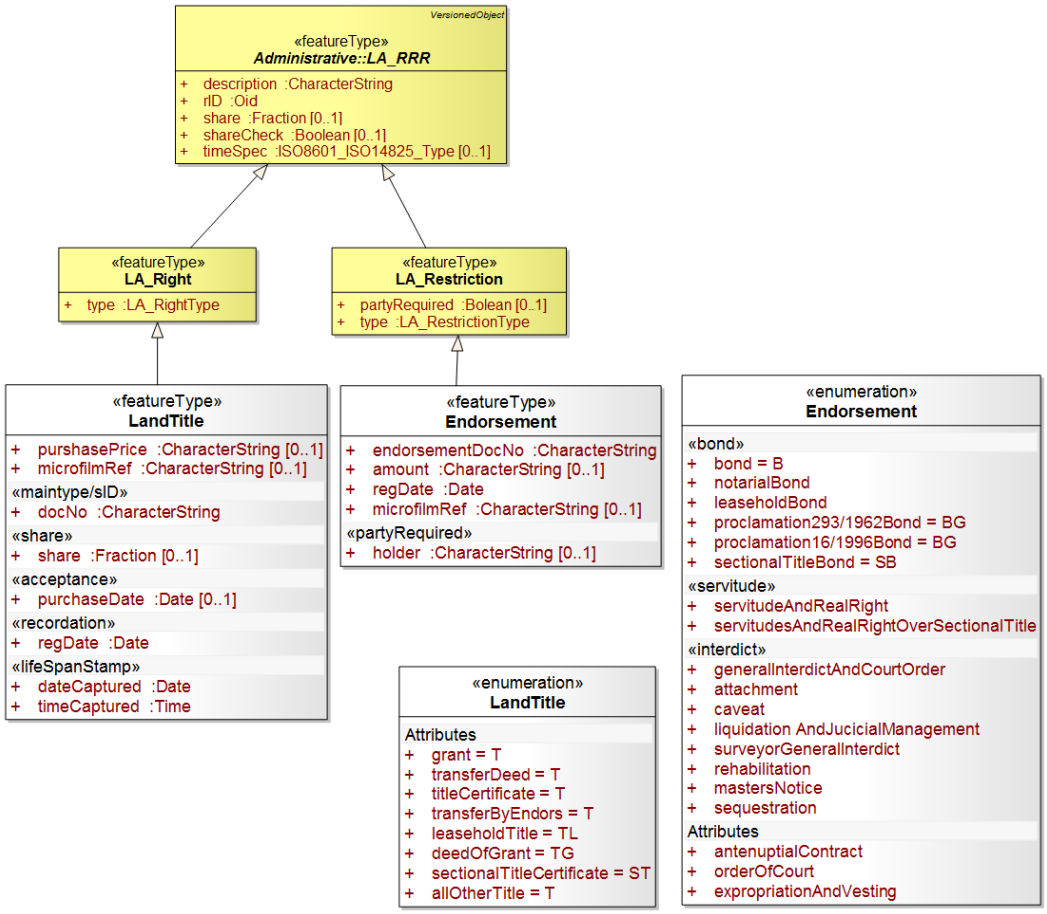

Figure 26. LA_RRR and South African classes of rights and restrictions (endorsements)

4.5.3 LA_BAUnit and corresponding South Africa entities comparisons

The *BAUnits* are administrative entities consisting of zero or more spatial units against which one or more unique and homogeneous rights, restrictions or responsibilities are associated to the entire entity (Lemmen, 2011). Rights, Restrictions or Responsibilities (RRRs) may affect only a part of the spatial unit, with the geometric representation of that part unknown, undermined or missing. In the South African deeds registry, it is established practice to register line servitude over a property of which the exact route description is undermined or unknown at the time of registration of the servitude. The exact route is then determined later and registered against the property by means of a notarial deed of route description. This is most common for electricity lines servitudes. Appendix 12 shows an

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instance-level diagram of a notarial deed of route description. Table 12 shows the *LA_BAUnit* and corresponding South African entities comparisons.

Table 12. LA_BAUnit and corresponding South African entities comparisons

LA_BAUnit	ZA attributes	ZA attribute description
name*	-	
type	*docNo* *endorsementDocNo*	Identifies the type of unit: land title, sectional title, leasehold, servitude, prospecting contract
uID	*docNo* *endorsementDocNo*	

* optional attribute

4.5.4 LA_SpatialUnit and South African (ZA) Property comparison

Table 13 illustrates the comparison between the *LA_SpatialUnit* and the South African cadastral property (ZA_Property).

Table 13. LA_SpatialUnit and Property attribute description

LA_SpatialUnit	ZA_Property	ZA_Property attribute description
extAddressID*	-	
area*	extent	This is the size of the property. It is usually represented as square metres
dimension*		
label*	erfNo	This is the registered number of property. It does not only include the erfNo but contains agricultural holding no, holding no, farm no, sectional title scheme no.
	townshipName	townshipName contains not only the township name as the attribute field name suggests but may also contain agricultural holding name, scheme name, registration division (farms).
	additionalDesc	The additional property information where necessary.
	portion	portion no or sectional title unit no (in the case of sectional title scheme)
	restant	The remainingExtent/restant attribute contains the remaining extent of the property, for example, the remaining extent of a township or farm or erf, etc.
	province	This is the name of province within which the property is situated
referencePoint*		
suID	LPICode	A LPI stands for *Land Parcel Identifier*. This is the unique code for property allocated by Surveyor-General office within which the land is situated and it

		is used mainly for mapping purposes.
surfaceRelation*	-	
volume*	-	
-	diagram	diagram (also known as diagramDeedNo) is the original deed when the property was first registered in the deed registry. It is mainly used for reference purposes.
-	propertyType	The type of property. There are various types of properties registered at the deeds offices. The following are codes that are encountered in the deeds data: E = Erf; F = Farm, T = Township, etc.

*optional attribute

Land is described with reference to registered number of the land (e.g. erf no 1, *Portion 5* of *Erf 200*" or "*Holding 55*", if it is agricultural land "*The farm Braamfontein*" or "*Portion 12 of the farm Parkfontein*" or "*Portion 200 (a portion of 12) of the farm Swaartkoppies*", etc. The description includes the name of registration division, administrative district and the name of the province within which the land is situated.

Figure 27 illustrates types of property and associated attribute information as derived from the sample deeds registration data.

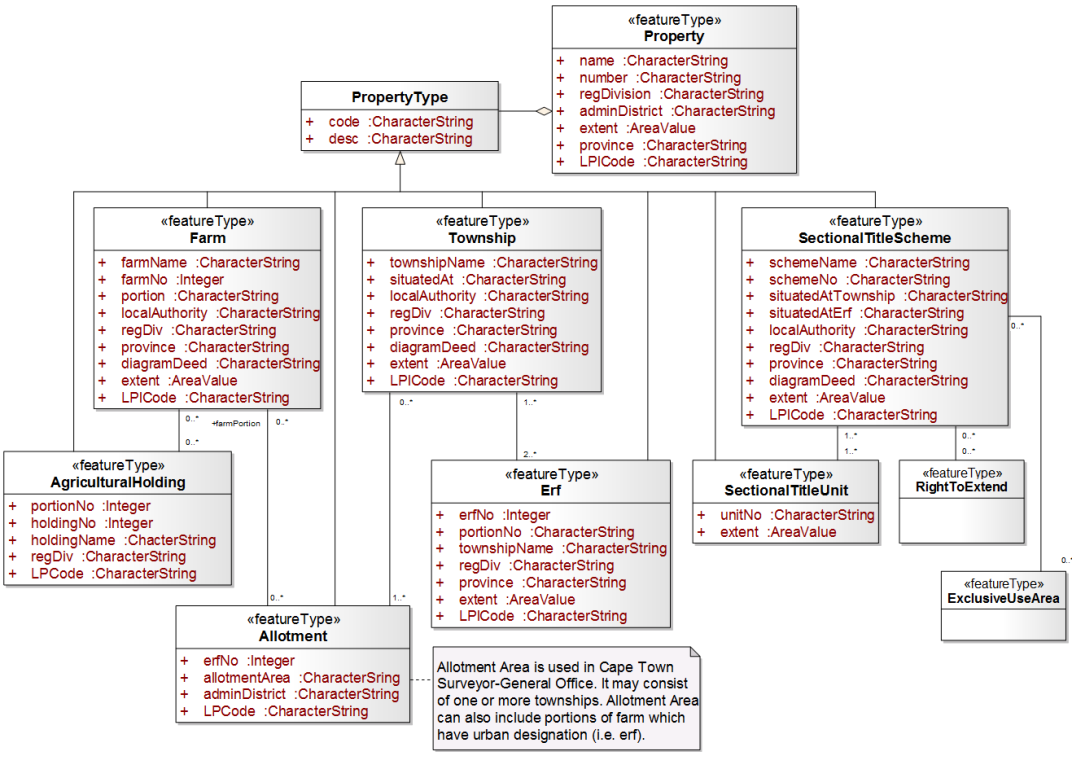

Figure 27. South African Property Types with associated attributes

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4.5.5 LA_AdministativeSource and South African (ZA) source comparison

This sections deals with comparison between the LA_AdministrativeSource and the South African administrative source. In Figure 26, *docNo* attribute in the Person class and *endorsementDocNo* attribute in the Endorsement class contain codes that represent the nature of administrative source documents. Figure 28 shows examples of source documents that were encountered in the deeds sample data. In the data sample, different codes were encountered. No reference is found of the code descriptions. This made it difficult to make up what the codes represent. Therefore, further information was required in order to interpret the codes. The descriptive information of the codes was obtained from the Chief Registrar of Deeds Circular No. 2 of 2009. This circular provided the current descriptions of the codes encountered electronic deeds records in the deeds offices.

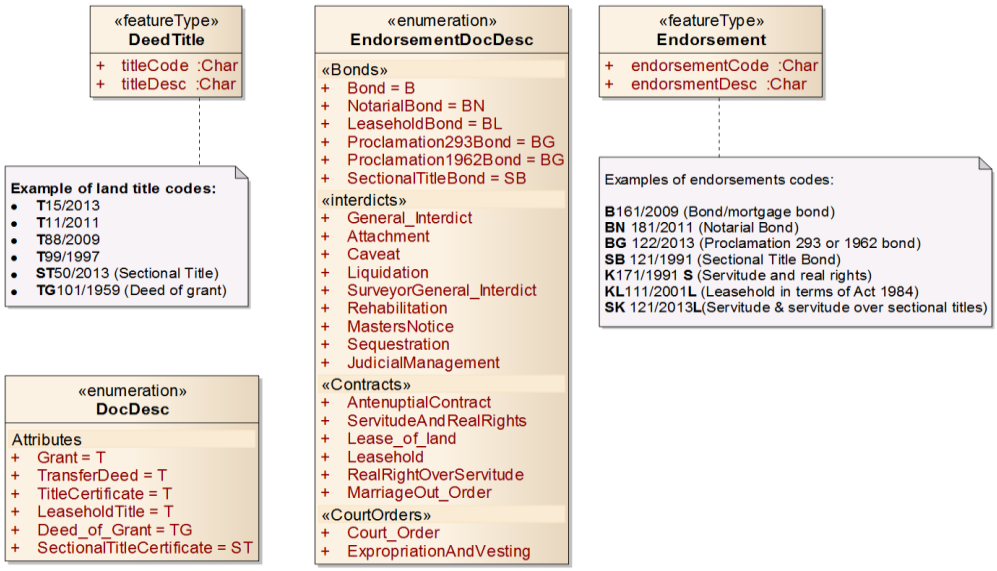

Figure 28. South African administrative source document types

Table 14 shows the comparison between the LA_AdministrativeSource and South African attributes related to administrative source documents.

Table 14. LA_AdministrativeSource attribute comparison

LA_AdministrativeSource	Record Type = 4 Person	Person attribute description
acceptance*	*registrationDate* *purchaseDate*	The registration date represents "the date of force of law of the source by an authority"
availabilityStatus*	microfilmReference	microfilmReference number or unknown
extAchiveID*	-	*The identifier of a source in an external*

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		registration
lifeSpanStamp*	*dateCaptured*	The date that the deeds document was captured into the Deeds Registration System (DRS).
	timeCaptured	The time that the deeds or document was captured into the DRS.
maintype*	*docNo endorsementDocNo* ***(Endorsement class)***	The type of document is reflected by the deed no allocated upon the registration of deed documents. For example, **T**1232/2013 for Deed of Transfer and other land titles.
quality*	-	The quality of the source
recordation*	registrationDate	The date of registration (recordation) of the source by the respective deeds registry office
source*	-	*The responsible party of the source;*
submission*	- *registrationDate*	The deeds must be attested and executed by the conveyancers in the presence of the relevant registrar of deeds within which the property is situated. The date of submission of the source by a party is the same as the registration date of the source.
sID*	*docNo/deedNo/endorsmentDocNo*	The deeds registry offices allocate unique identifier of the deeds source documents and other documents

The nature of deed documents is disclosed in a deeds registry by means of a heading as this is important for ascertaining the nature of a deed at a glance without having to examine it. For example, Deed of Transfer, Deed of Servitude, Notarial Deed of Servitude, Certificate of Registered Sectional Title, Deed of Lease, Deed of Route Description, etc. The deed is followed by a code and serial number. Examples are: Deed of Transfer T10/2014, Deed of Lease TL 20/2013, and Deed of Servitude SK101/2013S, etc.

Table 15 shows the cross-mappings between the LADM mandatory classes and the corresponding South African entities.

