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PREDICTING LAND REALLOCATION FOR UPGRADED URBAN DEVELOPMENT PLAN IN RWANDA (1960-2030) CASE STUDY : KABEZA SITE, KICUKIRO DISTRICT OF KIGALI CITY

Thesis: Presented and defended in fulfilment of the requirements for the award of the Degree of Doctor of Philosophy in Surveying at Université Privée Africaine Franco-Arabe (U.P.F.A.)

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CERTIFICATION

This is to certify that the thesis entitled: **“Predicting land reallocation for upgraded urban development plan in Rwanda (1960-2030). Case Study: Kabeza site, Kicukiro District of Kigali City)”** Submitted by Eng. HABIYAREMYE Jean Pierre to the **Université Privée Africaine Franco-Arabe (U.P.A.F.A.)** for the award of Doctor of Philosophy (PhD) in Surveying under my direct supervision and guidance. The work embodied in this thesis is original and has not to my knowledge been published or submitted in part or full for any other Degree of this or other University.

Supervisor

Prof. Cush NGONZO LUWESI, PhD
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DEDICATION

This final research is dedicated to:

My family

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DECLARATION

I, **HABIYAREMYE Jean Pierre**, declare that the content of this thesis is my own work except where acknowledged. It has never been presented or submitted anywhere else for any other or similar award at any other university or institution of high learning.

Student names and Signature

Eng. Jean Pierre HABIYAREMYE

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ABSTRACT

The land is required for the development of basic public infrastructure. Compensation for current rights holders of such land must be negotiated. Also, the resulting subdivisions will thus be smaller than the original portions of land, and the parcellation exercise will mean that households do not hold the same portion of land they were having before planning. All these aspects can lead to conflicts over land if not properly managed.

To reduce conflicts, a detailed topographic survey of the area has undertaken. Secondary data have obtained from the Rwanda Land Management Authority. The Kigali City master plan provides useful information while the Google Earth Pro platform proved beneficial. The study determined a contribution coefficient factor for each household land parcel/portion before readjustment.

The new design has ameliorated the issues in the area as much as possible compare to the former layout. The development of basic infrastructure in this area is positive for all residents and improves land tenure security. All parcels are 2168 Plots including residential extension with 1873 plots for Single Family Residential, 295 Plots remained as Existing Residential and 14 plots having a total area of 4.2 ha will be affected by public utilities, Roads with 28.9Km of length, Ravine having 1.2km of the length, Green Space with 0.4ha, Sport and Leisure with the area of 2.5ha, forest with 3.2ha and Water tank occupied 0.1ha, a contribution coefficient factor on each parcel to achieve the people’s welfare and equitable reallocation of land is 27% and 470,278Frw is predicted the most suitable financial factors for new plots and 317,456Frw for the plots previously permitted and construction projects within Kabeza Site all calculated using the formula developed during this research.

However, there are still some serious concerns evident in the newly readjusted area. These should be viewed as recommendations to be considered by future research implementers and partners, particularly the local government units overseeing the research sites. The most important emerging issues are the growing income disparity with the exclusion of the poorest from the development process. Thus, developers and state entities should work together to identify measures to minimize the negative impacts of interventions on the poor and women and also to minimize negative impacts on the environment.

KEY WORD: Land Reallocation, Urban development plan, Contribution Coefficient factor.

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RESUME

Des terrains sont nécessaires pour le développement des infrastructures publiques de base. L'indemnisation des titulaires actuels des droits sur ces terres doit être négociée. De plus, les subdivisions résultantes seront ainsi plus petites que les portions de terre d'origine, et l'exercice de morcellement signifiera que les ménages ne détiennent pas la même portion de terre qu'ils détenaient à l'origine. Tous ces aspects peuvent conduire à des conflits fonciers s'ils ne sont pas correctement gérés.

Pour réduire les conflits, un relevé topographique détaillé de la zone a été entrepris. Les données secondaires ont été obtenues auprès de l'Autorité de gestion foncière du Rwanda. Le plan directeur de la ville de Kigali fournit des informations utiles tandis que la plateforme Google Earth Pro s'est avérée bénéfique. L'étude a déterminé un facteur de coefficient de contribution pour chaque parcelle/portion de terre des ménages avant le réajustement.

Le nouveau design a amélioré autant que possible les problèmes de la zone par rapport à l'ancien aménagement. Le développement des infrastructures de base dans la zone est positif pour tous les habitants et améliore la sécurité foncière. Toutes les parcelles sont 2168 parcelles, y compris l'extension résidentielle avec 1873 parcelles pour le résidentiel unifamilial, 295 parcelles sont restées en tant que résidences existantes et 14 parcelles d'une superficie totale de 4,2 ha seront totalement affectées par les services publics, routes avec 28,9 km de longueur, ravin ayant 1,2 km de longueur, espace vert avec 0,4 ha, sports et loisirs avec une superficie de 2,5 ha, forêt avec 3,2 ha et le réservoir d'eau occupait 0,1 ha, un facteur de coefficient de contribution sur chaque parcelle pour assurer le bien-être de la population et une réaffectation équitable des terres est de 27 % et 470 278 Frw sont les facteurs financiers les plus appropriés pour les nouvelles parcelles et 317 456 Frw pour les parcelles précédemment autorisées et les projets de construction dans le site de Kabeza tous calculées avec la formule développé lors de cette recherche.

Cependant, il existe encore de sérieuses préoccupations évidentes dans la zone nouvellement réajustée. Celles-ci doivent être considérées comme des recommandations à prendre en compte par les futurs exécutants et partenaires de la recherche, en particulier les unités gouvernementales locales supervisant les sites de recherche. Les problèmes émergents les plus importants sont la disparité croissante des revenus avec l'exclusion des plus pauvres du processus de développement. Ainsi, les promoteurs et les entités étatiques devraient travailler ensemble pour identifier des mesures visant à minimiser les impacts négatifs des interventions sur les pauvres et les femmes et aussi à minimiser les impacts négatifs sur l'environnement.

MOT CLÉ : Réallocation des terres, plan d'aménagement urbain, facteur de coefficient de contribution.

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CHAPTER ONE: GENERAL INTRODUCTION

1.1. Background of the study

According to the Unite Nations (UN), 924 million people, almost one out of three urban dwellers, were living in informal settlements in 2003 (Rwanda Land Management and Use Authority(RLMUA), 2021). Of these, 874 million live in low and middle-income countries (RLMUA, 2021). The proportion of urban poverty is undoubtedly increasing: 43% of the population of developing cities is living in informal settlements while 71% of sub-Saharan Africa cities are informal (RLMUA, 2021). In Rwanda, 61.7% of the population lives in informal settlements although the urbanization rate stands at around 18.4% as per 2017 statistics (RLMUA, 2021). However, in many developing countries, urban conditions continue to be diffuse and disorganized. The lack of proper planning generates unsafe and dangerous conditions for everyday life, and blocks access to jobs, educational, and cultural opportunities (Felipe Francisco De Souza et al., 2013).

The process of land reallocation involves the assembly of all properties belonging to different landowners in a certain area, followed by a new subdivision of land into parcels and redistribution of the land to the same landowners, based on the share (in terms of the area and valuation) of each one's land as a percentage of the whole area (Sonnenberg, 2002). The urban upgrading component is integrated by an 'Urban Communities subcomponent' which promotes the use of community driven development approaches. As such, it aims to support the strengthening of the legal framework governing community-based organizations and the formalization of their links with local governments; and building the capacity of community-based organizations for organization and management, self-regulation and active participation in decision making and service delivery (Community Driven Development in Urban Upgrading, 2004).

Land allocation is a highly sensitive issue, especially in areas where land ownership provides an important source of income for its inhabitants. As a consequence, the acquisition of land for a sanitation system requires reasonable compensation. Apart from such compensations, affected communities are often notably - and understandably - sensitive to changes in current agreements concerning land use (Sophia von Dobschütz, 2020). Some of the existing literature focused on land reallocation policies, associated with land tenure system, and its effects these policies have

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on land security (Liu, 1998; Brandt et al., 2002; Tan et al., 2006). Liu et al. (1998) use village-level data to analyze the frequency of land reallocation and its differences across villages. Brandt et al. (2002) concluded that land tenure security is influenced by the land reallocation through the magnitude and the frequency. Tan et al., (2006) use land reallocation as one sub-group of independent variables to find the determinants of land fragmentation.

Others tend to better understand what determinates land reallocation and to what extent land reallocation occurred, although it is well observed that land has been reallocated or adjusted during the legal contract period of 15 and even later 30 years. Kung (2000) believes that the incidence of land reallocation has been significantly influenced by the demographic change and availability of land, as well as the opportunities of off-farm employment and the development of local rental markets in villages. This conclusion has been mirrored by the finding of Yao (2000), which provided substantial evidence that the interaction of land reallocation in magnitude and frequency with income level and the endowment of local land resources, even though its effect is empirically implicit. Brandt et al. (2002) concluded that the scope and duration dependence of land reallocation is sensitive to the availability of off-farm employment, and thus permit an efficient allocation of land resources across households given the differential capability of participating in job market.

Rwanda is a developing country. As such, the government plans focus on solving problems arising from poor local urban upgrading. The service infrastructure must be maintained, constructed, or reconstructed for better achievement of a range of goals. These goals are expressed at different levels of government: the Central, Provincial, District, and Sector levels. An example is the Kigali City goals (Rwanda Land Management and Use Authority, 2017). In order to maintain the city’s vision ; the Local Urban upgraded development planning should be comprehensive, efficient, inclusive, informative, integrated, logical and participative, and fair while contributing to common interest operations such as securing public space, facilities and utilities (Rwanda Land Management and Use Authority, 2017).

Local land development planning and reallocating planned plots is the way of getting solutions and achieving the goals of different problems arising within the site to implement Kigali City master plan 2020 to have a smart city.

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Land reallocation is a planning tool to assist in systematic urbanization. The process aims to take rural or unplanned urban land, usually irregularly subdivided, and reallocate it, in the required balance, for public and private use according to town planning requirements (Demetris Demetriou, 2014).

It has great advantages in solving the land use problem in urban areas, but current land readjustment implementations are limited in many ways: for example, there are technical limitations in handling the wealth of data, economical limitations in compensation for acquire land, and social limitations in minimizing the inconvenience and conceived injustices (Demetris Demetriou, 2014). Land consolidation refers to the process in which fragmented or scattered plots of a farm family or farm are incorporated (Musa AVCI, 1998).Thus, sometimes, the terms land consolidation and land reallocation are used synonymously.

The process of land reallocation involves the assembly of all properties belonging to different landowners in a certain area, followed by a new subdivision of land into parcels and redistribution of the land to the same landowners, based on the share (in terms of a holding's area and land value) of each one's land in the whole area (Sonnenberg, 2002). In other words, it is a mechanism for land tenure change. It is accepted as the most critical and complex process of land consolidation given the many criteria that should be considered, the great importance of land in all societies and the comprehensive restructuring of land tenure generated after land consolidation. Van den Brink (2004, p.3) characterizes land reallocation as the "crowing glory" of land consolidation.

Urban upgrading is broadly defined as physical, social, economic, organizational, and environmental improvements undertaken cooperatively among citizens, community groups, businesses, and local authorities to ensure sustained improvements in the quality of live for individuals (Cities Alliance, 2016). More specifically, the primary goals of upgrading s are to provide secure land tenure in informal and often illegal areas, and to improve basic infrastructure and service delivery (Cities Alliance, 2016).

The urban upgrading component is integrated by an 'Urban Communities subcomponent' which promotes the use of community driven development approaches. As such, it aims to support strengthening of the legal framework governing community-based organizations and the formalization of their links with local governments; and building the capacity of community-

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based organizations for organization and management, self-regulation and active participation in decision making and service delivery (TheWorld Bank, 2004).

Rwanda's strategy for transformation under Vision 2050 aspirations focuses on High Quality and Standards of Life, Developing Modern Infrastructure and Livelihoods, Transformation for Prosperity, Values for Vision 2050 and International cooperation and positioning in the development of country-wide fiber optic roll out and rapid adoption of ICT, and a well maintained and expanding road network in urban and rural areas (The National Industrial Research and Development Agency (NIRDA), 2016).

Urban planning is not about images but is a way to make a difference; urban planning is a framework that helps leaders transform a vision into reality using space as a key resource for development and engaging stakeholders along the way. In order to maintain the city's vision ; the Local Urban upgrded develpoment planning should be comprehensive, Efficient, Inclusive, Informative, Integrated, Logical and Participative with fairness while contributing to common interst operations such as securaring public space, facilities and utilities (Kigali City, 2017).

1.2. Problem Statement

In Africa there is an open land conflicts are becoming more and more common across the continent because of increasingly population and wars. Market development and population growth provide an important part of the explanation for this development (Christian Lund et al., 2017). In Ethiopia, as in several other African countries, urbanization is occurring at a more rapid rate and the competition for land between agriculture and non-agriculture is becoming intense in the peri-urban areas (Achamyeleh Gashu Adam, 2018).

The development of the basic public infrastructure and the resulting subdivisions will thus be smaller than the original portions of land, and the parcellation exercise will mean that households do not hold the same portion of the land they held originally; uncontrolled urban sprawl. All these aspects can lead to conflicts over land if not properly managed. The growing demand of land for urbanization is a primary intended to be supplied by expropriations and reallocation of peri-urban land through lease contracts. It shows that land acquisition and delivery for urban expansion and development purposes is completely state-controlled on the rationale that all land belongs to the state and peoples of Rwanda.

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Local Land development plan of Kabeza site within Kicukiro District in the context of the city for citizens and city on move, from the initiative of the local community with the encouragement of Local Authority has provided using a participatory approach but some dwelling land will be lost to basic infrastructure and public infrastructure. Compensation is planned for those who will not accommodate in the upgraded plan. After the upgrading, various problems are expected those who no longer have access to any land in the site may be unhappy, there may be conflicts related to the smaller land parcels than were held before, conflict related to the sharing of land from a former parcel to a new parcel held by another but shifting land between households even in most cases is not voluntary at the household level, is a potential instrument to achieve an efficient allocation of land resources. This research focuses on Predicting land reallocation for an upgraded urban development plan at the Kabeza site to allocate each landholder a common share of the total area (equality rather than equity) and making sure that each former landholder acquires a parcel in the new plan of Kabeza Site to get a solution of all said problems.

1.3. Research questions

- How is the trend of the existing land use land covers at Kabeza site?
- How to make adjustments needed for upgrading the existing land development plans of Kabeza site?
- How to estimate a contribution coefficient factor necessary for the people's welfare and the design of an equitable land reallocation plan at Kabeza Site?
- How to predict the most suitable financial factors taken care of by land reallocation in urban development planning at Kabeza site?

1.4. Research hypothesis

Ho_1 (Null hypothesis1): There is no significant difference between the past and current adjustments of land use/land cover at Kabeza Site

H_{02} (Null hypothesis 2): There is no significant difference between the land use/cover change and the adjustments of land reallocation at Kabeza Site

H_{03} (Null hypothesis 3): There is no significant relationship between land reallocation and social equity/ welfare

H_{04} (Null hypothesis 4): There is no significant relationship between land reallocation and urban development planning.

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1.5. Objectives of the Study

1.5.1. Main Objective

The main objective of this research is to predict and design a land reallocation plan for upgraded urban development in Rwanda specifically the Kabeza Site in Kicukiro District of Kigali City, Rwanda.

1.5.2. Specific Objectives

The following specific objectives are pursued to achieve the main objective stated above:

- To assess and predict the existing land use land cover at Kabeza site of Kicukiro District,
- To make needed adjustments to upgrade the existing land development planning at Kabeza site,
- To estimate a contribution coefficient factor on each parcel to achieve the people's welfare and equitable reallocation of land,
- To predict the most suitable financial factors for urban development planning at Kabeza Site.

1.6. Significance of the study

1.6.1. For the Researcher

The output of this research will help to enhance knowledge and land reallocation design skills through the self-training and its application principles, theory, and techniques learnt from previous studies. It will also be the new design of physical planning and will give relevant information about the problems faced during new design technique will be used to reduce those problems. This research work intends to provide enough practice and more understanding of what we have studied during all academic studies especially the concept of land reallocation plan as well as the requirement to deepen so many courses to do this research as well as possible.

1.6.2. Social significance

The Research social benefits are following:

- ✓ This research should help people to reduce unemployment, increasing access to markets, skills and employment among others,
- ✓ Landscape management and development is the main need of our society, to gain a large space for other activities by reducing demographic pressure on arable land.

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- ✓ Infrastructures serviceability: It shows how easy and economic solutions this type of research can provide infrastructures such as water, electricity, telecommunication cabling to the population.
- ✓ Will offer diverse opportunities and social economic transformation as aligned in Rwanda's strategy for transformation,
- ✓ Development of the populations by ensuring the achievement on good health, reduction of the poverty, Safe transport of the goods and populations and safe urban planned area.

1.7. Scope of the research

This research focused and limited to the land reallocation of the upgraded urban development plan of the Kabeza site at 2.4 km from Nyanza Bus Parking and 1.5km from Agakiriro of Gahanga about 5 minutes with a car from Nyanza Bus Parking. It is a total area of 116.3 hectares. It extends in Karembure cell around 75% of the total area of Kabeza village and 26% of the total area of Mubuga Village.

1.8. Thesis Structuring

Chapter 1: General introduction which deals with Introduction, problem statement, research objectives, research questions, research hypothesis, significance of the research, scope of the research, and thesis structuring.

Chapter 2: Literature review, reviewing literatures around this research area. Telling what had been done before and what are the outcomes of the research.

Chapter 3: Methodology of the study, which deals with the methods, procedures, the definitions of the instruments that were used for the investigations and, the methods and techniques, used to collect all the data required.

Chapter 4: Results and discussion, which deals with the presentation, analysis and interpretation of the findings.

