University of Nairobi

School of Engineering

DEPARTMENT OF GEOSPATIAL AND SPACE TECHNOLOGY

Spatial Analysis of the extent to which Cadastral Survey Maps are updated in Kenya

(Case study of Rageng'ni Registration Section**)**

By

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Research Project submitted in partial fulfilment for the Degree of Master of Science in Geographic Information Systems, in the Department of Geospatial and Space Technology of the University of Nairobi

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Declaration of originality

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Dedication

I dedicate this project to my wife Winnie, our daughters Mary, Blessings and Joy as well as my parents; Mr. Apollo Odera and Mrs. Mary Odera.

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First, I thank God for His protection and good health during this project from the beginning to the completion of the project. I also would like to acknowledge my supervisor, Mr. Ben M. Okumu for his invaluable support throughout the completion of the project. His guidance and positive criticism in every stage of this project was of very much help to me.

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Abstract

This study is based on the analysis of extent to which cadastral maps are updated in Kenya (A case study of Ragengni Registration section). The study objectives were; to analyze the extent to which the Cadastral Survey maps are updated in Kenya, to review how cadastral survey maps are updated in Kenya, to compare the boundary lines from Preliminary Index Diagrams and the boundaries on the imagery and to investigate the extent of the updates.

To achieve the above **objectives** both primary and secondary data were used. Secondary data which included two Preliminary Index Diagrams (P.I.Ds) consisting of 126 parcels of land and registered mutation forms were obtained from Ministry of Lands (Siaya County office). Satellite imagery for the study area was obtained from *s*asplanet *(sasplanet.Nightly.171130.9738.link)*. Other secondary data included published reports, land policy documents and land legislations. Primary data included point data collected using GNSS Equipment.

The **methodology** consisted of initial planning, data identification and collection, data processing which mainly involved image mosaicking of downloaded tiles to form a single image. The second part of data processing included georeferencing of both the image and the PIDs using location coordinates picked using the GNSS Equipment. The georeferenced PIDs were then overlaid on the satellite imagery and analysis carried out.

On the **results**, this research has established that out of the total area of study, 25.15 Hectares, the extent successfully updated on the cadastral map covers an area of 9.655 hectares. This translates to 19.32% of the total area fully updated on the map. 80.68% of the area of study has no evidence of updates.

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Abbreviations and Acronyms

PID – Preliminary Index Diagram

JPEG – Joint Photographic Expert Group

Ha – Hectare

RIM – Registry Index Maps

1. INTRODUCTION

1.1 Definition of a Cadastral Map

Cadastral maps contain the descriptions of the boundaries of land parcels. The main objective of cadastral survey map is to show property boundaries in support of Land registration.

According to Mulaku (1995) key characteristics of a good cadastral map include; aids in land parcel identification, parcel indexing, determination of areas of land parcels, relocation of boundaries, parcel subdivision, land management, equitable valuation and property assessment, land planning and facilities management.

In Land registration, various types of cadastral maps are usually used in support the registration. The most popular survey maps are the cadastral survey plans for fixed boundary areas and the Registry Index Maps for rural areas. Other types of cadastral survey maps used to support land registration are the Preliminary Index Diagrams (P.I.D.s) (Siriba, 2011).

This project will focus on Preliminary Index Diagrams as the main land registration supporting document under this case study.

1.1.1 Cadastral Survey Plans

Cadastral survey plans are used in land registration to show the boundary information of surveyed land parcels and the adjoining parcels. The observations made like distances, bearings and coordinate values are also indicated. The cadastral survey plans are compiled from ground survey data of fixed surveys. The use of accurate survey instruments is required.

1.1.2 The Registry Index Maps (RIMs)

The Registry Index Maps (RIM) are prepared for the first registration as they are the main cadastral map for the land. They are used to serve the following purposes; to identify the ground for the parcel of land shown on the register, it assists in relocating boundary of given parcels of lands, ass a reference document to facilitate the subdivision of land and to help in area calculation of parcels of land.

