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Land Administration Impacts on Land Use Change

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Introduction

Conventional land administration attempts to formalize the interaction between people, the state, and the landscape (Farley et al. 2012; Gerlak 2014; Wannasai and Shrestha 2008). Land tenure formalization, also known as land tenure regularization (LTR), is the process that seeks to create state recognition of land rights, and subsequently land tenure security, in places where it previously did not exist (Williamson et al. 2010). LTR articulates the state-sanctioned bundle of rights, restrictions, and responsibilities that relates to the land (Durand-Lasserve and Selod 2009; Zevenbergen 2002). The desired outcome of LTR is that land users can more assuredly make decisions about land: the landscape can be reshaped by new land users and uses stemming from unambiguous land tenure security (Farley et al. 2012; Wannasai and Shrestha 2008).

That LTR will impact a landscape is generally agreed upon; however, the extent of the impact is less clear and highly dependent on the context. This is where the study area of land administration overlaps with the related area of land use change (LUC). Studies on the changing relationship between people and the environment are essential (Veldkamp and Lambinb 2001). It is also important to understand the impact of interventions in terms of landscape outcomes, changes to the built environment, as well as the multivariate natures of the change (Hersperger and Burgi 2010; Orenstein et al. 2011).

In this regard, works focus on measuring the impact of agrarian reforms (Farley et al. 2012), understanding the causes of LUC using statistical analysis (Serneels and Lambin 2001), and determining the demographic and socio-economic drivers of LUC (Mena et al. 2006; Mottet et al. 2006). The techniques embedded in geographic information system (GIS) and remote sensing tools underpin much of the work.

Despite much research on LUC, limited works appear to focus on how tenure formalization programs impact LUC. Of the studies that do exist, many tend to use only conventional remote sensing techniques and algorithms to assess changes in a Spatiotemporal manner: the social aspect is either not considered or is studied separately, meaning a more holistic viewpoint is lacking. This is particularly important in peri-urban areas, the transitional zones between urban and rural areas, where LUC can be rapid and a multitude of factors drive the process (Arko-Adjei 2011). Existing land users, often agriculturalists, seldom possess secure land tenure, and administrative voids may result in limited controls on LUCs. The impacts of LTR are not always holistically assessed in these contexts.

This gap in knowledge relating to the impact of LTR on agricultural LUC in peri-urban areas provides the focus for this chapter. Specifically, the effect of the Rwandan LTR program on agricultural LUC is examined over a specific epoch. An assessment of spatial, temporal, and social changes between 2008 and 2013 in an area of Kigali, Rwanda, is made. The types of rights held before the LTR program, nature of the rights held following LTR, and impact that the rights had on the decision making of landowners are studied. The actor-change (A-C) theory of Hersperger et al. (2010) acts as the basis for understanding LUC, and the spatiotemporal analysis makes use of GIS.

The chapter seeks to reveal a new understanding of the relationship between LTR programs and LUC through the application of a mixed socio-spatial method. The work will help to enhance understanding of the way in which people react to LTR policies in peri-urban areas. It will demonstrate to policy makers the potential intermediate and long-term consequences of such programs. The chapter first provides a theoretical background on LUC before detailing the research methodology, results, and key discussion points. The chapter concludes by hypothesizing future research directions.

Theoretical Perspective

LUC is an extension of the term "land use," a term with generalized understandings but multifaceted meanings. Many technical definitions might not consider the role of people. For Turner II et al. (1994), land use is as follows:

> the biophysical state of the earth's surface and immediate subsurface.

However, others make explicit mention of human involvement. Briassoulis (2000), in line with the Food and Agriculture Organization (FAO) (1995) suggest as follows:

> … 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.

In a similar vein, Sultana and Powell (2010) see land use as "the way the surface of the earth has been used through human activities like transport, farming, and industry." It can be viewed as "how" and "why" the land and its resources are being influenced (Briassoulis 2000; Meyer and Turner II 1994). In this regard, different people-made classifications emerge to understand the how and why: residential (for shelter/housing), commercial (for trade and commerce), agricultural (for farming), institutional, and recreational.

