THE LAND ADMINISTRATION INFORMATION SYSTEM IN SUPPORT OF LAND MANAGEMENT: A CASE STUDY OF KARONGI DISTRICT, RWANDA

JANVIER MUHIMPUNDU

February, 2016

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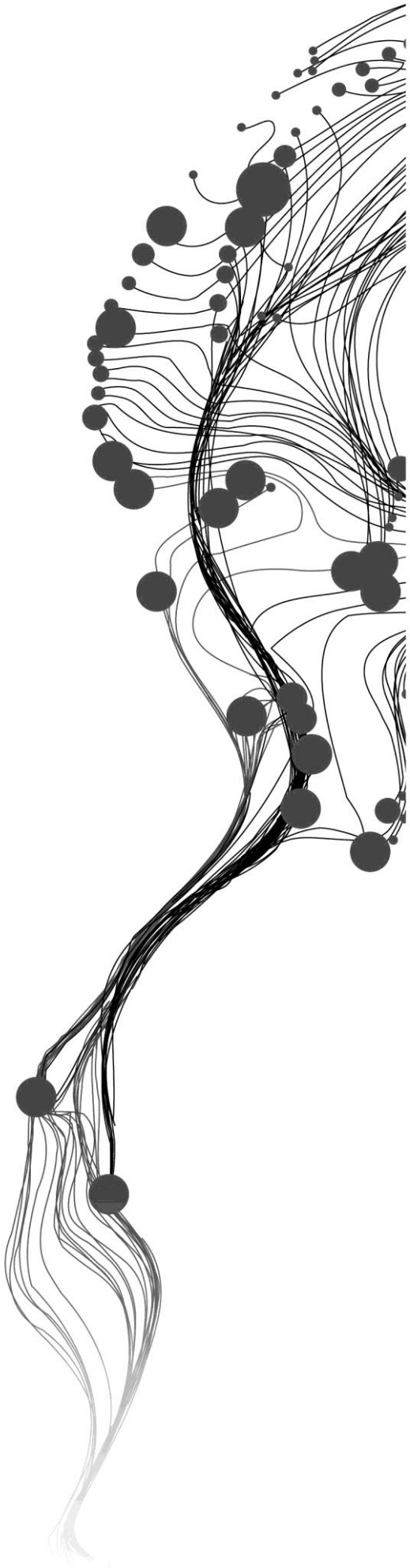

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Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of the University of Twente in partial fulfilment of the requirements for the degree of Master of Science in Geo-Information Science and Earth Observation.
Specialization: Land Administration

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ABSTRACT

Land information is recognized as a prerequisite for sustainable management of the land. In this perspective, the government of Rwanda, through the Rwanda Natural Resources Authority (RNRA), developed the Land Administration Information System (LAIS). The development of LAIS can be seen as part of the Land Tenure Regularization (LTR) program conducted in 2007-2013 in Rwanda. Land information collected during the LTR was stored in LAIS. The system was initially operational at central level but it became operational at the district level since 2014. One of the functions of LAIS is to supply land information to different users and customers. District officers involved in land management are expected to be among the main users and customers of land information delivered by LAIS. However, little was known about the impact of LAIS in land management activities performed by district officers. The goal of this research was therefore to examine the role of LAIS in support of land management activities performed at district level. For this research, with an exploratory nature, the case study approach seemed most appropriate. Karongi District was selected as a study area. Primary data were collected through structured, semi-structured and focus group interviews. They were also complemented by secondary data collected from Karongi District and RNRA. Findings showed that LAIS was developed in 2009-2012 to replace the Land Tenure Regularization Support System (LTRSS). The latter appeared not appropriate for sustainable maintenance of cadastral data. At its initial use in 2012, LAIS was composed of textual and spatial components storing respectively textual and spatial data. However, both components were not integrated and therefore, LAIS was renewed in 2014 to ensure the consistency of data and data sharing with other government agencies. LAIS is operational in Karongi District since January 2014. Karongi District officers can make use of land information delivered by LAIS by request. Therefore, they have to go to the Infrastructure One Stop Centre (IOSC) unit where two district officers (Acting Director and Lawyer) have direct access to LAIS. However, these two officers are only authorized to view information in the textual component of LAIS. In general, district officers orally ask their colleagues at IOSC to provide them with the needed information. For both textual and spatial information, district officers have to go to the provincial Office of the Registrar of Land Titles (ORLT) located in Karongi District. At this level, land information is provided to district officers by LAIS Processor and GIS Professional in charge of Karongi District or other professionals who have access to LAIS. Land information provided by LAIS is used in forestry, expropriation and construction of public infrastructures, development of rural settlement sites as well as construction permitting. However, in agriculture and environment protection, district officers rely on other sources of land information. They do not make use of LAIS because either they do not know that LAIS can provide them with relevant land information or they do not know LAIS at all. District officers who use land information delivered by LAIS indicate that the system improved their working conditions. However, the formal procedures governing the provision of land information from LAIS are considered long and time-consuming. District officers further comment that they don't have access to LAIS, not all land information can be accessed in IOSC, certain important information for land management is not available in LAIS and the system not updated. The study concluded that LAIS is supporting land management at the district level to a certain degree and the system is still in a transitional stage.

Keywords: *Land Administration Information System (LAIS)*, *land information, district officers, land management, land information system (LIS)*

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May the Almighty God bless you all.

DEDICATION

To my beloved wife Marie Claudine Niyonsenga and our sons Hervé Ihirwe Ganza and Ian Imena Sangwa
To my late mother Josephine Nyirabukima.

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ABBREVIATIONS

CRLT	: Chief Registrar of Land Titles
DDP	: District Development Plan
DLUP	: District Land Use Plan
e-MRS	: Electronic mortgage registration system
FIG	: Fédération Internationale des Géomètres (International Federation of Surveyors)
GIS	: Geographical Information System
IOSC	: Infrastructures One Stop Centre
IT	: Information Technologies
ITC	: Faculty of Geo-Information Science and Earth Observation
LAIS	: Land Administration Information System
LAS	: Land Administration System
LIS	: Land Information System
LTR	: Land Tenure Regularization
LTRSS	: Land Tenure Regularization Support System
LUC	: Land use consolidation
LWH	: Land Husbandry, Water Harvesting and Hillside Irrigation project
MINIRENA	: Ministry of Natural Resources
MINAGRI	: Ministry of Agriculture and Animal Resources
MINITERE	: Ministry of Lands, Environment, Forests, Water and Mines
MIS & ITS	: Management Information System and Information Technology Support
NAEB	: National Agricultural Export Development Board
NIDA	: National Identification Agency
NISR	: National Institute of Statistics of Rwanda
NLC	: National Land Centre
NLP	: National land policy
ORG	: Office of the Registrar General
ORLT	: Office of the Registrar of Land Titles
RDB	: Rwanda Development Board
REMA	: Rwanda Environment Management Authority
RLT	: Registrar of Land Titles
RNRA	: Rwanda Natural Resources Authority
RRA	: Rwanda Revenue Authority
RTDA	: Rwanda Transport Development Agency
UML	: Unified Modelling Language
UNECE	: The United Nations Economic Commission for Europe
UN-Habitat	: The United Nations Human Settlement Program
UPI	: Unique Parcel Identifier
VPN	: Virtual Private Network
WASAC	: Water and Sanitation Corporation

1. INTRODUCTION

1.1. Background and justification

Land information is a key driver of sustainable management of the land. In this respect, Garba & Al-Mubaiyedh (1999) argue that there cannot be an effective management of the land as long as there is not updated and accurate information on it. Detailed information of each individual land parcel is a major concern of land administration systems (Enemark, 2004). Williamson, Enemark, Wallace, & Rajabifard (2010) consider land information as an important government asset that drives policy making for both private and public sectors. Furthermore, land information plays a central role in decision-making, public administration as well as in land planning and development (Dale & McLaughlin, 1988). Due to the crucial role of land information in socio-economic and environmental sustainable development, various countries throughout the world undertake large scale programs of land registration and titling. Land information resulting from such programs is recorded in computerized systems commonly known as land information systems (LIS). A LIS includes a database of land-related data of a given area spatially referenced as well as techniques and procedures that govern the collection, maintenance, processing and dissemination of data (UNECE, 2005). LISs are required by a wide range of users such as government agencies at both central and local governments, landholders, real estate managers, lawyers, property valuation professionals and retailers as well (Dale & McLaughlin, 1999).

Scholars express different views about the role of land information provided by a LIS in land management activities. Tuan (2006) argues that LIS provides information related to land use, land use planning, land tenure and land value to other sectors such as agriculture, transport, construction and building, urban planning, taxation as well as mortgage registration. This is also confirmed by Williamson et al. (2010) who mention that cadastral information may be used to support taxation, land market, planning and land management. Moreover, the United Nations Economic Commission for Europe (UNECE) indicates that land information plays a crucial role in land management activities such as physical planning, land use planning in rural and urban areas, land consolidation and reallocation projects and environmental monitoring (UNECE, 1996). According to Kaufmann & Steudler (1998), cadastral data are used not only for legal and fiscal purposes but also for the management of facilities, base mapping, land valuation, land use planning as well as the environmental impact assessment. In summary, there is a close relationship between LIS and land management activities. To be successfully implemented, land management activities should be supported by the land information delivered by LIS.

From the literature mentioned above, it is seen that land information plays a wide range of roles in land management activities. It is a very important commodity that supports all kinds of activities related to the management of the land. Therefore, land information is always required by many organizations and professionals in their daily activities pertaining to land management. For this reason, national governments have invested considerable efforts to get cadastral information because they believe that it is a prerequisite for economic development in general and a foundation for efficient and effective management of land resources in particular. It is in this perspective that land registration projects have been implemented in different countries throughout the world, including Rwanda.

Since 2007, the government of Rwanda undertook a Land Tenure Regularization (LTR) program through pilots (Simbizi, Bennett, & Zevenbergen, 2015). Since 2009, LTR was fully implemented throughout the

country via a systematic land registration using general boundary approach (Enemark, Clifford, Lemmen, & McLaren, 2014; Muyombano, 2014; Biraro, 2014; Fosudo, 2014; Byamugisha, 2013). The main goal of LTR was to recognize and secure existing rights that people and organizations had over land and minimize land litigations by providing legally recognized land titles to rightful landowners (Sagashya & English, 2009). Till 2013, 10.4 millions of land parcels were registered in the whole country (Enemark et al., 2014). The information about each individual parcel was recorded in the Land Administration Information System (LAIS) which was centrally managed and maintained by Rwanda Natural Resources Authority (RNRA) through its Department of Lands, Mapping and Registrar of Land Titles (MINIRENA, 2012). The main functions of LAIS are the collection, storage, maintenance, retrieval and dissemination of parcel-based information. Initially, LAIS was operational at central level but nowadays the system has been decentralized in all the 30 districts of the country where it supports different activities related to land administration and land management.

In accordance with the provisions of the national land policy (NLP) adopted by the Government of Rwanda in 2004, the main objective of LAIS was to ensure a sound administration and management of the land (MINITERE, 2004). Ensuring a sound management of the land requires to some extent the supply of information needed by the users to execute land management activities. Districts are among the most important users of land information in Rwanda and their officers need different types of land-related information to implement land management activities. LAIS is the most reliable source of land information since it contains data legally recognized by the government. LAIS is now operational in all districts since 2014. So far, no research was conducted to assess the role of LAIS in support of land management activities performed by the districts. Does LAIS support the district officers in their land management activities at the local level as it is expected? This study is undertaken to bridge this gap in knowledge. Results derived from this research are important not only for Rwanda but also for other countries which have recently developed LISs. They may help land administration agencies to identify the problems to overcome in the first years of implementation of LISs but also to reinforce seen opportunities.

1.2. Research problem

A LIS supports land management by proving information about the land and various resources upon it as well the improvements that are developed on it. A LIS is useful when it was developed not for the benefits of information producers but for the users (Dale & McLaughlin, 1988). One of the purposes of the development of LAIS was to ensure proper land management (MINITERE, 2004) and provide land information to the users including district officers to facilitate land management activities. However, the role that LAIS plays in land management activities performed by district officers is unknown. So, there is a need to examine the role of LAIS in land management activities of the districts.

1.3. Conceptual framework

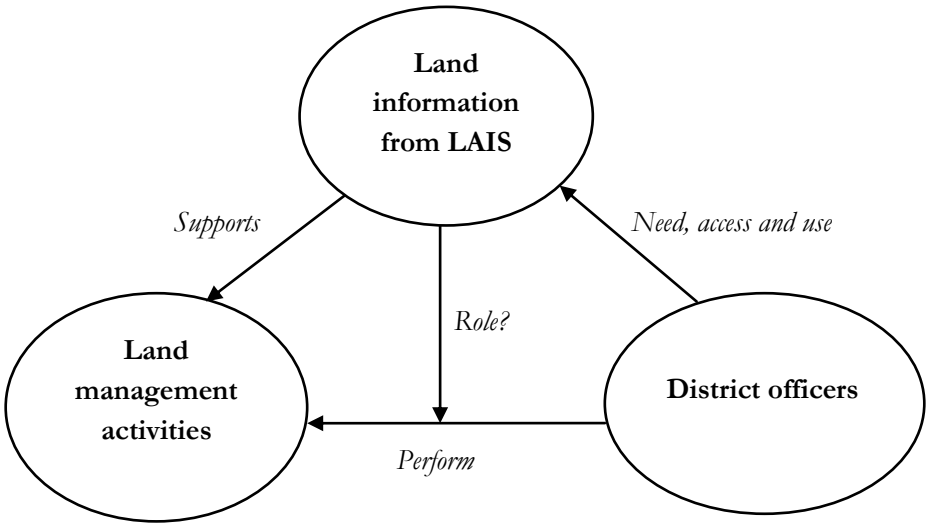

Figure 1-1: Conceptual design

The conceptual framework should be read as follows: district officers carry out land management activities. In order to perform these activities, it is supposed that they need information about land and this information is provided by LAIS. However, the role of the LAIS in land management activities of the district officers is unknown. This research intends to address this knowledge gap.

1.4. Research objectives

1.4.1. General objective

The overall objective of this research is to examine the role of the Rwandan LAIS in support of land management activities performed at the district level.

1.4.2. Specific objectives

The specific objectives of this research are:

1) To describe the development and use of LAIS at national and district level
2) To describe land management activities executed at the district level
3) To examine how district officers make use of land information provided by LAIS to perform land management activities
4) To understand how district officers perceive the role of LAIS in support of their land management activities

1.5. Research questions

1. *To describe the development and use of LAIS at national and district level*
   1.1. What are the characteristics of LAIS?
   1.2. How is LAIS used at the district level?
2. *To describe land management activities executed at district level*
   2.1. Which land management activities did the district execute since LAIS was implemented at the district level?
   2.2. What is the impact of the implementation of land management activities on the people-to-land relationship (parcels, owners and rights)?

3. *To examine how district officers make use of land information provided by LAIS to perform land management activities*
   3.1. How is the land information delivered by LAIS used by district officers in their daily work?
   3.2. What is the role of the land information provided by LAIS in land management activities performed by district officers?
4. *To understand how district officers perceive the role of LAIS in support of their land management activities*
   4.1. To what extent does the land information provided by LAIS satisfy the needs of district officers with respect to land management activities they perform?
   4.2. What is the impact brought by LAIS in working conditions of district officers?
   4.3. Which improvements do district officers suggest for the optimal support of LAIS to land management activities at the district level?

1.6. Research matrix

Specific objectives	Research questions	Data collection method & source of data	Anticipated results
1) Describe the development and use of LAIS at the national and district level	1) What are the characteristics of LAIS?	- Semi-structured interview with RNRA staff - Documentation	Historical development and description of LAIS
	2) How is LAIS used at the district level?	Structured interviews staff responsible of LAIS in the selected district	Use of LAIS in the selected district
2) To describe land management activities executed at district level	1) Which land management activities did the district execute since LAIS was implemented at the district level?	- Structured interviews with district officers - Documentation	Description and categorization of land management activities performed by the district since the introduction of LAIS at district level
	2) What is the impact of the implementation of land management activities on the people-to-land relationship (parcels, owners and rights)?	- Structured interviews with district officers - Documentation	Impacts of executed land management activities on parcels, owners and land rights
3) To examine how district officers make use of land information provided by LAIS to perform land management activities	1) How is the land information delivered by LAIS used by district officers in their daily work?	Structured interviews with district officers	Use of land information provided by LAIS in daily work of district officers
	2) What is the role of the land information provided by LAIS in land management activities performed by district officers?	Structured interviews with district officers	Contribution of land information delivered by LAIS in the implementation of land management activities executed by district officers
4) To understand how district officers perceive the role of LAIS in support of their land management activities	1) To what extent does the land information provided by LAIS satisfy the needs of district officers?	Structured interviews with district officers	Perceptions of district officers on availability, accessibility and quality of land information delivered to them by LAIS
	2) What is the impact brought by LAIS in working conditions of district officers?	Structured interviews with district officers	Improvements brought by LAIS in working conditions of district officers
	3) Which improvements do district officers suggest for the optimal support of LAIS to land management activities at the district level?	Focus group interview with district officers & staff responsible of LAIS at district level	Suggested improvements to optimize the use of LAIS in land management activities at district level

Table 1-1: Research matrix

1.7. Research design

This study was conducted in three main phases: pre-fieldwork, fieldwork and post-field work phases (see figure 1-2).

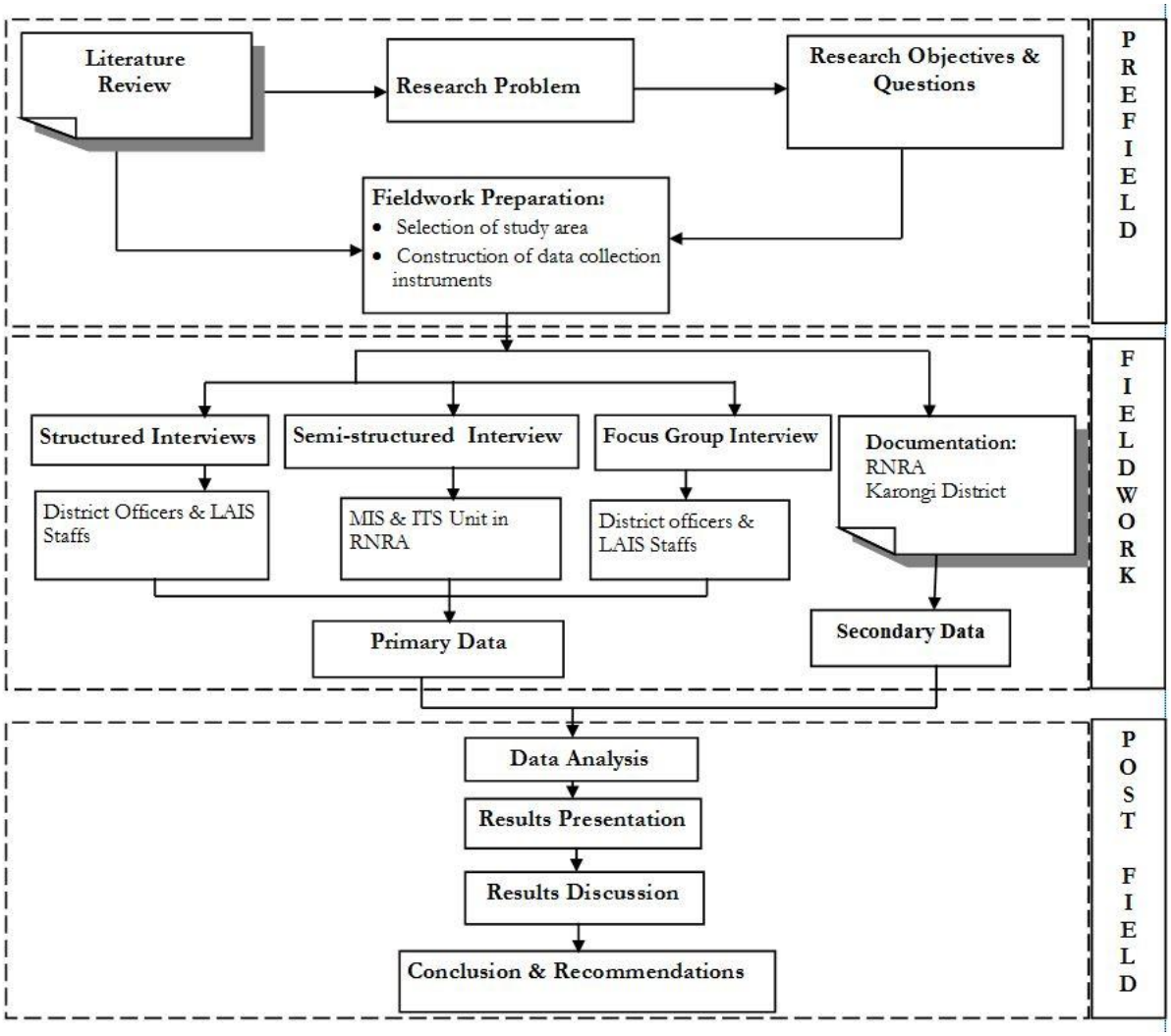

Figure 1-2: Research design

The first phase was dedicated to the review of previous literature on the subject area of interest from which the research problem, objectives and questions were derived. Before the fieldwork, the study area was selected and field data collection instruments were designed. The second phase was dedicated to the collection of primary data through structured, semi-structured and focus group interviews. Secondary data were also collected during this phase. The third phase focused on the analysis of data collected from the field, presentation and discussion of the results as well as the formulation of the conclusion and recommendations.

1.8. Structure of the research

The present research is divided into six chapters.

Chapter 1: Introduction

The chapter constitutes the overall introduction of the research. It provides the background and justification of the research, the research problem as well as the conceptual framework of the study. It also includes the research objectives which are translated into research questions. The research matrix and the research design are also presented.

Chapter 2: Literature review

The chapter provides an overview of the key literature and academic works related to the topic covered by this study. It embraces the key concepts frequently used in the present research: land information, land information system and land management. A brief history an overview of land tenure regularization and a brief description of land governance institutions in Rwanda are presented. In the end, the chapter discusses the organization and functioning of the districts in Rwanda.

Chapter 3: Research methods

The chapter describes the methodology used to carry out the research. The research strategy, data collection and analysis methods are discussed.

Chapter 4: Results

The chapter presents findings derived from the analysis of various data collected during the fieldwork based on specific objectives assigned to the study.

Chapter 5: Discussions

The chapter compares and contrasts the results achieved by the research against the literature reviewed in chapter two and new literature.

Chapter 6: Conclusion and recommendations

The chapter summarizes the study results and formulates the conclusion and recommendations. Based on the results derived from this research, further researches are also proposed.

2. LITERATURE REVIEW

2.1. Introduction

The chapter reviews previous literature related to this research by focusing on the main concepts and theories that constitute the basis of this research. Section 2.2 defines the concepts of land information, land information system and cadastre. Section 2.3 defines the concept of land management and land management activities. It also highlights the components of land management and establishes the link between land management and land information. Section 2.4 focuses on land tenure regularization program in Rwanda. Sections 2.5 and 2.6 respectively discuss land governance institutions as well as the organization and functioning of the district in Rwanda.

2.2. Land information, land information system and cadastre

2.2.1. Land information

Land information refers to any information associated with the land. This concept is sometimes used to mean land records and includes information related to the tenure, value and use of the land (Biraro, Bennett, & Lemmen, 2015). In a broad sense, "*land information is concerned about policy objectives, land and information acts, institutions responsible for the provision of products and services related to land administration processes on land objects (such as land and building) represented in spatial data or map, land rights concerning ownership, responsibility and restrictions on land objects, and personal information about the people who hold and use land and building*" (MINIRENA, 2012, p.6). UN-Habitat, ITC, & GLTN (2013), define land information at two levels: strategic level and substantive level. At the strategic level, land information encompasses various legislations and policies pertaining to the management of land-related information. At a substantive level, the land information includes textual, geometric and temporal information related to land parcels, land rights and land right holders. *The attribute information* may include the identification of natural and non-natural persons and the description of rights they hold over land. *Spatial information* is related to the size, boundaries, land use, land cover and other improvements made on the land. *Temporal information* may describe the duration of land rights, seasonal land use changes, spatial changes that affect the land over time, etc. In short, land information responds to the questions like *what* (information related to the size, use and value of the land parcel), *where* (spatial location of the land parcel) and *how* the land tenure is held (Byamugisha, 2014). Land information may be in a digital or paper-based form. Most time, information and data are interchangeably used to mean the same thing but in reality, these two terms are different. Dale & McLaughlin (1999) define information as data translated into a form that can be easily understood by decision makers. They indicate that land information is useful when the quality of data is good in terms of updatedness, accuracy, completeness, comprehensiveness and accessibility.