Table 15. Comparison of mandatory associations in the LADM and SA LRS

LADM source class	**LADM Destination class**	**Source entity**	**Destination entity**
LA_Party (0..1)	LA_Right (0..*)	Person (1)	ZA_Right (deedNo) (0..*)
LA_Party (0..1)	LA_Restriction (0..*)	Person (1)	ZA_Restriction (endorsmentDocNo) (0..*)
LA_Party (0..1)	LA_Restriction (0..*)	n/a	n/a
LA_BAUnit (1)	LA_Right (1..*)	-	
LA_BAUnit (1)	LA_Restriction (1..*)	-	
LA_BAUnit (1)	LA_Responsibility (1..*)	-	

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LA_Right (0..*)	LA_AdministrativeSource (1...*)	Person (1) (deedDocNo)	Property
LA_Restriction (0..*)	LA_AdministrativeSource (1..*)	endorsement	endorsementDocNo
LA_Responsibility	LA_AdministrativeSource	n/a	n/a

4.6 Discussion of the results

The chapter presented an overview of the South African land registration system and then followed by the analysis of a content of conventional deeds of transfer document. This was followed by examination of the data content from the sample of deeds of transfer text file. The sample data was acquired from the South African Registrar of Deeds office. Additional information included the DeedsWeb Bulk Information Layouts, the DOTS – List files layout, DRS Weekly Transfer, the DRS Fields, and the Fields in Records sent to Local Authorities. This information was essential to enhance understanding the structure of the data presented the acquired deed of transfer text file data. The surveyor-general general plans and diagrams were also obtained.

The chapter was limited to analysis and comparison of the LADM basic classes and South African land registration data. In the absence of a conceptual model of South African deeds property data model to analyze, the sample data obtained from the Chief Registrar Office was used. The bulk deeds transfer files from the Pietermaritzburg (Kwa-Zulu Natal deeds office) and weekly deeds transfer file from the Johannesburg deeds office were used. Both sample data were in a text file format. Additional information about the standard naming conventions of the columns and the descriptive information pertaining to the attribute naming were also obtained. The comparisons between the LADM basic classes and the classes derived from the sample data were limited to first level of conformance.

The results from the comparison show that there is semantic difference in the LADM and South African deeds registry information. In the both sample data, the parties' involved in land transaction are described as *Person* entity, owners, sellers and buyers. The LADM provides a rich semantic framework to extend the definition of parties in South African deeds registration system. The South African person entity contains information about the identity numbers of parties, names, types of parties. The role of parties is not clearly defined. The role of a party can only be identified from the field names (seller, buyers, and owners). There are a number of different roles of parties encountered in the South African deeds registries. A list of different types of roles is presented in the *DeedsWeb* website. Although the list describes them as parties encountered in deeds information, they can be

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described as role types in terms of the LADM. These role types include: owner, seller, buyers, mortgagee, mortgagor, lessor, lessee, usufructuary, spouse, administrator, etc.

A simple land transaction of sale may involve a number of party role types. For instance, the seller (usually a property owner but could also include trustee in an insolvent estate, a liquidator of a company, executor, etc.) and buyer of immovable property, the conveyancer or notary public, the bank in favour of whom the property is currently mortgaged, the financial institution in whose the property will in due course be mortgaged, the local authority (usually a municipality) concerned from which the rates clearance certificate must be obtained, the South African Revenue Services (SARS) from whom a transfer duty certificate must be obtained in compliance with the Transfer Duty Act of 1949. This process may become even more complex in the case of a new township establishment, subdivision of land into smaller portions or consolidation of land parcels. In such cases, the certified land surveyor would be required to draft and submit general plans or diagram, as the case may be. Surveyor-General would be required to examine and approve the plans or diagram of the land. The process may become even more complex when certain documents such as antenuptial contracts, notarial bonds and other contracts are involved. The LADM *partyRoleType* attribute provides for recordation of these different role types.

In the deeds sample data, rights and restriction are not clearly identifiable. In the person information, the deed title number attribute were encountered. The deed title number is a code used for lodgement purposes and it provides the nature of a deed. For example, code T represents all types of land titles encountered in the deeds registries. This is still broad as there are different types of land titles such as grants, transfer deeds, certificates of title, transfer of land by endorsements. The code TL presents certificate of leasehold titles, all leasehold transfers and those transferred by endorsements. In the sample data, only codes were encountered without the description of codes. The code descriptions were obtained from The Chief Registrar's Circular (2 of 2009). Similarly, restrictions are described using codes of which descriptions thereof were not presented in the data sample. Additional code description information had to be obtained from the Chief Registrar's Circular. The *Endorsement* entity stores all information related to restrictions associated with property. In the sample no data related to responsibility was encountered. However, in the conditional clause of conventional deed of transfer document, a number of restrictive conditions and those conditions those oblige the holder of right to do something on the property were encountered. The LADM can be used to orderly represent various types of rights, restriction and responsibilities associated with land.

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The South African deeds registration system is based on accurately surveyed land parcels. The land parcels are 2D representation of property boundaries. There are no 3D cadastral boundaries implemented in South Africa. There is a standard way in which properties must be described in the deeds documents. The data sample includes the relevant mandatory attributes specified for rights and restrictions in the LADM. The SpatialUnit class provides for the recordation of different types of spatial units, allowing for possible inclusion of other informal spatial units (e.g. informal settlements, villages, etc.) which remain largely not surveyed. The SpatialUnit class supports the incorporation of 3D spatial units or 3D cadastral representations. The Spatial unit concepts make it possible for inclusion of different levels of spatial representations, thus allowing for more complete spatial representations of various types of rights, restrictions, and responsibilities.

CHAPTER 5 APPLICATION OF LADM IN THE CITY OF JOHANNESBURG LAND INFORMATION SYSTEM (LIS)

This chapter was published on in the South African Journal of Geomatics, Vol. 2, No. 3, June 2013, as a paper by Dinao Tjia and Serena Coetzee under the same title.

5.1 Introduction

ISO 19152, *Geographic information -- Land Administration Domain Model (LADM),* was published by the International Organization for Standardization (ISO) as an International Standard on 19 November 2012 (ISO 19152, 2012). The LADM is a conceptual schema that facilitates the exchange and maintenance of different data sets by different organisations, especially in distributed systems. The schema may be implemented in one or more organisations, at national, regional or local levels. The LADM design is based on the fact that different organisations have different responsibilities in data maintenance.

In distributed systems, databases are developed independently to serve specific purposes. This implies that the reality is modelled differently depending on the purpose. Various countries have developed cadastres based on different purposes. A cadastre is a 'public register of quantity, value and ownership of land in a country, compiled to serve as a basis for taxation' (Simpson, 1976). This public inventory is usually based on surveyed boundaries. The International Federation of Surveyors (FIG) defines a 'cadastre' as a parcel based, and up-to-date land information system containing a record of interests in land… It usually includes a geometric description of land parcels linked to other records describing the nature of interests, the ownership or control of those interests, and often the value of the parcel and its improvements' (FIG, 1998). It may be designed for fiscal, legal or land use management purposes, etc.

The most common alternatives of cadastral systems implemented in different countries are: 'centralised or decentralised systems; land registration with a separate or integrated cadastre; positive or negative systems of land registration, fiscal or legal cadastres; general or fixed boundaries and parcel identification methods; government-financed systems or self-financed; and systematic or sporadic adjudication' (Bogaerts & Zevenbergen, 2001). These alternatives led to different implementations within and across different countries. In the absence of common vocabulary, the alternative systems implemented by different countries do not facilitate easy exchange of data, particularly across national borders (Hess & de Vries, 2006).

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In order to resolve the semantic heterogeneity, the LADM provides a shared conceptualisation within the land administration sphere. The LADM focuses on the rights, restrictions and responsibilities (RRRs) in land and their geospatial components. The LADM can be implemented in one or more organisations. This paper examines the application of the LADM in South Africa, using the City of Johannesburg's Land Information System (CoJLIS) as a case study. The remaining sections are as follows: section 2 discusses related work on the LADM; section 3 provides the CoJLIS background; section 4 presents a cross-mapping between the LADM basic classes and the CoJLIS entities; sections 5 and 6 present the research results and conclusion, respectively. The length limitation of a journal article does not allow a full description of the LADM and the South African system of land administration. We have added explanations and references where applicable and the reader is referred to these for additional information.

5.2 Related work

The LADM is based on the Cadastre 2014 vision which promotes the complete recordation of private and public RRRs in the future cadastral systems (Kaufmann & Steudler, 1998). It is not intended to be complete for any specific country, but rather aims to be the foundation from which a country-specific model can be established (ISO 19152, 2012). A country's land laws and land-related practices may restrict or allow for extension of the possible instances, attributes and other variables in the LADM (Griffith-Charles, 2010).

A number of countries considered the adaption of the LADM to their local needs. Examples documented in ISO 19152 (2012) are the country profiles for Portugal, Australia, Indonesia, Japan, Hungary, the Netherlands, the Russian Federation and the Republic of Korea. Elia et al., (2013) investigated the adaptation of Core Cadastral Domain Model (LADM's earlier version) in the Cyprus Land Information System (CLIS) with the aim of improving its data model. In Portugal, an object-oriented conceptual model based on LADM has been developed for the Portuguese Cadastre and the Portuguese Real Estate Register (Hespanha et al., 2009). Pouliot et al (2013) used the LADM in a comparative case study between condominium/co-ownership in Quebec and Alsace Moselle.

The United Nations Food and Agriculture Organisation Solutions for Open Land Administration (SOLA) project in Samoa, Nepal and Ghana developed LADM based software and a data dictionary for the development of computerised Land Administration Systems (Lemmen, 2012). The objective of the OSCAR project is to develop a cadastral application based on the LADM (OSCAR, 2012).

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The Federation of International Surveyors (FIG) and United Nations Human Settlements Programme (UN-HABITAT) developed the Social Tenure Domain Model (STDM) as a specialisation of the LADM (Augustinus et al., 2006). The STDM is a subset of the LADM for modelling the relationship between people and land in the pro-poor environments e.g. informal settlements.

In Europe, the LADM was applied in the Infrastructure for Spatial Information in Europe (INSPIRE) in order to 'prove its compatibility' with the INSPIRE cadastral parcel model (ISO 19152, 2012). Further investigations were undertaken to examine the integration of LADM with the European Land Parcel Identification Systems (LPIS) implemented in the European Union. Recent research studies focus on the proper recording of 3D legal rights, especially in urban areas where space is limited (Van Oosterom, 2013; Paulsson, 2013). Navratil & Unger (2013) investigated 3D cadastre requirements for height systems. The LADM allows for inclusion of 3D cadastral registration.

The literature review on the LADM presented examples of various explorations into the application of the LADM in different countries and organisations. However, South African studies exploring the applicability of the model within its local context are not yet available. This research presents an initial exploration of the LADM application within the South African context.

The vision of the City of Johannesburg (CoJ) is to develop a unified repository of property information within its jurisdiction. Historically, the CoJ departments which dealt with property information operated separate databases and systems (Tjia & Coetzee, 2012). This mode of operation made property information maintenance and sharing across departments virtually impossible and resulted in data duplication and misinterpretation. The lack of integration of property data and systems negatively affected service delivery turnaround times for development applications (i.e. township development, subdivision, consolidation, etc.). This in turn affected the economic growth of the CoJ. Because various departments used independent databases, customers often had to be referred from one department to the other in order to obtain a complete set of property data. This impacted negatively on the customer experience. Figure 29 shows the old CoJ Property Value Chain Model on which the CoJ Land Information System (LIS) is based.

The creation of a property in the CoJLIS begins at the stage when an applicant submits a development application (e.g. township establishment, subdivision, consolidation, etc.).

Different processes can be followed: the township establishment process is conducted in accordance with the town planning ordinance; an alternative process is done in accordance with the Less Formal Township Establishment Act (LFTE); or a third alternative process is conducted in terms of the Development Facilitation Act (DFA). The LFTE and DFA processes were popular over the last decades; they were used to fast-tract development post-1994.