1.1.3 Preliminary Index Diagrams

Preliminary Index Diagrams (PIDs) are the tracings of land parcels images from enlarged un-rectified aerial photographs which served as interim cadastral maps in support of rapid land titling (Nyadimo, 2006). According to Onulo and Kaland (2006), Preliminary index diagram can also be defined as a land

parcel index map traced from unrectified enlarged aerial photographs. They were used in many developing countries including Kenya temporarily to speed up land registration pending preparation of more accurate documents.

The concept of general boundaries in land registration was initially introduced in Kenya through the Native Lands Registration Ordinance in 1959. (Wayumba, 2018). The concept was later adopted to demarcate the boundaries of the newly adjudicated land parcels. Preliminary Index Diagrams are the main documents used to support the registration of this boundary type.

P.I.Ds have been used in Kenya for nearly 50 years to support land registration. In general boundaries areas, physical features are used describe the boundaries and usually surveyed using less accurate survey methods. The Preliminary Index Diagrams and Registry Index Maps are therefore produced as the resultant maps to be used to support land registration and titling.

During production of P.I.Ds, the aerial photographs were taken at a scale of 1:12,500 or 25 000 and the photographs were further enlarged four time to a scale of 1:2,500. The PIDs were the tracings of the adjudicated land parcels from the unrectified aerial photographs which served as interim cadastral maps that were used to support rapid titling. The Preliminary Index Maps have remained as the main base for the registration of adjudicated land parcels in the rural areas of Kenya.

1.2 History of Land Registration

After Kenyan independence, one of the main land reform programs was land adjudication. The process was initiated to produce land titles to the Kenyan people by formally registering the rights of indigenous people to land (Siriba, 2011). Land adjudication was carried out in the high agricultural potential areas and the group ranches.

Land Adjudication process in Kenya is based on the Land Adjudication Act chapter 284 of the Laws of Kenya. The process begins by the Cabinet Secretary for Lands declaring land area be adjudicated. The Cabinet Secretary then appoints an adjudication officer to steer the process.

In Kenya, a formal land registration system consists of information of boundary and a cadastral map that supports the registration of parcels of land. Kenya has two main forms of cadastral boundary systems. These are general and fixed boundary systems (Odera, 2015). The high increase in population has led to an increase in demand for individual land ownership in Kenya. Land continue to be subdivided to

smaller units. This situation demands the frequent updating of cadastral maps to accurately depict land parcel boundaries on the ground.

This study aims to analyse the spatial extent to which the Cadastral maps are updated in Kenya, a case study of Rageng'ni Registration Section. Using spatial analysis techniques and case study methodology techniques, the aim is to determine the extent to which cadastral maps are updated and to explain why and how the maps are updated. This will help to advice on policy for better land administration and management

1.3 Problem Statement

Land adjudication was carried out in the high agricultural potential areas and the group ranches. In Rageng'ni Registration section, Land adjudication was carried out between years 1971-1974. The Preliminary Index Diagrams were finally produced in 1975 (Survey of Kenya) to support in the registration of individual interests in Land.

The high increase in population has led to an increase in demand for individual land ownership in Kenya. Land continue to be subdivided to smaller units. This situation demands the frequent updating of cadastral maps to accurately depict land parcel boundaries on the ground.

In the area of study land owners continue to carry out parcelations during succession. Visible delineations marking the extent of interests in land (locally known as 'kiewo') are visible on the ground. "*Kiewo*" which literally means the boundary or the position of the extents of interests on land (in traditional context) is frequently used during transactions to mark the extents of land parcels.

This research therefore raises questions on whether the parcellations witnessed on the ground are updated on the cadastral maps. The extent to which these parcellations are carried out continue to worry. This research therefore aims to investigate the extent to which these parcellations are updated on cadastral maps hence the analyzing the extent to which cadastral maps are updated in Kenya with a case study of Rageng'ni Registration section.

1.4 Main Objective

1.4.1 Main Objective

To analyze the extent to which the Cadastral Survey maps are updated in Kenya (case study of Rageng'ni Registration)

1.4.2 Specific Objectives

i) To review the procedures for updating cadastral survey maps in Kenya (case study of Rageng'ni Registration)

ii) To compare the boundary lines on Preliminary Index Diagrams and the visible demarcations on the satellite imagery

iii) To investigate the extent of the parcellations that are updated on the cadastral maps.

