UNIVERSITY OF NAIROBI

LAND READJUSTMENT STRATEGY IN SLUM REDEVELOPMENT USING GIS. CASE STUDY: MZAMBARAUNI SLUM IN MTWAPA, KILIFI COUNTY

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A project report submitted to the Department of Geospatial and Space Technology in partial fulfillment of the requirements for the award of the degree of:
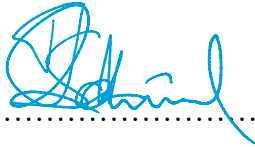**Master of Science in Geographic Information System**

JULY, 2021

Abstract

The developing world is facing rapid urbanization which has led to the proliferation of slums in most of the urban areas. Many models and strategies have been tried in the attempt to redevelop slums. This study demonstrates how land readjustment, as a tool that has been widely applied in urban areas, can be used in redeveloping slums. The project focused on using GIS mapping and analysis in land readjustment and reallocation of the newly planned regular settlement area of Mzambarauni slum. Redevelopment of slums usually involves manipulation and analysis of large datasets both spatial and non-spatial. This can be challenging without a platform that can integrate all these datasets as well as enable visualization of the spatial distribution. GIS provides a platform for integration, scientific analysis and visualization of spatial data resulting in the decision-making process being easier and efficient in land readjustment for slum redevelopment. The study discusses the application of land readjustment strategy as an alternative to the conventional approaches to slum upgrading, through consideration of initial structure/plot sizes when drafting proposals and reallocations. It also showed how GIS can be a useful tool for improved accuracy and reliability of datasets in the entire land readjustment process from mapping of the existing situation to the drafting of the proposals and reallocation of the planned land parcels.

Declaration

I Daniel Sakwa Kutoyi, here;by declare that this project is my own original work. To the best of my knowledge, the work presented here has not been presented for a degree in any other institution of higher learning.
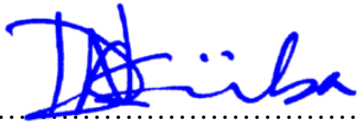
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Daniel Sakwa Kutoyi   Date

This project has been submitted for examination with my approval as a university supervisor.

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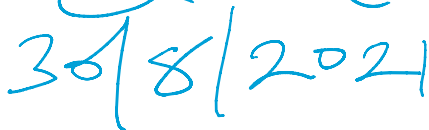Course Name: Geographic Information System

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Case Study: Mzambarauni Slum in Mtwapa, Kilifi County**

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Acknowledgements

Table of Contents

List of Figures

List of tables

Abbreviations and acronyms

PSUP   Participatory Slum Upgrading Programme

UDD   Urban Development Department

UN   United Nations

SDG   Sustainable Development Goals

GIS   Geographic Information System

ISUDP   Integrated Strategic Urban Development Plan

LR   Land Readjustment

MLPP   Ministry of Lands and Physical Planning

SDHUD   State Department of Housing and Urban Development

KENSUP   Kenya Slum Upgrading Programme

KISIP   Kenya Informal Settlement Improvement Programme

CHAPTER 1: INTRODUCTION

1.1. Background

The growth and spread of slums has become a global phenomenon and a global challenge of increasing concern throughout the last century, particularly for the cities of developing countries. Large urban centres across the world from Asia, to Africa, to the Americas continue to see exponential population growth. Projections show that, by 2050, continued urbanization and population growth will add approximately 2.5 billion people to the world's total urban population (United Nations, 2015).

In 1962, it was estimated that only one Kenyan out of every 12, that is about 8.3% of the population, lived in urban centres. By the year 1999, the population in the urban areas had increased to approximately one Kenyan out of every three, which is about 34.5% translating to approximately 10 million people. By the year 2015, urbanization levels were estimated at 44.5% with approximately 16.5 million people inhabiting in urban areas. This figure is set to hit 54% by 2030 with an estimated 23.6 million people living in urban areas and 85 million people by 2050 (Fengler, 2010).

The unprecedented urban growth rate in Kenya, has led to the emergence of slums dotting most of the Kenyan cities and towns. These slums are characterized with similar appalling conditions of temporary self-constructed houses often made of inappropriate building materials, lack of secure tenure with most squatting in private or government land, inhabiting environmentally fragile areas, congestion resulting from unstructured and unplanned developments, poor hygiene situation, inadequate social services such as schools, medical services and poor accessibility.

According to the UN Habitat, a slum is defined as a household that lacks one or more of these necessities; access to potable water, access to improved sanitation, sufficient living area, durable housing and security of tenure. This definition has been varied slightly country to country especially in the developing world.

UN-HABITAT presented a "worst-case" slum scenario, in which growth rates were projected to continue unrelieved with the number of residents rising from nearly one billion in 2005 to 1.4 billion by 2020. Though the Millennium "slum target" has been achieved by improving the lives of 227 million people, that target of 100 million was only 10% of the global slum population. China and India alone had achieved most of the global slum target by improving the lives of 125 million slum dwellers. Even then, "Eradicating poverty was and is the greatest global challenge

facing the world and is a core requirement for sustainable development, especially for developing countries" (United Nations, 2008). In this regard, Kenya has undertaken several schemes and programmes from time to time in order to promote city-wide planning and urban development as well as enabling slum dwellers to gain access to the basic services such as potable water, sanitation, health and educational facilities and security of tenure. Such initiatives include Kenya Slum Upgrading Programme (KENSUP), Kenya Informal Settlement Improvement Project (KISIP) and other settlement specific programmes funded by both the Government and donors. Despite the government's efforts in slum upgrading programmes aimed at addressing the problems affecting these areas, much more needs to be done to achieve sustainable development goals (SDGs) - 9 of making cities and human settlements inclusive, safe, resilient and sustainable.

Land readjustment provides an alternative ideology for slum redevelopment. It aims at balancing the interests of the key stakeholders in the slums and the local government as well as bringing in the private sector in slum upgrading initiatives. It includes the provision of basic infrastructure such as sanitation and sewerage disposal, drainage, access roads and footpaths, social amenities and housing proposals with the key component being the securing of tenure (UN-Habitat, 2016a).

1.2. Problem Statement

The phenomenon of rural-urban migration mainly attributed to influences like the economic pull of the cities and job opportunities, leading to pronounced urban growth, will continue in the coming years, thus exponential growth in slums. Exploration of alternative ideologies in slum upgrading with more research and better preparation will ensure the negative side effects of slums are ameliorated.

There have been several strategies or models to manage the slums in Kenya and elsewhere. Some of these strategies include: 1) building houses for the slum people, 2) taking no action to tackle the problem of slums with the assumption that slums will disappear with economic improvement, 3) wanton destruction and clearance of slum areas. The other strategy was the site and service schemes where Governments identified land, provided minimum infrastructure and social services to accommodate slum dwellers who were then expected to build the modern houses then seen as affordable by the majority.

Studies done on slums in Kenya have focused on the physical characteristics and socio-economic analogies. Mukeku (2018) in his study of Kibera slum in Nairobi, Kenya stresses the need for slum upgrading programmes to pay attention to the strong yet hidden interrelationship, that is the spatial-temporal formation of the slum and the socio-economic activities and practices of its residents, in order to meet the needs of the beneficiaries in a sustainable manner. Remi and Jochen (2018) studied the impact of the electrification programme in Kibera slum by the Government of Kenya where the study explored the implications of introducing such service in a slum and noted the effects of politics in such initiatives. Kerubo (2015) investigated the role of socio-economic dynamics in slum upgrading programmes whose findings showed that most slum upgrading initiatives have benefited the landlords more and excluded other groups especially the tenants.

Many slum upgrading initiatives in Kenya have either failed or stalled mainly due to the complex phenomenon of land ownership and titling. For instance, this has been observed in Korogocho, Mathare and Kibera, where major upgrading projects have stalled. The insatiable appetite of slum dwellers to own a parcel of land has always overshadowed the overall goals of slum upgrading and redevelopment. The previously discussed and many other studies have demonstrated the need for alternative approaches in slum upgrading. This project focused on land readjustment principles as a slum redevelopment approach and how GIS can be incorporated to enhance its implementation. Ultimately, the shift of focus from land titling to exploration of land readjustment can be a compromise between redevelopment of slums and the slum dwellers' needs of land ownership.

1.3. Objectives

The overall objective of the study is to demonstrate how land readjustment can be applied for slum redevelopment using GIS with a case study of Mzambarauni slum in Mtwapa, Kilifi county.

Specific objectives

 i.   To review the land readjustment process.

 ii. To evaluate the current spatial layout and characteristics of Mzambarauni slum.

 iii. To demonstrate application of GIS in land readjustment.

Research questions

 i.   How can land readjustment be implemented for slum redevelopment using GIS?

ii. What are the socio-economic characteristics of the settlement?

iii. What is the extent of the settlement?

iv. What are the characteristics and location of the structures?

Research matrix

Table 1: Research matrix

	Objectives	Research Questions	Method	Resources	Expected output
1.	To review the land readjustment (LR) process	How is land readjustment implemented?	Literature review	Papers, studies, journals, reference books.	How LR can be applied in slum redevelopment
2.	To evaluate the current spatial layout and characteristics of Mzambarauni slum	What is the extent of the settlement? What are the characteristics and location of the structures?	• Delineate the extent of the settlement. • Create a topo map of the settlement.	Satellite imagery, existing topographic data, cadastral plans	• Current extent of the settlement • Topo map of the settlement
3.	To demonstrate application of GIS in land readjustment for slum redevelopment	How can GIS be used to enhance the implementation of land readjustment?	• Consolidation of the slum to a unit • Bring out the structuring elements • Subdivision of the remaining land • Reallocation of the newly subdivided plots	Topo-cadastral map	• Readjusted structures and plots proposals (advisory plan)

1.4. Justification for the Study

As earlier indicated, several models and strategies have been employed to tackle the challenge of upgrading slums. Some of these strategies and models have failed to achieve their objective of upgrading slums and this is due to the complex nature of the slums. Under the developed and approved Mtwapa ISUDP, slum upgrading strategy earmarked Mzambarauni slum as one of the areas of focus for upgrading through action area planning.

Land readjustment focuses on public-private partnerships with cooperation of the community which provides an opportunity for exploration of alternative slum redevelopment strategies. The project will also aim at demonstrating the applications of GIS in such initiatives. This study would therefore assist both national and county governments in exploration of different model to undertake slum redevelopment as well as the capabilities of GIS as a decision-making support tool.

1.5. Scope of work

The study will focus on demonstrating the application of land readjustment principles in slum redevelopment using Mzambarauni slum in Mtwapa town, Kilifi county as the case study. The scope will include review of land readjustment documentation, review of the enumeration and socio-economic secondary data, creation of a topocadastral map and applying land readjustment in the creation of an advisory plan for the redevelopment of the settlement.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This chapter discusses the definition of slums, factors contributing to the emergence of slum and previous attempts to slum upgrading. Further, it provides an understanding of GIS and its application in slum upgrading. Finally, land readjustment concept and its implementation is discussed.

2.2. Understanding slums

2.2.1. Slum definition

Slums can be viewed as congested, highly populated area characterized by poor housing and squalor (UN-Habitat, 2018). This is the general perception of what slums are and how they can be defined.

A more scientific and widely accepted definition of a slum according to an expert committee convened by the UN Habitat in 2002, a slum household as one in which the inhabitants lack one or more of the following deprivations:

i) Lack of access to improved water source; A household is considered to have adequate access to potable water and if there is, then at least 20 litres per person per day.

ii) Lack of access to improved sanitation facilities; A household would be considered to have access to improved sanitation facility, if an excreta disposal system exists and can be accessed either in private or public by a reasonable number of people.

iii) Lack of sufficient living area; 3 people should not share the same habitable living room of minimum 4m^2.

iv) Lack of housing durability; A structure is considered durable, if it is built on a safe environment and can protect its inhabitants from climatic conditions.

v) Lack of security of tenure; individuals or groups should have legal rights that protect them from forced eviction.

Slum definition has remained a political debate with different countries adopting different criteria in their definitions. Considering the situation in Kenya, most of the residential areas would fall under the category of slum, since they lack one or more of the above criteria. Due to this fact, the term slum has been used for areas with extremities on the deprivations.

2.2.2. Emergence of Slums

Rapid urbanization in most developing countries has left most local authorities/governments struggling to provide basic urban services to its population. Kenya is not an exception and with an upsurge of urban population after independence, most towns have been plagued by the emergence of slums. The emergence of slums in Kenya can be traced back to the colonial era when Africans were not permitted to own land in major towns and the hinterlands (Anderson & Mwelu, 2013). Trade between the East African countries made the manufacturing industry in Nairobi to grow. This subsequently led to the influx of people who settled near their work places in makeshift structures as squatters, creating slums in Nairobi and most of the major towns where there was some industrial development.

The emergence of slums can be attributed to different factors considering why, how and where there is growth of slums (Roy et al., 2014). Economic growth has seen growth in population in most urban areas, but the economic growth is not always adequate to support the population. With the urban formal job market dwindling, the bigger urban labour force has been forced to eke out a living from the informal sectors. The low levels of income from most of these sectors result in this population seeking alternative shelter ending up in slums (UN-Habitat, 2018).