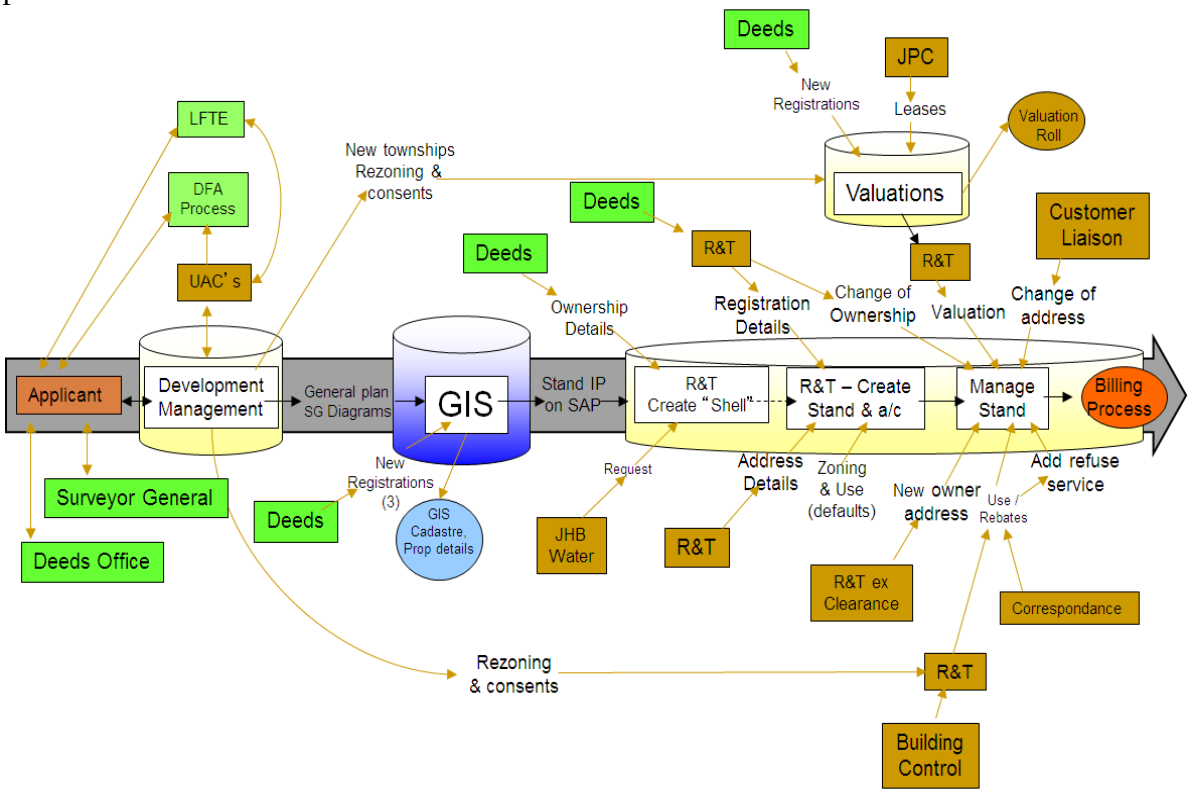

Figure 29. The CoJ Property Value Chain (Tjia & Coetzee, 2012)

A number of entities within and outside CoJ are involved in the development application process. The Utilities, Agencies and Corporatised Entities (UACs), such as JHB Water, City Power, and Jo'burg Water comment on services in the proposed development. The Surveyor-General Office approves the survey plans of developments. The Deeds Office provides the registered property ownership information. The CoJ GIS division captures the Surveyor-General approved plans and allocates street addresses. The Valuation division determines the property value. The Johannesburg Property Company (JPC) supplies the Valuation division with the CoJ lease properties. The Rates and Taxes (R&T) department captures the change of ownership from the deeds ownership data. The Customer Liaison division updates the change of address and also maintains the postal address details. R&T uses the ownership data (new owner's address) to generate the tax clearance certificates.

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R&T creates a customer billing account. The Revenue division collects the revenue from the property assessment rates and services charges (e.g. water, sewerage, electricity, etc.).

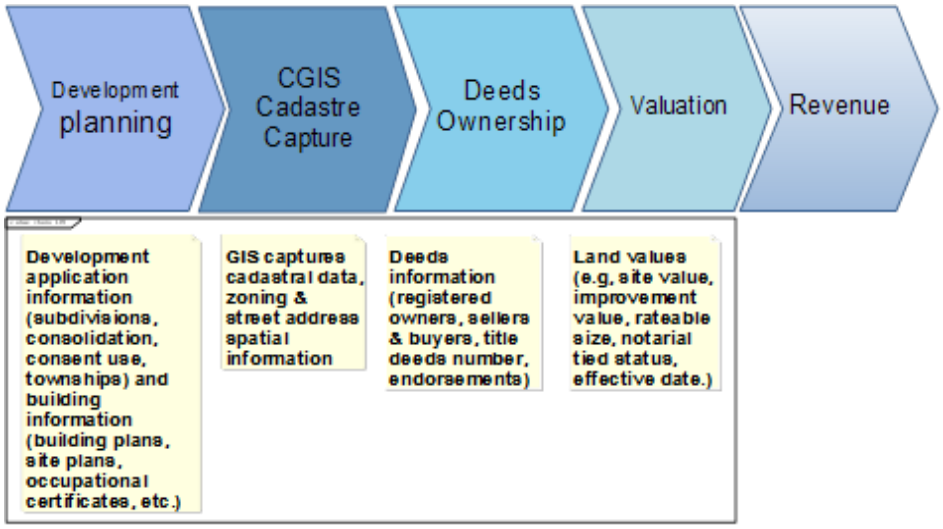

Figure 30. The CoJ property value chain of events

5.3 Comparison between the LADM basic classes and the CoJLIS

The LADM provides a conceptual framework and the actual implementation of the LADM is dependent on the development of an application schema. The application schema needs to be tested for conformance with the LADM in terms of package and level (ISO 19152, 2012). The LADM specifies three levels of conformance. For the purpose of this paper, the first level was examined which is limited to the basic classes of the LADM. For the first conformance level in the LADM, the following classes, are relevant: VersionedObject, LA_Party, LA_RRR and its specialization LA_Right, LA_BAUnit, LA_SpatialUnit and LA_Source and its specialization.

LA_AdministrativeSource.

In this section the results of the tests for the classes, attributes and associations in the LADM are documented by showing a mapping between the LADM elements and the elements in the CoJLIS data model. Subsection 4.1 shows the class mapping, subsection 4.2 the attribute mapping and subsection 4.3 the mapping of associations. The data in the CoJLIS was inspected as a means to understand the model but it was not tested against the LADM requirements.

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Class mapping

Figure 31 shows the cross-mapping of the LADM basic classes against the corresponding CoJLIS entities. The CoJLIS geodatabase schema was exported into the Enterprise Architect modelling tool using its ArcGIS workspace functionality. The information represented was extracted from sample data from the CoJLIS database. For readability purposes, the stereotypes are displayed to group the related attributes. The CoJLIS look-up tables are shown as enumerations in Figure 31.

The CoJLIS includes information corresponding to the LA_Party, LA_RRR, LA_Right, LA_BAUnit and LA_SpatialUnit classes. VersionedObject, LA_Source and LA_AdministrativeSource are not represented in the CoJLIS. Table 16 shows the mapping between the LADM classes and the CoJLIS entities.

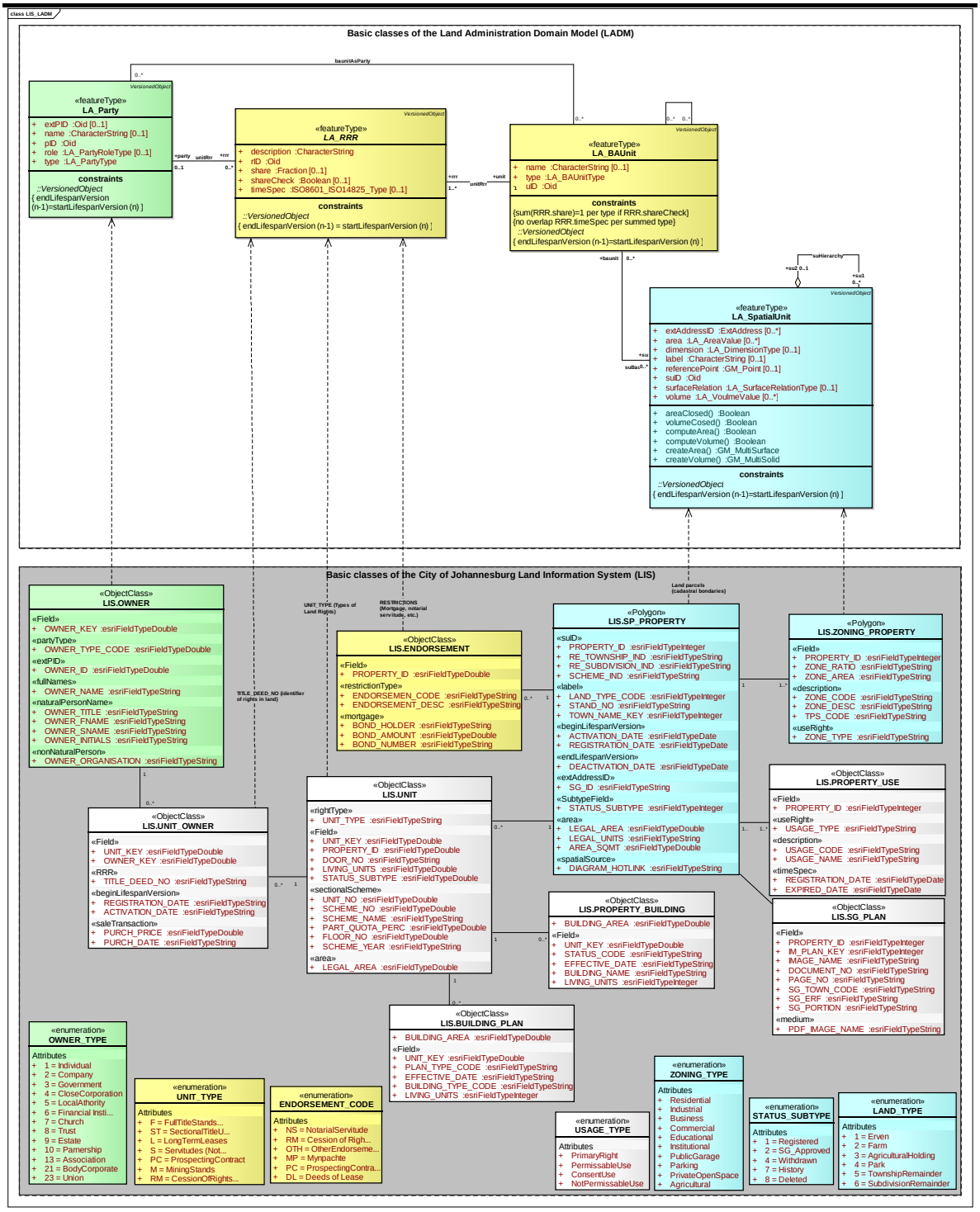

Figure 31. The LADM and CoJ LIS basic classes

VersionedObject is the superclass of all classes in the LADM. Its attributes store historical data, i.e. inserted and superseded data are given a time-stamp. In this way, the contents of the land administration data can be reconstructed, as they were at any historical moment. The CoJLIS data model contains lineage data (not included shown in Figure 30) for the

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spatial units only. There is a one-to-many relationship between LIS.SP_PROPERTY and the LIS.LINEAGE entity. The lineage includes descriptive information about the property development processes. CoJLIS does not include timestamps for each individual entity and therefore does not conform to the LADM.

Table 16. The LADM basic classes and their corresponding CoJLIS entities

LADM basic class	CoJLIS entity
LA_Party	LIS.OWNER
LA_Right (LA_RRR)	LIS.UNIT_OWNER
LA_Restriction*	LIS.ENDORSEMENT LIS.PROPERTY_USE LIS.ZONING_PROPERTY LIS.BUILDING_PLAN
LA_Responsibility*	-
LA_BAUnit	LIS.UNIT
LA_SpatialUnit	LIS.SP_PROPERTY
	-
LA_AdministrativeSource (LA_Source)*	LIS.SP_PROPERTY. DIAGRAM_HOTLINK
LA_SpatialSource*	LIS.SG_PLAN
VersionedObject	-

* optional class

Attribute mapping

In this subsection the attributes of the mandatory classes (see Table 13) in the LADM are mapped to corresponding attributes in the CoJLIS data model.

LA_Party and the corresponding CoJLIS OWNER class

The attributes of LA_Party are: extPID (identifier of party in an external database), type of party (e.g. natural and non-natural persons), name of party, the role of party, and the identifier of party (ISO 19152, 2012). Table 17 shows the LA_Party and LIS.OWNER comparison.

The LIS.OWNER entity class contains information about the owner(s) of a property in the role of rate payers or developers. The OWNER_TYPE_CODE attribute stores the code that represents the type of owner: individual, company, close corporation, trust, etc. The owners in the CoJLIS are identified in OWNER_ID by using the identity numbers as captured in the national population register. Passport numbers are used for foreign

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nationals. The OWNER_NAME attribute stores the registered legal full name of the owner. The OWNER_TITLE, OWNER_INITIALS, OWNER_FNAME and OWNER_SNAME, as well as the OWNER_ORGANISATION attributes are populated by the Revenue department through the SAP billing system. The OWNER_ORGANISATION attribute represents the organisation's name or names of non-natural parties, such as companies, close corporation, trust, etc.

There is duplication of owner names in the CoJLIS data model. The OWNER_NAME and OWNER_ID attributes are populated through the CoJLIS interface, while the OWNER_TITLE, OWNER_INITIALS, OWNER_FNAME, OWNER_SNAME and OWNER_ORGANISATION attributes are populated through the SAP billing system. There is a one-way flow of information from the CoJLIS to the SAP billing system, implying that the OWNER_TITLE, OWNER_INITIALS, OWNER_FNAME, OWNER_SNAME and OWNER_ORGANISATION attributes are available but empty in the CoJLIS data. This duplication results in discrepancies in owner information, for example, when the new owner is filled into the OWNER_NAME attribute but the SAP billing system does not yet reflect the new owner in the other five attributes.

Table 17. LA_Party and LIS.OWNER attribute comparison

LA_Party	LIS.OWNER	LIS.OWNER attribute description
extPID*	OWNER_ID	The ID number (or company registration number) of the owner
name*	OWNER_NAME	The full names of the owner (from the Deeds Office)
	OWNER_TITLE	The title of the owner
	OWNER_INTIALS	The initials of the owner
	OWNER_FNAME	The first names of the owner
	OWNER_SNAME	The surname of the owner
	OWNER_ORGANISATION	The organisation name
pID	OWNER_KEY	The system generated unique identifier of an owner.
role*	-	The CoJLIS model contains only the owners of property. Their role is not distinguished. However, the owner of a property may be a rates payer, buyer or seller
type	OWNER_TYPE_CODE	The type of party (i.e. individual, company, trust, etc.)