1.5 Justification for the Study

During the last few decades, the demand for the individual land ownership in Kenya has rapidly increased due to increasing population. Consequently, there has been an increase in land parcellations into smaller units. Existing Land registration supporting documents have shown frequent amendments on the Preliminary Index Diagrams to support this.

Due to the high rate of land parcellations around the area of study (Rageng'ni Registration Section) and the multiple benefits of an updated survey map, there is need to investigate the extent to which parcellations are updated on cadastral survey maps in Kenya. A well updated survey map ensures the security tenure, access to credit, a proper land use planning and an overall sustainable development.

1.6 Scope of work

This study involves the use satellite imagery to compare the visible demarcations with the boundary lines existing land registration documents, Preliminary Index Diagrams (P.I.Ds) and certified copies of registered mutation forms used for amendments in the area of study will be used as an additional information on P.I.Ds. The research project has singled out two Preliminary Index Diagrams (Diagrams 17 and 21) that will be used for analysis. The parts selected from the two P.I.D.s constitute a total of 126 parcels and an area of 499 719.595 m^2

The Preliminary Index Diagrams covering Rageng'ni registration section, produced in 1975 were created from an enlarged unrectified aerial photograph which were taken at a scale of 1:12 500 and later enlarged four times to a scale of 1:2 500.

Satellite imagery will help in identifying physical demarcations, analyze the parcellations and to help in comparing boundaries on Preliminary Index Diagrams and the satellite imagery. The GNSS Equipment will be used to pick the boundaries of few land parcels in the study area. These points will then be used

in orientation of both the P.I.Ds and the satellite imagery. The main software to be used in this study are; ArcMap (version 10.5) and Global Mapper (Version 8). Main sources of data for this study will be obtained from the ministry of Land, Siaya County office, Sasplanet (sasplanet.Nightly.171130.9738.link) and ground survey (coordinate picking from GNSS equipment (Pentax G5 Series). Other sources will be old publications.

1.7 Research Matrix

Table 1: Research matrix developed to provide research milestones and directions

No	Research Objective	Research Questions	Data Requirements	Methods/Procedures	Possible Outcomes
1	To review the procedures for updating cadastral survey maps in Kenya	What are the steps in updating cadastral maps?		Data Review	-A procedure outlining the processes of updating cadastral maps
2	To compare the boundary lines on Preliminary Index Diagrams and the visible demarcations on the satellite imagery	-Which methods can be used to compare the satellite imagery and P.I.Ds?	-Satellite Imagery -P.I.D.s - Certified mutation forms - Parcel corner coordinates	Data overlay Statistical comparison of P.IDs and Satellite imagery	-A map showing the extent of the updates.
3	To investigate the extent of the parcellations that are updated on the cadastral maps	What are the percentage areas covered by the updates?	-Satellite Imagery,P.I.D.s, Certified mutation forms, Parcel corner coordinates	Data analysis	Map showing the extents of updates and parcellations

1.8 Project Outline

This project is discussed under five main chapters. Chapter one provides an overall introduction to the project. The remaining four chapters are described as follows.

Chapter two will provide a literature review on the analysis of the extent to which cadastral maps are updated in Kenya. The literature review will begin by covering various types of cadastral maps used for land registration in Kenya, such as: Preliminary Index Diagrams, Registry Index Maps and Cadastral Survey Plans. The second part will discuss the usefulness of high resolution satellite imagery on aiding analysis in Surveying and Mapping. The other topics to be reviewed include; Land registration in Kenya, Land Adjudication, the role of land boards and Land subdivision process. The last part of this chapter will outline the process of updating cadastral maps in Kenya.

Chapter three will describe the methodology that was used to achieve the objectives of this research. The first part will provide a flow chart diagram of the methodology. The second part will provide detail on data sources, implementation, planning, data collection methods, data processing techniques and data analysis. The last part will briefly discuss the results.