Chapter 5: Conclusions and recommendations, which is the last, present conclusions, recommendation to state the output of the research**.**

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CHAPTER TWO: LITERATURE REVIEW

2.1. Theoretical and Empirical Studies

The land use and land cover change of an area is an outcome of natural and socio-economic aspects and their operation by the human in time and space. Land use land cover (LULC) changes are mostly influenced by increase and decrease in population growth in the system (Lambin et al., 2003), economic growth, and physical factors including topography, slope condition, soil type, and climate (Setegn et al., 2009; Yalew et al., 2016). Land-use change is a matter of historical process as relating to how people use the land. It modifies the availability of different resources including vegetation, soil, and water (Ahmad, 2014). Land-use change directly affects the amount of evapotranspiration, groundwater infiltration and overland runoff. Land use land cover change is an important issue considering global dynamics and their responses to environmental and socio-economic drivers (Akpoti et al., 2016; Bewket, 2002; Hurni et al., 2005). Land use land cover alterations, negatively affect the patterns of climate, natural hazards and socio-economic dynamics on a global and local scale (Chakilu & Moges, 2017; Hegazy & Kaloop, 2015; Sewnet, 2015). Information on land use/cover and potentials for their best use is essential for the selection, planning, sustainable land resource management and understanding the changes in hydrological processes to meet the increasing demands for basic human needs and welfare.

Global cities, which are the engines of economic development (Sherbinin, et al., 2007) with large populations, are most vulnerable to the impacts of land use and land cover (LULC) changes. The LULC change is a driver of global environmental change such as emission of greenhouse gases (MEA, 2005), habitat loss/fragmentation and biodiversity loss (Lambin, et al., 2000, Sala, et al., 2000), and reduce the quality of human wellbeing (Lambin, 1997; Boissiere, et al., 2009). According to the figures from the UN (2016), over 54.4% of the world population in 2016 lived in cities and it is projected to increase to 60% by 2030 exerting extra pressure on urban resources. This increase is progressing at a higher rate in the developing countries where cities are growing thereby rapidly changing urban landscapes.

Research about automating the land reallocation process began in the Netherlands at the end of the sixties, a decade that was characterized by the establishment of large scale computers, i.e. mainframes. In the early 1970s, a computer support system called LIN was introduced, focusing

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on supporting the administrative problem of land reallocation. In particular, LIN was a registration system able to store the original cadastral details before land consolidation, the intermediate design steps and the final design. Therefore, LIN could not actually directly support the decision making process of land reallocation (Rosman and Sonnenberg, 1998).

About a decade later, Delft University of Technology and the Netherlands Cadastre cooperated to build a computer model for the process of land reallocation (Van der Schans, 1972, cited in Rosman and Sonnenberg, 1998).The model consisted of three consecutive steps: design of a value allocation plan; design of the general layout of the new parcels; and the fixation of the boundaries of each newly formed parcel. This system, called INOK, had two allocation algorithms: one based on a heuristic and the other based on a linear programming model (De Vos and Rosman, 1991, cited in Rosman and Sonnenberg, 1998).

Despite these efforts, a survey commissioned by the Netherlands Cadastre in 1994 revealed that INOK was insufficient to support land consolidation planners. It was under used because it was mainly an information management system rather than a decision support system. The statement of Rosman and Sonnenberg (1998, p.6) that “the development of an integrated design support system for land reallocation which comprises the three steps mentioned above is uncertain”, shows how difficult a task it was, even thirty years after the first attempts at the end of the sixties! During that period, two studies were carried out at Delft University of Technology to modify and improve the existing models of INOK. The first one was that of Rosman and Sonnenberg (1998) on land distribution and the second one by Buis and Vingerhoeds (1996) and Buis (1999) on land partitioning, both of which are discussed later in more detail.

A multidisciplinary research team (Tourino*et al.*, 2001; 2003) built a GIS-based tool to support several tasks of land consolidation. In particular, the system they developed supports automated generation of nearly optimal parcel reallocation, using simulated annealing and an evaluation of alternative solutions via comparative analysis. Additionally, it provides spatial and administrative land consolidation information management, which can be accessed via a Web-GIS based on various user levels. In the latter, landowners may address spatial questions about their property before and after the project. Although the system has some limitations discussed later, this work constitutes the most outstanding research regarding land reallocation that has been published. Conversely, some other related studies (especially those found in conference

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proceedings), either does not provide necessary explanation and details about the research or they have poor quality content. As a result, a critical review of these studies proved problematic, despite the effort spent on this activity.

The most interesting part of the research by Tourino et al. (2001; 2003) is the automated parcel reallocation algorithm, which combines a region growing algorithm and simulated annealing optimization. An iterative seeded growing method is used to generate an initial distribution of the tessellated area among the domains (parcels). The area is divided into 'stands'. A stand (which is a land block) is a part of a land consolidation area which is enclosed by roads, other physical boundaries (e.g. rivers) and the external boundaries of the consolidated area. Each stand is divided into square cells (pixels). Region growing uses a heuristic flooding process, based on a linear objective function. It is a heuristic function comprised of six terms. Each term is a constraint to guide the growth of the parcels. The planner may guide the process by weighting the importance of each term via a coefficient. The algorithm works separately for each stand, trying to obtain the most feasible set of parcels as possible (in terms of shape).

Parcel growing begins from an initial seed (a point). Seeds represent the owners' petitions in each land block. In particular, a seed is a pointer that assigns a location in the land block to a landowner, as a starting point for the reallocation of a new parcel. Each seed is represented by its location and an associated score regarding a new parcel within the particular stand. Each landowner may have more than one seed in a stand. A significant limitation of the system is that the planner has to distribute seeds to landowners manually, using some system functions as an aid. In other words, land distribution is not carried out automatically. A uniform distribution of seeds is preferable in order to obtain more regularly shaped parcels. While the aim of the planner is to place the seeds as close as possible to the landowners' preferences, on the other hand, the planner may reject some landowners' preferences which are judged as unreasonable and try to balance the seeds in a stand by adjusting the location and the score of seeds. Each stand may get a definite score (e.g. representing the total area of the stand). Once the seeds have been distributed in stands, each seed is an input point to the region-growing algorithm, to create the domains. Region growing may generate many alternative parcel partitions by changing the weights (Demetris Demetriou, 2014).

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Thereafter, simulated annealing is used to generate the new parcels (in terms of shape) without changing the location of each domain. The algorithm can be applied to the best (or to any other) partition of the previous stage, aiming to minimize another objective function which represents the quality of the partition. This is a non-linear cost function that is comprised of two terms; the first one represents the objective to obtain parcels with regular shapes and the second one is a constraint to maintain the score for each landowner. The reason for trying to obtain as far as possible the initial parcel shapes using the region-growing algorithm is that simulated annealing depends strongly on the starting solution. This is a disadvantage of this method as well as of classical optimization methods; that is, the search for an optimum solution relies on one initial solution which iteratively may converge to an optimum or near optimum solution. As a result, even though simulated annealing is robust, fast and capable for solving large combinatorial problems such as land-use management, it does not guarantee the optimal solution (Datta et al., 2006).

Another limitation of the system is that it cannot take into account all the factors of the process, such as barriers (e.g. buildings, irrigation channels, wells, etc.) and pictorial elements (e.g. contour map, slope map, etc.). System evaluation showed that the results were strongly influenced by the shape of the stand and the size of the original parcels. Additionally, the final output was far from the experts' partition, which can intervene and adjust it. Nevertheless, the results were judged by researchers as moderate but encouraging.

The authors emphasize that not all of the factors in the consolidation project can be quantified by this tool, so experts should take the final decisions based on their knowledge, experience and other information available to them. This conclusion suggests the need for utilizing other more appropriate methods which may mimic the human reasoning process. Such methods, i.e. expert systems, are employed in our research. Another important conclusion of the research (Tourino et. al., 2001, p.57) was that "further research is needed in the optimization algorithms of the automated reallocation, because there are many external parameters that influence the consolidation process; in addition, new optimization techniques can be considered. Anyway it is not easy to fix the best target function". This suggestion provides us with a challenge to use other optimization methods such as genetic algorithms and seek a better objective function. Genetic

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algorithms do not have the disadvantage of simulated annealing mentioned above because they use a population of solutions while searching for the optimum, instead of one initial solution.

Eventually, the researchers note that the stands management module, i.e. the process of seed allocation, could be also improved with a semi-automated procedure for the distribution of seeds in the stands. An ambitious aim of this research is to fully automate this process by integrating GIS with expert systems. Despite the limitations mentioned, the system seems to be a powerful tool for decision making regarding land reallocation, which dramatically reduces the time and cost of land consolidation plans. The process is more transparent and it involves the direct participation of landowners. The evaluation module of this system will be discussed in section 4.7.2 in more detail.

According to Semlali (2001), Reallocation is carried out either based on the area or the soil class and/or other constraints. The limitation of this method is that each of the four methods represents an ‘extreme’ reallocation strategy and they cannot be combined. Therefore, the results are biased by certain criteria constraints.

As in other studies, the best solution obtained from the first stage, i.e. computed reallocation, is an input to the second stage, i.e. graphical reallocation. It is an iterative process which determines the final position of the new properties, taking into account the imposed tolerances on the redistributed values. The final position is not clarified if it includes the creation of parcel shape.

The third part involves the analysis of the results, regarding the location of parcels before and after land consolidation, the satisfaction of the landowners’ preferences and whether the constraints are satisfied. A global indicator of satisfaction is used to evaluate the performance of the results for the whole project. The system was evaluated using a test area. The author notes that the proposed methodology is rapid and more consistent compared to classical methods and additionally the allocated time for the reallocation process was reduced from several months to several hours. The authors do not provide adequate information about how the model works, how landowners’ preferences are taken into account, how reallocation conflicts are solved, how the location of the new parcels is defined, and how the parcels are automatically generated. Additionally, analytical system evaluation figures are not provided. Soil classes, the value of

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land occupied by infrastructure (e.g.roads, irrigation canals, etc.) and the reduced value corresponding to each landowner (Semlali, 2001).

Temporary land reallocation involves the determination of the placement of the landowners in the blocks, i.e. the land distribution process as defined in this research. Five basic criteria are taken into account in this process: existing buildings, wells, etc., in the parcels before consolidation; the existing location of a parcel; the landowners' preferences; the existence of a dominant soil class in a block; and the existence of a parcel whose value is higher than the mean of all the parcels of a specific area. Every criterion is assigned a weight based on its quality and importance. The model determines the list of landowners who will be allocated land in each block with an approximate position of the new parcels (Demetris Demetriou, 2014).

Unfortunately, as in the previous study, the authors do not provide adequate information about how the model works, how landowners' preferences are taken into account or how reallocation conflicts are solved. A limitation noted is that this is a semi-automatic process since it involves the intervention of the planner. The last step, i.e. definitive land reallocation, involves identifying the exact position and definite location of each new parcel in a block. While it is noted that this is a fully automated process, no information is provided about the process and the methods used. According to the research, the evaluation of the system, which was tested using an actual project, showed promising results although the system was not the end in itself (Demetris Demetriou, 2014).

Finland's new object-oriented cadastral information system is a multi-purpose cadastral system used by the National Land Survey of Finland (Vitikainen, 2002). The new tools of object-oriented cadastral information system introduced in 1998, and which deal with land administration, provide functions for land consolidation. In particular, a module of the object-oriented cadastral information system is the Valuation and Land Consolidation module. However, the available functions of this module focus on specific customized functions regarding database management, statistical analysis, and financial matters and aid the design of a land consolidation project. No advanced analytical models to support the planner or automate the land reallocation process are provided.

Other researchers who have worked on developing information systems for land reallocation are Marcus (2004) and Kovacs (2001) in Hungary, without providing any detailed technical

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information about these systems and their models. In a recent study, Yomralioglu et al. (2007) developed an analogous raster-based system for assigning land values to parcels before and after the project. Land value is the prominent element for carrying out land distribution. A similar study was carried out by Feryandi et al. (2007) using remote sensing data.

Chen and Jiang (2000) developed an event-based approach to spatio-temporal modeling of land subdivision systems. The location of parcels and the time a parcel is designed (e.g. because of a subdivision), represent the different states of land parcels over time. This is a good idea which could be investigated for the different states of a land reallocation plan, i.e. from the original cadastral situation to the new final land consolidation plan. Such a process could monitor the evolution of the decisions (e.g. of an automated land reallocation model) taken for the land reallocation plan, so as to explain system behavior and decisions at each stage.

Urban planning is the process of developing and designing urban areas to meet the needs of a community. The practice draws from a number of disciplines architecture, engineering, economics, sociology, public health, finance, and more and strives to prepare cities and towns for the future. It is typically used as part of a larger city plan, and should tie back to your city's mission and vision statements. One more thing to note: Urban planning is more effective when you approach it with a strategic lens. That means setting clear goals, measuring progress, and strategically defining and executing projects (Marisa Sailus, 2021).

Conveyers and Hills (1984) define planning as 'a continuous process which involves decision and choices, about normative ways of using available resources, with the aim of achieving particular goals at some time in future.

Urban planning also designs and regulation of the uses of space that focus on the physical form, economic functions, and social impacts of the urban environment and on the location of different activities within it. Because urban planning draws upon engineering, architectural, and social and political concerns, it is variously a technical profession, an endeavour involving political will and public participation, and an academic discipline. Urban planning concerns itself with both the development of open land ("greenfields sites") and the revitalization of existing parts of the city, thereby involving goal setting, data collection and analysis, forecasting, design, strategic thinking, and public consultation. Increasingly, the technology of geographic information systems has been used to map the existing urban system and to project the consequences of

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changes. In the late 20th century the term sustainable development came to represent an ideal outcome in the sum of all planning goals (Marisa Sailus, 2021).

Africa is estimated to reach an urbanization rate of 50% in 2035 (UNDESA, 2014). The number of urban dwellers in Africa is projected to increase from 400 million in 2010 to 1.26 billion in 2050. Presently, at 23.5% urbanization rate, the East African Community is the least urbanized African region (UN-HABITAT, 2010).

Urbanization is an opportunity for socio-economic growth. Well-planned urbanization may help achieve the proper use of land, other natural resources and of investment into infrastructure services, and may help initiate local economic development.

Urbanization in Rwanda is characterized by demographic growth and by migration to urban areas, accompanied by the installation of displaced people and returnees after the 1994 genocide against the Tutsi. The urban population has increased from 4.6% in 1978 to 16.5% in 2012. The Vision 2020 prepares for reaching 35% in 2020. The average urban density surveyed in 2012 with 1,871 inhabitants per square kilometer has more doubled since 2002. The current annual growth rate of the urban population is 4.1%. The capital city Kigali accommodated about half of the urban population in 2012 (NISR, 2014). With the EDPRS2 and the Urbanization and Rural Settlement Sector Strategic Plan, six secondary cities were selected for the promotion of urban development outside of the capital city: Rubavu, Musanze, Huye, Rusizi, Nyagatare, and Muhanga. There levels of urbanization vary with the Districts of Musanze, Huye, Muhanga and Rusizi having an urban population above 15%, and Nyagatare District above 10% (NISR, 2012). However, Urbanization is occurring fast throughout Rwanda, as evidenced by expansion of unplanned urban settlements in cities and their surroundings.

Swedish International Development Cooperation Agency has mentioned that urban development planning need to look at Social aspect, Economic aspect, Environmental aspect and Democratic aspect. Urban growth brings a potential increase in conflict between environmental, economic, political, social and cultural interests as well as between the public and private sectors. Planning must counteract these tensions. The challenge is to support plans and standards that protect public interest, the local environment and the poor, and to balance private and public costs and interests. Political commitment plays a significant role. Governments are rarely prepared for the ongoing urban growth as the planning horizon of politicians is often too short. The distribution of

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responsibility and authority between levels of government is often ineffective and fiscal systems often need reforming. Decentralization is rarely coupled with sufficient resource allocation or investment budgets, with smaller municipalities particularly suffering. Inadequate links between planning and budgeting often results in non-implementation of plans. Local authorities lack creditworthiness due to inadequate fiscal and regulatory frameworks and capacity for revenue generation. Low tax collection rates result from people living on unregistered plots where they are not recognized by the authorities, as well as inadequate and outdated mapping and non-computerized land management systems (Swedish International Development Cooperation Agency, 2006).

2.2. Land use/cover change (LULCC) prediction

Land is the basis for most biological and human activities on the earth. Agriculture, forestry, industries, transport, housing and other services all use land as a natural and/ or an economic resource. Land is also an integral part of ecosystems and indispensable for biodiversity, carbon cycle, etc. Therefore harmonized and reliable data and information on land cover/use status and changes are crucial for various policy sectors and stakeholders (Eurostat regional, 2011).

Most biological and human activities are land-based. Land is accounted for in two ways: as biogeographical land cover and as socioeconomic land use. Land cover indicates the visible surface of land (e.g. crops, grass, water, broad-leaved forest or built-up area). Land use indicates the socioeconomic purpose for which the land is used (e.g. agriculture, forestry, recreation or residential use). Data on land cover and land use are essential for observing and managing a range of key environmental and socioeconomic trends, many of which are linked to the sustainable use of resources and climate change.

In one of its land data collection systems, Eurostat collects land cover and land use data in the field through an area frame survey called LUCAS. It was launched in spring/ autumn 2009 simultaneously in 23 European Union countries. Bulgaria, Cyprus, Malta and Romania were not covered by the 2009 survey. Field surveyors visited the identified points and collected information on land cover, land use and selected agroenvironmental indicators for 234 700 points distributed among 23 Member States. Landscape diversity was recorded along a 250 m-long line eastwards from each point (the LUCAS transect). Each visit was documented by numerous

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photographs, which form an important part of the LUCAS dataset, especially in terms of landscape description (Eurostat, 2011).

Land cover is the physical material at the surface of Earth. Land covers include grass, asphalt, trees, bare ground, water, etc. and Land use is a description of how people utilize the land and of socio-economic activity. Urban and agricultural land uses are two of the most commonly known land use classes (Fisher et al., 2005).

Although the terms land cover and land uses are often used interchangeably, their actual meanings are quite distinct. Land cover refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil or other. Identifying, delineating and mapping land cover is important for global monitoring studies, resource management, and planning activities. Identification of land cover establishes the baseline from which monitoring activities (change detection) can be performed, and provides the ground cover information for baseline thematic maps.

Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture. Land use applications involve both baseline mapping and subsequent monitoring, since timely information is required to know what current quantity of land is in what type of use and to identify the land use changes from year to year. Land cover and use information may be used for planning, monitoring, and evaluation of development, industrial activity, or reclamation. Detection of long term changes in land cover may reveal a response to a shift in local or regional climatic conditions, the basis of terrestrial global monitoring (Government of Canada, 2015)

Land use planning is a public policy exercise that designates and regulates the use of land in order to improve a community's physical, economic, and social efficiency and well-being. By considering socioeconomic trends as well as physical and geographical features (such as topography and ecology), planning helps identify the preferred land uses that will support local development goals (Abhas K. Jha et al., 2010)**.**

2.3. Land reallocation planning

2.3.1. Land reallocation principles

Land reallocation referred to as land reparcelling, is inherently a spatial planning process and in particular, is a very complex spatial allocation problem. The problem can be defined as: "how to optimally rearrange the existing land tenure structure in a certain rural area, based on the

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country's existing land consolidation legislation, (which together with the current practices imposes a series of criteria and constraints) so as to fulfill the aims of the particular land consolidation project (Demetris Demetriou, 2014).

In general, the land reallocation process can be split into five main stages: data collection, preliminary calculations, preliminary land reallocation, definite land reallocation and implementation (Demetris Demetriou, 2014).

Land consolidation is a planned readjustment and rearrangement of fragmented land parcels and their ownership. It is usually applied to form larger and more rational land holdings. Land consolidation can be used to improve rural infrastructure and to implement developmental and environmental policies (Pasakarnis G et al., 2010).

Land consolidation based on regulations derived from legislation varies from country to country. Furthermore, land reallocation relies on circulars, directives and legal expert advice issued by the land consolidation authority concerned. All these documents, define the principles of land reallocation for each country. A land consolidation Expert carries out a land reallocation plan based on these principles, rules of thumb and his/her personal knowledge and experience (Demetris Demetriou, 2014).

2.3.1.1. Fundamental principles

Site Committee in collaboration with consultant must prepare a land consolidation and reallocation plan for the affected area which shall, as far as possible (Demetris Demetriou, 2014).

2.3.1.2. Complementary principles

Complementary principles are defined by two main sources: the legal expert advice provided by the Government's legal services to the public institution having Land Surveying and Urban Planning in its attribution for a specific matter and Advice notes issued throughout the implementation of land consolidation (Demetris Demetriou, 2014).

2.3.1.3. Expert knowledge and judgment

Although the fundamental and complementary land reallocation principles strictly define a set of rules for the process, the role of the Consultant expert is extremely important. The success of the plan strongly depends on their knowledge, experience and judgment. On the one hand, the expert must carry out the process without violating the rules (except in some cases where a differentiation is permitted after providing a robust justification), which mainly aims to produce

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an efficient and fair land reallocation plan. On the other hand, the expert must satisfy the preferences and interests of hundreds of (or sometimes more than a thousand) landowners (Demetris Demetriou, 2014).

Additionally, many other criteria, such as equity, equality, environmental protection, and local socio-economic and cultural values and conditions, should be taken into account. Thus, the Expert is the central element of this decision-making process. The Expert must establish a compromise between the conflicting views, duties and interests of the stakeholders involved, i.e. the affected landowners, the Site Committee, the Central Government Authority and the local authority, in the light of the legislation provisions and the economic, social and environmental sustainability of the plan. Furthermore, the Expert must fill in the gaps and offset the weaknesses of both the fundamental and complementary principles, which sometimes may be fuzzy (e.g. the increase of property value after land consolidation should not be significant) or when no explicit provision is included (e.g. for environmental protection, or parcel shape, orientation etc.).

Additionally, the Expert has to analyze the existing ownership data so as to define some very important parameters that influence the new plan, which should be approved by the Head of the Department and then by the Site Committee. For instance, the definition of the minimum area and value limits owned by a landowner so as to be granted or refused a property in the new plan; the definition of the 'small-medium-large holding' which defines the number of parcels that should be allocated to each landowner. Also, the Expert carries out the preference sessions with each landowner, aiming at discussing the potential reallocation of his property. Thus, the Expert's skills need to be substantial to convince a landowner to accept a certain solution (Demetris Demetriou, 2019).

2.3.2. The steps follow in order to make land reallocation

1. Subdivision of the interested area in land parcel where each new land parcel is enclosed by roads, streams, canals and the external boundaries of the study area,
2. Calculation of the total area of new subdivided parcel,
3. Definition, of which landowners will not be granted property in the new plan, based on the minimum area according to the physical plan guidelines,
4. Definition of which parcels will be exempt from reallocation, based on the relevant decision of the Site Committee. These parcels can be shown on a map,

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5. Calculation of the contribution coefficient of landowners for the value of land occupied by public facilities, i.e. roads, canals, etc. and finding formula to use for both financial contribution and land share
6. Calculation of the land area should be allocated to each landowner after the subtraction of the land area calculated by the contribution coefficient,
7. Definition of the number of parcels that can be allocated to each landowner based on the principle of Holdings in undivided shares,
8. Calculation of the initial available land (in terms of size) for reallocation in each block,
9. Reallocation of properties. This is an iterative, trial and error process, which proceeds block by block, by considering how to reallocate the properties in a certain block. Firstly, the property in the block owned by the landowners is considered followed by the potential to transfer the property of other landowners in that block (Demetris Demetriou, 2014).

2.3.3. Top up a substandard output plot size

A plot, where the area is under the minimum size before planning, can be completed to reach these limits during planning. Every landowner who receives a 'completed Plot' should be satisfied with respect to the defined criteria by the Committee, when compared to any other landowner in the new plan. These criteria are: area of the ownership before land consolidation; residence of the landowner (Demetris Demetriou, 2014).

2.3.4. Holdings in undivided shares:

The allocation of a plot in undivided shares (part of the land held specific common interest or other interesting project which will not remove it easy from the field. e.g. Macadamia Plantation) should be avoided. However, in the case where there is no potential for allocating separate plots, the following prerequisites should be satisfied: all the landowners should have owned the same plot in undivided shares before the land consolation; the written declaration should state that all the co-landowners will commonly exploit the plots as per predefined use (Demetris Demetriou, 2019).

2.3.5. Upgraded urban development plan

Upgrading is also called in low income urban communities are many things, but at its simplest it has come to mean a package of basic services: clean water supply and adequate sewage disposal

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to improve the well-being of the community. But fundamental is legalizing and 'regularizing' the properties in situations of insecure or unclear tenure (David Saithwaithe, 2000).

Upgrading customarily provides a package of improvements in roads, footpaths and drainage as well. Solid waste collection is frequently included with its positive impact on health, along with street lights for security and night activity. Electricity to homes is often initiated later and sometimes even before. But this physical improvement is only the beginning: health issues need to be addressed by providing clinics and health education programs, school facilities and teacher training are needed to attack the lack of basic education, and lastly programs are offered to increase income earning opportunities and the general economic health of a community. Upgrading is the start to becoming a recognized citizen (David Saithwaithe, 2000).

Urban Upgrading development plan aims to alleviate poverty by improving infrastructure (such as access roads, water, drainage, sewerage, and street lights, school, kindergartens, health and community centers) and providing microcredit loans to the urban poor living in low-income areas. The research uses participatory methods as a key design principle and aims to influence planning processes to become more inclusive and pro-poor (NguyễnVănTư, 2014).

2.4. Urban Development planning

Urban growth is multifaceted, while it brings economic and development opportunities, it also puts pressure on the urban space, infrastructure and environment. Gender and generational relations change as new urban, often multi-ethnical, cultures emerge. The challenge is to balance different needs and interests, choose between different scenarios and guide development towards common goals including improved livelihoods for the urban poor. Urban planning differs from country to country, but it generally encompasses controlling and enabling tools. Controlling tools include spatial plans, zoning and land subdivision regulations, building codes and standards, while enabling tools include public land acquisition and allocation, investment in public infrastructure, green spaces and service facilities, and stimulation of public-private partnerships. It is important to keep in mind that much city growth in developing countries happens outside authorized planning (Sonam Wangyel Wang et al., 2020)..

Conventional urban planning and design skills are often inadequate to cope with urbanization in developing countries where most planning legislation is inherited, in many cases from the colonial time, and not based on the actuality on the ground. Realistic urban development

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planning requires an integrated approach to cope with the complex reality and fast changing conditions. Planning tools need to be multi-disciplinary and participatory including women and men at all levels of decision-making. Services should be affordable and accessible for all inhabitants. Laws, regulations, policies and plans that facilitate access to land, housing and financial markets, particularly benefiting the poor and marginalized, need to be enforced (Sonam Wangyel Wang et al., 2020).

Physical planning is a design exercise that uses the land use plan as a framework to propose the optimal physical infrastructure for a settlement or area, including infrastructure for public services, transport, economic activities, recreation, and environmental protection. A physical plan may be prepared for an urban area or a rural area. A physical plan for an urban region can have both rural and urban components, although the latter usually predominates. A physical plan at a regional scale can also deal with the provision of specific regional infrastructure, such as a regional road or a bulk water supply system. Land use plans and physical plans are not necessarily mutually exclusive. It is common practice in many countries to prepare comprehensive development plans that address both land use zoning and the provision of physical infrastructure. Such an exercise is more meaningful if carried out in the context of a strategic planning process, whereby the proposals in the land use plan and the physical plan become part of a comprehensive development plan. While land use and physical plans are outcome-oriented, strategic plans are more process-oriented (Abhas K. Jha et al., 2010)**.**

According to Word Bank (2007), Physical planning is a design exercise that uses the land use plan as a framework to propose the optimal physical infrastructure for a settlement or area, including infrastructure for public services, transport, economic activities, recreation, and environmental protection. A physical plan may be prepared for an urban area or a rural area. A physical plan for an urban region can have both rural and urban components, although the latter usually predominates. A physical plan at a regional scale can also deal with the provision of specific regional infrastructure, such as a regional road or a bulk water supply system.

Planning for infrastructure and services: This component deals with network alignments and land allocation for infrastructure services. The critical services include water supply, wastewater management, solid waste management, and storm-water management. Power supply and telecommunications networks may also be important. In all these cases, the existing systems

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need to be documented and proposed improvements need to be conceptually worked out to the extent that is required for assessing land-related issues. The output is a set of maps. Project formulation for infrastructure is a separate activity, but may be carried out concurrently or integrated with the planning process (Abhas K. Jha et al., 2010).

Planning for public buildings and social infrastructure deal with allocation of land for facilities related to health, education, government, recreation, community development and disaster shelters. In the planning process, the questions that need to be addressed are: What facilities existed pre-disaster? Should refuges be built? What is the extent of damage? Do any facilities need relocation? Were pre-disaster facilities adequate? What does the reconstruction policy envisage: restoration of pre-disaster levels or improvement? What is the land requirement? What facilities are required as part of new housing to be created? The output of this component is a set of maps showing locations of proposed facilities and project briefs for creating them. Planning infrastructure projects is covered in (Abhas K. Jha et al., 2010).

Community Driven Development (CDD): Poor people are often viewed as the target of poverty reduction efforts. CDD approaches, by contrast, treat poor people and their institutions as initiators, as collaborators and as resources on which to build (World Bank, 2003).

CDD is broadly defined as giving control of decisions and resources to community groups. CDD frameworks link participation, community management of resources, good governance and decentralization (World Bank, 2003).

With a view to generate sustainable and wide- ranging impacts, CDD operations and regional strategies have increasingly embraced two important pillars of sustainability and scale: linking communities to private sector and local governments (World Bank, 2003).

2.5. Theoretical and Conceptual Frameworks

2.5.1. Conceptual Framework

The conceptual framework that was used in the study shows two variables: the independent variables which stand alone; and the dependent variable which changes as a result of the independent variable manipulation.

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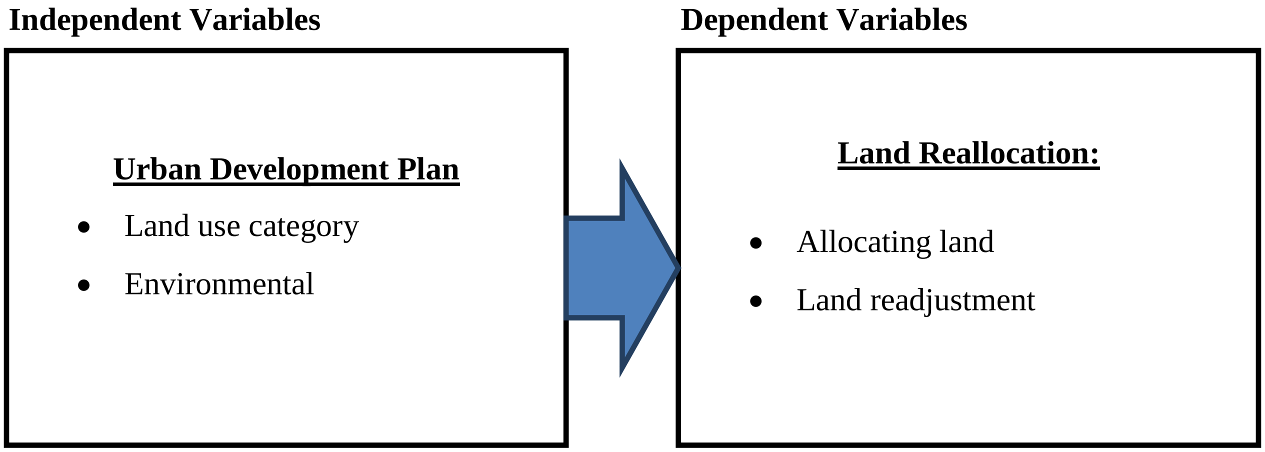

Figure 1: Flowchart for Conceptual framework

2.5.1.1. Independent Variables

The independent variable is the condition that you change in an experiment. It is the variable you control. It is called independent because its value does not depend on and is not affected by the state of any other variable in the experiment. Urban Development plan as independent Valuable has the task of providing fundamental planning tools ensuring the Kabeza site's innovative development in line with social, economic and ecological requirements.

It specifies whether an area is designated as recreation or for transportation purposes, housing construction, or existing plantation protection under the Land use category as has a residential zone where this study focused on land subdivision to the plot size of 15m * 20m but because the developed area was some part constructed all designed plots have not fitted said plot size. Land use category of public space where people come together to enjoy the site and each other, these spaces make the Kabeza site's high quality of life possible where an author has designed a recreational zone and green space for site beautification.

Transport systems connect the parts within the Kabeza site and neighborhood and help shape them, and enable movement throughout the site. They include road, rail, bicycle, and pedestrian networks. The balance of these various transport systems is what helps define the quality and character of developed areas, and makes them either friendly or hostile to pedestrians. But in this study, the road network has only developed for the width of 9m including roadway, drainage side, and sidewalk and road reserve for other basic infrastructures like electricity, water supply system, Fiber optic and green space along the road for beautification of the site.

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These constructions usually form part of specific sector programmes, including capacity-building measures. Special attention is also paid to the slums of large cities. Rehabilitation and reconstruction comprises in particular social infrastructure following natural disasters or conflicts. Environmental Protection includes programs that are aimed at reducing risks to the environment from contaminants such as hazardous materials and wastes, fuels, and oils. In this study five ways that can make the Kabeza site healthier and more sustainable that have been considered are urban agriculture promotion where existing plantations, and forest have protected within the site, encouraging healthy diets by fighting against using plastic etc , food security, Boosting green spaces for healthier environments and improved lifestyles and reconnecting with the neighborhood area.

2.5.1.2. Dependent Variables

The dependent variable is the condition that you measure in an experiment. You are assessing how it responds to a change in the independent variable, so you can think of it as depending on the independent variable. Land Reallocation as a dependent valuable in this study is the activity of allocating land again and land readjustment as an exercise and optimizing problem or the process of reallocating parcels to pre-determined blocks according to the preferences of landowners with conventional reallocation method or manual reallocation.

Land Allocation is the process used for the distribution or provision of land as a right of occupancy or lease to an individual or a group of persons or legal persons or institutions and organizations with respecting general, source, destination, and offset components for rules of allocation. Land allocation is a highly sensitive issue, especially in areas where land ownership provides an important source of income for its inhabitants. As a consequence, the acquisition of land for a sanitation system requires reasonable compensation. Apart from such compensations, affected communities are often notably and understandably sensitive to changes in current agreements concerning land use. In Land reallocation, a part of Land allocation, Land readjustment also includes as an effective tool in the regeneration projects through increased land values while engaging and involving the original residents and landowners as stakeholders.

After the Plot subdivision process is done on consolidated land, each land owner must have land after planning with respect to the total area he/she was having before planning. Land use was the important part that has been described in this study where an author has defined and designed

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different land use categories to the standard of the urban development plan also upgrading the Kabeza site. Before starting land reallocation after developing a physical plan within the site, the contribution coefficient factor has been calculated in this study and helps in the land allocation where each land owner must contribute at the same percentage as the contribution coefficient factor of the total area. This particular percentage has to be determined by only considering proposed space for basic infrastructure and public spaces. The financial contribution also must be used to know the financial contribution to the sponsor specifically the implementation of basic infrastructure and public spaces as the amount of money paid per landowner.

Land readjustment as part of the Land reallocation system is an approach and technique applied to promote optimal use of land through a participatory and inclusive planning process where land owners of the Kabeza site voluntarily consolidate their contagious plots for proper infrastructure servicing and neighborhood public space provision and land redistribution method applied is by land size where land reallocation method preserves the spatial location of the initial parcel.

The allocation of land resources is adjusted and optimized through the characteristics of the actual population served in the area to determine the new urban population that can be effectively accommodated by the national land authority.

The whole site output land shall be reallocated to original landowners and public land under temporary plot codes in the form of numbers on the replotting plan map, and all new land configurations boundaries are to be marked in line with approved replotting and land reallocation plan.

