

# **Land Tenure Regularisation in Rwanda: the outcome for agricultural land use change in peri-urban Kigali**

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## **Errata**

### **Citation 1**

In-text citation on page 9, Section 2.4 paragraph 1, line 14, should be in the text as (Deininger *et al.*, 2010), not (Deininger, 2010).

In-text citation on page 9, Section 2.5 paragraph 1, line 4, should be in the text as Deininger *et al.* (2010) not Deininger, (2010).

In-text citation on page 9, Section 2.5 paragraph 1, line 13, should be in the text as (Deininger *et al.*, 2010), not (Deininger, 2010).

### **Citation 2**

In-text citation on page 9, section 2.6, paragraph 1, line 2, should be in the text as Sultana and Powell (2010), not Sultana (2010).

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In-text citation on page 12, section 2.9, paragraph 4, line 7, should be in the text as (Sultana & Powell, 2010), not (Sultana, 2010),

In-text citation on page 19, section 4.2, paragraph 3, line 2, should be in the text as Sultana and Powell (2010), not Sultana (2010).

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### **Citation 3**

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In-text citation on page 10, section 2.6, paragraph 2, line 4, should be in the text as Meyer and B. L. Turner (1994) not Meyer (1994).

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In-text citation on page 10, section 2.6, paragraph 2, line 9, should be in the text as Meyer and B. L. Turner (1994) not Meyer (1994).

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In-text citation on page 11, section 2.7, paragraph 2, line 3, should be in the text as Meyer and B. L. Turner (1994) not Meyer (1994).

### **Citation 4**

In-text citation on page 11, section 2.7, paragraph 3, line 11, should be in the text as (Aspinall & Hill, 2008) not (Aspinall, 2008).

### **Citation 5**

In-text citation on page 19, section 4.2, paragraph 1, line 12, should be in the text as Darke *et al.* (1998) not Darke (1998)

### Chapter section

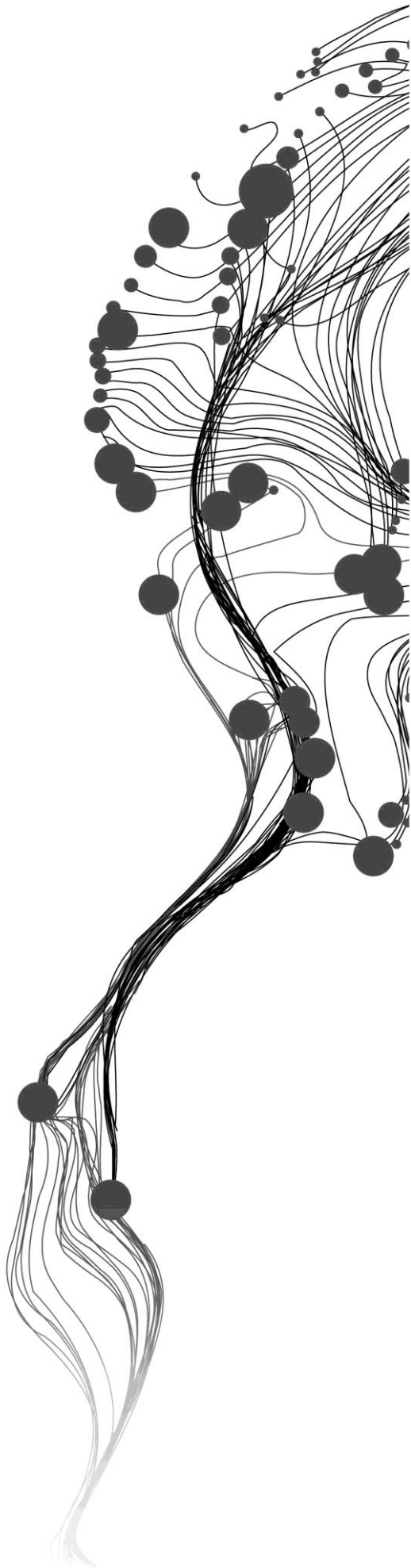
Chapter 5, section 5.3 paragraph 4 line 2 should be (section 4.7.2) not (section 4.6.2) and line 3 should be (section 4.5.6) not (section 4.5.4).

Chapter 5, Section 5.2.2 Paragraph 1, Table 5.2: number of respondents is 22 (88%) not 23 (typographical error).

### List of References

- Aspinall, R. J., & Hill, M. J. (2008). *Land Use Change: Science, Policy and Management* Boca Raton: CRC Press.
- Darke, P., Shanks, G., & Broadbent, M. (1998). Successfully completing case study research: combining rigour, relevance and pragmatism. *Information Systems Journal*, 8(4), 273 - 289.
- Deininger, K., Augustinus, A. C., Enemark, S., & Munro-Faure, P. (2010). *Innovations in Land Rights Recognition, Administration and Governance: Joint organizational discussion paper issue 2 : proceedings from the annual conference on land policy and administration*. Washington D.C.: The World Bank.
- Meyer, W. B., & Turner, I. (1994). *Changes in land use and land cover: a global perspective* W. B. Meyer, & BL Turner, II (Ed.) (pp. 537). Retrieved from [http://books.google.nl/books/about/Changes\\_in\\_Land\\_Use\\_and\\_Land\\_Cover.html?id=X1pNRW6r0BoC&redir\\_esc=y](http://books.google.nl/books/about/Changes_in_Land_Use_and_Land_Cover.html?id=X1pNRW6r0BoC&redir_esc=y)
- Sultana, S., & Powell, W. (2010). Land use. In B. Warf (Ed.), *Encyclopedia of geography* (pp. 1727-1733). Thousand Oaks, CA: SAGE Publications, Inc.





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Specialization: Land Administration

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#### DISCLAIMER

This document describes work undertaken as part of a programme of study at the Faculty of Geo-Information Science and Earth Observation of the University of Twente. All views and opinions expressed therein remain the sole responsibility of the author, and do not necessarily represent those of the Faculty.

This work is dedicated to my enduring wife Olukemi Adebisi Fosudo and my children Oluwafisayo, Oluwafadekemi, Adefolarin and Mofehintoluwa.





## ABSTRACT

The impact of land tenure have not been adequately assessed in land use change studies. Many studies have discussed various driving forces of land use/land cover change and the resultant impacts, but have not identified secure tenure as a driving force. Secure tenure influences landowner (Actor) in making land use decision that results in land use change (Change). There is a need to study every aspect of human-environment relationship, especially to ensure sustainable land administration. Therefore, this research focuses on the assessment of the outcome of agricultural land use change, which occurred due to impact of secure tenure derived from land tenure regularisation (LTR) in Rwanda. The study identifies how statutory land right derived from land tenure regularisation program motivates the landowners' land use decision-making leading to land use change. The study uses Remote Sensing/Geographic Information Systems' change detection method to assess the spatiotemporal agricultural land use changes which take place in the peri-urban area of Kigali, Rwanda. This method is applied to explain the land use dynamics between 2008 and 2013. In order to detect changes, cadastral map of the study area was overlaid on the raster Ortho-photo image of 2008 and Google image of 2013. Cluster selection was done for different land use classifications (built, partly built and vacant). Statistical analysis was done using the ArcMap statistics generator tool to derive the total land area in each constructed map. This was used for comparative parcel/land size analysis. The results revealed that, within the 5 years, a total of 2074 agricultural parcels out of 3562 total parcels in the study area changed to 1080 parcels making a loss of 994 agricultural parcels. In terms of land size, this translates to 457.5 hectares out of a total land size of 1144 hectares in the study area changed to 354.5 hectares making a loss of 103 hectares of agricultural land size. The relationship existing between the land tenure regularisation and land use change was also evaluated through interviews, and the result revealed a high significance influence of secure tenure on landowners toward land use decision making, leading to land use change.

### Key words

agricultural land, change detection, land tenure regularisation, land use change, secure tenure.

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## LIST OF ACRONYMS

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DLB	District Land Bureaux
FAO	Food and Agricultural Organisation
GIS	Geographic Information Systems (Science)
GLP	Global Land Project
GoR	Government of Rwanda
LAIS	Land Administration Information System
LAS	Land Administration System
LCC	Land Cover Change
LUC	Land use Change
LUCC	Land use /cover change
LULC	Land use / land cover
LTR	Land Tenure Regularisation
NAFA	National Forestry Authority
NLC	National Land Centre
NLP	National Land Policy
OGMR	Rwanda Geology and Mines Authority
OLL	Organic Land Law





# 1. INTRODUCTION

## 1.1. Background and Justification

Generally, land tenure regularisation (LTR) or formalisation programs are targeted at ensuring tenure security on land, through the formalisation of informal occupation. According to Williamson *et al.* (2010), formalisation involves a holistic approach which is usually carefully designed to support all categories of land management systems. Therefore, a well designed and implemented regularisation program requires sustainability. This can only be achieved by constantly monitoring and ensuring that land administration objective which include, "*recording and disseminating information about ownership, value, use and development of land when implementing land management policies*", are achieved (Williamson *et al.*, 2010).

However, security of tenure relates to the degree of recognition and guarantee of property rights, which is hinged on two major components that include the "*duration of rights and effective legal protection against eviction*" (UN-Habitat, 2008). It is observed that the implementation of the LTR program has impacts on the people and the general landscape particularly as the security of tenure influences land use decision-making and consequently land use change (Farley *et al.*, 2012; Wannasai & Shrestha, 2008). Many land use changes are thus based on the premise that tenure security gives the individual various rights such as; right to use, transfer, lease, lend or alienate, etc. Moreover, the use right can be for different purposes that encourages investment and enhance agricultural productivity, ensure optimal use of natural resources, promote leasing, and reduce possible conflicts which results from undefined tenure (Farley *et al.*, 2012), and lead to land use change.

Changes resulting from the LTR and land use can thus be seen as multivariate (Farley *et al.*, 2012; Hersperger & Burgi, 2010), and this comes in the form of changes that can also be categorised as both "*physical and ownership fragmentation of landscapes*" (Farley *et al.*, 2012). Meanwhile, changes that relate to physical fragmentation can be attributed to land use/land cover (LULC) change due to agricultural practices, climate change impacts as well as expansion of urban areas due to population dynamics. Other changes that relate to ownership fragmentation can be regarded as changes which occur in land ownership including absolute transfer of rights, alienation through subdivision, as well as conversion of use (Farley *et al.*, 2012). All these can be related to secure tenure, which consequently influences decision making.

In Rwanda, secure tenure was not guaranteed prior to 2003 because, since the pre-colonial era, land holding was administered under a customary land tenure system, while, during the colonial period the legal system was used, mainly in favour of the colonial masters. This resulted in a dual system. Although the customary land tenure was dominating, it conferred inadequate tenure security on the citizens (Payne, 2011). The LTR program brought the conferment of rights and secure tenure to the citizens. The preparation of National Land Policy in 2004, and Organic Land Law (OLL) in 2005 allowed the Ministry of Land, Environment, Forestry, Water and Natural Resources (MINITERRE) to embark on complete field discussions across Rwanda. This eventually resulted in absolute systematic registration of the country and defined the status of all landowners (Payne, 2011) as well as giving adequate land rights.

The securitization of tenure in Rwanda as a national program thus led to the issuance of approximately 8.4 million land titles to the citizens (Kanyesigye, 2013). This has enhanced dynamic land use changes both in the urban and peri-urban areas. Amongst these are the changes from agricultural land to other uses, such

as residential housing, commercial etc., as the case may be. Therefore, the implication of these changes requires a check to ascertain an alignment or a derailment from the overall objective of land administration that is, sustainable development.

This research, therefore, seeks to assess the impact of the LTR program on land use particularly the resultant changes that occur on agricultural lands. Specifically it intends to examine the case of the peri-urban area of the Gasabo district, Kigali city, Rwanda. The study area is located in Kinyaga and Masoro both cells within Gasabo district, Kigali city and the area is described in chapter 4, figure 4.1.

## **1.2. Research problem**

The land tenure regularisation program is intended to ensure formalisation of titles and absolute tenure security so as to enhance the land rights of the citizens. However this security of tenure conferred on the citizens, a bundle of rights in consonance with existing legislation (Durand-Lasserve & Selod, 2009; Zevenbergen, 2002). Thus, the interplay between the extent of the right and the resultant effect of decisions made by the right holder is of importance. What then are the impacts of the decisions made by the right holders on their environment or land use in terms of the changing pattern of the urban landscape?. Considering the Global Land Project, (GLP) according to Veldkamp (2009) every aspect of human-environment relationship should be studied, this is necessary to understand the way humans react to certain situations when they feel secured and this in essence forms the crux of this research.

It is observed that previous studies on land use change addressed the issues of LULC change between different periods to know the impact of agrarian reform on LULC change (Farley *et al.*, 2012). Meanwhile, Serneels and Lambin (2001) discussed issues regarding the causes of land use change with a view to developing statistical analysis in order to enhance general understanding of land use change. Others (Mena *et al.*, 2006; Mottet *et al.*, 2006) determined the impact of demographic and socio-economic drivers, geo-biophysical factors to enhance understanding of causes and effect of LULC changes. Farley *et al.* (2012) also looked at the effect of the change in tenure and agrarian conservation reform on LULC change.

However, there appears to be limited works, if any that study whether secure tenure that is derived from LTR leads to agricultural LULC change. This research evaluates the impact of the secure tenure on agricultural land use change, particularly in the peri-urban areas where there seem to be high competition for land and land use. It also reflects on secure tenure and landowners motivation to change land use.

## **1.3. Research objectives**

### **1.3.1. Main objective**

The main objective of this research is to assess the impact of the LTR program on agricultural land use change within the peri-urban area of Gasabo district of Kigali, Rwanda.

### **1.3.2. Sub objectives**

- 1 Examine the effect of the Rwandan LTR program on land rights in the study area.
- 2 Determine how agricultural land use has changed in the study area over a selected epoch.
- 3 Determine if a causal relationship exists between LTR and LUC.

## **1.4. Research questions**

### **1.4.1. Question for sub objective 1**

- (a) What are the types of right held before the land tenure regularisation program?

- (b) What is the nature of rights held following the land tenure regularisation program?
- (c) What impact did the rights have on the decision-making of landowners?

**1.4.2. Question for sub objective 2**

- (a) What was the extent of agricultural land use in the study area in 2008 at the beginning of the LTR program?
- (b) What is the extent of agricultural land use in the study area in 2013, when the regularisation program has been completed?
- (c) What is the difference in agricultural land use between the two periods? (i.e. actual change that occurred).

**1.4.3. Question for sub objective 3**

What is the outcome of the relationship between the LTR program and land use change as a result of the exercise of rights held by the landowners on agricultural land use?

**1.5. Conceptual Framework**

It is pertinent to note that many phenomena are better explained based on concepts. This research will thus not be an exception. Meanwhile, the land use phenomenon is one complex system which requires a multidisciplinary approach and its modelling should consider the peculiarities of the study especially in representing the drivers in the model (Veldkamp, 2001) as reflected in figure 1.1. However, the phenomenon of land use change of this research is hinged on land tenure and land use concept. The land tenure through the LTR program leads to secure tenure for landowners, which serves as a driving force (DF). Also, the land use takes on human activities on land and considers the conversion over time result in a change (LUC).

According to Hersperger *et al.* (2010), *"the major components of the land use change model are; Driving forces, Actors and Change. Driving forces are identified as those forces that together with actors shape land change especially as they constitute a complex system of dependencies and interactions and affects the whole range of temporal and spatial level. Actors are identified as decision makers and can be referred to as individuals, agencies, and institutions"*. They are further categorized as those which affect the driving force or those which change land directly. Four models are thus developed by Hersperger *et al.* (2010) which includes; (1) Driving Force-Change (DF-C), (2) Driving Force - Actor - Change (DF-A-C), (3) Driving Force Actor - Change (DFA-C), and (4) Actor-Change (A-C) each with its own characteristics. For the purpose of this research, the Actor-Change (A-C) model is adopted. Meanwhile, model selection usually requires an assessment of the model's characteristics particularly considering the model's suitability to the study. The characteristics include amongst others the following components to make a choice; study aim, the study area's geographical extent, volume of land use and owners as well as the data (Briassoulis, 2000).

In this research, going by the characteristics identified above and the guideline stated by Hersperger *et al.* (2010) the following consideration were made in model selection. As regards the aim of this study, firstly, the actors' behaviour and decision-making resulting to land use is based on secure tenure that the actor derived through the LTR program as a statutory intervention, was considered. Secondly, the study area's geographical extent which is a considerable coverage of two cells in two different sectors of Gasabo district. Thirdly, in terms of volume of land use and owners, the parcels, land size and owners that are directly affected are given considerations during data collection process. Lastly, concerning data, consideration was given to the actors' behaviour and land change data. The actor is considered as important in this study, since it is the actor's reasoning and values that constitute the major criteria influencing the pattern of land use. The driving force is hereby recognized as an influence on the actor. It

is the element that forms the idea or basis of the actors decision making. All these characteristics were considered to make a choice of Actor - Change model amongst the four models proposed.

In relation to this research, the following are hereby identified; the driving force being the secure tenure (land title or rights held) which resulted from the LTR, while the actor is the landowner. The secure tenure serve as evidence that motivates the actor to make certain decisions on land use (based on the value attributed to the secure tenure). The agricultural land use that changed to other uses residential/housing, industrial, educational, etc. The transformation zone of the peri-urban area of Gasabo district of Kigali is the focus of this study area. This research, therefore, assess the situation arising from this secure tenure (i.e. the issuance of land title to landowners through the LTR program) and the impact on land use as well as the extent of change that resultantly occurred due to these land uses. An adaptation of this concept is thus expressed in the figure 1.1 whereby 1a, shows the concept as proposed by Hersperger *et al.* (2010) and 1b, shows its adaptation to this research.

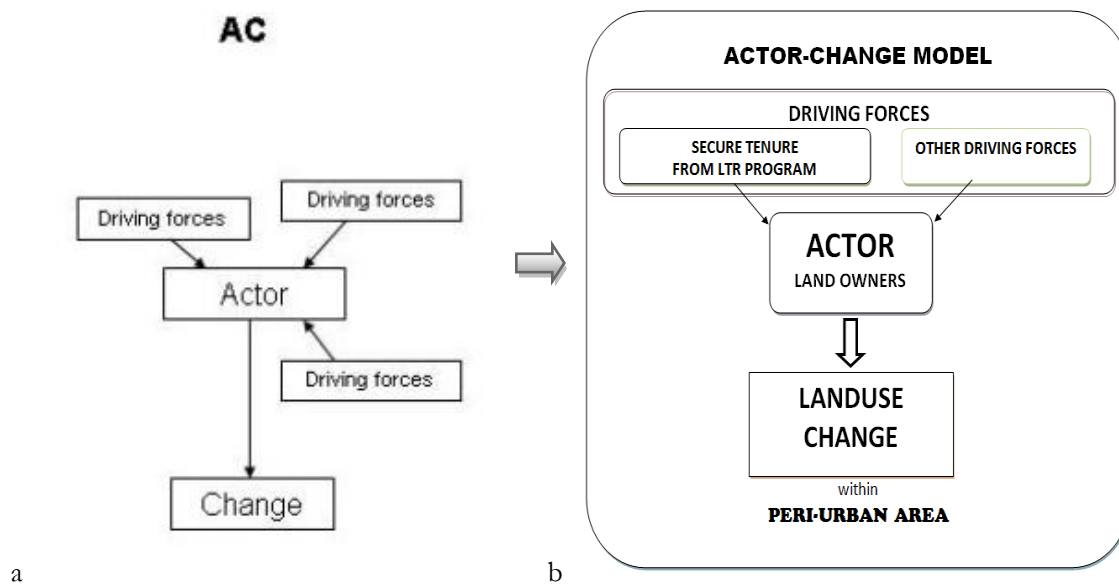


Figure 1.1: Conceptual framework: The Actor-Change model

An adaptation of Hersperger *et al.* (2010), linking land-use change with driving forces and actors.

In figure 1.1 above, the model according to Hersperger *et al.* (2010) states that the driving force influences the Actor who in turn makes the decision on land use leading to change. This is adapted in Figure 1.1(b) which equally has the driving force influencing the landowner being the actor to make land use decision leading to change and particularly within the peri-urban area in this case being the study area.

## 1.6. Overview of research stages

The research follows a three-stage plan as discussed below.

### 1.6.1. Pre fieldwork stage

This involves the formulation of research objectives and research questions and derivation of strategies. A review of the literature was conducted to adopt appropriate concepts and definitions relating to the research. This includes preparation of the research proposal, the preparation of interview questions for the different groups i.e. the landowners and government officials.

### **1.6.2. Fieldwork data collection stage**

Field work schedule: The fieldwork took place in Kigali. A total of 19 working days was scheduled for field data collection. This includes 10 days for official government protocols and interview of government officials, collection of some other relevant documents/data and attendance of Kigali master plan presentation. Also, 4 days were used for reconnaissance and field inventory, 3 days for the interview of 25 landowners of the two cells, while transcriptions, reviews and cross checks of data gathered were done for 2 days.

### **1.6.3. Post field work stage**

This stage of the research is meant for collation, analysis and interpretation of the data collected. This results in visualisation and discussion while the findings are made available in the thesis report.

## **1.7. Study constraints**

Like many others, this research also had some constraints which include;

- Language barrier and low literacy level are major constraints which were overcome with the aid of a translator who knows how to read, write and speak Kinyarwanda.
- Government bureaucratic protocol, delays in getting letter from the district Mayor, availability of the government official for interview and collection of official government documents.
- Time constraint is another issue whereby delays caused by government bureaucratic set up made other data collection extend beyond expectations. Also, attendance of the Kigali city master plan presentation and additional interview conducted in some government agencies took extra time.
- Non availability of many landowners for interview during the week (Monday-Friday) which made researcher to use the weekend also for interview.
- Data limitation in terms of availability of only one cadastral map that was used for the two periods under consideration. Thus, the total number of parcels derived from the cadastral map was used for the analysis in this research. Also, the research did not require to delve into the issue of subdivision of parcels because it was not part of the study objectives.

## **1.8. Thesis structure**

This research is structured into six chapters as follows:

Chapter One: Introduction, which gives a general overview of the background and justification of the research, is treated in this chapter. It includes the research problems, research objectives stating the follow-up sub objectives and research questions. It also includes a summary or description of the research stages stating how the thesis was carried out.

Chapter Two: The literature review which consists of the review of past works or literatures from the academics and international learned journals, textbooks on the theory and concepts of land and land administration, with direct relation to the research topic. It includes definition and concepts of LTR, tenure formalisation and security of tenure. Views on land use change and its driving forces, peri-urban change detection, is also discussed.

Chapter Three: The chapter gives a background to the Rwandan LTR program shedding light on tenure types and previous land holding systems at different periods in the past. The institutional/legal arrangements/procedures and processes of tenure regularisation program are also described.

Chapter Four: The research methodology chapter gives the details of how the research was conducted. It states the research techniques, research design and study area description. It describes; the methods, tools and techniques for collection of data, data collected, data processing and analysis as well as land use change detection method.

Chapter Five: This consists of results and findings which are derived from analysis of data collected from interviews of the landowners, the government agencies and field observations. It also contains the results of spatiotemporal analysis of the differences between previous and current extent of agricultural land use in the study area between the periods before LTR program in 2008 and after LTR program in 2013.

Chapter Six: Conclusions and recommendations in which the results are discussed while areas of further research are also suggested.

## **1.9. Conclusion**

In this chapter, an overview of the research introduction was done. This includes the research background and justification, stating the need to determine how certain driving force influences land use change. It identifies the concept of linking land use change with driving forces proposed by Hersperger *et al.* (2010) with the characteristics as they relate to the research. The main research objective is to assess the impact of LTR program on agricultural LUC. This is particularly supported by research sub objectives and questions which are all meant to guide the achievement of the main objective. However, the stages required to carry out the research and the different sections of the report are also stated.

## 2. LITERATURE REVIEW

### 2.1. Introduction

Research is laid on the bedrock of past and current concepts and theories. Therefore, this chapter consists of concise review of the literature relating to this research and takes clues from those concepts and theories which support the research content and context. Amongst these are land and land administration, tenure and land tenure, land regularisation, land use/land cover, land use change and the driving forces as well as land use classification and change detection. The different views adopted are thus harmonised in line with the research objectives as they serve as a guide to the study.

### 2.2. Land and land administration

Land is basically a major resource and an essential factor of production. It is regarded as very vital in the provision of housing, agriculture and general economic developments, while it equally forms a key basis of poverty alleviation (UN-Habitat, 2008). Therefore, it requires good administration to ensure a balanced and equitable distribution to all citizens and amongst land uses for a balanced urban-rural development. With such a balanced development, poverty will be alleviated, and citizens will enjoy a good sense of belonging. In order to ensure a good sense of belonging, access to land like many other basic human need is fundamental. This resulted in the need to ensure tenure security for all citizens. The issue of tenure security in land administration also expresses the degree of recognition and guarantee of property rights, and it particularly rests on the "*duration of rights and substantive legal protection against eviction*" (UN-Habitat, 2008).

The need for land administration thus becomes necessary based on the definition by the UNECE (2005) in Williamson *et al.* (2010), that is, "*the process of recording and disseminating information about ownership, value and use of land and its associated resources*". Also, the general nature of land and land resources as well as its administration is very essential to ensure sustainable development. This sustainability is expressed in the land administration functions as shown in figure 2.1 below, adapted from Williamson *et al.* (2010).