* optional attribute

The CoJLIS data model conforms to the LA_Party attribute requirements of the LADM. The OWNER_ID attribute corresponds to the extPID attribute, the OWNER_KEY

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attribute to the pID attribute and the OWNER_TYPE_CODE attribute to the type attribute in LA_Party. The name attribute in LA_Party is represented by more than one attribute in the CoJLIS data model. There is no attribute in the CoJLIS data model that corresponds to the role in LA_Party. However, this attribute is optional in the LADM.

The CoJLIS is designed to store information about owners of property with the purpose of collecting revenue from property rates and service charges. However, there are a number of other parties involved in the development process at the CoJ. The key parties include an applicant or developer who submits an application for development approval; the surveyor who prepares the layout plan for the land proposed to be developed; and the conveyancer who collects rates clearance from the municipality and prepares the deed of sale and deed of transfer, certificate of title, etc. Adding the role of the party to the CoJLIS data model would enable representing the fact that parties may play different roles in LA. The current labelling of all parties as owners in the CoJLIS data model restricts inclusion of other parties who are not necessarily the owners but who are involved in the development process and property value chain.

LA_RRR and corresponding CoJLIS classes

LA_RRR is an abstract class with three specializations: LA_Right, LA_Restriction and LA Responsibility (ISO19152, 2012). LA_Right represents an action or set of actions that parties may perform on or using an associated resource. The rights are in the sphere of private and customary law. A restriction (represented by LA_Restriction) is an obligation to abstain from doing something. This can be either formal or informal in nature. An example of a formal restriction in South Africa is a registered servitude for the conveyance of electricity in favour of a specific community. According to the LADM, a mortgage is a special restriction type. A responsibility (represented by LA_Responsibility) is a formal or an informal obligation to perform something. An example from CoJ is the obligation to pay property rates and service charges, or an obligation to maintain the property by fencing it. The attributes of LA_RRR are: description of the RRR, rID, share, shareCheck, timeSpec. Table 18 shows the LA_Right class and LIS.UNIT_OWNER attribute comparison for a property ownership right.

Table 18. LA_Right and LIS.UNIT_OWNER attribute comparison

LA_Right	LIS.UNIT_OWNER	LIS.UNIT_OWNER attribute description
description*		
riD	TITLE_DEED_NO	The title deed number for the title deed document that is

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		registered at the Deeds Office when the property was transferred to the current owner.
	UNIT_KEY	The system generated unique identifier for a unit.
share*	-	
shareCheck*	-	
timeSpec*	-	
type	TITLE_DEED_NO	The prefix and suffix of the title deed number indicate whether it is full title, sectional title, etc.
	REGISTRATION_DATE	This is the date of registration of the property at the Deeds Office or transfer date to the new owners.
-	ACTIVATION_ DATE	Activation of the ownership right.
-	PURCH_PRICE	The price paid for the property. In these cases one needs to order the copy of the title deed document to get more information.
-	PURCH_DATE	The date the property was purchased (i.e. offer to purchase)
-	OWNER_KEY	The system generated unique identifier for an owner.

* optional attribute

The CoJLIS data model includes the two mandatory LA_Right attributes, rID and type. The TITLE_DEED_NO attribute stores the unique identifier of a right and other interests in land. The data is sourced from the Deeds Office. The Deeds Office allocates unique title deed numbers or lodgement codes. The type of right (i.e. freehold title, sectional title right, leasehold, servitude, mineral right, prospecting right, etc.) is embedded in the prefix and/or suffix of the TITLE_DEED_NO attribute. Additional information about the property transaction is stored in the CoJLIS, namely the title deed registration or transfer date, the activation date, the purchase price, the date of purchase. This information is also obtained from the Deeds Office. In addition the system generated unique identifier of the owner is included in the CoJLIS as a means to link it to the owner of the right.

LIS.ENDORSEMENT in the CoJLIS corresponds to the LA_Restriction and LA_Mortgage classes in the LADM. Endorsements are restrictions registered against a particular property. A property may have zero or more endorsements. Endorsement types are bonds, notarial servitudes, notarial tie agreements, and long-term lease agreements. A mortgage bond is a limited real right and thus also a restriction. Table 19 shows the attribute comparison of LA_Mortgage, a specialization of LA_Restriction, with LIS.ENDORSEMENT for a bond. Corresponding attributes for the mandatory attributes in LA_Restriction and LA_Mortgage are included in the CoJLIS data model.

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Table 19. LA_Mortgage and LIS.ENDORSEMENT attribute comparison

LA_Restriction	LIS.ENDORSEMENT	LIS.ENDORSEMENT attribute description
description*	ENDORSEMENT_DESC	The description of endorsement
rID	ENDORSEMENT_CODE	A unique endorsement code assigned by the Deeds Office.
share*	-	
shareCheck*	-	
timeSpec*	-	
partyRequired*	-	
type (LA_RestrictionType)	ENDORSEMENT_CODE	The type of endorsement (i.e., interdict, bond, etc.) is embedded in the prefix and suffix of the endorsement code.
amount*	BOND_AMOUNT	The amount of the endorsement. In the case of a bond this will be the registered bond amount. This amount is the amount registered and not the outstanding amount.
interestRate*	-	
ranking*	-	
type* (LA_MortgageType)	-	
-	BOND_HOLDER	The name of the bond holder, e.g. ABSA or Standard Bank.
-	BOND_NUMBER	The unique number for the bond assigned by the Deeds Office.

* optional attribute

The ENDORSMENT_CODE and ENDORSEMENT_DESC attributes describe the type of endorsement. These two attributes correspond to the description, rID and type attributes in LA_Restriction. LIS.ENDORSEMENT also contains the bond number, bond amount and the bond holder. The BOND_AMOUNT in LIS.ENDORSEMENT corresponds to the amount attribute in the associated LA_Mortgage class.

LIS.PROPERTY_USE contains types of restrictions that relate to land use: actual use, permissible use, consent use or illegal (not permitted) use. Land use is regulated by the town planning ordinance of 1986 which makes provision of how land should be used. A change in the land use will result in a change in the market value of the property and ultimately a change in property tax revenue. The actual usage and monitoring of illegal use are defined by the Valuations department and managed by the Law Enforcement division, respectively. Consent use may be given over and above the permissible usage determined by the zoning. Table 20 shows the attribute comparison of LA_Restriction with LIS.PROPERTY_USE for land use restrictions.

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Table 20. LA_Restriction and LIS.PROPERTY_USE attribute comparison

LA_Restriction	LIS.PROPERTY_USE	LIS.PROPERTY_USE attribute description
description*	USAGE_CODE	A code to describe the usage
	USAGE_NAME	The descriptive name of the usage
rID	-	
share*	-	
shareCheck*	-	
timeSpec*	-	
partyRequired*	-	
type	USAGE_TYPE	Type of usage (i.e. primary right, permissible use, consent use, non-permissible use)
-	REGISTRATION_DATE	Date of registration of the restriction.
-	EXPIRED_DATE	Date when the restriction expores (could be null).
-	PROPERTY_ID	The unique system generated property identifier.

* optional attribute

The mandatory type attribute in LA_Restriction is included in the CoJLIS data model, but there is no unique identifier for a land use restriction.

LIS.ZONING_ PROPERTY is a spatial layer that records the zoning details associated with individual properties. The ZONE_CODE and ZONE_DESC attributes describe the zoning. The ZONING_TYPE enumeration class shows the zoning types, i.e. residential, industrial, business, etc. In the CoJLIS there is a one-to-many association between a spatial unit and the zoning of that spatial unit, but similar to the land use restriction there is no unique identifier for a zoning restriction.

The CoJ examines and approves building plans within its jurisdiction. A building plan describes the restrictions for buildings on a unit. The approved building plan is a legal document. LIS.UNIT may be associated with zero or more building plans (LIS.BULDING_PLAN). A building plan is a diagrammatic representation of a building. In the CoJLIS a building plan has the following attributes: building plan type, building area, building type, living units and effective date. The information in LIS.BUILDING_PLAN is maintained by the Building Control department within the Development Management division. In the CoJLIS there is no unique identifier for a building plan; it is associated with a unit through the UNIT_KEY.

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In this section we described how rights and restrictions are represented in the CoJLIS data model. The data model does not include responsibilities in the way they are represented in the LADM. Responsibilities, such as maintenance of the property by the owner, e.g. fencing of the property, are commonly found in the deeds document and in the conditions of township establishment. The responsibility information is contained in the original deed document. The valuation and legal administration departments maintain copies of the deeds documents as part of the development application process.

LA_BAUnit and the corresponding CoJLIS UNIT class

The basic administrative unit (LA_BAUnit) in the LADM corresponds to LIS.UNIT in the CoJLIS data model. The LA_BAUnit may consist of 'zero or more spatial units against which one or more unique and homogenous rights, restrictions and responsibility are associated to the entire entity as included in a land administration system' (ISO 19152, 2012). A right, restriction or responsibility may be held by one or more parties for the whole LA_BAUnit. A right, restriction or responsibility can relate to a specific portion of a spatial unit where the geometry of such portion is absent: for instance, the right of way servitude of which the area and location are described textually (and not specified with coordinates or reference points). The attributes of LA_BAUnit are: name, type and uID (identifier). Table 21 shows an attribute comparison between LA_BAUnit and LIS.UNIT.

Table 21. LA_BAUnit and LIS.UNIT attribute comparison

LA_BAUnit	LIS.UNIT	LIS.UNIT attribute description
name*	-	
type	UNIT_TYPE	Identifies the type of unit: full title, sectional title, long term lease, servitude, prospecting contract, mining stand or cession of rights.
uID	UNIT_KEY	System generated unique identifier for the unit.
-	DOOR_NO	Door number of the unit, which could differ from the unit umber. Only applicable for sectional title schemes.
-	FLOOR_NO	Floor number of the unit. Only applicable for multi-storey sectional title schemes (e.g. flat blocks).
-	LIVING UNITS	Number of living units (households) on the unit.
-	LEGAL_AREA	Legal area of the unit.
-	PART_QUOTA_PERC	The legal area as a percentage of the total area of the sectional title unit. Only applicable for a sectional title unit.
-	STATUS_SUBTYPE	Status indicator of the unit, i.e. registered, approved, withdrawn, etc.
-	SCHEME_NO	Number of the sectional title scheme. Only applicable for a sectional title unit.

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-	SCHEME_NAME	Name of the sectional title scheme. Only applicable for a sectional title unit.
-	UNIT_NO	Unit number in a sectional title scheme. Only applicable for a sectional title unit.
-	SCHEME_YEAR	Year in which the sectional title scheme was registered. Only applicable for a sectional title unit.

* optional attribute

LIS.UNIT_TYPE identifies the type of basic administrative unit, including full title, servitude and long term lease. Many of the attributes in LIS.UNIT are related to a sectional title unit only, which could lead one to think that the entity represents only sectional title units. The DOOR_NO, FLOOR_NO and LIVING_UNITS attributes are populated by the Valuation department.

LEGAL_AREA and PART_QUOTA_PERC attributes are used for the valuations. The sectional title unit information is represented in SCHEME_NO, SCHEME_NAME, UNIT_NO and SCHME_YEAR and is imported from the data from the Deeds Office. LIS.UNIT includes the two mandatory attributes (type, uID) specified for a LA_BAUnit in the LADM.

LA_SpatialUnit and the corresponding CoJLIS SP_PROPERTY class

The LADM defines a spatial unit as ‘a single area (or multiple areas) of land and/or water, or a single volume (or multiple volume) of space’ (ISO 19152, 2012). Spatial units support the creation and management of basic administrative units. There are different types of spatial units: sketch-based, text-based, point-based, line-based, polygon-based, or topology-based. The attributes of LA_SpatialUnit are: area, dimension (of the spatial unit), extAddressID (link(s) to external address(es) of the spatial unit), label (a short textual description of the spatial unit, e.g. for local purposes), referencePoint (a co-ordinate set of a point inside the spatial unit), suID (spatial unit identifier), surfaceRelation (above or below the surface) and volume (in case of a 3D spatial unit). Table 22 shows an attribute comparison between LA_SpatialUnit and LIS.SP_PROPERTY.

Table 22. LA_SpatialUnit and LIS.SP_PROPERTY attribute comparison

LA_SpatialUnit	LIS.SP_PROPERTY	LIS.SP_PROPERTY attribute description
extAddressID*	-	
area*	AREA_SQMT	The area as calculated by a cadastral capturing tool.
dimension*	-	

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label*	SG_ID	The complete description of the property by land parcel type, stand number, registration division identifier, township number. For example, 'Erf 45 Braamfontein'.
	STAND_NO	Unique stand number within the proclaimed town, e.g. '45'.
	TOWN_NAME_KEY	The foreign key that links LIS.SP_PROPERTY to the township name entity (not represented in CoJLIS core of this article).
referencePoint*	-	
suID	PROPERTY_ID	The unique property identifier
surfaceRelation*	-	
volume*	-	
-	LEGAL_AREA	This area is captured from the Surveyor-General approved plans or diagrams.
-	LAND TYPE_CODE	The type of land: erf, farm, agricultural holding, etc.
	ACTIVATION_DATE	Date on which this property was activated in the CoJLIS.
	REGISTRATION_DATE	Date on which this property was registered at the Deeds Office.
	DEACTIVATION_DATE	Date on which this property was deactivated in the CoJLIS, e.g. if it is not approved and thus will not be registered at the Deeds Office.
	STATUS_SUB_TYPE	Status indicator of the property, i.e. registered, approved, withdrawn, etc.
	LEGAL_AREA	Legal area of the property
	LEGAL_UNITS	Units in which the legal area is represented, e.g. ha or m^2
	DIAGRAM_HOTLINK	Link to a copy of the document. See explanation in 4.5.