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CHAPTER THREE: MATERIALS AND METHODS

3.1. Research design

The site has been selected by a researcher as a planning area based on the development of the region and demands for development of the district to make Kabeza one of the smart cities in the region, uncontrolled increase of population with the site, rapidly land use land cover change and observational design will be used during this study as a chosen type of design as the table 1. has defined.

Table 1.Used methodology for the study

Objectives	Hypotheses	Methodology	Statistics
To assess and predict the existing land use land cover at Kabeza site of Kicukiro District	Ho1 (Null hypothesis 1): There is no significant difference between the past and current adjustments of land use/cover at Kabeza Site	Parametric prediction and trendshift analysis of land reallocation	-Land use/cover change (LULCC) -Pearson regression model for land use/cover change adjustments for 1960-2030; and -Nonparametric tests for Trendshift analysis
To make needed adjustments to upgrade the existing land development plans at Kabeza site	H02 (Null hypothesis 2) : There is no significant difference between the land use/cover change and the adjustments of land reallocation at Kabeza Site	Comparison of means between LULC and Land reallocated adjustments	-Homogeneity test of LULCC and Land reallocated adjustments -Normal distribution of the difference between the two variables

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To estimate a contribution coefficient factor on each parcel to achieve the people's welfare and equitable reallocation of land	H03 (Null hypothesis 3): There is no significant relationship between land reallocation and social equity/ welfare	Differentiation of land reallocation and social equity/ welfare	-Chi-square test of the difference between land reallocation and social equity/ welfare -Estimate of a contribution coefficient factor
To predict the most suitable Financial factors for urban development planning at Kabeza Site	H04: (Null hypothesis 4): There is no significant relationship between land reallocation and urban development planning.	Non Parametric prediction model (Logit, Probit or Tobit) of the relationship between land reallocation and urban development planning	Logistic regression model for urban development planning subject to land reallocation

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3.2. Presentation of the Study Area

Kabeza Site is located in Kicukiro District, City of Kigali, and Capital of Rwanda. The following map expresses the city of Kigali extracted from the administrative boundary map of Rwanda.

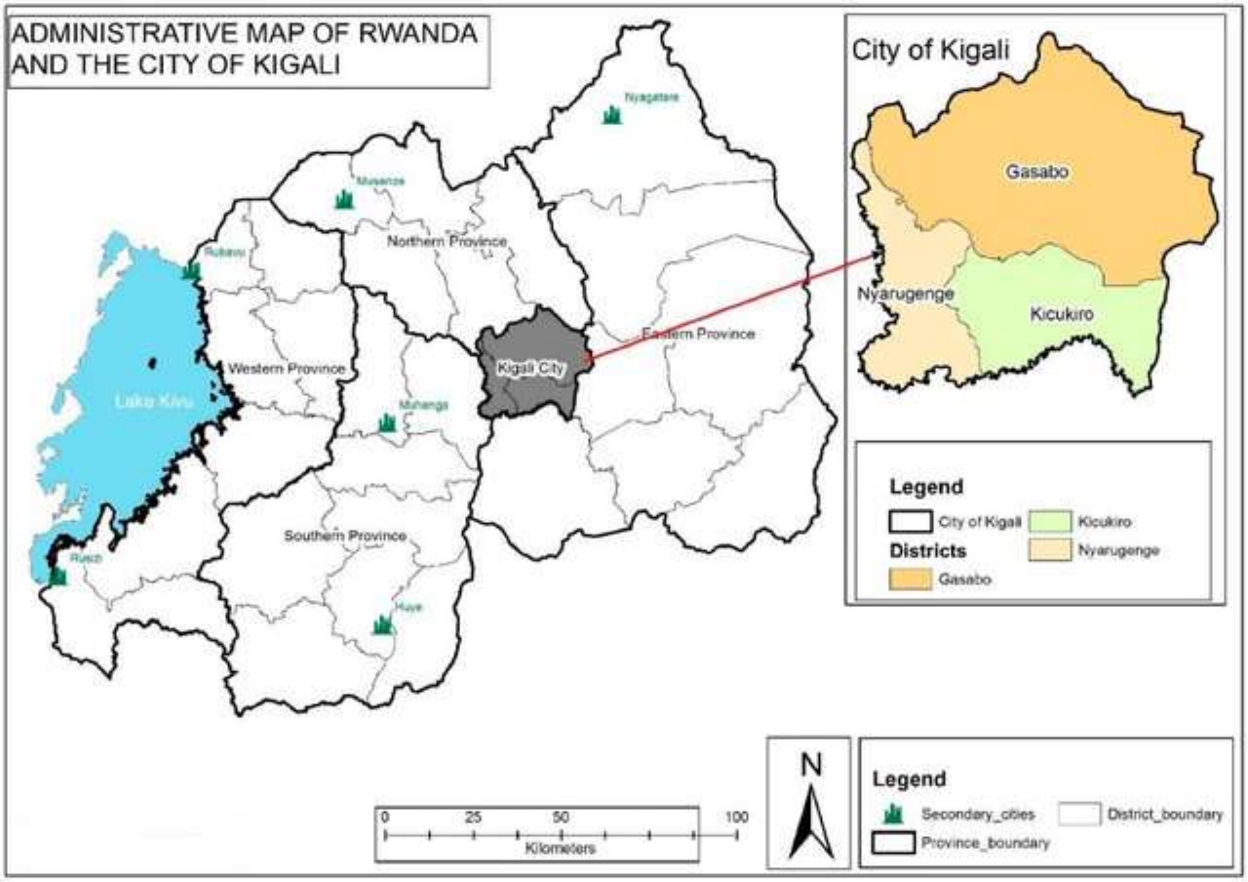

Figure 2: Kigali City map from administrative boundary of Rwanda (Kigali Master Plan, 2023)

The study covered area of 116.3ha in Kicukiro District, Gahanga Sector and Karembure Cell within Kigali City for X= 509021.6m, Y= 4775632.7m as the figure 3 expresses exact location of the site within Kicukiro District .

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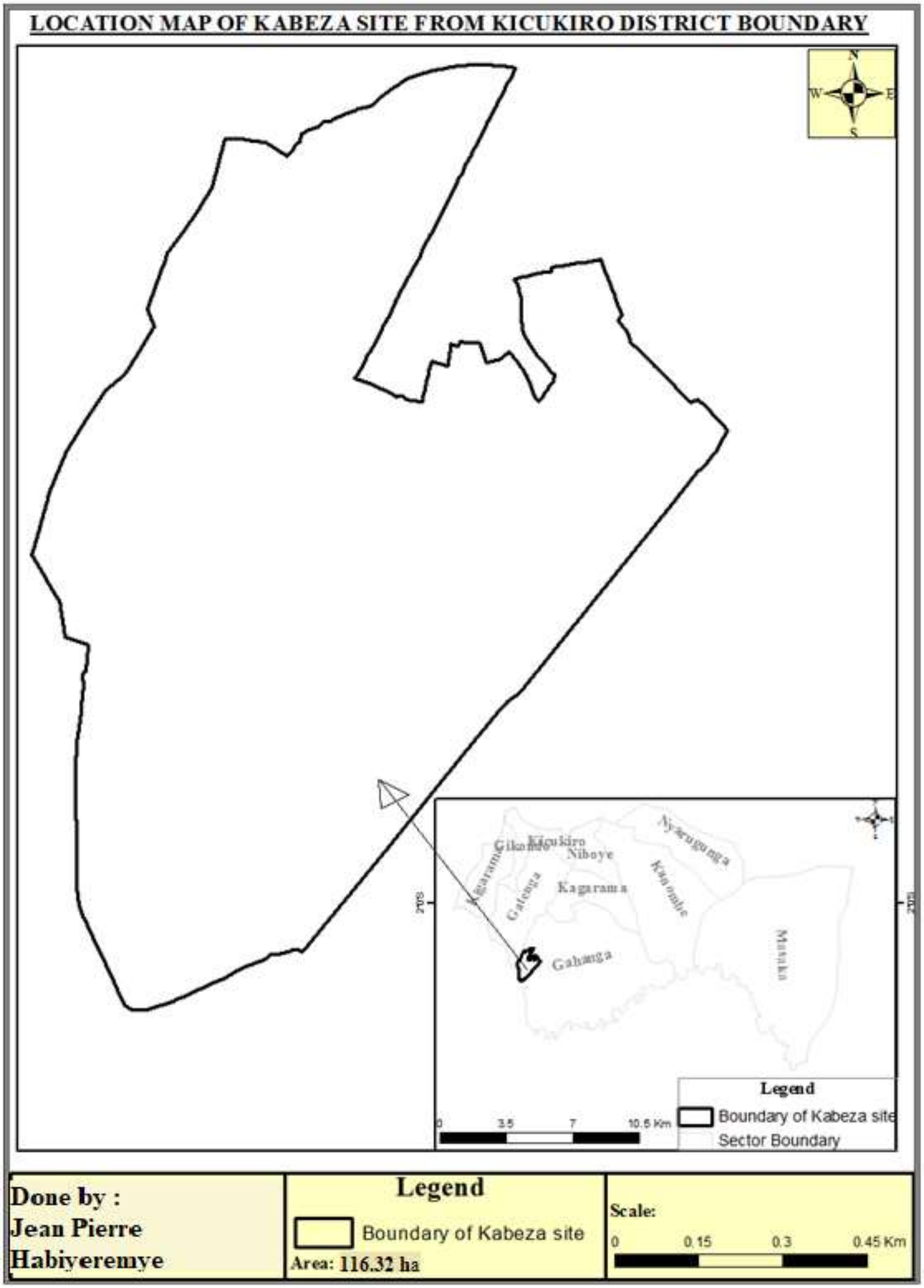

Figure 3: Location map of Kabeza site form Kicukiro District (Primary data, 2023)

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Kabeza site is located at 2.4Km from Nyanza Bus Parking and 1.5km from Agakiriro of Gahanga. The different people from the different regions especially from central Business development and others from Bugesera International Airport will come to stay on this site safely and do their business around Gahanga new Kigali City Market and they will get basic infrastructure.

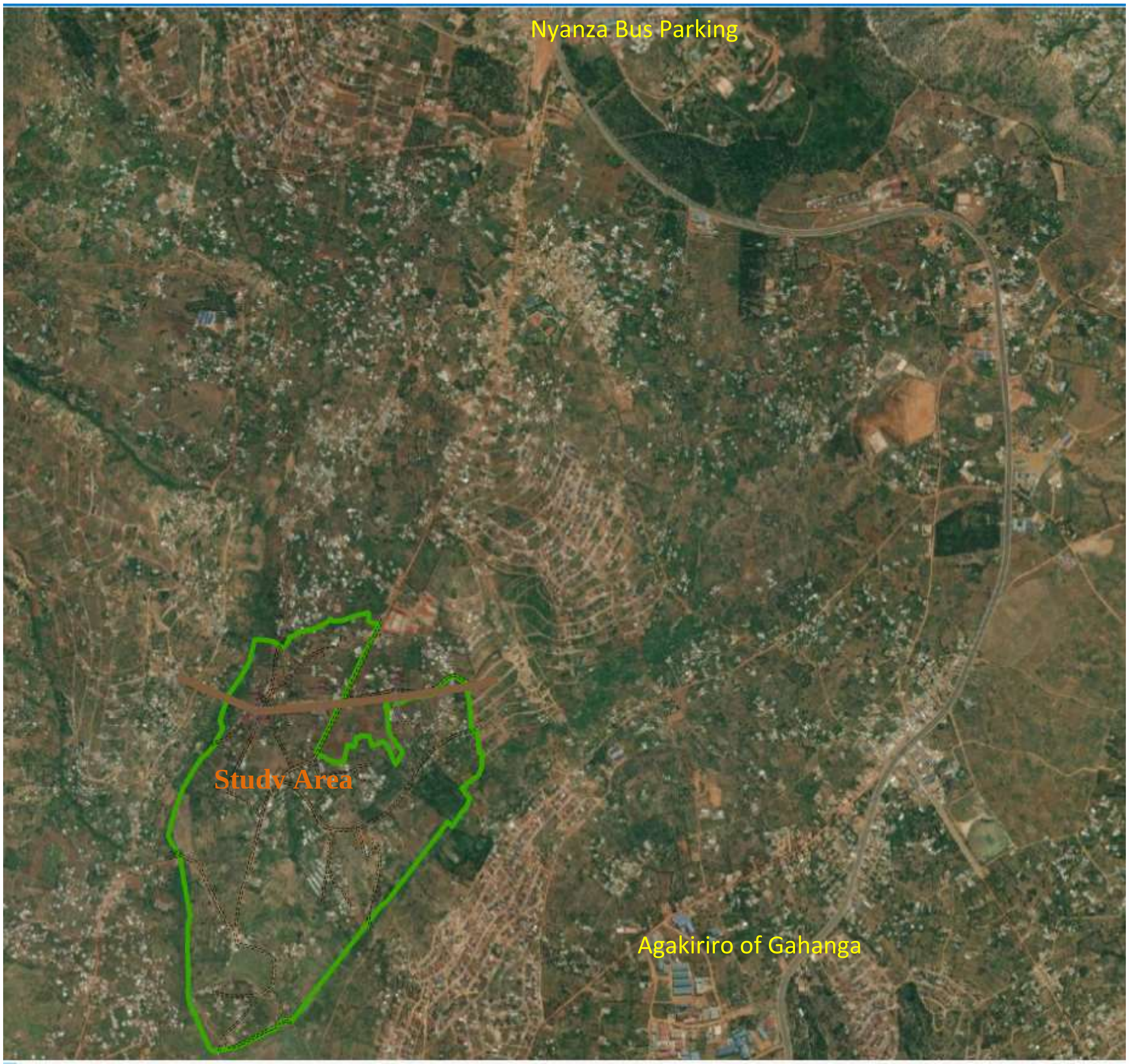

Figure 4: Ortho image of Kabeza Site from Google Earth Pro

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3.3. Sampling methods and techniques

3.3.1. Population of the study

The target population for this study included all resident of the site with total population of 550 residents (NISR, 2012)

3.3.2. Sampling techniques

The Simple random sampling technique was used in the study to select the participants of the study where each member of the population has an equal chance of being selected and helps ensure high internal validity: randomization is the best method to reduce the impact of potential confounding variables.

3.3.2.1. Sample size

Slovin's formula has adopted in this study for Sample size calculation as follows:

$$n = \frac{N}{1+N(e)^2}, \qquad \text{(Equation 1)}$$

n is the sample size, N is the population size and e is margin error (T S Nanjundeswaraswamy et al., 2021),

$n = \frac{550}{1+550(e)^2}$ = 521.3, then equal 522

From the above formula, by using the marginal error of 0.01 or 1% i.e. 99% confidence; hence the researcher calculated the sample size from the 550 population. Therefore, the sample size that was used is 522.

3.3.3. Criteria of participants' selection

A participatory approach has been adopted which is a process of equitable and active involvement of all stakeholders in the formulation of development policies and strategies and the analysis, planning and local development plans, monitoring, and evaluation of development activities.

Especially landowners will be subjectively involved in the implementation of this project after mobilization and explaining how and procedures of making this research using community meetings without putting aside the Local Authorities.

The results from this research are a reallocation plan and a detailed upgraded urban development plan of the Kabeza site /Karembure to make sure that every person who was

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having parcel before planning gets a plot referring to the area of the parcel before planning and considering all public infrastructures that have planned in the site.

3.4. Data collection techniques and instruments

3.4.1. Type of data and techniques of data collection

To carry out this research observation method was used during data collection where primary data and secondary data were used. Trilateration used technique for determining a position. The following table shows all activities, techniques and instruments used during this study.

Activities	Techniques	Instruments
❖ Site reconnaissance ❖ Detailed topographic Survey ❖ Systematic boundary parcel resurvey	Trilateration	DGNSS Receiver, Panger, Hammer, Total station
❖ Meetings with Landowners (interview)	-	-

3.4.1.1. Field Survey

The topographic data have been collected from the field to have a crucial understanding of the topography of the area; those points have been collected with the DGNSS receiver and Total station. The interesting points are the existing nature and manmade features, infrastructures within and near the site.

3.4.1.2. Interviews

An unstructured interview which is very flexible, helps your respondent feel comfortable and at ease, reducing the risk of bias, and more detail and nuance, was used where was open-ended and has helped the researcher to gather detailed information on this topic by field observation in which information was obtained and unstructured interview has taken during a consultative meeting with land owners.

3.4.1.3. Documentary review

For this study, the data from the Kigali City master plan and Google Earth professional platform allows visualization, assessment, overlay, and creation of geospatial data was used.

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3.4.2. Data collection instruments

3.4.2.1. Documentary review chart

The following figure illustrates a summarized work flow of the documentary review until the end of this study.