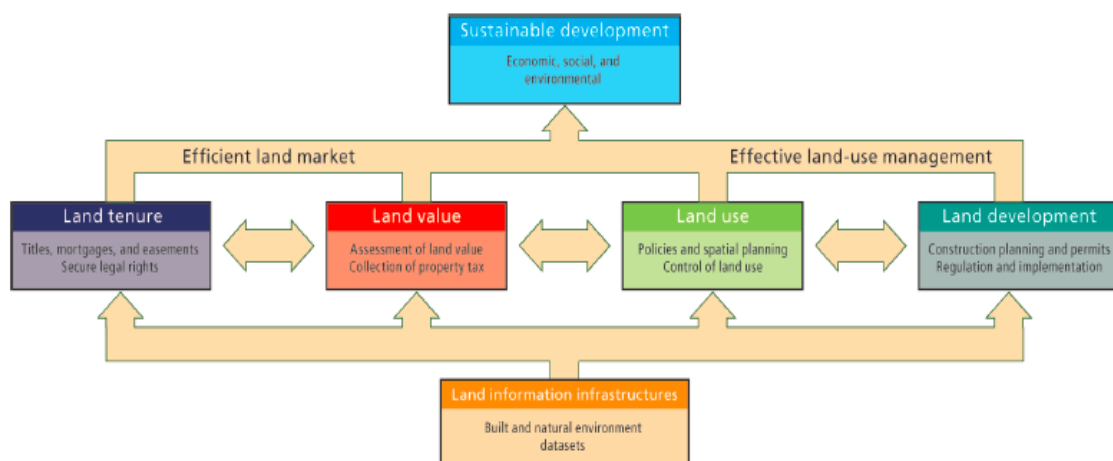


Figure 2.1: A global land administration perspective for sustainable development.

In line with the above perspective, this research looks at the land tenure and land use aspect of Land administration functions with a view to examining the tenure security and its relationship with land use change.

### 2.3. Tenure and land tenure

Tenure refers to human to land relationship. According to Ciparisse (2003), it can also be viewed as, "*the individual or group to land relationship and the associated natural resources, it can be legal or customary*". This relationship thus confers some rights and restrictions on the individual or group. Therefore, it is pertinent to note that customarily or legally, basic rules are associated with tenure, stating how the property rights are allocated within and amongst the right holders. The tenure systems also spells out modalities for use of a particular land/resource and under certain conditions. However, Williamson *et al.* (2010), defines land tenure as, "*the processes and institutions which ensure secure access to land and the system of allocation, surveying and mapping, recording parcel boundary information, modifications relating to parcel information, alienation issues through sale, lease, or credit security; and conflict management regarding ownership boundary claims*". Meanwhile, sustainable land administration is only achievable under a well defined tenure system, which is all encompassing and representational. In a bid to define the tenure system, the continuum of land rights describes the different classification under the informal and formal classification. This range from perceived tenure approaches, customary, occupancy, anti- eviction, adverse possession, group tenure, leases and registered freehold (UN-Habitat, 2008; Williamson *et al.*, 2010). Figure 2.2 below shows the continuum of land rights adapted from Williamson *et al.* (2010).

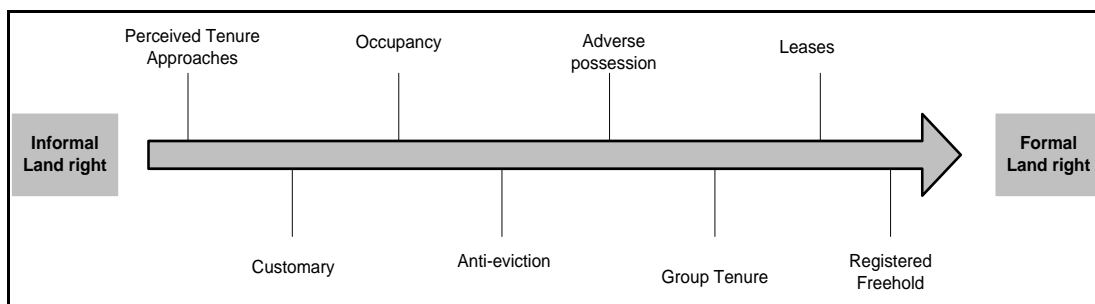


Figure 2.2: The continuum of land rights (UN-Habitat, 2008)

Also, land tenure according to Unruh (2010), Durand-Lasserve and Selod (2009) refers to the way in which social relations associate with land use and ownership. It is also viewed as a bundle of rights within a society or community which is based on regulated resource sharing. Land tenure is also viewed by Olima and Obala (1999) as, "*the systematic land holding which embody legal, contractual and communal arrangements under which people gain access to and utilize land*". However, if land tenure is not legal or statutory, it is subject to some form of informality, (depending on the existing land law of the country) which results to the need for tenure regularisation. Moreover, land tenure is organized differently in every jurisdiction in the world, and this results in the creation of various rights and interests in land (Zevenbergen, 2002). Such rights existing on land are stated in the bundle of rights as; usufruct rights i.e. right to use, rights to grow crops, plant and harvest trees and fruits, or even build, transfer rights including rights to sell, give out as mortgage, lease or rent. Other forms of right are; exclusion rights which give the individual, group or community the right to excluded others, enforcement right which refers to the legal, institutional and administrative arrangements to guarantee rights (Arko-Adjei, 2011; Zevenbergen, 2002). Land tenure, therefore, in the context of this research relates to the legal ownership structure including institutional arrangements that enhance the ownership rights in the study area.



## 2.4. Security of tenure

Secure tenure is viewed differently but particularly relates to the degree of recognition and guarantee of rights, or a method of protecting people's associations with land (Ciparisse, 2003; Williamson *et al.*, 2010). Similar view exists in various literature (Payne, 2004; UN-Habitat, 2008; van Gelder, 2010). Tenure security is believed to have a strong role to play in the operations of land tenure as it generally gives landowners the feeling of secured and continued access to and use of land (Unruh, 2010). It is observed that many past tenure arrangements seldom give adequate security especially those associated with customary tenure due to the fact that communal norms and values inform the land rights allocation. In contemporary times, communal norms and values have been replaced with written laws and policies. This method made previous land tenure arrangements and people's past association with land gradually insecure. Therefore, many landowners need to regularise their tenure that brings about a stronger relationship between land and landowners. However, it is observed that this security of tenure have impacts on land owners' decision making concerning investment, or use of land for various purposes including; building, buying, selling, renting, loaning, inheriting, or alienation depending on how secure one's land right is (Deininger *et al.*, 2010; Unruh, 2010). Therefore, a land without secure tenure is classified as informal and this falls under land meant for tenure regularisation.

## 2.5. Land tenure regularisation or formalisation

An insecure tenure is attributable to poor land tenure system. Therefore, regularisation of ownership is required. This is a process whereby informal/illegal occupation of land is legalized giving the owner the legal right to private ownership of land, so as to substantiate informality in tenure. However, LTR as discussed in some literature including Deininger *et al.* (2010) is described as "*a set of administrative procedures undertaken for the purpose of recognizing and securing existing rights that people and organizations other than the State have to, in, or over different categories of land*". According to Durand-Lasserre and Selod (2009), it is a way by which informal tenure is integrated into administrative recognition and a further delivery of rights to informal households. This is observed to be dependent possibly on legitimate public policy objective. This opinion particularly relates to the case of Rwanda where systematic adjudication of all lands that had informal status became formalized, and all landowners are subsequently issued legal titles to their lands. For the purpose of this research, LTR is defined as, "*the process through which existing land rights of people or organizations over different categories of land are recognized, guaranteed and secured through administrative procedure to ensure formalisation and delivery of land rights to people*" (Deininger *et al.*, 2010; Durand-Lasserre & Selod, 2009).

Meanwhile, one can say that land regularisation is a peculiar phenomenon especially with regard to the way land is being accessed in most developing countries. Land tenure systems take different turns as defined by the ownership land units structure of a country (Famoriyo, 1984), and this calls for proper land management. Where tenure is customary, it may lack adequate security and can reduce the extent of investments and development initiatives. However, Zevenbergen (2002), posits that 'the land tenure is an input in the registration black box', and on which security is hinged. Although systematic registration in the form of holistic LTR is necessary to ensure proper land administration but also certain forces still impact on it. Despite the solution through LTR, it seems not to be a saving grace to the inadequacies of land registration, as Van der Molen (2002), and Zoomers (2000) posits that, it is still not the global tenure remedy concerning land. In the case of Rwanda, the essence of LTR is to ensure that all landowners have security of title and in the long run ensure optimal use of their land. Optimal utilisation of land results in different ways of land use that makes landowners to change land use particularly based on motivation.

## 2.6. Land use and land cover

The term, 'land use' have generic characteristics. Therefore, it requires careful definition considering its multifaceted meaning. However, Sultana and Powell (2010), states that, "*land use refers to the ways in which*

*earth's surface has been transformed by human activities such as farming, industry, transport, and urbanization".* These activities relate directly to how humans restructure land to suit their needs. In another view, land use concerns how and why the land and its resources is being influenced (Briassoulis, 2000; Meyer & B. L. Turner, 1994). Basically, land is put to use to satisfy human needs, which is of different categories such as residential (for shelter/housing), commercial (shopping), agricultural (farming) institutional and recreational, etc. The interrelationship between these land use categories forms the dynamically urbanized environment, which requires good land management. However, according to FAO (1995), in Briassoulis (2000), "*land use concerns the function or purpose for which the land is used by the local human population and can be defined as the human activities which are directly related to land, making use of its resources or having an impact on them*".

Meanwhile, land use and land cover are sometimes interchangeably used even though they are not synonymous, it is necessary to distinguish between the two. Land cover as put by Briassoulis (2000), Turner II *et al.* (1994) refers to, "*the biophysical state of the earth's surface and immediate subsurface*". Also, "*land cover describes the physical state of the land surface: as in cropland, mountains, or forests*"(Moser, 1996). Meyer and B. L. Turner (1994), adds that, "*it embraces, for example, the quantity and type of surface vegetation, water, and earth materials*". Invariably, "*The term originally referred to the type of vegetation that covered the land surface, but has broadened subsequently to include human structures, such as buildings or pavement, and other aspects of the physical environment, such as soils, biodiversity, and surfaces and groundwater*" (Briassoulis, 2000; Meyer & B. L. Turner, 1994; Moser, 1996). The close relationship in the way which the terms are used brings about their interchangeable connections, which makes Meyer and B. L. Turner (1994) to posit that, "*A single land use may equally correspond fairly well to a single land cover, for example, pastoralism to unimproved grassland*". Meanwhile, a particular land cover may be attributed to different uses, for instance, agricultural land with varieties of crops, or forestland with several purposes. Also, in term of administrative or spatial delineation, a single land use can accommodate several smaller land cover units e.g. woodlands, settlement, pastures, etc. (Briassoulis, 2000). In the case of this study, land use refers to that activity to which human employs or subjects land. This includes; agricultural and residential or industrial land use, that may also be regarded as land cover (Meyer & B. L. Turner, 1994), and equally have its managerial meaning. Also, the synonymous nature of these terms leads to the interchangeable use by many authors, as land use/land cover. (Briassoulis, 2000; Li *et al.*, 2005; Muttitanon & Tripathi, 2005; Orenstein *et al.*, 2011).

Considering many human activities, also as opined by Mitsuda and Ito (2011), there is a need to ensure good land use organisation. Therefore, an organized land can be viewed as a function of good land policy, land planning and land development. Land use is seen as a direct reflection of some form of expression of tenure that has been appropriately arranged. However, Williamson *et al.* (2010) refer to land use in the land administration context as the processes and institutions that control the use of land, based on laws and regulations at all administrative levels, it includes the enforcement of land use regulations, conflict management, etc.

With a well organized land tenure system under the LTR program in Rwanda, many land management arrangements appear to have been put in the proper state. The rights held play a major role in their land use decisions. However, urbanization and land use dynamics, migration of people from rural to urban, including natural population growth and socio-economic system which directly impacts the environment bringing about changes in land use are of importance (Dubovyk *et al.*, 2011). Such change impact seems peculiar to the peri-urban areas where there is high competition for land and land use, a reflection of the pressure of urban housing and other requirements. Meanwhile, Doygun (2009), observes that agricultural land use of high proximity to the urban areas are particularly more prone to such changes (either conversion or modification). Therefore, land use as regards this study is taken in line with the last sentence of the paragraph 2 of this section. It also requires good administration through institutional processes as

proposed by Williamson *et al.* (2010) to ensure appropriate zoning, development and building control particularly the conversion of land in the peri-urban area as in this study.

## 2.7. Land use/land cover change and driving forces

Land use or land cover changes as put by Briassoulis (2000), are changes that could be quantitative in terms of coverage (either expanding or reducing) particularly for a given land use or land cover. Meanwhile, land use or land cover change can be distinguished both in meaning and conceptually. Land cover change as put by Turner II *et al.* (1994), Briassoulis (2000) refers to two types of change that includes conversion and modification. Whereas land cover conversion has to do with a change from one land cover type to another, land cover modification, on the other hand, involves reconstruction or functional change without necessarily changing from one use type to another. These changes may result from natural processes like climate variations, volcanic eruptions or some natural/ biophysical causes. However, Briassoulis (2000) observes that most of the land cover changes happening lately relates to human actions. Also, Briassoulis (2000), further notes that, "*land use (both deliberately and inadvertently) alters land cover in three ways; converting the land cover, or changing it to a qualitatively different state; modifying it, or quantitatively changing its condition without full conversion, and maintaining it in its condition against natural agents of change*".

Similarly, land use change relate to either the conversion from one use to another, that is, changes in the structure of land uses in an area or the modification of a certain land use. Land use change according to Meyer and B. L. Turner (1994), involves either a change to another use or intensification of the existing land use. Thus, changes in land use can be attributed to the dynamic transformation of the state of the land from one particular state to another in the form of development. If a parcel in its original state is vacant and due to change dynamics, it becomes built up (wholly/partly) then change has occurred. However, many changes occurring on land are driven by certain forces attributable to the dynamics of human activity and environmental/climate impacts and this complex processes need to be studied or modeled (Bennett *et al.*, 2011). Therefore, it is pertinent to distinguish the linkage between land use and land cover because environmental impacts of land use change is to a larger extent particularly affected by land cover changes and driving forces.

Other authors have discussed various issues relating to land use change and the driving forces including Kombe (2005), Mottet *et al.* (2006), Serneels and Lambin (2001). The driving forces and actors are equally identified with their peculiarities to the change that is measured amongst others. Mottet *et al.* (2006) identifies drivers of land use change as cultural, socio-economic and technological including biophysical factors, this is in relation to livestock farming systems. Others also view driving forces to include natural, socio-cultural, economic, political and technological driving forces (Diogo & Koomen, 2012; Hersperger & Burgi, 2010). Policies and other socio-political factors as observed in some human actions may also be taken as driving force. In such instance, driving force in the context of this research is the secure tenure. This is in relation to one of the models of Hersperger *et al.* (2010) (i.e. Actor-Change), as earlier stated in section 1.5. Meanwhile, such land use change study can bring about an improved knowledge which can result in evidence-based policy useful for another land use policy formulation (Aspinall & Hill, 2008).

## 2.8. Peri-urban land use change

The land use change impact in this research is based on the peri-urban area thus there would be a need to define the peri-urban for the purpose of this research. The term peri-urban can be described as transitional zones between urban and rural areas that are undergoing urbanization and progressively assuming many of the characteristics of urban areas (Arko-Adjei, 2011). Such zones are said to be undergoing some transformation expressed in the rural-urban continuum phenomena and are referred to as urban fringe.

Other perspectives of peri-urban include the one described by Zasada *et al.* (2011) whose European perspective of peri-urban areas are understood to be such mixed areas under urban influence having rural morphological traits. The characteristics of peri-urban are also linked to the pressure on urban development both physically and socially and the urban lifestyle of rural areas. However, this study adopts the description or definition of Arko-Adjei (2011) which describes the peri-urban with its transitional traits. Land use change is thus prominent in this peri-urban area since it is a zone of transition.

## 2.9. Land use change detection and analysis

At any level, (either peri-urban or larger/global scale) land use/land cover change detection and measurement of such changes, that depend on any spatial scale can be regarded as multidirectional. This is bearing in mind that land use transition is not deterministic (Lambin & Meyfroidt, 2010). Therefore, '*the higher the spatial level of detail, the larger the changes in the areal extent of land use and land cover which can be detected and recorded*' (Briassoulis, 2000). Furthermore, Briassoulis (2000), suggests that the analysis of change requires the determination the level of spatial and temporal interrelationship of land use and land cover. Thus, stipulating the detail at spatial and temporal levels is necessary in change detection. Firstly, it helps in directing the selection of the land use and land cover types for analysis. Secondly, it identifies the triggers and processes of change for detection. Thirdly, it helps in identifying and explaining the spatiotemporal connection between land use and land cover, supported by the advantage of detecting the changes through LUC maps comparison (Briassoulis, 2000; Estoque & Murayama, 2011).

Analysing land use change thus involves change detection processes and temporal assessment of the extent of changes that occur in a particular location. Change detection according to Alkema *et al.* (2012) is one of the earth observation application in which spatiotemporal data integration is required. The authors identified three levels of change that includes; gradual, sudden and periodic. Many techniques of change detection are also identified which includes; (a) Algebraic technique for change detection, such as image differencing, image ratioing, vegetation index differencing, image regression, change vector analysis and change matrix. (b) Classification based change detection, such as; post classification comparison, spectral and temporal analysis, unsupervised change detection and hybrid change detection. (c) Visual analysis for change detection using human the eye by visual interpretation. (d) GIS approach that involves overlay on an image, and according to Alkema *et al.* (2012) can be done by combining maps and images. GIS overlays on image data can provide a means of better interpretation and for detection of changes e.g. new building, change in parcel boundaries, or forest limits, etc. and such results can be directly combined with other data in GIS e.g. to update LULC information. Other methods include; transformation, model based method and object based change detection.

Meanwhile detecting land use change is achievable through various techniques, each with its own peculiarities in detecting and interpreting change based on classifications. For example, Alkema *et al.* (2012); Erenner *et al.* (2012); Estoque and Murayama (2011); Lu *et al.* (2004); Orenstein *et al.* (2011) states that it can be done through Integrated GIS and Remote Sensing method. This incorporates image data and GIS data such as the overlay of Cadastral layers directly on a raster layer (image) and the analysis is done with the GIS to obtain further results. In using this GIS approach, remotely sensed (Ortho photo or Google image) data of previous and current status of the land are important. Thus, Cadastral overlay on the raster image is identified as a way by which change can be detected, (for instance, through identification of newly built parcels from vacant ones or changes in parcel use or parcel boundaries). In the course of detecting changes, land uses are grouped into classes through which variations are measured.

The techniques stated above by Alkema *et al.* (2012) correlates with Sultana and Powell (2010) that the innovation of Geographic Information Systems (GIS) technology allows the integration of various sources

of land use data. Particularly original land (field) surveys (including land use inventory), aerial photographs (Ortho-photo), satellite imagery data, land use and land cover maps (Cadastral maps), forest inventories, and property records (to reconstruct ownership history). This makes GIS technology an important means of advancing the understanding of the spatial, temporal, and decision-making apparatus of land use and land use changes over the past two decades (Sultana & Powell, 2010). Therefore, analysing land use change requires ascertaining that some land conversion or modification that has occurred needs to be measured. This leads to land use change detection i.e. the process of identifying certain alteration in the state of an object or a phenomenon through periodic observation (Singh, 1989).

Meanwhile, based on any of the above change detection methods, good land use change analysis will involve; (a) an assessment of the area change and the rate of change occurring, (b) the spatial distribution of change type, (c) change trajectories of land cover types and (d) accuracy assessment of change detection results (Bhatt, 2012; Lu *et al.*, 2004; Orenstein *et al.*, 2011). More so many land use change detection undergoes processes such as; image selection or acquisition, image registration, geometric and radiometric/atmospheric correction and multi-temporal analysis. Essentially, choice of technique for change detection and accuracy assessment is also an important consideration (Lu *et al.*, 2004). The interest of this study is hinged on detecting the changes that occurred in the conversion of parcels from agricultural use to other uses. This is done by assessing the extent of such agricultural land conversion in temporal terms.

#### **2.10. Land use classification for change detection**

Studies of land use change will compare one land use or land cover to another, and to be able to do so successfully, there is a need to group objects into classes. Thus, in line with the definition of Sokal (1974), that classification is, *"the ordering or the arrangements of objects into groups or sets on the basis of their observable relationships which can be based on inferred properties"*, it is necessary to do some classifications when doing land use change study. This describes the relationships of the constituent objects in a simple manner such that general statement can be made regarding the classes. According to Briassoulis (2000), many land use classifications are based on vegetational and artificial covers, for example, the 'World land use classification, the second land use survey of Britain classification, Canadian Land use classification and the World map of present day landscapes' (Moscow State University-UNEP 1993, Rjabehakovnd). Briassoulis (2000) observes certain drawbacks as identified by other authors on classification. This relates to definition of units, class overlaps, multiplicity of objectives especially in relation to disciplinary foci. Such cannot be separated from studies, and conclude that existing classification do not use common classificatory principles and often meld land use and land cover. Therefore, land use classification takes the form and definition most suitable to author's research objectives.

Common types of classification especially in the areas of image analysis or image classification are done with pixel values selection. Researcher thus selects objects based on their spectral characteristics and generates classification such as buildings, grassland, bare land, water body, wetlands trees and so on which results in the generation of a classified image (Bakx *et al.*, 2012). The grouping of such similar land cover categories into different cover classes are thus distinguished from one another for the purpose of land use/cover change analysis.

The processes of classification are similar yet based on varied study objectives they also have some differences. For instance certain multi-band image classification according to Bakx *et al.* (2012) may include; selection and preparation of image, definition of clusters, selection of the classification algorithm, running of the actual classification, and result validation. This varies from other classification types which

do not require classification based on pixel selections. However, classification type depends on data available and knowledge of the area under investigation.

Therefore to classify land use without selecting pixels, approach similar to visual interpretation may be used. It is also possible to use auxiliary GIS layers such as building footprints to guide the segmentation or classification by visual interpretation (Bakx *et al.*, 2012). In a land use change study, for instance, Orenstein *et al.* (2011) in assessing the changes that take place within a geographic area classify land covered with physical and anthropogenic structure (i.e. primarily buildings and roads) as 'built' space. Other lands were referred to as open space (i.e. spaces that have not been built, non paved) e.g. agricultural land, sand dunes, forests, shrub lands and vegetation. However, classification depends on the magnitude and quality of land use change in terms of land use/land cover type and such attributes of the land use type will be considered in terms of spatial scale or environmental or socio-economic character. An adoption of the classification used by Orenstein *et al.* (2011) is considered as suitable for this study.

### **2.11. Evaluating the relationship between secure tenure and change**

Having identified the different parts of this research, such as land tenure, security of tenure and regularisation, land use/land cover change and the driving forces, and change detection, there is a need to evaluate the relationship between the secure tenure and change. This is embedded in the relationship that exist between the LTR and LUC and would require a systematic assessment. This will reveal the extent to which one variable impact on the other. The overall impact of the relationships that exist between variable are measurable based on a ranking. However, ranks represent the ordering of certain variables according to their importance. Quite often, a set of criteria are stated to form the basis on which to compare and evaluate variables (Abeyasekera, 2005).

In the evaluation of the relationship, weighted techniques are applicable. This can be in ranks of 1-3, 1-5 or more categories. (Abushnaf *et al.*, 2013). Ranking may also be in the form of a subdivision of percentiles and of equal ranges such as dividing 100 percent into five, whereby each is, for example, 20%. Evaluation scales depend on the nature of the study, data obtained and the researcher's perception etc., since there is no static parameter for measurement. This may be in categories of; slight, moderate and severe in a particular evaluation exercise. It may also be categorised as; important, considerable and not important, or low, average and high. Others may follow the Macbeth's approach such as; very weak, weak, moderate, strong, very strong and extreme (Crown, 2009). However, this study would adopt a three rank scale of; low, average and high in order to assess the level of significance of the variables under consideration.

### **2.12. Conclusion**

In this chapter a review of various literatures was done considering that this research is a multifaceted study with views into different aspects. In order to adequately treat the research objectives, the study reviews related literatures and works done by authors on various aspects of the research. This includes land tenure, tenure security and land tenure regularisation or formalisation. It reviews works on land use/land cover as well as their differences and it includes land use change and driving forces which triggers land use change. The study also review different works on the methods of change detection and the process, while a definition or description of the spatial characteristics of the study (peri-urban) is equally stated. All these cover the concept, theory and processes which relates to the research in the different sections as a guide for the successful achievement of the main objective of the study.

## 3. THE RWANDAN LAND TENURE REGULARISATION PROGRAM

### 3.1. Introduction

This chapter discusses the land tenure regularisation program in Rwanda, shedding light on tenure types, and previous land holding systems at different periods in the past. The institutional arrangements/procedures, the processes of the land tenure regularisation program and the extent of success are also discussed.