2.2.2. Land information system and cadastre

LIS and cadastre are fuzzy concepts and scholars expressed different views about their meanings. By definition, "*an information system is a combination of human and technical resources, together with a set of organizational procedures, that produces information in support of some managerial requirements*" (Dale & McLaughlin, 1988, p.8). An information system specific to land is termed land information system. According to the International Federation of Surveyors (FIG), *"a land information system is a tool for legal, administrative and economic decision-making and an aid for planning and development which consists on the one hand of a database containing spatially referenced land-related data for a defined area, and on the other hand, of the procedures and techniques for the systematic collection, updating, processing and distribution of data. The base of a land information system is a uniform spatial referencing system for the data in the system, which also facilitates the linking of data within the system with other land-related data*"

(Larsson, 1991, p.2; UNECE, 1996, p.60; (Tuladhar, 2004); UNECE, 2005, p.71). According to Williamson et al. (2010), LIS is a system developed in order to collect, process, store and disseminate land-related information. Wyatt & Ralphs (2003) relate LIS to Geographic Information System (GIS); they consider LIS as a specialized form of GIS designed to handle land ownership, land management and land planning related issues. LISs may be developed to play different roles; they may store data related to the environment, infrastructure development, cadastre or socio-economic records. They may focus on one or more functions and they are not mandatorily dedicated to the management of land parcels even if studies have demonstrated that LIS that supports land administration are basically centered on spatial units. In other words, a LIS is not always parcel-oriented because it may be also designed to collect information for other domains such as forestry, geology or soil (UNECE, 2005). A LIS is fundamentally composed of three elements: geographical data, cadastral data and attribute data (Nahrin & Rahman, 2009). Normally, a LIS is composed of a registry and a cadastre. The former is the database that stores the legal information of the property such as ownership, area, charges and liens. The latter forms a database that stores graphic and alphanumerical data associated with the land parcels such as features, land use and geographic coordinates of the parcels (Bandeira, Sumpsi, & Falconi, 2010). Both databases are commonly linked by the unique parcel number. In the context of this study, the registry and cadastre respectively refer to the textual component and spatial components of a LIS that store respectively attribute and spatial land information.

According to Larsson (1991), a LIS performs six functions or processes such as collection, storage, updating, retrieval, analysis and dissemination of land information and its products may be data, records, maps, statistics and others (Figure 2-1).

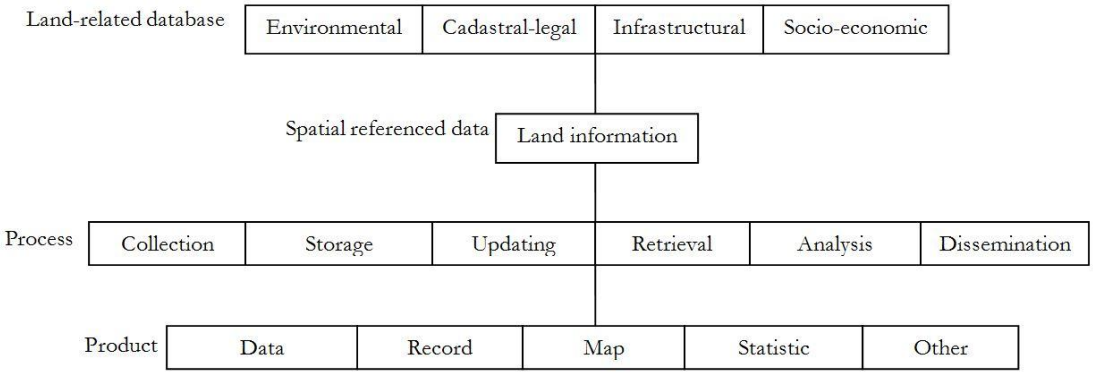

Figure 2-1: Land Information System (Larsson, 1991)

A LIS is the outcome of systematic or sporadic registration of the land in a given area (Biraro, 2014). In fact, land registration and cadastre are complementary and sometimes not easy to distinguish. Hensen (2010) defines land registration as the process whereby rights in land are officially recorded through either deeds or titles. Land registration responds to the questions "*who*" and "*how*". Contrarily to land registration, the cadastre responds to the questions "*where*" and "*how*". Land registration focuses on subject-right relationship while the cadastre deals with right-object relationship (see figure 2-2). FIG defines cadastre as "*a parcel-based and up-to-date land information system containing a record of interests in land (i.e. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership and control of those interests, and often the value of the parcel and its improvements* (FIG, 1995). In other words, cadastre is "*a methodically arranged public inventory of data concerning property within a certain country or district based on a survey of their boundaries*" (Hensen, 2010, p.5). From the database perspective, a cadastre is considered as a LIS whereby information is referenced to unique and well-defined land parcel (Effenberg, 2001). Depending on their uses, there are 3 types of cadastre: *fiscal cadastre* developed for valuation and land taxation purposes, *juridical or legal cadastre* established for legal purposes and *multipurpose cadastre*

designed to support land management and land use, enable sustainable development and the environment conservation. A multipurpose cadastre means the same as LIS (FIG, 1995; Zevenbergen, 2002). To these three categories of cadastre, Williamson et al. (2010) add a fourth category called *land-use cadastre* defined as a register of land use.

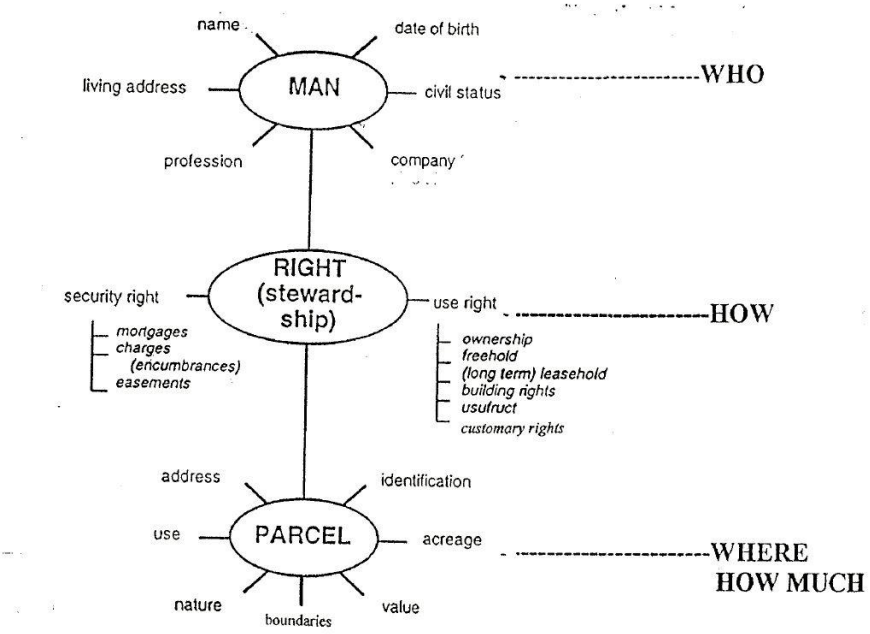

Figure 2-2: Content and relation land registration - cadastre (Hensen, 2010)

A cadastre should be always up-to-date. In this regard, Hensen (2010) states that a cadastre loses its value as long as it is not timely updated regardless of how well it was established. Therefore, all the changes that occur on parcels over time should be reflected and updated in both cadastral maps and records (Tuan, 2006).

2.2.3. Components of a LIS

According to Cruz (2006), an information system has the following components: *data, software and hardware, people, methods and procedures*. The same components had been discussed and developed before by Tuladhar (2004) who indicated that a parcel-based geo-information system includes the following components:

- **Datasets**: There exist two categories of datasets such as *basic cadastral data* and *supporting data*. Basic cadastral data are related to land ownership while supporting data include geodetic reference points, topographical data, orthophotos or images, socio-economic information and thematic or natural resources information.
- **Processes or functions**: This component refers to the processes used for collection, processing, storage, maintenance, analysis and dissemination of data.
- **Hardware and software**: This component includes all IT equipment required to run the system. The choice of hardware and software to be used to run a LIS is dependent upon the volume of data, applications and organizational functions.
- **Well trained people**: This component includes human resources required for the development and implementation of the system. In this regards, Tuladhar (2004) mentions that the number and the level of training of human resources is a key driver of the success of any LIS. Therefore, during the development or improvement of a LIS within a given organization, human resources responsible for the system should be carefully selected and managed.

Data constitute the main component of a LAIS. Wyatt et al. (1998) consider data as the fuel any LIS depends on. The same authors reiterate the importance of human resources in LIS and prove that this component represents 50% of the total cost allocated to the development of a LIS.

2.2.4. Determining user requirements of an information system

Determining the requirements of the users and stakeholders is considered as the most important step in the development of information systems (Browne & Rogich, 2001). User requirements are different from the system requirements. Amyot (2003) defines user requirements as a set of objectives or functions expected from the system by its users and stakeholders whereas the system requirements refer to ideas to be incorporated in the system or application which is being developed. User requirements describe the user needs or activities that the users can perform with the information system under development. When the requirements are not clearly and understandably defined, this leads to the failure of the system and its inability to satisfy the needs and expectations of the users and stakeholders. Hickey & Davis (2004, p.67) identifies five activities involved in the process of determination of the requirements: *elicitation, analysis, triage, specifications and verification.*

- **Elicitation**: learning, uncovering, extracting, surfacing, or discovering needs of customers, users and other potential stakeholders.
- **Analysis**: analyzing the information elicited from stakeholders to generate a list of candidate requirements, often by creating and analyzing models of requirements, with the goals of increasing understanding and searching for incompleteness and inconsistency.
- **Triage**: determining which subset of the requirements ascertained by elicitation and analysis is appropriated to be addressed in specific releases of a system.
- **Specifications**: documenting the desired external behaviour of a system.
- **Verification**: determining the reasonableness, consistency, completeness, suitability and lack of defects in a set of requirements.

2.2.5. Access to land information

Access to land information by the user community is one of the major concerns of land administration systems (LAS) throughout the world. For this reason, FIG (1995) suggests that accessibility to land information should be one of the criteria for evaluating the success of formal LAS. Additionally, FIG recommends that LAS should be efficiently and effectively able to provide access to information to all the users within constraints of cultural sensitivities, legal and privacy issues. This view of FIG is also confirmed by Anh, Nhat, Thuy, Prickett, & Van (2010) who recognize that access to land information plays a fundamental role in decision making concerning land management and investment in land and therefore, it should be considered as a priority for every LAS. Land information should be available and readily accessible to all the users who need it for different purposes. Users of land information could be the general public, professionals, decision makers, private organizations as well as public institutions at both central and local level. However, Dale & McLaughlin (1999) prove that government and public organizations are the first beneficiaries of a LIS and they can be simultaneously users and producers of land information. Burns, Grant, Nettle, Brits, & Dalrymple (2006) state that access to information can be guaranteed to the users through decentralized land offices, simple procedures as well as affordable fees.

Linh (2009) has identified three main factors that drive access to land information: policy aspects, technological aspects and human resources aspects. Policy aspects refer to the provision and disclosure of information to the public and include openness and pricing policies, copyright and privacy law, data protection and standards. Technological aspects refer to different technologies used to collect, store,

update, process and distribute land information through the LIS. Human resource aspects refer to all human resources required to build and sustain land administration related infrastructure.

Access, availability and provision of land information can be guaranteed to the users in several ways. Land information can be accessed through intranet, internet, check of paper-based registers and visit land offices. Hensen (2010) argues that land information may be provided to the users orally, in writing, fax and internet. Nowadays, land agencies are publishing their products and services on web portals in order to improve the availability and distribution of information to their intended users. In the Netherlands for instance, the national land agency, Dutch Kadaster as a customer-oriented organization, makes land information openly available and accessible to the customers through the internet where they can access to cadastral maps and attribute data upon payment of a certain fee. In Croatia, access to land information is freely open to every citizen through the internet. However, online access to information is exclusively reserved to attribute data while cadastral maps are physically accessed at local land offices (Custovic, 2010). In other countries where LAS are not yet computerized, land information is exclusively accessed by consulting paper-based registers and maps in land offices. Despite the effort undertaken by countries to improve access to land information through the computerization of land records and online access to information, there is a call for setting up strict and transparent procedures and laws dictating how personal information kept in databases is accessed and used in order to regulate access to land information (UN-Habitat et al., 2013). Legislation related to access to land information identifies rights of access to data and specifies the users who are allowed to make changes in the databases and under which conditions. It also specifies the users who are allowed to use the land information for other purposes than the ones for which land information was delivered (UNECE, 2005).

Depending upon the historical, socio-economic and legal context of a country, access to land information may be open or restricted. For instance, in some countries such as Indonesia, Malaysia, Laos and China, plans and maps are almost used for military purposes and therefore, availability and access to land information are subject to some restrictions. In other countries like the United States and New Zealand, land information is available and accessible for free. In contrast, in Europe and Australia, availability and access to land information are based on cost recovery principle whereby a customer ought to pay a certain fee equivalent to the cost necessary for maintenance or collection of data (Williamson et al., 2010). Despite the progress undertaken in the field of accessibility to land information, research has proved that majority of developing countries still lack proper access to land information (Adlington et al., 2000).

2.2.6. Importance of the land information systems

Authors have different views about the importance of a LIS. Basically, a LIS may support all activities which require spatial and attribute information about the land. Larsson (1991) argues that land information facilitates land transactions, guarantees security and protection of land ownership, reduces land disputes, supports decision making and facilitate land use and land management. It also supports public control and land policy implementation measures. Hadjiraftis (1991) argues that land information is used in a wide range of activities such as transfer of land ownership, administration of land tax and rates, environment management, support to national defence and security, supporting mineral extraction, provision and management of utilities and services, urban planning as well as conducting market research. According to Tuladhar (2004), LIS supports land administration activities such as alienation, transfer, valuation, development and utilization of land. A LIS is developed to support decision-making and enhance the capacity of LAS to conduct efficiently the collection, interpretation and application of the land information (Ali, Zevenbergen, & Tuladhar, 2013). LIS provides information related to land use, land use planning, land tenure and land value to other sectors such as agriculture, transport, construction and building, urban planning, taxation and mortgage registration (Tuan, 2006). Cete & Yomralioglu (2013) argue that LIS may be used to support land taxation, land market, land management as well as sustainable

development. From the examples mentioned above, it is seen that a LIS can be used in a wide range of activities. However, to be efficiently useful, a LIS should be updated, accurate, complete, accessible and developed for the interests of the users community instead of the producers of land-related information (Hadjiraftis, 1991).

2.3. Land management

This section reviews the concept of land management, components of land management as well as land management activities based on previous literature published in this matter.

2.3.1. Defining the concept of land management

The concept of land management has been defined by many authors. According to the UNECE (1996), land management is the process by which land resources are put to good effect. Land management encompasses all the activities pertaining to the management of land resources from environmental and economic perspectives. It refers to the processes by which the physical land resources are effectively used independently of their ownership by the government, legally recognized entities as well as private persons (UNECE, 2005). Land management entails all the activities executed to attain the goals set forth for a proper use of land resources. Such activities may be undertaken to promote efficient use of the land within existing patterns or to develop the land through investments in land accompanied or not by the change of existing land use (Larsson, 2010). Williamson et al. (2010) define land management as a set of activities related to the management of the land resource undertaken in order to attain socio-economic and environmental sustainable development. In their view, Dale & McLaughlin (1988) indicate that land management involves fundamental policy decision-making concerning the nature and extent of investments in the land on the one hand and the daily decisions made by land administration professionals on the other hand.

Dale & McLaughlin (1988) identify five phases involved in land management: (1) *monitoring phase* dedicated to the gathering of information related to the environment where decisions and actions need to be taken, (2) *planning phase* allocated to the analysis of alternative courses of action, (3) *policy making phase* whereby particular course of action is selected, (4) *operations phase* whereby selected course of action is implemented and (5) *the further monitoring phase* whereby the results of the operations may be reviewed if necessary. The process of land management requires the participation of several actors. In this regard, UN-Habitat (2012) indicates that managing and administering the land involve a wide range of formal and informal actors such as government (national government, Districts, City Councils and local authorities), non-government and private organizations. Each actor participating in the processes of land management has a role to play.

2.3.2. Components of land management

When defining land management, Enemark, Williamson, & Wallace (2005) and Enemark (2006) highlight the concept of land management paradigm (see figure 2-3). They argue that within the context of a country, land management activities are described by the land policies, land information infrastructures as well as land administration infrastructures in support of economic, social and environmental sustainable development (figure 2-3). By using different techniques and tools of land and resources management, every country implements the goals stipulated in its land policy (Williamson et al., 2010). In this context, *"the land policy consists of a combination of socio-economic and legal prescriptions that dictate how the land is to be used and how the benefits from the land are to be shared"* (UNECE, 2005, p.60). The characteristics and content of the land policy vary depending on cultural, historical, social, economic and legal contexts specific to every country. The land policy is derived from the national policy and is associated with tenure security, land markets, land taxation, environment and natural resources management, management and control of the land use, distribution of the land to the poor and landless, minorities and women as well as different

measures adopted in the spirit of handling land litigations and preventing speculation on the land (Enemark, 2006).

Land administration functions are considered as the main component of land management paradigm and aims at ensuring efficient management of rights, restrictions and responsibilities as well as risks associated with the property, land and natural resources (Enemark et al., 2005). Land administration is defined as "*the process of recording and disseminating information about the ownership, value and use of land and its associated resources when implementing land management policies*"(UNECE, 1996).

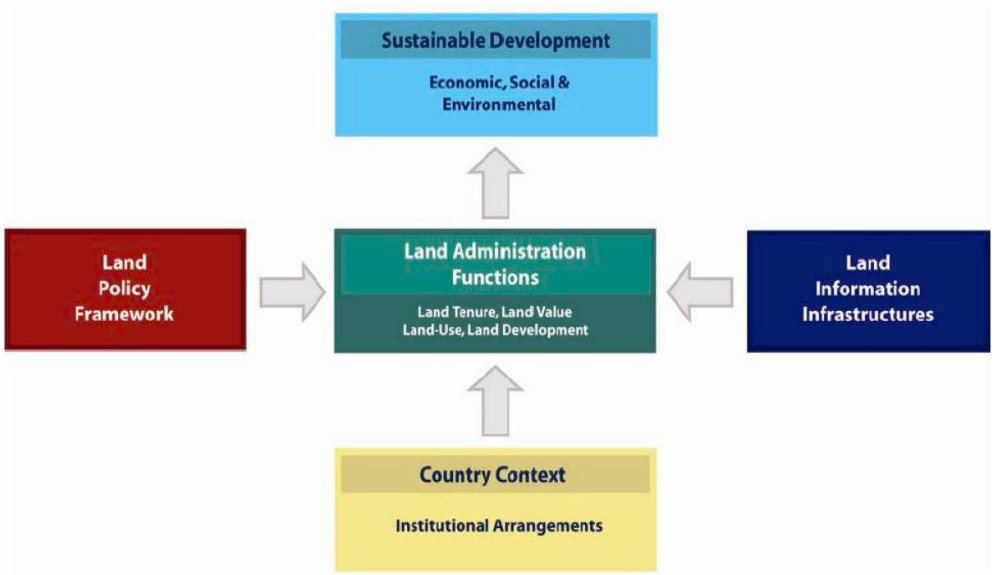

Figure 2-3: Land Management Paradigm (Enemark et al., 2005)

It is a system put in place by the country in order to record and manage land rights (Burns et al., 2006). Land administration includes four functions such as land tenure, land value, land use and land development. The objective of land tenure is to ensure security and formal transfers of rights that people and organizations have in land and natural resources. Land value deals with land and property valuation and taxation whereas land use is concerned with planning and control of the use of the land and natural resources. Land development ensures the implementation of utilities, infrastructures and construction planning (Enemark, 2006). Land administration functions cannot work efficiently and effectively if they are not supported by land information infrastructure which encompasses cadastral and topographic datasets. It facilitates access to complete and updated information regarding the built and natural environment (Enemark et al., 2005).

2.3.3. Land management activities

The concept of land management activities is repeated in many kinds of literature but it is not clearly defined. Aleknavicius & Aleknavicius (2005) states that land management activities encompass the land use change planning and the implementation of land management related projects that change the boundaries or main use of the land parcel. Such projects comprise construction activities, construction of roads and forest plantation. These authors give an example of agricultural land in urban fringes which is often subdivided and transformed into residential, recreational and commercial land uses. It is noticeable that all these activities lead to changes that affect the land use and the boundaries of land parcels. In contrast with the previous author, UNECE defines land management activities in a broad sense and states that land management includes all the activities concerned with the management of physical resources such as farming, mining, property and estate management, urban and rural physical planning, development

and management of utilities and services, management of land related resources like forestry, soils and agriculture, the implementation of land use policies, environmental impact assessment as well as monitoring activities that affect efficient use of the land (UNECE, 2005). Based on both definitions, we can conclude that land management activities refer to all the activities executed by the human being in order to attain a sustainable utilization of the land and resources developed on it.

2.3.4. Linkage between land information and land management

Over time, the land is increasingly becoming a scarce resource. As a result, there is an increasing pressure on land worldwide. Therefore, there is a need for a better management of land and development controls by the public sector. However, a sound land management cannot be achieved without information about the land itself (Larsson, 1991). For this reason, detailed information about ownership, location, size as well as rights, restrictions and responsibilities associated with each individual land parcel constitutes a prerequisite for land management activities. Williamson et al. (2010) argue that land related information constitutes a valuable government asset and a key driver in policy making in both public and private sector. Policy makers, planning officers, land administration professionals as well as private individuals need land information and use it on a daily basis (Dale & McLaughlin, 1988). Furthermore, availability of information about the land reduces uncertainty during decision making and planning; and ensures a sound management of land resources. In other words, land information and land management are closely linked; land information constitutes a pillar that all land management activities depend on.

2.4. Land tenure regularization in Rwanda: an overview

Since 1997, the government of Rwanda undertook a wide program aiming at reforming the management of the land to promote the sustainable economic development of the country based on land resources. In 2004, the first national land policy (NLP) was adopted by the government. The NLP recognized the land as a common property for all the Rwandans including the ancestors, current and future generations (MINITERE, 2004). One of the goals of the NLP was the formalization of the system of land tenure in order to speed up the sustainable development of the country. It was envisaged to secure land tenure through a systematic registration of the land to promote investments in land, particularly in rural areas. In order to ensure sound land administration and land management, the NLP also planned to develop a well designed and multipurpose land registry where all the land properties and buildings should be recorded (MINITERE, 2004). To implement the provisions of the NLP, the organic land law N^0 08/2005 of 14/07/2005 determining the use and management of land in Rwanda was enacted (Republic of Rwanda, 2005) and was followed by the promulgation of several laws and tools which were required to attain the objectives of the NLP. Article 30 of the organic land law stipulated that registration of the land a person holds was mandatory (Republic of Rwanda, 2005). To implement this article, the land tenure regularization (LTR) program was launched in 2007 (Simbizi et al., 2015). The purpose of LTR was to recognize and secure existing rights that people and organizations had over land (Sagashya & English, 2009). Between 2007 and 2008, a trial on systematic land registration was undertaken in four administrative Cells of the country to test the feasibility of LTR program and the results from this exercise were promising. Consequently, a systematic land registration was launched countrywide since 2009 via general boundary approach (Biraro, 2014) and the country was entirely covered by the end of 2013 (Simbizi et al., 2015). As a result, 10.4 millions of land parcels were registered by 2013 (Enemark et al., 2014). In order to guarantee efficient and secure storage and management of cadastral data collected during the LTR program, two computer-based systems were developed: the land tenure regularization support system (LTRSS) which stored textual data related to land parcels and the geographic information system (GIS) which stored spatial data. LTRSS and GIS were linked by a unique parcel identifier (UPI) (MINIRENA, 2012).

2.5. Land governance institutions in Rwanda

Land governance institutions operate at both central and local government level and include the Ministry of Natural Resources (MINIRENA), Rwanda Natural Resources Authority (RNRA), Infrastructure One Stop Centre (IOSC) unit, Sector and Cell Land Committees (see figure 2-4). The MINIRENA formulates land-related policies, drafts laws and ministerial orders that dictate procedures pertaining to administration, planning and allocation of the land. RNRA is a national land agency established by the government of Rwanda in 2011 (Republic of Rwanda, 2011). RNRA leads the overall management of natural resources countrywide including land, forestry, water, mines and geology (MINIRENA, 2012). According to its current organizational structure, RNRA is subdivided into four departments including the Department of Land, Mapping and Registrar of Land Titles, Department of Forestry and Nature Conservation, Department of Mining and Geology as well as the Department of Integrated Water Resources Management. In land matters, RNRA is specifically responsible for land registration, issuance and keeping of authentic land titles and other information regarding land in Rwanda (Republic of Rwanda, 2011). RNRA is also responsible for the management and maintenance of the LAIS.