The failure by the government to provide low-cost housing has greatly contributed to the continued slums proliferation in our towns. According to Roy et al. (2014), housing market dynamics have an impact in the growth of slums as they affect affordability of real estate. Both formal and informal housing markets impacts slums externally and intrinsically respectively. The informal housing sector has continued to fill the gap of housing, especially for the low-income earners, by providing housing that is affordable. The high land market value in cities and towns has led to the overall emergence of slums, as houses are developed in areas that are not fit for habitation or on squatted land.

Poor governance and a lack of political goodwill are also contributors to the emergence of slums. Politicians are charged with the responsibility of formulation of laws and regulations that would guide the upgrading, redevelopment and prevention of slums. This would also inform proper institutional arrangements for dealing with the slum challenge. Without good governance and political will, little can be done to tackle the challenge of slums. Slums have always been seen as vote banks for politicians and thus it is not in their interest uplift the standards of living for these places (Roy et al., 2014; UN-Habitat, 2016b; World Bank, 2016).

2.2.3. Previous slum upgrading attempts

Globally, there has been an evolution in slum policies and urban authorities have adopted different strategies in dealing with the slum challenge. This ranged from in-situ upgrading, relocation to forced evictions. These strategies starting in the 1950s can be categorized as: "Laissez-Faire" in the 1950s, "Site and Service" in the 1970s, "Slum Upgrading" in the 1980s (Banes et al., 2000), "Tenure and Enabling Approach" in the 1990s and "Slum-free cities" in 2000s (Rowe, 1990; Roy et al., 2014). Several indigenous policies were also implemented across the world, for example "Slum Redevelopment Scheme" in Mumbai, India which was evidenced by the complexities of enabling housing provision (Mukhija, 2001) or "Rio Favela Development" in Rio, Brazil. Upon review, it was noted that there was need more to be done in terms of policies (Roy et al., 2014).

The Government of Kenya initiatives in slum upgrading can be traced back to the 1970s with the site and service schemes. These started in Nairobi in collaboration with the World Bank and it was mainly to address the housing deficit that was being experienced (World Bank, 1978). This was followed by other slum upgrading initiatives. In the 2000s with the call for slum free cities, an initiative by the world bank and UN Habitat, the Government initiated the Kenya Slum Upgrading Programme (KENSUP) in 2004 (Anderson & Mwelu, 2013; Muraguri, 2011). Implementation was in all provincial headquarters and secondary towns with a population of 20,000 and above. This programme targeted both the physical and social infrastructure improvement and housing improvement in some cases. The programme achieved several key milestones of note being the Kibera slum upgrading where 822 housing units were constructed in the Soweto East village (SDHUD, n.d.). Although the project had its successes, it was met with resistance by some of the residents who claimed that they had been given the land on which they were settled and thus they wanted to be given titles for the land. Others cited that most of the beneficiaries of the housing units are outsiders who were erroneously enumerated. Several court cases were filed and this resulted in the projects stalling.

In 2011, the Government of Kenya initiated the Kenya Informal Settlement Improvement Programme (KISIP) with funding from the World Bank. It began with implementation of projects in 15 municipalities and then it was upscaled to other towns across the country (Anderson & Mwelu, 2013; Muraguri, 2011). The KISIP programme entailed institutional

strengthening, provision of security of tenure, infrastructure improvement and planning for urban growth.

2.2.4. Slums in Mtwapa

Mtwapa town is located to the south of Kilifi county at the border with Mombasa county, and it is approximately 16 km from Mombasa town. It is usually considered as a dormitory to Mombasa town as most of the people who work in Mombasa live in Mtwapa. It has a population of approximately 127,737 people as per the 2019 census report (KNBS, 2019).

Access to land by the local has been confined to the hinterlands as a vast of the land is owned by absentee landlords. The blind inheritance of laws at independence by the Government provided continuity in the injustices that had been created (Mwagonah, 2017). The locals have thus resorted to settling on most of the undeveloped land, as they consider these lands to be rightfully theirs. This has given rise to "professional squatters" who will move from one settlement to another seeking compensation or selling land once issued with ownership documents.

An Integrated Strategic Urban Development Plan (ISUDP) for Mtwapa was prepared in 2008 under which 11 slums were identified in its slum upgrading strategy (UDD, 2008). These were Kwa Nyambura, Makadara, Mtomondoni, Four Farm, Kwa Mavitswa, Maweni, Soweto, Mwando wa Panya, Kwa Goa, Majengo and Mzambarauni as shown in figure1. These varied in status as 9 of them were on private land either as tenants at will or squatters, while 2 of them were squatting on government land, that is, Majengo and Mzambarauni settlements. From the study, it can be deduced that most of the residential areas in Mtwapa were actually slums by definition. Since the study, some land owner compensated dwellers in their land and the areas redeveloped, others which are more of slums due to lack of land titles are in the process of acquiring while others have court cases against evictions by the land owners.
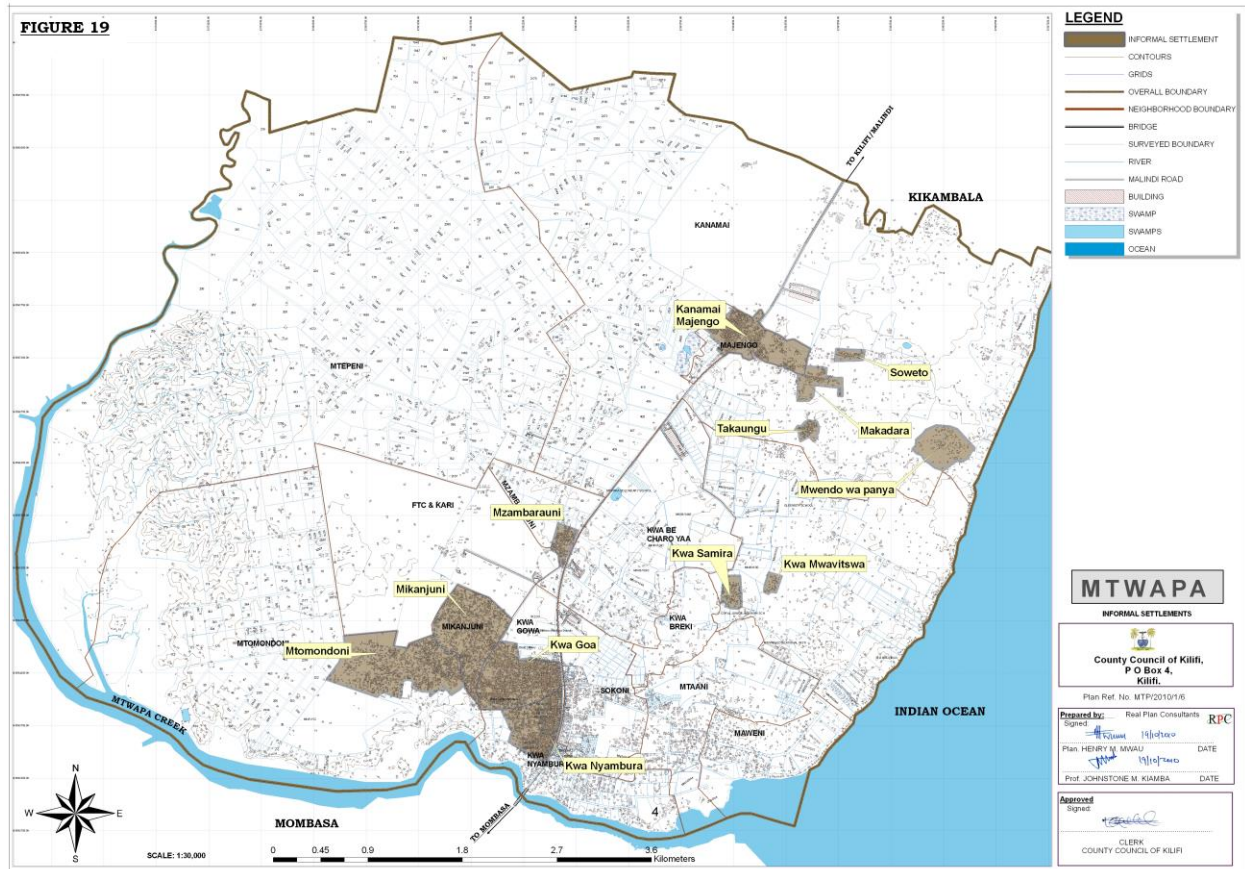
Figure 1: Extract from the Mtwapa ISUDP showing the informal settlements in Mtwapa town.

Mzambarauni settlement was chosen because it sits on government land and there was an initiative on upgrading through the Participatory Slum Upgrading Programme (PSUP) of the UN-Habitat which begun in 2011. There is also enumeration and socio-economic data for the settlement that was collected under the programme. The approved ISUDP also proposed, under the slum upgrading strategy, for the planning and regularization of two settlements on government land, that is Mzambarauni and Majengo slums, to secure tenure for the dwellers as well as uplifting their living standards.

2.3. Land readjustment

2.3.1. Concept and practices.

Land Readjustment (LR) concept is assembling small land parcels into one large parcel and then redistributing the land after infrastructure provision and creation of public spaces and or space for private development (El Shimy, 2012). It is a crucial land management tool in urban planning when suitable reformation of private land is necessary for residential purposes. Due to the

10

inadequacy of urban land, LR as opposed to compulsory land acquisition emerges as a trend that is favoured due to less conflicts (Lozano et al., 2013). The framework of implementation ensures participation of the affected landowners or residents throughout the process. Alternatively, LR concept can be defined as assembling contiguous land/plots into one large one large parcel and then reallocating the land after the prerequisite infrastructure such roads, sewerage, storm water drainage and many others, public spaces and plots for private development where possible have been provided (UN-Habitat, 2016a).

Implementation of LR in different countries might follow slightly divergent steps to achieve the target, but the basic process followed includes:

   i.   Scoping (delineating) the extent of the area of interest,

   ii. Mapping the existing situation taking into account the existing property and features of interest,

   iii. Enumeration and socio-economic survey capturing all the property owners,

   iv. Readjustment of the land,

   v.   Determination of the plot sizes before and after the readjustment,

   vi. Compare the valuation and finally implement the proposals (El Shimy, 2012; Lozano et al., 2013; Yomralioglu et al., 1996).

LR has been extensively applied in urban areas as a tool for expansion due to the inadequacies of urban land for expansion. A number of countries have practiced LR in a manner specific to their context in terms of policies and other factors. Germany is one of the oldest examples of LR, known as Umlegung. Japan adopted the German model in the early 1900s and it was mainly implemented as a reconstruction tool after disasters. In Korea, the aftermath of the Korean War and political instability of the 1940s resulted in housing and urban facility shortages, creating the need for urban renewal where the tool of choice was LR. Currently, LR in Taiwan, China is largely used to convert rural land into urban uses. In south America, Colombia has some of the best examples of LR in the cities of Medellin and Bogota where LR overcame the challenge of 'lot-to-lot' developments and ensured the inclusion of low-income families in the redevelopment process (De Souza et al., 2018; Lozano et al., 2013; Rodriguez, 2012).

In Africa, LR has been practiced in Angola where the informal settlements and agricultural land in the peri-urban areas of Huambo city were readjusted in Fatima and Camussamba (UN-Habitat, 2013). This resulted in different government stakeholders sensing the urgent need for the

application of new and innovative approaches towards urban planning and expansion as well as slum prevention. In Egypt, LR was implemented to provide sustainable development in the slum areas of Aljama as a pilot to demonstrate the implementation of the LR process in a slum set up (El Shimy, 2012; UN-Habitat, 2013).

The method is useful when there is unusual subdivisions and scattered development that are uneconomical, and the need for reorganization of old structures and provision of infrastructure. LR, however, affects land tenure and changes the existing ownership structures according to the developed advisory plan. Therefore, distribution of the new land parcels is the most sensitive stage of the whole process, which requires a highly refined solution to the land distribution (Yomralioglu et al., 1996). This is inevitable for slum areas due to the limited available land. There needs to be a careful analysis of land, socio-economic and planning dimension, during the project to avoid conflicts upon completion of the proposals.

The UN's Global Land Tool Network (GLTN) initiated a variation of the LR by introducing the participatory and inclusivity aspect into the process. The modified LR is called the Participatory and Inclusive Land readjustment (PILaR) has gained popularity due to its inclusion of more stakeholders in the process of land readjustment. Apart from the key stakeholders of the landowners/landlords and the local government, the PILaR process includes the tenants and the vulnerable groups as additional key stakeholders (UN-Habitat, 2016a). This is aimed at balancing the interests of the different interest groups within the settlement.