### 3.2. Background to the Rwandan land tenure system

The LTR can be regarded as a peculiar land administration phenomenon especially about the way land is being accessed in most developing countries. It is recognised as a solution to the inadequacies of land tenure system in some countries and particularly to ensure good use and management of land. There are different views and definitions of land tenure (section 2.3) and particularly as human to land relationship and its associated resources. In order to ensure good tenure administration, Rwanda embarked on LTR program to boost the human to land relationship, to ensure sustainable land management system. The LTR changed the system of land holding which dates back to pre-colonial era with the tenure regimes ranging from the pre-colonial, colonial and post independence periods until this period of land regularisation. According to Rurangwa (2013) access to land in Rwanda was previously through inheritance or leasing by customary tenure arrangements and the major characteristics of the pre-colonial tenure is said to include the holding systems such as:

- Ubukonde: A system of tenure with the law enacted by the clan chief being the owner of a vast land and who resettle many families called 'abagerewa', those who later enjoyed right over the land which they occupy.
- Igikingi: A system of tenure that gives the right to graze, accorded by the king or one of his chiefs known as "Umutware w'umukenke" to any family that rear livestock.
- Inkungu: A tenure system by which the political authority (unilaterally or on other's behalf) allocate plot of land from escheated lands to those who required it.
- Gukeba: A system or process of settling family into grazing land (by the authority in place) (Rurangwa, 2013).

Meanwhile, the land tenure system during the colonial period according to Musahara (2006), Sagashya and English (2012), was an offshoot of the provision of the 1962 Rwandan constitution (Art.108). This was an inherited Belgian land tenure regulation which ushered in the legal system that recognises the original inhabitants possession yet under state land ownership with limited rights. This has a relationship with the Belgian and German colonial arrangements of land holding in the past.

However, the post independence land tenure system introduced land management strategies as a result of land scarcity. This meant that individual ownership of land for cultivation reduced from about 2 hectares in 1960 to 1.2 hectares in 1984 and since the 1990s. Rurangwa (2013), states that, "*the country experienced a deadlock in the land issue. The problems include; insufficient agricultural production, increasing population pressure on natural resources, a growing number of landless peasants, and steep competition among projects of agriculture, livestock, and natural reserves. Thus, government strengthened its role in the appropriation of vast stretches of land*". All these and some

other reasons ignited the need for the LTR program while necessary policies and laws are formulated to ensure proper implementation (section 3.2).

### 3.3. The Rwandan tenure reform process

Land is regarded as one major asset of Rwanda, a country in which most livelihoods is hinged on land. (Rurangwa, 2013). On the realisation of the need to alleviate poverty and boost the economy of the nation, the Rwandan government developed a comprehensive legal and institutional framework for land governance. The Rwandan LTR program as one of the land tenure reform strategies was implemented with the main objective of ensuring that all Rwandans have access to and use of land. This is particularly in line with the provision of chapter four of the Rwandan NLP. Also, provisions of section 2, article 39 of the new organic law 2013 which states that, "*individuals owning land shall exploit the land in accordance with its nature and intended use*", such exploitation include building or planting crop (GoR, 2004, 2013). The LTR program was also supported with various programs (GoR, 2012b). Bearing in mind that the past land tenure arrangements require review due to many circumstances and the realisation of the need to perfect the land tenure system and put in place a good land management system. The dynamic turn through the LTR program systematically brought all land to first registration and to gave all citizens an opportunity to have equal access to the new land ownership systems.

The Rwandan LTR program is hinged on both legal and institutional/implementation frameworks that ensure its relative success. The reform introduced tenure definitions that ensure recognition of state public and state private properties as well as individual/private properties the basis on which land title is referred. It stated the responsibilities of the institutions such as grant of rights to land, establishment of laws governing land acquisition, transfer and use. The national land policy establishment in 2004 aim "*to institute a land tenure system that guarantees tenure security for all Rwandans and give guidance to the necessary land reforms with a view to good management and rational use of national land resources*" (GoR, 2004). In order to ensure proper implementation of the 2004 NLP organic land law, no 08/2005 was enacted to determine the use and management of land in Rwanda.

Santos *et al.* (2012), noted that the LTR went through periods of research and public consultation in order to ensure the absolute success of land management. It involved pilots, carried out in four areas, and this was completed between 2006-2008 while the national land centre (NLC) was equally established to ensure the implementation of the organic land law.

### 3.4. Institutional framework for LTR program

In order to ensure a successful implementation of the LTR program, the country established necessary institutions with their terms of reference as stated in the land administration system (LAS) manual amongst which are stated below GoR (2012b).

- (a) The Ministry of Natural Resources (MINIRENA) with the mission of ensuring the protection and conservation of the environment to achieve optimal and rational utilization of natural resources for sustainable national development. It was also saddled with the responsibility for addressing issues of policy through ministerial orders that set out laws and procedures for administration planning and allocation of lands.
- (b) The land commission was established to oversee the implementation of the OLL and oversee the District land administration.
- (c) Sector and Cell land committees are both established as the grass root point of contacts for land registration.



- (d) Rwanda National Resources Authority (RNRA) was established to merge the National Land Centre (NLC) the National Forestry Authority (NAFA), and the Rwanda Geology and Mines Authority (OGMR) to ensure a well coordinated land resources administration and management.
- (e) The government also established the office of the registrar of land title, district land bureaux, (one-stop centre) in many districts to ensure proper co-ordination and management of lands. All these served as the aid to a successful LTR program.

### **3.5. Implementation of the LTR program**

The implementation process was in two phases which is quite systematic as proposed in the Strategic road map for land tenure (GoR, 2009) as follows;

- (i) Preparatory phase 2006-2008 and
- (ii) Full Implementation phase. 2009-2013

(i) The preparatory process: This involved field consultations and particularly to determine the scope and detail feasibility of tenure reform envisaged under the organic land law. Secondly, field trials were completed in 2007/2008 selecting some districts of which Gasabo District was one and this ensured grass root participation, adequate awareness and formulation of other legislation towards improving the implementation. Thirdly, capacity development was also done across all levels both professional administrative and at sector and cell levels to aid the LTR program implementation. Finally, resource mobilisation of necessary materials such as aerial Ortho-photo base maps, design and printing of manuals and documents were produced. Completion of the field trials enabled the knowledge of work rates, costs and other resource requirements for full implementation while it also gave an idea of the acceptability level and appropriateness of the strategy for full implementation (GoR, 2011).

(ii) The full implementation phase: when the program was launched at every district, national register was opened for recording of registered parcels through two systems: (a) a systematic registration system and (b) sporadic (demand-driven) system. This results to the issuance of either of two types of title, which includes leasehold and full ownership (freehold) to land.

### **3.6. Land use and management success recorded**

The rate at which the implementation of the LTR was done showed some level of commitment. The trial started in 2006 and full implementation commenced 2008. A general boundary system was used to demarcate parcels with the aid of Ortho-photo and enlarged satellite images. By the end of March, 2012, 10 million parcels had been demarcated (GoR, 2012b). Meanwhile, in 2013, 8.4 million parcels has been registered (section 1.1) showing the commitment to, and success of the program.

The program also led to the formulation of many laws, policies, preparation of the master plan, zoning plans and regulations, establishment of ministries, commission and authorities and agencies which are all meant to ensure sustainable land governance.

Rurangwa (2013) observed that the successes recorded from the registration includes;

- (a) Clear and strong institutional framework through which many of the institutional procedures for land administration are spelt out.
- (b) Strong legal framework which involved promulgation of laws, policies and ministerial orders that will guide/regulate the administration of land.
- (c) A systematic framework that allowed securing and delivery of land title to owners through LTR

(d) Through the LTR program land tenure was properly defined, and these were stated in the land laws to avoid contradiction and overlap of interests. Government and private lands are respectively defined even the land title's position as collateral.

Other successes attributed to the program are the resultant development of the national land use master plan which enhances a rational use of the land resources and national data portfolio (Ortho-photo and base map) a tool that facilitates land administration and management. Also, development of land administration information system (LAIS) with digital register that enhances land data maintenance. There is no doubt that all these enhanced land use in many ways and thus led to land use change.

### **3.7. Conclusion**

The chapter traced the tenure regimes and identified the previous tenure systems in the study area. It also identified the root of these tenure systems and legal affiliations as well as the need to introduce land management system. This required land management system and poverty alleviation brought about the establishment of necessary policies and laws and subsequently the LTR program as a tenure consolidation. The study also identified the establishment of necessary institutions required to support the implementation of the LTR program and stated some of their functions. The strategy for the implementation of the LTR program was identified while part of the successes recorded was noted.

## 4. RESEARCH METHODOLOGY

### 4.1. Introduction

The research into land use change is borne out of the need to understand the existing relationships and interactions which occur in the environments towards a sustainable land management. This interrelationship was viewed from the perspective of LTR and land use change, its impact results from decisions that affect land use. Therefore, there is a need to know what effect the secure tenure has on the rights of the people and how this result into changes in land use, what the extent of the change is and on the long run, determine the relationships between LTR and LUC. In order to do this, a suitable research method was used for collection of data (with appropriate tools and techniques), processing and analysis of data, all of which are stated in this chapter.

### 4.2. Research techniques

This research adopts approaches relating to analyzing physical and social phenomenon. An assessment of the various ways or strategies by which the research objective can be achieved was done. This gave a clearer view of the research in consonance with Cavaye (1996) that says research method is, "*a way to systematize observations, describing ways of collection and also indicating both tools and data collection techniques*". Thus, amongst the various types of research methods available, case study method was applied. Systematising observation involve from the out-set the search into relevant texts or literatures with a view to assessing the theoretical and conceptual approaches and in this study, it was applied to LTR and land use change. As part of systematising the research, a proposal that outlines the main study objective and sub objectives including the research questions meant to guide the research in achieving the goal was prepared in a research matrix. The data types, the steps to be taken in carrying out the research and the likely outputs were stated. Approaches for data collection involve interview, field observations, as well as document and text studying with combination of information system as stated by Darke *et al.* (1998), and particularly with reference to the LTR program.

Method of change detection was applied towards satisfying one of the research objectives which is to determine the extent of agricultural land use change in the study area. This was achieved through the determination of the amount of change that occurred within a selected epoch. In order to detect changes that occurred this research adopted a suitable technique of spatial analysis using the GIS approach (section 2.9). Also, a selection of different categories of land use/land cover (either built or vacant parcels) were done as classified in relation to the spatial data of the study area with classification method (section 2.10). This was supported by the field inventory data leading to change detection in the two periods under consideration.

This GIS approach adopted is referred to as innovative techniques of Geographic Information Systems (GIS) technology by Alkema *et al.* (2012); Sultana and Powell (2010). It was used by Orenstein *et al.* (2011) in a previous study aimed at measuring and interpreting patterns of built space from different sources of data. This approach seems to have made GIS technology an important means of advancing the understanding of the spatial, temporal, and decision-making apparatus of land use and land use change over the past two decades (Sultana & Powell, 2010). Analysing land use change in this manner helped in ascertaining that some types of land conversion or modification that occurred can be detected. Also

identifying certain alterations in the state of an object or a phenomenon through periodic observation can be done (Singh, 1989).

The interest of this study therefore, is hinged on detecting the changes that occurred through the conversion of parcels from agricultural use to other uses thereby assessing the extent of such agricultural land change in temporal terms. Other analytical processes which required statistical approach was done using descriptive statistical method while results were also discussed. Also, method of evaluation of the relationship between LTR and LUC was stated. Details of these methods are in the subsequent sections of this chapter. However the general overview of the research design adopted in this study is expressed diagrammatically in figure 4.1 below.

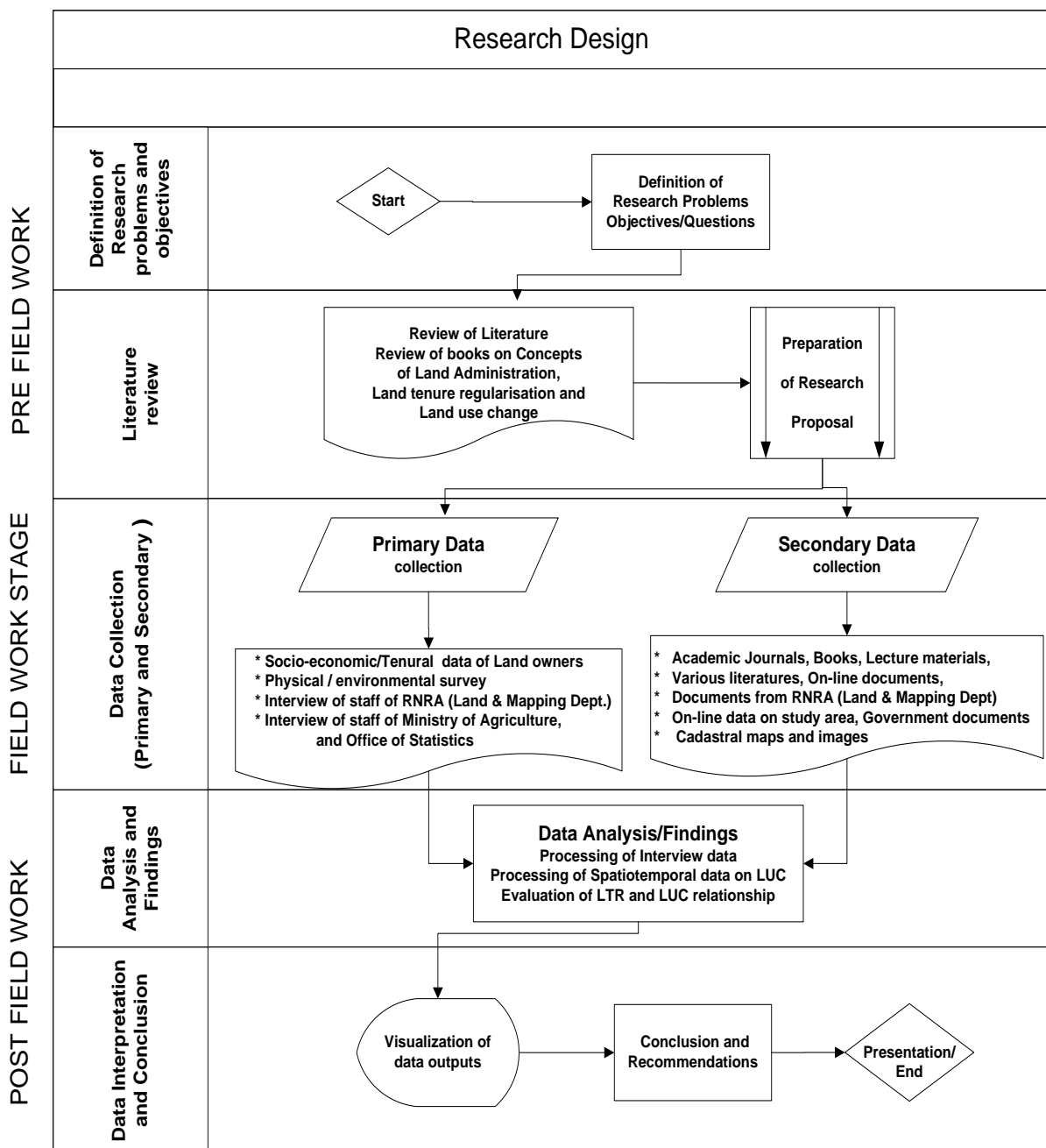


Figure 4.1: A description of the research design

#### 4.3. Study area characteristics

Rwanda is an east African country characterised by her hilly nature and is nicknamed "*land of a thousand hills*" GoR (2008). It is located between latitude 1°04' to 2°51' south and longitude 28°53' and 30°53' east of the Greenwich meridian. It is bounded by Democratic Republic of Congo in the west, Uganda in the north, Tanzania in the east and Burundi in the south. Kigali is the administrative capital. The country is divided into 5 provinces, with 30 districts, 416 sectors and 2,146 cells. These cells also have smaller units of villages within them referred to as Imidugudu (Sagashya & English, 2012) The study area is a combination of two cells Kinyaga and Masoro from two different sectors Bumbogo and Ndera of Gasabo district within Kigali. The country's gross land area is approximately 26,340 square kilometres with approximately 10,537,222 inhabitants by the 2012 provisional population census, with an average annual growth rate of 2.6%. Considering the 2002 population figure of 8,128,553 inhabitants, Rwanda's population density rose from 321 per sq. km to 416 per sq. km between 2002 and 2012 respectively (GoR, 2012a). This is regarded as high and particularly for Kigali where Gasabo district is located, the density is assumed to be higher. Kinyaga and Masoro gross land area is approximately 514.5 and 629.5 hectares respectively, which makes the total area of 1144 hectares or 11.44 square kilometres.

Land in Rwanda has been fragmented into small holdings and this enhances individual ownership and utilisation of land (Sagashya & English, 2012). The process of certification through land tenure regularisation program can thus be regarded as a stabilizing land tenure strategy. It was observed that the land in the study area was originally agrarian (rural/agricultural) but over the past years it started assuming an urban status although it is currently peri-urban.

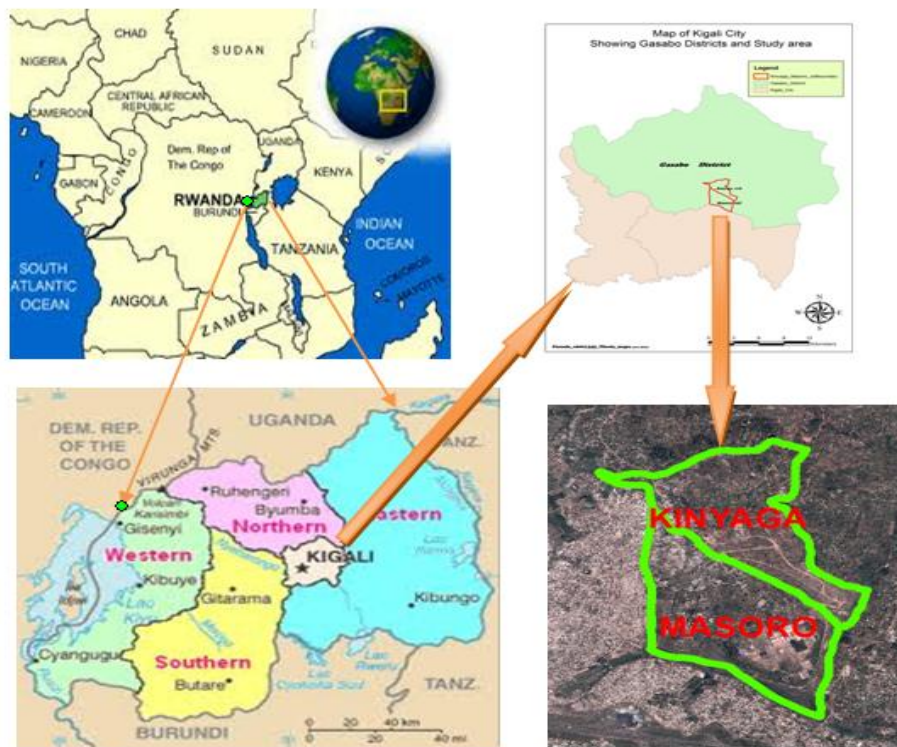


Figure 4.2: Location map of Kigali, Rwanda showing Gasabo district and the study area.

Gasabo district has been identified as a district with the highest population of 530,903 with 1,237 persons per sq. km and an average annual growth rate of 5.2% which is higher than the national average. (GoR, 2012a). Therefore land in the district is of high importance and appropriate management is necessary. The

landscape of the study area is not different from the general hilly and undulating land common to the entire country and this is not seen as a hindrance to building as land is being built even on daily basis. Kinyaga and Masoro (study area) is also of high proximity to the city and this is reflected in the figure 4.2 below showing the location of study area.

#### **4.4. Description of sampling techniques**

Land use change studies can be done on a varied extent and with varied sampling methods. In this research, stratified sampling method was adopted. This involved selection of two cells (strata) Kinyaga and Masoro, from two different sectors Bumbogo and Ndera in Gasabo district of Kigali. These are part of the peri-urban areas of Kigali with potentials for change. However, a non-random sampling of 25 parcels was done for the interview of the landowners to determine their motivation for the development that might have led to changes occurring in the study area within the period under consideration.

#### **4.5. Data collection and method of acquisition**

This study used primary and secondary sources of information.

##### **4.5.1. Primary data collection**

This involved direct contact with providers of the information required and raw data sets were collected. This was in form of interviews and field inventory.

##### **4.5.2. Interviews**

In order to validate the research question, the primary data required was collected through interview of landowners. This was done with semi structured interview questions prepared to allow for certain options and some open-ended questions (please see [appendix A-1 and A-2](#) for the English language and Kinyarwanda language versions of the interview questions). A total of 25 landowners were non-randomly selected across the study area. Also, officials of relevant government land agencies such as the Deputy Director General (DDG) Land and Mapping Department of Rwanda Natural Resources Authority (RNRA), was interviewed as well as the Director development permit department of Gasabo district One Stop Centre. The professional in charge of soil management in the General Directorate and Crop Production, a department of Ministry of Agriculture, was interviewed and Officers of the Kigali city One Stop Centre who are in charge of large scale development, commercial and industrial development permits were equally interviewed. The GIS analyst in the Office of Statistics was also interviewed. All these were contacted to ensure data adequacy for this research (the interview questions for these government officials can be found in [appendix A-3 to A-7](#), while the introduction letter required to facilitate field data collection are in [appendix F](#)).

Data collected through interview thus includes information on ownership status, rights held, length of occupation, level of tenure security and motivation due to secure tenure and how this influence their land use. Also from the government officials, information on the roles played in LTR program, government position on land use and changes taking place in relation to the study area was gathered.

##### **4.5.3. Field Inventory**

Land use change studies have their peculiarities, and in order to carry out land use change study successfully, one of the steps identified as important is the field observation (Bakx *et al.*, 2012). Therefore an inventory of land use was done using the field inventory datasheet ([appendix B refers](#)) to satisfy part of the sub objective 2 and 3 of the research and it involved identifying built parcels, partly built and vacant parcels and land use as at 2013. This involved field observation and recording of the land use situation as

at the time of the research with the aid of printed cadastral map mounted on the Ortho-photo image of the two cells.

#### **4.5.4. Secondary data**

The secondary information used in this research includes data collected from books and learned journal articles on land administration and land use change. Also, documents from the government departments such as report, constitution/laws, policies, master plan document and population information document were all used.

#### **4.5.5. Raster data**

The data collected include the raster image of a part of the Gasabo, Kigali captured on 7/7/2013 from Google with an altitude of 1400 m on-screen and 1680x1050 pixels and resolution of 96 dpi was obtained from the ITC remote sensing laboratory. This image was provided in tiff format and was used for spatiotemporal analysis of the changes that occurred in the study area. An Ortho-photo raster image of 2008 covering the study area Kinyaga and Masoro was collected from the land and mapping department of RNRA, Kigali. The raster information is 10000,10000 columns and rows with its number of bands as 3, cell size (X,Y) at 0.25, 0.25 while the uncompressed size is 286.10 MB. The image is in tiff format, of 8 bit pixel and the pyramids on level is 6 and resampling was with nearest neighbourhood. The image extent is 4790000 at the top, 515000 on the left, 517500 right and 4787500 at the bottom. This Ortho-photo showed the exact land use situation in the study area as at 2008 before the commencement of the LTR program.

#### **4.5.6. Vector data:**

Digital copy of the cadastral map of the two cells which constitute the study area Kinyaga and Masoro was given by the land and mapping department of RNRA. This aided both field knowledge and relationship of the parcels of the two cells to the physical situation and in the selection of the parcels in different categories (built, partly built and vacant) parcels for land use change analysis. This cadastral map is the base map of parcellation for the study, and it is the only one provided by the RNRA, for the two periods. It was used for assessment of the period before and after the LTR program respectively.

### **4.6. Data processing**

#### **4.6.1. Processing of primary data collected**

Data collected through interview was originally written on the interview questions and jotters. In all the 30 interviews of landowners and government officials, 21 respondents were recorded while 9 disagreed with recording. All the interviews were transcribed in word document format for further analysis after collection.

#### **4.6.2. Processing of secondary data collected**

Raster data was provided in digital format, the Google image was taken to ArcMap and was geometrically aligned with the cadastral map (parcel shape files) The Ortho-photo raster data was also geometrically aligned in ArcMap. Both images were used in the process of change detection. A geo-database was prepared in ArcMap to keep all such relevant interoperable dataset for analysis.

### **4.7. Method of data analysis/presentation**

Data presentation in this research took varied methods. This includes qualitative and quantitative as well as through Information systems.

#### 4.7.1. Qualitative method of Analysis

A qualitative transcription/interpretation of the interview of landowners and government officials was done, (excerpts of this can be found in [appendix C1 - C3](#)). Also, official government documents were reviewed and summarised as necessary. These formed various parts of the thesis results.

#### 4.7.2. Quantitative method of Analysis

Part of the interview data collected were analysed using descriptive statistical method. This includes statistical tables, graphs, pie or bar charts for interpreting the results. Many of the statistical aspects of the GIS parcel data were calculated using the statistics report generator in attributes data table from the field "SHAPE AREA" in the attributes data table. Total shape area per respective land use category (i.e. built, or partly built, or vacant) were derived through the field calculator and was converted from square meters to hectares.

#### 4.7.3. GIS/Spatiotemporal analysis

The following data were used for spatiotemporal analysis of the study area.

- Ortho photo map of the study area 2008.
- Google image of July 7th 2013.
- Cadastral map of both Kinyaga and Masoro.
- Field inventory data of the land use situation of the study area.

#### 4.7.4. Classification of land use into three thematic categories

Spatiotemporal analysis was aided by classification of land use into three thematic categories. These are; *built parcels, partly built and vacant parcels*. These classes were derived to aid change analysis.