Following on, LUC can be described as the people-driven actions that modify how the Earth's surface is utilized. Meyer and Turner II (1994) view LUC as change of land use from one type to another, or intensification of the existing land use. Put more simply, LUC may refer to the conversion or modification of land (Briassoulis 2000). The change can be quantified in terms of coverage (Briassoulis 2000).

LUC is often viewed as a local environmental activity (Abiodun et al. 2011; Foley et al. 2005, 570). However, despite differences in land use practices globally, the consequences of LUC remain similar, if not connected. When the results of LUC are aggregated globally, they contribute to the changing carbon cycle, the loss of total agricultural land, the loss of biodiversity, habitat fragmentation, and ecological overexploitation (Foley et al. 2005; Houghton et al. 2001; Pielke et al. 2002). On the specific case of peri-urban LUCs, high competition for land, migration from rural to urban areas, natural population growth, and socioeconomic systems operating at various scales influence the changes (Dubovyk et al. 2011). Doygun (2009) observes that the agricultural land use in close proximity to urban areas is more affected by such changes (either conversion or modification).

Meanwhile, it is also necessary to define the relationship between land use and "land cover." At times they are used interchangeably, but at other times they are distinguished (Briassoulis 2000; Li et al. 2005; Muttitanon and Tripathi 2005; Orenstein et al. 2011). Briassoulis (2000) describes land cover as

> the physical state of the land surface: as in cropland, mountains, or forests.

Moser (1996) and Meyer and Turner II (1994) add that

> it embraces … 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 and Turner II 1994; Moser 1996).

The close relationship in the way that the terms are used brings about their interchangeable connections, which makes Meyer and Turner II (1994) posit that

> A single land use may equally correspond fairly well to a single land cover.

However, a particular land cover may be attributed to different uses, for instance, agricultural land with varieties of crops or forestland with several purposes. In terms of administrative or spatial delineation, a single land use can accommodate several smaller land cover units, for example, woodlands, settlements, and pastures, among others (Briassoulis 2000). At any rate, the often synonymous understanding of the terms leads to the use of the term "land use/land cover." In the work by Lu et al. (2004), land use/land cover changes are categorized as follows: long-term natural changes in climate conditions, geomorphologic and ecological processes such as soil erosion and vegetation succession, human-induced alterations of vegetation cover and landscapes such as deforestation and land degradation, interannual climate variability, and the greenhouse effect caused by human activities.

Regarding scientific research on LUC, numerous perspectives are evident. Farley et al. (2012) address the issue from the perspective of impact on agrarian reform. Serneels and Lambin (2001) focus on developing statistical analyses to create a general understanding of LUC. Meanwhile, Mena et al. (2006), Mottet et al. (2006), and Farley et al. (2012) determine the impact of demographic and socioeconomic drivers, and geo-biophysical factors, to enhance the understanding of LUC causes and effects. LUC models are another area of scientific enquiry (e.g., Verburg et al. 2004). These works provide the theoretical underpinnings for this chapter.

Existing LUC models are generally based on (1) driving forces, (2) cross-scale dynamics, (3) level of analysis, (4) spatial interaction and neighborhood effects, (5) temporal dynamics, and (6) level of integration (Verburg et al. 2004). Another model is the one proposed by Hersperger et al. (2010). Components of the LUC model are identified as driving forces, actors, and change. Driving forces, along with actors, shape the changes in land use. They are a complex system of interdependent interactions occurring across space and time. Actors are decision makers and might be individuals, agencies, and institutions. They can affect the driving force. From this, four change types are derived: (1) driving force-change (DF-C), where the driving force causes the change; (2) driving force-actor-change (DF-A-C), where

multiple driving forces influence an actor to make an LUC; (3) driving force actor-change (DFA-C), where there is an interplay between the driving force and the actor; and (4) A-C, where an actor's reasoning and values influence the land use causing change.

In this chapter, the A-C model is adopted; as per suggestions from Briassoulis (2000), the model's characteristics were found to fit the intended case study context, including geographical extent, volume of land use, and data availability. This can be used to model the type and extent of LUC arising from actor decisions following LTR. The selection is further justified in the section "Methodology."