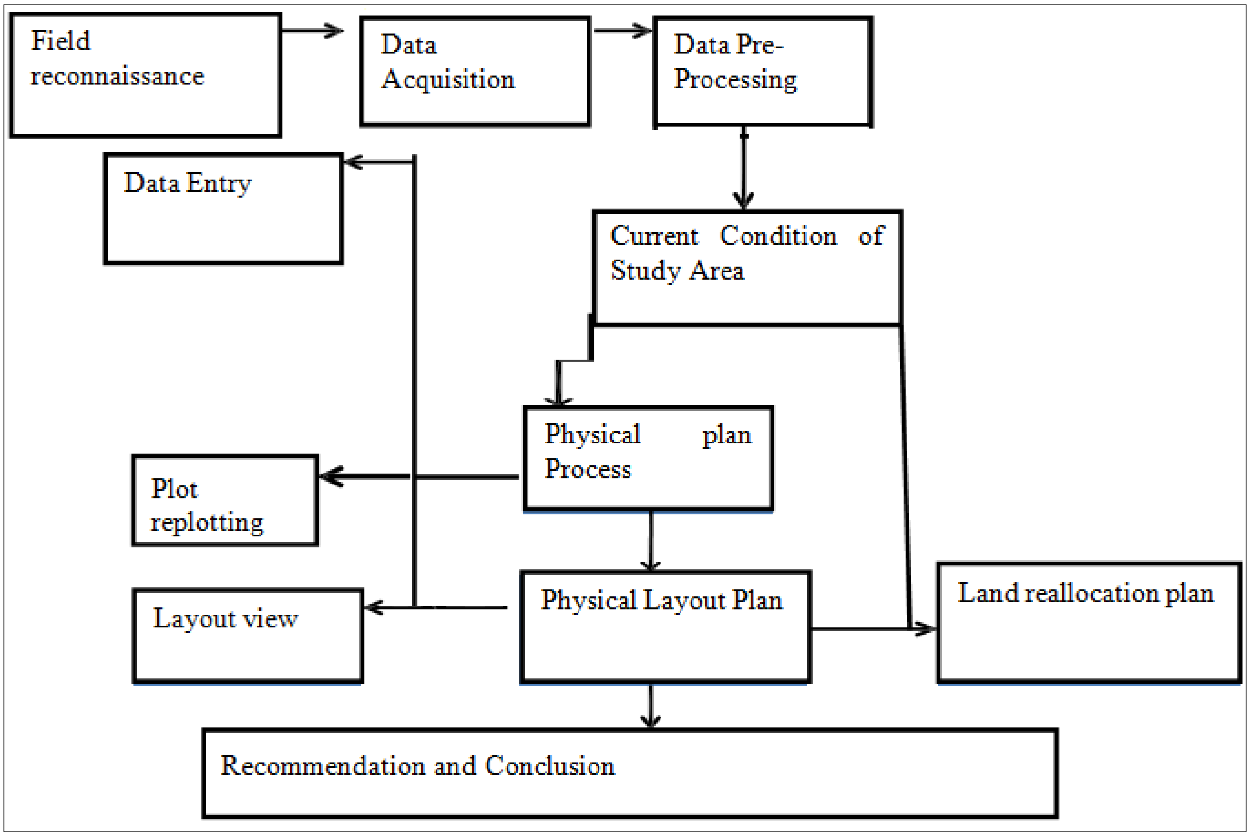

Figure 5: Workflow of the study method

3.5. Data analysis techniques

During data analysis, Pearson correlation coefficient calculation and Chi-square test and Normal distribution were used.

The Pearson correlation coefficient, r, can take on values between -1 and 1. The further away r is from zero, the stronger the linear relationship between existing land use land cover and predicted land use land cover within 1960-2030. The following formula has been used

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$ (Obilor, Esezi Isaac (Ph.D), et al., 2018), (Equation 2)

where r is Pearson correlation coefficient, x is Existing land use land cover, y is predicted land use land cover in 1960-2030 and n is number of variables.

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Significance test t value calculated as follow:

$$t = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}}, \quad \text{(Equation 3)}$$

after finding critical value of t from statistical table at significance level α = 0.01 and calculating confidence interval *df* = n-2 (Obilor, Esezi Isaac (Ph.D), et al., 2018), Then check hypothesis using the following statement:

- If *t* value is less than the critical value of *t,* null hypothesis didn't reject otherwise null hypothesis will be rejected.

Comparison of means between Land Use Land Cover and Land reallocated adjustments using Homogeneity test two variables has applied for examining whether Land use land Cover and Land readjustment are independent in influencing the test statistic deducting under the following formula:

$$\boldsymbol{x^2 = \sum \frac{(Observed - Expected)^2}{Expected}}, \quad \text{(Equation 4)}$$

Normally for testing both independence and homogeneity computation of the degree of freedom $(df) = (r-1)(c-1)$, where r is the number of rows and c is the number of columns but in the two-way table as it is, in this case, the number of rows must not consider and find using the statistic concept that has helped the researcher to decide whether the null hypothesis is rejected or not.

A normal distribution is a type of continuous probability distribution in which most data points cluster toward the middle of the range, while the rest taper off symmetrically toward either extreme. In this research Normal distribution was used for identifying if there is no significant difference between two variables with the following steps:

Let X have a normal distribution with mean μ_x, variance ${\sigma_x}^2$, and standard deviation σ_x.

Let Y have a normal distribution with mean μ_y, variance ${\sigma_y}^2$, and standard deviation σ_y.

If X and Y are independent, then X−Y will follow a normal distribution with mean $\mu_x - \mu_y$, variance ${\sigma_x}^2 + {\sigma_y}^2$, and standard deviation $\sqrt{{\sigma_x}^2 + {\sigma_y}^2}$.

The idea is that, if the two random variables are normal, then their difference will also be normal.

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Land reallocation as it is specifically to redistribution of the land to the initial landowners where Calculation of the contribution coefficient of landowners for the value of land occupied by public facilities, i.e. roads, canals, etc. was focused in this research and the following formula has developed by Author of this Thesis to calculate Contribution Coefficient Factor (**CCF**) for each land as follows:

$$\textbf{CCF}= \left(\left|\frac{TEP-TNP}{TPP}\right| * 100\right) + PD, \qquad \text{(Equation 5)}$$

Where **CCF** – Contribution Coefficient factor on each parcel, **TEP-** Total area of the Existing parcel before planning (Initial parcel or Site area) except for built-up area and Existing infrastructures, **TNP-** Total area of the New Proposed Plot including the occupied area of the New proposed infrastructures, **TPP-** Total area of the Proposed plot except infrastructures area occupied, **PD** – Percentage of total area destroyed by New proposed Public infrastructures within the area.

The financial contribution factor is a coefficient developed by the Author to distribute this factor to all parcels before making Consolidation to know the land contribution of the individual but when this research will come to implementation each individual will need to pay fees for all the work done during the preparation of this site and implementation to make successful land readjustment research using participation approach after land consolidation.

The formula of the Financial Contribution factor has been developed by the Author of this Thesis as follows:

$$\textbf{FC}= \left(\frac{TVP}{NPP} * CCF\right) + DAT, \qquad \text{(Equation 6)}$$

FC- Financial Contribution, **TVP-** Total Value of the project, **NPP-** Total Number of the New Proposed Plot, **CCF** – Contribution Coefficient factor and **DAT-** Distributed amount from Total value to new plot within the site after planning. The Financial Contribution of previously permitted construction projects and integrated plots previously constructed that have been upgraded were calculated using the following formula:

$$\textbf{FCPC}= \left(\frac{\mathrm{TVP}-(\mathrm{DTV}*\mathrm{NPP})}{PPC}\right), \qquad \text{(Equation 7)}$$

Where **PPC** is the total number of the plot previously permitted for constructions projects or integrated plots previously constructed and **DTV-** Distributed amount from the Total value to the new plots after designing.

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3.5.1 Reminder of the study objectives

This study deals with the design of the most suitable urban development plan for Kabeza site, in Kicukiro District of Kigali City as **Table 1** shows methodology has used in order to achieve the following four (4) major objectives, namely:

1) To assess and predict the existing land use land cover at Kabeza site of Kicukiro District
2) To make needed adjustments to upgrade the existing land development planning at Kabeza site
3) To estimate a contribution coefficient factor on each parcel to achieve the people's welfare and equitable reallocation of land
4) To predict the most suitable financial factors for urban development planning at Kabeza Site

3.5.2. Research Procedure

The following steps will use during preparation for the planning process:

- Reconnaissance,
- Overlaying developed basemap on the existing LUDP to compare proposed land uses versus existing situation on the ground,
- Carry out Topographic Survey to collect data and verify information,
- Generating Topographic map as a better way of understanding and analyzing the terrain of the study area,
- Predicting land use land cover change,
- Adjusting the existing land reallocation plan,
- Estimating a contribution coefficient factor for land reallocation,
- Predicting the most suitable financial factors for urban development planning at Kabeza Site.

During data analysis on this research, the following softwares have taken into account:

- AutoCAD 2018 &CAVADIS17 for topographic surveying reporting to make details topographic map and mapping of existing features.
- ArcGIS Pro for analyzing and demonstrating the site plans of different purpose requirements and also to upgrade urban development planning, replotting, Land

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reallocation, layout plan and hydrology analysis by showing Flow accumulation within the study area.

- Microsoft Excel for data management and reporting,
- Microsoft Word in writing and combining the layout from other softwares,

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CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

Chapter four deals with the analysis of study results and discussion respect of study objectives. Primary data were collected from the field and collected data has as defined in Table 2 expressing land use land cover. This chapter gives all findings in the form of descriptive and inferential statistics. It starts with also piloting analysis. The researcher also has given testimonies per each study objective as findings on the open questions. The outputs of Chapter 4 are the inputs of the last Chapter.

4.1. Assessment and predict of the existing land use land cover at Kabeza Site

Land use Land cover defines how the management and modification of natural environment or wilderness into built environment and what covers the surface of the earth, and description of how the land is used within area.

4.1.1. Assessment of the existing land use land cover at Kabeza site

There are existing parcels, most of them in this area, which have no access roads and other infrastructures. Referring to figure (6), some of the existing parcels are bigger than 300 m2 and others are less than 300m2 according to the land titles provided by the National Land Authority, also from the Kigali master plan this site has been planned as the Low-density residential densification zone (R1A).

Figure 6 : Current image of the site with existing parcel (Primary data, 2023)

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Figure (7) shows the current land-use types (existing situation) at the study area before planning. These include agriculture, commercial center, residential to another part, road, forest and water tank as it has shown in the table 2.

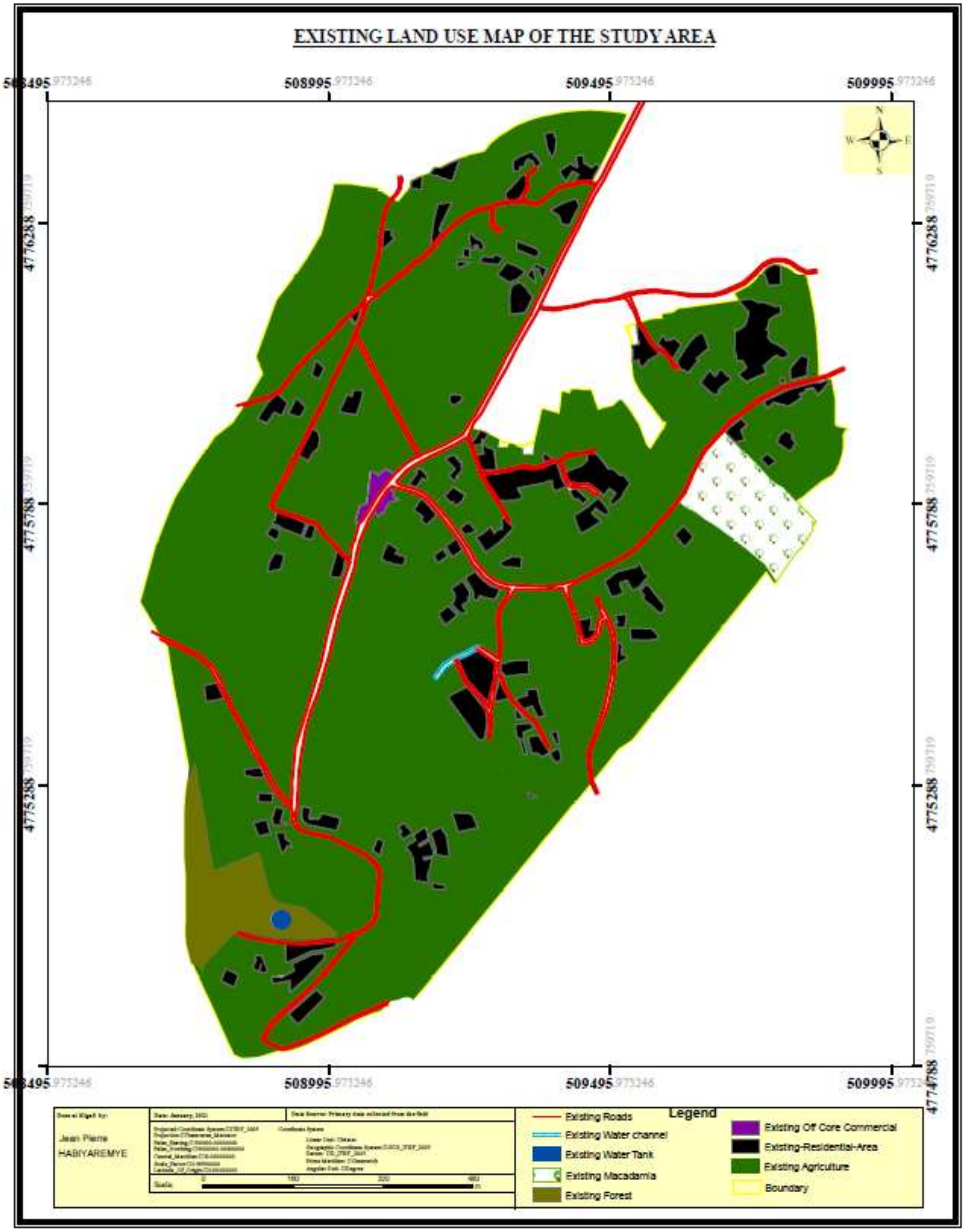

Figure 7: Current Land use land cover map of the site (Primary data, 2023)

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All Assessed items have shown that agriculture is predominant as existing land use as table 2 presents results from collected data.

Table2: Existing land use Land cover

LAND USE LAND COVER	Area (ha)	%
Residential	13.5	11.6
Forest	1.6	1.3
Water tank	0.1	0.1
Commercial	1.8	1.6
Agriculture	96.1	82.6
Transportation	3.2	2.8
Total	**116.3**	**100%**

Source: Primary data (2023)

4.1.2. Independent Variables

The variables were grouped into five categories: (1) land use (area of different land uses); (2) population (number of population residents). Specifically, land use types were categorized into residential, Forest, water tank, commercial and Agriculture. Areas of land use (in hectares) of 13.5, 1.6, 0.1, 1.8, 96.1 and 3.2 were surveyed. Land use variable data were acquired from the field using DGNSS Receiver and Total station.

4.1.3. Topography

Referring to Figure (8), the topography of this site is presented with an average of 1457.7m of height and with a difference in elevation of 133.6m where the high level is 1529.5m and low level is 1395.8m as it has shown in the following diagram.

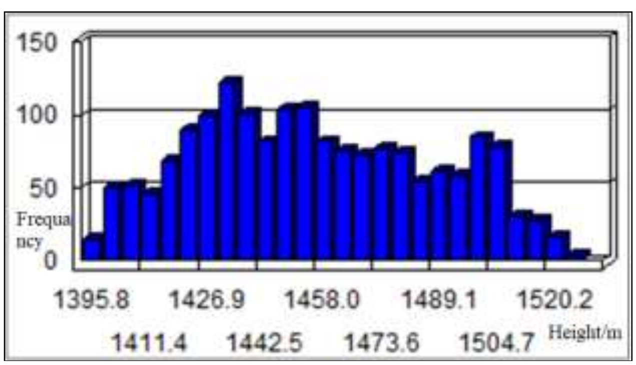

Figure 8: Frequency Distribution of the Height within study area (Primary data, 2023)

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The selection of locations for proposed roads is usually based on the topography, soil characteristics and environmental factors. Kabeza site is Level terrain according to the following formula:

With a 5m contouring interval, the number of contours lines per km was calculated as follows: Number of contours lines per km = (1529.5 m – 1395.8m)/5 m*0.4km = 11 contours per km (Road Engineering for Development, 2nd Edition, Richard Robinson and Bent Thagesen, 2004).

The following figure shows a contour map of the Kabeza Site:

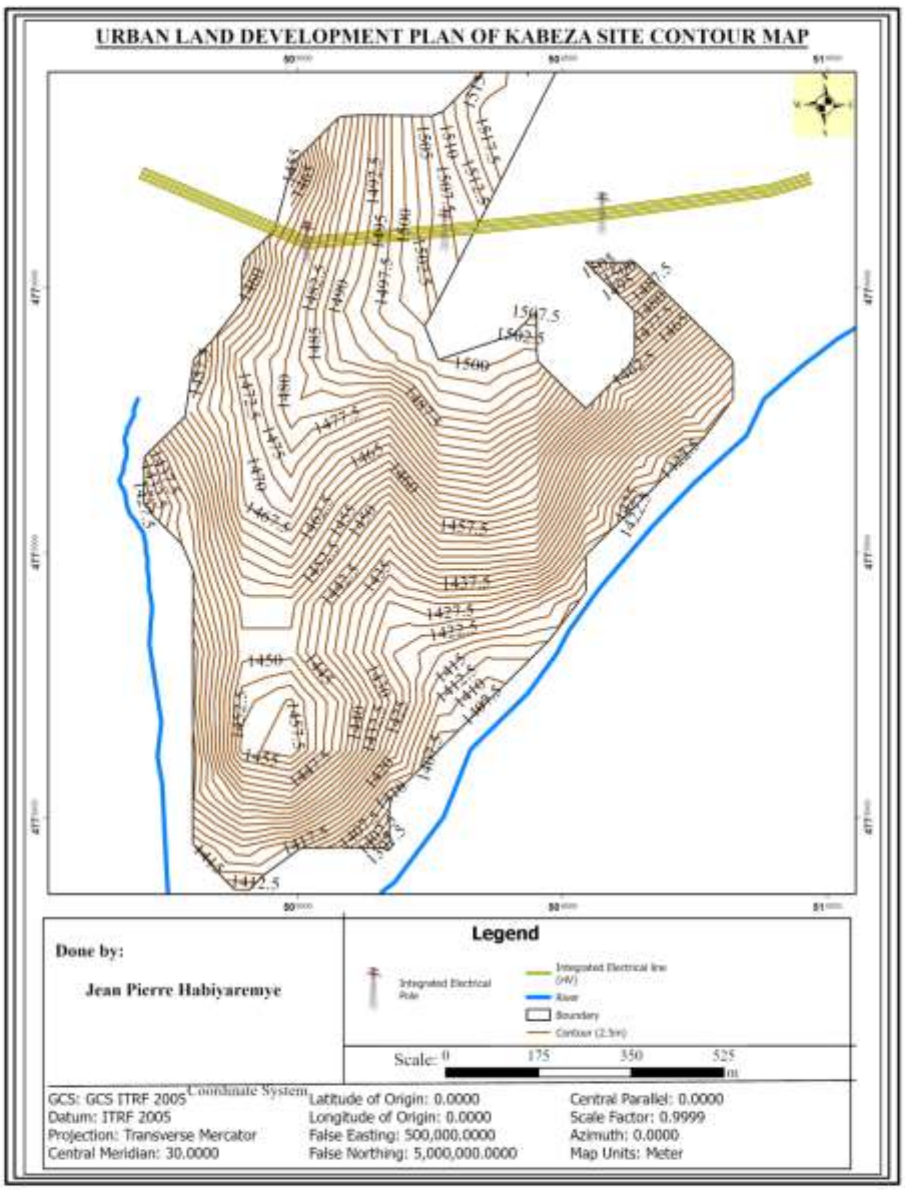

Figure 9 : Kabeza Site Contour map (Primary data, 2023)

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After analyzing contours, it is also necessary to analyze the slope of Kabeza Site in order to be specific during zoning and identifying whether is residential or not with reference to the slope analyis where the Slope is presented in percentage between of 0% to 33.6% with avarage of 15.0% of slope as it has shown in the following figure.