- Built parcel: This is a class of parcels that at the initial period before the LTR program was already built and basically had no space for agricultural practices.
- Partly Built/partly agricultural parcels are the medium or large parcels that had buildings and other parts used for agricultural practices.
- Vacant parcels: These are parcels that were agricultural lands and were not built before LTR program and are not likely to be built. A part of the study area which is lowland/wetlands also forms part of this category.

These classifications are necessary to ensure that the different groups of parcels fall into one land use category. They are then used to generate a change detection map to know where a parcel that was initially vacant has become built between the period before and after the LTR program.

#### 4.8. Analysis of land use change

One of the intuitive ways of extracting information from remote sensing images is by visual image interpretation (Bakx *et al.*, 2012) This is dependent on researcher's cognition of patterns and colours in relation to real world features. In line with this, the land use change detection technique as described earlier (section 2.9) was used for the periods 2008 and 2013. Also, identification and selection of the different land use categories based on the study's classification(section 2.10). The built parcels were selected and grouped in a thematic map called 'built' for both 2008 and 2013 respectively. These constitute the 'built map' for illustration of land use situation before and after LTR program. Similar selection was done for 'partly built' and 'vacant' (agricultural) parcels for the two periods before and after the LTR program. These thematic maps were used for analysis, both in terms of number of parcels and land sizes in hectares that were originally built or agricultural before and after the LTR program respectively. Further analysis was done with the method described earlier (section 4.7.2) as uniquely assigned to each parcel



which falls in the different thematic categories of built, partly built and vacant respectively. Thus, statistical data on land use change for the periods before and after the LTR program were generated and further analyzed.

#### 4.9. Approach for spatiotemporal land use change detection

Generally, approaches for change detection are quite similar but are particularly adapted to suit researcher's objectives. The general approach for land use change detection is stated earlier (section 2.9), while an adaptation to satisfy the objective of this study includes the following; digital data acquisition, geometric correction, study area extraction, cluster selection, determination of land use classes, change detection and reporting. This is diagrammatically expressed in the figure 4.3 below and the processes involved in change detection is also described in the flow chart as reflected in figure 4.4.

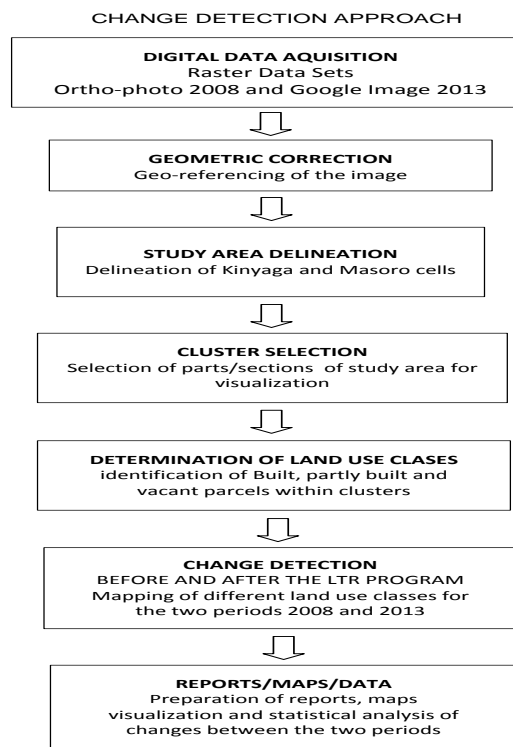


Figure 4.3: General approach to land use change detection

#### 4.10. Land use change detection process

The process of spatiotemporal land use change detection that is adopted by this study goes through the following steps and is particularly described in the flow chart of figure 4.4.

- Step 1: The process of acquisition of datasets that include the raster and cadastral data of the study area for the different periods under consideration.
- Step 2: This involves the investigation of the datasets where geometric correction and necessary checks are made on the datasets to ensure that it suits the objectives of the study.
- Step 3: Identification and delineation of the study area so as to enable clear definition of boundaries based on GIS overlay of the datasets, whereby the cadastral layer is laid on the raster layer. This also aided the identification of the status of each parcel. This was done for the two periods under study (before and after the LTR program).

- Step 4: The different clusters are then selected based on the different classes identified for the study (section 4.7.4). The selected parcels built or vacant are then exported as a layer in ArcMap. for further processing (cluster selection for detecting change in figures 4.5, 4.6 and 4.7 refers)
- Step 5: Generation of thematic land use map for each class are then generated from the selected clusters.
- Step 6 At this stage, the land use maps are used. This involves analysis of change that occurred in each period from each thematic map. Statistical/quantitative analysis is done in line with the process earlier described (section 4.7.2). Also, the total number of parcels and land size covered by each land use class are generated. Results of the analysis are then compiled in a report for further use.

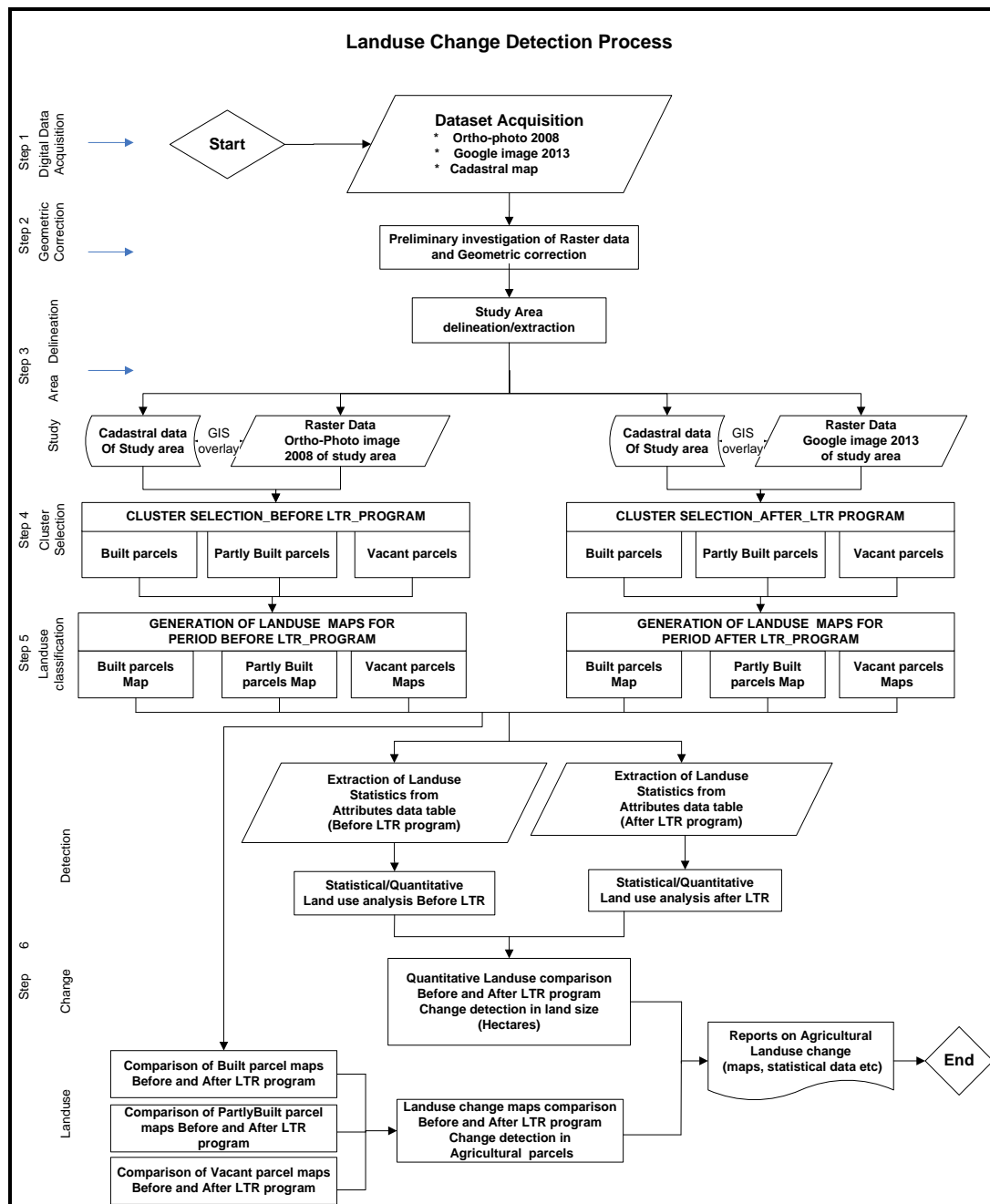


Figure 4.4: Land use change detection process (an adaptation)

#### 4.11. Method for detecting changes that took place before and after the LTR program

The change detection reflected in Figures 4.5, 4.6 and 4.7 was achieved by method earlier described (sections 2.9 and 4.8) (Bakx *et al.*, 2012; Orenstein *et al.*, 2011). This resulted in the detection of the built, partly built and vacant parcels in the study area which was used to make the respective thematic maps (Figures 5.2, 5.4, 5.7, 5.9, and 5.10) for further qualitative and quantitative analysis.

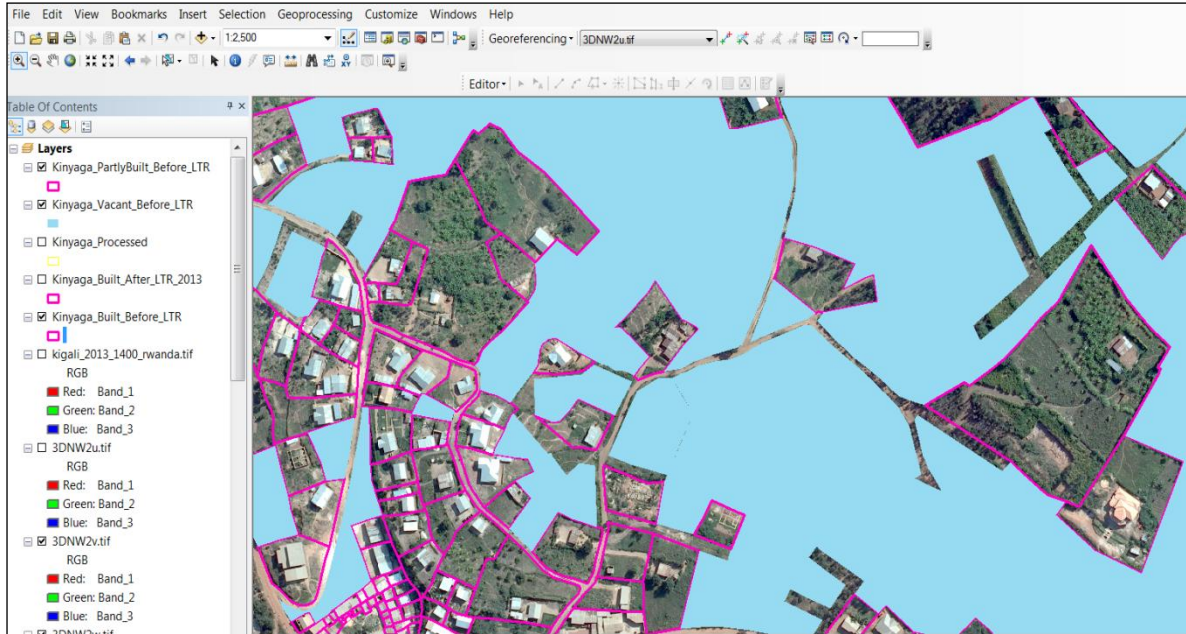


Figure 4.5: Detecting built parcels within a cluster before the LTR program in 2008.

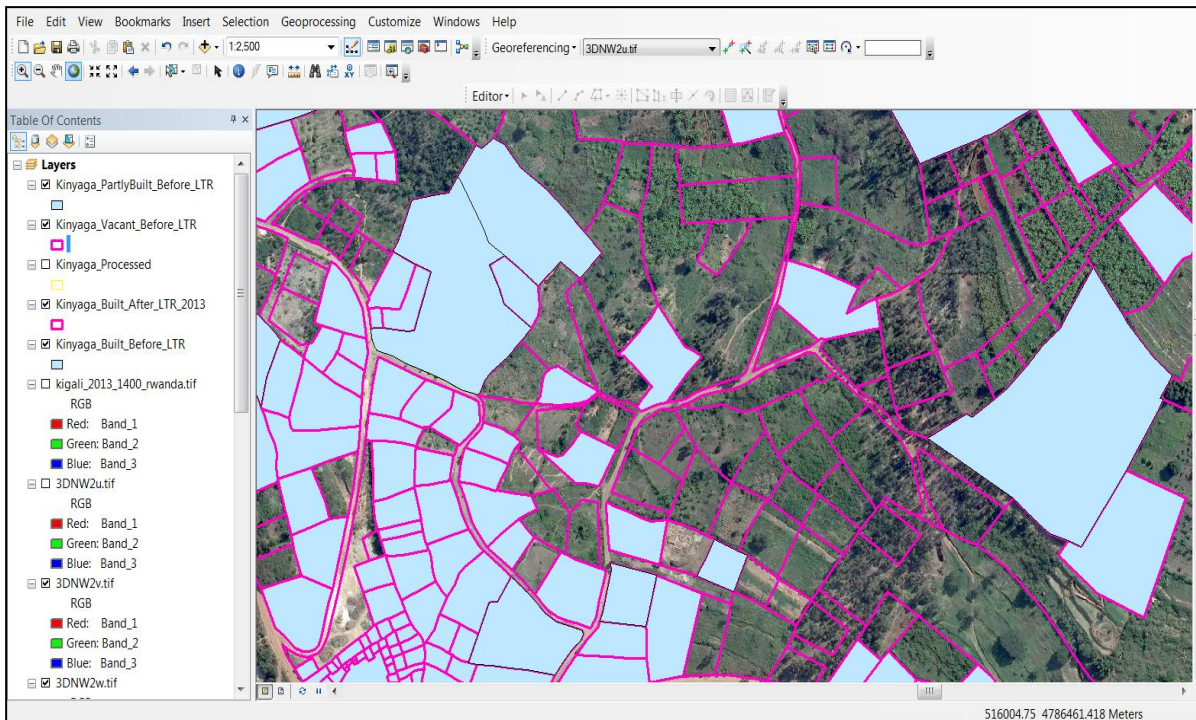


Figure 4.6: Detecting vacant parcels within a cluster before the LTR program in 2008.



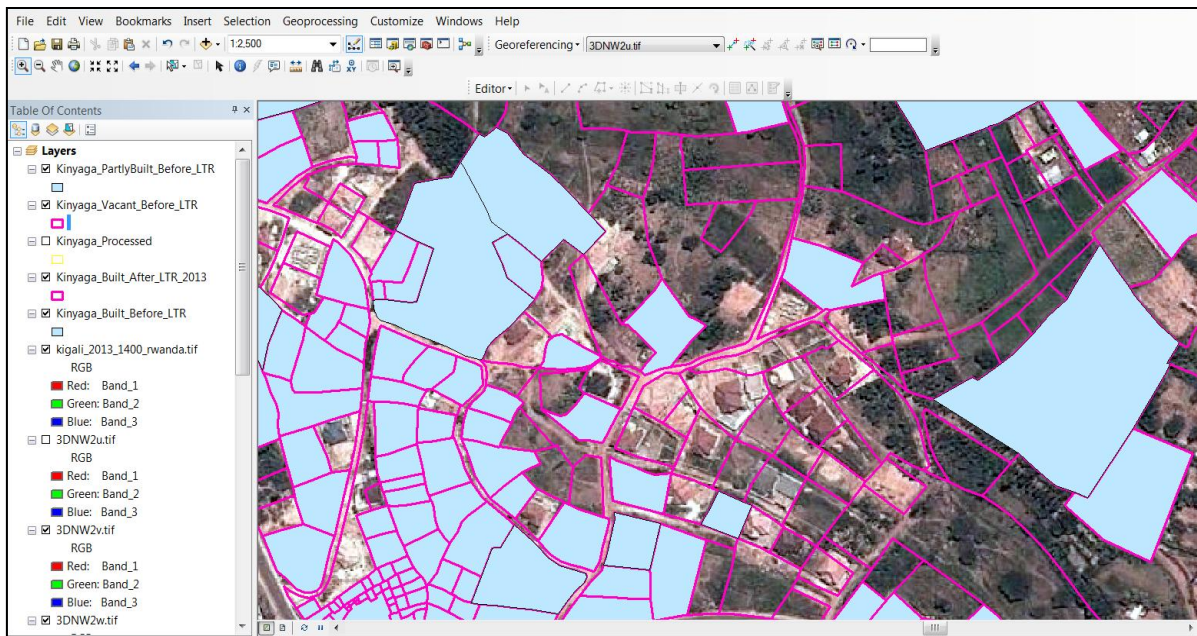


Figure 4.7: Detecting built parcels within a cluster after the LTR program in 2013.

The figure 4.7 above shows the typical cluster within the study area where new parcels have been built after the LTR program. This reveals the changes that took place between the period under study. One basic issue is that change detection is not a longitudinal process as it may be done in a variety of ways based on study objective. Therefore, the GIS approach was used to determine built and vacant parcels in order to arrive at the result required to achieve the study objectives.

#### 4.12. Method of evaluation of relationship between the LTR and LUC

The basis for the evaluation of the relationship between the LTR and LUC was stated in section 2.11. The use of multi-criteria analysis to assess the relationship requires an appropriate ranking. In this research, ranks of 1-3 were chosen and related to the percentage of the respondents for each category of the responses, bearing in mind the volume of data and need for a fair assessment. The different categories are; (1) low significance ranging between 1-33%, (2) average significance 34-66%, and (3) high significance 67-100%. This was applied to the data obtained on the extent of motivation of the respondents derived through ownership of land and procurement of secure tenure that triggered land use decisions making leading to land use change.

#### 4.13. Conclusion

A methodological and sequential description of techniques involved in the conduct of this research was treated in this chapter. The researcher implemented the research design to a realistic state, linking the theoretical and practical aspects of research as it applied to the study area bearing in mind the characteristics. The data required, collection method, its processing and analysis, were all attempted bearing in mind the study objectives. Approaches and processes for change detection based on certain classifications were used. The process was described diagrammatically and implemented practically to ascertain its authenticity in line with the study research questions to deliver the required result.

## 5. RESULTS AND FINDINGS

### 5.1. Introduction

This chapter consists of the results of data collected and analyzed from interview of the landowners, the government agencies and field observations. It also contains the result of the spatiotemporal analysis of the extent of agricultural land use change that occurred in the study area (Kinyaga and Masoro cells in Gasabo district) during the periods 2008 and 2013 respectively. Findings from the study are also explained along with the results. The study objective is to assess the impact of LTR program on agricultural land use change within the peri-urban area of Gasabo district in Kigali, Rwanda. Most often, land of the peri-urban area, particularly in agrarian communities like this study area are originally agricultural. The proximity to the urban area constitutes a high influence on the rate at which change would occur. Conversely, this may not influence change depending on the control measures that may have been put in place both at local and state level. In the case of Gasabo district, it was observed that, in the past, the cells were agrarian. However, it was also observed that recent land management initiatives particularly land tenure arrangements (secure tenure) triggered changes and awareness that motivated many landowners to make certain decisions and act as change agents. An assessment of the degree of change and its relative causes and effects forms the crux of this chapter and this is addressed with the sub objectives and research questions.

### 5.2. Effect of the LTR program on land rights

The LTR program with its intent and purpose was meant to grant landowners a secure tenure. This is reflected in the way the program was carried out. However, before granting title through the LTR, were there existing tenure arrangements? Also, how did this impact on land use change? These amongst others are issues to bear in mind.

#### 5.2.1. Type of rights held before the LTR program

Land tenure arrangement prior to the LTR program have their peculiarities as put by Rurangwa (2013), that, *"in Rwanda, there was a juxtaposition of both customary and statutory tenure in rural and urban areas respectively"*. Some landowners particularly in the study area prior to LTR held their lands under one form of customary tenure arrangements or the other. The customary system called 'gukeba' (please see section 3.2 for the description). Landowners who bought land and settled in the study area between 1994 and 2007 before the commencement of LTR program confirmed they were only given agreement paper by former owners, while the cell leaders testified to the transactions. These arrangements were under the customary tenure system. However, it was observed, that some respondents who bought land, built or renovated, and started living in the study area after the LTR program did not hold land rights before the LTR and were not part of previous tenure systems. Their own land rights are held under the LTR program. In order to determine the rights held, information about parcel ownership and tenure system was obtained. The results on parcel ownership revealed that all the 25 respondents owned the parcel on which the survey was conducted.

The respondents were further asked about their ownership process to determine how they became owners of such parcel and from their responses, it was observed that 23 respondents representing 92% had full ownership through purchase of the parcels while 2 respondents 8% inherited the parcels. It was observed

that many of the respondents (landowners) are relatively new in the study area, and they constitute the agent of the land use change which took place.

From the survey conducted it was observed that many of the respondents had their tenure under the LTR arrangements while some had theirs under the former customary system of Gukeba. Some respondents did not know the meaning of tenure. However, result revealed that 2 respondents representing 8% of total sample size had their tenure under the customary tenure system before the LTR program. Also, 20 respondents representing 80% of total sample size had their tenure based on the LTR program certification and 3 respondents representing 12% did not know what tenure mean. It was observed that many of the respondents did not live in the study area before the LTR. The certification seems to have involved all and sundry, and this eventually placed everyone on similar tenure system. Table 5.1 shows the responses on the tenure type in the study area.

Table 5.1: Tenure system within the study area

Description	No of respondents	% of respondents
Customary	2	8
LTR (Statutory rights)	20	80
Don't know tenure	3	12
Total	25	100

### 5.2.2. The nature of rights held following the LTR program

In order to determine the tenure status of respondents after the completion of the LTR program, information relating to current right status was derived through the interview. 22 out of the 25 respondents representing 88% of the landowners sampled indicated that they had their land certificates from the LTR program and/or had processed after subsequent transactions. 3 respondents representing 12% are still processing their certificates and did not have their land certificate at the time the survey was conducted. The issuance of this land certificate resulted to the ownership of statutory freehold or leasehold titles by the landowners. Land rights following the LTR program is regarded as statutory or legal since the ways by which the title was delivered are stated in the Rwandan land policy, land law, and other statutory guidelines. However, it is assumed that those who had no certificates or are still processing will eventually hold either the freehold or the leasehold title. This resulted from recent purchase of parcels or transfer of the rights in which they need to change the name to theirs in the land registry and be issued their own certificates. The result on possession of land certificate is expressed in the table 5.2.

Table 5.2: Possession of land certificate

Description	No of respondents	% of respondents
Yes	23	88
No	3	12
Total	25	100

### 5.2.3. Impact of the rights on the decision-making of landowners

Determining if having the land certificate (i.e. secure tenure) has influenced or motivated landowners in developing their parcels is also essential to satisfy one of the objective of this study. This was to know if the rights held influenced their decision-making as regards building, leading to change. Information gathered from the field indicated that 18 respondents representing 72% of the sample size were motivated to develop considering their secure tenure. Also, 4 respondents representing 16% showed that it made no difference to them and 3 respondents i.e. 12% said that it was not the secure tenure that motivated them. They stated that since they needed a house to stay, and they had a parcel, they had to build and to stop staying in rented apartments. Their result is reported in Table 5.3.

Table 5.3: Motivation to build derived from possession of land certificate

Description	No of respondents	% of respondents
Yes (motivated)	18	72
No (not motivated)	3	12
Indifferent	4	16
Total	25	100

The result indicated that a higher number of the respondents were motivated by having land certificates that led to decisions to use their land for building against the previous agricultural land use. Others who were not motivated and those who felt indifferent appeared minimal. Thus, it was observed that the motivation derived from having land certificates contributed to the changes that occurred in the study area.

### 5.3. Determining the extent of agricultural land use change before and after LTR program.

Land use change occurred due to the impact of certain driving force influencing the actor's decision to build their land, leading to change. The previous section addressed the secure tenure part of the study objectives and its influence on the actor. This part is meant to determine the extent of change that occurred based on the actor's decision between a selected epoch (*time i and j* respectively, i.e. as at 2008 and in the year 2013). This involved change detection which means applying multi-temporal datasets to analyse temporal effects of the phenomenon (Singh, 1989).

Firstly, to detect the agricultural land use change within the two periods, process of change detection covering the study area was used (section 4.10). The aim of the change detection is to know how much of the agricultural land use changed or were converted between the time before the commencement of LTR in 2008 and as at the study period after the LTR in 2013. The results were derived based on the classifications (section 4.7.4).

Secondly, land use inventory was carried out in the field with the cadastral maps within the two cells to determine the status of the parcels. The results of the first and second steps were combined for visualisation and processing in ArcMap, and statistical result was derived through descriptive statistics and map visualisation as shown in the figures 5.1 to 5.10 of this chapter. Analysis was done in comparison of the two periods (before LTR 2008 and after LTR 2013) so as to show the differences in land use conversion before and after the LTR program.

The land size that was converted from vacant agricultural parcels to built or partly built parcels followed the method stated earlier (section 4.7.2). In the process of detecting changes, the same cadastral map was used for the two periods under consideration (2008 and 2013) (section 4.5.6). It is assumed that before the LTR program, there was no distinct subdivision of the study area as well as the entire country. It was the LTR program that introduced demarcation during the country-wide adjudication processes which resulted into the production of the cadastral maps that are currently being used. Thus, the cadastral map served as a base map for the study.