Application of LR can be done in conjunction with other tools such as land use planning, slum upgrading or land sharing (UN-Habitat, 2016a). Land use planning dictates where the key prerequisite infrastructure and urban services are to be located as per the planning standards. Thus, during the implementation of LR, the use of the planning principles in determination of the location of crucial services as well as the determination of the plot boundaries and minimum land parcel sizes. Similarly, for slum upgrading, the determination of the location of the basic infrastructure such as access roads, sewerage, housing, footpath and many more can go hand in hand with the LR approach when providing for the same.

The benefits of LR include: enhanced public-private-community cooperation, lowered initial capital for infrastructure improvement, benefit of land being used in an economical way and improved land value from the provision of infrastructure and other services. It also provides an opportunity for new developments in areas which would otherwise be impossible, an opportunity

for Own Source Revenue (OSR) for the local government, provision of land for low-income housing (El Shimy, 2012; Lozano et al., 2013). LR can be effective in ensuring indigenous people remain together thus maintains the social aspect as it uplifts the economic aspect of the area. Use of GIS in LR would provide accurate and reliable information during the process thus, building confidence of the local community.

LR is usually preferred as dwellers will not relocate to other unfamiliar places as a result of evictions for development but, structure/land owners with bigger allocations are mostly opposed to the process while the ones with small fragmented plots/structures which are virtually useless are for the process.

Comparatively, most slum upgrading initiatives would apply planning standards and the final advisory plan would depend on the criteria used or agreed upon by the stakeholders. For instance, if the agrees criteria is equal plots for everyone, then all the beneficiaries would get the same size of plot regardless of the size of the initially owned plot. This approach frequently leads to most of the structure owner being dissatisfied since they tend to surrender most of their property for the benefit of others. The minimum interventions approach would seek to maintain the status quo while providing urban infrastructure and services which compromises some of the planning standards and level of regularization. The fact that LR either considers the initial value or size or both in the readjustment process, provides an alternative that tends to balance the interests of the slum dwellers of fairness planning and allocations, while maintaining planning standards as would be the intention of the authorities.

2.3.2. Land consolidation vs land readjustment

Land consolidation and land readjustment can be defined as participatory strategies for rearrangement of land rights for the purposes of achieving desired land use (Louwsma et al., 2017).

The aim of land readjustment as discussed is to change the existing land use by reorganizing and adjusting the built-up areas which are irregularly planned to regular parcels with prerequisite urban services. It is mainly practiced in urban areas where the land is already developed.

Land consolidation which has been practised in Kenya, especially in the former Kikuyu district in the 1950's, is very similar to land readjustment, but generally applied in the rural areas (agricultural and forest areas) with the general objective of improving the production in

agriculture or conservation of forest areas (Viitanen & Vitikainen, 2005). Thus, the main difference is in the areas of application.

2.4. GIS in slum upgrading and opportunities in land readjustment

The ability to present a slum spatially, its attributes and socio-economic characteristics using GIS is an important addition to slum upgrading process. Communities own the process with a thorough understanding of all the aspect in the upgrading process, and dissemination in GIS provides this if adequately used during the process. GIS provides a platform for integrating spatial and non-spatial data, visual representation of data, management of geospatial information, tools for analysis and for supporting decision making (Saleh & Sadoun, 2006).

The different GIS tools such as buffers, queries, database and other customizations would give detailed information on building footprint, land area, dwelling units, available infrastructure, land ownership, slum inventory, household characteristics and many more. There is thus an urgent need for the adoption of GIS based techniques to collect and analyze slum data on a repeated basis, to support decision making and easily monitor the slum characteristics (Das et al., 2014). In the upgrading process, GIS will provide a linkage between the socio-economic and spatial data bringing out phenomenon that would have otherwise remained hidden.

In recent times, Participatory GIS has been employed in slum upgrading initiatives. Lefulebe et al., (2001) described PGIS as follows: "Participatory GIS is the integration of local knowledge as well as stakeholders' perspectives in a GIS". Like GIS, several definitions exist on PGIS, but they all culminate in the emphasis of community and stakeholders' participation in GIS processes within the slum redevelopment process.

Shelter Associates in their study of "GIS poverty mapping for integrated development of slums" in 2008, concluded that GIS is an integral tool for effective monitoring of slums growth and effective planning for sustainable slum redevelopment. Lefulebe et al., (2015) in their study "exploring the potential of geographical knowledge systems in upgrading informal settlements in Cape Town" emphasized the ability of GIS to improve the quality and efficiency of slum upgrading. This is through the range of benefits offered from the initial data collection process to visualization of the products. Use of GIS is ideal in mapping of slum conditions which inherently suffer from high heterogeneity (Anchang, 2016). Adepoju et al., (2013) demonstrated the effectiveness of using GIS and remote sensing in identification, mapping and monitoring of slums.

In the process of LR, several opportunities for the use of GIS emerge to facilitate efficiency and accuracy of the processes. During the scoping of the area of interest and mapping of the existing situation, GIS provides detailed information on the area by digitizing the ownership documents and building footprint (Das et al., 2014). Use of GIS also provides accurate and reliable information during the process thus, building confidence of the local community (El Shimy, 2012). Integration of non-spatial data with the spatial data is a key component to enable better analysis and decision-making. GIS provides a platform for database management and the tools necessary to perform analysis to reveal patterns and trends that would enhance the quality of the outputs. LR involves reorganization of developments and a comparison of the proposals and the existing situation (Yomralioglu et al., 1996). Utilizing GIS will enable easy analysis capabilities that would facilitate the readjustment process as well as the comparison of the proposals and the existing situation. GIS will also provide a better visualization platform of the thematic maps and the proposals at the end of the process. According to Das et al., (2014), there is an urgent need to adopt GIS based techniques in the collection and analysis of slum data to support decision-making and monitoring of slum characteristics.

2.5. Policy and regulatory framework

There is need to align the LR process to the existing policies and regulatory framework. If there is no specific laws on land readjustment, concepts can be borrowed from existing related legislation such as planning and land tenure related policies (UN-Habitat, 2016a). Several policies addressing the issue of slum upgrading and land ownership were reviewed to align the project objectives to them. These policies included:

i) National Land Use Policy (NLUP)

The policy recognizes the problem of proliferation of slums which is inevitable considering the rate of urbanization. To address the issue, the policy proposes the preparation and enforcement of land use plans and policy guidelines to address development activities, encourages the engagement of public private partnerships in the provision of affordable housing, public utilities and other social infrastructure to meet the demand for housing as well as urban services. This is through the creation of an enabling environment for public-private partnerships in the housing sector. The policy also proposes the mapping out of the number and the location of all slums and provide legal security of tenure (MLPP, 2017). Land readjustment promotes public private

partnership through creation of land for development by private developers, where possible, as an incentive for providing housing and or urban services to the settlement.

ii) National Slum Upgrading and Prevention Policy (NSUPP)

The NSUPP appreciates the challenge posed by the predominant land tenure system in Kenya, that is individual-based titling, which creates a challenge in slum upgrading/redevelopment. The policy thus proposed the development of alternative innovative instruments of land ownership that will enhance the realization of security of tenure for slums. Further it proposes the adoption of innovative and sustainable land regularization strategies to improve the living standards of slum dwellers. Another significant proposal is the inclusion of social housing for the urban poor in urban development interventions (SDHUD, 2017). Land readjustment considers the different ownership dynamics within the settlement and providing different solutions for land holding or social housing. For instance, LR would make proposals depending on the structure's sizes or values of property which will determine what allocation the owners get. Also, if a structure is large enough that it meets the minimum requirements for plot size, then this would be considered for an individual plot, otherwise, the structures are readjusted accordingly and proposed for block or shared titles or even social housing or housing through cooperative societies.

iii) Other policies and regulatory frameworks

The National Urban Development Policy (NUDP) and the Urban Areas and Cities Act (UACA), 2019 have both given cognition to the slum challenge and proposed the consideration of the informal areas in the city-wide planning interventions.

2.6. Summary of the literature review

The literature review has defined what slums are and the factors leading to their emergence. Slum upgrading initiatives globally and nationally have been highlighted giving their history and their successes and failures. This will inform the approach of redevelopment of the slum in this project when applying the LR concept. It has also highlighted the LR concept, its emergence, examples of its application in different countries and contexts. The conventional application of LR as applied in areas of urban expansion, creation of land for urban development in built up areas and some applications of the same in slums.

CHAPTER 3: MATERIALS AND METHODOLOGY

3.1. Introduction

This chapter presents the resources required, overall methodology and techniques of analysis to achieve the project's objectives. It details the data requirements and their sources, digitization process, analysis of the existing situation, application of the land readjustment and the list of software packages used.

3.2. Study area

The project was undertaken in Mzambarauni settlement in Mtwapa town, Kilifi county. This area was selected due to the availability of socio-economic data, survey plans and old maps which were used as reference data.
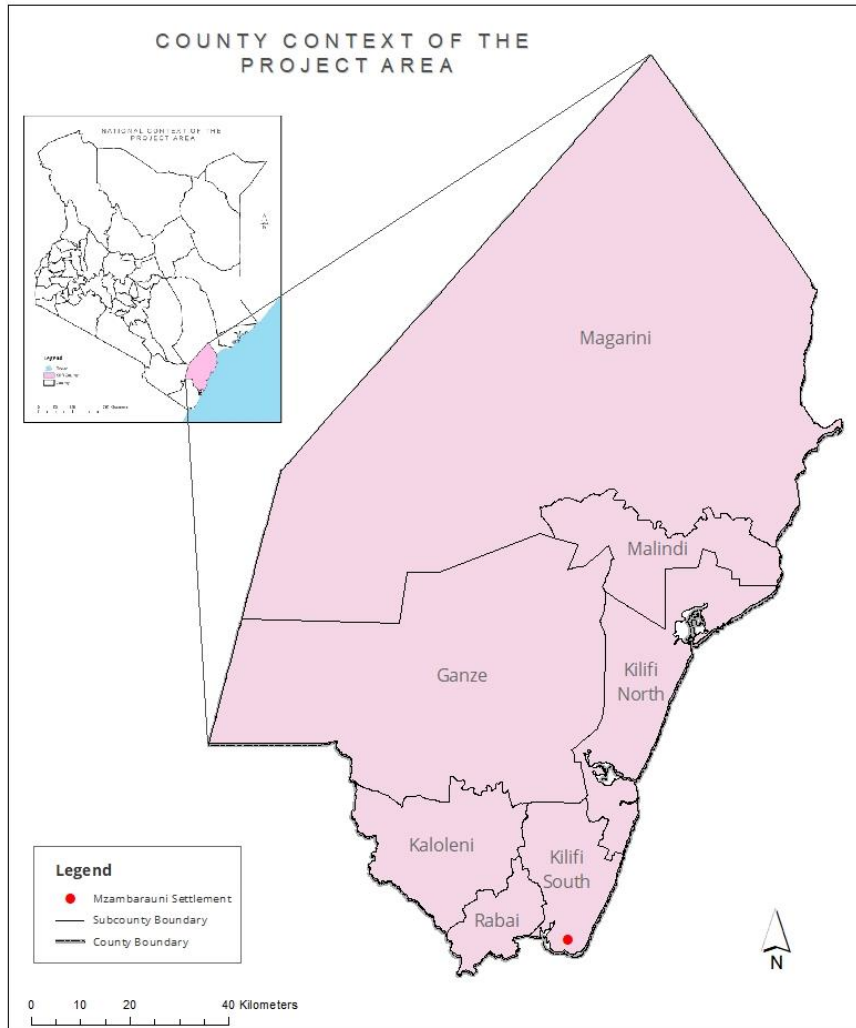
Figure 2: Map showing the location of Mzambarauni Settlement

3.3. Review of the land readjustment concept

This involved the review of relevant documentation, journals, books and online resources to appreciate the LR concept and its application in different contexts as presented in the previous chapter. This informed the preferred approach to undertake in this project.

3.4. Evaluation of the current spatial layout and building footprint

Several data types were identified for use in the project. A high-resolution satellite imagery was acquired to enable creation of a topographic map of the area. Survey plans covering the settlement were also acquired to accurately identify the extent of the settlement. Socio-economic and enumeration data was obtained from the UN-Habitat and this was reviewed to give a better appreciation of the area as well as its application during the analysis for the application of LR principles.

The survey plans were digitized in Microstation v8 and then exported to ArcGIS where most of the processing of the other datasets was done. Since most of the cadastral data was in Cassini, there was need to convert the data to UTM system which was the system that was used for data processing.

The satellite image was georeferenced using several points which could be distinctly identified from the image. Features were then extracted to create a topographic map of the settlement. The extraction focused on the areas in and around the settlement.

Ground truthing was undertaken to assess the accuracy of the maps and collect other properties of the settlement which included aspects like permanent or temporary structures, institutions, commercial areas and many other characteristics which were useful during the land readjustment process. Editing was done based on the ground truthing and the final maps were prepared.

The structures from the newly updated maps were allocated unique identifiers that formed the basis for reference of the structures within the settlement during the entire process.

3.5. Understanding the socio-economic characteristics of the slum

The general methodology involved desktop review of the existing enumeration and socio-economic information for the slum, from which the socio-economic characteristics of the settlement were determined. Other characteristics of the settlement were also considered either through collection or desktop review. Some of this information was linked to the maps as attributes to support in decision-making during the readjustment process.