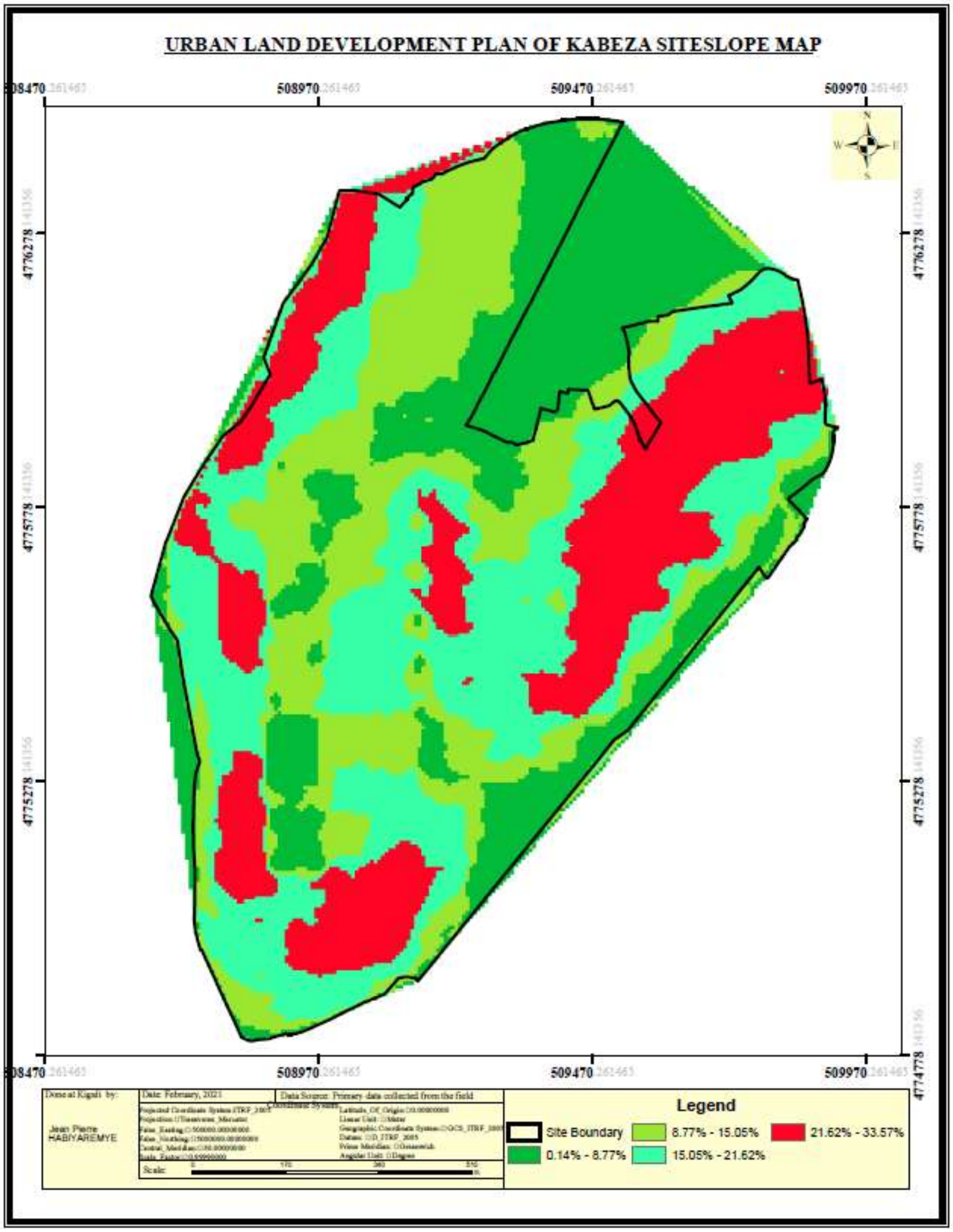

Figure 10 : Slope analysis of Kabeza Site (Primary data, 2023)

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4.1.4. Hydrology

In terms of Hydrology analysis the following figure shows water flow Accumulation that has used to choose where to put the main water drainage within site

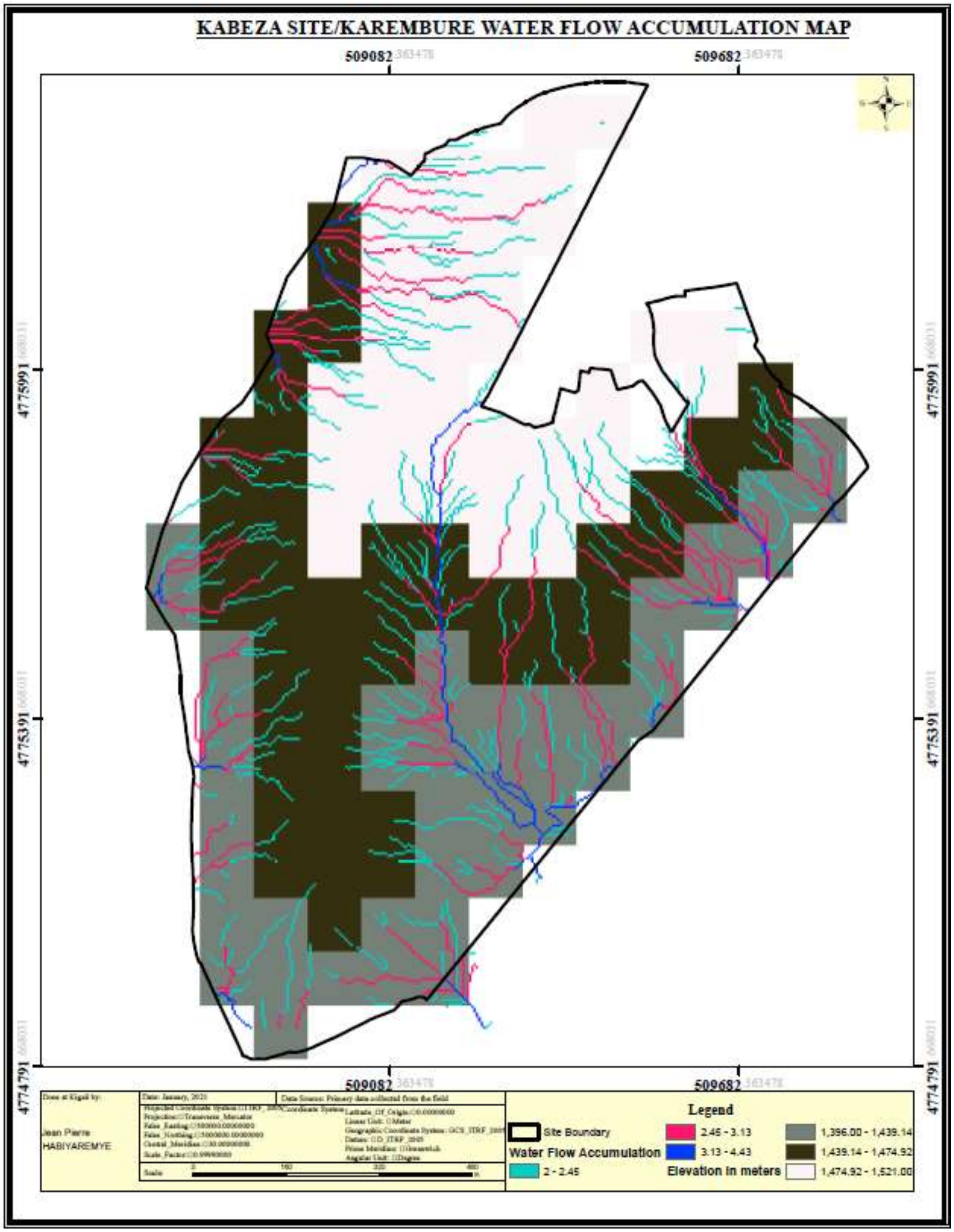

Figure 11: Flow Accumulation at Kabeza Site (Primary data, 2023)

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4.2. Predicting land use land cover at Kabeza site

After predicting land use land cover at the study area and making the design, the following table shows that residential, forest, water tank, agriculture and transportation presenting Predicted land use land cover and the commercial zone will be removed from the site because of Kigali master plan regulation zone. This site is for single-family residential, the reason why no commercial zone will integrate into this new design.

Table3: Predicted land use Land cover

LAND USE LAND COVER	Area (ha)	%
Residential	86.8	74.6
Forest	3.2	2.7
Open space	0.4	0.3
Water tank	0.1	0.1
Commercial	0	0
Agriculture	17.2	15.1
Transportation	8.7	7.5
Total	**116.3**	**100%**

Source: Primary data (2023)

Tables 2 and 3 illustrate existing land use land cover and predicted land use land cover, and the following figure shows land use land cover change by identifying Existing and predicting land use land cover.

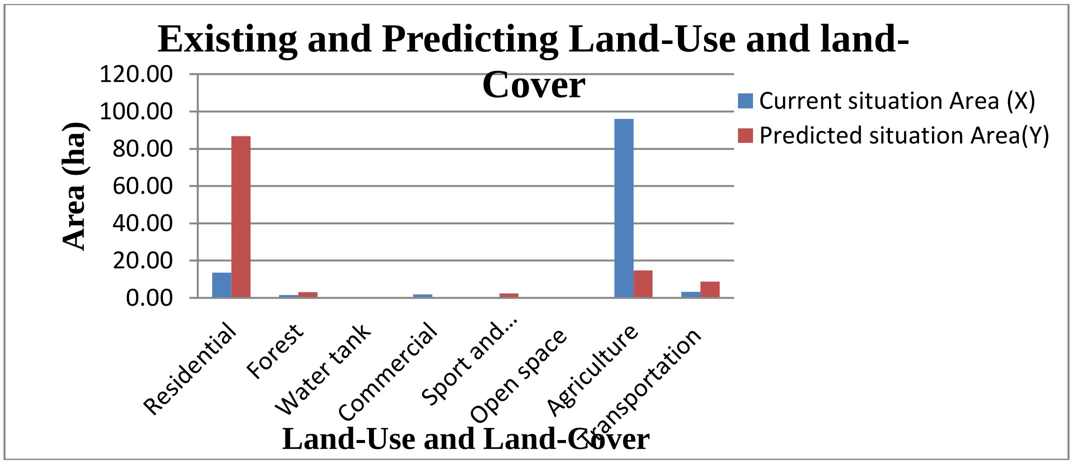

Figure 12: Existing and predict land use land cover at Kabeza Site (Primary data, 2023)

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Land use land cover change adjustments for 1960-2030 has analysis with Pearson regression model with Σx = 116.3, Σy = 116.3, Σxy = 2891.5, $\Sigma(x^2)$= 9433.4, $\Sigma(y^2)$ = 7930.8, $(\Sigma x)^2$ =13530.3, $(\Sigma y)^2$= 13530.3 and n= 6 then

$r =$ = 0.1, with n=6 testing whether the relationship between two variables is significant.

$t = 0.20$, and finding critical value of t in t table at α = .01 and df = 4, the critical value of t is 4.6.

4.3. Adjustments of upgraded urban development plan of Kabeza Site

Kabeza site needs to be upgraded because of installing or improving basic infrastructure, removal or mitigation of environmental hazards, providing incentives for community management and maintenance, constructing or rehabilitating community facilities such as nurseries, health posts, and community open space, regularizing security of tenure, home improvement and reallocation/compensation for the small number of residents dislocated by the improvement. During the upgrading of the area, some parcels remained as it is especially existing constructed parcels and existing roads with substandard widths need to be upgraded.

Kabeza site has been planned according to the different analyses with the following zoning according to the site residents' needs: Residential, Roads, Green Space, and Sport and Leisure as shown in table 4.

Table 4: Adjustment of upgraded urban development plan

UPGRADED LAND USE	Area (ha)	%
Existing upgraded residential plot	13.4	11.6
New residential plot	56.2	48.3
Agriculture	11.8	10.2
Forest	2.8	2.5
Open space	0.5	0.3
Sport and Leisure	2.5	2.1
Water tank	0.098	0.08
Upgraded Transportation	8.7	7.5
New Transportation	20.4	17.5
Total	**116.32**	**100%**

Source: Primary data (2023)

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The Local Land upgraded development Plan is local planning for future development and use of land in their area developed in informal settlements. Figure (12) shows well Local Land upgraded Development Plan of the Kabeza Site.

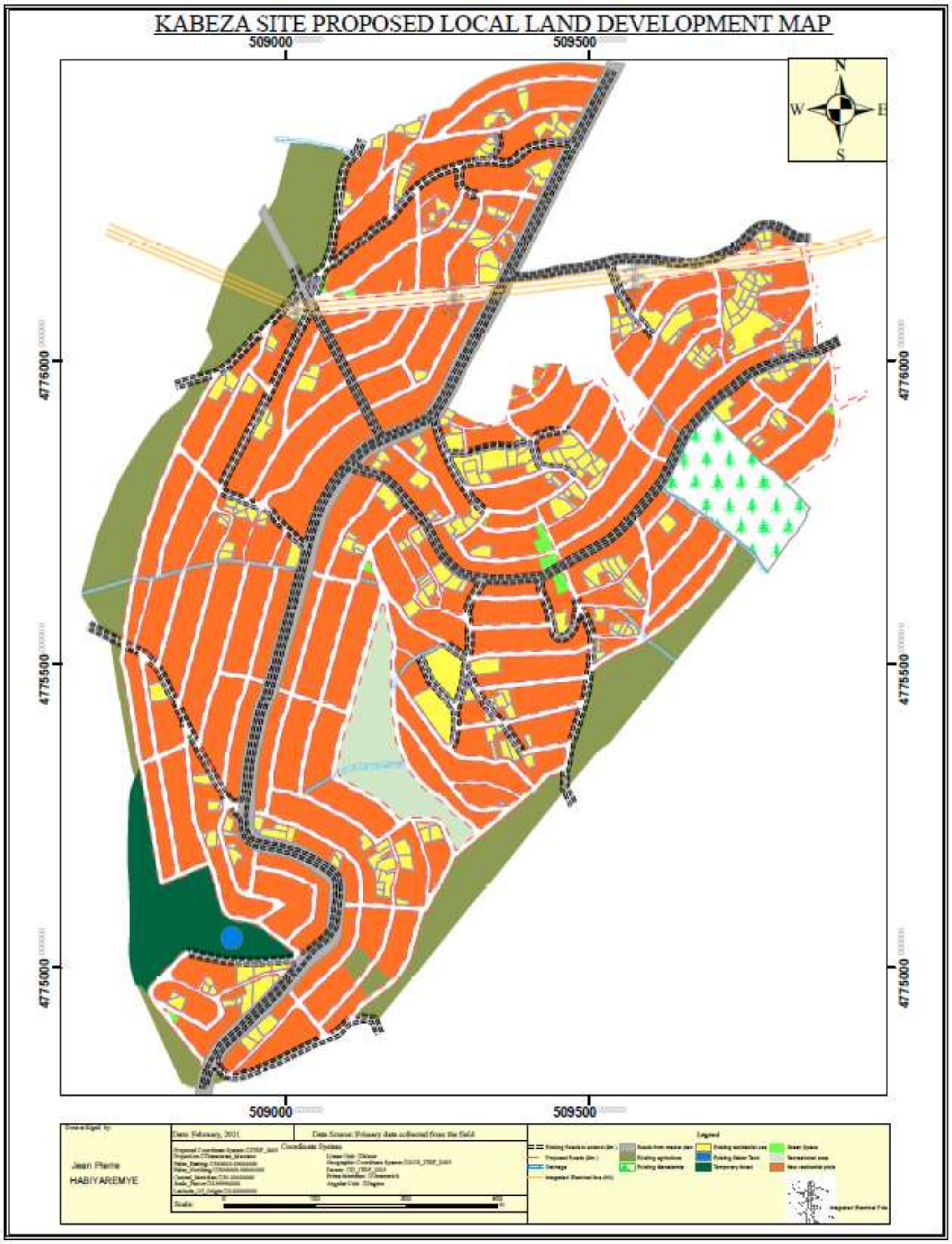

Figure 13 : Local Land upgraded development Plan of the Site (Primary data, 2023)

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4.3.1. Making and replotting the new parcels within Kabeza site

A replotting of the parcel happens when its lines are defined or when an existing parcel of the land incorporates additional land without creating a new independent parcel . Within the Kabeza site, parcels have been upgraded, and replotted by making the new plots as it has shown in Figure 13. From zoning requirements, this research has made on the area of 116.3ha by designing the plots having the size of 15m width and 20m of length says (15m*20m) but because of the shape and some obstacles of existing buildings, all planned plots have not fitted with 300 Sq.m as it has required. The smallest plot has 252 Sq.m and the maximum size of the plots is 300 Sq.m, the road with a total length of 28.8km about a total area of 25ha including water drainage of around 21.5% also 1.2km of the proposed ravine that passes through the site. Due to the topographic characteristic of the study area, while organizing and arranging the region, findings shown that there is some part of this area which is not suitable for residential that will use for Green space areas with 0.4ha, Existing Macadamia plantation of 3.0ha, Existing agriculture having an area of 11.8ha and forest occupied 2.8ha.