#### 5.3.1. Overview of general land use situation before the LTR program

The general land use situation in the study area was assessed on cell basis, and the results were combined to form a whole. Individual cell thematic analysis was performed for the period before and after the LTR. The results revealed that the total number of parcels in each cell are 1,597 parcels and 1,965 parcels Kinyaga and Masoro respectively, (please see the details expressed in [appendix E, table E-1](#)). Also, the

total land area for each of the cells are 514.5 hectares and 629.5 hectares in both Kinyaga and Masoro respectively. Therefore, a total of 3,562 parcels and gross area of 1144 hectares were recorded in the study area. The table 5.4 below shows the total parcels and land size relationship in the two cells of the study area.

Table 5.4: Total parcels and land size in the study cells

Description	Total parcels	Land area/size (ha)
Kinyaga cell	1597	514.5
Masoro cell	1965	629.5
Total	3562	1144

### 5.3.2. The differences in land use before the LTR program based on classifications

The analysis of land use before the LTR based on the classification (section 4.7.4) and through the change detection process (section 4.10.) gave the result showed in the table 5.5 below for the period before LTR program. The different categories of parcels and their respective land sizes were defined, and are expressed in the table 5.5 and figure 5.1.

Table 5.5: Total parcels/land size by classification before LTR program

Description	Total parcels	Land area/size (ha)
Built parcels	1123	67.1
Partly built	365	619.4
Vacant agricultural parcels	2074	457.5
Total	3562	1144

From the data obtained, it is observed that a total of 1123 parcels fell into the built category and this constituted 67.1 hectares of land in size while the partly built resulted to 365 parcels that covered an area of 619.4 hectares of land. The vacant agricultural parcels resulted to 2074 parcels that covered 457.5 hectares. However a variation as regards the correlation of both number of parcels and land size in the study area was observed, and this relates to the differences in parcel size and existence of some large parcels.

The large parcels are used for educational and industrial purposes, (i.e. primary/secondary schools as well as university) This includes parcel with p\_id 641 covered 20.7 hectares and parcel with p\_id 1163 covered 157.8 hectares in Masoro. The parcels were partly built in the period before the LTR program and became built after LTR. Another very large parcel with p\_id 449 which was partly built covered 211.8 hectares in Kinyaga cell. The parcel was zoned for industrial use. It was partly built before the LTR program and remained partly built even after the program. These three large plots added up to 390.3 hectares and constituted about 34% of the total land size. (this is regarded as significant).

Before the commencement of the LTR, the large parcels were partly built. On the industrial parcel there were many small buildings and agricultural lands scattered in different parts. However, after the LTR had been completed the large parcel remained partly built (with just few industrial buildings). This may be because, not all industries that are allocated part of the land have constructed their structures on the land. Data on cadastral subdivision of the industrial parcel was not made available for this study, and being a single parcel, it was categorised under one of the classifications (i.e. partly built). The only company that was well established and operational as at the time of study is the Azam Flour mills. Therefore, the variation observed in the non proportional land size between the two periods is based on the large area occupied by both educational and industrial parcels. The figures 5.1 shows the graphical illustration of the



built, partly built and vacant parcels in which the extent of this variation can be distinguished, while figure 5.2 shows the general land use pattern in the study area before the LTR program.

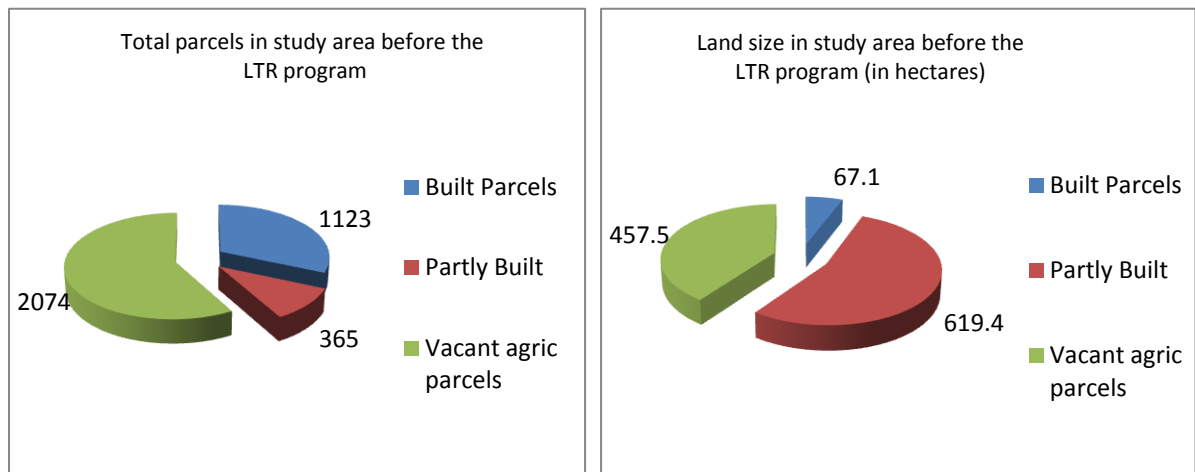


Figure 5.1: Parcels and land size distribution before the LTR program

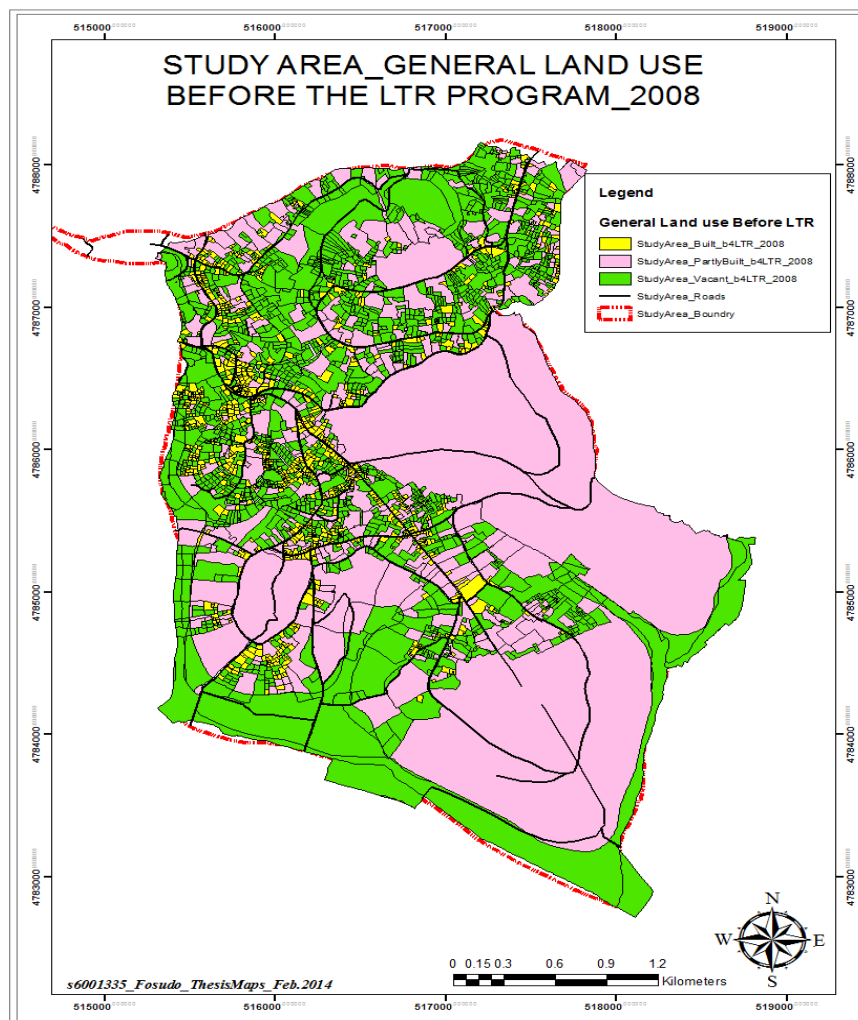


Figure 5.2: General land use map before the LTR program

### 5.3.3. The extent of agricultural parcels before the LTR program

The total number of parcels in the study area was determined to be 3562 parcels. Thereafter, built and partly built parcels were selected and the vacant parcels derived. These formed the agricultural parcels within the study area. The result showed that 2074 parcels were agricultural parcels as at 2008 before the LTR program. This constituted 58% of the total number of parcels in the study area at that time. Table 5.6 below shows the extent of agricultural parcels before the LTR program.

Table 5.6: Extent of agricultural parcels before the LTR program

Description	Total parcel nos.	% of parcel
Total no of parcel in study area	3562	100%
Total no. of agricultural parcels	2074	58%
Difference (built and partly built)	1488	42%

### 5.3.4. The extent of agricultural land size before the LTR program

The total land size of the study area was determined from the size of each parcel using the method stated earlier (section 4.7.2). This land area was summed up and converted from square meters to hectares, and this resulted to 1144 hectares. This data for agricultural land use was derived from attributes of the thematic map for vacant parcels, and it resulted to a total of 457.5 hectares that made 40% of the total land in the study area as at 2008 before the LTR program. Table 5.7 displays the result derived.

Table 5.7: Extent of agricultural land area/size before the LTR program

Description	Area/size in ha	% of area/size
Total land area/size in study area	1144	100
Total agricultural land area/Size	457.5	40
Difference	686.5	60

## 5.4. The difference in land use after the LTR program based on classifications

The nature of land use after the LTR program based on the classification identified in 4.7.4 above is also important for this study. This was derived using the same change detection process stated in section 4.10 to generate the land use situation map and data for the period 2013 after the LTR. The results are reflected in the table 5.8 and figure 5.3, while figure 5.4 shows the general land use pattern in the study area after the LTR program.

Table 5.8: Total parcels/land size by classification after the LTR program

Description	Total parcels	Land area/size
Built parcels	2001	332.4
Partly built parcels	481	457.1
Vacant agricultural parcels	1080	354.5
Total	3562	1144

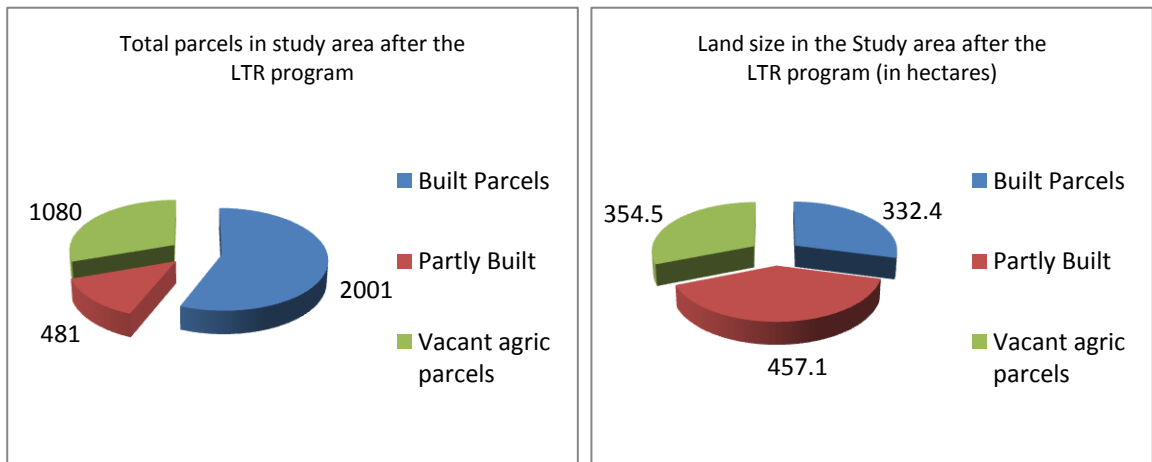


Figure 5.3: Parcels and land size distribution after the LTR program

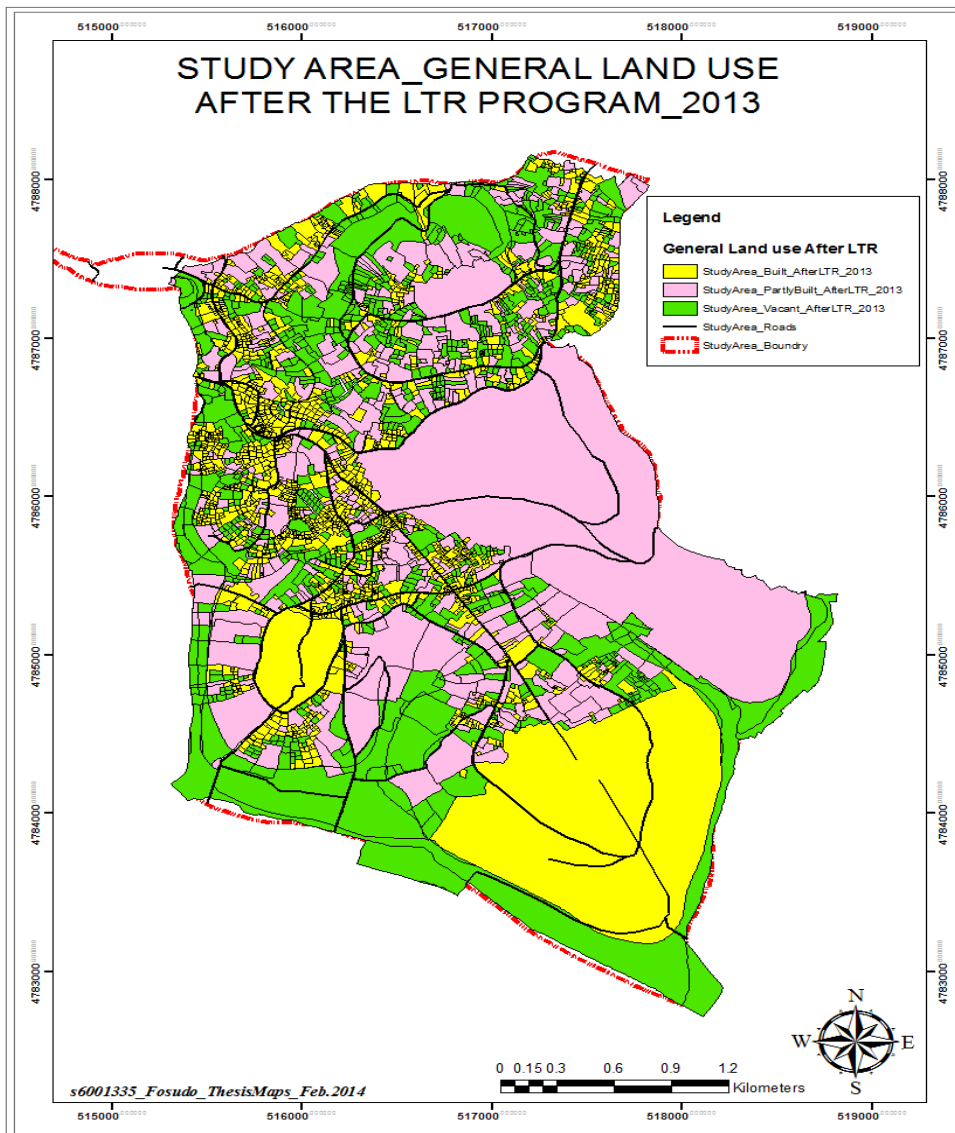


Figure 5.4: General land use map after the LTR program

#### 5.4.1. The extent of agricultural parcels after the LTR program

Bearing in mind that it is pertinent to determine the extent of the agricultural land use in terms of total parcels and land size for the period after the LTR in 2013, detection of the built and partly built parcels was made. The vacant parcels were generated, and the total number of parcels was also obtained from the attributes data table. The result obtained showed 1080 parcels that constituted 30% of the total number of parcels whereas 70% of the whole parcels constituted built or partly built. The result is reflected in the table 5.9 below.

Table 5.9: Extent of agricultural parcels after the LTR program

Description	Total Parcel nos.	% of Parcels
Total no. of parcel in study area	3562	100%
Total no. of agricultural parcels	1080	30%
Difference (built and partly built)	2482	70%

#### 5.4.2. The extent of agricultural land size after the LTR

In order to determine the extent of land size that is being used for agriculture after the LTR program in 2013, the parcels detected to be vacant were grouped, and the total land area was determined. This was also converted from square meters to hectares, and it resulted to a total of 354.5 hectares that constituted 31% of the total land size in the study area. This is shown in the table 5.10 below.

Table 5.10: Extent of agricultural land area/size after the LTR program

Description	area/size in ha	% of area/size
Total area/size in study area	1144	100
Total agricultural land area/Size	354.5	31
Difference	789.5	69

### 5.5. Analysis of actual agricultural land use before and after LTR program

A summary of the general thematic land use in the study area between the two periods (before and after LTR program) is reflected in the table 5.11 below. The total number of parcels in each category was assessed. The result indicated that built parcels were 1123 and 2001 parcels, while land size was 67.1 and 332.4 hectares before and after the LTR respectively. Partly built were 365 and 481 parcels while land size was 619 and 457.1 hectares before and after LTR respectively. Also, vacant agricultural parcels amounted to 2074 and 1080 parcels and 457.5 and 354.5 hectares before and after LTR respectively.

Table 5.11: General land use situation before and after the LTR program

Land use classification	No. of parcels before LTR	No. of parcels after LTR	Land size before LTR (hectares)	Land size after LTR (hectares)
Built parcels	1123	2001	67.1	332.4
Partly built parcel	365	481	619.4	457.1
Vacant parcels	2074	1080	457.5	354.5
Total	3562	3562	1144	1144

#### 5.5.1. Changes in the number of parcels

Comparatively, total number of built parcels was low before the LTR and this increased after the LTR. This indicated that many agricultural parcels that were vacant prior to the LTR became built after the LTR program. A difference of about 878 parcels was recorded as increase. The partly built parcels recorded

averagely low number, showing only a slight difference before and after the LTR program i.e. an increase of 116 parcels was recorded. On the part of the vacant agricultural parcels before the LTR program, it was 2074 parcels but this reduced by 994 parcels becoming 1080 parcels after the LTR program. Figure 5.5 below show the graphical relationships.

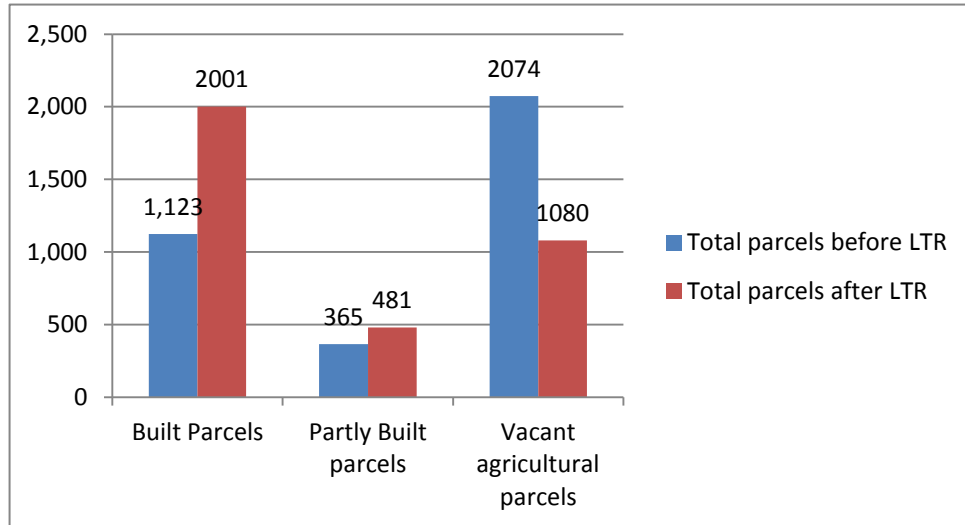


Figure 5.5: Comparative general land use situation before and after the LTR program

#### 5.5.2. Changes in land size

In terms of land size, the built land area with 67.1 hectares before the LTR was low, but it increased to 332.4 hectares after the LTR. This indicated a rapid increase of 265.3 hectares being built between the two periods. The partly built land area was 619.4 hectares before LTR, and this reduced to 457.1 hectares after the LTR. It showed a difference of 162.3 hectares. Meanwhile, the vacant agricultural lands before the LTR it was 457.5 hectares, and it reduced by 103 hectares leaving 354.5 hectares vacant as at the time of study. Non-proportionality in terms of land size was observed (section 5.3.2). Figure 5.6 shows the situation of land sizes before and after the LTR program.

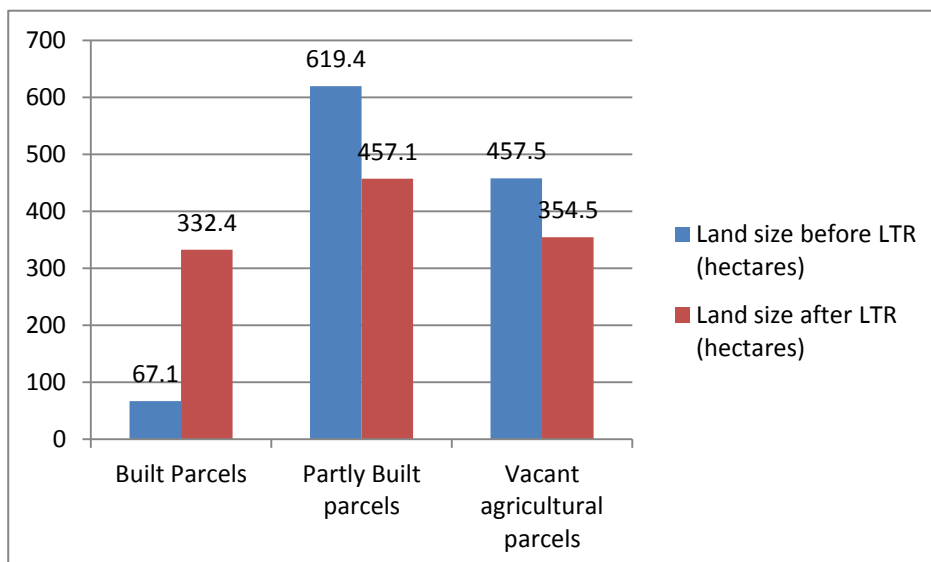


Figure 5.6: Changes in land size before and after the LTR program

## 5.6. Difference in the agricultural land use within the selected epoch

To summarise the actual change that occurred, a correlation of the previous and current agricultural land both in number of parcels and land sizes were made by deducting one from another. This was done by checking the total parcels and land size that was agricultural land use before the LTR program as at 2008 and that of 2013 after the program to get the difference (a table of summary of this data analysis can be found in [appendix D, table D-1](#)). It was observed that out of the total 3562 parcels and 1144 hectares of land, agricultural parcels totalled 2074 and 457.5 hectares before the LTR program in 2008 which constitutes 58 % of the entire parcels and 40% of the entire land size. However, in the period after the LTR program in 2013, the total agricultural parcels have become 1080 parcels and 354.5 hectares constituting 30% of the total parcels and 31% of the land size respectively. It was observed that a difference of 994 parcels and 103 hectares was recorded as changed between the two periods. This means the percentage of parcel loss from the agricultural parcels was 48% of the agricultural parcels. In terms of land size, it was 22% of the agricultural land area. The tables 5.12 and 5.13 shows the result of the actual change that occurred in terms of parcels and size of the total agricultural land.

Table 5.12: Difference in agricultural parcels within the selected epoch

Description	Total agricultural parcels	% of agricultural parcels
Total agricultural parcels before LTR	2074	100%
Total agricultural parcels after LTR	1080	52%
Difference	994	48%

Table 5.13: Difference in agricultural land size within the selected epoch

Description	Agricultural land area/size	% of agricultural land size
Total agricultural land size before LTR	457.5	100%
Total agricultural land size after LTR	354.5	78%
Difference	103	22%

The figure 5.7 shows the total agricultural parcels before and after the LTR program in 2008 and 2013 as derived through the analysis,

It was observed that many parcels within the study area that were vacant and used for agriculture purposes in 2008 had been built or converted to other uses as at the time of study in 2013.