Chapter four will show the results of the second and third specific objectives by providing maps and statistical summaries to illustrate on the extent of map updates. The first part of this chapter will show the results of importation of scanned PID into ArcMap Software, georeferencing and digitizing. The second and the last part of this chapter will compare the boundaries on PIDs and the satellite imageries, show spatial extents of the updates, also show the results of parcellations and the statistical summary of the map updates.

Chapter five will provide conclusions and Recommendations for this project.

2. LITEREATURE REVIEW

2.1 Introduction

This chapter will discuss literature review on procedures for updating cadastral maps in Kenya, various types of maps used to support land registration, importance of high resolution imagery on cadastral mapping and surveying, land registration in Kenya, land adjudication and the process of adjudication in Kenya, the importance of land control boards in regulation regulating land subdivisions and other transactions, the process of land subdivision under the general boundary systems and the amendment of Preliminary Index Diagrams.

2.2 Cadastral Survey Maps

Land registration in Kenya is supported by the following types of maps; Preliminary Index Diagrams (mostly covers rural areas categorized as agricultural zones), the survey plans (mainly used for regions covered by Fixed Boundary system especially urban areas) and Registry index maps (RIMs).

2.2.1 Preliminary Index Diagrams

Preliminary Index Diagram is a cadastral map produced through making direct tracing of land parcel boundaries as shown on an enlarged, unrectified aerial photograph. The aim of Preliminary Index Diagram was to serve as interim cadastral map in support of rapid land registration and titling while pending production of more accurate documents (Ondulo, 2006). The use of Preliminary Index Diagrams in Kenya resulted in the land registration and successful titling of agricultural lands.

The aerial photographs were enlarged four times to a scale of 1:2500 to facilitate the production of representative diagrams of the parcels on transparent paper. The resultant maps were preliminary diagrams and were then referred to as Preliminary Index Diagrams (PIDs because the photographs used in their production were unrectified.

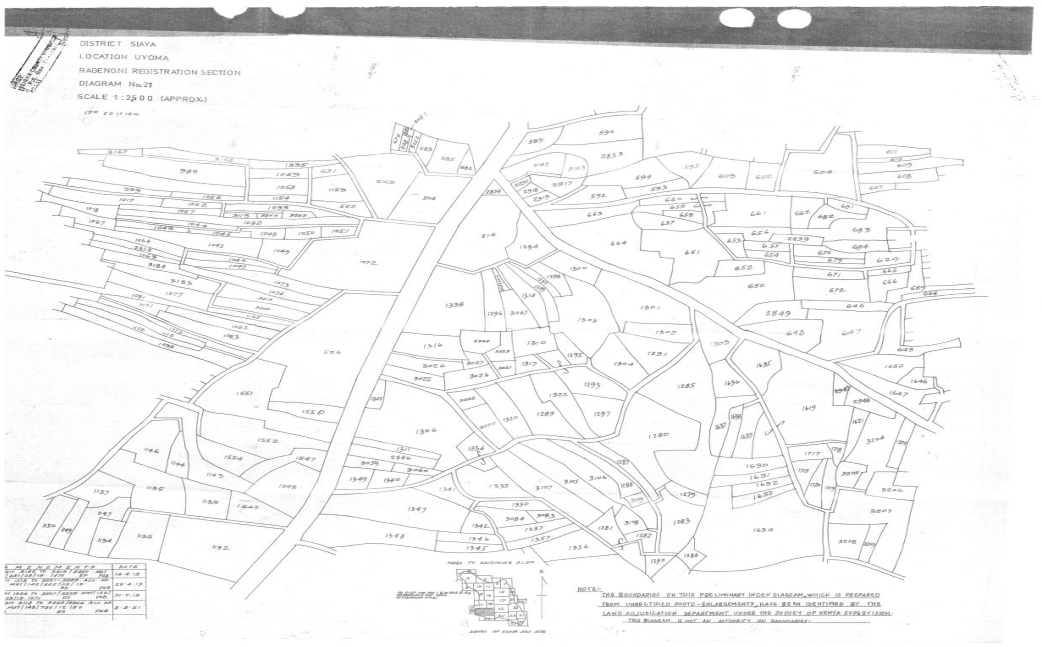


Figure 2. 1 *Preliminary Index Diagram showing part of study area*

2.2.2 The Registry Index Maps (RIMs)

The Registry Index Maps (RIM) are prepared for the first registration as they are the main cadastral map for the land. They are used to serve the following purposes;

i) To identify the ground for the parcel of land shown on the register.
ii) It assists in relocating boundary of given parcels of lands.
iii) As a reference document to facilitate the subdivision of land.
iv) To help in area calculation of parcels of land