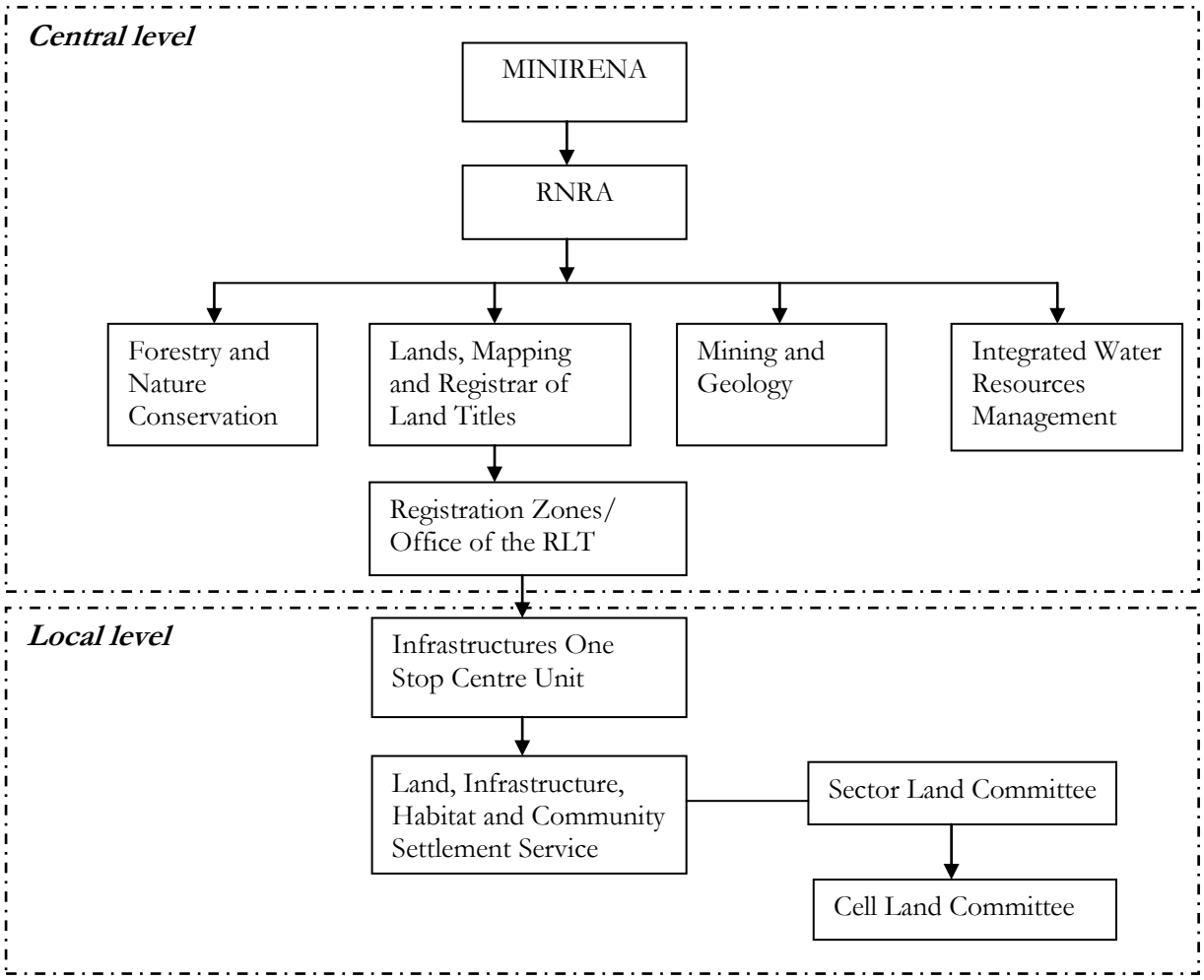

Figure 2-4: Land governance institutions in Rwanda (Adapted from MINIRENA (2012))

In accordance with the Presidential Order N⁰ 97/01 of 18/06/2014 determining the Functioning and the Competences of the Registrar of Land Titles, RNRA is led by the Director General of RNRA who is also the Chief Registrar of Land Titles (CRLT) whose competence covers the whole country. The CRLT is assisted by five Registrars of Land Titles (RLT) who operate in five Registration Zones namely North,

South, West, East and the City of Kigali and exercise their competence in zones where they are appointed. The Deputy Director General in charge of the Department of Lands, Mapping and Registrar of Land Titles also acts as a RLT and operates in the Office of the CRLT (Republic of Rwanda, 2014b). At the local level, the IOSC is responsible for land administration and land management matters at the district level and works under direct supervision of the RLT of the zone where the district is located. The Director of IOSC unit is also the land notary at the district level. The professional in charge of Land, Infrastructure, Habitat and Community Settlement at Sector level is responsible for land administration and management matters and acts as a land notary at Sector level. Technical activities of land management at Sector and Cell levels are supported by Land Committees members who act as the first point of contact for land registration and land use planning (MINIRENA, 2012).

2.6. Organization and functioning of the districts in Rwanda

In accordance with article 2 of the law determining the organization and functioning of decentralized entities in Rwanda, decentralized entities comprise the City of Kigali, Districts, Sectors, Cells and Villages. Article 3 of the same law stipulates that only the City of Kigali and the districts are decentralized entities with legal personality and therefore have financial and administrative autonomy (Republic of Rwanda, 2013). A district is administratively led by the Executive Committee chaired by the Mayor. Besides the Mayor, the Executive Committee includes two Vice Mayors in charge of Economic Development and Social Affairs. The District Executive Secretary acts as the Secretary of the Executive Committee and supervises all the district staff. The Executive Committee appoints the district staff required to run the district activities. According to the current organizational structure of the district (Appendix 1), a rural district contains 10 technical units having different responsibilities and a varying number of services and staff. The district personnel includes support staff such as secretaries, receptionists, drivers and technical staff composed of different officers. The latter is responsible for technical activities requiring specialization. They include engineers, agronomists, urban planners, environmentalists, land surveyors, among others. In the context of this research, a district officer refers to any district staff with particular skills, training or knowledge that enable him to accomplish technical activities and responsibilities stated in his/her job description.

3. RESEARCH METHODS

3.1. Introduction

This chapter discusses the research strategy and describes different methods that were applied by the researcher to collect data from the field. It also provides methods that have been used to analyse collected data.

3.2. Research strategy

For this research, a case study was considered most appropriate. A case study is one of the study designs used in qualitative research and it is adopted to get in-depth, multi-faceted understanding of an issue, event or a phenomenon of interest in its real-life context (Crowe et al., 2011). According to Benbasat, Goldstein, & Mead (1987), a case study may be used to examine a phenomenon in its real-life settings by using a variety of data collection methods in order to gather information about one or more entities such as people, organizations or groups. In the context of this research, a case study was adopted as research strategy because of two reasons. Firstly, this study is concerned with cadastre and case study methodology is mostly used in cadastre-related research as it was proved by Ali et al. (2013). Secondly, there were no previous studies conducted in Rwanda in the area concerning the role of LIS in land management activities. To contribute to a better understanding of this phenomenon not yet explored in the context of Rwanda, it was relevant to use the case study approach. In addition, this study was undertaken as an exploratory research and case study approach is more appropriate for such kind of research than other types of research strategies.

3.2.1. Case study selection

All the 30 districts of Rwanda use land information from LAIS to perform their land management activities. However, one district was selected among them as a case study. The criterion for selecting the study area was a district with experience in the use of LAIS. According to the report of the Government of Rwanda for the fiscal year 2013-2014, LAIS was operational in 10 districts namely Karongi, Musanze, Nyanza, Nyarugenge, Kicukiro, Gasabo, Nyagatare, Gatsibo, Rubavu and Huye (Republic of Rwanda, 2014a). In fact, Karongi was among the first 10 districts of Rwanda that were connected to LAIS in the beginning of devolution of LAIS at the district level. It is dominantly a rural district but with a secondary city. Based on this combination of rural and urban characteristics, Karongi District was selected given that it has land management activities reflecting rural and urban nature.

3.2.2. Study area description

Karongi is one of the 30 districts of Rwanda. It is located in the Western Province of the country (figure 3-1). With a total area of 993 Km2 and a population of 331,808 inhabitants (NISR, 2014), the average population density of the district is 334 inhabitants per Km2. Rubengera and Bwishyura are the most densely populated Sectors with 697 to 695 inhabitants per Km2 (Karongi District, 2014a). Karongi District is administratively divided into 13 Sectors, 88 Cells, and 538 Villages. The landscape of Karongi District is hilly with elevation ranging from 1,470 to 2,200 meters. The western part of Karongi District is covered by Lake Kivu, the biggest lake in Rwanda which separates the country with the Republic Democratic of Congo. Karongi is a rural district and agriculture and livestock are the main economic activities of the local population and employ 85.2% of households of the district (Karongi District, 2014a; 2013). Despite its rural characteristics, Karongi District has small urban areas located in Rubengera and Bwishyura Sectors forming the city of Kibuye (figure 3-1). A master plan of Kibuye City covering 45Km^2 was adopted by the district in 2003 (Karongi District, 2014a) and its implementation is currently creating several land management activities.

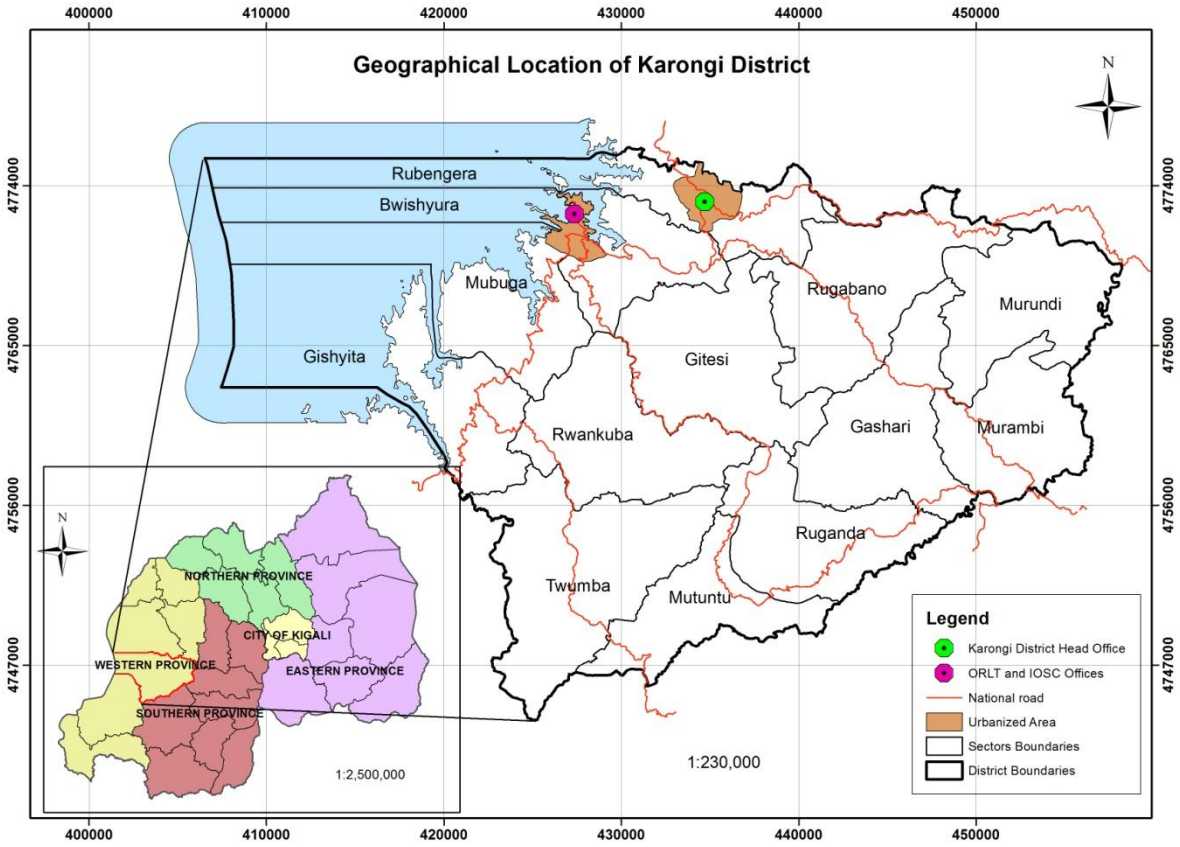

Figure 3-1: Geographical location of the study area

3.3. Data collection

This study was based on both primary and secondary data collection methods. Kumar (2011) states that primary data collection methods are used when there is no information concerning a given person, problem or phenomenon and must, therefore, be collected. Conversely, secondary data collection methods are applied when required information is available but needs to be extracted. As mentioned above, this research was undertaken as a case study and therefore, the study applied data collection methods which suit such kind of research strategy. In this respect, data collection methods for primary and secondary data have been chosen among six sources of sources of data for case study research proposed by Yin (2003) which include *documentation, archival records, interviews, direct observations, participant-observations* and *physical artifacts*. Field data were collected during three weeks dedicated to the fieldwork, from the 1st to the 23rd October 2015. The goal of the fieldwork was to gather not only primary data but also secondary data required to answer the research questions of the study. All the data were gathered in Karongi District and RNRA through different types of interviews and documentation.

Yin (2003) asserts that interview is the most important source of primary data in case study research. It is in this regard that interviewing was adopted as the main method of data collection in this case study. Three types of interviews were used including structured and semi-structured interviews as well as focus group interview. Kumar (2011) defines *structured interview* as a technique of data collection whereby a researcher asks the respondents a set of questions prepared beforehand by using the same content and structure of questions as they were predetermined in the interview schedule. In spite of their similarities, *semi-structured* interview is different from a structured interview. The latter is based on a list of predetermined questions that the interviewer wants to be answered. In contrast, a semi-structured interview is dynamic and based on an outline structure of key questions; the interview offers to the

interviewer the opportunity to go in deep of the main issues by asking further questions to the interviewees (Biggam, 2008). A semi-structured interview is viewed by Clifford, French, & Valentine (2010, p. 103) as follow: "*A semi-structured interview is a verbal interchange where one person, the interviewer, attempts to elicit information from another person by asking questions. Although the interviewer prepares a list of predetermined questions, semi-structured interviews unfold in a conversational manner offering participants the chance to explore issues they feel are important*". This means that the interviewer or researcher has the plenty flexibility to explore additional issues arising from the interviews but were not included in the interview guide while they are important for the research. Regarding *focus group interviews*, they usually refer to a homogenous group of 6 to 12 persons gathered together to discuss as deeply as possible a particular subject that has been prepared beforehand by the researcher who is considered as the moderator of the discussion (Clifford et al., 2010).

Another method of data collection used in this research is *documentation*. Yin (2003) recognizes documentation as an important research method used in case studies because it gives to the researcher further details that support information gathered from other sources of data.

3.3.1. Structured interviews

The structured interview was the main method used in this research. The aim of structured interviews was to gather information related to land management activities performed by district officers (specific objective 2), the use of land information provided by LAIS to execute such activities (specific objective 3) and the perceptions district officers with respect to land information provided by LAIS in support of land management activities (specific objective 4). The participants to structured interviews included district officers involved in land management activities and the staff responsible of LAIS in Karongi district. Each of these two categories of respondents had its specific interview schedule.

3.3.1.1. Structured interviews with district officers

The selection of district officers who participated in interviews was based on one condition: responsibilities related to land management.

Figure 3-2: Structured interviews with district officers

In order to identify district officers whose responsibilities are related to land management, the researcher had discussions with the Directors of all 10 technical units of Karongi District as provided by the organizational structure of a rural district in Rwanda (Appendix 1). Directors of units coordinate all district activities related to their respective units. They are supposed to know which of their staff members are involved in land management activities in their work. The discussion with them allowed the research to know district officers who were available in each unit and the ones who were involved in land management activities. The outcome of the discussions with directors of technical units was the list of

district officers responsible for land management activities per unit (table 3-1). In total 11 district officers have been selected. They were from three technical units: Infrastructure One Stop Centre (IOSC), Agriculture and Natural Resources and Good Governance. Table 3-1 shows district officers who were interviewed.

Interviews with district officers were carried out using a questionnaire containing a combination of closed and open-ended questions similar to all the respondents (Appendix 2). In order to facilitate the sessions, the interview schedule was translated from English to local language (Kinyarwanda) because the majority of participants were not able to express freely their opinions and answer all the questions in English. During the interviews, the researcher took notes of the answers provided by the respondents. The interviews took between 40 and 60 minutes and were conducted in the offices of the respondents (figure 3-2). The researcher took notes of all the responses provided by respondents to the questions.

N⁰	Post	Unit/Department	Organization	Number
1	Acting Director	Infrastructures One Stop Centre Unit	Karongi District	1
2	Agriculture Officer	Agriculture and Natural Resources Unit	Karongi District	1
3	Environment Officer	Agriculture and Natural Resources Unit	Karongi District	1
4	Forest and Natural Resources Officer	Agriculture and Natural Resources Unit	Karongi District	1
5	Cash Crops Officer	Agriculture and Natural Resources Unit	Karongi District	1
6	Building Inspection Officer	Infrastructures One Stop Centre Unit	Karongi District	1
7	Land Valuation Officer	Infrastructures One Stop Centre Unit	Karongi District	1
8	Road Development and Maintenance Engineer	Infrastructures One Stop Centre Unit	Karongi District	1
9	One Stop Centre Lawyer	Infrastructures One Stop Centre Unit	Karongi District	1
10	Infrastructures and Property Management Officer	Infrastructures One Stop Centre Unit	Karongi District	1
11	Territorial Administration and Decentralized Governance Officer	Good Governance Unit	Karongi District	1
Total				**11**

Table 3-1: List of district officers interviewed per unit

3.3.1.2. Structured interviews with the staff responsible of LAIS

In Karongi District, LAIS is operated by two staffs: LAIS Processor and GIS Professional respectively responsible for textual and spatial components of LAIS. They work in the office of the RLT in the Western Province located in Karongi District. The interview with LAIS staff was conducted without sampling because each of them has specific roles and responsibilities in LAIS. Structured interviews with the LAIS Processor and the GIS Professional have been conducted using a questionnaire composed of open and closed questions (Appendix 3). The interviews focused on the use of LAIS in Karongi District to supply land information to the users (specific objective 1, research question 2). The interview sessions took approximately 40 minutes and were conducted in the offices of the RLT in the Western Province (Figure 3-3). The researcher recorded the sessions and took some notes.

Figure 3-3: Structured interviews with LAIS staff

3.3.2. Semi-structured interview

This method was applied to collect in-depth information about the use and development of LAIS because little was known about this area. With regard to the selection of the key informant who could provide information related to the use and development of LAIS (specific objective 1), purposive sampling technique was applied. In this sampling technique, the researcher makes his own judgement about the person who is well-placed and willing to provide the best information required to attain the objectives assigned to the study (Kumar, 2014). Based on the indicators and variables to be tested in the first objective of this study, RNRA professional that was likely to provide all the information required was the one who was technically responsible of LAIS and had participated in the process of development of it. The researcher had discussions with the Acting Deputy Director General in RNRA in charge of the Department of Lands, Mapping and Registrar of Land Titles as well as the Director of Management Information System and IT Support Unit in RNRA to identify RNRA staff member who met this condition. As a result, the Software Development Engineer was selected among other RNRA staff as the key informant in this matter because she had been working with consultants who developed LAIS. In addition, she is currently among the managers of LAI in RNRA head office. Therefore, she was likely to hold informant about the historical development and the functioning of this system.

Semi-structured interview was conducted using an interview schedule that was established beforehand (Appendix 4) and translated in the local language to facilitate the interaction between the researcher and the interviewee. The interview was held in RNRA head office in Kigali, the capital city of Rwanda, and took approximately one hour. The whole session was recorded using an audio recorder.

3.3.3. Focus group interview

Focus group interview gathered 8 participants including 6 district officers (Forest and Natural Resources Officer, Infrastructures and Property Management Officer, Road Development and Maintenance Engineer, Building Inspection Officer, Acting Director of IOSC and Land Valuation Officer), LAIS Processor and GIS Professional. Based on the definition of a focus group interview given by Clifford et al. (2010) mentioned in section 3.3, it was crucial to select a homogenous group of participants to discuss deeply on various improvements required to optimize the role of LAIS in land management activities at district level (specific objective 4, research question 3) given that there were almost no previous studies conducted on this topic in Rwanda. To this end, the selected group was homogenous because it was composed of persons who use LAIS and/or the land information it provides in their work and were likely

to provide the information needed on the topic at hand. Some of the participants to focus group interview were the users of LAIS (LAIS Processor, GIS Professional and Director of IOSC) while others were the customers who use land information after requesting it from the users of the system. Focus group interview session took place in the office of IOSC of Karongi District and took 40 minutes. The topic was discussed based on guiding questions prepared beforehand by the researcher. Guided by the researcher as a moderator, participants got an opportunity to exchange their opinions on the topic. The conversation was recorded using an audio recorder.

3.3.4. Documentation

Documentation was used as a source of secondary data for this case study. The choice of this method was motivated by the fact that there was little information about the development and use of LAIS and land management activities in Karongi District. Detailed information could be extracted from different reports and administrative documents held by Karongi district and RNRA. In Karongi district, secondary data was collected from the District Development Plan (DDP), the District Land Use Plan (DLUP) and performance contracts of the district. Administrative documents and reports contained information concerning land management activities in Karongi District. In RNRA, secondary information was extracted from LAS manual and unpublished documents containing technical documentation of LAIS. Other data was also retrieved from the database of LAIS. Data from secondary sources complemented other methods used by the researcher in order to answer the first and the second specific objectives of the study.

3.4. Data analysis

Upon completion of the fieldwork, raw data gathered from structured, semi-structured and focus group interviews were transcribed in Microsoft Word for further analysis. Transcription of the interviews was done simultaneously with their translation from local language (Kinyarwanda) to English. Qualitative data collected from interviews were analysed through coding by using ATLAS.ti software. After importing the interview transcripts in ATLAS.ti, answers provided by the respondents to each question were grouped into categories and a code was assigned to each category. Similar responses were grouped under the same category and were assigned the same code. Responses grouped by categories were used to report findings of the research. Some responses provided by the respondents were reported verbatim. For quantitative data, analysis and visualization were performed by the researcher by using Microsoft Excel to produce tables and figures. Enterprise Architect was used to designing UML activity diagrams to represent the workflows for information supply. For secondary data, reports and official documents collected from RNRA and Karongi District have been reviewed to complement data collected from primary sources.

3.5. Summary

The research was conducted as a case study and Karongi District was chosen as a study area. Primary data have been collected through structured, semi-structured and focus group interviews with Karongi District officers, RNRA staffs responsible of LAIS in Karongi District and Software Development Engineer in RNRA head office in Kigali. Secondary data were collected in Karongi District and RNRA and they included various documents and reports respectively related to land management activities as well as the use and development of LAIS. Field data collection was followed by the transcription of interviews. Data analysis was done through coding by using ATLAS.ti software.

4. RESULTS

4.1. Introduction

This chapter presents findings and answers to the research questions. Section 4.2 presents the results regarding the development of LAIS and its use at national and district level and refers to specific objective 1. Specific objective 2 is covered in section 4.3 and describes land management activities in Karongi District. Section 4.4 examines the role of land information provided by LAIS in land management activities of Karongi District officers and covers specific objective 3. Section 4.5 focuses on specific objective 4 and presents perceptions of district officers towards the role of LAIS in support of land management activities. The chapter is closed by a summary of the results.

4.2. Development and use of LAIS at national and district level

The section starts with the historical development of LAIS since 2009 up to now. The section also provides a description of LAIS and discusses how it is used in Karongi District to supply land information to the customers including district officers.

4.2.1. Historical development of LAIS

Before the implementation of LTR program in Rwanda, more than 90% of the land was held under the customary regime (Rurangwa, 2004). Almost 10% of the land was legally registered. The cadastre was analogue and its purpose was land tax collection. There was a need to move from analogue to digital way of managing land information by developing a LIS. The first idea of developing LIS emerged in 2009 and was related to the implementation of LTR program in Rwanda (see section 2.4). However, earlier initiatives to develop a LIS had taken place. During the trial phase of LTR program in 2007-2008 and the systematic land registration, the National Land Centre (NLC) had already established a computerized system to ensure a secure storage of collected cadastral data. Two computer-based systems were developed: the Land Tenure Regularization Support System (LTRSS) which stored attribute data and the geographic information system (GIS) which stored spatial data. LTRSS and GIS were linked by a unique parcel identifier (UPI) (MINIRENA, 2012). However, this system was not appropriate for sustainable maintenance of cadastral data. There was a need to develop a new system capable of handling land transactions and ensuring the maintenance of cadastral data. To this end, NLC hired consultants from the Dutch Kadaster to develop the new system which was called Land Administration Information System (LAIS).

The process of development of LAIS started in 2009 and ended in March 2012. Since all cadastral data throughout the country were migrated Sector by Sector from LTRSS to LAIS starting by Gasabo District in the City of Kigali. During the migration process, LTRSS was blocked for all ongoing land transactions and when the process was completed LAIS took over this task (Nkurunziza, 2015). This migration was accompanied by the production of land titles in LAIS in replacement of LTRSS. The new data collected during the ongoing systematic land registration were entered in LAIS. Data maintenance and all land transactions were also performed in LAIS. In the beginning, LAIS was exclusively used by RNRA professionals because it was not yet decentralized at the local level. Initially, LAIS included two separate components: textual part and spatial part (GIS part) which were not integrated. This lack of linkage between both components of LAIS was a crucial challenge for RNRA professionals who used the system on daily basis. The lack of communication between textual and spatial information hampered the consistency of data as well as the quality and speed of workflow execution. In addition, it was not possible

to share LAIS data with other organizations, to integrate process data sourced from other institutions and to deploy LAIS to remote offices using a public network (RNRA, 2013). Thus, there was a call for upgrading the system to address these problems. Since 2013, a GIS expert from Dutch Kadaster was hired by RNRA to renew LAIS by integrating textual and spatial components and enabling data sharing with other government organizations. Renewal works were completed in 2014. In the actual system, textual and spatial components of LAIS respectively called LAIS-Admin and LAIS-GIS are integrated. Any change made in one of the two components is immediately integrated into the other one. This new version of LAIS was called LAIS 2 in replacement of the old version called LAIS 1. Figure 4-1 summarizes the evolution of LIS in Rwanda.