* optional attribute

LIS.SP_PROPERTY contains information related to the geospatial component of the rights. Sectional scheme and township boundaries are not included here, but are modelled separately in the

CoJLIS. The property data is captured from approved Surveyor-General general plans and diagrams. LIS.SP_PROPERTY has a corresponding attribute for the single mandatory attribute (suID) in LA_SpatialUnit.

A property is identified by a unique property identifier which is made up of an external identifier (SG_ID) and additional digits to represent the complex urban environment of the city. The SG_ID is the identifier of the land parcel (cadastral property) in the Surveyor-General's cadastral information management system. There are two types of areas in the LIS.SP_PROPERTY: the legal area and the area calculated by a cadastral capturing tool.

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LIS.SP_PROPERTY contains only 2D representations of land parcels, therefore the dimension and volume attributes are not relevant. The surfaceRelation attribute is not applicable, because the CoJLIS does not distinguish whether the property is on, below or above the surface.

There are different registered types of property, namely: erven (i.e. cadastral parcels in an urban area), farms (normally associated with rural or areas outside the cadastral demarcations), agricultural holdings and others (refer to the LAND_TYPE enumeration). In the LADM the LA_SpatialUnit class has two specializations: LA_LegalSpaceBuildingUnit and LA_LegalSpaceUtilityNetwork.

The LA_LegalSpaceBuildingUnit provides for the registration of legal space in a building as opposed to traditional models where registration of legal space was limited to land parcels only. In the CoJLIS LIS.UNIT may be associated with zero or more buildings (LIS.PROPERTY_BUILDING). A building property has attributes such as a building name, building area, effective date, a status code and living units. The BUILDING_AREA attribute represents the legal space that can be covered by a building.

LA_AdministrativeSource and the CoJLIS

Table 23. LA_AdministrativeSource attribute comparison

LA_AdministrativeSource	LIS.SP_PROPERTY	LIS.SP_PROPERTY attribute description
acceptance*	-	
availabilityStatus	-	
extArchiveID*	DIAGRAM_HOTLINK	A link to the title deed document
lifeSpanStamp*	-	
maintype*	-	
quality*	-	
recordation*	-	
sID	-	
source*	-	
submission*	-	
text*	-	
type	-	

* optional attribute

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Table 23 shows the attribute comparison for LA_AdministrativeSource. The LA_Source and its subclass LA_AdministrativeSource provide information about the availability and type of a source document, e.g. a title deed document for a property ownership right. An optional attribute in LA_AdministrativeSource specifies in which multimedia format the document is available. In the CoJLIS there are no entities corresponding to these two classes, but the DIAGRAM_HOTLINK attribute of the LIS.SP_PROPERTY class provides a link to the external source document. However, the link is not yet functional in the CoJLIS implementations (i.e. nothing happens when clicking on it). The CoJLIS data model is thus incomplete when compared to the LADM requirements about LA_AdministrativeSource.

Association mapping

Table 24. Comparison of mandatory associations in the LADM and CoJLIS

LADM source class	**LADM Destination class**	**CoJLIS Source entity**	**CoJLIS Destination entity**
LA_Party (0..1)	LA_Right (0..*)	LIS.OWNER (1)	LIS.UNIT_OWNER (0..*)
LA_Party (0..1)	LA_Restriction (0..*)	LIS.OWNER (1)	LIS.ENDORSEMENT (0..*), via LIS.UNIT_OWNER, LIS.UNIT and LIS.SP_PROPERTY
		LIS.OWNER (1)	LIS.PROPERTY_USE (1..*), via LIS.UNIT_OWNER, LIS.UNIT and LIS.SP_PROPERTY
		LIS.OWNER (1)	LIS.ZONING_PROPERTY (1..*), via LIS.UNIT_OWNER, LIS.UNIT and LIS.SP_PROPERTY
		LIS.OWNER (1)	LIS.BUILDING_PLAN (0..*), via LIS.UNIT_OWNER and LIS.UNIT
LA_Party (0..1)	LA_Responsibility (0..*)	n/a	n/a
LA_BAUnit (1)	LA_Right (1..*)	LIS.UNIT (1)	LIS.UNIT_OWNER (0..*)
LA_BAUnit (1)	LA_Restriction (1..*)	LIS.UNIT(1)	LIS.ENDORSEMENT (0..*), via LIS.SP_PROPERTY
		LIS.UNIT (1)	LIS.PROPERTY_USE (0..*), via LIS.SP_PROPERTY
		LIS.UNIT (1)	LIS.ZONING_PROPERTY (0..*), via LIS.SP_PROPERTY
			LIS.BUILDING_PLAN (0..*)

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LA_BAUnit (1)	LA_Responsibility (1..*)	n/a	n/a
LA_Right (0..*)	LA_AdminstrativeSource (1..*)	LIS.UNIT_OWNER (0..*)	LIS.SP_PROPERTY. DIAGRAM_HOTLINK (1), via LIS.UNIT
LA_Restriction (0..*)	LA_AdminstrativeSource (1..*)	LIS.ENDORSEMENT (0..*)	LIS.SP_PROPERTY. DIAGRAM_HOTLINK (1)
		LIS.PROPERTY_USE (1..*)	LIS.SP_PROPERTY. DIAGRAM_HOTLINK (1)
		LIS.ZONING_ PROPERTY (1..*)	LIS.SP_PROPERTY. DIAGRAM_HOTLINK (1)
		LIS.BUILDING_PLAN (0..*)	LIS.SP_PROPERTY. DIAGRAM_HOTLINK, via LIS.UNIT
LA_Responsibility (0..*)	LA_AdminstrativeSource (1..*)	n/a	n/a

Table 24 maps LADM associations to the corresponding associations in the CoJLIS data model. The associations in the CoJLIS are either equivalent or more restrictive than those in the LADM, except for LA_BAUnit's associations to LA_Right and LA_Restriction. In the LADM there is a mandatory association between a basic administrative unit to a right or restriction, but in the CoJLIS this association is optional.

5.4 Discussion of the results

The study compared the key entities in the CoJLIS data model concerned with parties, rights, restrictions and responsibilities, administrative and spatial units of land against the LADM basic classes. While there are corresponding CoJLIS entities for the relevant LADM basic classes, there are semantic differences between them. For example, the parties in the CoJLIS are modelled as owners. This restricts the inclusion of other parties involved in the land administration process. Another difference is that the CoJLIS data model contains descriptive lineage data for the spatial units only, whereas the LADM prescribes timestamps (but not descriptive information) for any change to an instance of most classes.

The duplication of owner name information in LIS.OWNER and the one-way flow of this information from CoJLIS to the SAP billing system, results in discrepancies in owner information. For example, when the new owner is filled into the OWNER_NAME attribute but the SAP billing system does not yet reflect the new owner in the other five attributes. Such discrepancies have been the cause of billing problems and bad publicity for CoJ in the past.

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The CoJLIS data model includes the relevant mandatory attributes specified for rights and restrictions in the LADM. However, additional information about the property transaction is included for the ownership right in the CoJLIS data model.

The identification of the nature of registered rights in the CoJLIS is not straight forward. It requires the interpretation of codes used to describe the types of rights. For example, the prefix and suffix before and after the serial number and year in the title deed number specifies the nature of the deed or document. This system of codes originates from the South African Deeds Office. Similarly, the identification of restrictions is a function of interpreting codes.

Information about restrictions on land, such as land use, zoning and building plans, are included in the CoJLIS but they do not have individual unique identifiers, as prescribed in the LADM. The reason is that these restrictions are managed in different systems at other CoJ departments. The disconnect between these systems and the CoJLIS is a cause for concern. Additional restrictions, such as coverage of buildings, floor area ratios, building lines and other general restrictions are not represented at all in the CoJLIS, which is another cause for concern.

Responsibilities, such as maintenance of the property by the owner, e.g. fencing of the property, are commonly found in the deeds document and in the conditions of township establishment. The responsibility information is contained in the original deed document, but the CoJLIS does not include responsibilities. Responsibilities are not required for the first conformance level of the LADM.

The type of spatial units in the CoJLIS include are land parcels. These are 2D representations of property boundaries. In the absence of 3D cadastral boundaries, the sectional title units in a flat or multiple-story building are not accurately represented geospatially. CoJLIS does not specify whether the property is on, below or above the ground. One of the attributes of the spatial unit in the CoJLIS links to a source document, i.e. a one-to-one association. This association is more restrictive than specified in the LADM, which allows multiple source documents for a basic administrative unit.

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5.5 Conclusion

This research compared the CoJLIS data model to the LADM, an internationally standardized conceptual land administration domain model. The LADM offers an opportunity for the CoJLIS upgrade project to develop an integrated property database model based on international standards. We have shown that the LADM can be used to describe land administration information at a municipality in South Africa, but that there are some semantic differences, as well as similarities and differences between classes, attributes and associations. Semantic differences are evident in the terminology discrepancies between the CoJLIS and the LADM. A first step for CoJ could be to convert the CoJLIS terminology to correspond to the internationally accepted LADM terms and definitions. This would already improve communication about land administration within the CoJ.

The current disconnect between different systems, each managing a different part of the land administration information at the CoJ, is a cause for concern. It is our understanding that work on a single integrated system has started.

The results of this research improve the understanding of land administration at municipal level in South Africa, but additional work is needed to describe the deeds and cadastral information produced by the Surveyor General's and Deeds Offices, i.e. a full South African profile of the LADM. For example, the CoJLIS relies heavily on data received from the Deeds Office, where the type of the deed or document is embedded in the title deed number.

The CoJLIS is based on the formal land registration system in South Africa which deals with registered land rights at the Deeds Office. For this reason, the CoJLIS model does not accommodate other property rights which have been created by the South African land reform programme. For the future, the incorporation of informal land rights is critical for the regularization of CoJ informal settlements. The concept of spatial unit could represent informal settlements in the CoJLIS. Further investigation into the possible use of the STDM is recommended.

CHAPTER 6 CONCLUSION

6.1 Introduction

This dissertation explored the applicability of the Land Administration Domain Model to South Africa through the analysis of the existing land administration elements of the deeds registration and cadastral systems as well as the land information systems implemented within the City of Johannesburg metropolitan municipality. This chapter represents the summary of the key research findings and research contribution. The recommendations for further research work are also presented.

6.2 Summary of the research findings

The research was divided into two areas of exploration: national systems of land registration and cadastre, and municipal land information system. The research examined the applicability of the LADM to the South African national land registration system (Deeds Registration Systems and Cadastre). The study also focused on the applicability of LADM within a context of local authority (municipality) in urban environment. The City of Johannesburg Municipality was used as a case study area. In both cases, the research was limited to the LADM classes required for the first level of conformance.

The study provided an overview of land administration at national and municipal levels through the survey of available literature which was largely characterized by pieces of legislation and regulations that govern the South African land administration, more particularly the land registration system and cadastral surveying. The general literature review of available research on land administration from a theoretical perspective and the previous research studies on the development of cadastral systems and early models of people-to-land relationships were examined. A review of the South African land administration system with a specific reference to land registration systems has provided a useful insight in the development of various instance diagrams of the South African land administration (presented in the appendices). This included, for instance, the modeling of permission to occupy land (appendices 13 and 14) and the mineral rights (appendix 11). The research entailed the analysis of the content of registered deeds documents. The information derived from a sample of registered deeds documents was used to derive different instance diagrams using the LADM as a framework to structure the information content. The instance diagrams are presented in Appendix 2 (a certificate of registered title), Appendix 4 (a sectional title transfer), Appendix 5 (a conventional deed of transfer),

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Appendix 6 (a sectional title deed of transfer), Appendix 7 (a deed of transfer through selling and buying), and Appendix 8 (a deed of lease). The LADM provided a meaningful way of presenting the different instances using the registered deeds documents encountered in the deeds registries.

The review of the South African land administration literature at a national level presented some of the key benefits of the current cadastral system and land registration system. For example, the South African cadastral surveying is described as one of the best in the world as it provides accurate delineation of boundaries for the purpose of registering the real rights in land, thus providing secure formal land tenure for registered properties. One of the challenges facing the current system is that the system of cadastral information management is not fully integrated with the deeds registration system due to the different business models currently in operation. The South African e-Cadastre project aims to integrate the two systems. This project provides the opportunity to use the LADM as an extensible reference schema upon which the current models can be refined to become more efficient and effective without re-inventing the wheel over and over again. It is globally recognized that there is a need for an internationally compatible standard in the cadastral domain given the fact that the world is becoming more and more globally integrated. The exchange of cadastral information would become easier with the adoption of common terminology in the land administration domain in general. The exchange of data within parties in one country and between different countries is said to be easier with the adoption of a shared set of concepts (i.e. vocabulary) within the land administration domain.

This research compared the City of Johannesburg land information system (CoJLIS) data model to the LADM. The case study compared the key entitles of the CoJLIS data model concerned with rights and obligations. The results of the cross-mappings of LADM first conformance level and the core CoJLIS entities shows that there are semantic differences between them. For example in the CoJLIS parties are represented as owners, thus limiting the inclusion of parties that hold not ownership but other rights such as servitude rights, leasehold rights, etc. In the LADM, an owner is described as a role type not a party. This way of modeling allows for inclusion of all other parties involved in land transaction and data maintenance activities. In the CoJLIS model, the identification of the nature of rights in land (such as rights, restrictions and responsibilities) is not a straightforward. The identification is based on the interpretation of different codes with their descriptions is not incorporated in the data model. This challenge emanates from the national deeds registration data supplied by the deeds office. The descriptions of codes are not provided

included in the standard weekly deeds transfer data supplied to the municipalities in South Africa. In order to understand the nature of rights in the data, this study referred to other deeds source documents such as the Chief Registrar's Circulars to obtain different codes and descriptions of the data presented in the deeds files. In terms of spatial units, the CoJLIS types of spatial units are surveyed land parcels which are obtained from the office of Chief Surveyor. These are 2D presentations of property boundaries. In the absence of the 3D cadastral boundaries in the national cadastral system, the sectional title units are not accurately represented geographically. Figure 32 shows the example of the map showing spatial representation of sectional units in a sectional scheme.