2.2.3 Cadastral Survey Plans

Cadastral survey plans are used in land registration to show the boundary information of surveyed land parcels and the adjoining parcels. The observations made like distances, bearings and coordinate values are also indicated. The cadastral survey plans are compiled from ground survey data of fixed surveys. The use of accurate survey instruments is required.

2.3 High Resolution Satellite Imagery

High resolution satellite imagery has proved to be very useful for cadastral surveying and Mapping in improvement PID. High spatial resolution space images are often available as geo-referenced rectified images rather than original. High resolution satellite imagery provides clearest visual distinction of

boundaries for digitizing and it becomes possible to determine distances and areas of parcels of land. **SAS.Planet** is an application program designed to enable viewing and downloading of high resolution satellite imageries. It also enables download of maps generated by such services as; VirtualEarth, Bing Maps, DigitalGlobe, Goggle Maps. Navitel maps etc.

2.4 Land Registration in Kenya

Land registration is a process of officially recording of interests and rights in land through either deeds or as title on land properties (Henssen, 1995). Land registration and cadastral maps complement and operate as interactively. It involves registration of an individual as the proprietor of land. The process confers the absolute ownership of that land with all its rights and privileges (Njuki, 2001).

2.5 The land adjudication in Kenya

In Kenya, the mapping and registration of rural lands was conceptualized as a government project to have lands under African customary ownership registered and this was accordance with the Registration Land Act.

2.6 Land Control Boards

In Kenya, Land Control Boards regulate Land subdivisions and other transactions in adjudication areas (Wayumba 2014).

2.7 The Process of Land Adjudication in Kenya

1. The process begins by the Cabinet Sectary for Lands appointing Land Adjudication officer to be in charge of land adjudication in an area.

2. Adjudication Officer further appoints the officers in Charge of Demarcation, Land Survey Officer and Records Officer to assist in demarcating, surveying and recoding interests within an adjudication section.

3. Adjudication officer declares the area as an adjudication section. The local community are sensitized on the implementation of the program.

4. Ministry of Lands (through the Adjudication Department) prepares a District “Stick-up Map” to help in identification of the approximate position of the adjudication section.

5. A six months period is fixed by the Adjudication Officer for receiving claims.

6. After demarcation, recording and surveying processes have been completed and all cases also heard, the Adjudication Officer sends the Adjudication register to the Director of Land Adjudication

7. A 60 days window is given for any objection (in writing) to the Adjudication. During this period, the Adjudication officer hears and.

8. Any person aggrieved by decisions of the Land Adjudication Officer can appeal to the Cabinet Secretary for lands.

9. After all the objections have been determined, the original adjudication register and the maps are forwarded to the Director of Surveys for printing and computation of acreage.

10. The Director of Land Adjudication signs the certificate of finality and sends the original register to the Chief Land Registrar for registration

The process of Subdivision under General Boundary systems

1. The Land owner requests for subdivision of the land parcel, the request is either verbal or through formal writing.

2. A Registered Physical Planner prepares a subdivision scheme plan

3. Physical Planner applies to the County Physical Planner for the approval of the subdivision scheme plan.

4. County Physical Planner approves the subdivision sends back the document to the Local Authority with his recommendations.

5. Local authority circulates the application to relevant offices for comments.

6. Scheme Plan is approved with conditions attached; Form PPA2 is signed and sent to the Planner.

7. The Planner then submits documents to the Land Control Board for consent of subdivision.

8. A Surveyor carries out a comprehensive survey on the ground and places all beacons.

9. Survey is submitted to the District Surveyor, complete with mutation forms, for checking and amendments of PIDs.

10. The County Physical Planner issues the Certificate of compliance if satisfied that the survey is according to the approved scheme.