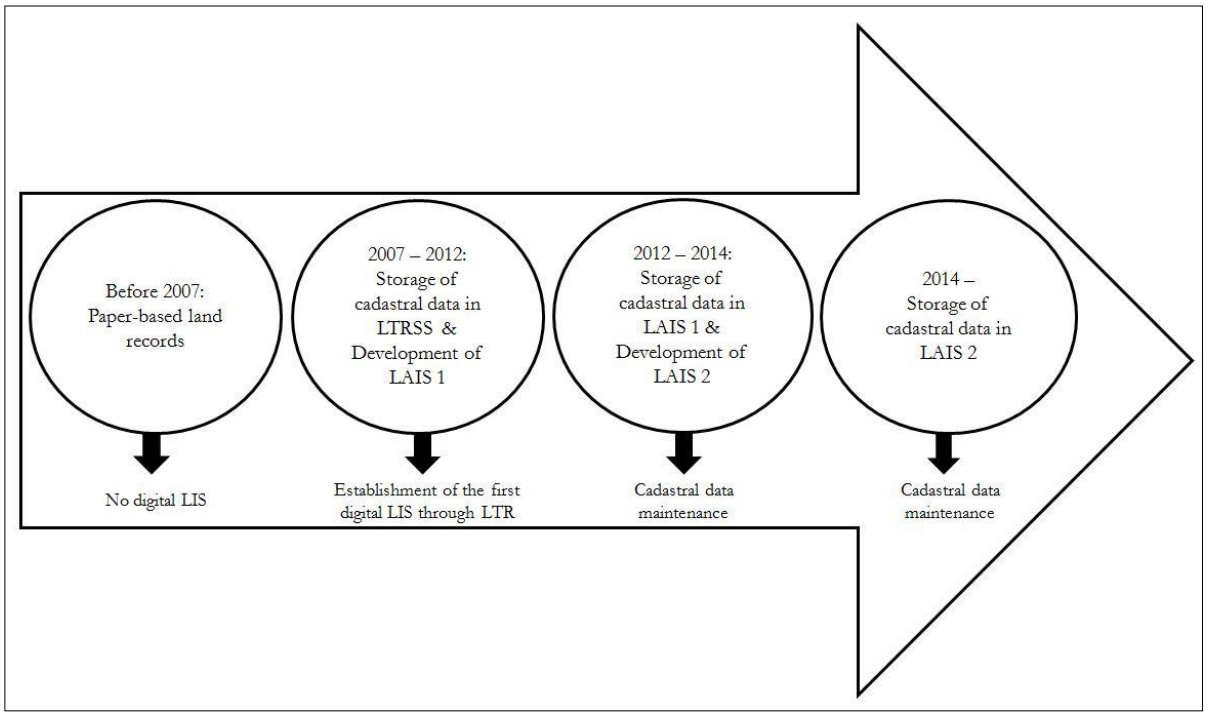

Figure 4-1: Evolution of land information system in Rwanda

During the process of development of LAIS 1, the professionals who worked in land administration services were consulted. The determination of user requirements was therefore conducted with the staff from these services and included land administrators and lawyers at the national level and in the City of Kigali. The former category was consulted to know how land transactions were conducted when the cadastre was still manual in order to develop the digital LIS based on existing situation. The latter category provided information about existing laws that dictated how land transactions were carried out in order to identify needed laws so as to facilitate the implementation of the new system. Potential users of land information and other stakeholders were not consulted when LAIS was under development not only during the development of LAIS 1 but not also during the renewal process of the system which led to LAIS 2.

When RNRA professionals started using LAIS 1 in 2012, they encountered small problems qualified as 'bugs'. To give an example, no land transaction was permitted in LAIS 1 when the registered land parcel was mortgaged or when it was in disputes. Additionally, in LAIS 1, it was possible neither to register condominiums nor to perform transactions on them. It was therefore necessary to make small changes in LAIS but it was not needed to modify anything on the structure of the system and the way it worked. In contrast to LAIS 1, LAIS 2 allows making transactions on the land parcels even though they are

mortgaged or are in disputes. The main improvements that were performed in LAIS since its development up to now were the integration of textual (LAIS-Admin) and spatial (LAIS-GIS) components, the creation of web services to enable LAIS data sharing with other organizations and the deployment of LAIS in remote offices at the district level. Other slight changes have been carried out on LAIS in order to register condominiums and carry out land transactions on them.

4.2.2. Description of LAIS

This section provides an overview of the architecture of LAIS, the structure of data recorded in the system as well as the users of LAIS. It also explains how data stored in LAIS are shared with other organizations. Current challenges that the system faces are also presented.

4.2.2.1. Architecture of LAIS

The architecture of LAIS illustrates the workflow for land transactions and land registration within the system from the submission of administrative documents by the client up the delivery of the land certificate to the client (figure 4-2). Land transactions are processed by different users of the system based on their roles: booking, accepting, processing, approving, printing and sealing. In addition, LAIS architecture illustrates the integration of both components of LAIS: textual component (LAIS-Admin) and the spatial component (LAIS-GIS). It also shows the connection between LAIS and other information systems of government agencies (RRA, e-MRS/RDB, Kigali City and NID) for the purpose of data sharing. These information systems are connected to the textual component of LAIS.

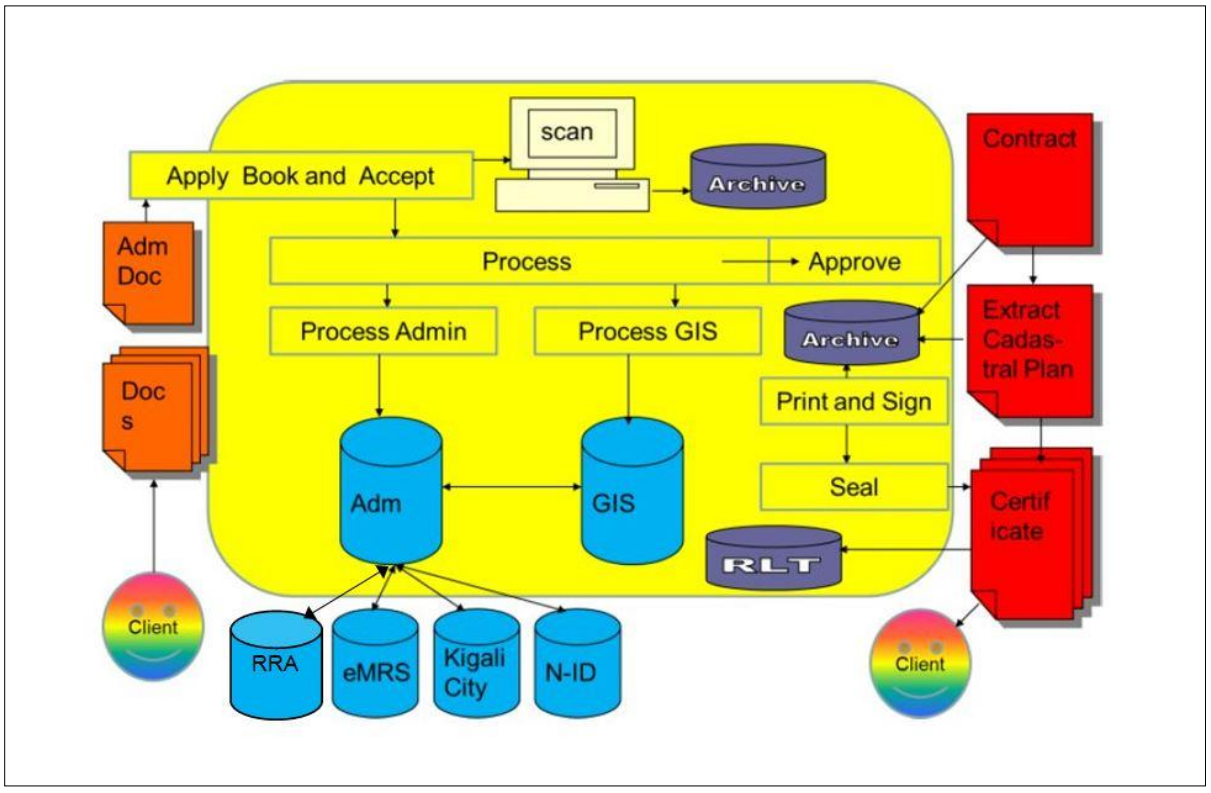

Figure 4-2: LAIS main architecture (Adapted from RNRA (2013))

4.2.2.2. LAIS data structure

Data stored in LAIS are structured in different catalogues and classes each containing a varying number of attributes as it is depicted in the database schema of LAIS in PostgreSQL illustrated in appendix 5.

According to LAIS technical documentation provided by RNRA, the most important classes composing the database schema of LAIS are the following:

- **Party**: It is the super-class for *NaturalPerson* and *NonNaturalPerson* sub-classes. *NaturalPerson* class stores information regarding names, gender, and date of birth and death of landowners. *NonNaturalPerson* class stores information concerning landowners classified as non-natural persons like organizations, companies, schools, churches, cooperatives, etc.
- **Right**: It is a super-class for *Realright* class. *Realright* stores information related to the rights the owners hold over land. In the Rwandan context, real rights can be a leasehold title or a freehold title.
- **Parcel**: This class stores information related to the parcel such as UPI, area, location (village_code), right, land use, lease term, the date when the lease term started being counted, first title documents, creation documents as well as changes which occur on the parcel over time.
- **Location**: Location classes store information related to the location of the parcels as well as the addresses of natural and non-natural persons in Rwanda. There are five location classes in LAIS: Province, District, Sector, Cell and Village. Each class has two attributes: code and name of the administrative entity the class represents. Sector and Village classes have a particular attribute called '*classification*' which is used to classify Sectors and Villages in categories (urban vs. rural areas) used to collect annual land taxes. Note that the UPI can also provide information about the location of a parcel from the Cell to Province level.
- **Administrative documents:** *AdminDoc* class is considered as the driver of all the transactions in LAIS. For each new land transaction, a new administrative document is generated for the concerned parcel.

Provinces	Number of parcels
City of Kigali	389,316
South	3,217,472
North	2,668,087
East	1,986,087
West	3,156,892
Total	**11,417,854**

Table 4-1: Number of parcels stored in LAIS per Province (Source: RNRA, October 2015)

Data provided by RNRA indicate that till 20 October 2015 LAIS stored 11,417,854 parcels distributed in the 4 Provinces and the City of Kigali as illustrated in table 4-1. The distribution of parcels per district is summarized in appendix 6.

4.2.2.3. Users of LAIS

In the context of this study, a user of LAIS is any registered person who is authorized by the system administrator to access the LAIS by using his/her username and password. Based on the list of the users of LAIS provided by RNRA, the users of LAIS can be grouped into four categories: RNRA staffs working at its head office, RNRA staff working in RNRA zonal offices in four Provinces and the City of Kigali, RNRA staff deployed in districts and district officers or staff. Currently, LAIS has 188 users distributed as follow: 77.1% are RNRA staff (head office (43.6%), zonal offices (19.7%) and RNRA staff in districts (13.8%)). District staff who are authorized to access to LAIS constitute 22.9% of the total number of the users of the system countrywide. Figure 4-3 shows the distribution of the 188 users of LAIS per category from the national level to district level.

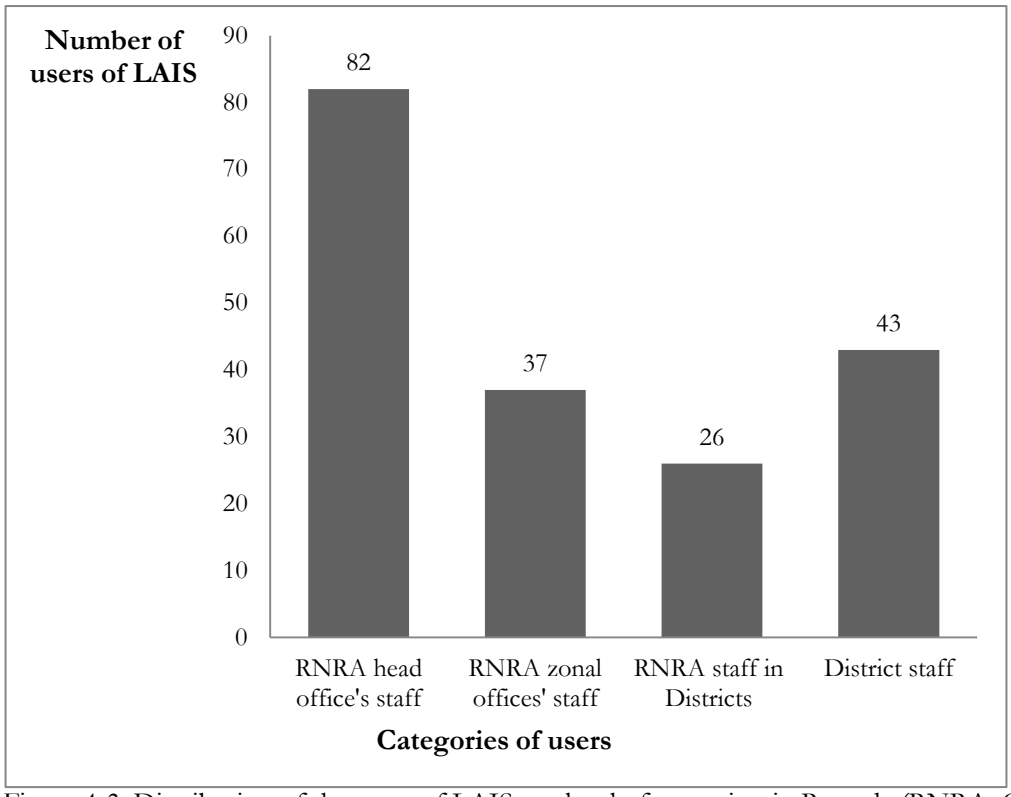

Figure 4-3: Distribution of the users of LAIS per level of operation in Rwanda (RNRA, October 2015)

Technical documentation of LAIS indicates that LAIS is a role-based application in which each user has a role to play in the system. Roles are assigned to different users by the system administrator and determine what each user is allowed to do in the system. To be able to use LAIS, each user is compulsorily assigned to one or more districts where he/she exercises his/her roles. A user can have one or more roles in the system. LAIS offers eight roles to its users: *viewer, booker, acceptor, processor, approver, printer, sealer* and *supervisor*. The distribution of roles to the users of LAIS at central and district level is summarized in appendix 8. Any authorized user who is connected to RNRA network through virtual private network (VPN) can access to LAIS either in RNRA head office, RNRA zonal offices and elsewhere in Rwanda by using his/her username and password. The server has the capacity to support up to 200 simultaneous connections. All the 188 users of LAIS use the same database regardless of the level (national, zonal and district level) where they operate.

4.2.2.4. Data sharing

Interview revealed that RNRA shares land information with other government organizations including Rwanda Development Board (RDB), the City of Kigali, Rwanda Revenue Authority (RRA) and National Identification Agency (NIDA) as it is depicted in figure 4-2:

- **RDB:** One of the departments of RDB, the Office of the Registrar General (ORG), is responsible for mortgage registration countrywide. By using electronic mortgage registration system (e-MRS) connected to LAIS through a web service, ORG can access to land information stored in LAIS. Data sharing helps the ORG to ensure the authenticity of the land titles presented by the customers for mortgage registration. Banks can also retrieve land information from LAIS through e-MRS and use it for mortgage registration purposes. Banks use land information especially when their customers are requesting loans and want to give their land as collateral.

- **The City of Kigali:** The City of Kigali uses land information provided by LAIS during the issuance of construction permits to the customers. LAIS is currently connected to construction permit system of the City of Kigali through a web service. Before issuing a construction permit, the City of Kigali can check whether the customer who is applying for a construction permit on a given parcel is the rightful owner of that parcel.
- **RRA**: Land taxes are nowadays collected by RRA. Access to land information needed in taxation such as UPI, parcel area, land use and location was made possible by connecting LAIS to taxation system of RRA. A web service was created to enable connection between both systems.
- **NIDA**: Through a web service, LAIS is currently connected to the national identification (NID) system. To this end, RNRA can retrieve in NID information concerning the identification of the landholders.

RNRA does not allow organizations mentioned above to retrieve information directly in LAIS database to ensure the security of the system. For this reason, a web service was created for each organization that shares cadastral data with RNRA. The current architecture of LAIS presented in figure 4-2 illustrates the connection between LAIS and other information systems of the organizations mentioned above for the purpose of information sharing.

4.2.2.5. Challenges faced by LAIS at national level

The main challenges faced by LAIS include the interruption of the communication between textual and spatial components due to unexpected loss of internet connection and cuts of electricity. The loss of network paralyses many land-related services countrywide because LAIS is used by many users. Another issue is related to the updatedness of cadastral data due to some informal land transactions which are not recorded in LAIS. Consequently, data stored in the system are not fully updated as it should be. Additionally, the migration of cadastral data from LAIS 1 to LAIS 2 left some small issues. There are some few data stored in LAIS 1 which were not transferred into LAIS 2 due to the big amount of data stored in the system and technical issues. Some data which were stored in LAIS 1 sometimes do not exist in the database of LAIS 2 and the system managers are obliged to return to the backup of LAIS 1 to fix such errors. These errors are identified especially when the staffs of RNRA receive the customers who complain that their land parcels are not recorded in LAIS while they already have their land titles.

4.2.3. LAIS in Karongi District

This section gives an overview of the use of LAIS in Karongi District, organisation, staffing and services delivered.

4.2.3.1. Organisation

LAIS is operational in Karongi District since January 2014. Prior to the decentralization of LAIS at the district level, the system was only operational at the central level in RNRA head office and five RNRA zonal offices located in the four Provinces and the City of Kigali. In Karongi District, customers including district officers who needed land information from LAIS were supposed to visit RNRA zonal office in the Western Province which is located in the city of Kibuye in Karongi District. The land information was exclusively provided by RNRA professionals. Now, LAIS can be accessed at the district level where RNRA staff responsible of LAIS and district officers connected to the system can deliver land information to the customers.

4.2.3.2. Staffing

The system is operated by two staff members: a LAIS Processor and a GIS Professional both employed by RNRA. They are directly supervised by the RLT in the Western Province. The LAIS Processor is responsible for the textual component of LAIS whereas the GIS Professional deals with the spatial

component of the system. Apart from Karongi District, the LAIS Processor is also responsible for Rutsiro District while GIS Professional is responsible for all the 7 districts of the Western Province (Rusizi, Nyamasheke, Karongi, Rutsiro, Rubavu, Ngororero and Nyabihu).

The list of the users of LAIS provided by RNRA illustrates that the LAIS Processor has four roles in LAIS: booking, accepting, processing and printing. GIS Professional has similar roles as the LAIS Processor except the role of printing but his roles are based on the spatial component of LAIS. As revealed by the interviews, the LAIS Processor books, accepts and processes different requests and applications of the customers who need various services or want to conduct various land transactions to be performed in the textual component of the system. His work is dominated by various land transactions such as sale, donation, succession, parcels exchange and the change in land use. His roles allow him to perform changes only in the textual component. When the transactions and requests are approved in LAIS by the RLT responsible of the Western Province, the LAIS Processor prints land titles or other documents and issues them to the applicants. Contrarily to the LAIS Processor, the GIS Professional performs spatial analysis of data needed by the RLT in his work. His work focuses on 3 main land transactions such as parcel subdivision, parcel merging and reshaping/area correction of parcels. He also produces cadastral maps requested by the customers for different purposes. Spatial data processing is the most important activity of his workload.

4.2.3.3. Users of land information delivered by LAIS

In Karongi District, the land information delivered by LAIS is used by several customers including public land notaries, district officers, public and private bailiffs, courts, general public, landowners, National Agricultural Export Development Board (NAEB), RDB, Rwanda Environment Management Authority (REMA) and Water and Sanitation Corporation (WASAC). Most of the users of the land information delivered by LAIS are mainly governmental organizations including the officers of Karongi District.

4.2.3.4. Use of LAIS for land information supply to the customers

One of the purposes of any LIS is to disseminate land information. In this respect, LAIS provides various types of land information to the customers in Karongi District.

Procedures to obtain land information

To get land information from LAIS, customers have a set of requirements to fulfil. As revealed by the interviews, the requirements that customers have to comply with depend on the type of customers and the nature of land information needed. For instance, if the customer is a public or professional bailiff who needs information about the land in order to execute a court judgement, his request must include the court decision. Generally, any customer who needs land information addresses a written request to the RLT mentioning the type of information he/she needs and the purpose of the information requested. Furthermore, the request has also to be accompanied by supporting documents justifying the reasons why the customer needs data. Land information is provided to all the customers for free. Requests for land information at RNRA zonal office follows established procedures. Requests are received by the Administrative Assistant of the RLT who records them in the specific paper-based register. Then they are sent to the RLT for examination and approval before being forwarded to the LAIS Processor or the GIS Professional depending on the component of LAIS where the requests will be processed. When the RLT does not approve the request, he notifies the customer through a written letter. Some requests for big data, especially those requiring advanced queries in the database of LAIS, are sent to RNRA head office in Kigali to be processed by IT professionals because there was no IT professional at the office of the RLT in the Western Province.

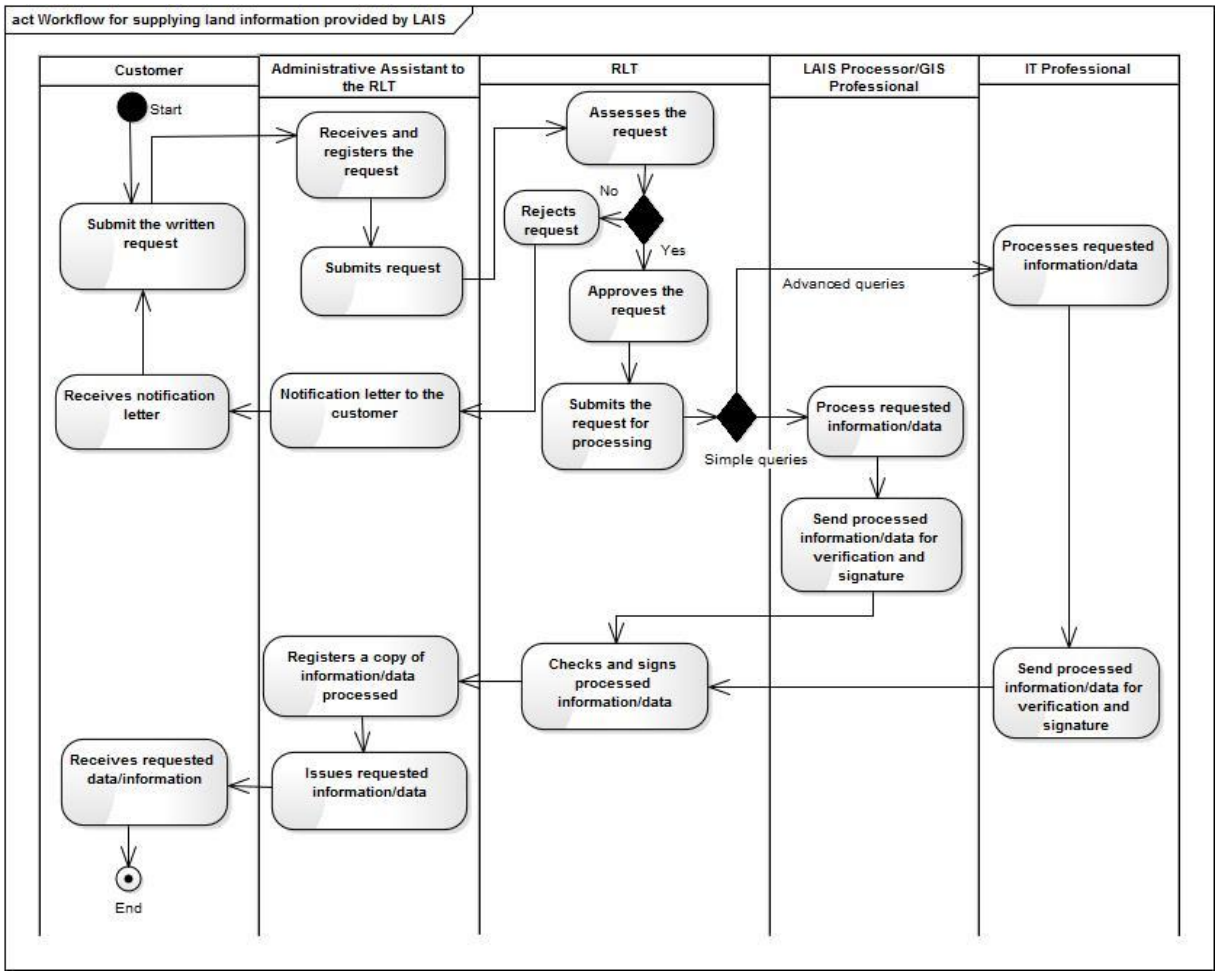

Figure 4-4: Workflow for the supply of land information provided by LAIS to the general customers

When the processing of received requests is completed, the output is sent back to RNRA zonal office to be signed by the RLT before being issued to the customers by the Administrative Assistant of the RLT. The average time required to delivers requested land information to the customers is 5 working days counted from the day when the request is received by the Administrative Assistant of the RLT. However, the time may exceed 5 working days when the requests have to be processed by IT professionals at RNRA head office. The workflow for supplying land information to the customers at the office of the RLT can be summarized in the UML activity diagram in figure 4-4.

Supply of land information to district officers

Interviews showed that LAIS Processor and GIS Professional receive requests for land information from district officers. As an example, for the period of 2014 - 2015, they received between 10 and 15 requests per month in average mostly coming from IOSC unit and few requests from Agriculture and Natural Resources unit. Several types of land information are requested by district officers but UPI, area, land use and names of the owners of the parcels as well as annotations associated with the parcels such as mortgage and disputes are the most requested types of land information by district officers. Sometimes, when the district is conducting expropriation for public interests or solving land related disputes involving a lot of land parcels, district officers request cadastral maps to support their activities. Land information may be delivered in paper or digital formats depending on the preferences of the district officers. District officers often request for land information verbally and they are responded in the same way. However, the interview revealed that this is not the formal way of requesting and supplying land information. For spatial data, district officers never request for ArcGIS shape files. The requirements and procedures governing

the supply of land information to district officers are nearly similar to those of the general customers mentioned above. The only difference is that the formal requests for land information are prepared by a concerned district officer and submitted to the Mayor of the District for signature. Then they are sent to the office of the RLT as it is done in the case of the general customers (see Figure 4-9).