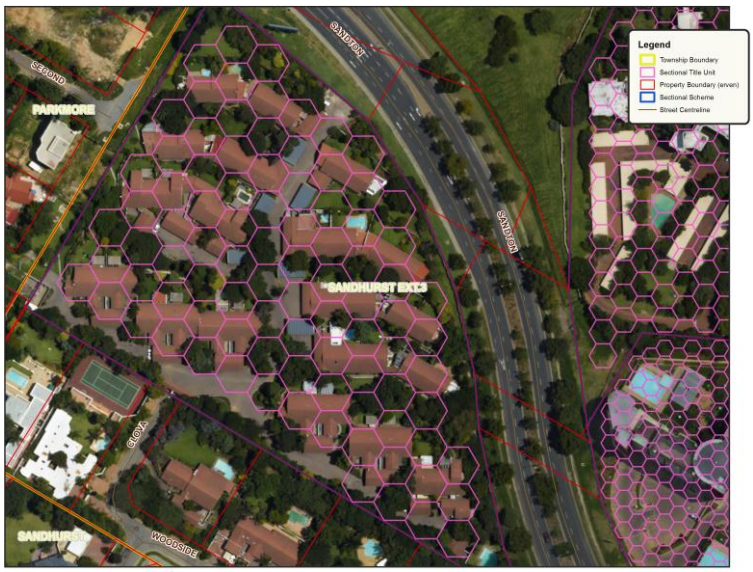

Figure 32. Spatial representations of sectional title units within the City of Johannesburg

The CoJLIS is based on the formal land registration system which deals with only registered property rights (real and limited rights) and obligations. For this reason, the CoJLIS model does not accommodate other property rights which have been established by the South African land reform programme. For example, the informal land rights which are crucial for the City of Johannesburg informal settlement formalization and regularization programme are not incorporated. There is a need to incorporate different spatial units. This research recommends further investigation into the possibility of using the social tenure domain model (STDM) in the further developments of municipal land information systems especially in rural municipalities where most people live on the customary land. It can be concluded that the LADM offers an opportunity for the CoJLIS upgrade project to develop an integrated property database model based on international standards.

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6.3 Summary of contributions

The research study contributes to the current international excepted notion that the 21st land administration systems (LASs) should be designed in such a way that they support the achievement of sustainable development through proper management of social, economic and environmental aspects of land. The proper administration of rights, restrictions and responsibilities (RRRs) associated with land is essential. The modern LASs must support complete registration of private and public rights, restrictions and responsibilities in land. The study is of both academic and practical significance in that it highlighted the relationship between people and land from the perspective of South Africa. The research highlighted the manner in which land is held, registered and spatially represented. Moreover, it highlighted challenges related to how parties, *RRR* and spatial extents are presented in the current model from national and local levels.

The study examined the national system of land registration and the municipal systems of land administration. This research has shown that the LADM can be applied to describe land administration information in South Africa. Moreover, the research results help to understand the land administration at both national and municipal levels. The LADM provides an opportunity to refine the current systems in the South African e-Cadastre initiative and in the CoJLIS upgrade project to develop an integrated cadastral information model based on international standards. In general, this research laid a foundation upon which the development of an LADM conformant municipal information model that is applicable to all other municipalities can be derived. More importantly, the research contributed towards the development of a comprehensive South African LADM profile.

6.4 Recommendations for further research

The research study provided an initial exploration into the applicability of the LADM within the South African context. Various countries, have examined the applicability of LADM in their respective areas. The study provided a base upon which further studies can be undertaken to develop a ISO 19152 conformant profile model that can be applied in South Africa. Further research is required to investigate how the profile can be developed which should involve all parties involved in land administration. The study was limited to LADM first conformance level, thus more research is required to examine various levels of conformance and or LADM packages, classes and attributes. Further studies are recommended to examine the applicability of the LADM within various areas falling outside the formal system of land registration (e.g. customary areas, informal settlements).

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South Africa. Prevention of illegal Squatting Act, no. 52 of 1951.
South Africa. Upgrading of the Tenure Rights Act, no. 1927 of 1991.
South Africa. Transfer Duty Act, no. 40 of 1949.
South Africa. Value-added Tax Act, no. 89 of 1991.
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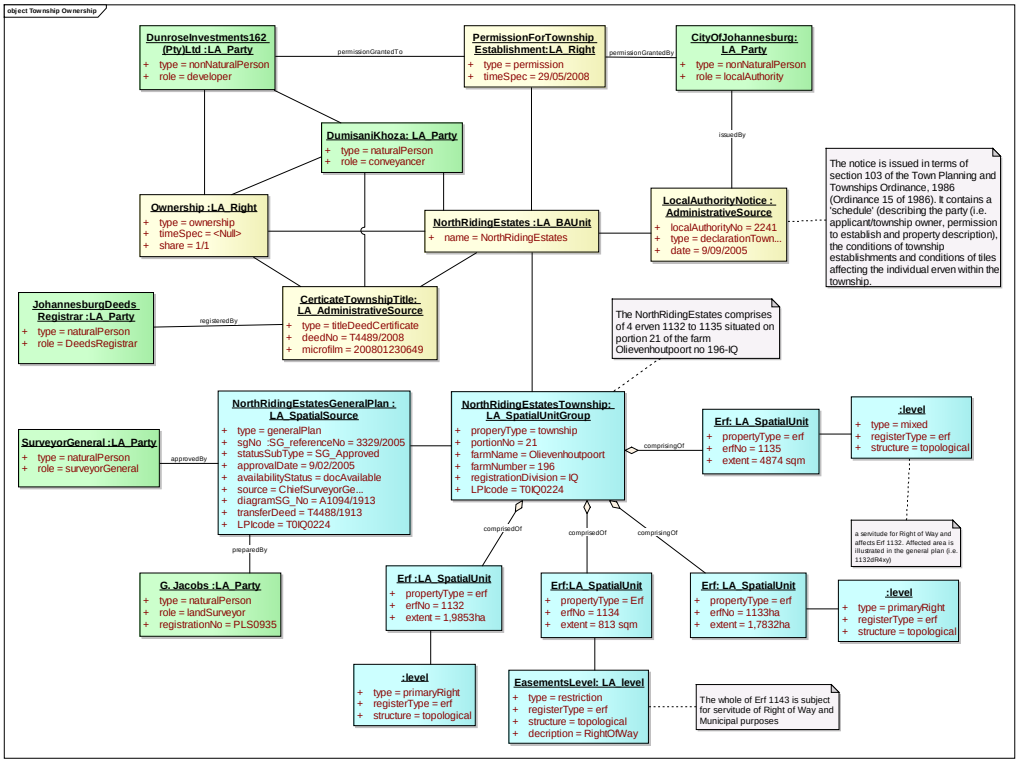
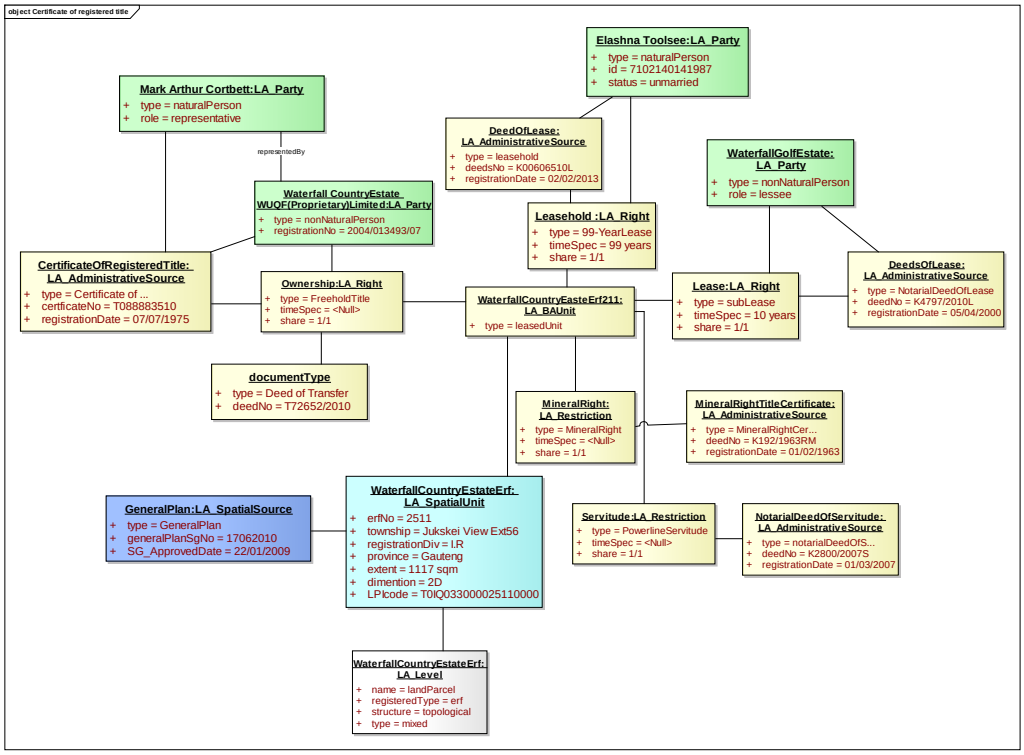
South Africa. Municipal Structures Act, no. 117 of 1998.
South Africa. Sectional Titles Act, no. 75 of 1986.

Appendices

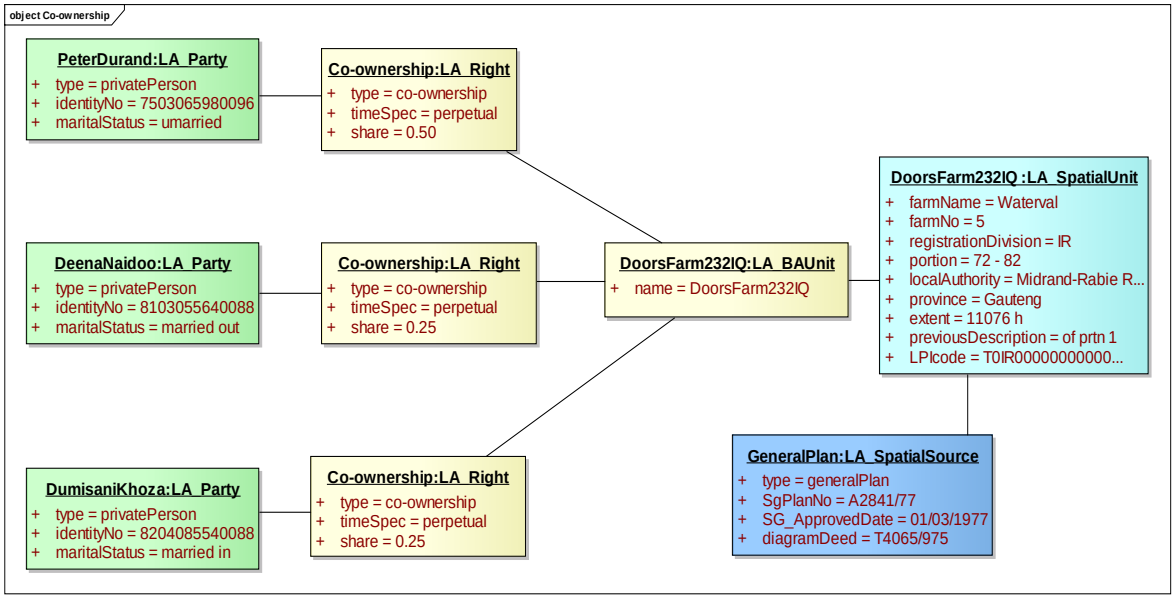
(Instance Level Diagrams)