3.6. Land readjustment process using GIS as a support tool

This concept becomes more useful when there is unusual subdivisions and scattered development as is the case for slums. The process ensures equitable contribution and benefits for all the participating entities in the initiative.

The approach adopted by the project involved the determination of the plot/structure sizes before and after the readjustment process. This method was preferred due to the dynamics and different characteristics of slums. The approach involved:

- Mapping of the existing situation
- Carrying out the readjustment process
- Reallocation proposal of the plots in the newly readjusted plan

Mapping of the existing situation: As explained above, this included creating a topo map using a recent high-resolution image (Google imagery). This facilitated a better appreciation of the character of the slum. The boundaries of the slum were ascertained by overlaying the digitized survey plans' boundaries on the map. This helped to determine the exact extent of the settlement and identify any existing interest within the settlement in form of surveyed land.

The mapping data was linked to the non-spatial data giving a better appreciation of the structures' characteristics. Once this was completed, the data was ready for the readjustment process.

Readjustment process: The process begun by consolidating the entire area so as to plan it as one unit. The second step was to bring out the structuring elements which gave the settlement its character. These included features like main roads (both within and without), environmental fragile areas, public facilities and any other feature of key interest.

The remaining land was then subdivided into plots taking into account the initial sizes of the structures and also the complexities of different ownership dynamics existing within the settlement. Different aspects of readjustment were considered to find the best solution for the slum based on the analysis of the existing situation. This included, provision of prerequisite urban services and plots for structure owners, private development or social housing.

Planning standards were taken into consideration while making provision for special planning zone as slums should be treated as such.

Reallocation of the plots in the newly readjusted plan: the reallocation process was done considering the initial sizes of the structures and the location of the original structures. The final

advisory plan ensured that all the initial owners were captured with their new plots clearly shown on the plan. The main principle in the readjustment process was ensuring that the dwellers in the settlement are not relocated very far from their original locations. This was achieved through readjusting/planning following the existing structure of the settlement to avoid demolitions. Further, the allocation of the plots was done considering how much of the structures fall within a plot or the distance to the proposed plots. This reduced considerably relocation of structures further from their original locations when reallocating them to their newly readjusted plots. The illustration in fig. 3 and 4 shows examples of how LR can be applied.
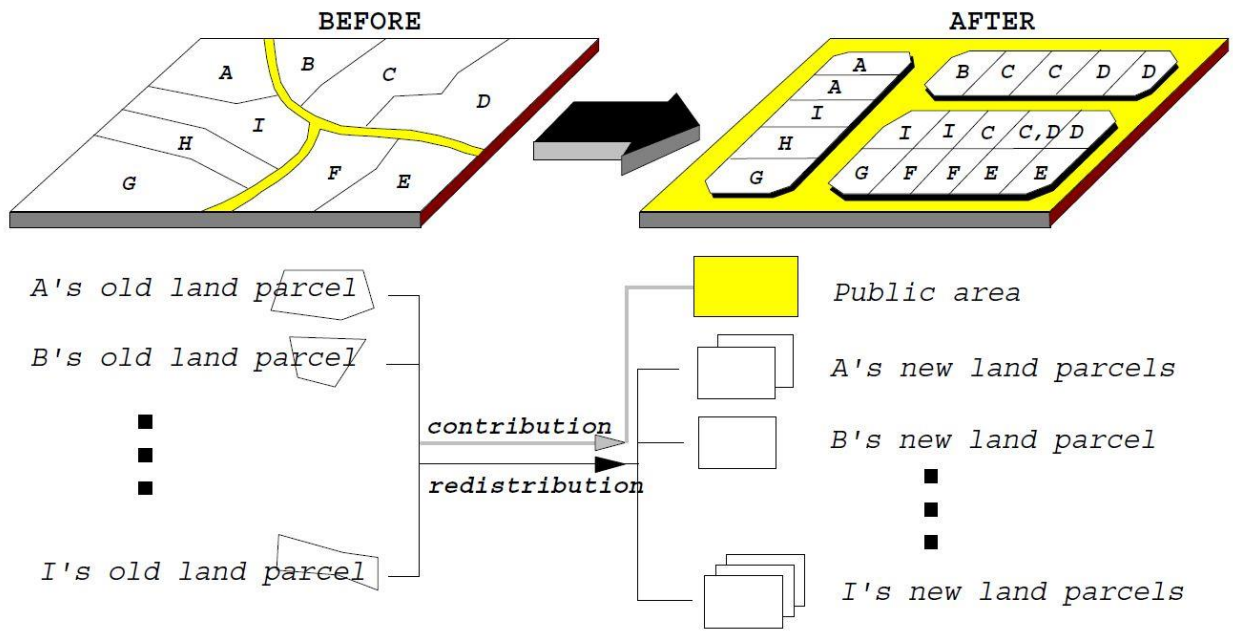

Figure 3: Land readjustment example 1   **(Source: Yamralioglu et. al. 1996)**
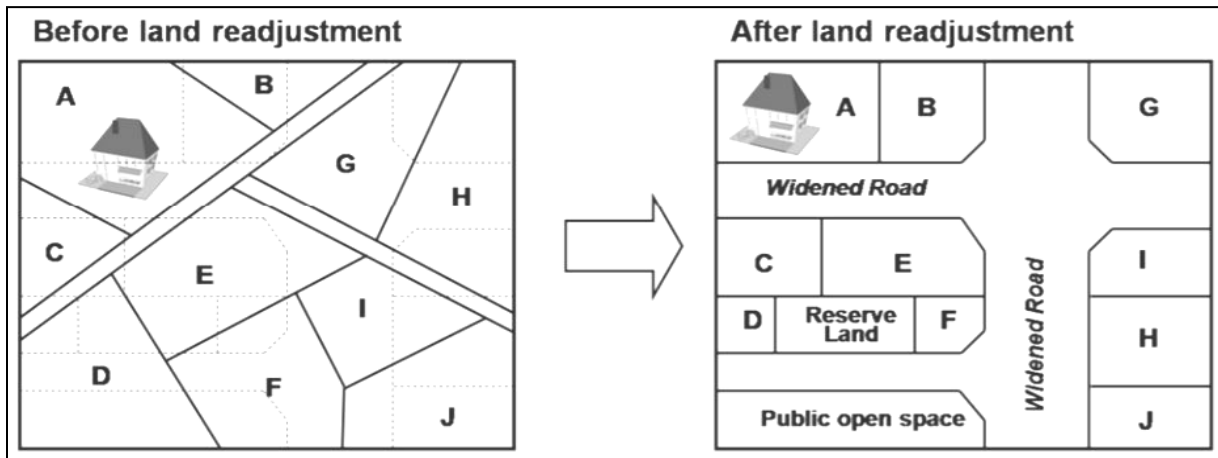

Figure 4: Land readjustment example 2   **(Source: Yung 2009)**

The flow chart of the activities is as follows:

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                    ┌─────────────────────────┐
                    │    Data acquisition     │
                    └─────────────────────────┘
                                 │
    ┌────────────────────────────┼──────────────────────────────┐
    │                            ▼                               │
    │            ┌─────────────────────────┐                     │
    │            │     Georeferencing      │                     │
    │            │    and digitization     │          Data       │
    │            └─────────────────────────┘       processing     │
    │                            │                               │
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    │            ┌─────────────────────────┐                     │
    │            │     Ground truthing     │                     │
    │            └─────────────────────────┘                     │
    │                            │                               │
    │                            ▼                               │
    │      ┌───────────────────────────────────┐                 │
    │      │   Map editing and linking to      │                 │
    │      │        non-spatial data           │                 │
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   │                             ▼                               │
   │             ┌─────────────────────────┐                     │
   │             │     Analysis of the     │      Readjustment    │
   │             │   structuring elements  │        process       │
   │             └─────────────────────────┘                     │
   │                             │                               │
   │                             ▼                               │
   │             ┌─────────────────────────┐                     │
   │             │     Analysis of the     │                     │
   │             │    existing situation   │                     │
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   │             ┌─────────────────────────┐                     │
   │             │    Concept planning     │                     │
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   │                             │                               │
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   │             ┌─────────────────────┐   ┌─────────────────┐  │
   │             │     Readjustment    │───│  Advisory plan  │  │
   │             │      process        │   └─────────────────┘  │
   │             └─────────────────────┘                        │
   │                             │                               │
   │                             ▼                               │
   │        ┌───────────────────────────────────┐               │
   │        │        Reallocation process       │               │
   │        │  (based on the location and sizes │               │
   │        │        of the structures)         │               │
   │        └───────────────────────────────────┘               │
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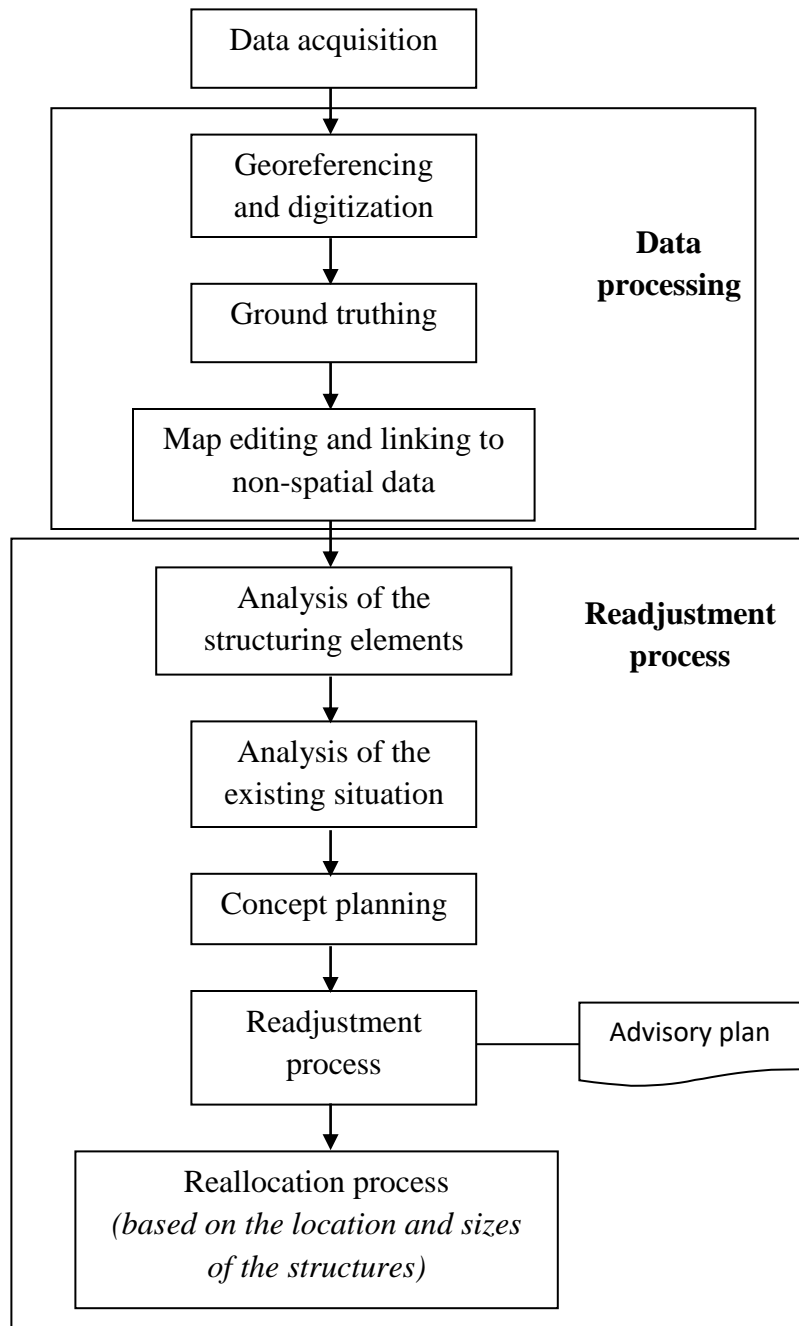
Figure 5: Flow chart showing the workflow of the methodology

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1. Introduction

This chapter elaborates the outcomes of the project as per the methodology employed. It discusses the results of the mapping process in appreciating the building footprint, the readjustment process and the reallocation.

4.2. Mapping

An up to date digital map of Mzambarauni settlement as digitized is as shown in figure 6. It was observed that the slum had a total of 300 structures of varying sizes and shapes. The range of area sizes of the building are as shown in table 2 below. In onscreen digitization, the roofs of the structures is what is mainly digitized, thus the assumption is that the areas are representative of the floor area which would normally be smaller. This was supplemented by non-spatial attributes such as place names and the permanency of the structures.

The map of the slum clearly depicts the structures that do not follow any standards or plans with an average size of approximately 78m^2. The structures are congested especially on the western side, with inadequate access. Observations on the ground noted that the area lacked adequate potable water and access to improved sanitation facilities. These factors emphasize the slum nature of the settlement as these are the aspects that qualify an area to be categorized as a slum.