4.2.3.5. Challenges faced by LAIS at district level

Interviews revealed that in Karongi District, LAIS faces challenges including the lack of enough IT equipment, unexpected disconnections of LAIS network which leads to the delay in processing the requests received from the customers, the cuts of electricity for many hours while the batteries used by RNRA zonal office in the Western Province can only survive for 3 hours after the cut of electricity. In addition, district officers mostly prefer to make oral requests of land information because they are faster than written requests while the LAIS Processor and GIS Professional are required to deliver data formally after the approval of the requests by the RLT as it is stipulated by the Presidential Order determining the functioning and competence of the RLTs. Furthermore, there is a delay in supplying information to district officers when the RLT is not available in his office for some days to approve the requests. The LAIS staff members, especially GIS professional, receives a lot of requests and become unable to deliver services to the customers in a reasonable time because there is only one person who processes all the spatial requests coming from Karongi District and other districts of the Western Province.

4.3. Land management activities in Karongi District

This section describes and categorizes land management activities performed by Karongi District officers in different fields. Additionally, it explores the effects of land management activities on the people-to-land relationship. Land management activities discussed in this section cover a period from 2014 to 2015 which coincides with the time when LAIS was introduced in Karongi District.

4.3.1. Description and categorization of land management activities performed by the District

The study did not cover all land management activities performed by Karongi District in 2014-2015. In order to select land management activities to be covered by the research, performance contracts of Karongi District for the financial year 2014-2015 were considered (Karongi District, 2014b). Performance contracts called "Imihigo" in Rwandan language refer the contracts signed every financial year between the President of the Republic of Rwanda and government institutions describing annual targets and objectives to be achieved by concerned institutions based on measurable socio-economic indicators. Performance contracts are recognized as the most important tool in the processes of planning, accountability, monitoring and evaluation because they strongly focus on results (Versailles, 2012). Performance contracts were introduced in Rwandan local governments in 2006. Since, the District Mayors sign annually an agreement with the President of the Republic related to the achievement of specific goals grounded from national strategic planning tools and district development plans (McConnel, 2010). At the end of every financial year, an evaluation of district performance contracts is carried out by the Government. Performance contracts are also considered as the most important annual planning tool of the district. All priority activities, including land management activities, to be performed by the district during every financial year are included in performance contracts. For this reasons, land management activities covered by this research were selected among priority activities included in performance contracts of Karongi District for the financial year 2014-2015.

Land management activities identified in the study area were grouped into the following components: agriculture, forestry and environment protection, expropriation and construction of public infrastructures, development of rural settlement sites as well construction permitting and building inspection. The grouping of land management activities was done based on similarities among activities particularly the

end outcome of identified activities. In this perspective, activities grouped in agriculture component aim at increasing agricultural production for food crops and cash crops. Forestry and environment protection related activities include all activities that aim at sustainable management of the environment and natural resources. Activities included in the component of rural settlement sites development intend to select and develop the land allocated to grouped settlements for the benefit of rural households relocated from scattered settlements and high-risk zones. Expropriation and construction of public infrastructures regroup all land management activities for which the purpose is to find the land suitable for the construction of public infrastructure and facilities. Construction permitting and building inspection concern all the activities that aim the development of urban land as well monitoring of the compliance with zoning regulations as specified in the master plan of Kibuye city.

4.3.1.1. Agriculture

Agriculture is the most important economic activity in Karongi District (Karongi District, 2013). Therefore, it plays a key role in land management activities of the district. Interviews revealed that agricultural land management activities include land use consolidation (LUC), expansion of coffee and tea plantations, hillside irrigation and radical terracing. LUC was implemented on large areas estimated to 52,629ha and focuses on crops selected by the district. Such crops are grown by local farmers on their own land and include maize, beans, Irish potatoes, cassava, wheat and soya. To implement the LUC, district and sector agronomists select and delineate areas suitable for a given crop. After the identification of farmers who own the land in the selected areas by local leaders at Village and Cell level, the area of cropping land is estimated for every farmer. Before the cropping season starts, all the farmers are sensitized by local leaders and agronomists at Sector level to grow selected crops in their respective land parcels. When the cropping season starts, every farmer prepares his land and grows the crop agreed on with the agronomists. The Ministry of Agriculture and Animal Resources (MINAGRI) in conjunction with the district assists the farmers by providing them with seeds and fertilizers that are distributed to them by Sector agronomists based on the area of the land each farmer has. Sector agronomists assist technically farmers during the whole cropping season.

Agriculture in areas of the high slope is sometimes accompanied by radical terraces and irrigation infrastructures such as water canals and irrigation dams to increase the productivity of the soil and help local farmers to grow crops three times a year regardless of rainfall irregularities. Figure 4-5 illustrates irrigation activities implemented in Rugabano and Rubengera Sectors by Land Husbandry, Water Harvesting and Hillside Irrigation project (LWH) in conjunction with Karongi District. LWH is a project under the MINAGRI launched in 2013. Till now, LWH has constructed radical terraces on the total area of 1,156ha among which 142.51ha have been serviced with irrigation infrastructures. Due to this project, 35% of the unused and barren land was transformed into the productive land (MINAGRI, 2015). Other radical terraces have been constructed on 91.3ha in Murundi, Twumba and Mutuntu Sectors (Karongi District, 2014b). Terraces are commonly constructed through community participation approach using the manpower composed of local farmers.

Figure 4-5: Irrigation infrastructures (irrigation canal and dam) in radical terraces in Rugabano Sector

Regarding extension of tea and coffee plantations, interviews revealed that this land management activity is implemented by the district to promote and increase the production of cash crops. In 2014 - 2015, new 395.5 ha of tea and 150ha of coffee have been planted by local farmers (Karongi District, 2014b). The district in conjunction with NAEB provides seedlings, fertilizers and pesticides to the farmers as an incentive. They also provide technical support to the farmers.

4.3.1.2. Forestry and environment protection

Land management activities in the field of forestry concern forest plantation in different Sectors of Karongi district. In 2014 - 2015, the district planted forest trees on the land covering an area of 790ha (Karongi District, 2014b). The district officer in charge of forestry and natural resources was responsible for this activity. He was supported by officers in charge of forestry at the sector level. With respect to environmental protection, the main activity pointed out by respondents was the protection of the catchment area of Mbirurume River by making progressive terraces on 250ha. Implementation, monitoring and evaluation were under responsibilities of the district officer in charge of the environment.

4.3.1.3. Expropriation and construction of public infrastructures

Projects regarding the construction of public infrastructures and utilities are often preceded by expropriation in order to get the land required to implement such projects. According to the respondents, Karongi District implemented expropriation projects mainly aiming at finding the land dedicated to public infrastructures for the benefit of the district and other government agencies. The following expropriation activities have been conducted by the district in the period of 2014-2015:

- Expropriation of 87ha of land belonging to the Ministry of Defence for the construction of marine base in Bwishyura Sector, Gasura Cell on the shores of Lake Kivu
- Expropriation of the land allocated to the construction of cross-border market of Ruganda in Bwishyura Sector
- Expropriation of the land for Bwishyura cemetery
- Expropriation of the land for the construction of the nursery school in Murundi Sector

With regard to the construction of public infrastructures, land management activities identified in this field include the construction of 26Km of water supply system for the supply of potable water to 12,085 households, construction of Youth Peace Centre in Rubengera Sector, construction of roads servicing parcels in Nyamishaba residential zones of the city of Kibuye, construction of 34 Km of Kivu belt

multinational tarmac road (Figure 4-6), construction and rehabilitation of dirt roads linking Sectors of Karongi District. These activities were also accompanied by expropriations of affected parcels.

Figure 4-6: Kivu Belt Multinational Road under construction

4.3.1.4. Development of rural settlement sites

Karongi district has been relocating rural households from scattered settlements and high-risk zones to grouped settlements. To achieve this goal, many rural settlement sites are being developed all over the district. Interviews revealed that the development of rural settlement sites is carried out by identifying suitable sites, elaborating layout plans, demarcating plots and putting in place roads servicing each plot as well as other basic infrastructures. In this matter, the key projects implemented by the district included:

- Development of 39 rural settlement sites (3 rural settlement sites per Sector)
- Resettlement of households in Bunyankungu model village in Rubengera Sector
- Plot servicing (creation of new roads) in Bunyankungu, Gahabwa and Nyabahanga model villages.

4.3.1.5. Construction permitting and building inspection

As revealed by the interviews, land management activities related to construction permitting and building inspection are mainly carried out in Kibuye City. They are related to the implementation of zoning regulations of Kibuye city master plan. They concern all the activities pertaining to the issuance of building permits to the citizens as well as building inspection activities organized by the staff of IOSC unit to verify whether the construction of buildings complies with rules and regulations stipulated in the master plan of Kibuye city.

4.3.2. Impacts of land management activities on people-to-land relationship

This study intended to find out the possible effects of the implementation of land management activities on the people-to-land relationship (parcels, land rights and landowners) in the study area. Almost all respondents demonstrated that the execution of land management activities in Karongi District leads to the changes that affect not only land parcels but also the land owners and land rights.

4.3.2.1. Changes in parcel size and land use

According to the respondents, this kind of changes results from subdivision and merging of land parcels, expropriation and development of rural settlement sites. Cases of parcel subdivisions occur mainly during plot demarcation in rural settlement sites whereby big parcels are split into small ones to comply with the standard size of a residential parcel in rural settlement sites which ranges from 400 to 600sqm. When parcels are smaller than the standard size, they are merged together. Additionally, the construction of new roads in rural settlement sites to service residential parcels is also qualified as the main cause of parcel

subdivision. With respect to parcel merges, they occur especially after expropriation for public interest and compensation whereby concerned land parcels are merged together to become one single parcel which belongs to the expropriator. Furthermore, parcels often change their use from one land use to another depending on the activity required by the district in the area. Expropriation and development of rural settlement sites and urban area are the most important causes of the land use changes in the study area. Additionally, forests are sometimes planted on agricultural land located on high slopes and this leads to the changes of land use from agriculture to forestry.

4.3.2.2. Changes in land ownership

The implementation of land management activities leads to the change of the owners of the land. The study identified three causes of the changes in land ownership: sale of parcels, exchange of parcels and expropriation. Sale and exchange of parcels occur particularly in rural settlement sites where the citizens who don't have the land within the site buy or exchange the land with those having land in the site in order to get a parcel to build residential houses and therefore move from scattered settlements or high-risk zones as recommended by the district. For the case of expropriation, the landowners change from private owners to the government agency that paid the compensation.

4.3.2.3. Changes in land rights

Land management activities in the study area sometimes affect the rights that the landholders have over land. One of the respondents explained such effects as follows:

"For rural settlement sites, there are some land parcels which were previously registered as agricultural land but when the sites were allocated to the rural settlement, there was a change of land use from agricultural to residential land use. This change leads to the change of the duration of land rights from 99 years for agriculture land use to 20 years for residential land use. For Expropriation, there was a change of the nature of land rights from emphyteutic lease to freehold titles (full ownership of the land) because the land was transferred from private owners to government organizations that normally hold freehold titles".

This statement indicates that the implementation of some land management activities in the study area contributes to a change of land use and subsequent change of the duration of land rights. Moreover, expropriations for public interest affects the nature and duration of land right in the sense that after compensation the land is transferred from private holders to public organizations which respectively hold leasehold titles (lease term ranging from 15 to 99 years) and freehold titles (full ownership of the land).

4.3.2.4. No changes

Some respondents perceive that land management activities such as LUC, tea and coffee plantation and radical terracing were executed without changes on parcel size, land rights and land ownership. They argue that for LUC, farmers whose parcels are located in the same consolidated area grow the selected crop on their own land parcels without changing their boundaries and the use. For the case of coffee and tea plantation, farmers grow these crops on their agricultural land and this does not change anything on parcel boundaries, use, rights and ownership of the land. In the same way, the protection of Mbirurume River's catchment area and radical terracing activities did not affect land parcels, landowners and land rights. District officers argue that progressive and radical terraces are constructed in land parcels but the boundaries, land rights and landholders remain the same.

4.4. Role of LAIS in land management activities performed by district officers

This section identifies different types and sources of land information used by district officers in their daily work. It provides an insight on how district officers access to land information they need to perform

land management activities. Furthermore, the role played by the land information delivered by LAIS in the implementation of land management activities is discussed in this section.

4.4.1. Use of LAIS by district officers

4.4.1.1. District officers using land information delivered by LAIS

Interviews revealed that 7 out of 11 interviewed district officers use land information from LAIS. 3 out of 4 district officers who don't use land information from LAIS indicated that they knew LAIS but they didn't know that it contains land information that can be useful for their work. One district officer didn't know LAIS at all (see table 4-2).

Unit	Know LAIS	Don't know LAIS	Use land information delivered by LAIS	Don't use land information delivered by LAIS	Use LAIS
IOSC	6	0	6	0	2
Agriculture and Natural Resources	4	0	1	3	0
Good Governance	0	1	0	1	0
Total	**10**	**1**	**7**	**4**	**2**

Table 4-2: Use of land information delivered by LAIS by district officers

From the table 4-2, it is seen that that land information from LAIS is mainly used by district officers working in IOSC unit. The IOSC unit is in charge of all the activities pertaining to public infrastructures, land administration, housing, urban planning and management at district level. Apart from one district officer, other district officers from Agriculture and Natural Resources and Good Governance units do not use land information from LAIS. Two district officers from IOSC unit namely the Acting Director and the Lawyer are the users of LAIS.

4.4.1.2. Ways of access to land information

Based on the way of access to land information, district officers can be grouped into two categories: the users of LAIS and the customers. The users of LAIS are district officers who are authorized by RNRA to use the system; they access to LAIS through the internet by using their usernames and password. This category includes two district officers both working in IOSC: Acting Director and the Lawyer of IOSC Unit. They are among 188 users of LAIS mentioned in section 4.2.2.3. Their role is to 'view' data in the textual component of LAIS. They do not have access to the spatial component of this system. The category of customers includes district officers who are not authorized to access to LAIS. They access to land information by making requests to the users of LAIS.

Interviews showed that district officers can access to land information in four ways: (1) direct access to LAIS through internet, (2) access to land information through the staff of IOSC who have direct access to LAIS, (3) access to land information through the LAIS Processor or the GIS Professional and (4) access to land information through other staff members working in the office of the Registrar of Land Titles (ORLT) in the Western Province. Acting Director and Lawyer of IOSC unit have direct access to LAIS through the internet and use it on a daily basis. They are only authorized to access textual component of LAIS. When they need spatial information they request it from GIS Professional in the ORLT. Other district officers who are not connected to LAIS mainly access to land information by making oral requests to the Acting Director or the Lawyer of IOSC unit. They can also request land information to the LAIS Processor and the GIS Professional responsible for LAIS in Karongi District respectively for textual and

spatial information. Textual information is particularly requested from the LAIS Processor when there is no internet connection in IOSC office. Rarely, district officers make requests of land information to other staff members of the ORLT who have access to LAIS.

4.4.1.3. Types of land information requested by district officers

District officers who use land information delivered by LAIS pointed out that they use various types of land information including the UPI (unique parcel identifier or parcel number), area of the parcel, land use, owners, location, categories of public lands, information related to mortgage and disputes associated with the parcels (Figure 4-7).

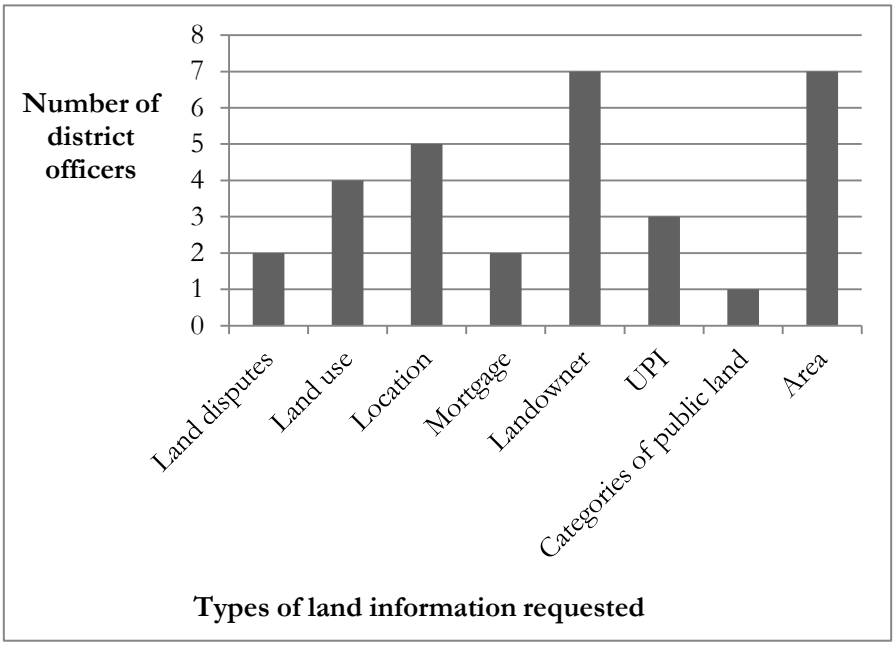

Figure 4-7: Types of land information requested by district officers

Figure 4-7 shows that the most requested types of land information by district officers includes area, land owner, location and land use of the parcels.

4.4.1.4. Number of requests for land information

As revealed by the interviews, two district officers (Acting Director and Lawyer of IOSC unit) who are authorized to access to LAIS use land information on daily basis. They can access to the system whenever they want by using their usernames and passwords. For district officers who don't have direct access to LAIS, the number of requests for land information in a month varies between 2 and 15. One respondent revealed that he makes 3 requests of land information in a year.

4.4.1.5. Format of land information

The interviews revealed that land information is delivered to district officers in two types of formats: digital format and paper-based format. In comparison with the digital format, the paper-based format is the most used. Digital format commonly comprises ArcGIS shape files and excel sheets. The paper-based format is especially used in case of cadastral maps requested by district officers when they are implementing projects involving a big number of land parcels such as expropriation for public interest covering big areas. However, a large number of the requests for land information are made orally by district officers and the information is also delivered to them in the same way. Given that district officers mainly request and receive land information verbally or in a paper-based format, there is no need for transformation or conversion of data before its use.

4.4.1.6. Alternative sources of land information

LAIS is not the sole source of land information used by district officers in their work. All 11 district officers interviewed indicated that they use other sources of land information apart from LAIS (see table 4-3). Land information is mainly requested from the courts and government agencies which produce and disseminate land-related data. District paper-based documents provide also relevant land information that district officers cannot find in LAIS. Furthermore, it was observed that local people and local leaders at Village, Cell and Sector levels constitute another important source of land information used by almost all the district officers in their work. To get the land information, respondents explain that land information is firstly collected from local people by Village leaders. Secondly, local leaders and technical staff at Cell and Sector levels respectively compile land information collected from Villages and Cells. Finally, land information gathered from all the Sectors is compiled at the district level by concerned district officers to constitute the overall land information to be used for land management activities. Land information is compiled in paper-based format up to Cell level. At Sector and district level, land information is compiled in both digital and analogue formats to facilitate archiving of data.

The district officers seem to prefer to use other sources of land information for two main reasons. The first and main reason is that they don't find in LAIS all the land information they need to execute their land management activities. This is the case of district officers who use land information provided by LAIS. One of them points out some examples of land information that is not available in LAIS while it is relevant for his work:

"Data concerning the District Land Use Plan are not available in LAIS while they are very useful in my daily work... Also, the land dedicated to all the categories of roads is not registered in LAIS. Roads buffers (22m or 16m) are not recorded in LAIS as public land while it is provided in road act and the land law. This land is registered neither to private landowners nor to the District or the state. I cannot forget to tell you that we do not have any information regarding the land where electricity and water supply networks are installed. It is also the same problem for optic fibre which was installed by RDB to distribute the internet".

District officers indicated that they miss in LAIS the land information concerning the land value, buildings and other improvements made on the land, perennial crops, land allocated to all categories of roads as well as the road land reserves as provided by road act and the land law, land where electricity and water pipelines and optic fibre networks pass as well as land information contained in the district land use plan. The missing land information includes also minutes of judgements executed by bailiffs, court decisions on cases of land disputes, parcels involved in conflicts after the completion of LTR. 5 out of 7 district officers who use land information delivered by LAIS indicated that they miss in the system land information which is relevant for land management activities. Two district officers asserted that they find in LAIS all the information they need for their work.

The second reason that motivates district officers to rely on other sources of information is the lack of awareness about LAIS. As revealed by the interviews, some district officers don't know that LAIS is operational in Karongi District and can provide them the land information that could be used in their land management activities. Thus, they continue using traditional sources of information they used before the introduction of LAIS in Karongi District.

N⁰	Source of land information	Information searched
1	Courts	Land disputes-related judgements
2	REMA	Marshlands and other protected areas
3	National land use planning portal of RNRA	District land use plan (DLUP)
4	Website of RTDA	Roads classification
5	NAEB	Land covered by cash crops
6	RHA	Urban development plan
7	District Forest Management Plan	Categories of forests, their location, areas and types of tree species
8	District property register	Public lands
9	Master plan of Kibuye City	Regulations on land use and building construction
10	Integrated District development plan	District land use plan
11	Local people	Land parcels, landowners, location, boundaries
12	Cell land committees	Land parcels, landowners, location, boundaries, land disputes
13	Local leaders at Village, Cell and Sector level	Land parcels, landowners, location, boundaries, land disputes
14	Cell and Sector technical staff	Land parcels, landowners, location, boundaries, land disputes
15	Land notaries	Land transfers

Table 4-3: Other sources of land information used by district officers

4.4.2. Role played by LAIS in land management activities of district officers

This section explores how district officers make use of the land information received from LAIS to execute different types of land management activities. Data are analyzed and presented based categories of land management activities identified earlier: agriculture, forestry and environment protection, expropriation and construction of public infrastructures, development of rural settlement sites and construction and building inspection.

4.4.2.1. Agriculture

Currently, it is commonly known that LISs supply land information that supports agricultural land management activities. However, it is not the case in Karongi district. Although agriculture is recognized as the most important economic activity of the district, the interviews revealed that LAIS does not play any role in agricultural land management activities. Agriculture encompasses a variety of activities but their implementation relies on other sources of land information. The land information to be used in agriculture-based activities is collected from local farmers by local leaders, Cell and Sector agronomists and compiled from the Village to District level.

4.4.2.2. Forestry and environment protection

LAIS is supporting land management activities related to forestry while for the environment protection LAIS is not used as a source of land information. In forestry matters, land information delivered by LAIS plays a role not only during different stages of forest plantation but also in the settlement of forest-related disputes. One respondent highlighted the application of land information provided LAIS in the process of forest plantation as follows:

"First, I identify the site to be forested. Then I request in IOSC data related to the parcels located within the site, their owners and areas; and based on the area of each parcel I calculate the number of seedlings to be planted in each parcel. For

the resolution of the land-related conflicts, the information received from LAIS helps me to solve forest-related problems (boundaries, area and ownership) between private landowners and the District".

In environment protection matters, land management activities executed by the district in 2014-2015 included the protection of the watershed of Mbirurume River by progressive terraces. However, LAIS did not contribute to any activity in this area. District officers used land information provided by local people and local leaders.

Land management activities	**Type of land information used**
Land use consolidation	Does not use land information delivered by LAIS
Expansion of coffee and tea plantation	Does not use land information delivered by LAIS
Radical terraces	Does not use land information delivered by LAIS
Forest plantation	Area and owners of parcels, neighbouring parcels, location of parcels
Protection of Mbirurume river watershed (250ha)	Does not use land information delivered by LAIS
Expropriation of 87ha of land belonging to the Ministry of Defence and allocated to marine base in Bwishyura Sector, Gasura Cell on the shores of Lake Kivu	Parcel numbers (UPI), area, owners, location and land use of the parcel, information about the mortgage, land disputes, neighbouring parcels
Expropriation of the land allocated to the construction of cross-border market of Ruganda in Bwishyura Sector	Parcel numbers (UPI), area, owners, location and land use of the parcels, information about the mortgage, land disputes, neighbouring parcels
Expropriation of the land for Bwishyura cemetery	Parcel numbers (UPI), area, owners, location and land use of the parcels, information about the mortgage, land disputes, neighbouring parcels
Expropriation of the land for the construction of the nursery school in Murundi Sector	Parcel numbers (UPI), area, owners, location and land use of the parcels, information about the mortgage, land disputes, neighbouring parcels
Expropriation and construction of youth centre in Rubengera Sector	Parcel numbers (UPI), area, owners, location and land use of the parcels, information about the mortgage, land disputes, neighbouring parcels
Construction of 26Km of water supply system	Owners, area, land use and location of the parcels
Construction of Kivu Belt Multinational Road (new tarmac road crossing the Western Province): part of Karongi District (34Km) & expropriation	Owners, parcel numbers (UPI), area, neighbouring parcels
Rehabilitation of Rugabano - Gasenyi - Karongi - Karongi dirt road & expropriation	Owners, parcel numbers (UPI), area, neighbouring parcels
Development of 39 rural settlement sites (3 rural settlement sites per Sector)	Owners, land use and area of the parcel, mortgage and conflicts related to concerned parcels
Resettlement of households in IDP model village of Bunyankungu in Rubengera Sector	Owners, land use and area of the parcel, mortgage and conflicts related to concerned parcels
Plot servicing in Bunyankungu, Gahabwa and Nyabahanga IDP model villages.	Owners, land use and area of the parcel, mortgage and conflicts related to concerned parcels
Issuance of building permits in Kibuye city	landowners, land use, area, basic infrastructures in place, land tax

Table 4-4: Types of land information from LAIS used by district officers in land management activities

4.4.2.3. Expropriation and construction of public infrastructures

LAIS is more consulted in expropriation and construction of public infrastructures than other fields of land management activities. Almost all the activities regarding the construction of public infrastructures are preceded by expropriation for the public interest. Land information is required in the whole process of expropriation. When undertaking expropriation, district officers stated that they use information from

LAIS such as area, land use and location of the parcels to know the value of the land to be paid as compensation because the value of the land is locally calculated based on the area and the land use of the parcels. In order to prevent disputes, they use information concerning land ownership in order to know the rightful owner of the land because it is the one who receives the compensation. Upon completion of compensation process, the expropriated land is transferred to the expropriator. Information associated with each parcel is consequently changed in LAIS in favour of the expropriator. Old landholders are removed from LAIS and replaced by the new holders. Normally, construction activities start after the payment of the compensation. The information about the area and location of the parcel is required to select suitable sites for public infrastructures, establish the architectural designs of buildings and plans of other types of infrastructures to be put in place.