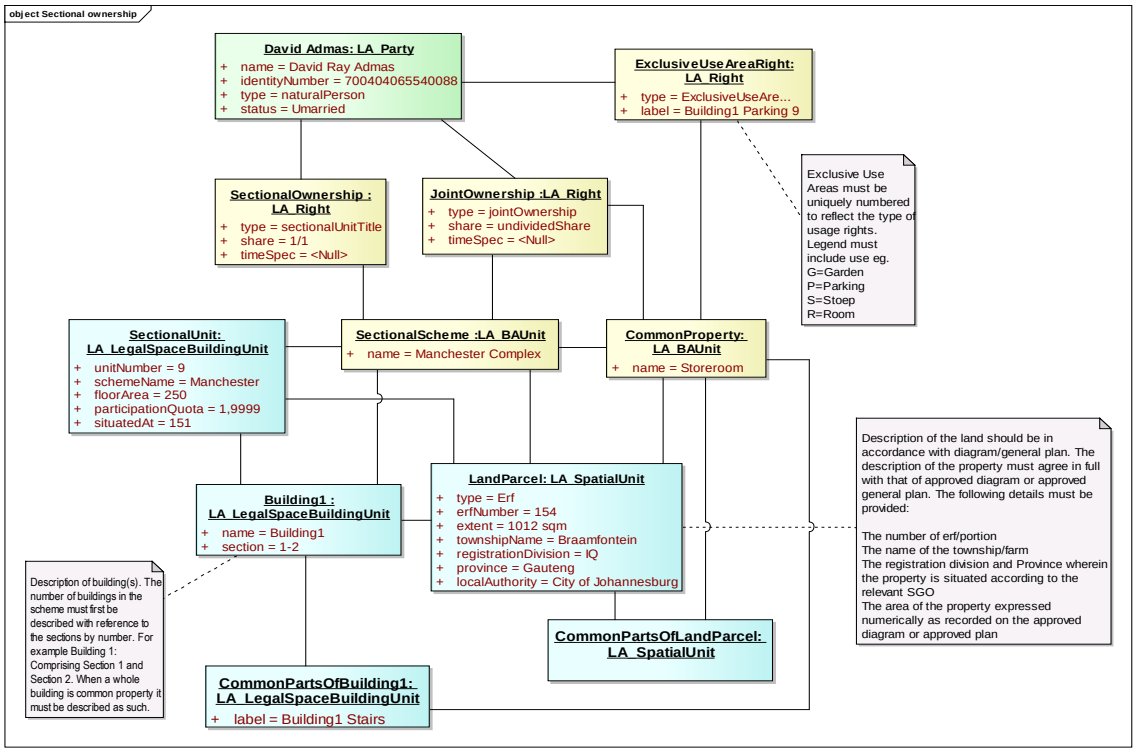
Appendix 1. Township ownership



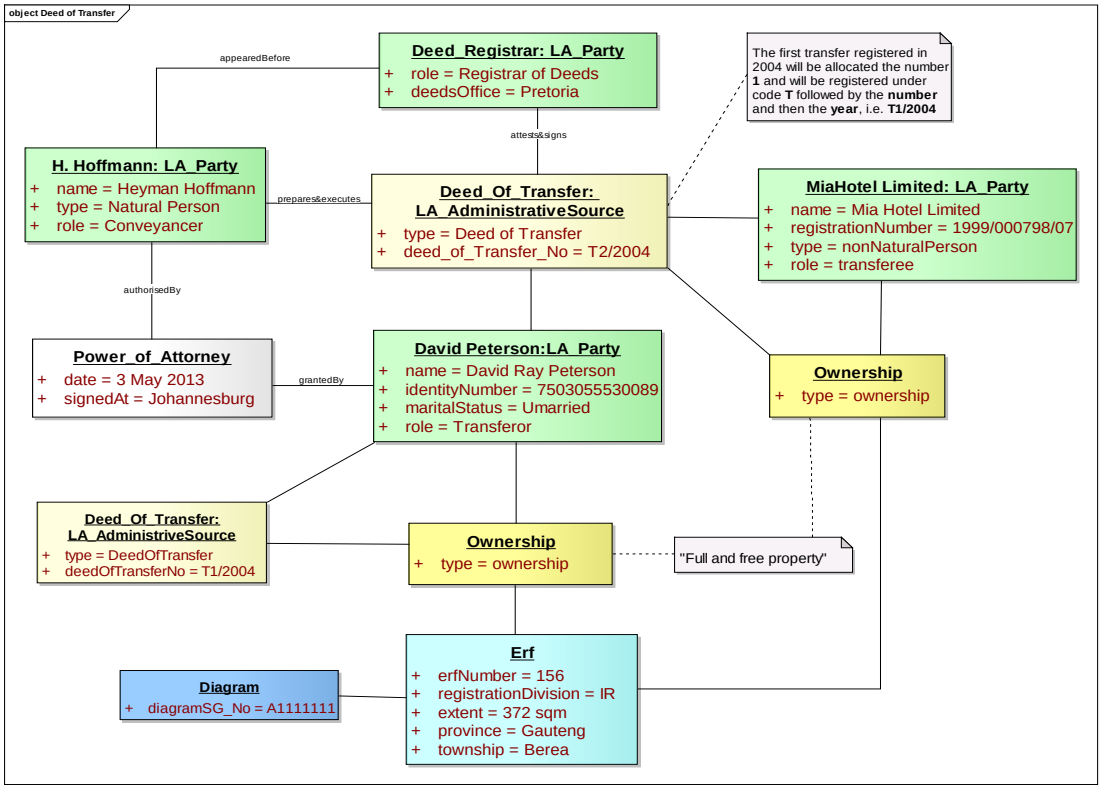
Appendix 2. A Certificate of Registered Title



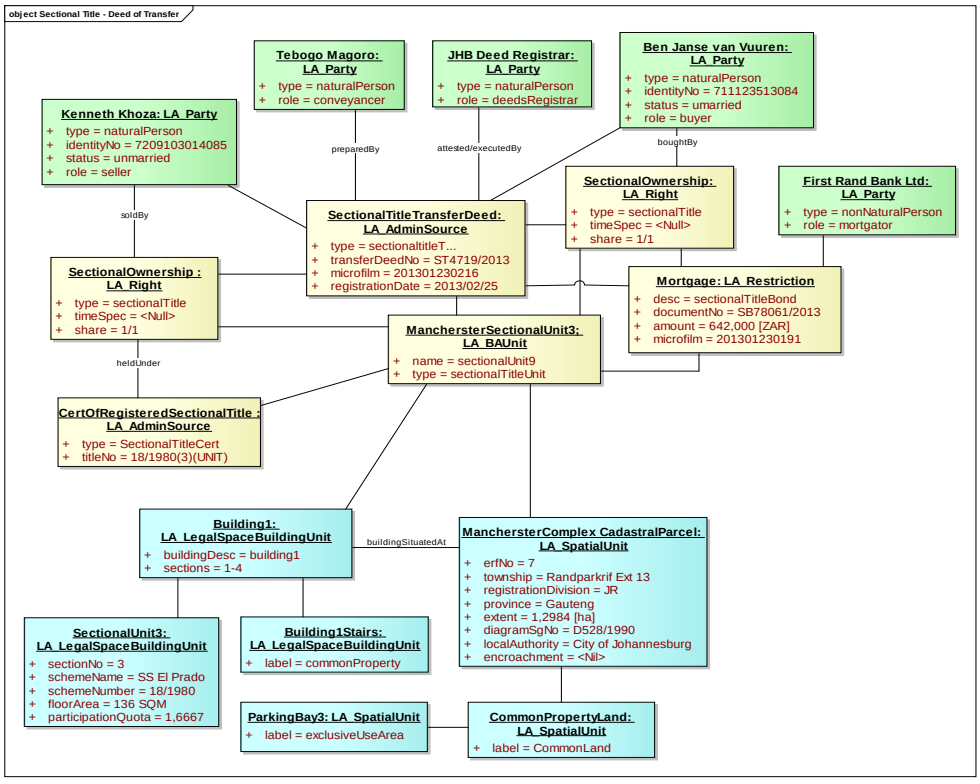
Appendix 3. Co-ownership



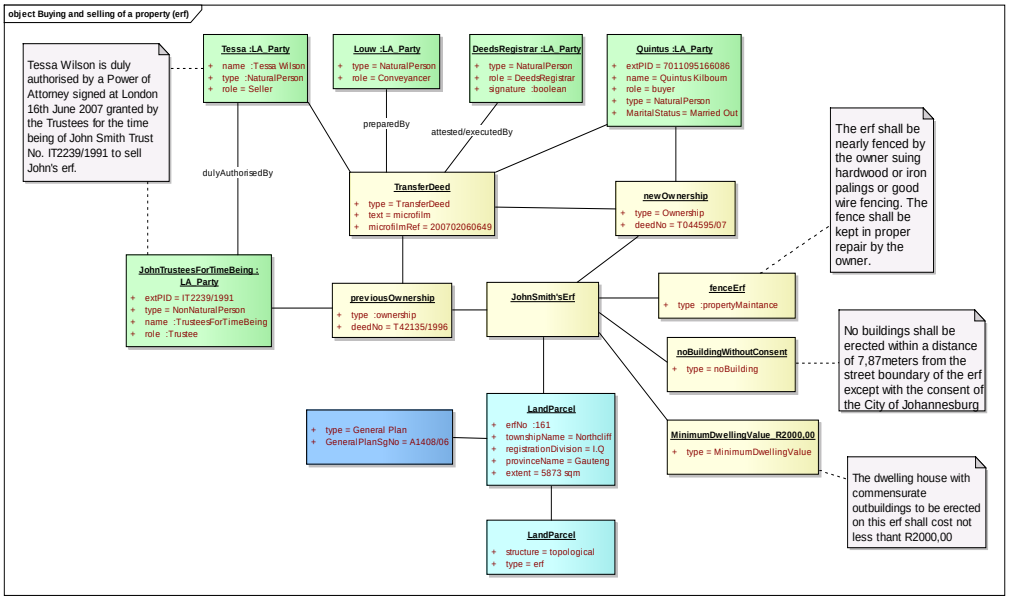
Appendix 4. Sectional ownership



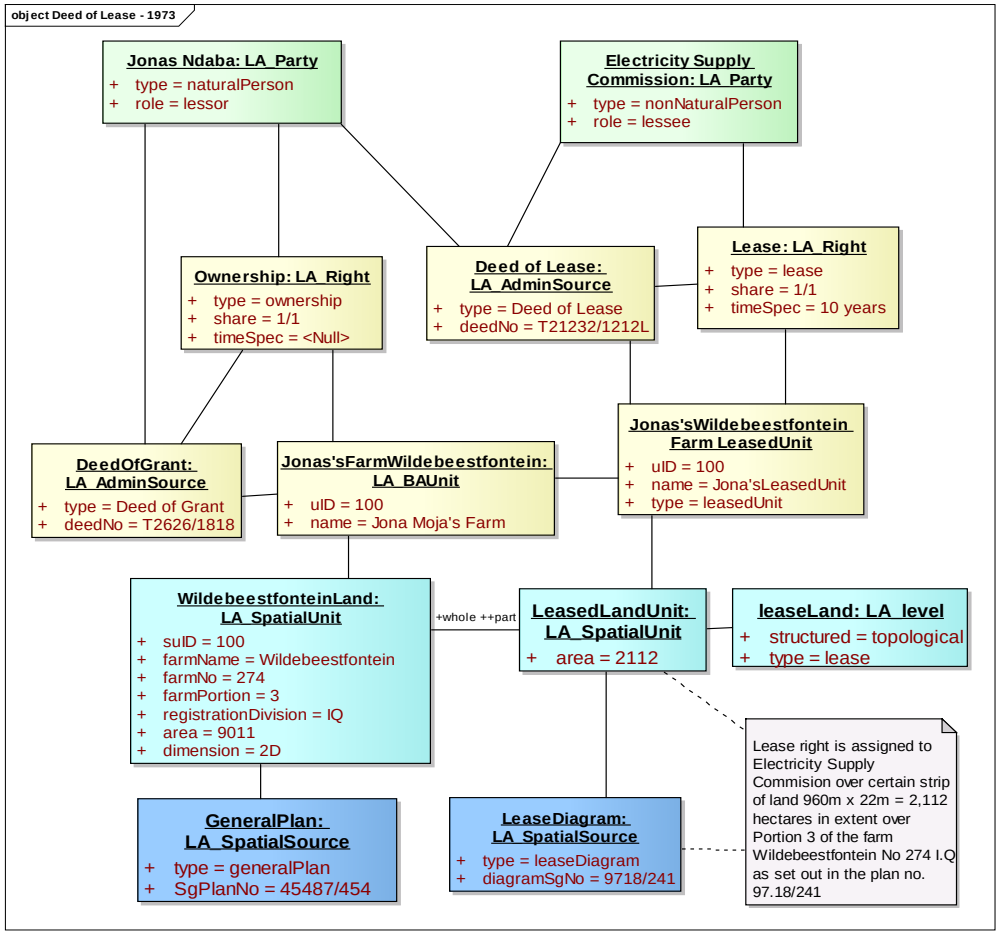
Appendix 5. Deed of Transfer of an erf



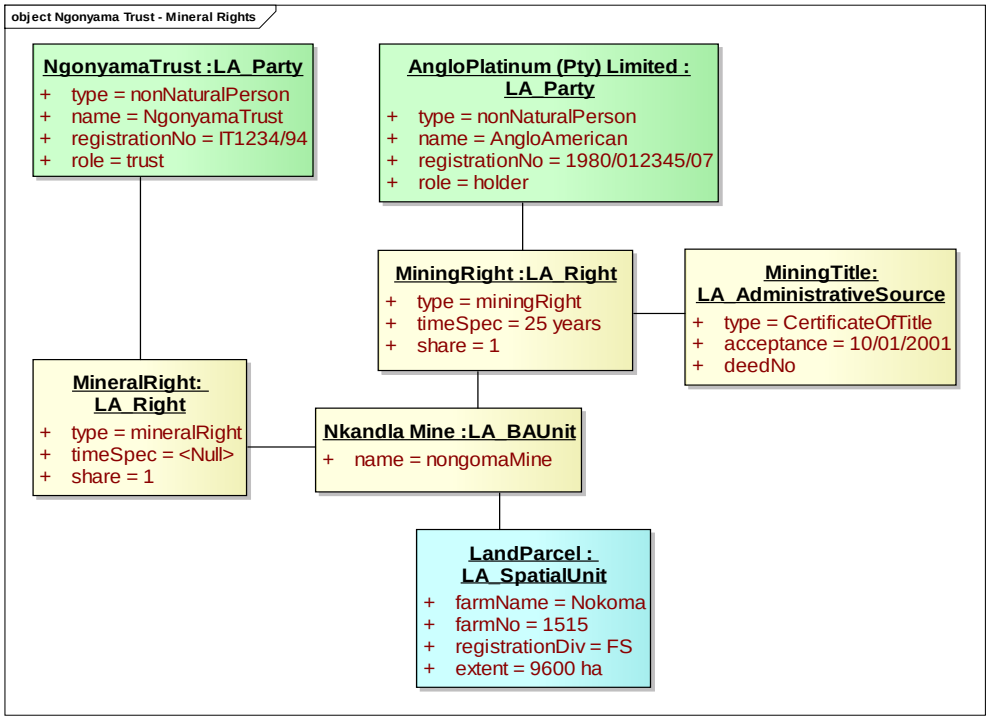
Appendix 6. Sectional Title – Deed of Transfer