Methodology

To determine the relationship between LTR programs and LUC, an analytical method considering social, spatial, and temporal aspects was applied to a case study area in the Rwandan capital of Kigali. The study areas, Kinyaga and Masoro cells, were two different cells within Bumbogo and Ndera of Gasabo districts of Kigali. Like much of Rwanda, the terrain is hilly and the general land use in the area was previously agricultural. However, urbanization processes are evident: residential, commercial, and industrial uses appear on the landscape. LTR was conducted in the area after 2008.

At its root, the analytical method was based on Hersperger et al. (2010). The A-C model was adopted. This model was considered appropriate because: (1) it was considered that reasoning and values of the actor constituted the major influencing factor on LUC following LTR; (2) the study area's geographical extent was considerable—two cells in two different sectors were included; (3) the volume of land uses and owners, parcels, land size, and owners could be given proper consideration during data collection process; and (4) consideration could also be given to actor behavior and land change data. Regarding the A-C model, the following were identified for the case study: (1) the driving force was considered to be the secure tenure resulting from LTR; (2) actor was considered to be the landowner; and (3) change relates to agricultural land use transitioning to other uses including residential, industrial, and educational uses.

Regarding data collection, the study adopted a dual sampling technique. This included stratified and random sampling of the study area. Two strata from Gasabo districts, namely, Bumbogo and Ndera sectors, were used. Meanwhile, two cells Kinyaga and Masoro, one cell from each of the two sectors of Bumbogo and Ndera, were also used to ensure representation. Data collection was both primary and secondary in nature.

Primary data were gathered through direct interviews of 25 randomly selected landowners in the different cells in September/October 2013. This

data were used to determine (1) the land tenure system in the area, (2) whether landowners or occupants possessed land certificates, and (3) whether the possession of land certificates impacted land use decision making. In addition, government officials from the Rwandan Natural Resources Authority (RNRA) Land and Mapping Department were interviewed. This assisted in determining if the government played a role in LUC in the area. Parallel to the interviews, an inventory of land uses in the study area was undertaken. Classifications for each parcel used included the following: built, partly built, and vacant.

Secondary data were collected from various sources. A raster image of the Gasabo district, on July 7, 2013 (i.e., post LTR), was collected from the Remote Sensing Laboratory of the Faculty of Geo-Information Science, ITC, University of Twente, Enschede, the Netherlands. In addition, a raster data set (i.e., a pre-LTR orthophoto map of 2008) of the study cells was obtained from the RNRA Land and Mapping Department. Vector data of the study cells (shape files) were made available by the same agency. Other secondary data included land documents, literature, journal articles, the Rwandan land policy, and related laws.

To evaluate the change relationship between LTR and LUC, two approaches were utilized. First, using the interview data the relationship between LTR outputs (land titles) and LUC was determined. For each interview, an influence rank of 1–3 was allocated Abushnaf (2013): the significance of ownership certificates influencing land use decisions could be derived for the study area. Second, from the imagery and spatial data change detection was performed between 2008 and 2013. The aim of this change detection was to determine the extent of LUC from 2008 to 2013. Specifically, agricultural land use converting to other forms was the focus. This involved change detection, which meant applying multi-temporal data sets to analyze temporal effects of the phenomenon (Singh 1989). Using ArcGIS, the parcel shape files resulting from LTR were overlaid atop the two raster images from 2008 and 2013. For each parcel, a different land use category (built, partly built, and vacant agricultural lands) was assigned. From the analysis, the size and percentage of each land use could be calculated for each epoch. By synthesizing the results of the qualitative social data (interviews) and Spatiotemporal approach (GIS data), an overarching understanding of the impact of LTR on LUC for the peri-urban area could be ascertained.

Results

Results from the enquiry are presented in the following way. First, the status of changing land tenures and its impact on land use decision making, as revealed by interviewees in the case study area, are revealed. Second, the changes in land use as ascertained by the spatial analysis are presented.