4.4.2.4. Development of rural settlement sites

LAIS is required in almost all the activities concerning the development of rural settlement sites. As revealed by interviews, developing rural settlement sites involves a lot of activities including the delineation of boundaries of the site, elaboration of layout plans, demarcation of roads and parcels in accordance with standard sizes, construction of basic infrastructures and roads servicing each parcel and construction of residential houses by interested citizens. To conduct all these activities properly, district officers stated that they need to know the number of parcels affected by the activities, their areas and their owners and LAIS is the source of such information. In addition, plot demarcation and roads creation lead to many changes affecting parcels due to the subdivision, merging, sale and exchange of parcels. It also requires expropriation of the land allocated to roads and other public infrastructures put in place in a given rural settlement sites. All these changes have to be reported and updated in LAIS accordingly.

4.4.2.5. Construction permitting and building inspection

The study demonstrated that land information delivered by LAIS was used in building permitting. As revealed by interviews, all the applications for building permits in Kibuye city have to fulfil the requirements set forth by the district: (1) a land title in the names of the applicant, (2) a proof of payment of land taxes, (3) the land use of the parcel on the land title must be related to the construction activity to be undertaken, (4) the area of the parcel must be more or equal to the required minimum size of the parcel in the area where the building has to be constructed and (5) architectural design of the building must fit the size of the parcel. All these requirements are checked in LAIS to make sure that the applicant in question is eligible for a building permit or not. However, the study revealed that LAIS is not used in building inspection activities in the study area.

4.5. Perceptions of district officers towards the role of LAIS in land management activities

The goal of this section is to explore perceptions of district officers regarding the role of LAIS in support of land management activities at district level. The section examines the needs and expectations of district officers related to land information required for the implementation of land management activities. It identifies improvements brought by LAIS in working conditions of district officers by comparing the situation before and after the introduction of LAIS in Karongi District. Additionally, the section presents suggestions of district officers regarding improvements to optimize the use of LAIS in land management activities of the district.

4.5.1. The needs for land information from LAIS

The interviews demonstrated that district officers do not share a common understanding of the extent to which LAIS satisfies their needs and demands for land information. The comparison between land information available in LAIS and the needs of district officers revealed that 4 out of 7 district officers

who use land information from LAIS are satisfied by the amount and types of land information provided to them by the system. They argue that the volume of land information that LAIS provides to them is appropriate for their land management activities and meets their needs. In contrast, 3 district officers express their dissatisfaction towards the amount and type of land information delivered to them by LAIS. The reason for this dissatisfaction is that district officers have to search for additional land information from other sources of land information apart from LAIS. One of them expresses his dissatisfaction as follows: "*The amount of information I get from LAIS does not respond to my needs; it does not help me to execute all of my activities related to road construction and maintenance. I am obliged to use other sources of information to complement the information I get from LAIS*".

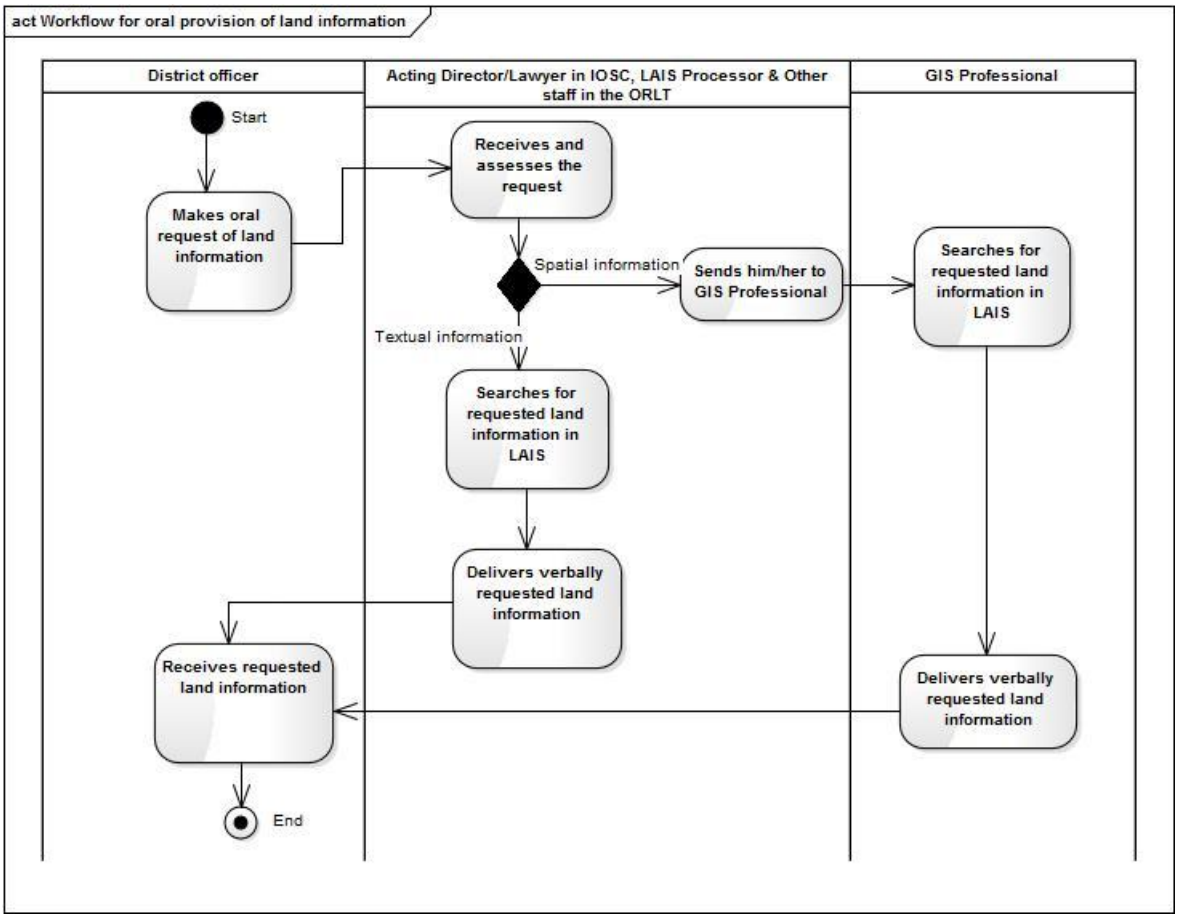

Figure 4-8: Workflow for informal provision of land information

Regarding the procedures required to get information from LAIS, almost all district officers pointed out that they are simple because they informally request and get verbally the information they need from their colleagues of IOSC unit, LAIS staff and other staff members working in the ORLT in the Western Province. Respondents also share the same view that the time required to get verbally land information from LAIS is short. Figure 4-8 summarizes the workflow for the informal supply of land information to district officers.

All district officers involved in land management activities are not authorized to access to LAIS. Only two district officers (Acting Director and the Lawyer of the IOSC unit in the district) are authorized by RNRA to use this system. However, they complain that they have limited access to LAIS because they can only access to textual information stored in the textual component of the system. They are not allowed to access the spatial component of the LAIS where spatial land information is stored. The poor internet

connection in the office of the IOSC unit is also perceived as another limitation to full access to LAIS because most of the time they are disconnected from this system.

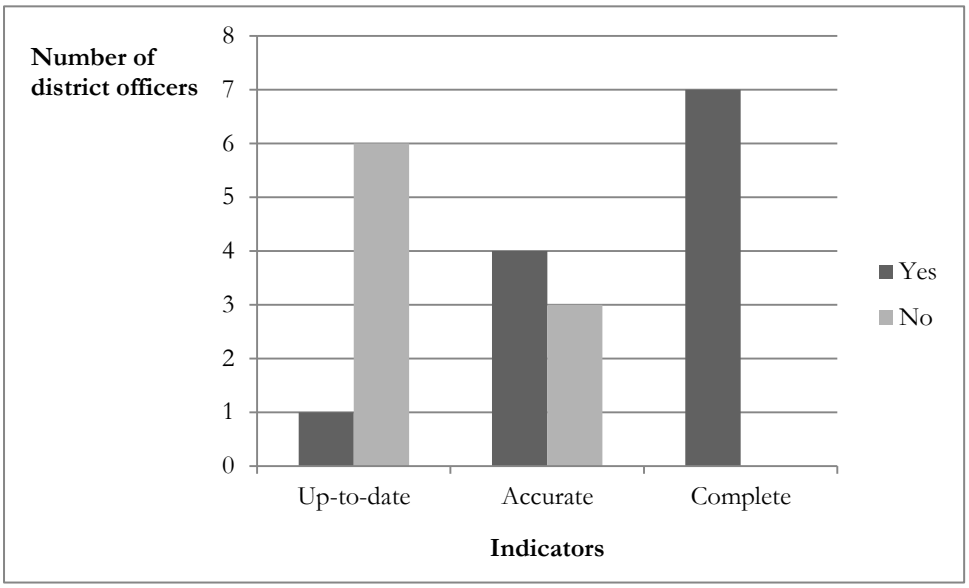

Figure 4-9: Perception of district officers on the quality of land information delivered by LAIS

The study also examined the quality of land information delivered to district officers by LAIS based on 3 indicators (Figure 4-9): updatedness, accuracy and completeness. In this respect, almost all the respondents mentioned that the land information they acquire from LAIS is not updated.
Following is the statement from one of the respondents when he was asked to what extent land information provided by LAIS is updated: *"I don't think so because on the field we face cases where the landowners registered in LAIS are different from the ones we find on the ground. I think this is due to sales of parcels which are not declared in LAIS in order to update changes in the system. I remember also the issue we face today concerning conflicting information between the land use stored in LAIS, the land use existing on the district land use plan and the land use on the ground. In this situation, it is hard for us to take a decision about the actual land use when we meet such cases. This is a serious problem for me".*

The interviews showed that that land information from LAIS was not updated due to two main reasons:

i. Informal land transactions or changes that occur on the land parcels that are not reported by landowners so that they could be recorded in LAIS. Such transactions include particularly the transfer of land rights by inheritance and sale, changes of the land use as well as subdivision and merging of parcels.
ii. Coexistence of two sources of land information legally recognized by the government but having contradictory/conflicting information: LAIS and DLUP. The challenges raised here was that the land use contained in LAIS is not the same as the one specified in the DLUP adopted by the District Council in 2014 while both sources of land information are officially recognized and concern the same area.

Regarding completeness, all the respondents asserted that the information they receive from LAIS is complete. With respect to spatial accuracy, some respondents stated that the information is accurate while others find it not accurate for their work at hand. The inaccuracy of land information concerns especially the shape and size of parcels. This is observed particularly when district officers are issuing building permits whereby they notice differences in shape and area of parcels when they compare data available in LAIS with field measurements performed with GPS. District officers concerned with building permitting

related activities prefer to make their own field measurements in order to get exact shape and area of parcels before issuing construction permits to the applicants.

4.5.2. Impact of LAIS on the work of district officers

This section identifies ways used by district officers to get land information before the introduction of LAIS in Karongi District. Secondly, it presents perceptions of district officers regarding the improvements that LAIS brought in their current working conditions compared to the situation before LAIS.

4.5.2.1. Ways of getting land information before the introduction of LAIS at district level

Interviews revealed that before LAIS was introduced in Karongi District, district officers involved in land management activities acquired land information from four sources: (1) local people, (2) local leaders, (3) field measurements and (4) consultation of analogue documents of the district. Given that there were no other sources of land information legally recognized by the government, district officers almost collected all the land information from local people and local leaders from Village, Cell and Sector levels. Sometimes, district officers went to the field to perform their field measurements using surveying equipment such as decameters, GPS and total stations. They could also consult paper-based documents held by the district such "Plan d'amenagement forestier du district" (District forest management plan) that contained land information specific related to all types of forests within the district, the district property register that contained information about immovable assets of the district (land and buildings) and the master plan of Kibuye city adopted by the district in 2003.

4.5.2.2. Improvements brought by the introduction of LAIS at district level

Since the introduction of LAIS in Karongi in January 2014, district officers started using it as a source of land information. The use of LAIS improved working conditions of district officers. As revealed by interviews, the introduction of LAIS at district level has made the work of district officers easier and faster than before. District officers no longer need to perform their own field measurements or to request land information from local people and leaders. This way of collecting land information was time-consuming and delayed the service delivery to the customers. With LAIS, reliable, trustable, accurate and legally recognized land information is available and can be easily accessible at the district level. As a result, the service delivery to customers has improved and become faster than before.

Situation before LAIS	Situation after LAIS
• The work was difficult	• The work is easy
• Errors and confusions about the land ownership	• No confusion about land ownership
• Delay in service delivery	• Fast service delivery
• Data collection required field measurements	• Accurate, reliable and trustable land information is available and accessible in LAIS
• Land information was collected from local people	
• Collection of land information was time-consuming	
• Many land-related conflicts during expropriation	• Diminution of land disputes during expropriation
• Confusion between public and private land	• No confusion between public and private land

Table 4-5: Perceptions of district officers on the improvements brought by LAIS in their work

During expropriations for public interest, it was not easy for district officers to know the rightful owners of the land to whom to pay the compensation. There was a confusion regarding the actual owner of the land. Since LAIS provides information about land ownership, the rightful owner of each parcel is known, thus there cannot be disputes on land ownership. In short, land disputes that district officers experienced

when conducting expropriation for public interests have been relatively reduced by the recordation of rightful landholders in LAIS.
Regarding public land, it was not easy to distinguish private land from public land covered by forests. The introduction of LAIS helped district officers to get information concerning all public land. The availability of the land information in LAIS contributed to the proper management of the district land.
Table 4-5 summarizes perceived improvements brought by the use of LAIS at the district level in working conditions of district officers in comparison with the situation in the past.

4.5.3. Optimizing the use of LAIS in land management activities of the district

The study collected views and opinions of district officers regarding the improvements that could be implemented by the managers of LAIS and Karongi district in order to optimize the contribution of LAIS in land management activities of the district. Suggested improvements constitute responses to some limitations concerning the use of land information provided by LAIS in land management activities mentioned earlier: long procedures governing the request and provision of land information, limited access to LAIS, lack in LAIS of datasets relevant for district officers, accuracy and updatedness of land information available in LAIS.

4.5.3.1. Procedures governing request and provision of land information

Even though there are formal procedures governing the request and provision of land information to district officers, the focus group discussion demonstrated that these procedures are complicated not only on the side of the ORLT at the provincial level but also on the district side when it comes to big cadastral data.

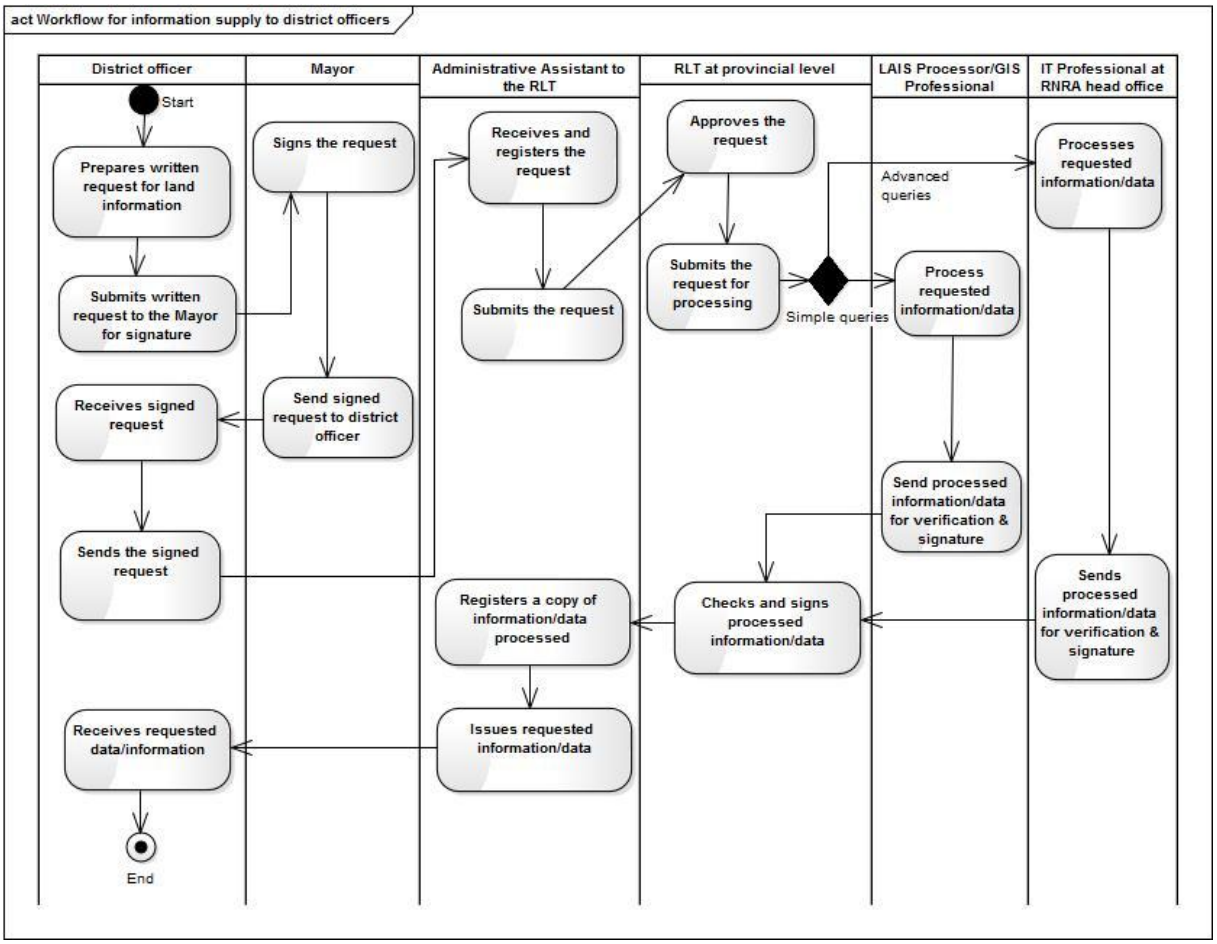

Figure 4-10: Workflow for the formal provision of land information to district officers

District officers complain that the ORLT requires them to submit the requests for land information accompanied by a letter signed by the Mayor of the District. This is difficult for them because they have to wait for a long time (approximately one week) to get the letter signed by the Mayor. In addition, when the requests are officially submitted to the ORLT at the provincial level, district officers wait for their approval by RLT. This bureaucracy leads to the delay in the provision of land information with a subsequent delay in the execution of land management activities of district officers. The workflow for the formal provision of land information to district officers is summarized in figure 4-10.

In order to minimize the bottlenecks that undermine the request and provision of land information, the participants suggested that there should be official procedures governing request and provision of land information between the office of the RLT and the district. These procedures should unambiguously specify the workflow and requirements regarding the provision of land information delivered by LAIS. In this perspective, the participants suggested that the requests for land information from the district should be officially signed by the Mayor and transmitted to the RLT for assessment and approval and then forwarded to the LAIS Processor and the GIS professional for processing. The requested land information must be signed by the RLT before being delivered to district officers. To speed up the process of the provision of land information at the ORLT side, the RLT should delegate the power to one of his staff so that he could approve the requests for land information when the RLT is not available in his office.

4.5.3.2. Access to land information provided by LAIS

District officers pointed out that they don't have access to LAIS and the two district officers of the IOSC unit (Acting Director and Lawyer) who are connected to the system are only authorized to view data in the textual component. They are not allowed to access to spatial data. Additionally, the lack of ArcGIS software installed in their computers and the poor internet connection within the office of IOSC hamper the full and permanent access to LAIS. To overcome these obstacles, participants suggested the following improvements:

i. To facilitate access to LAIS by district officers, all the staff of IOSC should be connected to both components of LAIS so that they could deliver land information to other district officers. Meanwhile, Acting Director and Lawyer of IOSC unit who are connected to LAIS should be authorized by RNRA to provide both textual and spatial land information to other district staff members.
ii. ArcGIS software is required to all the users of LAIS at the district level to facilitate their access to spatial data.
iii. IOSC office should have enough IT equipment and be connected to the internet to enable full and permanent connection to LAIS.

4.5.3.3. Volume of land information

With respect to the amount of land information delivered to district officers by LAIS, participants reiterated that there are relevant types of land information they miss in LAIS such as land value, buildings, permanent crops, various improvements made on the land, roads and their land reserves, water and electricity supply networks as well as optic fibre network. Participants suggested that all these datasets could be incorporated in the database of LAIS or connect LAIS to the information systems containing these datasets. These two alternatives could enable the managers of LAIS to bridge the gap in land information and meet the demands of land information of the district officers.

4.5.3.4. Quality of land information

Concerning the quality of land information, participants mentioned that cadastral data stored in LAIS are not updated and others are not accurate. In order to improve the quality of the land information stored in LAIS, the participants suggested the following intervention measures:

i. Upgrade progressively existing cadastral data through rectification of boundaries and area correction starting from the city of Kibuye where the land value is high.
ii. Sensitize landowners to report changes that occur on their land parcels so that they could be recorded in LAIS to maintain the system up-to-date. The reporting of changes that occur on land parcels was recently made easy and accessible to landowners by the creation of a service in charge of land management at Sector level. Landowners should visit this service to update the changes without walking long distances to the IOSC unit.
iii. Find out the root causes which push landowners not to report changes affecting their land parcels in order to take palliative measures.

4.6. Summary

LAIS was developed to replace the LTRSS which was not appropriate for sustainable maintenance of cadastral data collected during the LTR program in Rwanda. Initially, LAIS was composed of textual and spatial components storing respectively textual and spatial data. Both components were not integrated and this was an obstacle to the consistency and sharing of data. As a solution, LAIS was renewed in 2014 and now both components are synchronized. LAIS data are shared with other government organizations. LAIS has 188 users countrywide who play different roles in the system. Since January 2014, LAIS is operational in Karongi District where it used to support different activities including the provision of land information needed by district officers for land management activities. Land management activities identified in Karongi District were grouped into 5 categories: agriculture, forestry and environment protection, expropriation and construction of public infrastructures, development of rural settlement sites as well as construction and building inspection. The implementation of land management activities have various impacts on the people-to-land relationship and resulted in changes in parcel size, land ownership and land rights. Land information delivered by LAIS plays a role in land management activities mentioned above but other alternative sources of land information are used too. District officers can access to land information stored in LAIS by requesting it verbally to the two district officers of the IOSC unit who have direct access to LAIS, the staff responsible of LAIS in Karongi District (LAIS Processor and GIS Professional) or other professionals working in the ORLT. Almost all the district officers share the same view that the formal procedures governing the acquisition of land information from LAIS are difficult for them. Moreover, access to LAIS is challenging for them because they almost don't have direct access to the system. Regarding the quality of land information, district officers perceive that cadastral data stored in LAIS are complete, not updated and relatively accurate. District officers also perceive that the introduction of LAIS at district level has improved their working conditions compared to the past. To minimize the bottlenecks related to the supply of land information, further improvements were suggested by district officers so that LAIS could optimally support land management activities at district level.

5. DISCUSSIONS

5.1. Introduction

The previous chapter presented the results from the fieldwork. This chapter compares the results of this study with previous literature reviewed in chapter 2 and new literature. Discussion of the results is centred on the specific objectives of the research. Sections 5.2 and 5.3 respectively discuss the results pertaining to the development and use of LAIS and land management activities in the study area. Section 5.4 focuses on the role of LAIS in land management activities in the study area while section 5.5 discusses the perceptions of district officers with respect to the contribution of LAIS in land management activities performed by the district. The chapter is concluded with a summary.

5.2. Development and use of LAIS

In accordance with the provision of the NLP of 2004, it was planned to develop a multipurpose land registry in order to ensure a sound administration and management of the land in Rwanda (MINITERE, 2004). LAIS was developed in this perspective. The development of any information system starts by the determination of the requirements of the users. The latter is recognized as the most important step in the development of any information system (Browne & Rogich, 2001; Hickey & Davis, 2004). When it is poorly conducted, the information system development project is likely to fail (Hickey & Davis, 2004) because it cannot meet user needs. In the case of LAIS, user requirements determination was carried with government professionals who worked in land administration services at national level and in the City of Kigali such as land administrators and lawyers. However, external users of land information, customers and other stakeholders were not involved in this process.