Table 2: Areas of existing structures

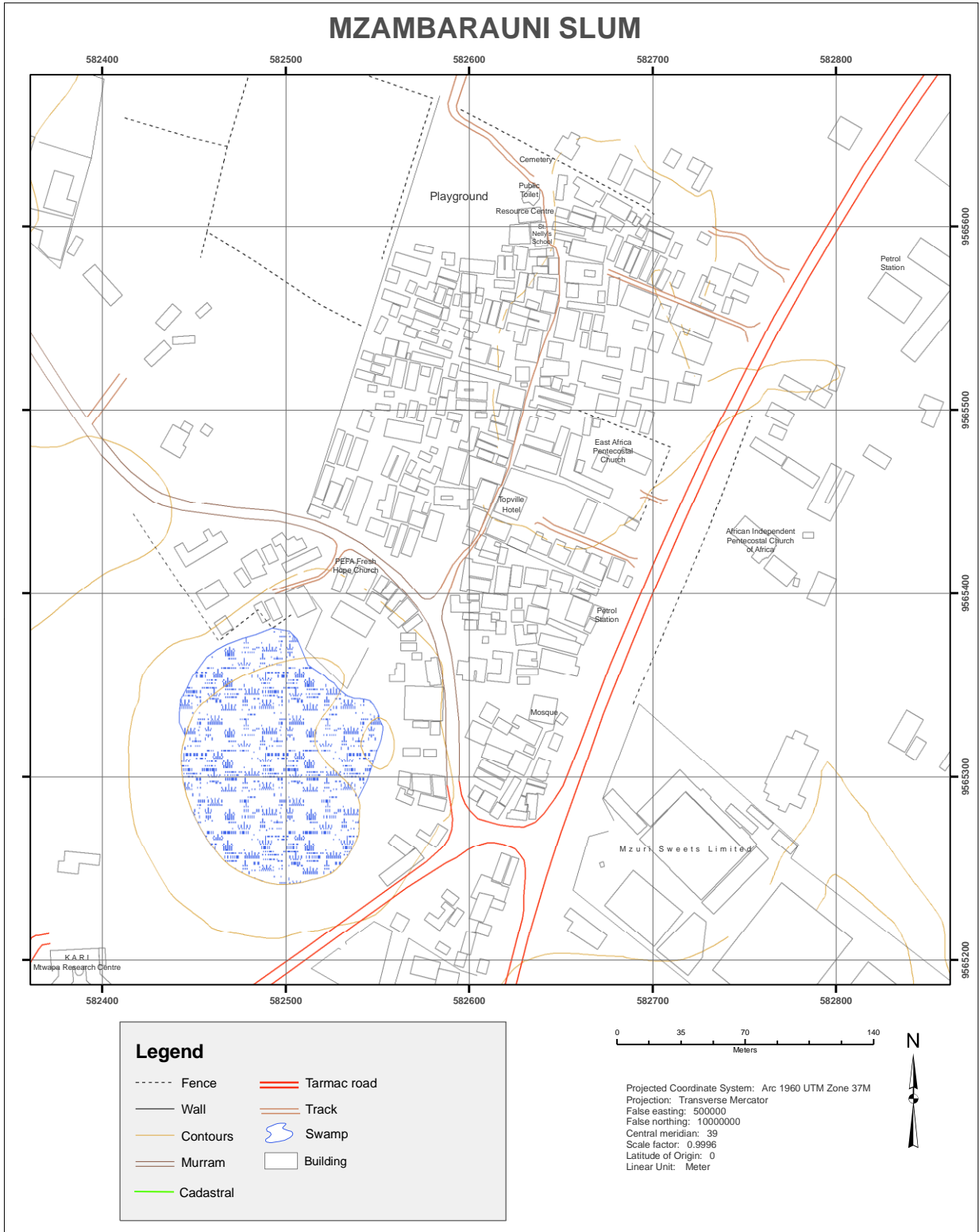| Structure area sizes	
Area size (m^2)	**Number of structures**
<= 15	12
16 – 50	118
51 – 100	100
Above 100	70

Figure 6: Mzambarauni slum topo map

4.2.1. Cadastral information

The following survey plans; FR 96/14, FR 109/10, FR 236/165, FR 480/185, FR 434/116 and FR 286/138, covering the area of interest were acquired and digitized in MicroStation v8. The CAD files were converted to shapefiles and projected to the same coordinate system as the other vector data to enable overlaying of the same. It was observed that there existed some survey plans within the boundaries of the slum. It was also noted that there were some structures which laid on the road reserve as per the survey plans. The total area of the settlement is approximately 6 ha. Figure 7 shows the cadastral information overlaid on the map.

The digitization of the imagery and cadastral information was done differently and thus the accuracy of the two datasets might have a slight difference. The cadastral dataset's original projection was Cassini which had to be converted to UTM. This process with the follow up adjustments produces some errors. To overcome this challenge, the digitized corners of the cadastral information was linked to fence corners that could be uniquely identified to improve on the representation accuracy. The cadastral information revealed that some structures are built on the road reserve as they fall outside the limits of the boundary. It was also observed that there are plots demarcated within the settlement belonging to private individuals.
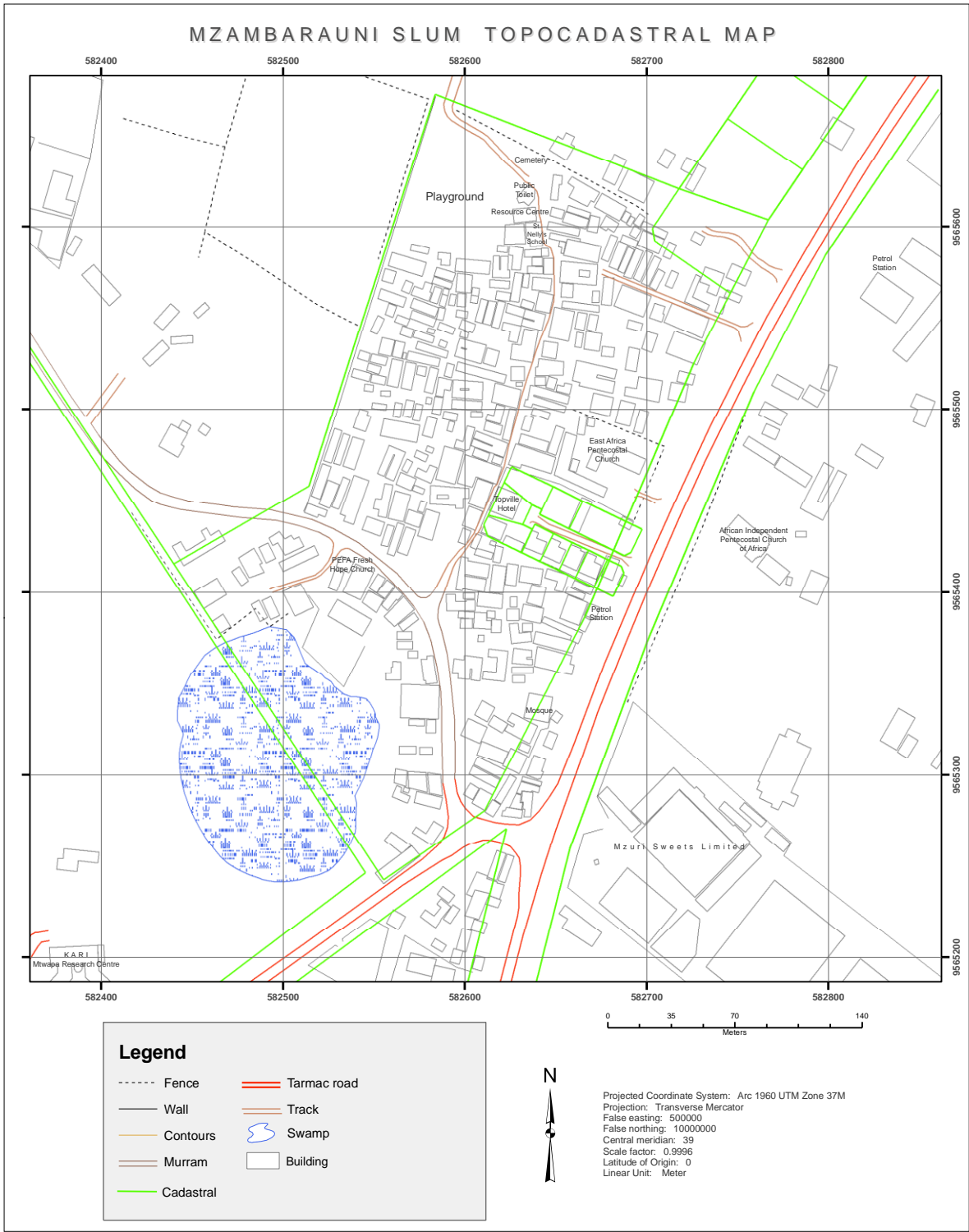
Figure 7: Mzambarauni topo-cadastral map

4.3. Socio-economic status

The secondary data for the socio-economic status of the settlement was reviewed and some key observations were noted as follows:

4.3.1. Tenure status

It was noted that 57% of the dwellers are structure owners with 43% being tenants. Most of the structure owners are single-structure owners while a few several structures owned by family members in the African cultural *'boma'* setting.

4.3.2. Household size

The majority of the families in the slum have an average of 3 to 4 members while 43 % of the structures consist of only one room. This emphasizes the inadequate living space for most of the families as observed from the average structure sizes. The table below summarizes the household size information.

Table 3: Household size

Household size	Percentage
1 – 2	16.7 %
3 – 4	76.7 %
Above 5	6.7 %

4.3.3. Occupation

The majority of the dwellers are self-employed engaging in informal businesses both within the settlement and outside. The small percentage of the ones employed are casual labourers who depend on the nearby industries and private businesses. The proximity of the slum to the main town of Mtwapa means that there are also more opportunities for employment. The table 4 below summarizes the occupation of the dwellers:

Table 4: Occupation

Occupation	Percentage
Private sector	7 %
Casual labour	13 %
Self employed	70 %
Unemployed	10 %

4.3.4. Monthly rent

A larger percentage of the tenants pay below Ksh. 1000 which is mainly attributes to the fact that they are mostly paying for one room which are either temporary or semi-permanent. This is summarized as follows:

Table 5: Monthly rent

Monthly rent (Ksh.)	Percentage
Below 1,000	41 %
1,001 – 1,501	26 %
1,501 – 2,000	18 %
2,001 – 3,000	8 %
Above 3,000	7 %

Other key observations include the mode of transportation used where a majority of the residents either walk or use *'bodaboda'* motorcycles. Potable water in the settlement is mainly accessed through water buying points or water vendors as most of the structures do not have direct access to piped water. The majority of the dwellers use pit latrines with very few houses having flush toilets.

4.4. Land readjustment process

The process was initiated by identification of the structuring elements, analyzing the existing situation, creation of blocks and finally subdivisions of the block and the readjustment of the structures within the provided plot proposals.

4.4.1. Structuring elements

These are elements that have a direct influence on the area and would affect the proposals. It was observed that the area borders the main highway from Mombasa to Malindi along which most of the commercial activities are concentrated, while the road to Mtepeni passes in the southern part of the slum. There is a swampy area at the southern boundary and a cemetery on the northern boundary, both areas where development cannot occur. Figure 7 below shows a map that captures the structuring elements of the slum.