From the interview data analysis, the changing status of land tenure and its impact on land use decision making could be investigated. Prior to LTR, land tenures in the study area were found to be customary in nature and fell into one of four categories: *Ubukonde*, *Igikingi*, *Inkungu*, and *Gukeba* (Rurangwa 2013). Following LTR, of the 25 respondents 20 indicated that they now held an LTR land certificate and 2 suggested that they possessed a customary tenure, whereas 3 did not know what kind of tenure they held. Although LTR appears to have been pervasive, it can be said that the remnants of former systems and understandings persist. Meanwhile, with respect to how the bestowed LTR land titles impacted land use decisions, 18 of the 25 respondents were motivated to invest in, or further develop, their lands; 4 suggested that the titles did not influence decision making; and 3 respondents were indifferent to the question.

From the spatial data analysis (Figure 12.1), the amount of agricultural LUC over the two epochs could be determined. In 2008, the two cells Kinyaga and Masoro were revealed to contain 1597 and 1965 each, and constituted 515 ha and 630 ha, respectively. Therefore, in total the study area consisted of 3562 parcels and 1144 ha. Prior to LTR, 1123 parcels (67.1 ha) were considered built, 365 parcels (619 ha) were partially built, and 2074 parcels (458 ha) were agricultural. This meant that in 2008, 58% of land parcels in the area, or 40% of the total study area, were considered agricultural. Subsequent to LTR in 2013, 2001 parcels (332 ha) were considered built, 481 parcels (457 ha) were considered partially built, and 1080 parcels (354.5 ha) remained as vacant agricultural parcels. The number of agricultural parcels had dropped from 58% to 30% (28% change) of the total number of parcels, and the total area of agricultural land use had dropped from 40% to 31% (9% change) within the 5 years (Figure 12.2).

Discussion

This chapter seeks to reveal the relationship between LTR programs and LUC. The subsequent discussions explore the extent of agricultural LUCs following LTR, whether those LUCs were driven by landowners motivated by LTR, and the success of the method applied.

LUC is certainly observed in the study area between 2008 and 2013. The number of built parcels rose by 25% during the period. This constitutes 23% of the total land area. In addition, whereas 365 parcels (619 ha) were already in transition in 2008 (i.e., partially built), an even greater number (481 parcels or 458 ha) was in transition in 2013. Of course, some may have been in transition for the entire study period; however, a certain level of LUC cannot be denied. In the study area, it can be concluded that agricultural land uses were shifting to industrial, commercial, or