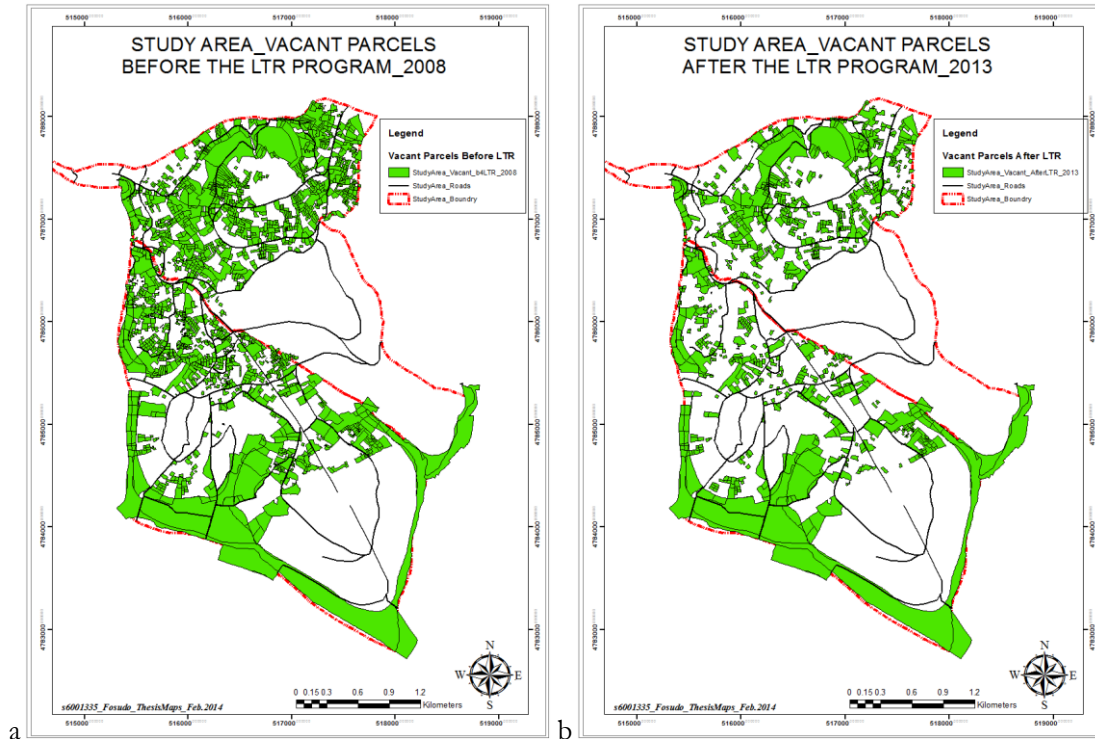


Figure 5.7: Maps of vacant parcels before and after the LTR program

In order to know the actual change that occurred, the difference in agricultural parcel was expressed from the total number of agricultural parcels in the study area. This was derived by comparing the total agricultural parcels before and after the LTR program in terms of percentage of agricultural parcels that changed. It was observed that the total agricultural parcels at the commencement of the LTR program in 2008 was 58% of the total parcels in entire study area, while as at the study period in 2013, it was 30% making a difference of 28% in actual change. However, in terms of land size, it was 40% in 2008 and in 2013 it became 31% making an actual change of 9% of the total land size in the study area. This is expressed graphically in figure 5.8 below.

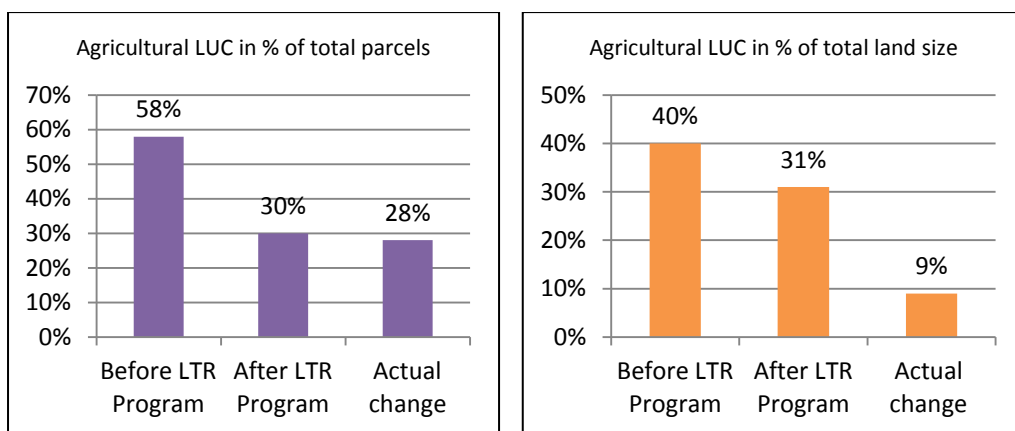


Figure 5.8: Actual agricultural land use change (parcels and land size)

### 5.7. Analysis of land use change in terms of built and partly built parcels

The built parcels in the study area were assessed for the two periods before and after the LTR program so as to visualise the extent of change that occurred in the built and partly built categories. It showed how much was built before and how much was built after, and also to expressed the extent of agricultural land

use change between the two periods. Analysis revealed that total built parcels were 1123 before the LTR program while this increased to 2001 parcels after the LTR program. The difference is reflected in the figure 5.9, showing the extent of built up parcels in the study area before and after the LTR program 2008 and 2013 respectively.

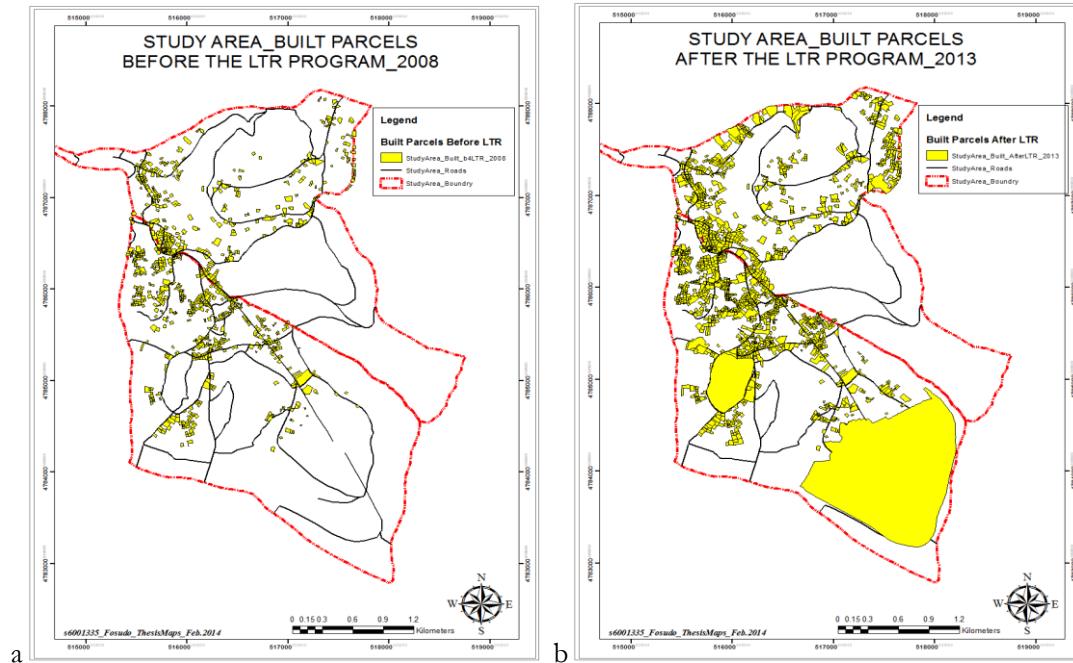


Figure 5.9: Maps of built parcels before and after the LTR program

The partly built parcels was assessed and these constituted 365 parcels before the LTR program and increased to 481 in 2013 after the LTR program showing a difference of 116 parcels. On the contrary the land size reduced from 619.4 to 457.1 hectares due to the transition of some large parcels that became built between 2008 and 2013. The difference is expressed in the maps in figure 5.10 for the two periods.

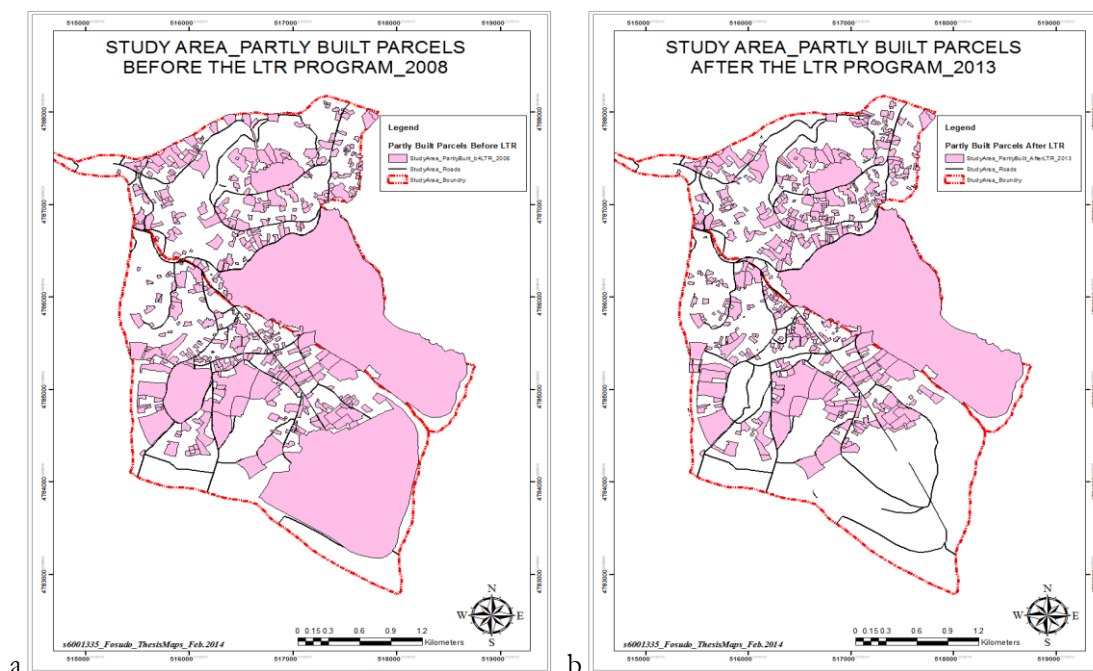


Figure 5.10: Maps of partly built parcels before and after the LTR program



### 5.8. Determining the relationship between the LTR and LUC

Relationship between the LTR and LUC was derived through the extent to which the secure tenure obtained through LTR program motivated landowners to make land use decisions leading to land use change. It is important to note that human decisions have become a major determinant for land use change through the various modifying activities that are associated with land use (Foreman *et al.*, 1997), many of which are hinged on their tenure status as observed in this study. Therefore, it seems difficult to separate the rights and interests held in land from the motivation of the owner to optimally transform it to a beneficial utility. The change resulting from such use on the long run, would have an impact on land administration in terms of feedback on the outcome of LTR. Such changes may lead to need for up-to-dateness of both the database or land use impacts considering temporal/spatial over a selected epoch for further land use policy and/or decision making (Jing *et al.*, 2013). The relationship between these components of change derived through secure tenure can thus be viewed in the context of the figure 5.11.

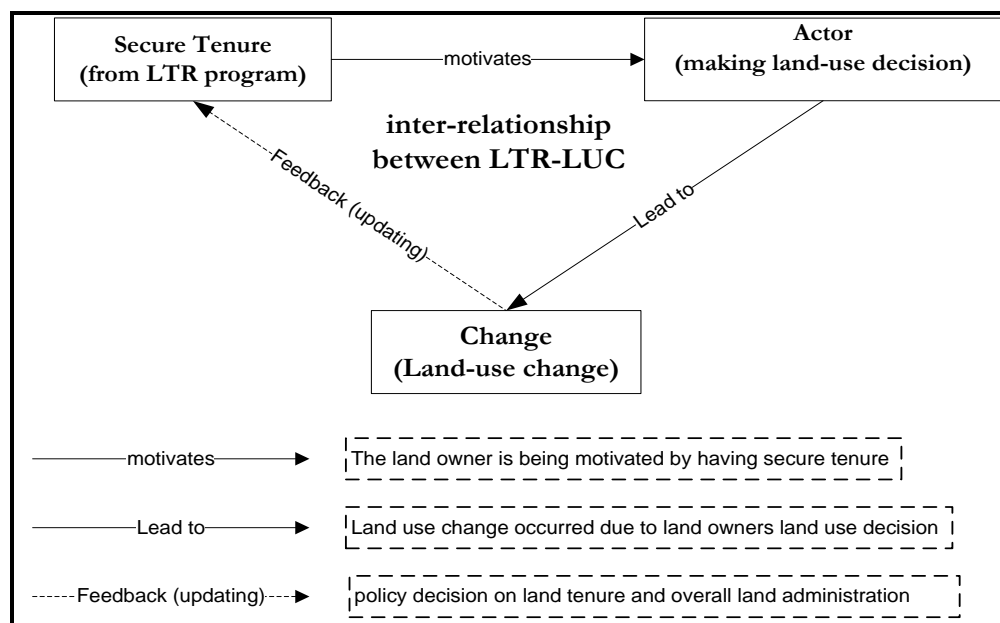


Figure 5.11: LTR and LUC relationship

#### 5.8.1. Evaluation of the LTR and LUC relationship in terms of secure tenure

Evaluating the relationship between the LTR and LUC was achieved by determining the level of significance of the motivation derived from having secure tenure by landowners. The following evaluation criteria as explained in section 4.12 was used. This includes; low significance, average significance and high significance and this is expressed in the ranges stated in table 5.14.

Table 5.14: Criteria for evaluation of relationship between LTR and LUC

Criteria	Percentage of motivation (in range)
Low significance	Between 0-33%
Average Significance	Between 34-66%
High significance	Between 67-100%

In order to determine the effect of the relationship between LTR and LUC, it is therefore pertinent to look at the overall impact of the motivation derived from the secure tenure. Data used for this purpose was obtained from beneficiaries of the LTR program.

From the data gathered, it was observed that 72% of the respondents were motivated by secure tenure, 12% were not motivated while 16% of respondents were indifferent in their decision-making. Overall result from this analysis showed that the majority of respondents were motivated by secure tenure conferred by LTR. This category of respondents falls within the range of high significance criterion of the impact of secure tenure from LTR leading to land use change. This is expressed in Table 5.15.

Table 5.15: Evaluation of relationship based on motivation derived from secure tenure

Description	% of respondents	Evaluation of responses
Yes (motivated)	72	High Significance
No (not motivated)	12	Low Significance
Indifferent	16	Low Significance
Total	100	-

The response from the government official as regards motivation of the landowners and tendency to change land use, also complements this evaluation of relationships between secure tenure and land use. In the words of the DDG, *"one of the things which we have realised and we know is that once people have secure tenure, they put improvement on their land and development might be building and might be anti corrosive mechanism..."*. This statement confirmed the position of the majority of the respondents concerning relationship between having the secure tenure and land use change. The DDG further confirmed that secure tenure motivates landowner's decision to build especially when they are confident in the land titles conferred on them.

#### 5.8.2. Relationship between LTR and LUC in terms of parcel and land size change

As derived from the analysis of the extent of parcels converted or changed from agricultural land use to other uses in the period before and after LTR program, a transitional change was observed. Many parcels that were vacant became built or partly built, while some partly built parcels became fully built. This showed that land use change was driven by dynamic decision-making as observed within a short time frame of 5 years. The land area that changed looks smaller in term of size, compared to the total number of parcels. This has been explained in section 5.3.2. However, most of the changes that occurred relates to landowners' decision based on motivation derived from secure tenure.

#### 5.9. General observations

The area referred to as wetlands, shown in figure 5.12 was observed to form part of the current agricultural parcels. This area is about 128.7 hectares. A small part of this wetland constituting 0.24 hectares has been built. (although quite minimal but considering its being a hazard zone, caution towards building in such area is required). Meanwhile, it was observed that other parts are still vacant and formed part of the agricultural land as at the time of this study.

Another observation in the course of data collection is the availability of a newly formulated zoning regulation and Kigali city master plan (both of which are yet to be signed to law as at the time of this research). These may have a slight impact on future developments. Interview response at the Gasabo district one-stop centre revealed, that the landowners are currently being sensitised on the need to observe specified land use before they build. This is in line with the proposed zoning and master plan. The zoning regulations also operates as a measure to enhance land management in line with the provision of the Land use planning law. The chapter III, articles 10-14 of the law which states that, *"applicant shall apply in writing and approval shall only be granted in accordance with provisions of the law and elements of the master plan. Such approval shall only be determined by competent authority based on ministerial orders in which modalities for change has been determined"*. Also the Land policy also stipulates under the general principles that government has the duty

to promote and support ecological and economic dynamics by guiding the behaviour of land users (GoR, 2004, 2012c)

In the course of the interview, attempt was made to determine from the landowners if land use type was specified in their land certificates, many respondents confirmed that land use was specified but some did not adhere to the specified land use. Many parcels were previously agricultural and had been built before the introduction of the recent zoning regulations. Also, during the interview with a government official in charge of land administration,(land and mapping department) it was confirmed that the zoning regulation has not been signed into law yet. It is operational, only to sensitize all intending developers of the need to adhere to provisions of the zoning law and the provision of the master plans. Meanwhile, according to the response of the DDG on position of government on change, he says, *"current land use shall be retained even when it is not in compliance with the zoning, only that the approval for a change may not be granted, if future request is made for any non-conforming use. Thus, the authority will retain current use in its existing state"*. This is indication that any applicant trying to change later will be made to adhere to the zoning plan. This confirm that government position is to ensure compliance with the newly proposed zoning plan and would retain all land currently zoned for agricultural purposes. This appear to be a complementing strategy to ensure good land administration.

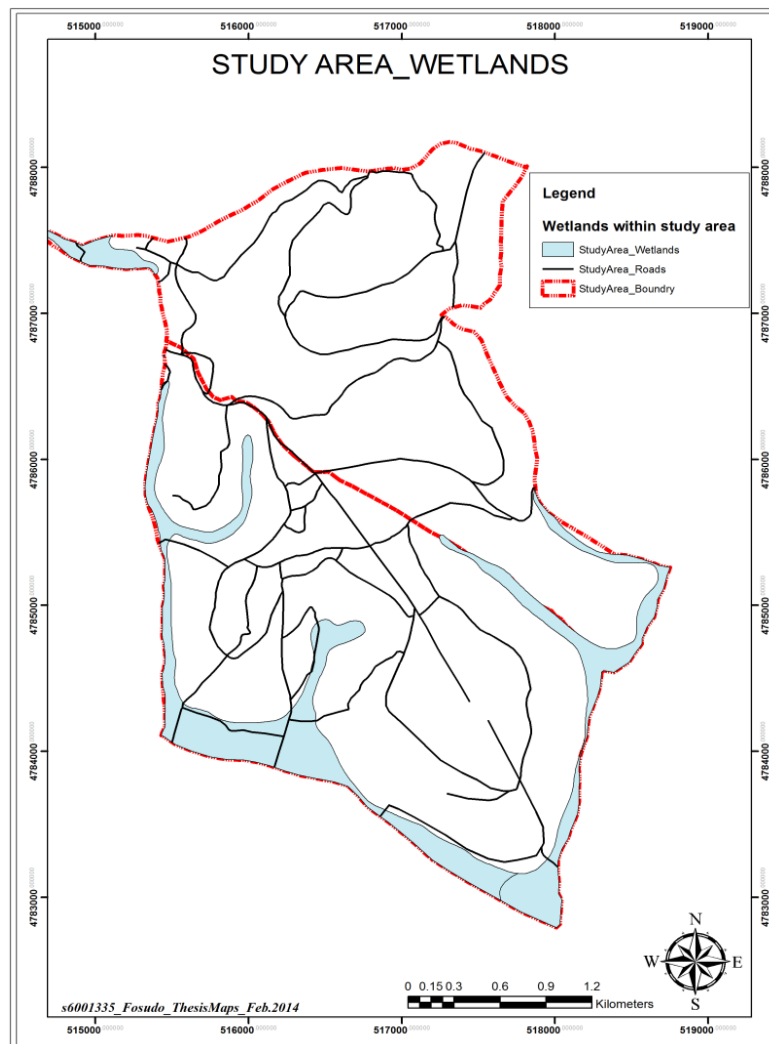


Figure 5.12: Wetlands in the study area

### **5.10. Validity of results**

Although fieldwork and analysis for this research was conducted in the last quarter of the year 2013, a greater percentage of results of this research may become obsolete in the nearest future. Therefore, it is required to continue to ensure constant update of change dynamics in land use comprising built, partly built, vacant or agricultural parcels in the study area using a combination of modern observation methods for land use change.

### **5.11. Conclusion**

In this chapter, the study confirmed the type of rights held, how the landowners reacted to the rights held, and if these rights informed land use decision-making of landowners. It identified the general land use and the various thematic land uses as well as their relationships in terms of the total number of parcels and land area coverage that changed. It noted the actual change which occurred both with maps and charts in different figures. The chapter also included an evaluation of the relationships between the LTR and LUC by assessing level of significance. The influence of the driving force on the landowner was seen in this study as expressed in the results and findings.

## 6. CONCLUSION AND RECOMMENDATIONS

### 6.1. Introduction

This chapter consists of discussions from the analyzed data, while some inferences from the analysis are also drawn. The study made attempts to assess the impacts of LTR on land use change. It discussed land use change within the peri-urban area as a result of LTR program relating to land reform policy formulation and implementation. In land use change studies, some drivers are stated in section 2.7 while drivers of land use change like the secure tenure was identified and also require to be studied which this research considered and did. The results of the impact of such driving force influence on the actor leading to change are thus discussed in this chapter. The view of the researcher is also stated, and other areas for further research in the land use change topic are also suggested.

### 6.2. Conclusion

This study was conducted with the main objective of assessing the impacts of LTR program on agricultural land use change in the peri-urban area of Kigali in Rwanda. In order to achieve the objective three sub objectives were stated which are hereby discussed below;

The first sub objective is, to examine the effect of the Rwandan LTR program on land rights.

To achieve this objective, three questions were formulated and these guided the findings of the tenure system and its impacts on the rights of landowners and are discussed as follows;

- 1 What were the rights held before the land tenure regularisation program?

From a review of the literature, it was observed that there was a juxtaposition of both customary and statutory tenure system (Rurangwa, 2013)(Section 5.2.1 refers). Therefore, it can be said that there was a mixture of tenure system before the LTR program since customary and legal rights were both operational. It was also observed during the interview that the 'gukeba' system was known to be operational in the study area (Section 3.2). This was confirmed by 2 indigenous respondents (Section 5.2.1). However, considering the fact that the study area was agrarian in the past, past tenure before the LTR can be taken to be customary tenure.

- 2 What is the nature of rights held following the land tenure regularisation program?

The Rwandan LTR program as one of the land tenure reform strategies introduced formalisation of tenure enabled by policy and legislation (section 3.3) and brought statutory tenure system and conferred on the people, statutory rights. As at the time of this study, 8.4 million titles had been issued (section 1.1). Therefore following the LTR program, statutory rights were held by many of the landowners. The ownership status observed during the interview confirmed that 88% of the respondents already possessed their land certificate and this granted them statutory freehold or leasehold (section 5.2.2). This subsequently gave landowners rights of access to land and to exploit in accordance with its nature and intended use (GoR, 2013). Thus from the study conducted it can be concluded that rights held following the LTR program is statutory/legal rights.

3 What impact did the rights have on the decision-making of landowners?.

It is believed that tenure influences land use decisions making (Farley *et al.*, 2012; Wannasai & Shrestha, 2008). This is reflected in the response of the interview of secure tenure impacts on landowners in the course of this research. Many of the landowners interviewed had secure tenure (Table 5.2 refers). This gave them a bundle of rights supported with the certification that motivates landowners to make land use decisions such as to build, plant, graze or even transfer as a way to fully exploit their rights of ownership. From the results of the survey conducted, a good percentage of the respondents i.e. 72% confirmed their motivation (Section 5.2.3, Table 5.3 refers). The impact of the rights held on the decision making of the landowners as derived through this motivation led to land use change which was observed in the study area. On the issue of the secure tenure impact on land owners, many landowners had the notion of authenticity of land ownership based on the bundle of rights embedded in the secure tenure either in the short or long run. The confidence derived by many landowners and also as found out during interviews showed that many of them had in mind that they possessed tangible land right, thus did not hesitate to build their parcels. Some landowners also did not hesitate to transact through sale or lease. All these resulted to change of the original landscape either (agricultural) to the current state (built/mixture of land uses). This is related to the landscapes fragmentation (physical or ownership) (section 1.1).

The second sub objective is how agricultural land use has changed over a selected epoch

In order to determine how agricultural land use has changed as required in sub objective 2, a change detection technique was used. This involves data integration technique according to Alkema *et al.* (2012); Erenner *et al.* (2012); Estoque and Murayama (2011); Lu *et al.* (2004); Orenstein *et al.* (2011), (section 2.8). The general approach is particularly described in section 4.9 with figure 4.3 while section 4.10 and figure 4.4 expresses the change detection process followed with screen shots of the process in figures 4.5, 4.6 and 4.7. Three research questions were equally formulated to achieve the objective and these are discussed below;

1 What was the extent of agricultural land use in the study area as at 2008 at the beginning of the LTR program?

The extent of agricultural land use in the study area before the LTR program as at 2008 as shown in the section 5.3.3, table 5.6 reveals that, from a total of 3562 parcels, 2074 parcels that constitute 58 % of the total number of parcels in the study area was used for agriculture before the LTR program. This translates to 457.5 hectares in land size that forms 40% of the total land size of 1144 hectares (section 5.3.4, table 5.7 refers). The figure 5.7(a) shows the visual characteristics of the agricultural land use before the LTR. It was observed that prior to the LTR program many parcels were still used for agricultural practice. Although some parcels were partly built and partly used for agricultural practice, these were not considered as full agricultural parcels, the study centred on those parcels that are solely agricultural for this analysis.

2 What was the extent of agricultural land use in the study area in 2013, when the regularisation program had been completed?

After the LTR program in 2013, the agricultural land use in the study area reduced to 1080 parcels that formed 30% of the entire parcels in the study area as expressed in table 5.9 (section 5.4.1). Also in terms of land size it was 354.5 hectares that constituted 31% of the entire land size of 1144 hectares (Section 5.5.2 and Table 5.10 refers). The visual expression of the extent of land use after the LTR program refers

to figure 5.7 (b). After the LTR program, many landowners had built their parcels even though they were agricultural parcels before the LTR program.

- 3 What is the difference in agricultural land use between the two periods? (i.e. actual change that occurred).