In general, after replotting the findings showed that newly designed plots area of 1873 plots for the Residential Extension area from 652 parcels unplanned, 295 plots have been upgraded by considering built-up area occupied total area of 13.44ha says 11.6% of the total area and for the new plots for the residential area are 1873 plots with 56.1ha says 48.3% of the total area of Kabeza site, the recreational area of 2.5ha and 4.2ha have destroyed by basic infrastructures about 3.6% of the total area of the Site.

4.3.1.1. Comparison of land use land cover and Land reallocation adjustments

By making a Comparison of means between Land Use Land Cover and Land reallocated adjustments using the Homogeneity test two variables (LULC and Land reallocation) from the given data in the following table**:**

Table 5: Observed value for LULC and Land reallocated adjustments

	Residential	Agriculture	Forest	Open space	Sport and Leisure	Water tank	Transportation
Land Use Land Cover	69.6	11.8	2.8	0.4	2.5	0.1	25.0
Land	56.2	11.8	2.8	0.4	2.5	0.1	20.4

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Reallocation							

Source: Primary data (2023)

Expected values have calculated from combined percentage of the observed values and providing the following table

Table 6: Expected value for LULC and Land reallocated adjustments

	Residential	**Agriculture**	**Forest**	**Open space**	**Sport and Leisure**	**Water tank**	**Transportation**
Land Use Land Cover	68.4	12.9	3.1	0.4	2.7	0.11	24.7
Land Reallocation	57.4	10.8	2.6	0.3	2.3	0.09	20.7

Source: Primary data (2023)

Then, $x^2 = 0.3$ and computing degree of freedom (df)

df= 7-1 = 6 and $p - value$ is 0.999.

4.2.1.2. Normal distribution

X = 16.03

The standard deviation of the data set is: 23.4

Y = 13.5

The standard deviation of the data set is: 18.7

E(X-Y) = 16.03-13.5 = 2.6

SD (X−Y)= ($\sqrt{23.383^2 + 18.7439^2}$ =29.9683 ≈ 30

Result of Normal distribution of the difference between the two variables

Z score	**6.802**
P(X > 206.418)	**0**
P(X ≤ 206.418)	**1**
P(X ≤ -206.418 ∪ X ≥ 206.418)	**1**
P(-206.418 ≤ X ≤ 206.418)	**0**

Source: Primary data (2023)

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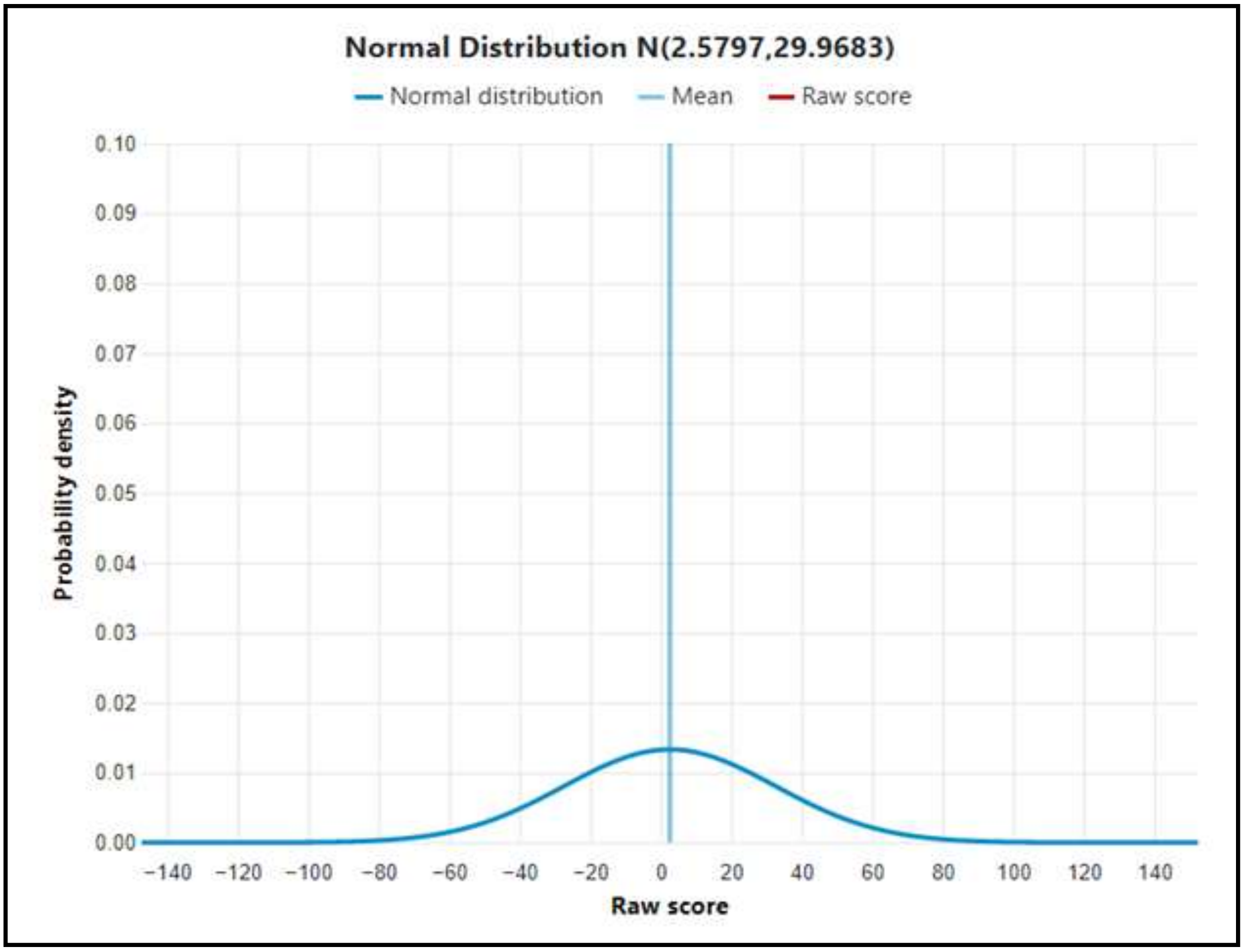

Figure 14 : Normal distribution (Primary data, 2023)

4.4. Estimating Contribution coefficient factor on each parcel to achieve the people's welfare and equitable reallocation of land

4.4.1. Differentiation of Land reallocation and Social equity/welfare

The area currently is settled in an unplanned and disorganized format and hasn't yet adopted the urban planning structure. The area currently has a population of 550 residents with 125 households. From 550 residents, 324 residents are men and 176 residents are women and 50 Children with 43 people in category one of poor. After reallocating land, every resident will get a new plot according to the area of the existing parcel and those who have a small parcel will need upholding and each will contribute an equal share in terms of percentage even financially will be shared commonly to the new plot means that no one will lose her/his land in this research because after making design complete parcel by infrastructures will be reallocated to another

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place within the site on the land gotten from shared plots calculated from coefficient contribution factors.

A chi-square test of the difference between land reallocation and social equity/ welfare was done and the finding illustrated in the following table:

Table 7: Land reallocated plots to the site resident

Social equity/welfare	Number of person	Land Reallocated (Number of plot)
Men	324	1103
Women	176	600
Children	50	170
Total	**550**	**1873**

Source: Primary data (2023)

From observed data using the Chi-Square test for checking Null hypothesis 3 by the significant relationship between land reallocation and social equity/ welfare, the table below provides the observed cell totals, expected cell total and the chi-square statistic for each cell.

Results						
	Number of person	Land Reallocated (Number of plot)				*Row Totals*
Men	324 (323.92) [0.00]	1103 (1103.08) [0.00]				1427
Women	176 (176.15) [0.00]	600 (599.85) [0.00]				776
Children	50 (49.94) [0.00]	170 (170.06) [0.00]				220
Column Totals	550	1873				2423 (Grand Total)

Source: Primary data (2023)

The x^2 is 0.0003 and $p-value$ is 0.999859 which is greater than x^2 means 0.999859 larger than 0.003.Then, there is no significant relationship between land reallocation and social equity/ welfare. Therefore, H03 (Null hypothesis 3) didn't rejected.

4.4.2. Estimate of a contribution coefficient factor

Kabeza Site research land distribution have made according to the Contribution Coefficient Factor on each parcel using the data as it is shown in the following table:

Variables	Values
TEP	100.8ha
TNP	87.9ha

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TPP	56.1ha
PD	3.6%

Source: Primary data (2023)

Then, $CCF = \left(\frac{100.844-87.88}{56.12} * 100\right) + 3.63\% = 26.7\%$ Says, 27%. Now Contribution Coefficient Factor is 27% that must be subtracted to each parcel, including public interest and land compensation of destroyed parcel in the new designed plan.

4.5. Making and designing a land reallocation plan of Kabeza Site

The following steps have followed in order to make land reallocation:

1. Subdivision of the interested area in the plots where each new plot is enclosed by roads and proposing code to the new plots, streams, canals and the external boundaries of the study area,
2. Calculation of the total area of new subdivided plot,
3. Calculation of the contribution coefficient factor of landowners for the value of land occupied by public facilities, i.e. roads, canals, etc. using the Equation 5
4. Calculation of the land area that should be allocated to each landowner after the subtraction of the land area calculated from the contribution coefficient factor,
5. Definition of the number of plots that can be allocated to each landowner based on total land area he/she has
6. Calculation of the initial available land (in terms of size) for reallocation in each block,
7. Reallocation of properties. This is an iterative, trial and error process, which proceeds within the site, by considering total land area subtracted by Contribution Coefficient factor of the properties. And the following map has provided

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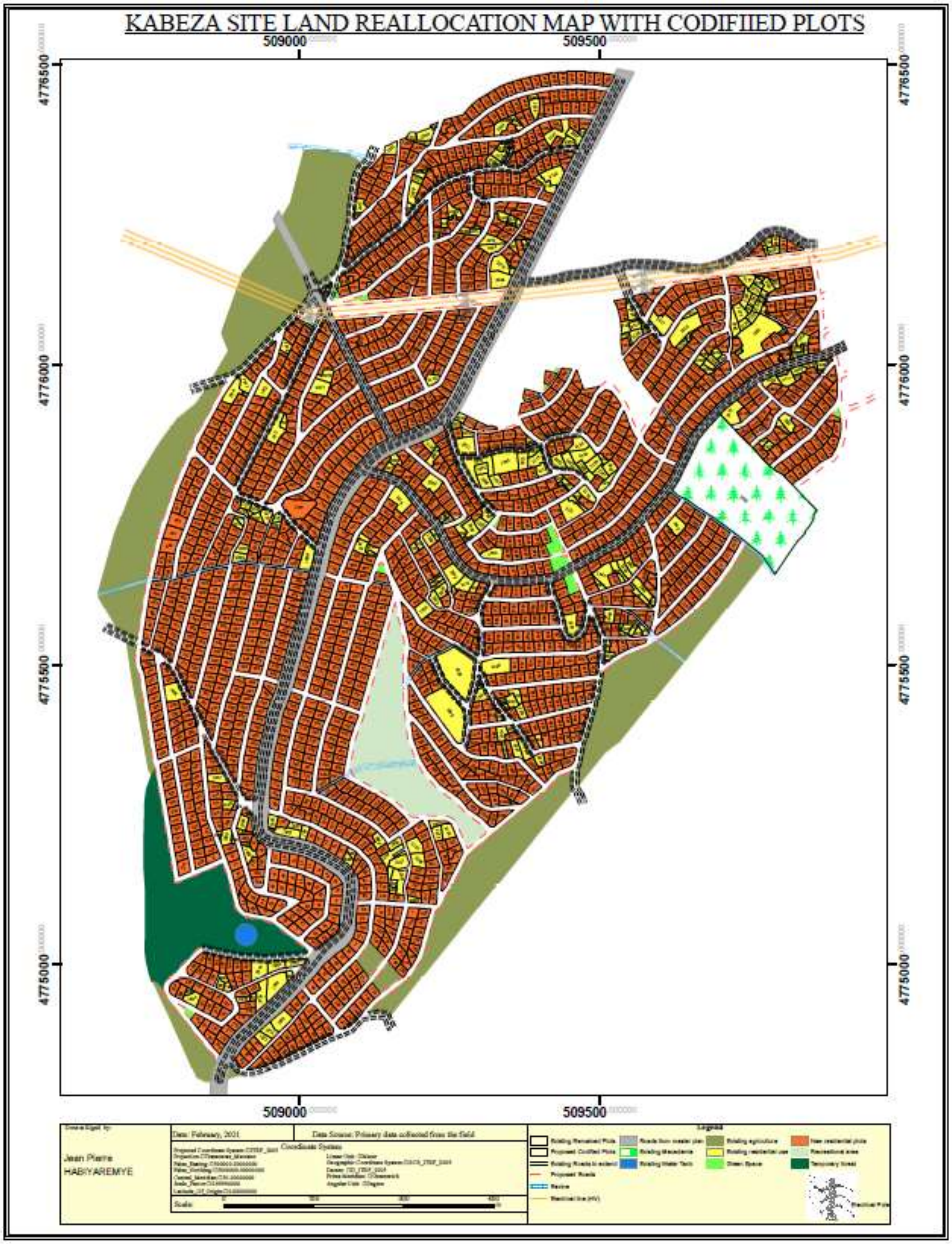

Figure 15 : Land Reallocation Plan Kabeza Site (Primary data, 2023)

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After making land reallocation, land owner will need the new land title fitted with designed Local Land Urban development plan. The following process also will be use to make plots registration and making new land titles:

1. Preparation of the reallocation plan,
2. Production of deed plan of each new plots,
3. Collection of existing land title by Competent Authority from public institution in Charge Land Services with the full file having deep plan of the plot, proof of payment for land transaction fees as it is defined by competent public institution , proof of payment for basic infrastructures fees, copy of identification card of the plot owner, civil status certificate, Physical plan approval letter from Competent public institution ,
4. Subdividing of the new plots by considering submitted Kabeza site replotting plan Shapefiles/ Geodatabase and inserting it in LIS (Land Information System),
5. Production of land title in line with submitted Shapefiles/Geodatabase of the reallocated plan,
6. Printout the new land title or submission of land title to the owners using electronic communication,

4.6. Predicting the most suitable financial contribution for urban development planning at Kabeza Site

There is a financial contribution from each plot to make successful land readjustment research using the participation approach after land consolidation by considering the total amount of the research as the following table explains well in detail by identifying some research that will need before and during implementation.

Table 8: Summary of costs and priority projects

Project	Description	Cost		
		Quantity	Unity Price (Frw) /Parcel	Total
Road and Ravine	Road tracement and Ravine study and demarcation on ground	30.09 Km	84,000	182,120,000

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Electricity and Water	Water supply system at each plot and electricity distribution	15.045Km	300,000/1km	4,513,500
Deed plan	Making deed plan of each plot	2168 Plots	30,000	65,040,000
Physical plan development	Data collection, Making layout plan, physical check on the site, setting out new proposed road, topographic report	2168 Plots	100,000	216,800,000
Beaconing	Buy beacons, transport and Stake out	6504	10000	65,040,000
Sub total				**533,513,500**
Contingency (30%)				**160,054,050**
Total				**693,567,550**
Say Six hundred ninety three millions five hundred sixty seven thousand and Five hundred fifty Rwandan francs (693,567,550 Frw) Distributed amount from Total value to the new plots after designing is 320,298frw				

Source: Primary data (2023)

With reference to the Kigali Masterplan2020 especially on zoning guidelines, the plots must have a maximum area of 300 Sq.m for residential plots.

The planned recreational area within the site will have specifically Sport and Leisure where site residents are the one for developing these activities by making equal contribution but if there is any other person from outside the site or within the site who want to develop Sport and Leisure in the planned recreational area he/she must pay those land to Site Committee and get access and right to develop this area. The land owners before planning will get compensation for the plot within the site from shared land gotten from the distribution coefficient calculated from each parcel. But if the site residents do not agree on land as compensation, they will get compensation in terms of money on a generic market price that will be defined by a Certified Valuer for the Site Committee on-site service and will need to be updated yearly. During the development of this site especially for construction; Kigali Master plan guidelines must be followed.

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Also, the financial contribution coefficient that will be needed from each plot to make successful this project has been calculated considering the data provided in the following table:

Variables	Values
TVP	693,567,550Frw
NPP	1873
CCF	27%
DAT	320,298
PPC	295

Source: Primary data (2023)

Then, FC= $\left(\frac{693,567,550}{1873} * 27\%\right) + 320,298$ = 470,278 Frw by considering all works done in the site and financial contribution on each plot then, total amount will be 470,278Frw including works done and public facilities.

Financial Contribution of previously permitted construction projects has calculated as follows: FCPC= $\left(\frac{693,567,550-(320,298*1873)}{295}\right)$ = 317,456 Frw

To make sure that this project will be implemented in a proper way after making land reallocation, research has also checked if there is any relationship between land reallocation and urban development planning that will affect also the contribution coefficient factor and financial contribution from each plot developed with site.

Table 9: Land reallocation vs Urban development planning

LAND USE	Area of Land reallocation planning	Area occupied by Urban development planning (ha)
Residential plot	56.2	69.6
Agriculture	11.8	11.8
Forest	2.8	2.8
Open space	0	0.4
Sport and Leisure	2.5	2.5
Water tank	0	0.1
Transportation	0	29.1

Source: Primary data (2023)

Using Probit model to analyze relationship between land reallocation and urban development planning and finding shows that Significance level is 0.0294 and is less than P which is 0.9.

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4.7. Discussion

According to Liping, et al. (2018), rapid increase in human population and associated economic development further exacerbates the rate of these changes especially in fast growing urban areas threatening their sustainable growth.

Rapid growth in the absence of adequate plan and infrastructure expedites LULC changes which are associated with degrading ecosystem services and human well-being. Generally, cities in developing nations are characterized by poor infrastructural plans, high immigration rates, growing squatter settlements, etc. This demand addressing unique challenges, opportunities for urban adaptation, mitigation responses and for mainstreaming them into urban development plans (Mallupattu et al, 2013; Kanal, et al., 2019; Mishra, et al., 2019).