It can be observed that the slum's growth has been curtailed by the swamp to the south, main road to the east and fenced private farms to the east and north. The swamp and cemetery sites are areas that need to be conserved as required by the Planning Handbook.
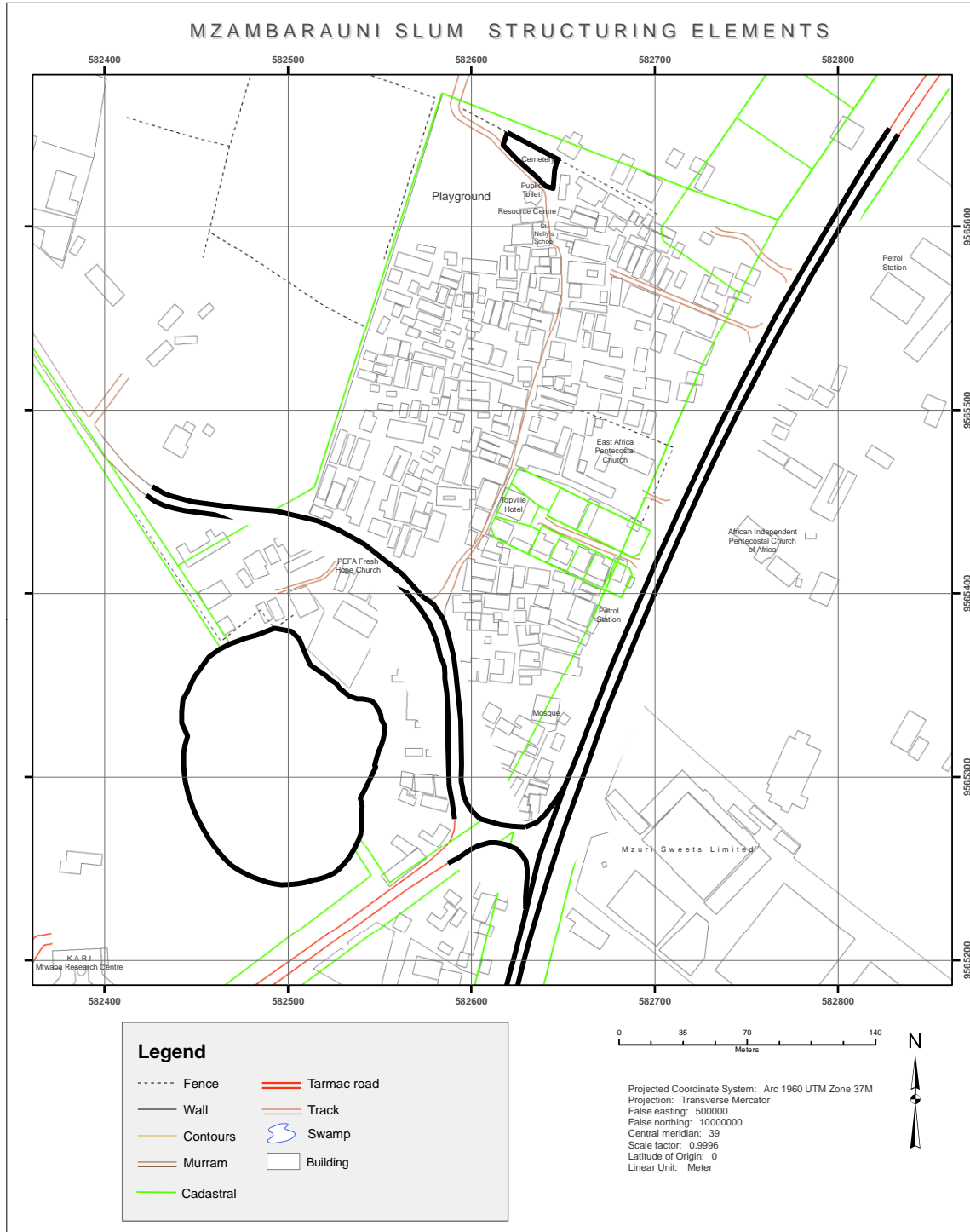

Figure 8: Structuring elements of Mzambarauni slum.

4.4.2. Existing land use

The existing land use of the slum is predominantly residential with commercial land use found along the main roads which is usually a very common trait for slums. The other land uses found within the settlement include public purpose and environment. The status of the structures in terms of their permanency was collected and added as attributes of the structures to enable visualization and also inform during drafting of the proposals.

It can also be noted that accessibility within the settlement is very poor as most structures have no direct access as seen from the image or as observed on the ground. The slum is mainly served by a track, which is virtually invisible as one enters the slum, that runs through the settlement from the south to the north. The maps below show the existing land use and the permanency status of the structures.
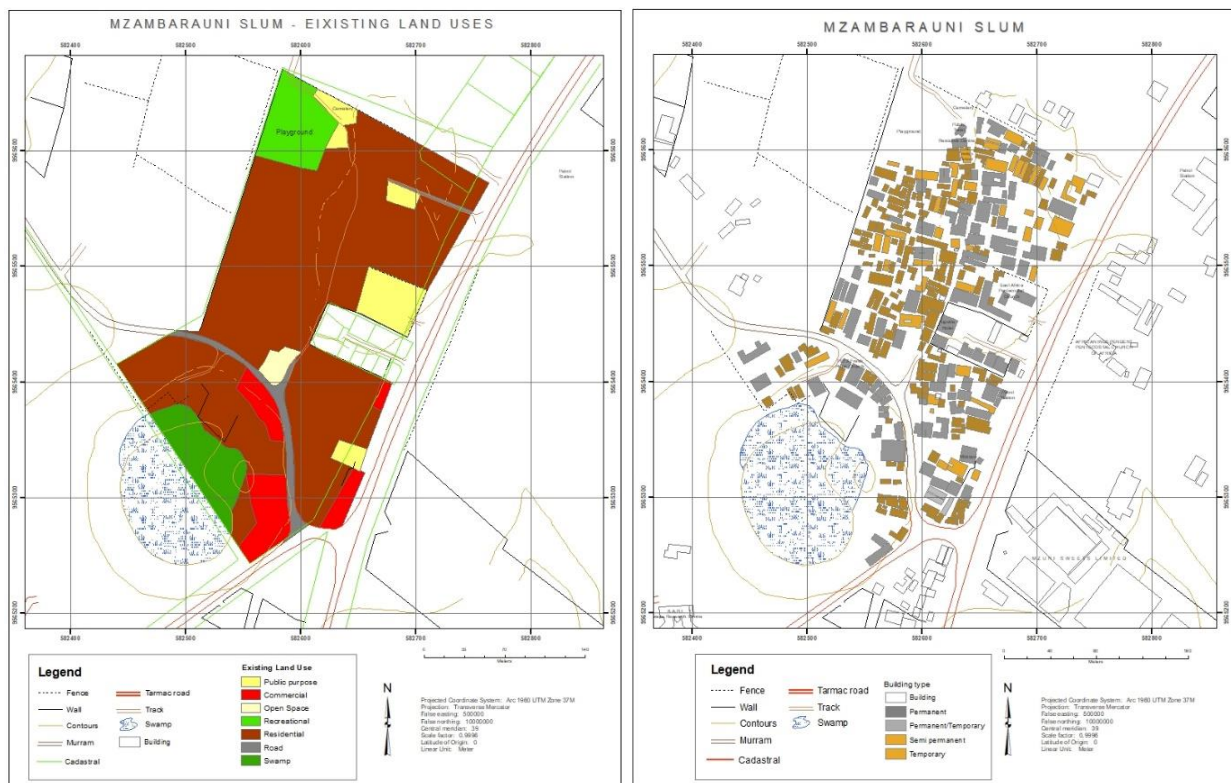

Figure 9: Map showing the existing land use and the status of the structures

The table below gives the percentage coverage of the existing land uses. These were determined during the ground truthing. It was observed that even though most of the slum is residential,

there are several informal traders within the settlement selling their wares outside their structure especially along the tracks within the settlement.

Table 6: Existing land use coverage

Existing land use	Area (m^2)	Percentage coverage
Public purpose	4,036	6%
Recreational	3,803	6%
Roads	1,945	3%
Conservation	3,875	6%
Residential	45,580	71%
Commercial	4,427	7%
Open space	661	1%
Totals	**64,327**	**100%**

4.4.3. Concept planning (blocking)

As discussed earlier, LR process is initiated by assembling all land rights within the area of interest and then subdivide after provision of prerequisite urban services. Once the unit was established, it was subdivided into smaller units called blocks to ease the process of drafting the proposals. Blocks were created leaving reserves for access roads and other urban services. This was done taking into consideration the character of the slum, for instance, which are the main tracks within the settlement, how are the structures distributed and how are the fragile areas going to be conserved. The structures' permanency status was key to making proposals especially where demolition or relocation of structures is involved.

The settlement was subdivided into 13 blocks which is as a result of the intent to provide access to the proposed land parcels and the existing structure of the settlement dictating areas where provision of access will not lead to demolition of many structures. three of the blocks are public purpose and environmental consisting of a playground, cemetery and a swampy area. The remaining 9 blocks are mainly residential with pockets of commercial, especially along the roads, informal schools and churches. The following map shows the proposed blocks for the settlement.
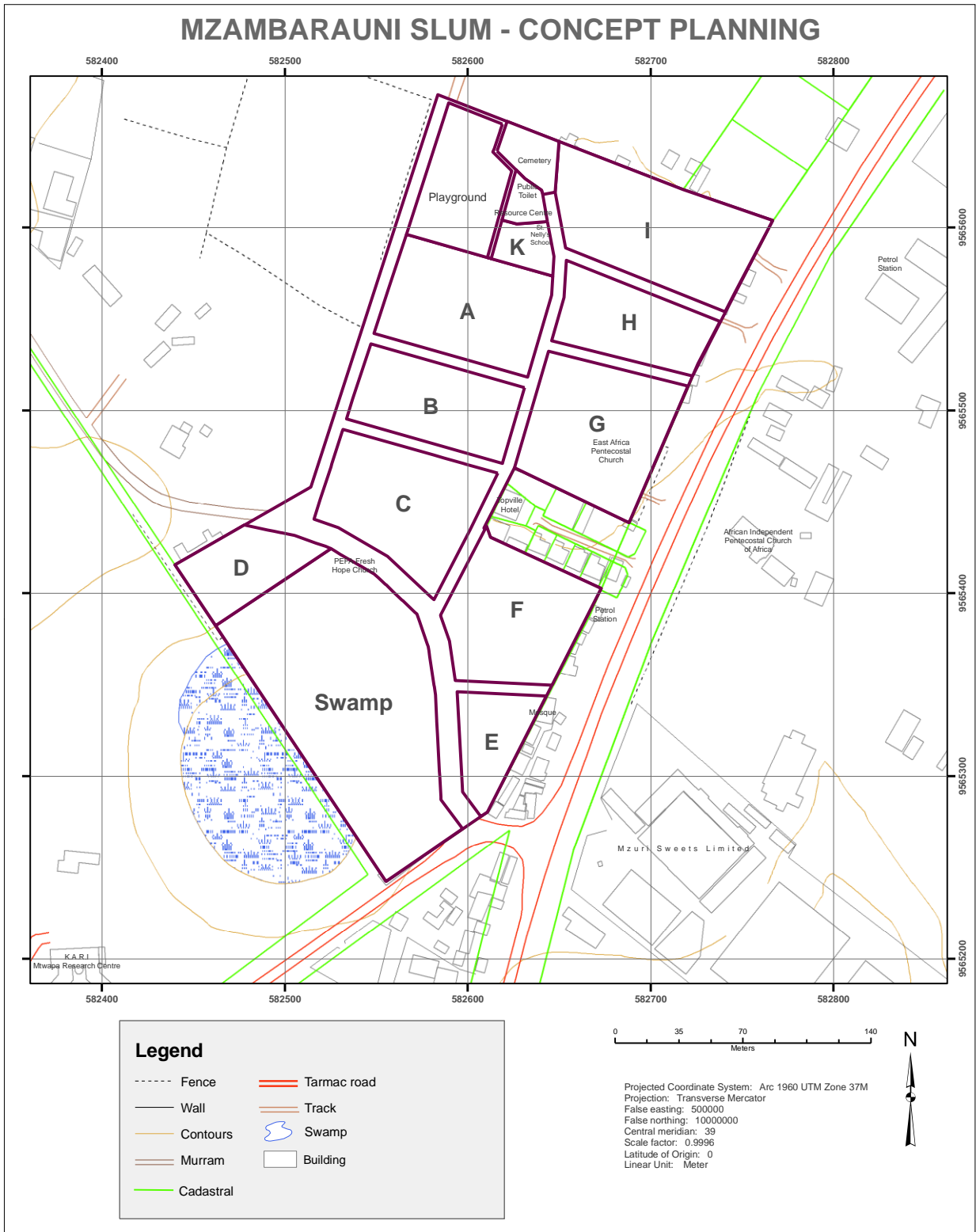
Figure 10: Concept planning (creation of blocks)

Analysis of each of the blocks was done to assist in the decision making when formulating the proposals. This included the areas of the blocks, number of structures and their average sizes in each of the blocks, since these need to be accommodated within the respective blocks. The analysis of these blocks is as summarized in the table below:

Table 7: Summary of the proposed blocks

Block ID	Area (m²)	No. of structures	Remarks
Block A	4,904	48	
Block B	3,804	40	
Block C	5,062	29	
Block D	2,321	8	
Block E	1,976	20	11 structures on road reserve
Block F	4,833	30	4 structures on road reserve
Block G	5,422	20	
Block H	3,214	16	
Block I	5,994	33	Partly subdivided
Block K	756	9	
Playground	3,262	0	
Cemetery	526	0	
Swampy area	12,805	33	Mostly commercial structures

4.4.4. Readjustment and reallocation process (planning)

The readjustment process was done block by block depending on the above analysis and their specific characteristics. The process was anchored on the Physical and Land Use Planning Act, 2019 and the provisions in the Physical Planning Handbook. The standards for slum upgrading as provided for in the handbook are as follows:

Table 8: Slum upgrading standards

Slum upgrading initiative		
Housing typology	**Minimum plot sizes (m²)**	**Maximum plot coverage**
Detached	223.2	50 %
Semi detached	148.8	65 %
Row housing	111.6	65 %