11. The District Land Registrar is then furnished with the Land Control Board consent, Form PPA2, Form PPA5 and a copy of the approved subdivision scheme plan.

12. Once the PID has been amended, the Surveyor pays the checking fees and amended PID is forwarded to the District Land Registrar for issuance of Title Deeds

2.8 Amendment of Preliminary Index Diagrams

During land subdivision, cadastral maps are subjected to amendments in order to update the proposed subdivisions the P.I.D.s. The Process of Amending P.I.D.s include;

i) Surveyor after completing the ground survey submits 3 sets of fully compiled mutation forms to the district surveyor for checking.

ii) District surveyor checks the mutation forms for compliance with the survey regulations and standards.

iii) The District surveyor then issues new plot numbers for the proposed plots.

iv) One mutation form is forwarded to the amendment section to be used for amending the P.I.Ds

Chapter summary

This chapter has reviewed some of the literature on analysis of the extent to which cadastral maps are updated in Kenya. It has outlined various procedures for amending cadastral maps in Kenya.

The next chapter will discuss the methodology with which the main research objective and specific objectives of this project were answered.

3. METHODOLOGY

3.1 Area of study

The study area is located in Rarieda Sub-County, Rageng'ni Registration Section (figure 3.1). Rageng'ni is located in the Western Kenya, Siaya County in Kenya. The study area was chosen for its data availability and familiarity with the area of study. Preliminary Index Diagrams (P.I.Ds), at a scale of 1:2500 that covers the area are available. The satellite imagery of good quality is also available. Ragengni is in a rural set up and is covered by the general boundary system. The cadastral survey maps covering this area are mainly Preliminary Index Diagrams which are not so accurate and were created using unrectified aerial photographs which were enlarged to a scale of 1/2500.