As at 2013 when the program had ended the actual change that occurred translates to the total agricultural land loss between the two periods 2008 and 2013 (5 years). From data obtained, it was observed that, in terms of parcels, a total of 994 parcels out of 2074 parcels that constitute 48% of total agricultural parcels has been built. Meanwhile in terms of land size a total of 103 hectares out of 457.5 hectares that constitute 22% of the total agricultural land size. In relation to the total parcel in the study area, this 994 parcels translate to 28% (figure 5.8), while in terms of total land size in the study area, the 103 hectares translates to 9%. However, it is observed that there is rapid agricultural land change in the study area within the two periods (section 5.6).

The third sub objective is to determine the outcome of the relationship between the LTR and LUC, as a result of the rights held.

This was done through an evaluation of how significant the secure tenure had influenced the landowners towards making land use decision which led to land use change. The result reveals that there is high significance influence of secure tenure on landowners who made land use decisions which resulted to change of land use in the study area within the period under study (table 5.15 ). According to the analysis, 72% of the landowners who had secure tenure admitted motivation based on the rights held and 4% and 3% of the respondents were indifferent and not motivated, respectively (table 5.3). It is equally assumed that respondents who were indifferent/not motivated seem to have made up their mind to proceed with making land use decision bearing in mind also that their certificates are either under processing, or will be procured later. Also, that being the rightful owners of their parcels they can build and have other necessary documentation done at convenience.

### **6.3. Recommendations**

This study explores the spatiotemporal patterns of land use change in Kinyaga and Masoro cells of Gasabo district in Kigali Rwanda. It confirms the applicability and effectiveness of GIS techniques in assessing a detailed land use change particularly from vacant agricultural land use to built land use of different categories within the study area based on the certain human actions. One important factor is that the study area experienced transformation within a short time of 5 years relative to the impact of secure tenure as a driving force influencing landowners to make land use decision. Although in most situations changes occur, the drivers are not noticeable but by careful observation and study like this, it will be revealed.

A study on human reactions to issues and policies can equally reveal why changes occur. Policies do normally shape landscapes through human actions but it may be unnoticeable if study is not conducted. When studies are carried out on such a phenomenon, then the true state is revealed, causes are known, possible impacts are derived and possible consequences of such actions are known in order to inform the concerned. In this case policy makers should be aware of such changes taking place to ensure good land management.

In order to contribute to knowledge in this area of study, the following are hereby suggested:

- Further research can be done to identify some other driving forces that impact on land change within the peri-urban area. Also, the driving forces that might have adverse effect on the functionality of the landscape, if identified, can be addressed on time. For instance, new intervention and infrastructure provisions in the peri-urban area, peri-urban industrial development and how they trigger on land use around them leading to possible land use change, etc.
- In the course of investigating the impact of secure tenure on agricultural land use change, a newly introduced zoning regulation was identified as a possible influence on land use change. This has been introduced by the government for the land administration agency to use as a guide and has been used to sensitize the people, guiding them on the use of land in conformity with the newly prepared Kigali city master plan 2013. Further research may also be conducted to determine the impact of zoning in controlling land use change and level of conformity. Considering the changes that occurred after the zoning since the sensitization has just started the level of adherence to the regulations can also be measured.
- Research on rate of change (e.g. the rate at which agricultural land use is changing) can be considered not only in the peri-urban but also in the rural areas generally (even though it may not have an immediate impact yet it can inform land administrators in advance). The driving force(s) influencing such change can also be determined.



## LIST OF REFERENCES

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- Abeyasekera, S. (2005). Quantitative analysis approaches to qualitative data: why, when and how? (pp. 97-106.).
- Abushnaf, F. F., Spence, K. J., & Rotherham, I. D. (2013). Developing a Land Evaluation Model for the Benghazi Region in Northeast Libya using a Geographic Information System and Multi-criteria Analysis. *APCBEE Procedia*, 5(0), 69-75. doi: <http://dx.doi.org/10.1016/j.apcbee.2013.05.013>
- Alkema, D., Bijker, W., Ali, S., Zoltan, V., & Wouter, V. (2012). Data Integration *The Core of GIScience: a systems-based approach* (pp. 373-349). Enschede, The Netherlands: International Institute for Geo-Information Science and Earth Observation, ITC.
- Arko-Adjei, A. (2011). *Adapting Land Administration to the Institutional Framework of Customary Tenure: The case of peri-urban Ghana*. Amsterdam, The Netherlands: IOS Press BV
- Aspinall, R. J., & Hill, M. J. (2008). *Land Use Change: Science, Policy and Management* Boca Raton: CRC Press.
- Bakx, W., Jansen, L., Schetselaar, E., Temofli, K., & Tolpekin, V. (2012). Image Analysis. *The Core of GIScience: A systems-based approach* (pp. 206-213). Enschede, The Netherlands: International Institute for Geo-Information Science and Earth Observation, ITC.
- Bennett, D. A., Tang, W., & Wang, S. (2011). Toward an understanding of provenance in complex land use dynamics. *Journal of Land Use Science*, 6(2-3), 211-230. doi: 10.1080/1747423X.2011.558598
- Bhatt, A. (Producer). (2012). A Review of change Detection Techniques. [Seminar Presentation, Indian Institute of Technology] Retrieved from [http://www.slideshare.net/abhishek\\_bhatt/a-review-of-change-detection-techniques](http://www.slideshare.net/abhishek_bhatt/a-review-of-change-detection-techniques)
- Briassoulis, H. (2000). *Analysis of land-use change: Theoretical and Modeling approaches. The Web Book of Regional Science*, Retrieved from <http://www.rri.wvu.edu/WebBook/Briassoulis/chapter1%28introduction%29.htm#1.3.2>
- Cavaye, A. L. M. (1996). Case study research: a multi-faceted research approach for IS. *Information Systems Journal*, 6(3), 227-242.
- Ciparisse, G. (2003). *Multilingual Thesaurus on Land Tenure*. Rome, Italy: FAO-United Nations.
- Crown. (2009). *Multi-criteria analysis: a manual*. London: Communities and Local Government Publications Retrieved from [www.communities.gov.uk](http://www.communities.gov.uk).
- Darke, P., Shanks, G., & Broadbent, M. (1998). Successfully completing case study research: combining rigour, relevance and pragmatism. *Information Systems Journal*, 8(4), 273 - 289.
- Deiningner, K., Augustinus, A. C., Enemark, S., & Munro-Faure, P. (2010). *Innovations in Land Rights Recognition, Administration and Governance: Joint organizational discussion paper issue 2 : proceedings from the annual conference on land policy and administration*. Washington D.C.: The World Bank.
- Diogo, V., & Koomen, E. (2012). Land-use change in Portugal, 1990-2006: Main processes and underlying factors. *Cartographica*, 47(4), 237-249. doi: 10.3138/cart0.47.4.1504
- Doygun, H. (2009). Effects of urban sprawl on agricultural land: a case study of Kahramanmaraş, Turkey. *Environmental monitoring and assessment*, 158(1-4), 471-478.
- Dubovyk, O., Sliuzas, R., & Flacke, J. (2011). Spatio-temporal modelling of informal settlement development in Sancaktepe district, Istanbul, Turkey. *ISPRS Journal of Photogrammetry and Remote Sensing*, 66(2), 235-246. doi: <http://dx.doi.org/10.1016/j.isprsjprs.2010.10.002>

- Durand-Lasserve, A., & Selod, H. (2009). The Formalization of Urban Land Tenure in Developing Countries. In S. Lall, M. Freire, B. Yuen, R. Rajack & J.-J. Helluin (Eds.), *Urban Land Markets* (pp. 101-132): Springer Netherlands.
- Erener, A., Düzgün, S., & Yalciner, A. C. (2012). Evaluating land use/cover change with temporal satellite data and information systems. *Procedia Technology*, 1(0), 385-389. doi: <http://dx.doi.org/10.1016/j.protcy.2012.02.079>
- Estoque, R. C., & Murayama, Y. (2011). Spatio-temporal urban land use/cover change analysis in a hill station: the case of Baguio city, Philippines. *Procedia-Social and Behavioral Sciences*, 21, 326-335.
- Famoriyo, S. (1984). Administration of land allocation in Nigeria. *Land Use Policy*, 1(3), 217-224.
- FAO. (1995). *Planning for a Sustainable use of Land Resources: Towards a new approach*. Rome, Italy: FAO.
- Farley, K. A., Ojeda-Revah, L., Atkinson, E. E., & Eaton-González, B. R. (2012). Changes in land use, land tenure, and landscape fragmentation in the Tijuana River Watershed following reform of the ejido sector. *Land Use Policy*, 29(1), 187-197. doi: <http://dx.doi.org/10.1016/j.landusepol.2011.06.006>
- Foreman, T. W., Pickett, S. T. A., & Zipperer, W. C. (1997). Methods for spatial and temporal land use and land cover assessment for urban ecosystems and application in the greater Baltimore-Chesapeake region. *Urban Ecosystems*, 1, 201-216.
- GoR. (2004). *National Land Policy*. Kigali, Rwanda: GoR.
- GoR. (2008). Rwanda in Statistics and Figures (pp. 110). Kigali, Rwanda: National Institute of Statistics of Rwanda (NISR),.
- GoR. (2009). *Strategic Road Map for Land Tenure Reform*. Kigali: Government of Rwanda.
- GoR. (2011). *Mid Term Review (MTR) of DFID's support to the Government of Rwanda's Land Tenure Regularisation Programme*. Kigali, Rwanda: Terra Firma.
- GoR. (2012a). 2012 Population and Housing Census, Provisional Results (pp. 52). Kigali Rwanda: National Institute of Statistics of Rwanda (NISR).
- GoR. (2012b). *Land Administration System Manual*. Kigali, Rwanda: Rwanda National Resources Authority, Ministry of Natural Resources.
- GoR. (2012c). *The Planning of Land use and Development in Rwanda: Law no°24/2012 of 15/06/2012 relating to Official Gazette n° 31 of 30/07/2012*. Kigali: GoR.
- GoR. (2013). *Organic Law Determining the use and Management of Land in Rwanda: Law no° 03/2013/OL of 16/06/2013 Repealing Organic Law N° 08/2005 of 14/07/2005* Kigali, Rwanda: GoR.
- Hersperger, A. M., & Burgi, M. (2010). How do policies shape landscapes? Landscape change and its political driving forces in the Limmat Valley, Switzerland 1930-2000. *Landscape Research*, 35(3), 259-279. doi: 10.1080/01426391003743561
- Hersperger, A. M., Gennaio, M. P., Verburg, P. H., & Burgi, M. (2010). Linking Land Change with Driving Forces and Actors: Four Conceptual Modelss. *Ecology and Society*, 15(4).
- Jing, Y., Bennett, R., & Zevenbergen, J. (2013). *Up-to-dateness in Land Administration: Setting the Record Straight*. Paper presented at the FIG Working Week 2013, Abuja, Nigeria.
- Kanyesigye, F. (2013, August 19). Land office issues 8.4 million titles, *The New Times* Retrieved from <http://www.newtimes.co.rw/news/index.php?i=15454&a=69652>
- Kombe, W. J. (2005). Land use dynamics in peri-urban areas and their implications on the urban growth and form: the case of Dar es Salaam, Tanzania. *Habitat International*, 29(1), 113-135. doi: [http://dx.doi.org/10.1016/S0197-3975\(03\)00076-6](http://dx.doi.org/10.1016/S0197-3975(03)00076-6)

- Lambin, E. F., & Meyfroidt, P. (2010). Land use transitions: Socio-ecological feedback versus socio-economic change. *Land Use Policy*, 27(2), 108-118. doi: <http://dx.doi.org/10.1016/j.landusepol.2009.09.003>
- Li, L., Zhang, P.-Y., & Hou, W. (2005). Land use/cover change and driving forces in southern Liaoning Province since 1950s. *Chinese Geographical Science*, 15(2), 131-136.
- Lu, D., Mausel, P., Brondizio, E., & Moran, E. (2004). Change Detection Techniques. *International Journal of Remote Sensing*, 25(12), 2365-2407. doi: 10.1080/0143116031000139863
- Mena, C. F., Bilsborrow, R. E., & McClain, M. E. (2006). Socioeconomic drivers of deforestation in the Northern Ecuadorian Amazon. *Environmental Management*, 37(6), 802-815. doi: 10.1007/s00267-003-0230-z
- Meyer, W. B., & , & B. L. Turner, I. (1994). *Changes in land use and land cover: a global perspective* W. B. Meyer, & BL Turner, II (Ed.) (pp. 537). Retrieved from [http://books.google.nl/books/about/Changes\\_in\\_Land\\_Use\\_and\\_Land\\_Cover.html?id=X1pNRW6r0BoC&redir\\_esc=y](http://books.google.nl/books/about/Changes_in_Land_Use_and_Land_Cover.html?id=X1pNRW6r0BoC&redir_esc=y)
- Mitsuda, Y., & Ito, S. (2011). A review of spatial-explicit factors determining spatial distribution of land use/land-use change. *Landscape and Ecological Engineering*, 7(1), 117-125. doi: 10.1007/s11355-010-0113-4
- Moser, S. C. (1996). A partial instructional module on global and regional land use/cover change: assessing the data and searching for general relationships. *GeoJournal*, 39(3), 241-283.
- Mottet, A., Ladet, S., Coqué, N., & Gibon, A. (2006). Agricultural land-use change and its drivers in mountain landscapes: A case study in the Pyrenees. *Agriculture, Ecosystems & Environment*, 114(2-4), 296-310. doi: <http://dx.doi.org/10.1016/j.agee.2005.11.017>
- Musahara, H. (2006). Improving Tenure Security for the Rural Poor. Rwanda–Country Case Study. *FAO/LEP Working Paper*, 7.
- Muttitanon, W., & Tripathi, N. K. (2005). Land use/land cover changes in the coastal zone of Ban Don Bay, Thailand using Landsat 5 TM data. *International Journal of Remote Sensing*, 26(11), 2311-2323. doi: 10.1080/0143116051233132666
- Olima, W. H. A., & Obala, L. M. (1999). The effect of existing land tenure systems on urban land development: A case study of Kenya's secondary towns, with emphasis on Kisumu. *Habitat International*, 23(1), 113-124. doi: 10.1016/S0197-3975(98)00024-1
- Orenstein, D. E., Bradley, B. A., Albert, J., Mustard, J. F., & Hamburg, S. P. (2011). How much is built? Quantifying and interpreting patterns of built space from different data sources. *International Journal of Remote Sensing*, 32(9), 2621-2644. doi: 10.1080/01431161003713036
- Payne, G. (2004). Land tenure and property rights: An introduction. *Habitat International*, 28(2), 167-179. doi: 10.1016/S0197-3975(03)00066-3
- Payne, G. (2011). Land Issues in the Rwanda's post conflict law reform In R. Home (Ed.), *Local case studies in African land law* (pp. 21-38). Cape Town: Pretoria University Law Press (PULP).
- Rurangwa, E. (2013). *Land Tenure Reform: The Case Study of Rwanda*. Paper presented at the Land Divided: Land and South African Society in 2013, in Comparative Perspective', Cape Town, South Africa.
- Sagashya, D., & English, C. (2012). Designing and Establishing a Land Administration System for Rwanda: Technical and Economic Analysis.
- Santos, F., Fletschner, D., & Daconto, G. (2012). *Enhancing Inclusiveness of Rwanda's Land Tenure Regularization Program: Initial Impacts of an Awareness Raising Pilot*. Paper presented at the Annual World Bank Conference on Land and Poverty.

- Serneels, S., & Lambin, E. F. (2001). Proximate causes of land-use change in Narok District, Kenya: a spatial statistical model. *Agriculture, Ecosystems & Environment*, 85(1-3), 65-81. doi: [http://dx.doi.org/10.1016/S0167-8809\(01\)00188-8](http://dx.doi.org/10.1016/S0167-8809(01)00188-8)
- Singh, A. (1989). Review Article Digital change detection techniques using remotely-sensed data. *International Journal of Remote Sensing*, 10(6), 989-1003.
- Sokal, R. R. (1974). Classification: Purposes, Principles, Progress, Prospects. *Science*, 185(4157), 1115-1123.
- Sultana, S., & Powell, W. (2010). Land use. In B. Warf (Ed.), *Encyclopedia of geography* (pp. 1727-1733). Thousand Oaks, CA: SAGE Publications, Inc.
- Turner II, B. L., Meyer, W. B., & Skole, D. L. (1994). Global Land-Use/Land-Cover Change: Towards an Integrated Study. *Integrating Earth System Science*, Allen Press, 23(1), 91-95.
- UN-Habitat. (2008). *Secure Land Rights for All*. Nairobi, Kenya: United Nations Human Settlements Programme (UN-Habitat).
- Unruh, J. (2010). Land Tenure. In B. Warf (Ed.), *Encyclopedia of geography* (pp. 1724-1726). Thousand Oaks, CA: SAGE Publications, Inc.
- Van der Molen, P. (2002). The dynamic aspect of land administration: an often-forgotten component in system design. *Computers, Environment and Urban Systems*, 26(5), 361-381.
- van Gelder, J.-L. (2010). What tenure security? The case for a tripartite view. *Land Use Policy*, 27(2), 449-456. doi: <http://dx.doi.org/10.1016/j.landusepol.2009.06.008>
- Veldkamp, A. (2009). Investigating land dynamics: future research perspectives. *Journal of Land Use Science*, 4(1-2), 5-14. doi: 10.1080/17474230802645592
- Veldkamp, A., Lambin, E. F. (2001). Predicting land-use change. *Agriculture, Ecosystems and Environment*, 85, 1-6.
- Wannasai, N., & Shrestha, R. P. (2008). Role of land tenure security and farm household characteristics on land use change in the Prasae Watershed, Thailand. *Land Use Policy*, 25(2), 214-224. doi: 10.1016/j.landusepol.2007.07.003
- Williamson, I., Enemark, S., Wallace, J., & Rajabifard, A. (2010). *Land Administration for Sustainable Development*. Redlands: ESRI.
- Zasada, I., Fertner, C., Piorr, A., & Nielsen, T. S. (2011). Peri-urbanisation and multifunctional adaptation of agriculture around Copenhagen. *Geografisk Tidsskrift*, 111(1), 59-72.
- Zevenbergen, J. (2002). *Systems of Land Registration: Aspects and Effects*. (Ph. D), Delft, The Netherlands.
- Zoomers, A. (2000). *Current land policy in Latin America: regulating land tenure under neo-liberalism*. Royal Tropical Institute.

# APPENDICES

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## Appendix A: Semi structured interview questions

### A-1 Questions for landowners (English language)

**Title: Land tenure regularisation in Rwanda: the outcome for agricultural land use change in peri-urban Kigali.**

These interview questions are meant to gather data for M.Sc. research conducted by P. O. Fosudo. Your kind cooperation and objective response will be highly appreciated.

#### Questions for individuals/landowners.

**Introduction/courtesy:** Good morning (in local dialect) How are you and how is the family? How is work? Hope everything is fine? Yes and I too. I'm happy to be in your country, it is good to be here. My name is Peter Fosudo I'm a student of UT, Faculty ITC and I am doing a research on land regularisation. I'm trying to know how the land tenure regularisation has influenced or contributed to land use decision making, leading to change in the agricultural land use. Please note that Information required is for academic purpose.

**NB:** Please circle or underline answer as appropriate.

- Q1 Are you the owner of this parcel/plot? Yes/No
- Q2 If **Yes**, did you Buy or Inherit the parcel or others (specify).....
- Q3 If **NO**, are you a tenant, or occupier, others (specify).....
- Q4 Have you been living here or using the land, before LTR program? Yes/No
- Q5 Under what tenure system was the right/title that you had before the LTR program?  
a) Ubukonde, (b) Igikingi, (c.) Inkungu (d) Gukeba (e) Others(specify e.g. customary/legal)
- Q6 Were you given any certificate at that time? Yes/No
- Q7 Can you please explain more on owning land before the land tenure regularisation (LTR) program .....
- Q8 I believe that your land has been regularised and you now have a land certificate? Yes/No
- Q9 What can you tell us about the LTR and owning land now with the LTR program .....
- Q10 Kindly tell us how having this certificate has influenced you concerning the use of your land.....
- Q11 What are some other reasons that motivated you to use your land for this purpose? .....
- Q12 Is the land use specified in your land certificate? Yes/No
- Q13 Which land use is specified in your own land certificate?.....

**NB:** Observe the adherence to specified land use Is there any change?.....

- Q.14 If changed (ask): What made you to change the use of your land (a) Increased revenue, (b) government regulation, (c) others specify).....

Q15 Is there something you would like the Government to do concerning the agricultural land use in this area?.....

**NB: The old customary tenure types:**

**Ubukonde:** System of tenure with law enacted by the clan chief being the owner of a vast land and who resettle many families called abagerewa, those who later enjoyed right over the land they occupy.

**Igikingi:** a system of tenure which gives right to graze, accorded by the King or one of his chiefs known as “Umutware w’umukenke” to any family that reared livestock.

**Inkungu:** a tenure system by which the political authority (unilaterally or on other's behalf) allocate plot of land from escheated lands to those who require it.

**Gukeba:** A system or process of settling family into grazing land (by the authority in place).

**A-2 Questions for landowners (Kinyarwanda language)**

**Umutwe w amagambo:** igikorwa cyo kwandika no gutunga ibyemezo by ubutaka mu Rwanda ndetse n induka mumikoreshereze y ubutaka bwahingwagaho mu nkengero z umugi wa Kigali.

Ibi bibazo byateguwe mu rwego rwo gukukanya amakuru awifashishwa mu bushakashatsi burigukkorwa na Bwana Peter .O. Fosudo mu rwego rwo kubona impyabumenyi yisumbuye master ubufatanye bwanyu buzadushimisha.

**Ibibazo byagenewe abantu kugiti cyabo / banyirubutaka.**

**Intangiriro:** Mwaramutseho amakuru yanyu ndetse murugo baraho? Kukazi biragenda? Ndizerako byose bigenda neza? Nanjye ndaho.nishimiye kugera mugihugu cyanyu nibyiza kuba hano. Amazina yanjye ni Peter Fosudo ndi umunyeshuri muri UT agashami ka ITC nkaba ndigukora ubushakashatsi kubijyanye n iyandikwa ry ubutaka. Ndikugerageza kumenya uburyo igikorwa cyo kubarura no kwandika ubutaka cyaba cyaragize uruhare mugufata ibyemezo byaba byaratumye habaho impinduka mu mikoreshereze y ubutaka.

NB: ca uruziga cg uce umurongo muni y igisubizo nyacyo

- Q1 Niwehoh nyiri iki kibanza Yego/ Oya
- Q2 Niba ari Yego waba warakiguze warakirazwe cg ubundi buryo (sobanura).....
- Q3 Niba ari Oya niwowe nyirubutaka cyangwa cg urabukoresha gusa cg ikindi (sobanura).....
- Q4 Mbere y igikorwa cyo kwandika ubutaka warusanzwe uba hano cg warahakoreraga? Yego/Oya
- Q5 Ni ubuhe buryo warutanzemo ubutaka mbere y igikorwaw cyabaayeho cyo kwandika uutaka?  
(a) Ubukonde (b) Igikingi (c) Inkungu (d) Gukeba  
(e) ubundi buryo ( sobanura urugero : uburyo bwa gakondo, uburyo bwemewe n amategeko)
- Q6 icyo gihe waba warahawe ikemezo cy ubutaka? Yego/Oya
- Q7 Ushobora gusobanura uko byari bimeze gutunga ubutaka mbere y igikorwa cyo kwandika ubutaka  
.....
- Q8 Ndizera ko uutaka bwanyu bwabaruwe kandi mukaba mufite icyemezo cy ubutaka? Yego/Oya
- Q9 Niki mwatubwira kuri gahunda yabayeho yo kwandika ubutaka ndetse nuko bimeze gutungaubutaka nyuma y iyo gahunda .....  
.....

Q10 Mushobora kutubwira uko kugira ibyangombwa by ubutaka byaba byaragize uruhare mugufata icyemezo kijyanye n icyo wakoreshaga ubutaka bwanyu .....

Q11 Nizihe mpamvu zindi zaba zarabateye gufata icyemezo cyo gukoresha ubutaka bwanyu icyo mubukoresha ubu? .....

Q12 Mbese ku cyangombwa cy ubutaka haba handitseho icyo mukoresha ubutaka bwanyu? Yego/Oya

Q13 Ku cyangombwa cy ubutaka handitseho ko bukoreshwa iki?

NB: Ukuikije ibyanditse ku byangombwa kubijyanye n imikoreshareze y ubutaka ukagereranya n uko bukoreshwa haba harimo itandukaniro?

Q14 Niba byarahindutse (baza): niki cyaguteye guhindura icyo wakoreshaga ubutaka bwawe

(a) kwiyongera k ubushobozi (b) amategoko ya leta (c) izindi mpamvu sobanura. ....

Q15 Haricyo wakifuza ko leta yakora kubyerekeranye n ubuhinzi muri aka gace .....

**NB:** Uburyo bwa gakondo

Ubukonde: uburyo bwakoreshwaga n umutware agabira ubutaka abaturage ariko bukaguma ari ubwe.

Igikingi: ni uburyo umwami cyangwa umutware w umukenke yahaga aborozi ubutaka kugirango babwororereho.

Inkungu: ni uburyo abayoboizi baha ibyangombwa by ubutaka kubutaka busanzwe budakoreshwa kubaturage babusabye.