Source: Physical Planning Handbook

It was observed that each block had different characteristics which informed the drafting of the proposals. Block A was characterized by small temporary structures with a few large permanent structures that followed no order. Considering the total area of the block, the LR principle of proportionately readjustment based on the size of the structures and standards given in the planning handbook, the area would not be adequate for all the structures to be accommodated. Block title is thus proposed for the block and the structures were readjusted following plot partitions created after making provisions for 4m accesses to each plot partitions. Some structures have been considered for more than one plot due to their original large sizes.
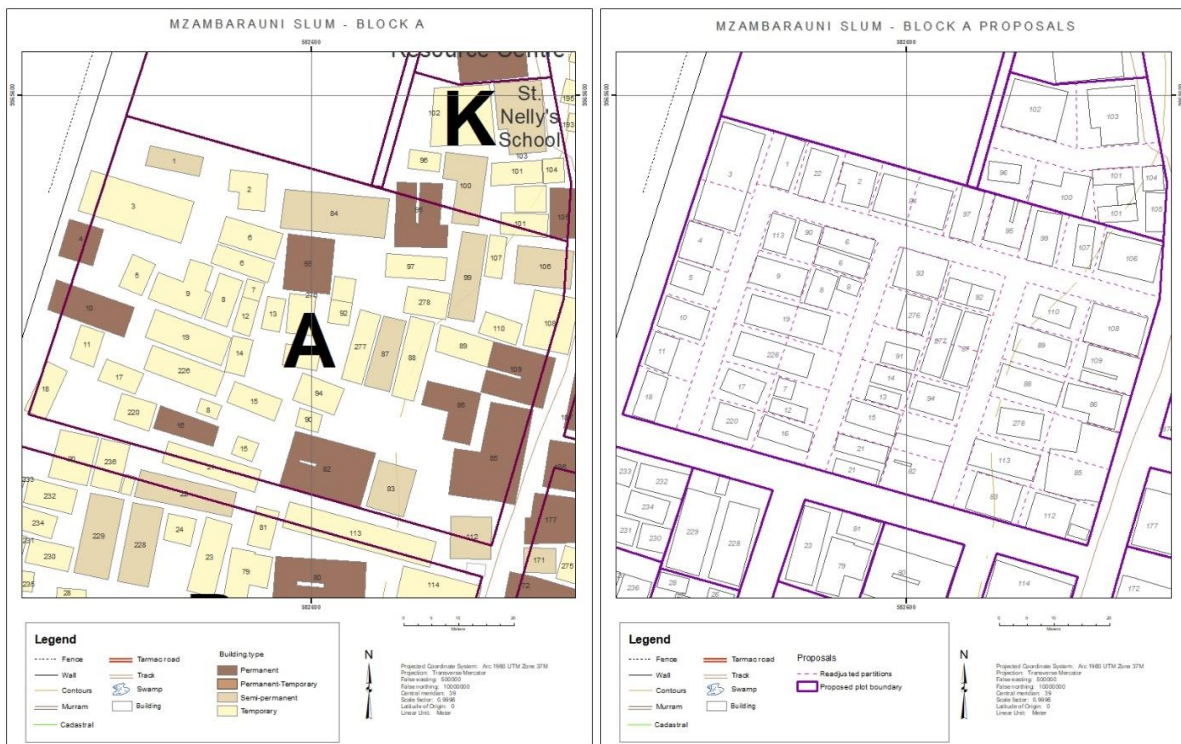

Figure 11: Block A existing situation and the proposals maps

Although block B has a high number of structures almost similar to block A, there are several large structures that led to the consideration of shared plot titles which were planned providing 6m access to each of the plots. The structures were readjusted to fit within the plots based on their location, sizes and permanency status.
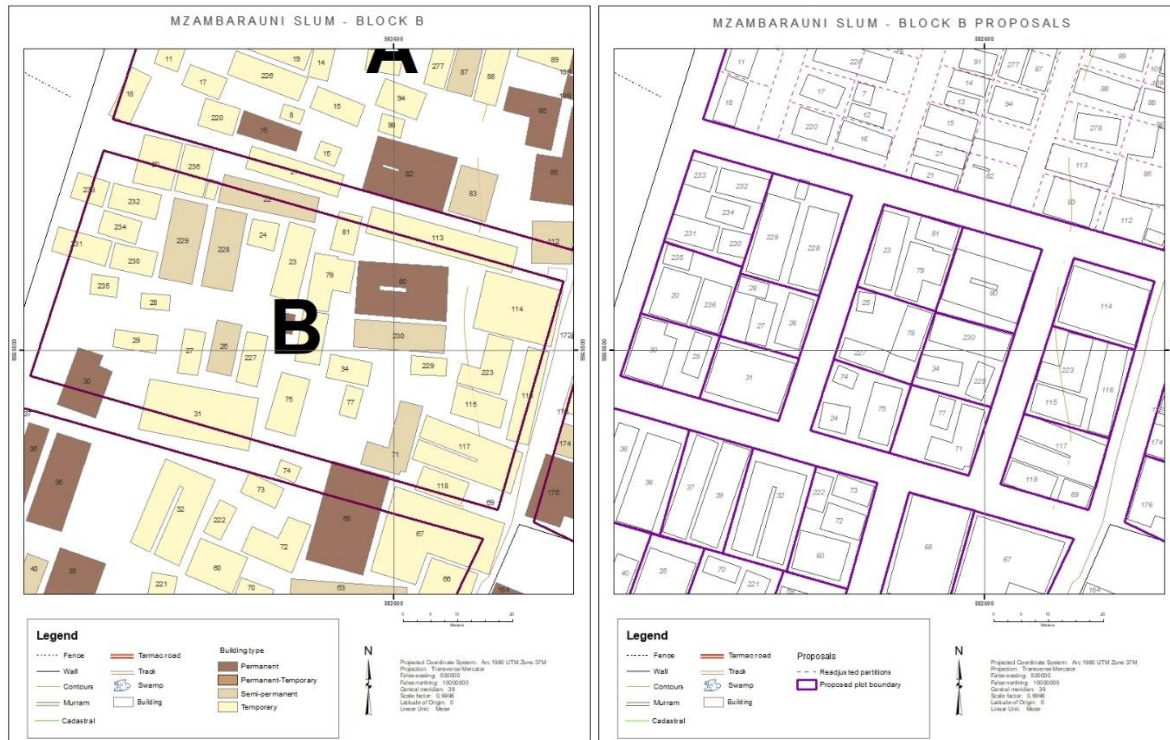
Figure 12: Block B existing situation and the proposals maps

Block C predominantly has large structures which hosted both businesses and rental rooms. The proposals tried to ensure minimal relocation of the structures except for areas earmarked for access and services. The plots along the main road to Mtepeni are proposed for residential cum commercial so that there is continuity of existing commercial activities. Most of the structures along the road in this block are row housing with businesses on the last rooms along the road. These structures were also very large as compared to many of the other blocks.

In the proposals for the block, plots were created avoiding destruction of many of these structures. Since most of the structures were oriented in almost similar direction, the plots were also proposed in the same orientation. Structures that fell on proposed road reserves Readjustment of structures affected either by the proposed plots or road reserves was done to ensure conformity with the proposed boundaries. Some of the structures are proposed to share plots so that they conform to the planning standards as stipulated for plot sizes.

Figure 13: Block C existing situation and the proposals maps

The swamp area is proposed for conservation and the total area was determined by the contour lines which clearly illustrates the topography of the area. It was noted that 33 structures were on the area earmarked for conservation. Block D next to the swamp is mainly proposed for residential dwellings. The best alternative for this is to have social housing that would accommodate the displaced structures in the area proposed for conservation. This can be considered for the block D or Block A where flats for affordable housing can be developed to accommodate more of the residents. The other alternative is to identify alternative land to where the displaced structures can be resettled.
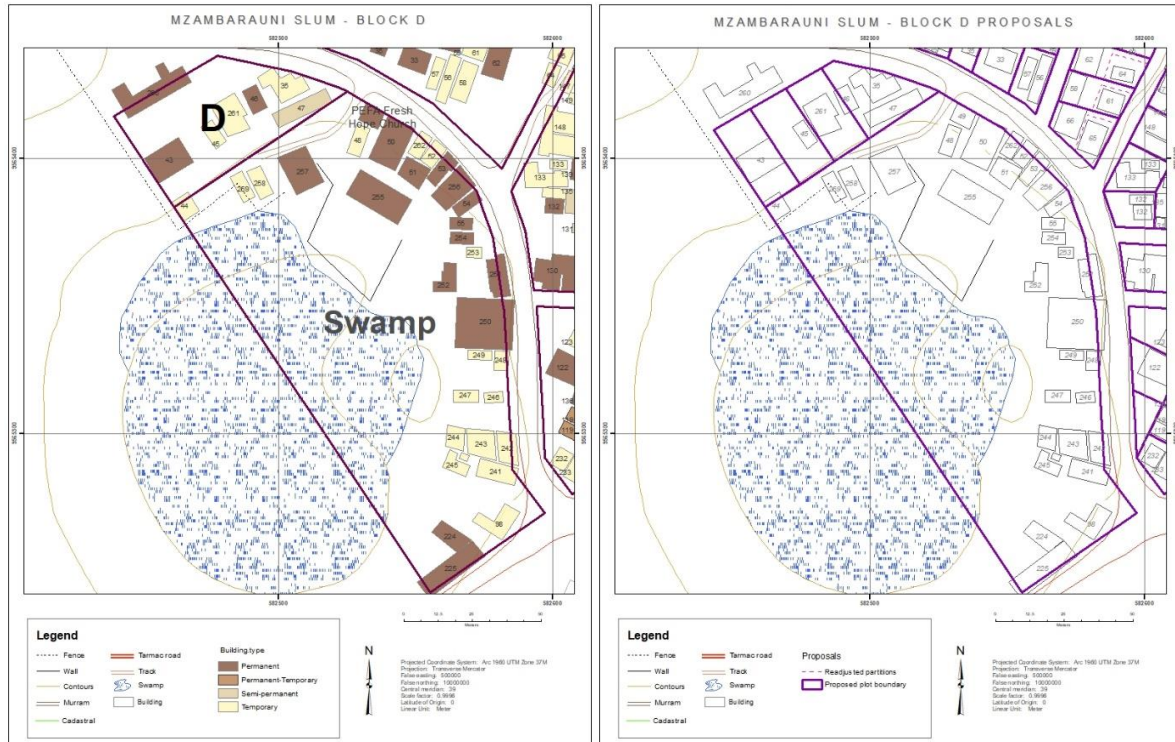
Figure 14: Block D existing situation and the proposals maps

Blocks E and F had 13 structures which fell on road reserve when the cadastral layer was overlaid on the map. Most of these structures hosted businesses which were extensions of the main structures. Due to the existing land size, it is difficult to accommodate these structures within the block, hence it is proposed that these structures be accommodated in an alternative land or within the social housing scheme. The plots along the main highway are proposed for commercial cum residential for continuity of the existing business activities. The proposed plot boundaries tried to minimize relocation of the existing structures while providing access. This was done by accommodating as much as possible the permanent structures and creating boundaries along spaces between the structures. The provided access is of 6m as opposed to the 9m prescribed in the Physical Planning Handbook because land is inadequate and from the socio-economic review, most of the households in the slum depend on public transport and *'bodabodas',* thus treating this settlement as a special planning zone, 6m access roads have been proposed throughout the settlement. Block F abuts surveyed land that has been developed with permanent structures. The proposals prescribe back to back plots along the boundary as opposed to the road from the survey plans as this would create a lot of demolitions.

Figure 15: Blocks E and F existing situation and the proposals maps

Block G hosts a church which also has a school whose land is proposed to be maintained and the area designated as public purpose. The block is also characterized by large permanent structures dotted with a few small structures. It is proposed that the large structures have individual plots while the small structures share plots after provision of a 6m access. The orientation of the proposed plots follows the existing structures orientation to avoid demolitions. The access road between block H and I is proposed from the existing track which formed entry into the slum from the main road. Block H is also characterized by large structure hence it is proposed for individual and shared plots. For the shared plots, partitions were created to give guidance on the readjustment of the structures.

The maps below show the existing situation and the proposals for the two blocks.

Figure 16: Blocks G and H existing situation and the proposals maps

Block I has a concentration of row structures which are mainly rentals. The proposals were made to accommodate the structures the way they are whilst providing the necessary 6m access to each of the plots. The proposal is to revoke the existing subdivision and readjust it to accommodate the slums structures.

Figure 17: Block I existing situation and the proposals maps

Comparisons between the existing and the proposed land use coverage shows that the public purpose land use coverage remained at 6% and this is mainly due to the land size limitations, hence proposals maintained most of the existing public purpose land. Transportation had the highest positive change in term of coverage, from 3% to 19%, attributed to the fact that there existed no accesses within the slum. The Physical Planning Handbook and the PLUP Act indicated as a standard that all proposed plots must have access provided with the minimum at 9m. The proposal recommends 7m reserve for the main roads due to the requirements of other services that would be accommodated, and 6m for all other access provisions. Conservation area coverage also increased from 6% to 20% due to the conservation area of the swamp increasing to capture the high-water point. The residential percentage decreased as most of the settlement was initially predominantly covered by residential but after the proposals, the provision of urban services led to the decrease in residential areas.