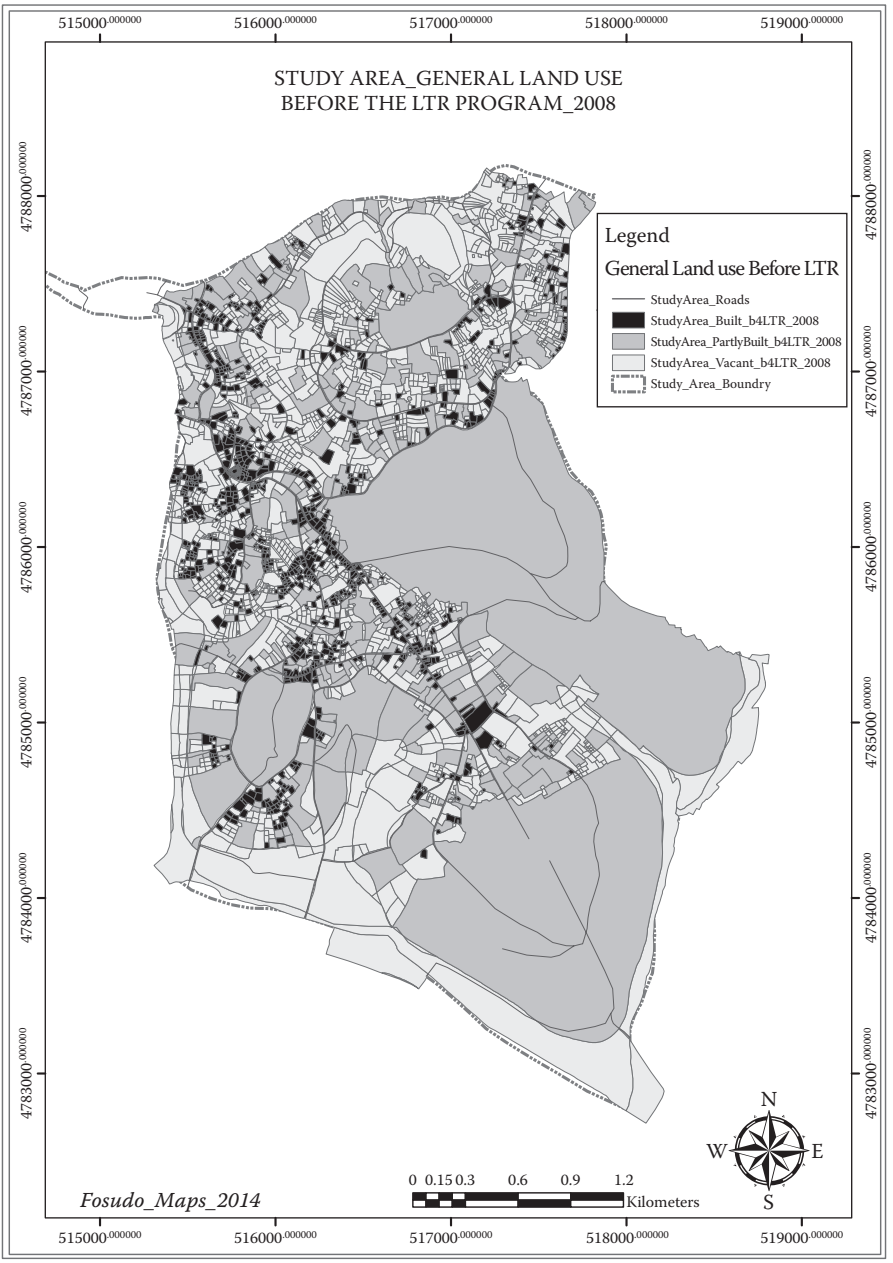

FIGURE 12.1
Land uses in the study area in 2008.