Gukeba: ni uburyo bwakoreshwaga n aabayobozi hatangwa ubutaka bwo guturaho.

### A-3 Questions for the DDG, Land and Mapping Department, RNRA

Q1 Name of respondent.....

Q2 Department of respondent.....

Q3 Designation of respondent.....

NB: I believe your organization/department has been involved in the land tenure regularisation program

Q4 Kindly enlighten me on the role of your organization/department (Land and Mapping) in the Land Tenure Regularisation program?.....

Q5 Do you have records of agricultural parcels of Kinyaga and Masoro cells in your office?..Yes/No

Q6 If Yes, can I be privileged to see/have it? Yes/No

[NB: If Yes, To be collected as data/document]

Q7 Do you receive application from agricultural landowners or those who purchased the land asking for change of land use e.g. from agricultural to residential or other uses? Yes/No

Q8 Are some of these applications approved? Yes/No

Q9 Does you have cadastral map covering the approved changes in your organization? Yes/No

Q10 What is your organization's stance on change of agricultural land use to other uses particularly within the peri-urban areas such as Kinyaga and Masoro cells of Gasabo district, Kigali city.....

Q11 What more can you say about change of agricultural land use to other land uses.....

.....  
Q12 Kindly tell me about the possible relationship existing between land tenure regularisation program and change in Land use?.....  
.....

NB: Other questions arising from discussions

**Conclusion:** Thank you very much for cooperation and contribution to this research. (Get respondent's details for acknowledgement purpose).

**A-4 Questions for Gasabo district, One stop centre**

- Q1. What roles did your office play in the LTR program?.....  
.....
- Q2. When landowners change land use do they give you documents/reason to support the change? Yes/No
- Q3. (Follow up question on change and zoning plan) Do you enlighten them about their land use? Yes/No
- Q3. When was the zoning plan prepared?.....
- Q4. Is that what you use to guide approval now? Yes/No  
Can you give me information about the total number of parcels that has changed within a particular period in Kinyaga and Masoro? Yes/No
- Q5. Is there no record of parcels which changed from agricultural land use to other uses like residential etc? Yes/No (explanation) .....
- Q6 (follow up question) Did this zoning plan aid land use development? Yes/No
- Q7. Did this zoning support agricultural land use? Yes/No (explanation).....  
.....

**A-5 Questions for Kigali city, One stop centre**

- Q1 Name of respondent? .....
- Q2 Department of respondent?.....
- Q3 Designation of respondent?.....
- Q4 What was the role of your Department in the land tenure regularisation program?.....  
.....
- Do you have records of agricultural parcels in your office? Yes/No
- Q5 Do you receive applications from agricultural landowners for changing the use of their lands e.g. from agricultural use to residential or other uses? Yes/No
- Q6 If Yes: What reason do applicants give for change of the agricultural land use to other uses?.....  
.....
- Q7 If No: In your opinion do you suppose that LTR program brought about agricultural land use change to other land use especially around the Kigali city periphery? .....
- .....
- Q8 Can you please provide more explanation on what you know about change of agricultural land use to other land uses? .....
- .....



**A-6 Questions for Ministry of Agriculture**

Q1 Name of Interviewee.....

Q2 Department of interviewee.....

Q3 Designation of interviewee.....

NB: I believe your Center has been involved in the Land Tenure Regularisation program in some ways.

Q4 Kindly enlighten me on the role played by one stop center in the LTR program?  
.....  
.....

Q5 Do you deal with requests relating to agricultural land change within Kinyaga and Masoro cells in your office? Yes/No

Q6 If Yes, to which land use(s) do applicants usually request to change?.....

Q7 But specifically, do you receive application from agricultural landowners or those who purchased agricultural land asking for change? Yes/No  
.....

Q8 Are these applications approved? Yes/No

Q9 Do you have the cadastral map covering the approved changes? Yes/No

Q10 What is your Organization's stance on change of agricultural land use to other uses particularly within the peri-urban areas such as Kinyaga and Masoro cells of Gasabo district, Kigali city?.....  
.....

Q11 What more can you say about change of agricultural land use to other land uses within Kinyaga and Masoro cells .....  
.....

Q12 It is believed that Secure tenure resulting from LTR program enhances land development leading to land use change, can you explain some of the possible relationship you know that exists between LTR program and change in Land use? .....  
.....

**A-7 Questions for National Institute of Research and Statistics**

Q1. Can you provide me with information on the current population census figure of the Kinyaga and Masoro as at current year 2013? Yes/No

Q2. Can you please give information on the extent of agricultural land use change which has occurred?

Q3. What role did your organisation play in the LTR program

Q4. Do you have the statistics or records of land ownership past and present Yes/No

Q5. (Follow up question) Does it mean you do not deal with land tenure issues? Yes/No

Q6. At what level then do you have population?.....

Q7. It appears you do not have some of the data, what other information can you give?.....  
.....



**Appendix C: Excerpts from transcription of interviews**

Table C-1: Excerpts from interview of government officials

Organisations → Focus	Ministry of Agriculture	RNRA	Gasabo district One-stop centre	Kigali city One-stop centre	National Institute of Research and Statistics
Name of respondents	Mr. Emmanuel Twagirayezo	Engr. Didier Sagashya	Mr. Phillip Rutazigwa	Mr. Patrick Arinawe	Mr. Florent Bigirimana
Department of respondents	General directorate and crop production	Land and Mapping Department.	Development Permit Department.	Development permit Department.	GIS section, ICT Department.
What is the role of your organisation in the LTR program?	Did not play any role. Departmental functions includes land use consolidation and others are spelt out in the ministerial order.	Partake in the coordination and registration of lands during the LTR program.	This is a construction office and we deal with construction permits and renovation.	For us here the master plan is what we use for all operations and it was completed in 2012.	No role.
Do you have records of agricultural parcels?	No, everything about land records are in the National Land Centre, RNRA.	N/A	No	We do record them in our data base but because the use does not change here we have the RNRA and that is where the issuance of title and change in use is done, people go there for changes.	No, maybe you can get that from RNRA.
Do you receive application from landowners for agricultural land use change?	No	The application are treated at the District level. They are forwarded to Land and Mapping to change the	We receive only the applications for development permit.	N/A	N/A

Land tenure regularisation in Rwanda: the outcome for agricultural land use change in peri-urban Kigali

Can you please explain more on the roles of the Department?	The department assess farmers application for aid and crop expansion and recommend farmers for assistance.	Normally, we control the land use at the national level, that is the general land use of the whole country. At the district level they go into details.	The department is concerned with granting development permit for all those who apply.	N/A	N/A
Do landowners give documents to evidence their change?	N/A	N/A	Not all	N/A	N/A
Do you enlighten the landowners on land use change?	N/A	N/A	Yes	N/A	N/A
You mentioned zoning plan How do you use the zoning plan?	N/A	N/A	Yes, it was prepared 2011 but not signed to law yet. We only use it now to guide those who are developing.	N/A	N/A
Can you give total number of parcels that has changed over a period of time?	N/A	N/A	I cannot, it's difficult to get exact number. Before now no zoning plan so people change at their own discretion.	N/A	N/A
Did the zoning plan support agricultural land use?	N/A	N/A	Yes and there is a lot of agricultural practices going on, we also have residential and protected areas (P1, P2).	Yes	N/A
Could secure tenure or	N/A	Ok, one of the things	N/A	N/A	N/A

Land tenure regularisation in Rwanda: the outcome for agricultural land use change in peri-urban Kigali

having land certificate influence the landowners or encourage them to develop their land?	which we have realized and we know is that once people have secure tenure they put improvement on their land and development might be building, might be anti-erosive mechanism	N/A	Yes, yes.	N/A	Yes they are still there. Generally agricultural land use is one use you can easily change that is why That was before.	N/A
Before the LTR were most of the lands in Kinyaga and Masoro originally agricultural land?		N/A	Yes, As I said, Yes once people have security of tenure, they feel comfortable, to develop their land.	N/A		N/A
Then I think secure tenure also was a boost to the use that people now put their land.		N/A	Yes, and that is also part of our new laws, all land use should be based on land use planning or zoning plan and so you cannot pretend you have land and use it for whatever suits you. You have to follow the guidelines of land use policy.	N/A	N/A	N/A
The zoning plan seem to have come a bit later.		N/A	Actually we intend that	N/A	Now you have to	N/A
What is the		N/A		N/A		N/A

Land tenure regularisation in Rwanda: the outcome for agricultural land use change in peri-urban Kigali

<p>organization's position on agricultural lands, is change still allowed or not?</p>	<p>they should remain following the land use plan.</p>	<p>follow the master plan. Land according to land use report may have been Agricultural but now if it is commercial in the report you cannot do the same agriculture again. * We are still allowing agriculture since it is easy to change. Though for now we are not so strict but assuming a land was commercial zone and now it is agriculture and you want to put up a structure we cannot allow you because the land use has changed.</p>	<p>N/A</p>
<p>What more can you tell me about the change of agricultural land use, Is there a plan to maintain agricultural lands, Is this possible since people may develop without seeking approval?</p>	<p>There is at the city/district level a department in charge of inspection and inspection are meant to prevent any construction where it is not allowed. Also sector/cell officials are in charge of ensuring that no change is allowed where it should not be.</p>	<p>* We are still allowing agriculture since it is easy to change. Though for now we are not so strict but assuming a land was commercial zone and now it is agriculture and you want to put up a structure we cannot allow you because the land use has changed.</p>	<p>N/A</p>
<p>But in your own opinion, what can you say is the possible relationships which exists between the LTR and LUC?</p>	<p>As I said earlier its only one, once you secure tenure to people they will develop though such development might influence the change in land use. But for the case of Rwanda, the change in land use should always be</p>	<p>People whose land is zoned under agricultural land use pay no tax while those zoned for residential which pay taxes. I think its one of the ways to promote agriculture.</p>	<p>N/A</p>

Land tenure regularisation in Rwanda: the outcome for agricultural land use change in peri-urban Kigali

Did zoning support the agricultural land use?	N/A	directed by the policy/zoning plan.	N/A	Yes	N/A
Can I get some information on land use changes, extent of changes which has occurred over time?	N/A	N/A	N/A	N/A	I don't think, because what we only deal with is statistics but there may be useful information in the census results only that it has not yet been published.
I will like to know what was the current population of Kinyaga and Maostro i.e. as at 2008 and 2013.	N/A	N/A	N/A	N/A	Before, It is not easy there is a little change in the cell administrative boundary. Now they have merged some cells and it is only possible to get the figures of the 2012 population.
Do you have the statistics or records of type of land ownership past and present?	N/A	N/A	N/A	N/A	No, What we get in the census is house ownership not parcel. May be just a matter of knowing how many people live in their own house not land information.

**NB: N.A= Not Applicable (question is not applicable).**

Land tenure regularisation in Rwanda: the outcome for agricultural land use change in peri-urban Kigali

Table C-2: Excerpts from interview of Kinyaga cell landowners

Kinyaga interviews =>	Extract_1	Extract_2	Extract_3	Extract_4	Extract_5
Question					
Are you the owner of the parcel	Yes	Yes, I am the owner.	I am the owner and also I own another plot around here.	Yes	Yes
Have you been living here/using the land, before LTR program?	No, I just came to this area two weeks ago after finishing renovation	I bought it from the former owner. That was July 2011	I have been here for long time, I was born here and my parents and grandparents used this land and I inherited it.	I bought it.	I have been living here for almost 50 years
Under what tenure system was the right/title that you had before the LTR?	I did not acquire it before the LTR program	N/A	It was customary at that time .	Don't know	I think it is the Gukeba system
I believe that your land has been regularised and you now have a land certificate under LTR?	Yes	Yes	Yes	Yes	Yes
Kindly tell us how having this certificate has influenced you concerning the use of your land	Having the certificate makes me feel confident as it gives me an assurance of security.	Where I'm living before is too expensive, and this is where I find land since it has certificate, so I like to build it.	I have many building here, I sold some and started building after I got the certificate. Also because the area is developing, I sold part of my parcel and I had money to develop other part.	It made me to feel to build. That is what I am doing now. I am the owner of my plot.	I have the certificate now, I can sell or build.
What are some other reasons that motivated	Even though the former owner had	The master plan specify that here we	Constructing new buildings especially	Before there was no security, but now it is	N/A



Land tenure regularisation in Rwanda: the outcome for agricultural land use change in peri-urban Kigali

<p>you to use your land for this purpose.</p>	<p>built residential house on it, when I saw the property I was also motivated also by the landscape/view.</p>	<p>commercial house in this parcel was because this area is being developed and we have sell one parcel in order to have money to construct these buildings.</p>	<p>more secured</p>
<p>Which land use is specified in your own land certificate?</p>	<p>Residential</p>	<p>At the first time the plot was cultivating (for cropping) then I went to change it for housing and I can build what I have now.</p>	<p>Residential (but did not comply).  Agricultural but the authority allow us to use for residential</p>
<p>If changed (ASK): What made you to change the use of your land (a) Increased revenue, (b) government regulation, (c) others (specify)</p>	<p>N/A</p>	<p>No changed from specified zoning</p> <p>It is because the development that are taking place so we had a new road so we went to ask the permit so that we can construct new buildings because we wanted to gain money.</p>	<p>To generate revenue  This was a very big parcel and the house is very old but now we have sold part of the land (to generate revenue)</p>

**NB: N.A= Not Applicable (question is not applicable).**

Land tenure regularisation in Rwanda: the outcome for agricultural land use change in peri-urban Kigali

Table C-3: Excerpts from interview of Masosro cell landowners

Masosro interviews => Questions	Extract_1	Extract_2	Extract_3	Extract_4	Extract_5
Are you the owner of the parcel	Yes, I bought it.	Yes, I bought it (about 4 years ago).	Yes, I bought it.	Yes, I bought it (about 7 years ago).	Yes, (I bought it (last year September i.e. 2012).
Have you been living here/using the land, before LTR program?	No	No	No	Yes	No
Under what tenure system was the right/title that you had before the LTR?	Don't know, I got here only one year ago.	N/A	N/A	N/A	N/A
I believe that your land has been regularised and you now have a land certificate under LTR?	Yes	Yes	Yes	Yes	Yes
Kindly tell us how having this certificate has influenced you concerning the use of your land	I have not been influenced by the certificate.	I have a choice what to use the land for what will bring me money.	I see it as very potent, it is good to consider for mortgage investment.	I can decide on how to use the land that is why I am still doing agriculture before I have money to build my house.	It give me some sense of security so I can build my house.
What are some other reasons that motivated you to use your land for this purpose.	According to the master plan, it was said that this place should be residential.	I want to build house for rent.	The land is good in a good area.	I only have to use it for agriculture now since I don't have money to construct.	This place is good for living and also proximity to my children's school.
Which land use is specified in your own land certificate?	Residential.	Yes (Agricultural).	Yes, (Agriculture / Grazing)..	Yes (Residential).	Yes (formerly agriculture but has been zoned residential). N/A
If changed, What made you to change the use of your land (a) Increased revenue, (b) government regulation, (c) others (specify)	No changes.	To generate revenue.	Increased revenue.	No change, it is government regulations that has made it residential.	

**Appendix D: Summary table of data analysis to support sub objective 2.**

Table D-1: Analysis of extent of land use change as it affects agricultural lands

Description	Number of parcels		Grand Total parcels	Area in hectares		Grand Total Area in hectares	% of total parcel that changed	% of total area that changed
	Kinyaga	Masoro		Kinyaga	Masoro			
			Study area Kinyaga and Masoro			Kinyaga and masoro		Kinyaga and masoro
What is the total number of parcels in each of the cells as at 2008	1597	1965	3562	514.5	629.5	1144	44.8%	55.2%-
How many parcels were agricultural lands in each of the cells as at 2008	968	1106	2074	181.7	275.8	457.5	(58%)	40%
How many parcels were agricultural lands in each of the cells as at 2013	577	503	1080	129.7	224.8	354.5	30%	31%
What is the difference between the two periods	391	603	994	52	51	103	28%	9%
Cumulative	994		3562	103		1144	-	-

NIB:

- 1 Cadastral map collected from the land and mapping department was used to support the generation of this data.
- 2 Spatiotemporal analysis in ArcGIS was done to derive some statistics.

**Appendix E: Extracts from analysis-breakdown of general land use in the study area**

Table E-1: Breakdown of land uses in the two cells before and after the LTR program

Cell/Period	No. of Parcels	% of Parcels	Area in hectares	% of hectares	Remarks
<b>Kinyaga Before LTR</b>					
Built Parcels	462	28.93	28.8	5.6	About 60.61% of the total parcels was agricultural before LTR while 39.39% falls into the built and partly built categories.
Partly Built parcels	167	10.46	304.0	59.1	
Vacant agricultural parcels	968	60.61	181.7	35.3	
Total	1,597	100.00	514.5	100	
<b>Kinyaga_ After LTR</b>					
Built Parcels	807	50.53	73.7	14.3	After the LTR program 63.87% of the parcels in Kinyaga has been changed to built/partly built while agricultural is now 36.13%.
Partly Built parcels	213	13.34	311.1	60.5	
Vacant agricultural parcels	577	36.13	129.7	25.2	
Total	1,597	100.00	514.5	100	
<b>Masoro Before LTR</b>					
Built Parcels	661	33.64	38.3	6.1	In Masoro 56% of the parcels was agricultural parcels before LTR while 43.72 was built and partly built indication that agricultural land was greater that 50%
Partly Built parcels	198	10.08	315.4	50.1	
Vacant agricultural parcels	1,106	56.28	275.8	43.8	
Total	1,965	100.00	629.5	100.00	
<b>Masoro After LTR</b>					
Built Parcels	1,194	60.76	258.7	41.1	74% of the parcels has been changed to built/partly built while 26% is currently agricultural. A net loss of 30% in total of agricultural parcels is recorded
Partly Built parcels	268	13.24	146.0	23.2	
Vacant agricultural parcels	503	26.00	224.8	35.7	
Total	1965	100.00	629.5	100.00	
Grand Total	3,562 parcels	100.00	1,144.0 ha	100.00	

Appendix F: Field data collection support letters



**UNIVERSITY OF TWENTE.**

The Director General  
Rwanda Natural Resource Authority  
P.O Box 4413 KIGALI  
Rwanda

**FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION**

FROM  
Dr. Ir. Walter T. de Vries

DATE  
20 September 2013  
OUR REFERENCE  
LV20/3WdV/20

PAGE  
1 of 2

SUBJECT  
TRANSPORTATION SUPPORT FOR DATA COLLECTION FIELDWORK IN RWANDA

Hon. Minister,

On behalf on University of Twente, Faculty of Geo-Information and earth observation, I am pleased to write to your office requesting for assistance in transportation facilities of our students who will be in Rwanda for fieldwork and data collection.

Our students are required to conduct a data collection fieldwork as part of their MSc thesis research. On this academic year, students from department of PGM, specialization in Land administration will be coming to Rwanda for the period of four weeks starting from 28<sup>th</sup> September to 25<sup>th</sup> October 2013.

It is from this note that we are requesting assistance in transportation facilities authorization for the following students to carry out data collection:

Names	Msc Topic	Intended Districts
1. Potel Jossam (Rwanda)	Displacement and Land Administration in post conflict period- Case of Rwanda	Kayonza and Ngoma
2. Ntaganda Francois (Rwanda)	Investigating the contribution of land tenure regularization for land dispute: the case of polygamy and land rights in Rwanda's Northern Province	Musanze and Gicumbi
3. Muyombano Sylvain (Rwanda)	Ensuring sustainable cadastral updates: as assessment of user needs perspectives	Kamonyi District

P.O. Box 217  
7500 AE Enschede  
The Netherlands



UNIVERSITY OF TWENTE.

DATE

OUR REFERENCE  
GFM/10289/GH/ds

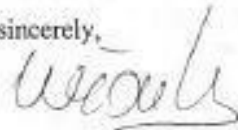
PAGE  
2 of 2

Names	Msc Topic	Intended Districts
✓ 4. Peter Fosudo (Nigeria)	Land tenure regularization in Rwanda and the outcome for change in agricultural land use of peri-urban area of Kigali	Gasabo District
5. Joseph Ataguba (Nigeria)	Towards a disturbance-integrated compensaiton method for land expropriation: a case of Rwanda	Bugesera District
6. Mukwaya Songo (Tanzania)	Land administration in early recovery post-conflict period in Rwanda	Kayonza
7. Felicien Niyoniringiye (Rwanda)	Contribution of land tenure regularization to land investments: A case study of large farmers of Eastern Province in Rwanda	Nyagatare and Kayonza
8. Ms. Mireille Biraro (Rwanda)	Land information maintenance: assessment and options for Rwanda	Kigali
9. Jean Guillaume Manirakiza (Rwanda)	The role of land records in support of post-conflict land administration: A case of Rwanda	Gasabo district

According to University regulations, we can facilitate the data collection through providing a return ticket from The Netherlands to Rwanda, Insurance coverage (150 €) and a small amount for local travel (100 €). As the latter amount may be limited, we have advised our Rwandese students in particular to search for sponsors to co-finance the additional expenses should this be necessary. I would like to assure you that the data needed are for academic purposes and they will be treated with full confidentiality.

Should you require any further information, I am at your disposal to answer any questions regarding this issue through the contact details provided hereunder.

Yours sincerely,



**Dr. Ir. Walter T. de Vries** | Course Coordinator 'Land administration' ; course coordinator 'governance and spatial information management' | Faculty of geo-information science and earth observation | University Twente | P.O. Box 217, 7500 AE Enschede, The Netherlands | Tel. +31 (0)53 4874 475 | [w.t.devries@utwente.nl](mailto:w.t.devries@utwente.nl)



# UNIVERSITY OF TWENTE.

TO WHOM IT MAY CONCERN

FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

DATE  
23 September 2013  
OUR REFERENCE  
LA/1318R/WdV/gm

PAGE  
1 of 1

SUBJECT  
Request for support

Dear Sir or Madam,

We herewith certify that Olulade Peter Fosudo is registered at the University of Twente, Faculty of Geo-Information Science and Earth Observation (ITC), the Netherlands, as a student attending an 18-month Master of Science course in Land Administration (LA). ITC has more than 60 years of experience and develops and transfers knowledge in the field of Geographic Information Systems and Remote Sensing.

As part of the MSc course Olulade Peter Fosudo will be doing a research titled 'Land Tenure Regularisation Program and the outcome for change in land use'. The research will include a 'fieldwork' consisting of secondary and primary data collection, which will tentatively take place in Kigali, Rwanda from 28 September until 25 October 2013.

The research mainly concerns 'An assessment of the impact of the land tenure regularisation program on agricultural land use change'. It's hoped that this research will contribute to land tenure and land use systems both in Rwanda and other countries.

ITC highly appreciates your support in providing him the necessary information during the stated fieldwork period.

We guarantee you that the information, that would be made available to Olulade Peter Fosudo, will only be utilized for the research objectives and not for any other purpose. Besides, Olulade Peter Fosudo will make proper acknowledgement and reference to the source of the information in the final document.

Yours sincerely,



Dr. ir. Walter T. de Vries  
Course Coordinator Land Administration  
Faculty of Geo-Information Science and Earth Observation (ITC)  
University of Twente  
P.O. Box 217  
7500 AE Enschede  
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University of Twente (UT) is registered at the Dutch Chamber of Commerce under nr. 5410603000

REPUBLIC OF RWANDA



Kigali on 24 SEP 2013  
N° 1070/16.03/RNRA

MINISTRY OF NATURAL RESOURCES  
P.O. BOX 3502 KIGALI  
Tel: (+250)252582628  
Website: [www.minirena.gov.rw](http://www.minirena.gov.rw)

The Mayors of... GASABO DISTRICT

Through: Hon. Minister of Local Government  
KIGALI




Dear Sir/Madam

**Re: Support for Fieldwork and Data collection**

With reference to the letter N0. LA/2013/WdV//9 dated 6<sup>th</sup> September 2013 from the University of Twente situated in the Netherlands and currently attended by some of Rwandan students who are employees of Rwanda Natural Resources Authority and some from Districts,

We are requesting for your facilitation and cooperation in assisting these students, as per the above said attached letter to carry out their fieldwork and data collection on time.

Sincerely,

  
Evode IMENA  
Minister of State in charge of Mining

CC

- The Director General, Rwanda Natural Resource Authority



REPUBLIC OF RWANDA



Ref. N° 26.83/07.0102/2013

CITY of KIGALI  
GASABO DISTRICT  
WEBSITE: [www.gasabo.gov.rw](http://www.gasabo.gov.rw)  
E-mail : [info@gasabo.gov.rw](mailto:info@gasabo.gov.rw)  
PO Box : 7066 KIGALI

To: Mr. Peter FOSUDO  
Kigali on 8<sup>th</sup> October 2013

RE: SUPPORT FOR FIELD WORK AND DATA COLLECTION

Dear Sir,

Reference is made to the letter N°1070/16.03/RNRA dated September 24<sup>th</sup> 2013 from the Ministry of Natural Resources requesting to support you for field work and data collection;

Gasabo District has the pleasure to inform you that you are granted the field work in the District.

Sincerely,

The signature of Ndizeye K. W. is written in black ink over a circular official seal. The seal contains the text 'AMARERE KA GASABO' at the top and features a central emblem with a figure and a shield.

NDIZEYE K. W.  
Mayor of Gasabo District  
CC:  
-Honorable Minister of Local Government  
- H.W. the Mayor-City of Kigali  
KIGALI.