The comparison of the existing and final proposals for the settlement are as shown in the table below and the figure below shows map for the final proposals.

Table 9: Existing and proposed land use coverage

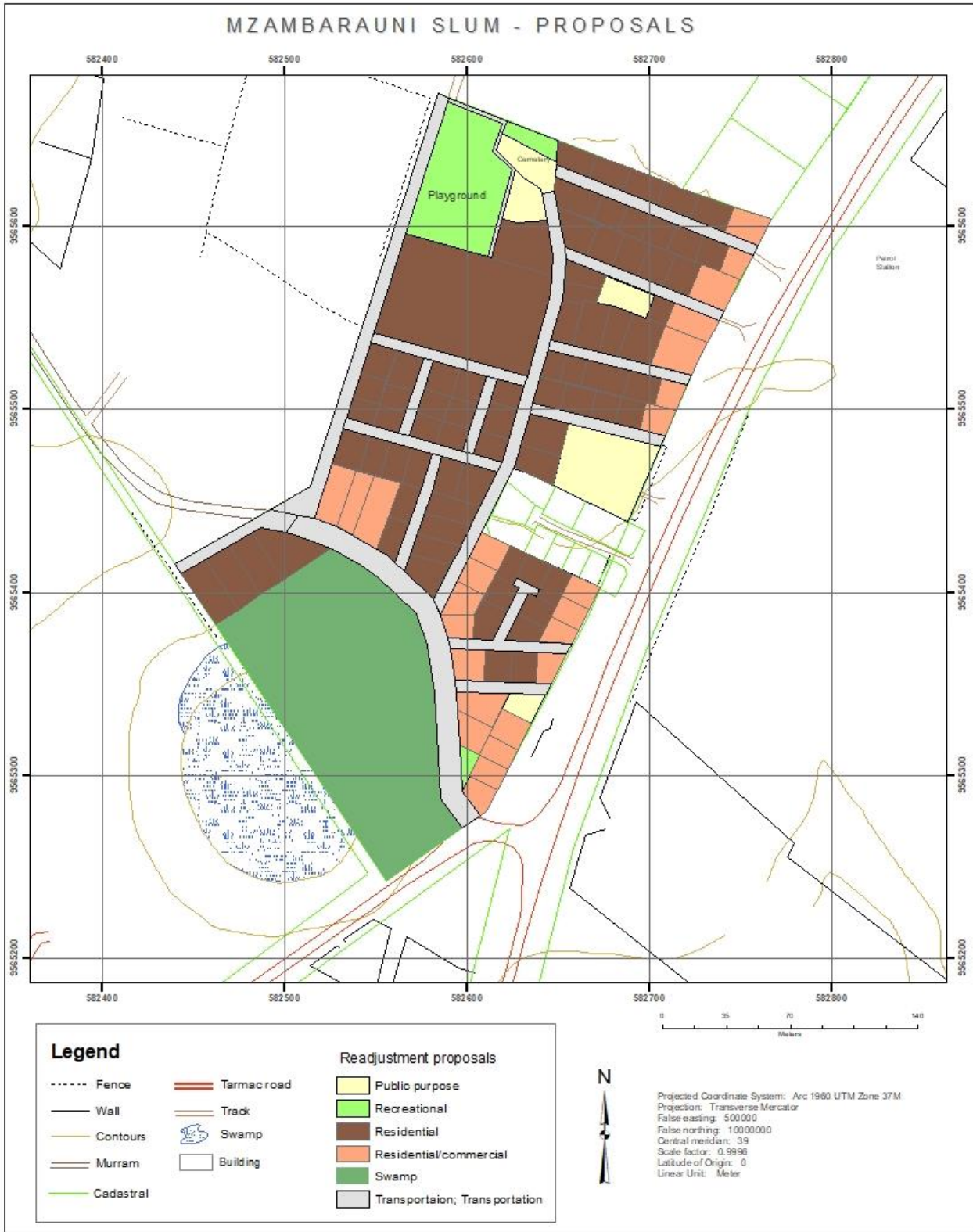|	Existing land uses		Proposed land uses	
Land use	**Area (m²)**	**Percentage coverage**	**Area (m²)**	**Percentage coverage**
Public purpose	4,036	6%	3,559	6%
Transportation	1,945	3%	11,882	19%
Conservation	3,875	6%	12,805	20%
Residential/commercial	4,427	7%	7,302	11%
Residential	45,580	71%	25,305	39%
Recreational	3,803	6%	3,474	5%
Open spaces	661	1%	0	0%
Totals	**64,327**	**100%**	**64,327**	**100%**

Figure 18: Final proposal map for Mzambarauni slum.

4.5. Discussion of results

During the readjustment process, one of the key principles was to minimize relocation and this is to maintain the social structure of the settlement while, reorganizing the land into more economically useful land. To evaluate the readjustment process on this particular aspect, an analysis was done on the existing structures and the proposed readjusted structures to gauge the amount of relocation. This was done through analyzing the centroids of the buildings before and after readjustment as shown in the map below.
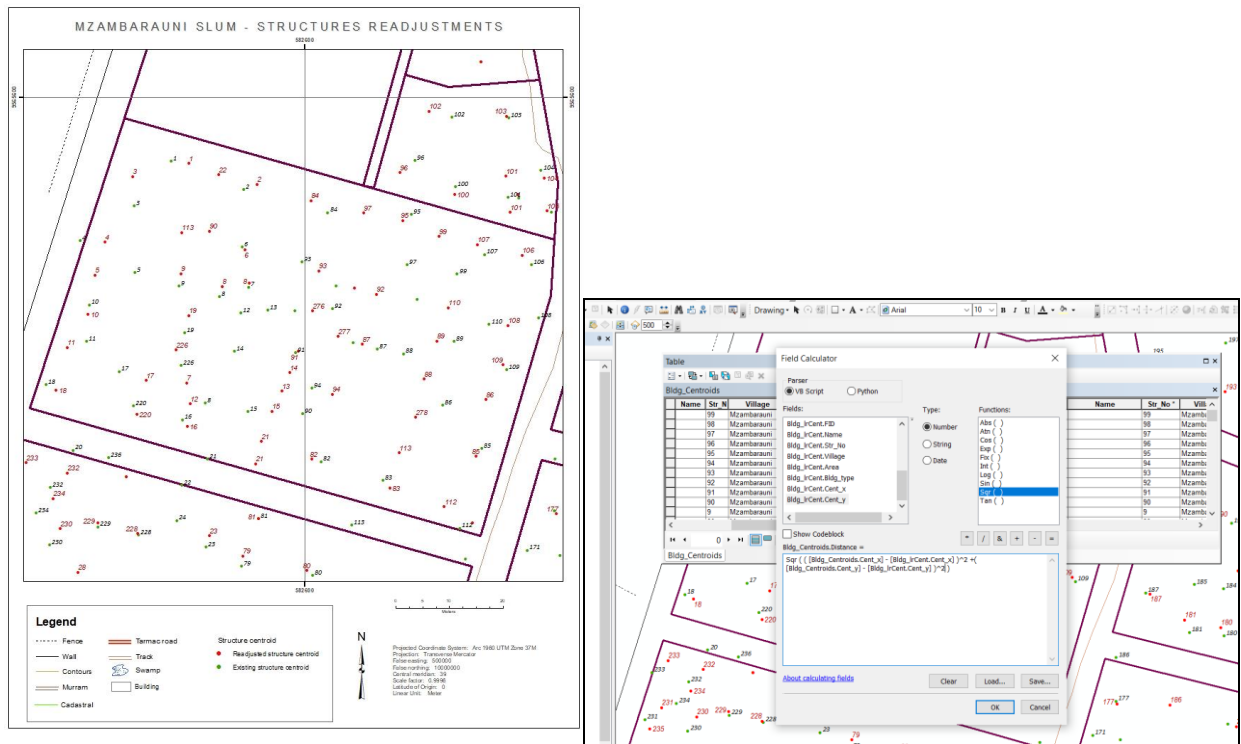

Figure 19: Dot map showing the structures before and after the readjustment process and computation of the distances

The distance between the pair of point for each of the structures was computed and the results were as shown in the table below:

Table 10: Relocation distance of the structures

Distance (m)	Number of structures affected	Percentage of the total
0	86	31%
1-5	122	44%
6-10	35	13%
Above 10	34	12%

It was observed that 86 structures were not affected in the readjustment. This was as a result of the structures which were accommodated in their current location since the structures' sizes were large enough for consideration to form individual parcels. There are also 30 structures which were built on the area earmarked for conservation at the swamp. 122 structures were identified for relocation by 1m to 5m and 35 structures by 6m to 10m. These were mainly structures that had to be relocated to provide for access and reserves for urban services. 34 structures were relocated by over 10m, of these 8 were relocated by over 30m. The main reason for this is because these structures were on road reserves and there were no available spaces of the created parcels nearby.

The fact that more than half of the structures have only relocated by less than 10m shows this approach to be more viable for slum upgrading initiative. The readjustment of the structures and provision of individual and shared parcels provides a balance on the interests of the slum upgrading interventions of plot ownership and achieving organized planned settlements that allow for urban services provision.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

A review of the land readjustment process revealed that LR can be applied in slum redevelopment. It attempts to minimize relocation and demolition while providing an alternative option for slum upgrading. The project has demonstrated that security of tenure can be achieved in slums through readjustment of structures within a planned setting. This provides a balance between plot ownership for the slum dwellers and achieving proper planning for the slums. Land readjustment can thus be concluded to be a powerful and economical approach to slum redevelopment. It could be preferable as it results in very minimal movements of the residents and reduces conflicts due to the proportional benefits as observed in the study. Owners with large structures would benefit from individual plots or more than one plot partitions, in the case of block titles, while small structure owners would share plots. This gives a sense of fairness in allocation of the plots, hence reduced conflict. It maintains the social aspect of the slum as it improves the living standards of the dwellers.

The project successfully showed that use of high-resolution imagery coupled with other datasets like cadastral information, feature attributes and socio-economic data provides critical information on the extent of slums, building footprint and slums character which gives an appreciation of the characteristics of slums. GIS provided a platform for integration of different data types, visualization, analysis and presentation of both spatial and non-spatial data which are key component in a slum redevelopment processes of appreciating the existing situation, extent of the settlement and further analysis during the readjustment and reallocation process.

The project also demonstrated that GIS plays a critical role in slum upgrading and its use greatly enhances decision making. The ability to manipulate data to create new datasets and information makes the application of GIS an efficient and effective tool in supporting decisions. Integration of non-spatial data like the permanency status of the structures enabled better visualization of the structures and their characteristics which greatly enhanced the decision-making process during concept planning and plot subdivision proposals. Utilization of GIS improved accuracy and reliability of the decision stemming from the information and datasets in the entire process from mapping to the drafting of the proposals, providing a strong basis for making recommendations. This approach would extensively enhance confidence of communities and other stakeholders in the redevelopment project.

Adequacy of land remains a big challenge in slum redevelopment initiatives given the high densities of people in the settlement in the slums and habitation of fragile areas by some dwellers, as revealed by the project. Alternative land or vertical development are the main approaches currently being employed to address this challenge. LR can be used to identify sites within the slums during redevelopment where social housing could be put up through governments or public-private partnerships.

The overall success of such initiatives will depend so much on the attitude of the structure owners towards accepting to surrender parts of their property for urban services and achieve regular planned areas.

5.2. Recommendations

GIS is being embraced by many in slum upgrading initiatives recently and, in this regard, it is recommended that automation of some of the aspects to reduce assumptions of biasness especially in developing of proposals. An automation tool in the GIS environment for LR that can determine placement of readjusted structures/parcels of land would greatly enhance accuracy and efficiency of approach by reducing human biasness. Communities and other stakeholders will own the process more if such can be achieved in all aspects of slum redevelopment.

It has been observed that the smallest allowable plot sizes are not suitable for slum redevelopment projects especially for high density slum areas with limited land. It is thus recommended that this can be reviewed considering the options that LR provides of readjusting property within blocks and ensuring provision of access and other urban services.

There is need for governments to embrace LR approach in slum redevelopment, using GIS as a tool for support, as an alternative to the conventional methods which have been met with resistance from some slum dwellers, due to interests mainly in land ownership. Regulations to accurately determine a share of the readjusted plots as per the shares surrendered for urban services need to be established. Automation in GIS environment would make such process more efficient and accurate if such policies were formulated. Consideration of the incorporation of private developers in such initiatives, thus reducing the initial capital for infrastructure improvement and provision of housing in such settlements, should be encouraged considering the observation of adequacy of land for resettlement. The Kenyan Government is currently implementing the Big Four agenda, of which one is affordable housing. Slum areas are mostly located in prime locations within the urban areas for such projects as the affordable housing

initiatives. Use of GIS techniques to map out and analyze the existing slums and their characteristics and the application of LR strategies could be used in identification of such sites especially within the larger urban areas. It is thus recommended that governments embrace more the use of such in tackling the challenge of slums and provision of housing.

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