Cruz (2005) and Todorovski & Lemmen (2007) demonstrated that meeting the needs and expectations of the users and customers is a key driver to the success of an information system or a cadastre. Hence, before developing a LIS, it is important to identify external users of the products and services it will provide, for which purposes and how such products and services will be used. The study on the design of an information system for land use conducted in the Philippines by Cruz (2005) indicates that user requirement elicitation starts by the identification of the main users, customers and clients of the products and services provided by an information system followed by the identification of their needs and demands. In the case of the development of LAIS, the needs and expectations of the external users of land information and other stakeholders were not taken into consideration. The reason for this non-involvement of external users and customers could be related to the purpose of LAIS at its initial phase of development. In fact, at the time of development of LAIS, the main purpose of the system was the maintenance of parcel-based information collected during LTR program. It was a change from paper-based to computer-based procedures of handling land transactions but particularly the establishment of efficient procedures of land registration in Rwanda (MINIRENA, 2012). Therefore, it could be understandable that user requirements elicitation mainly involved professionals who dealt with the maintenance of land transactions when the cadastral system was manual rather than the external users of land information because the main goal of LAIS was not the supply of land information but the maintenance of cadastral information. However, the need for determining the requirements of the users of land information is currently at the top of RNRA priorities. Recently, this agency conducted an identification of land information requirements in various agencies and organizations as well as the private sector in Rwanda (Nkurunziza, 2015). This new initiative intends to make LAIS a customer-oriented information system.

The architecture of LAIS (figure 4-2) and the roles of 188 users of LAIS countrywide (section 4.2.2.3) make clear that the main purpose of this information system is the maintenance of land transactions. The roles that the users of LAIS have in the system are centred on the processing of various land transactions received from the clients. This was also the case for the LAIS staffs in Karongi District (section 4.2.3.2). It was found that the contribution of LAIS in the provision of land-related information is still low in comparison with other functions that the system performs. In other words, LAIS fulfils properly all the six functions of a LIS (collection, storage, updating, retrieval, analysis and dissemination) as indicated by Larsson (1991) except for the dissemination of land information. This could be justified by the fact that in the 4 years of existence of LAIS, the priority goal of the system was the maintenance of cadastral information rather than its provision. In addition, the lack of the linkage between the two components of LAIS hindered the exchange of land information (RNRA, 2013). However, the renewal of the system permitted to RNRA to undertake the process of land information supply. The starting initiative was the online exchange of land information stored in LAIS with other government agencies namely RRA, RDB and the City of Kigali that use land information for taxation, mortgage registration and construction permitting respectively (section 4.2.2.4). Furthermore, Nkurunziza (2015) indicates that RNRA is exploring how secure internet routes can be used to facilitate the exchange of land information, enhance service delivery and create a geoportal. This agency is also studying the possibilities of sharing data with other government organizations such as courts, city planning agencies, taxing agencies, Ombudsman and the MINAGRI. These initiatives could improve the access to land information.

The staffs responsible for LAIS in Karongi District indicated that they provide land information to Karongi District, courts, NAEB, RDB, REMA, WASAC, public and private bailiffs and the general public. From this list, it is can be seen that the users of land information provided by LAIS are mainly government organizations. Furthermore, the study revealed that RNRA does not share LAIS data with private organizations. This can be considered as a normal phenomenon in the development and implementation of a LIS as indicated by Dale & McLaughlin (1999) who stated that public organizations are often the first beneficiaries of a LIS.

In Karongi district, LAIS is operated by two staffs namely LAIS Processor and GIS Professional respectively responsible of textual and spatial components of the system. Both staffs are employed by RNRA. They work at the provincial office and are directly supervised by the RLT in the Western Province. Their main task is to perform daily land transactions received from various customers. Besides this main task, they provide land information to Karongi District officers and the general public. The analysis of the list of the users of LAIS shows that beside Karongi District, the LAIS Processor is also responsible of Rutsiro District whereas the GIS Professional is responsible of all the 7 districts of the Western Province. At the district level, LAIS can be accessed by 2 staffs of IOSC unit who are authorized to view textual information in the system. Other district officers and those who are involved in land management activities are not connected to LAIS and they cannot access land information through the internet. For their land information needs, they mostly depend on the 2 staffs of IOSC unit and LAIS staffs at the provincial office. Mostly, district officers request land information from the provincial LAIS staff, as they can provide both textual and spatial data.

Results showed that the staffs responsible of LAIS in Karongi District experience to have too many requests to process: LAIS Processor has to process all the requests from both Karongi and Rutsiro Districts while GIS Professional processes the requests from 7 districts of the Western Province. It seems quite impossible for the two LAIS staffs to process land transactions and supply land information at the same time given that they have many customers to receive. Furthermore, there is no possibility for customers to access land information online. As a consequence, they are a delay in the processing of land

transactions and the supply of land information. In addition, the continuing use of traditional sources of land information by district officers could also result to some extent from this problem they do not get easily land information in LAIS.

5.3. Land management activities in Karongi District

Several land management activities have been identified in Karongi District. Based on their similarities particularly their purpose, identified land management activities have been grouped into five categories: agriculture, forestry and environment protection, expropriation and construction of public infrastructures, development of rural settlement sites and construction and building inspection (Section 4.3.1). Some of these activities like agriculture, development of rural settlement sites, forestry and environment protection, construction of public infrastructures have been implemented on a large scale whilst others cover small areas of land.

Land management activities affect the land parcels, land owners and land rights. Land management activities affect land parcels through the changes of boundaries and the main use of the land (Aleknavicius & Aleknavicius, 2005). It may also bring about the subdivision of the land (Wyatt & Ralphs, 2003). The change of boundaries implies the change of the size and shape of the parcels. Cases of land use changes, parcel splitting and merging subsequent to the implementation of land management activities have been encountered in the study area (see section 4.3.2). Additionally, some land management activities may lead to the change of land owner and the nature and duration of land rights. This mainly occurs in cases of expropriation for public interests whereby after compensation land parcels are transferred from private landholders to the expropriators. The land rights associated with these parcels change from emphyteutic lease titles to freehold titles. For the case of development of rural settlement sites, the change from agriculture to residential land use brought about the change of the lease term from 99 years to 20 years. Sales and exchanges of residential parcels also cause the change of landowners through the transfers of land rights between the parties.

In the view of district officers involved, the execution of certain land management activities such as LUC, tea and coffee plantation, radical terracing and the protection of river watershed by progressive terraces did not affect the parcels, landowners and land rights. However, even though district officers argue that such activities don't change land rights, boundaries, size and owners of the parcels, it is noticeable that the shift from one land use pattern to another imposes new restrictions to landholders even if such obligations and new land use patterns are not recorded in LAIS. Restrictions refer to land-related obligations imposed to landholders for the benefit of the society as a whole. Restrictions are used by managing authority to control the use and activities on land (Williamson et al., 2010). Before the implementation of new land management activities in Karongi District, landowners used their land in accordance with land use regulations that were in place. The introduction of new land use regulations by the district such as mono-cropping (for cash and food crops), taking care of constructed progressive and radical terraces are viewed as changes in restrictions associated with the parcels. As stated by Deininger, Augustinus, Enemark, & Munro-Faure (2010), landholders could only adhere to permitted land use; they are restricted from doing anything else. Thus, land management activities such as LUC, tea and coffee plantation, radical terracing and the protection of river watershed by progressive terraces in the study area bring about the changes in restrictions that affect the use and activities permitted on the land by the district.

5.4. Role of LAIS in land management activities of the district

The study found that land information delivered by LAIS is mainly used by district officers working in IOSC unit. District officers from other units almost don't use land information from LAIS (Table 4-2). Within the IOSC unit, there are 2 district officers namely Acting Director and Lawyer who are authorized by RNRA to access to LAIS using their usernames and passwords. They access LAIS on a daily basis and deliver land information to other district officers, in particular, other district staff sharing the IOSC office. So, those staff in the IOSC office benefit from the fact that they share the same office with the staff that can access to LAIS. Moreover, IOSC staffs have easy access to land information in the office of the RLT in the Western Province because it is located near the IOSC office. The study revealed that other district officers don't use land information from LAIS; either they don't know that the system contains information that can be useful for their work or they don't know LAIS at all. The IOSC unit and the RLT offices where LAIS is accessed are located at 20Km from Karongi District head office (figure 3-1). Due to this distance, these district officers are not in frequent contact with IOSC officers and the LAIS staffs of the RLT; this could be the reason why they are not very aware of LAIS. Also, the distance makes they have no travel to IOSC and RLT offices to get land information. This could be the reason that they prefer to use the land information from other sources that they know and available rather than LAIS. This proximity to the offices where LAIS is accessed could be viewed as one of the causes of the differences in the use of land information delivered by LAIS by district officers working in IOSC unit at the expenses of others.

District officers get land information by making a request to the Acting Director and Lawyer of IOSC unit who have access to LAIS through the internet. However, Acting Director and Lawyer of IOSC deliver only textual information because they are authorized to access only the textual component of LAIS. District officers can also get land information from LAIS Processor and GIS Professional who respectively deliver textual and spatial information. Sometimes, district officers request land information from other staffs working in the office of the RLT. District officers request land information in two ways: oral request and written request. Oral requests are commonly preferred and used by district officers because they are easier and faster than written requests. The latter require long and time-consuming procedures that delay the work of district officers. However, oral requests are not recognized as the formal/official way of requesting land information; they are used for simple information that can be immediately retrieved from the system and delivered verbally to the district officer who needs it. According to the law, the provision of the land information stored in the LAIS is authorized by the RLT (Republic of Rwanda, 2014b). That is why request and supply of land information through written ways is considered as the formal way of access to land information by the customers. The study revealed that written requests are mostly used for big data (spatial and textual data) for which processing takes a long time. They must be approved by the RLT before being processed. Before the land information is officially transmitted to the district, it is also signed by the RLT. This implies that exchange of land information between the district and the ORLT is officially done in writing. Similar findings were also identified by Dangol (2012) in the study conducted in Nepal where he indicated that municipalities get land information from land administration offices by sending written requests. Land administration offices transmit the requested land information using the same approach. Globally, results show that almost all requests for land information are done by district officers informally.

LAIS plays a role in land management activities in Karongi District. However, it is limited to some activities. Within a period of approximately two years since the introduction of LAIS in Karongi District, land information from LAIS is supporting planning and implementation of various land management activities such as forestry, expropriation and construction of public infrastructures, development of rural settlement sites as well as construction permitting. The study revealed that construction of public

infrastructures and expropriation as well as the development of rural settlement sites use more land information from LAIS than other that land management activities. Other sources of land information are being used as well (table 4-3). Prior to the introduction of LAIS in Karongi District, land information was mainly collected from local people by local leaders and was compiled from the Village to the district level. The introduction of LAIS two years ago brought a new source of land information which is not yet fully known and used by all district officers concerned by land management activities. In other words, district officers are in the transitional period from the use of traditional sources of land information to LAIS. This could be one of the reasons why the use of traditional sources of land information by district officers remains important.

The role of LAIS in land management activities in Karongi District demonstrates the linkage between land information and land management (see section 2.3.4) as indicated by FIG (1995) which recognizes land information as a prerequisite for achieving land management objectives. It also illustrates the role that a LIS plays in land management as it was highlighted by several scholars such as Hadjiraftis (1991), Larsson (1991), Tuladhar (2004)and (UNECE, 2005). However, the key important sectors of land management namely agriculture and environment protection make use of other sources of land information rather than LAIS. Many agricultural and environmental activities such as land consolidation, radical terracing, hillside irrigation and protection of river watersheds are being executed in Karongi District on a large scale and one should expect a role for LAIS. However, the responsible district officers are not aware that LAIS could be useful for them. They continue using traditional ways of acquisition of land information despite the existence of LAIS in Karongi District. This could be understandable because district officers are in the transitional period from traditional sources of land information to the use of LAIS as a new source of information. Results show that land information used to implement agricultural and environmental activities essentially comes from local communities and leaders. Specifically for LUC, agronomists rely on estimated data concerning the area of the land under LUC program that are collected by local leaders as it was the case before the introduction of LAIS in Karongi District. However, the MINAGRI has been considering such kind of data as an obstacle to the proper monitoring and evaluation of the impact of LUC program because they are based on 'rough estimates' compiled by agronomists (MINAGRI, 2012). The use of land information provided by LAIS could be a solution to this problem.

5.5. Perceptions of district officers towards the role of LAIS in land management activities of the district

Land information provided by LAIS partially satisfies the needs and demands of district officers involved in land management activities. Some of the district officers expressed their satisfaction towards the volume of information delivered to them by LAIS in comparison with their needs whilst others point out the inability of LAIS to meet their demands for land information required to implement land management activities. The latter argue that some datasets are not available in LAIS while they are needed by district officers in their daily work. This dissatisfaction and unavailability of important datasets in LAIS could be attributed to the lack of a prior consultation of the users of land information, including district officers, when the LAIS was under development as it was mentioned in section 4.2.1.

District officers using land information delivered by LAIS have a shared understanding that procedures they use to get land information in LAIS are simple and the time required to receive requested information is short. When they need land information, they request it verbally to the two staff of IOSC unit having access to LAIS, the LAIS Processor and GIS Professional or other staff working in the office ORLT in the Western Province. Even though they are mostly used, oral requests for land information

made by district officers to the office of the RLT are viewed as informal; it is like an 'arrangement' made to district officers to facilitate their work. That is why such way of requesting and providing land information concerns information that can be checked or retrieved immediately in LAIS and given verbally to district officers. Otherwise, any land information contained in LAIS is provided to district officers upon written request signed by the Mayor of Karongi District and addressed to the RLT (see figure 4-10). Because district officers have this advantage of getting land information orally either from their colleagues of IOSC units or the staff of the RLT, they follow formal procedures for requesting land information when it comes to spatial data and textual data that take a long processing time (section 4.5.3.1). Interviews revealed that district officers perceive that these formal procedures of acquisition of land information are difficult and time-consuming on both district side and the office of the RLT side. This bottleneck could be viewed as a consequence of the lack of appropriate technology enabling district officers to access themselves to land information online without spending a long time when fulfilling all the requirements at both Karongi District and the ORLT sides.

District officers have limited access to LAIS. Even though LAIS was decentralized by RNRA at the district level to facilitate access to land information, almost all the district officers don't have direct access to the system. Open access to LAIS by all district officers could be seen as a solution to this problem. However, open access to LAIS is hampered technological limitations, human resources and the lack of policies and laws regulating access to land information. Technological obstacles comprise the lack of strong internet connection in the office of IOSC unit, repeated electricity cuts, insufficient IT equipment and the lack of software and adequate technology that can facilitate the online access. Human resource aspects are concerned with insufficiency of the staffs responsible for LAIS at the district level: the two LAIS staffs responsible for LAIS in Karongi District are also assigned to other districts of the Western Province and their workload is considered too high. Furthermore, the lack of IT professionals (at district and provincial level) who can perform advanced queries in LAIS is also viewed as a human resource constraint to the provision of land information to district officers. So far in Rwanda there are not policies, laws and regulations that dictate how land information is accessed, shared and distributed between producers and users. These policy and legal instruments identify rights of access to data and specify the users who are allowed to make changes in the databases and in which conditions. It also specifies the users who are allowed to use the land information for other purposes than the ones for which land information was delivered (UNECE, 2005). The aforementioned obstacles to access to land information confirm findings of Linh (2009) who proved that access to land information is dependent upon three factors namely policy aspects, technological aspects and human resources aspects. Thus, limited access to LAIS could be qualified as one of the obstacles to the contribution of LAIS in land management activities in Karongi District next to low awareness to LAIS, distance to offices where LAIS is accessible, long and time-consuming procedures of acquisition of land information, missing of relevant datasets in the system, use of traditional sources of land information, insufficiency of IT equipment, poor internet connection and cuts of electricity.

District officers have diverse views on the quality of land information delivered by LAIS depending on the type of data quality indicator and the land management activity the land information is used for. They indicate that land information recorded in LAIS is complete, relatively accurate but not updated. Land information stored in LAIS is not updated due to informal land transactions which are not reported by landholders so as to be recorded in the system (see section 4.5.3.4). Failure to maintain cadastral data was also identified in the study conducted in Pakistan by Ali et al. (2013) whereby a large number of stakeholders involved in land administration complained that cadastral maps contained outdated information and therefore could not be used to extract exact information related to land parcels and ownership. Specifically for Rwanda, the results derived from World Bank research on the impacts of LTR

demonstrated that 32% of land transactions in rural areas were formally recorded while 68% were not officially registered in LAIS (Nkurunziza, 2015). Concerning the accuracy, some of the district officers state that land information recorded in LAIS is accurate while others contradict this view. This disagreement on the accuracy of land information results in the fact that accuracy of data normally depends upon the purpose to which data is used for (UNECE, 2005). It was found that respondents who perceived that land information is not accurate are the ones dealing with land management activities where high accuracy is very important such as construction permitting and construction of public infrastructures. Conversely, respondents involved in expropriation, forest plantation and road construction and maintenance asserted that land information is accurate because their activities do not locally require highly accurate data. Additionally, cadastral data stored in LAIS cannot be highly accurate given that parcel boundaries have been demarcated through the general boundary system during the implementation of LTR program (Sagashya & English, 2009; Enemark et al., 2014; Biraro, 2014; Muyombano, 2014). In this system, highly accurate data cannot be achieved given that boundaries of parcels are not accurately surveyed as it the case for fixed boundary system.

Even though the introduction of LAIS at district level has improved working conditions of district officers who use land information delivered by this system, further improvements were suggested by district officers. They came up with the following: clear and short procedures governing request and provision of land information, ensuring full access to LAIS by IOSC staffs, availability of enough IT infrastructures and equipment, incorporation in LAIS of key datasets mostly needed for land management activities or connecting LAIS to others land-related information systems for data sharing, progressive and sporadic upgrading of existing cadastral data through a fixed boundary system and setting up adequate measures to ensure timely updating of data in LAIS (section 4.5.3). As the most important and urgent intervention, they suggested making LAIS information available and accessible online through the internet for all district officers. This could be a sustainable solution given that Karongi District head office is connected to the internet network through fiber optic.

5.6. Summary

LAIS was developed without prior consultation of external users of land information, customers and other stakeholders so that they could express their needs and expectations from the system as recommended in the normal process of development of information systems. As a result, there is a gap between land information available in LAIS and land information required by district officers in their land management activities. To fill this gap, district officers use other sources of land information. Despite this drawback, LAIS plays a role in various land management activities of the district and has improved working conditions of district officers compared to the past. However, the provision of land information from LAIS faces different challenges such as limited access to the system by district officers, long and time consuming procedures of acquisition of land information, insufficiency of IT infrastructures and equipment and the lack of policies, laws and regulations that dictate how land information is accessed, shared and distributed between producers and users.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Introduction

Previous chapters focussed on literature review, research methodology, presentation and discussion of the results of the study. This last chapter concludes the research based on specific objectives of the research. Recommendations and future research are also formulated.

6.2. Conclusions

The overall objective of this research was to examine the role of the Rwandan LAIS in support of land management activities performed at the district level. This main objective was achieved through four specific objectives each divided into underlying research questions. The final conclusion is drawn based on specific objectives.

6.2.1. Specific objective 1: Describe the development and use of LAIS at the national and district level

The process of development of LAIS started in 2009 and was completed in 2012. This system replaced LTRSS which was not appropriate for sustainable maintenance of land-related data collected during the LTR program conducted in Rwanda in 2007-2013. Since March 2012, all land-related data stored in LTRSS were migrated Sector by Sector to LAIS. Initially, LAIS was composed of textual and spatial components storing respectively textual and spatial data. The lack of the linkage between textual and spatial components hindered the consistency of data, the quality and speed of workflow execution, data sharing LAIS with other agencies, the integration of process data sourced from other institutions and the deployment of LAIS to remote offices using a public network. To overcome this problem, LAIS was renewed in 2013-2014. As a result, both components are now synchronized. In LAIS, cadastral data are stored in secured databases organized in different catalogues and classes. Currently, the system stores 11,417,854 land parcels. Through web services, cadastral data stored in LAIS are shared with other government agencies such as RDB, NIDA, RRA and the City of Kigali. Currently, LAIS has 188 users playing different roles in the system and operating at national, provincial and district levels. Since January 2014, LAIS is operational in Karongi District where it is operated by two RNRA staffs namely LAIS Processor and GIS Professional both working in the office of the Registrar of Land Titles (ORLT) in the Western Province. They use it to process land transactions and provide land information to district officers and the general customers. Request and provision of land information follow the procedures set forth by RNRA. Furthermore, LAIS is used by two district officers working in the Infrastructure One Stop Centre (IOSC) unit and can use it to provide attribute land information to other district officers who need it.

6.2.2. Specific objective 2: Describe land management activities executed at the district level

In the period LAIS started being operational in Karongi District (January 2014) and the period of the field data collection (October 2015), various land management activities were identified in Karongi District and were grouped into the following categories: agriculture, forestry and environment protection, expropriation and construction of public infrastructures, development of rural settlement sites as well as construction permitting and building inspection. Land management activities in Karongi District had various impacts on the people-to-land relationship and resulted in changes in parcel size and use, land ownership and land rights. Changes in parcel size resulted from parcel subdivision or merging subsequent to the construction of roads in rural settlement sites, subdivision and merging of land parcels to achieve the standard size of residential parcels in rural settlement sites. Changes in parcel size also were the result of expropriations for public interest where two or more land parcels were merged together into one single parcel owned by the expropriator. Other land management activities led to the changes of the land

ownership through expropriation, sale and exchange of parcels. Changes in land use led to the changes of the duration of land rights. For example, the change of the land use from agriculture to residential land use led to the change of the duration of land rights from 99 years to 20 years. This type of change mostly occurred in rural settlement sites where agricultural land is transformed into residential land. Land management activities in Karongi District brought about the changes in the people-to-land relationship and consequently the land information also changed and needed to be updated accordingly in the LAIS.

6.2.3. Specific objective 3: To examine how district officers make use of land information provided by LAIS to perform land management activities

Land information delivered by LAIS is mainly used by district officers in the IOSC unit. Other district officers involved in land management activities do not use LAIS as a source of land information: either they don't know that the system contains information that can be useful for their work or they don't know LAIS at all. District officers make use of other sources of land information apart from LAIS. The most requested land information in LAIS concerns the area, owner, location and land use of the parcels. District officers who use land information delivered by LAIS make between 2 and 15 requests for land information in a month. Those who do not use LAIS continue to rely on land information sourced from the courts, government agencies, district paper-based documents, local people and local leaders at Village, Cell and Sector levels.

District officers can access to land information stored in LAIS by making requests to the two district officers who are authorized by RNRA to access to LAIS namely Acting Director and Lawyer of IOSC unit. They can also request for land information to the staff responsible for LAIS in Karongi District (LAIS Processor and GIS Professional) or other professionals working in the ORLT in the Western Province. Even though two district officers are authorized to access to LAIS and deliver land information to other district officers, this access is exclusively limited to the textual component of the system. This means that they can only access to textual information in LAIS at the district level. To get spatial information, they have to make requests to GIS Professional at the ORLT at a provincial level like other district officers.

Land information delivered by LAIS plays a certain role in land management activities. In forestry, LAIS is used to identify sites to be forested, parcels located within each site, their sizes and owners. The parcel area is used to know the number of trees to be planted. In expropriation and public infrastructure construction, land information concerning the area, land use and location of parcels supports property valuation while the information related to land ownership is used to know the rightful owners of the land. In addition, LAIS supports all the activities associated with the development of rural settlement sites such as delineation of boundaries of the site, elaboration of layout plans, demarcation of roads and parcels, construction of basic infrastructures and roads servicing each parcel and construction of residential houses by interested citizens. Furthermore, LAIS also supports the construction permitting by providing parcel-related information required to deliver building permits to the applicants. Note that land transactions subsequent to the implementation of each land management activities such as parcel subdivision and merge, parcel exchange, sale, and land transfers caused by expropriation are also updated through LAIS. The study found that construction of public infrastructures, expropriation and the development of rural settlement sites use more land information from LAIS than other land management activities. The implementation of agriculture and environment protection-related activities exclusively relies on other sources of land information rather than LAIS.

6.2.4. Specific objective 4: Understand how district officers perceive the role of LAIS in land management activities

District officers have differing perceptions towards the type of land information provided to them by LAIS. Some district officers are satisfied by the amount and type of land information they acquire from LAIS. Others district officers express their dissatisfaction towards the amount of land information provided to them by LAIS because this system does not deliver to them all land information they need for the implementation of land management activities. The missing datasets include land value, buildings, improvements made on the land, perennial crops, roads and their land reserves, water and electricity supply networks, and optical fibre network. They use other sources of land information to find such information which is not available in LAIS. Almost all the district officers share the same view that the acquisition of land information from LAIS is simple and fast because they request orally land information and get it immediately. This is the case of district officers that share the IOSC office. However, for requests concerning big data (attribute and spatial information requiring long processing time), procedures become long and time-consuming because district officers have to follow formal procedures governing the provision of land information. When it comes to data requiring advanced queries, requests for land information are sent to RNRA head office in Kigali, the capital city of Rwanda, to be processed by IT Professionals. Such procedures are not simple on both Karongi District and the ORLT sides.