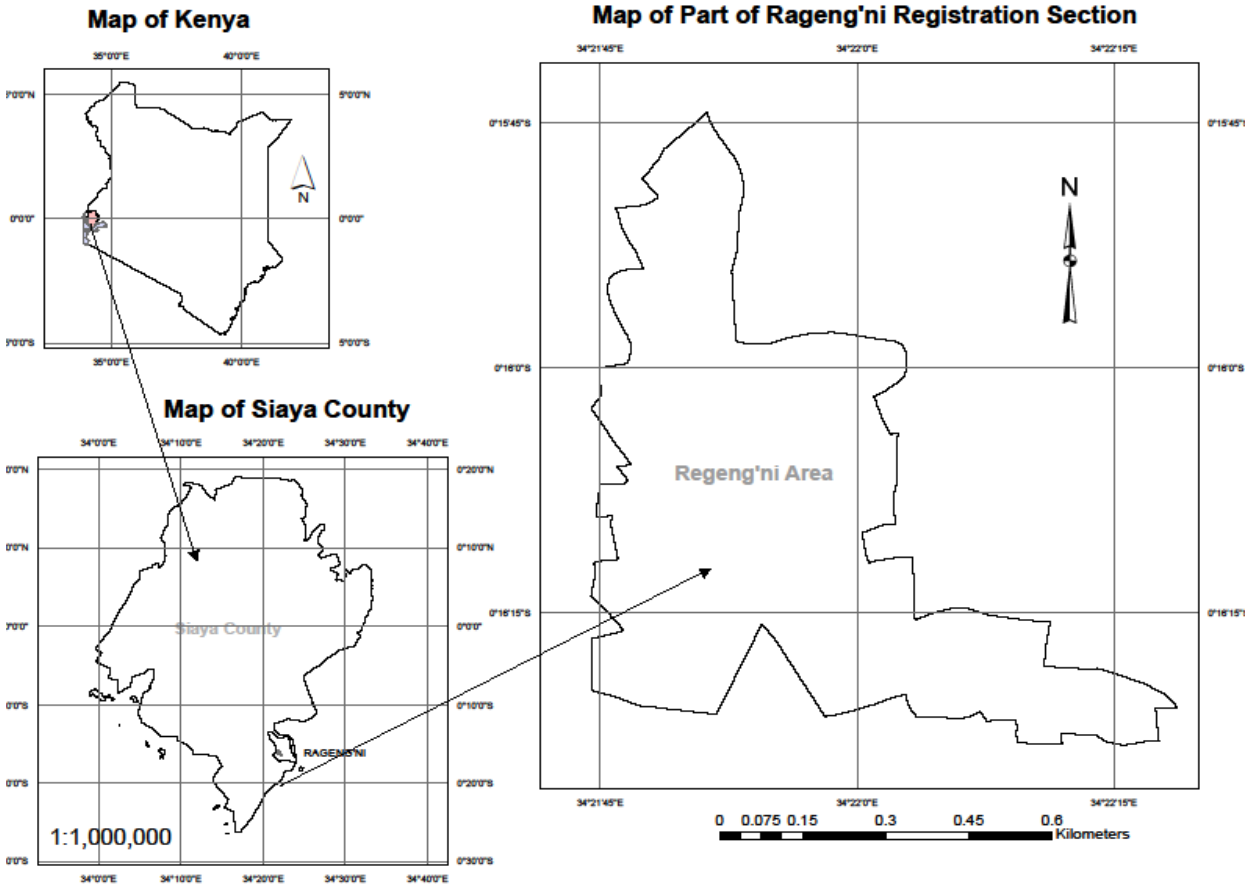


Figure 3. 1 *Map of the Study Area*

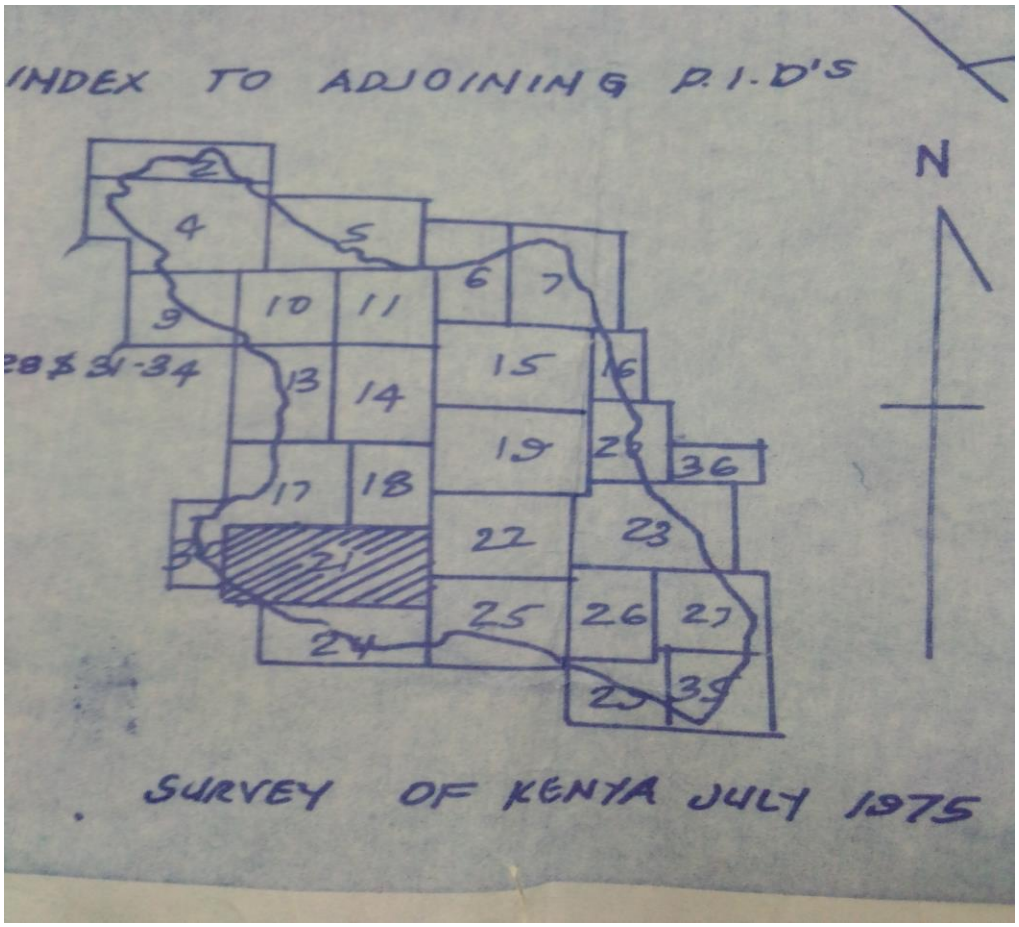


Figure 3. 2 *Ragengni Registration Section*

The study proposed a conceptual flow –diagram chart (*Figure 4*) to analyze field data to determine their suitability. The overall research approach was mainly focused on the comparison of different datasets from which the P.I.Ds. The main assumption of the study is that the physical demarcations on the ground form part