Table 3 displays the changeover of LULC categories from 1960 to 2030. In 1960, agriculture is dominated by 82.6 % of the total area, followed by residential 11.6%, transportation 2.8%, commercial 1.6%, forest 1.3%, water storage 0.1%. When compared to 1960, the percentage of area covered in 2030 had decreased for commercial and agriculture up to 0 % and 10.2% respectively. An increase in percentage was observed for residential, transportation, forest, sport and leisure and open space up to 59.9%, 25.02%, 2.4%, 2.1 and 0.3% respectively. Change in area was not observed for the Water storage (tank) between the periods.

The study fails to reject the Null hypothesis 1 (Ho1) stating that “There is no significant difference between the past and current adjustments of Land-use and Land-cover at Kabeza Site”. Hence, the new Kabeza site landscape as planned in the Kigali master plan regulation zone is likely to be significantly different from the existing LULC in the area.

Urban planning touches on numerous city life elements new and pre-existing land, buildings, roads, communal spaces, transportation, economic development, infrastructure, and the environment, among others (Marisa Sailus, 2021).

Table 4 displays the Adjusted of the upgraded urban development plan where a residential area has increased up to 69.6ha with 1873 New Proposed Plots and 295 existing adjusted Plots, transportation with a total length of 28.9Km, Leisure and sport with an area of 2.5ha, Ravine having 1.2km of the length, Open Space with 0.4ha, Leisure and sport with an area of 2.5ha, Forest with 3.2ha and Water tank occupied 0.098ha.

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The study fails to reject the Null hypothesis 2 (H02) stating that "there is no significant difference between the land use/cover change and the adjustments of land reallocation at Kabeza Site".

Yomralioglu and Parker (1993) developed an interesting Geographic Information System-based land readjustment system for land reallocation in urban land consolidation projects, which is mainly based on the assignment of land market values to properties. It is a vector based system which automates the land valuation, land subdivision and distribution processes. Semlali (2001) used GIS and conventional programming to solve the problem of land reallocation and land distribution, which is split into two parts: the computed reallocation and the graphical reallocation. The process is carried out in three parts: the first part involves a computed redistribution using four methods depending upon the farmers' requirements, the administration priorities and the project constraints. Constraints used are the landowners' requirements, habitat, soil class and the cadastral situation before land consolidation.

Estimating a contribution coefficient factor on land parcels using Equation 5 for achieving the people's welfare and equitable reallocation of land has been carried out in this study. Thus, the study fails to reject the Null hypothesis 3 (Ho3) stating that "There is no significant relationship between land reallocation and social equity/ welfare".

A financial contribution means the expenditure of a person in terms of money resources toward real or personal property by contributing to the project. There shall be a financial contribution from each plot to make a successful land readjustment project using a participation approach after land consolidation by considering the total amount of the project. Compensation for the plot within the site will be done from shared land gotten from the distribution coefficient calculated from each parcel. If the residents do not agree to take the land as compensation, they will get compensation in terms of money on a generic market price that will be defined by a Certified Valuer for the Site Committee on-site service and will need to be updated yearly. The Financial Contribution of previously permitted construction projects must be calculated using Equation 6 and 7. Also, the study fails to reject the Null hypothesis 4 (Ho4) stated that" There is no significant relationship between land reallocation and urban development planning". The findings assist site residents and policymakers in developing their sites.

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The author carried out all technical details and prepared the map, analysis, and results discussion as Table 10 and Table 11 shows a summary of general outcomes from the study and a comparison of finding respectively.

Table 10: Table summarize in general outcome from the study as figure 12 shown

Objectives	Hypotheses	Result	Comments
To assess and predict the existing land use land cover at Kabeza site of Kicukiro District	Ho1 (Null hypothesis 1): There is no significant difference between the past and current adjustments of land use/cover at Kabeza Site	Residential with area of 86.82ha	Null hypothesis 1 is not rejected
		Forest with area of 3.17ha	
		Water tank with area of 0.098ha	
		Agriculture with area of 17.53ha	
		Open space with area of 0.37ha	
		Sport and Leisure with area of 2.48ha	
		Transportation with area of 8.70ha	
To make needed adjustments to upgrade the existing land development plans at Kabeza site	H02 (Null hypothesis 2) : There is no significant difference between the land use/cover change and the adjustments of land reallocation at Kabeza Site	Existing upgraded residential plot with area of 13.44ha	Null hypothesis 2 is not rejected
		New residential plot with area of 56.18ha	
		Agriculture with area of 11.82ha	
		Forest with area of 2.83ha	
		Open space with area of 0.37ha	
		Sport and Leisure with area of 2.48ha	
		Water tank with area of 0.098ha	
		Upgraded Transportation with area of 8.7ha	
		New Transportation with area of 20.402ha	
To estimate a contribution coefficient factor on each parcel to achieve the people's welfare and equitable reallocation of land	H03 (Null hypothesis 3): There is no significant relationship between land reallocation and social equity/ welfare	$\mathbf{CCF}=\left(\frac{TEP-TNP}{TPP}*100\right)+PD$, CCF is 27%	Null hypothesis 3 is not rejected

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To predict the most suitable Financial Contribution for urban development planning at Kabeza Site	H04: (Null hypothesis 4): There is no significant relationship between land reallocation and urban development planning.	**FC=** $\left(\frac{TVP}{NPP} * CCF\right) + DAT$ **, CF** is 470,278Frw for new designed plots and FCPC= $\left(\frac{\text{TVP}-(\text{DTV}*\text{NPP})}{PPC}\right)$ is 317,456 Frw for the plots previously permitted and construction projects	Null hypothesis 4 is not rejected

Source: Primary data, 2023

After analysis and designing made during this research, the comparative table has been provided to identify the result before and after the study as Table 11 stated with reference to figure 14:

Table 11: Comparative table of finding

Before detailed study (Before Planning)	**After detailed the study (After Planning)**
Transportation with area of 3.2ha	New transportation with area of 20.4ha
	Upgraded transportation with area of 8.7ha
-	Total Length of Ravine 30.1Km
652Existing Parcel (Unplanned)	1873 New Proposed Plots
	295 Existing Remained Plots
-	Green Space/Open space with area of 0.4ha
-	Recreation area (Leisure/sport) of 2.5ha
-	4.22ha have totally destroyed by basic infrastructures
Residential with area of 13.5ha	Residential with area of 86.8ha
Water tank with area of 0.1ha	Water tank with area of 0.1ha
Agriculture with area of 96.1ha	Agriculture with area of 17.5ha
Commercial with area of 1.8ha	-
Forest with area of 1.6ha	Forest with area of 3.2ha
-	Land Contribution Coefficient Factor is 27%
-	Financial Contribution is 470,278Frw for new designed plots
-	Financial Contribution of previously permitted and constructed plot is 317,456 Frw

Source: Primary data, 2023

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CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

The main objective of this research is to predict and design a land reallocation plan for upgraded urban development in Rwanda specifically in Kigali City, Kicukiro District, Gahanga Sector and Karembure Cell at Kabeza site. Local land development planning and reallocation planned plots as the way of getting solutions and achieving the goals of different problems arising within the site to implement the Kigali City master plan 2020 to have a smart city.

The data collected from the field, and a topographic survey showed that the existing situation has not been well planned on the standard and indicates that the new design is ameliorated as much as possible in comparison to the existing living.

The conclusion of the study relies also on the acceptance or failure to accept study hypotheses. Based on the analysis, there is no significant difference between the past and current adjustments of land use/land cover at Kabeza Site, no significant difference between the land use/cover change and the adjustments of land reallocation at Kabeza Site, also no significant relationship between land reallocation and social equity/ welfare and no significant relationship between land reallocation and urban development planning.

Assessing and predicting the existing land use land cover at the Kabeza site of Kicukiro District provides a Residential zone area of 86.8ha, Forest coved area of 3.2ha, Water tank with an area of 0.1ha, Agriculture with an area of 17.5ha, Open space with an area of 0.4ha, Sport and Leisure with an area of 2.5ha and Transportation with an area of 8.7ha. Making needed adjustments to upgrade the existing land development planning at the Kabeza site shown that the Existing upgraded residential plot has occupied by area of 13.4ha, the New residential plot with area of 56.2ha, Agriculture with an area of 11.8ha, the Forest with an area of 2.8ha, Open space with area of 0.2ha, Sport and Leisure with area of 2.5ha, Water tank with area of 0.1ha, Upgraded Transportation with area of 8.7ha and New Transportation with area of 20.4ha. All parcels are 2168 Plots including residential extension with 1873 plots for Single Family Residential, 295 Plots remained as Existing Residential and 14 plots having a total area of 4.2 ha will be affected by public utilities. 27% is estimated as a contribution coefficient factor on each parcel to achieve the people's welfare and equitable reallocation of land with this formula CCF= $\left(\frac{TEP-TNP}{TPP} *\right.$

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$\mathbf{100}\Big) + \boldsymbol{PD}$ and 470,278Frw is predicted the most suitable financial factors for urban development planning at Kabeza Site calculated from the following formula **FC**= $\left(\frac{\boldsymbol{TVP}}{\boldsymbol{NPP}} * \boldsymbol{CCF}\right) + \boldsymbol{DAT}$ and 317,456Frw for the plots previously permitted and construction projects calculated using this formula **FCPC**= $\left(\frac{\mathbf{TVP-(DTV*NPP)}}{\boldsymbol{PPC}}\right)$.

5.2. RECOMMENDATIONS

Based on these results, several recommendations were formulated. For an adequate consideration of urban and rural design during the physical planning and design process, the following recommendations are proposed:

- The project implementers and partners, particularly the local government units overseeing the project sites, should pay particular attention to the growing income disparity and the exclusion of the poorest of the poor from the development process since this may lead to social disparities.
- Institute necessary processes to allow the inclusion of all the poor in community consultations and also their participation in community organizations and urban development.
- Promote a regulatory environment for competitive transport services.
- Identify measures to minimize the interventions' negative impacts on the poor and women.
- Identify measures to minimize negative impacts on the environment.
- Building design will be the responsible of the individual land owner and must follow the Kigali City Master plan guideline zone.
- To make a detailed feasibility study of the road, water drainage, ravine and sewage system within the site
- To follow the good implementation of Land reallocation by Site Committee in collaboration with Government Authority, especially the local Government.

The following are considerations for the design of future similar research:

1. Design, implementation and maintenance of infrastructure should be integral to the research design and operations; infrastructure users particularly the households who hold

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most of the benefits (i.e., transport operators) should be required to bear a larger share of facility maintenance and upkeep.

2. The packaging of all infrastructures accompanying the research should be accompanied by other support interventions that ensure the inclusion of the poor and help enhance their capacities and capabilities. Some of these interventions are the provision of credit, microenterprise development services, agricultural technology transfer, social capital formation, and gender integration.
3. The conventional approach must be adopted to solve the problem with many conflicting criteria and constraints by applying some basic calculations and decision-making.

In the end, the researcher developed the Contribution Coefficient Factor as land that will be shared from every land and Financial Contribution used by a plot to make this research successful and encourage other researchers to continue further research in the different region using Equation 5, 6 and 7 as provided formulas during this study.

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References

1. Abhas K. Jha, Jennifer Duyne Barenstein, Priscilla M. Phelps, Daniel Pittet, Stephen Sena (2010). A Handbook for Reconstructing after Natural Disaster, The International Bank for Reconstruction and Development/ The World Bank, Washington DC 204333.
2. Barbara C. Colley& P.E (2005), Practical Manual of Land Development (Fourth Edition), McGraw-Hill
3. City of Kigali (2020), Guidelines for elaboration and implementation of local land development plans, Kigali.
4. David Saithwaithe (2000). Roundtable on Urban Upgrading, Johannesburg, South Africa.
5. Demetris Demetriou (2014). The development of an intelligent SDSS for land consolidation, University of Leeds
6. http://cega.berkeley.edu/assets/miscellaneous_files/22_-ABCA_Urbanization-research_paper-ABCA.pdf
7. http://web.mit.edu/urbanupgrading/upgrading/case-examples/overview-africa/country-assessments/download/10-CountrySummary.pdf
8. http://www.tcpghana.gov.gh/doc/structureplan.pdf
9. https://documents1.worldbank.org/curated/en/909671468270272353/pdf/Agricultural-land-redistribution-and-land-administration-in-Sub-Saharan-Africa-case-studies-of-recent-reforms.pdf
10. https://europa.eu/capacity4dev/topics/urban-development
11. https://masterplan2020.kigalicity.gov.rw
12. https://openknowledge.worldbank.org/bitstream/handle/10986/2653/488960pub0replacement0file09780821376270.pdf?sequence=1
13. https://pdf4pro.com/view/district-development-plan-2013-2018-kicukiro-gov-rw-428bed.html
14. https://pure.diis.dk/ws/files/68278/Land_rights_and_land_conflicts_in_Africa_a_review_of_issues_and_experiences.pdf
15. https://unece.org/fileadmin/DAM/hlm/documents/Publications/landadmin.devt.trends.e.pdf
16. https://web.itu.edu.tr/tahsin/tahsin/PhD-Thesis_files/CH00.pdf

ISSN: 1987-1791

17. https://www.accessengineeringlibrary.com/content/book/9780071494373
18. https://www.ccap.pku.edu.cn/docs/20171229202003123919.PDF
19. https://www.fig.net/resources/proceedings/fig_proceedings/fig_2003/TS_13/PP13_2_Essadiki_et_al.pdf,
20. https://www.ihrp.uic.edu/files/Zoning_Primer_508.pdf
21. https://www.jica.go.jp/jica-ri/publication/booksandreports/l75nbg00000ltoak-att/LAND_READJUSTMENT_web.pdf
22. https://www.langeberg.gov.za/langeberg-documents-and-notices/publications/idp/455-human-settlement-plan/file
23. https://www.researchgate.net/publication/221899396_The_impact_of_land_reallocation_on_technical_efficiency_Evidence_from_China
24. https://www.researchgate.net/publication/238693052_A_GISBASED_LAND_READJUSTMENT_SYSTEM_FOR_URBAN_DEVELOPMENT
25. Ian Williamson, Stig Enemark, Jude Wallace & Abbas Rajabifard (2010). Land Administration for Sustainable Development, Esri Press.
26. JF Chriqui, E Thrun, A Sanghera (2018).Components of Local Land Development and Related Zoning Policies, Associated with Increased Walking: A Primer for Public Health Practitioners, Chicago
27. Kigali City (2018). Local Land Development plan Guidelines, Kigali
28. Kigali City (2020), Kigali city zoning Regulations (2020 edition), Kigali.
29. Mevlut Uyan, Vahit Tongur, Ela Ertunc (2020). Comparison of different optimization based land reallocation models, Computers and Electronics in Agriculture, Elsevier.
30. Ministry of Infrastructure (2008), National Urban Housing Policy for Rwanda, Kigali.
31. Musa AVCI (1998). A New Approach Oriented to New Reallotment Model Based on Block: Priority Method in Land Consolidation, Ege Üniversitesi Ziraat Fakültesi, Tarımsal Yapılarve Sulama Bölümü, Bornova, İzmir-Turkey.
32. Nguyễn Văn Tư (2014). Vietnam Urban Upgrading Project, Ward 4, District 6, Ho Chi Minh City.

ISSN: 1987-1791

33. OBILOR, Esezi Isaac (Ph.D.) & AMADI, Eric Chikweru (PhD) (20180. Test for Significance of Pearson's Correlation Coefficient, International Journal of Innovative Mathematics, Statistics & Energy Policies 6(1):11-23
34. Pr. M. ESSADIKI, Pr. M. ETTARID, Pr. P. ROBERT (2003). New Approach for Land Reallocation using a geographic information system, 2nd Regional Conference of the FIG, Marrakech
35. Prof. Mohammed ESSADIKI, Prof. Mohamed ETTARID & Prof. Pierre ROBERT (2003). Optimisation of Technical Steps of Rural Land Consolidation Project Using a GIS: Land Reallocation Step, FIG Working week 2003, Paris.
36. Republic of Rwanda (2015). Ministerial order n°04/cab.m/015 of 18/05/2015 determining urban planning and building regulations, Kigali
37. Republic of Rwanda (2021), Law Nº27/2021 of 10/06/2021 Governing Land, Official Gazette nº Special of 10/06/2021, Kigali
38. Republic of Rwanda (2021). National Land Use & Development Master Plan (NLUDMP 2020-2050), Official Gazette n° 15 bis of 26/04/2021, Kigali.
39. Republic of Rwanda (2021). Presidential Order N° 058/01 of 23/04/2021 Establishing the National Land Use and Development Master Plan, Kigali
40. Rwanda Housing Authority (2010). Affordable Housing Development project in Rwanda, Kigali
41. Rwanda Land Management and Use Authority (2021). A Practical guide for conducting participatory land readjustment in Rwanda (First Edition), Kigali.
42. Serife Tulin Akkaya Aslan, Muge Kirmikil, Kemal Sulhi Gündoğdu & Ismet Arici (2017). Reallocation model for land consolidation based on landowners' requests, Turkey
43. T S Nanjundeswaraswamy & Shilpa Divakar (2021). Determination of sample size and sampling methods in applied research, Proceedings on Engineering Sciences, Vol. 03, No. 1 (2021) 25-32,doi: 10.24874/PES03.01.003
44. United Nations (1987), The Rio Declaration on Environment and Development
45. United Nations (2000), The World Commission on Environment and Development.

ISSN: 1987-1791

46. Wisconsin Department of Administration Division of Intergovernmental Relations, Wisconsin State Cartographer's Office (2017).Final Report: Statewide Parcel Map Database Project ran from January 2016 to October 2017 (Version 3), United States.
47. Xiaobin Zhang & Yanmei Ye (2016). Land Reallocation in Land Consolidation: a Chinese Mode and Its Future Direction (8069), FIG Working Week, Christchurch.

ISSN: 1987-1791