Access to LAIS at the district level is challenging for district officers because they don't have access to the system except the two officers working in IOSC unit. Even the two district officers who have access to LAIS are only limited to the textual component of the system. They don't have access to the spatial component of LAIS. Regarding the quality of land information, district officers perceive that cadastral data stored in LAIS are complete, relatively accurate but not updated. All district officers who use land information delivered by LAIS perceive that the introduction of LAIS at district level has improved their working conditions in comparison with the situation before LAIS. However, further improvements are required so that LAIS could optimally support land management activities at district level. To achieve this goal, district officers suggested that there should be a short workflow for the provision of land information to district officers, permanent connection and access to LAIS for the benefit of the district officers concerned by land management activities, enough ICT infrastructures, incorporation of additional datasets in the databases of LAIS, progressive upgrading and updating of cadastral data coupled with data sharing between LAIS and other information systems containing relevant data for district officers.

6.3. General conclusion

The purpose of this research was to examine the role of the Rwandan LAIS in support of land management activities performed at the district level. The study was undertaken after almost two years since the introduction of LAIS in Karongi District. Findings showed that the system is not fully known and used by all district officers who may need it for the acquisition of land information required for the implementation of land management activities. They also showed that not all required land information can be found in LAIS. Conventional ways of acquisition of land information continue to be important. Users of land information delivered by LAIS prefer the informal way of requesting information from their fellow colleagues in the IOSC office and the staff working in the ORLT at provincial level. The identified bottlenecks mentioned above should be seen as part of this transitional stage towards the full implementation and use of LAIS at the district level. It was noticed that the use of LAIS as a source of land information is in the transitional period between the traditional ways of acquisition of land information and the new way using LIS. However, the lesson learned from this exploratory research specific to Karongi District showed that LAIS is playing a role in land management activities and has improved working conditions of district officers compared to the past.

6.4. Limitations of the study

This case study was conducted in 1 out of 30 districts of Rwanda by using structured, semi-structured and focus group interviews. Structured interview with 11 district officers was the main source of data collected during the fieldwork. Data about the development and use of LAIS were provided by 1 manager of LAIS in RNRA head office and 2 staffs (LAIS Processor and GIS Professional) responsible in charge of LAIS for Karongi District. The applied methodology provided a deep understanding of how LAIS is being used to supply land information to district officers when they are implementing different land management activities for the specific case of Karongi District. However, results came from a limited number of research participants and might not be generalized to all the 30 districts of Rwanda where LAIS is being used for the implementation of land management activities. This limitation may affect to some extent the validity of the results. However, as an exploratory case study, it provided a good insight for further research. It is therefore necessary to expand this study to other districts in order to get a broad view of the contribution of LAIS in land management activities performed at the district level.

6.5. Recommendations

Based on findings derived from this case study, the following recommendations are formulated:

- As some district officers do not know LAIS as a source of land information, it is important to conduct awareness raising and sensitisation about the use of LAIS at the district level.
- Secure internet connection and IT equipment need to be in place to facilitate online access to LAIS by all district officers.
- Authorize district officers to access both textual and spatial information in LAIS given the importance of land information in land management activities at the district level.
- Customer satisfaction survey to improve the LAIS should involve all the users and customers of land information in Rwanda.
- Adopt policies and laws that regulate access to land information in Rwanda given that LAIS stores a big amount of data that need to be accessed and used by a wide range of users and customers for different purposes.

For future research, it is recommended the following areas:

- The study examined the role of land information delivered by LAIS in land management activities performed by district officers by taking one district as a case study. This exploratory research revealed some important bottlenecks mentioned above. Therefore, future research should ascertain if the identified issues and problems are recognisable in other districts of Rwanda or whether they are part of the transitional situation from analogue to digital ways of acquisition of land information.
- Further studies should investigate why LAIS is not known and used by some district officers and why different sources of land information are being used apart from LAIS.
- Research should analyse how best to involve customers in the determination of the types of land information that LAIS should provide to the users and customers.
- Future research could also examine how land information delivered by LAIS is accessible to different categories of users and possible factors that drive access to land information in Rwanda.

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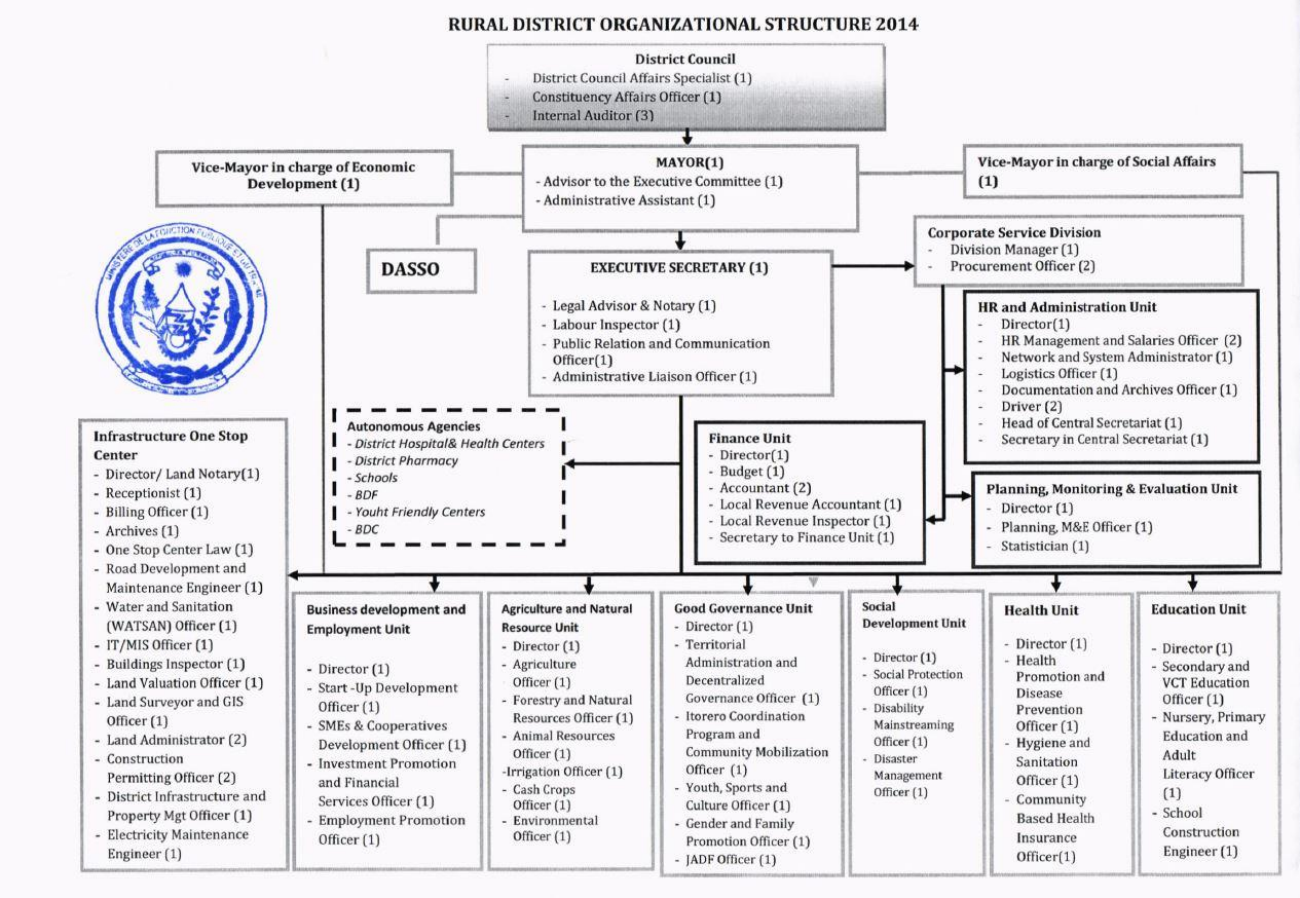
LIST OF APPENDICES

Appendix 1: Organizational structure of rural District in Rwanda



Appendix 2: Structured interview with district officers

1. Introduction

I would like to thank you for taking your time to meet with me today. My name is Muhimpundu Janvier, I am conducting a research on "The Land Administration Information System in support of land management: A Case Study of Karongi District". I would like to get from you information about the role of the land information provided by Land Administration Information System (LAIS) in land management activities you perform in your daily work as a district professional. The interview would take approximately 40 minutes. I will be recording the interview because I do not want to miss any of your comments. The same time, I will be taking some notes about our conversation. The responses from this interview will be kept confidential and only used for the purposes of this research. I assure you that any information I will include in the final report will not identify you as a respondent. Are you willing to participate in this interview?

2. Identification of respondent

Interviewee names: .....
District: .....
Unit: .....
Name of the post occupied: .....
Experience on the post in Karongi District: .....
Date of interview: .....10/2015 Start time: .....End time: .....

3. Questions for interview

3.1. Use of land information from LAIS in the execution of land management activities

1) Do you use land related information provided by LAIS in your daily work?
   - ☐ Yes
   - ☐ No
2) a) If yes, which types of land-related information (datasets and attributes) do you use?
   b) If no, why don't you use land information delivered by LAIS?
3) How many requests for land information delivered by LAIS do you make in a month?
4) By which ways do you access to land information provided by LAIS?
5) Do you use other sources of land information apart from LAIS in your daily work?
   - ☐ Yes
   - ☐ No
6) If yes, which other sources of land information do you use in your daily work?
7) Which land related activities have you been conducting in your service from 2014 up to 2015?
8) How many parcels were affected by each land management activity?
9) Which changes did each activity cause to the parcels?
10) Did the land management activity change the land ownership?
    - ☐ Yes
    - ☐ No
11) If yes, which landownership changes did the land management activity caused?
12) Did the land management activity change the duration of land rights?
    - ☐ Yes
    - ☐ No
13) If yes, which changes did the land management activity cause in terms of the duration of land rights?

14) How many landowners were affected by the activity?
15) Which types of land information (datasets & attributes) do you request from LAIS to execute your activities?
16) In which ways do you request for land information?
17) In which data format is the land information delivered?
18) Do you have to make some conversions/transformations of data from LAIS before using it for your land management activity?
    - ☐ Yes
    - ☐ No
19) Did you manage to find in LAIS all the information you needed to perform land management activities?
    - ☐ Yes
    - ☐ No
20) If no, which types of land information did you miss in LAIS?
21) At which stages of the land management activity do you need land information from LAIS?
22) How do you use received the land information in the execution of each stage of land management activity?

3.2. Perceptions of District officers about land information provided by LAIS

23) To which extent are you satisfied with the amount of information provided to you by LAIS in comparison with your information needs for land management activities?
24) How do you rate the amount of information delivered to you by LAIS in comparison with your information needs for land management activities?
25) In your opinion, how do you perceive the procedures required to get land information from LAIS?
26) How do you rate the time required to get requested land information from LAIS?
27) How do you rate the ways to access to land information delivered by LAIS by District officers?
28) In your opinion, do you find the land information provided by LAIS updated?
29) Do you find the land information provided by LAIS accurate enough to help you to accomplish your land management activities?
30) To what extent is the land information provided by LAIS complete?
31) How did you get land information needed in land management activities before the introduction of LAIS at District level?
32) In your view, by comparing the situation before and after the introduction of LAIS at District, which improvements did the LAIS bring in your work related to land management activities?

Appendix 3: Structured interview with LAIS Processor and GIS Professional

1. Introduction

I want to thank you for taking your time to meet with me today. My name is Muhimpundu Janvier, I am conducting a research on "The Land Administration Information System in support of land management: A Case Study of Karongi District". I would like to get from you information about the use of Land Administration Information System (LAIS) in Karongi District. The interview would take approximately 40 minutes. I will be recording the interview because I do not want to miss any of your comments. The same time, I will be taking some notes about our conversation. The responses from this interview will be kept confidential and only used for the purposes of this research. I assure you that any information I will include in the final report will not identify you as a respondent. Are you willing to participate in this interview?

2. Identification of respondent

Interviewee names: .....
Organization: .....
Unit: .....
Name of the post occupied: .....
Date of interview: .....10/2015 Start time: .....End time: .....

3. Questions for interview

3.1. Overview on the use of LAIS at District level

1) When (Date, month and year) was LAIS operational in Karongi District?
2) How many staff is employed by LAIS in Karongi District?
3) What is your role in LAIS?
4) What are the external users of land information delivered by LAIS in Karongi District?
5) Which activities do you perform with LAIS?
6) Among these activities, which ones do you frequently perform with LAIS?
7) What are the requirements a customer has to fulfil to get land information delivered by LAIS?
8) What are the procedures required to customers to get land information from LAIS?
9) How many days does it take to get requested land information?

3.3. Use of LAIS to deliver land information to district officers

10) Do district professionals request for land information from LAIS?
    - ☐ Yes
    - ☐ No
11) If yes, how many requests from district professionals do you receive per month for the period of 2014 - 2015?
12) Which types of land information (datasets and attributes) do they request for?
13) In which data formats do you deliver to them the information they request?
14) In which units of the district do requests come from?
15) In which services of Karongi District do requests come from?
16) What are the procedures required to district officers to get land information from LAIS?
17) How long does it take to deliver the requested land information to district officers?
18) What are the challenges do you face related to the use of LAIS to supply land information to the customers?

Appendix 4: Semi-structured interview with LAIS technician in Rwanda Natural Resources Authority

1. Introduction

I want to thank you for taking your time to meet with me today. My name is Muhimpundu Janvier. I am conducting a research on "The Land Administration Information System in support of land management: A Case Study of Karongi District". I would like to get from you information about the historical development and use of LAIS at the national level. The interview would take approximately one hour. I will be recording the interview because I do not want to miss any of your comments. The same time, I will be taking some notes about our conversation. The responses from this interview will be kept confidential and only used for the purposes of this research. I assure you that any information I will include in the final report will not identify you as a respondent. Are you willing to participate in this session?

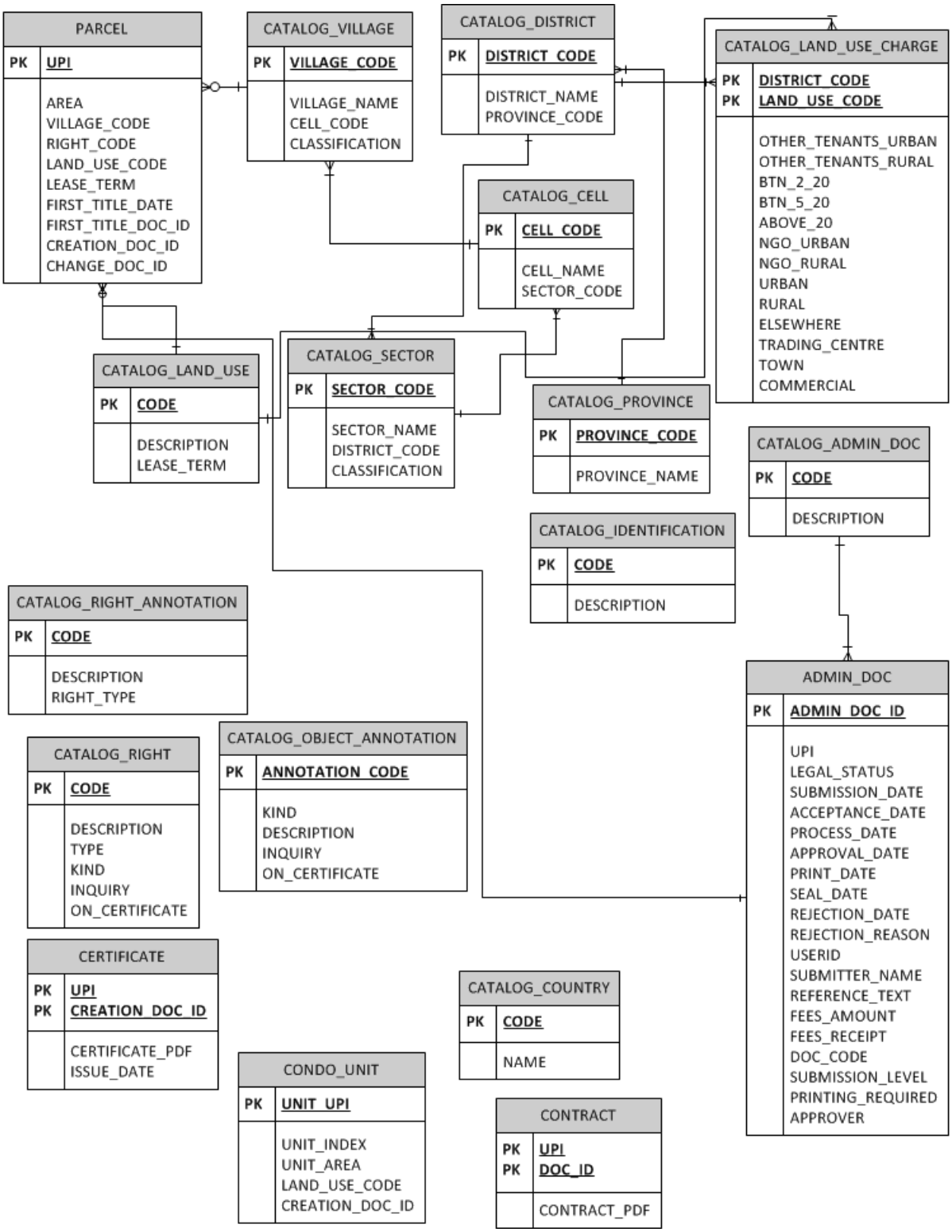
2. Identification of respondent

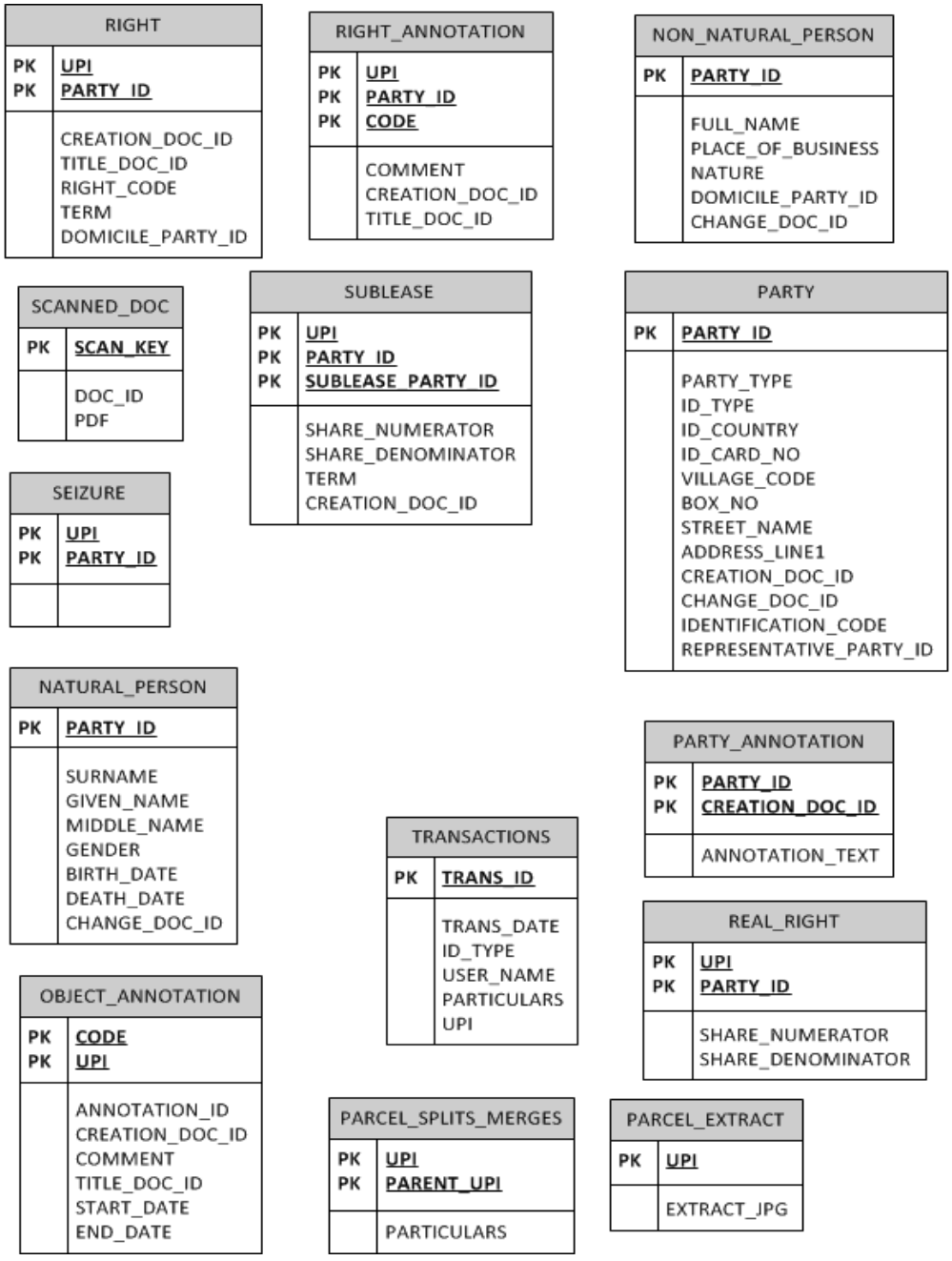
Interviewee names: .....
Organization: .....
Unit: .....
Name of the post occupied: .....
Date of interview: .....10/2015 Start time: .....End time: .....

3. Questions for interview

1) What is the history of LAIS?
2) What are the user requirements of LAIS and how were they identified?
3) Which data sets and attributes does LAIS store?
4) How many land parcels does LAIS store nowadays and how are they distributed per District and per Province?
5) Was LAIS renewed? If yes, how many times was it renewed and why?
6) What are the users of LAIS and what are their roles in the system?
7) What are the external users of land information delivered by LAIS?
8) With which organizations does RNRA share land related data stored in LAIS?
9) By which ways does RNRA share land related data with these organizations?
10) What are the challenges does LAIS face nowadays?

Appendix 5: Database schema of LAIS in PostgreSQL





Source: RNRA, October 2015

Appendix 6: Number of parcels stored in LAIS per District and per Province

N⁰	District	Number of parcels
1	Nyarugenge	74,498
2	Gasabo	228,392
3	Kicukiro	86,426
Number of parcels/City of Kigali		**389,316**
4	Nyanza	316,012
5	Gisagara	375,890
6	Nyaruguru	472,427
7	Huye	367,526
8	Nyamagabe	484,881
9	Ruhango	393,347
10	Muhanga	414,311
11	Kamonyi	393,078
Number Of Parcels/Southern Province		**3,217,472**
12	Karongi	460,251
13	Rutsiro	507,194
14	Rubavu	385,264
15	Nyabihu	425,597
16	Ngororero	545,943
17	Rusizi	373,640
18	Nyamasheke	459,003
Number of parcels/Western Province		**3,156,892**
19	Rulindo	424,157
20	Gakenke	600,778
21	Musanze	492,569
22	Burera	569,059
23	Gicumbi	581,524
Number of parcels/Northern Province		**2,668,087**
24	Rwamagana	269,162
25	Nyagatare	246,948
26	Gatsibo	370,324
27	Kayonza	264,566
28	Kirehe	259,012
29	Ngoma	301,518
30	Bugesera	274,557
Number of parcels/Eastern Province		**1,986,087**
Total number of parcel/Rwanda		**11,417,854**

Source: RNRA, October 2015

Appendix 7: List of research participants

N⁰	Post	Unit/Department	Organization	Number
1	Acting Director	Infrastructures One Stop Centre Unit	Karongi District	1
2	Agriculture Officer	Agriculture and Natural Resources Unit	Karongi District	1
3	Environment Officer	Agriculture and Natural Resources Unit	Karongi District	1
4	Forest and Natural Resources Officer	Agriculture and Natural Resources Unit	Karongi District	1
5	Cash Crops Officer	Agriculture and Natural Resources Unit	Karongi District	1
6	Building Inspection Officer	Infrastructures One Stop Centre Unit	Karongi District	1
7	Land Valuation Officer	Infrastructures One Stop Centre Unit	Karongi District	1
8	Road Development and Maintenance Engineer	Infrastructures One Stop Centre Unit	Karongi District	1
9	One Stop Centre Lawyer	Infrastructures One Stop Centre Unit	Karongi District	1
10	Infrastructures and Property Management Officer	Infrastructures One Stop Centre Unit	Karongi District	1
11	Territorial Administration and Decentralized Governance Officer	Good Governance Unit	Karongi District	1
12	LAIS Processor	Department of Land and Mapping	RNRA	1
13	GIS Professional	Department of Land and Mapping	RNRA	1
14	Software Development Engineer	Management Information System and IT Support Unit	RNRA	1
Total				**14**

Appendix 8: Distribution of the users of LAIS per roles

Roles in LAIS	**Number of users per role**				
	RNRA head office	RNRA zonal office	RNRA staff in districts	District staff	Total
View	30	10	2	41	**83**
Printer	1	1	0	0	**2**
Approver	2	4	0	0	**6**
Booker, Acceptor, Processor	35	4	8	1	**48**
Booker, Acceptor, Processor, Printer	3	8	11	0	**22**
Booker, Acceptor, Processor, Printer, Sealer	6	10	5	0	**21**
Booker, Acceptor, Processor, Printer, Sealer, Supervisor	1	0	0	0	**1**
Booker, Acceptor, Processor, Sealer	4	0	0	1	**5**
Total	**82**	**37**	**26**	**43**	**188**

Source: RNRA, October 2015