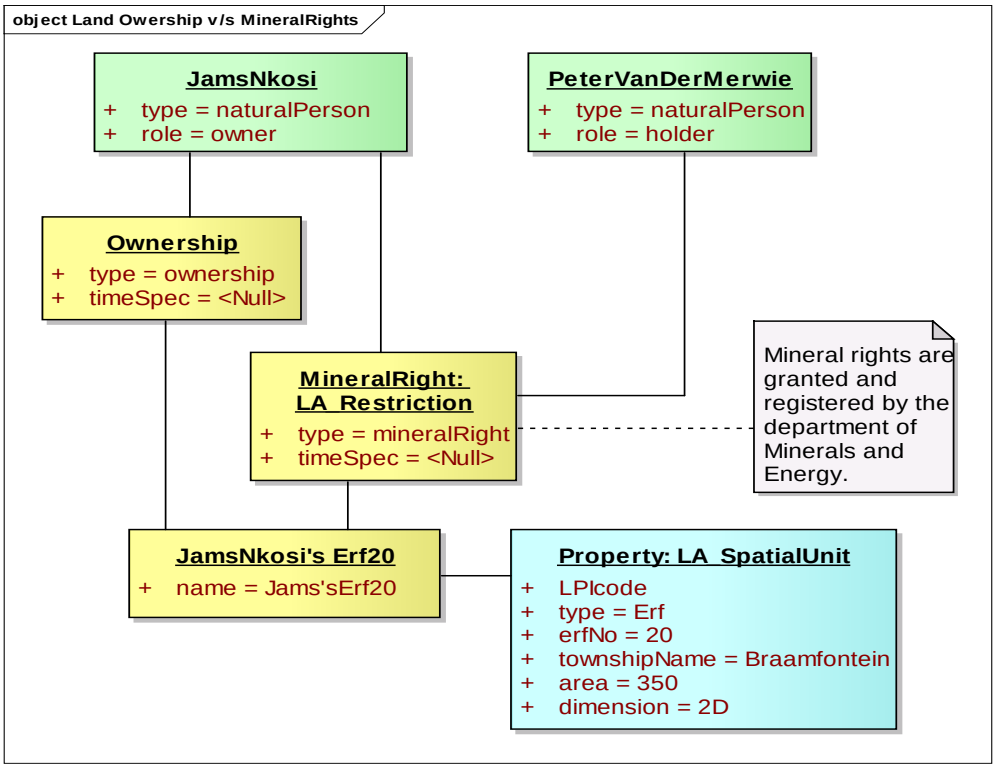
Appendix 7. Selling and buying of property



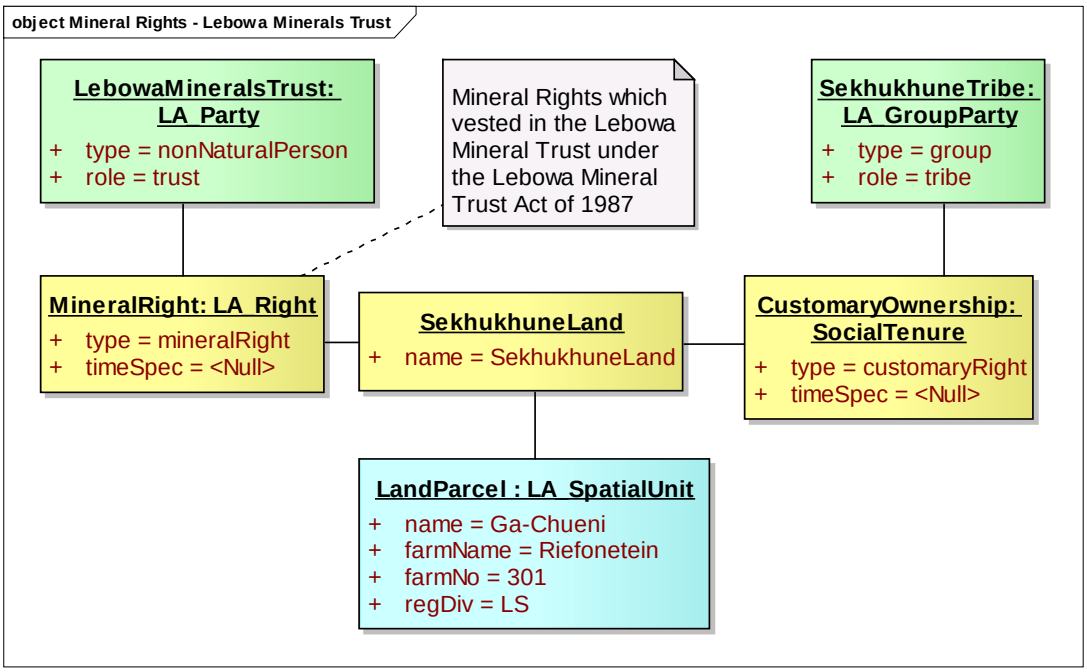
Appendix 8. A deed of lease



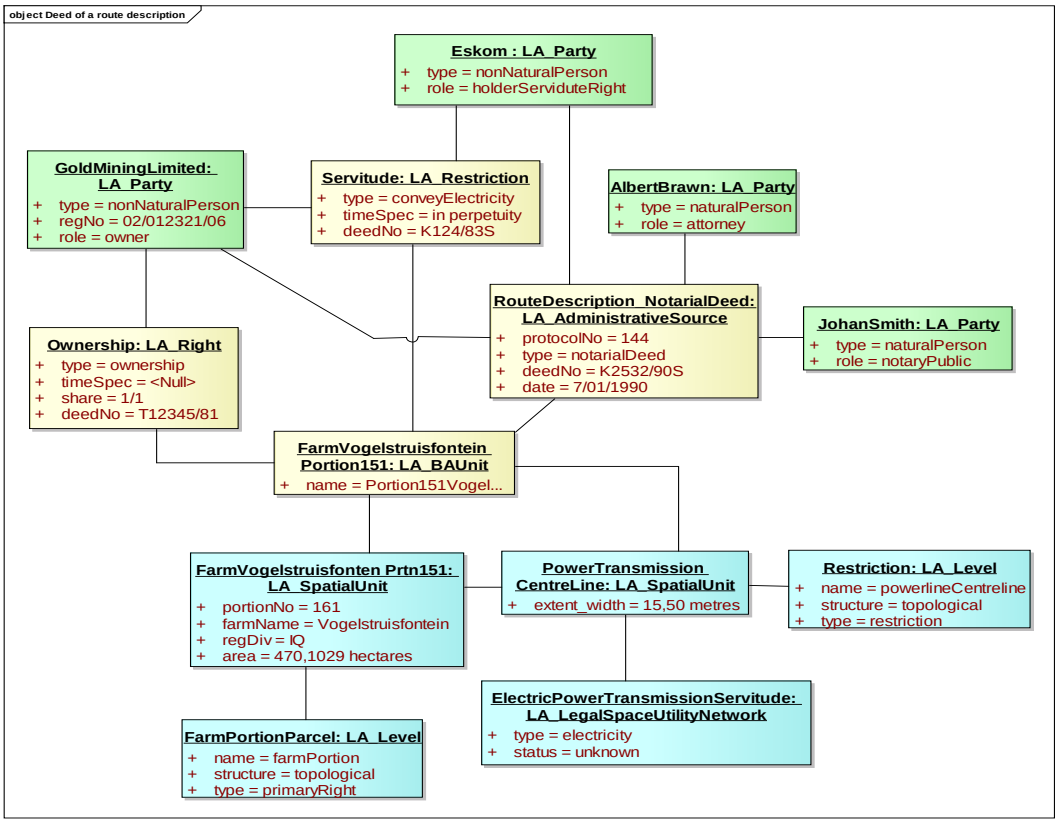
Appendix 9. Mineral Rights



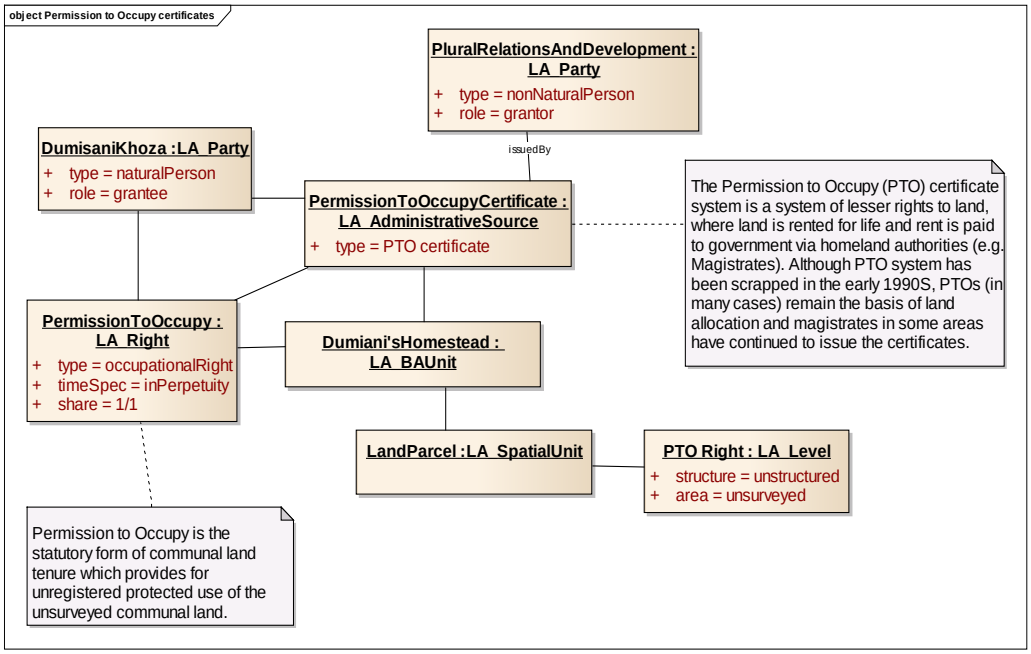
Appendix 10. Mineral Rights as restriction on ownership



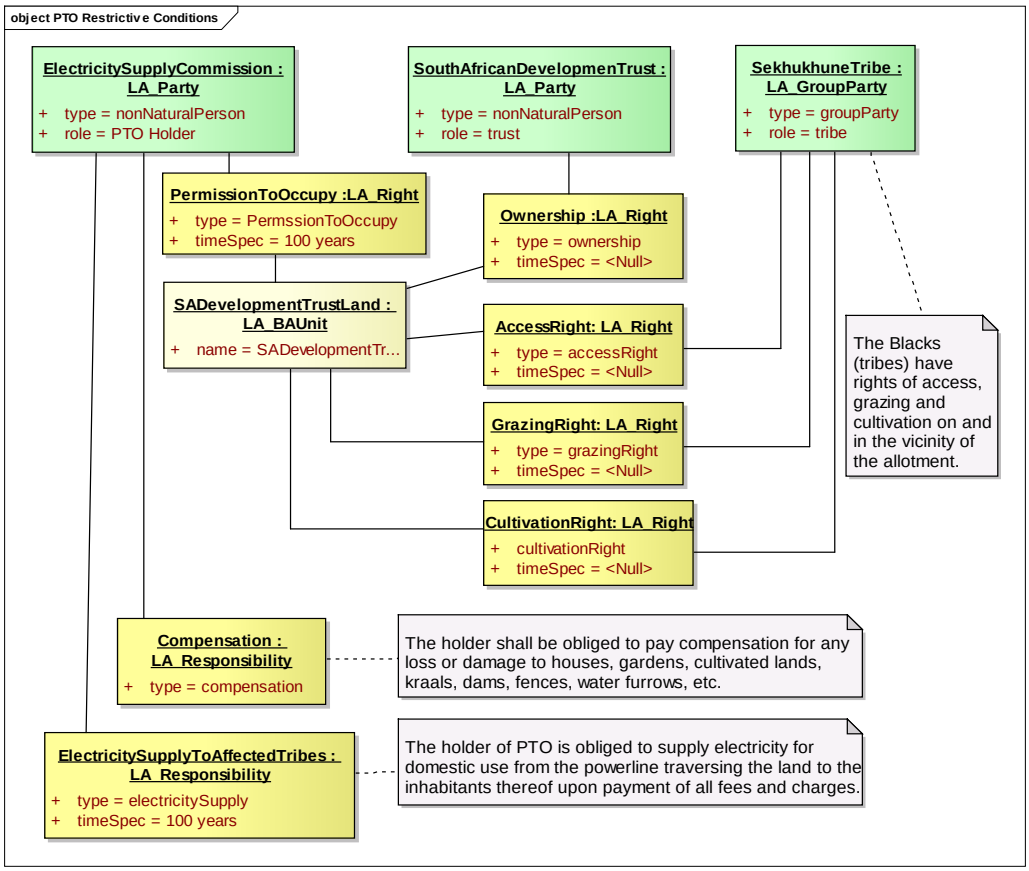
Appendix 11. Mineral Rights vested in Lebowa Mineral Trust



Appendix 12. A Notarial Deed of Route Description



Appendix 13. A Permission-to-Occupy (PTO)



Appendix 14. A Permission-to-Occupy (including restrictive conditions)