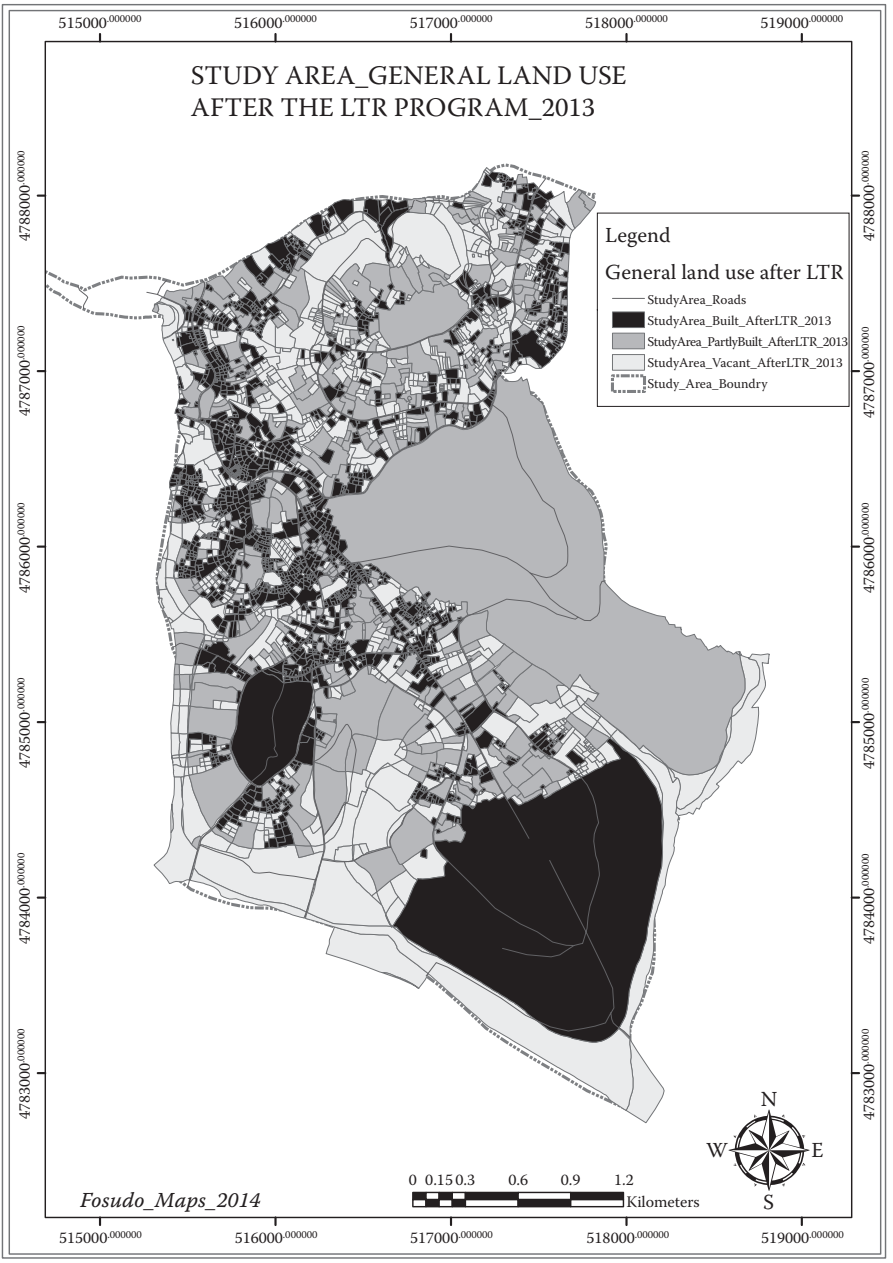

FIGURE 12.2
Land uses in the study area in 2013.

residential uses. The significance of LUC is difficult to judge as no control group existed.

Determining how much of the LUC can be attributed to LTR is a difficult task. Although LTR might have had a significant influence, there could have been other contributing factors. The qualitative interview data provide some insight in this regard: 18 of the 25 respondents suggested that the outputs of LTR, that is, the land titles, motivated their actions in the period between 2008 and 2013, particularly with respect to investment. Unfortunately, a control group was not available and, in addition, those who may have been owners in 2008, and had subsequently sold lands on account of LTR, were not directly taken into account. At any rate, it appears national land policies, laws, and the subsequent LTR program had some level of impact on agricultural LUCs in the study area. A deeper study would be needed to distinguish and disaggregate other possible influences, for example, the creation and implementation of city master plans, rural to urban migration, and economic growth more generally. Overall, based on the compiled results, it does appear that the agricultural LUC can be traced to LTR: LTR, via secure tenure, motivated landowners to act, and land uses subsequently changed based on these decisions.

Regarding the applied methodology, the change detection method, based on multi-temporal spatial data sets and a simple classification system, helped to derive a discrete understanding of LUC in terms of land parcels and areas. A limitation is that only vector data sets from 2008 were available: parcel mutations including subdivision and consolidation, if they occurred, could not be observed. The parcel mutations would reveal more about the nature of LUCs that occurred. The supporting interview data could be used to discern reasons for the changes; however, a greater number of interviews would have made the accompanying reasoning more robust.

Conclusion

The chapter sought to reveal a new understanding of the relationship between LTR programs and agricultural LUC in peri-urban areas through the application of a mixed socio-spatial method. The approach derived inspiration from the A-C model of Hersperger et al. (2010): it was perceived that the LUC occurring was driven by actors. The results revealed that LUC occurred in the study area over the study period: aerial imagery and high-resolution satellite imagery can indeed be used to detect LUC in peri-urban areas. However, the extent to which the LUC can be attributed to LTR is still open to debate. Certainly, the qualitative interview data revealed that LTR influenced the majority of the sample population; but other factors may have also been attributable, not the least being city

master plans, rural and urban migration, and sustained economic growth more generally. Further research could attempt to distinguish the influence of LTR from other interventions and driving forces. Overall, it is felt that the work helps to enhance understanding of the way in which people react to LTR programs in peri-urban areas. It demonstrates to policy makers the potential intermediate and long-term consequences of such programs.

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