of land parcellations and land subdivisions. The assumption also forms the basis of the analysis.

3.2 The methodology flow chart diagram

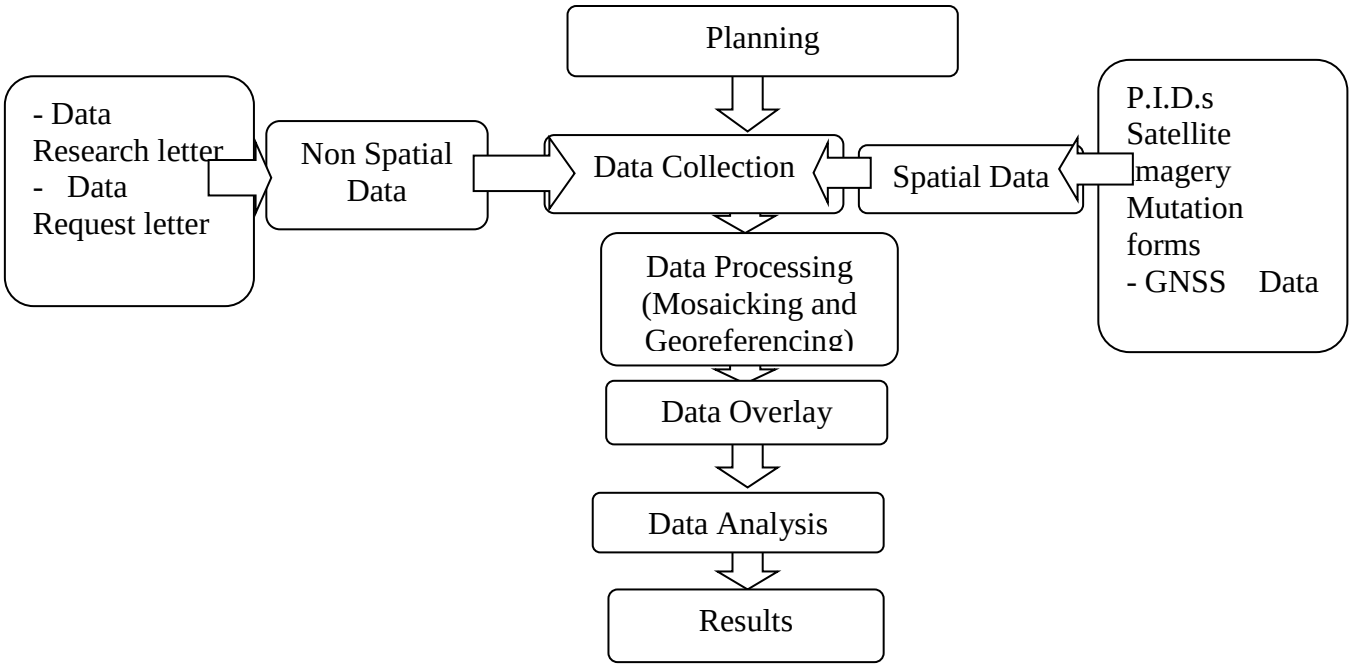


Figure 3. 3 *Overview of the Methodology*

Table 3. 1 Data Sources

No	Dataset	Source	Format
1	Preliminary Index Diagrams	Siaya county lands office	Hardcopy
2	Satellite imagery	Sas.planet	Raster
3	Mutation forms	Siaya county lands office	Hardcopy
4	GNSS Coordinates	Field picking	Vector

3.3 Implementation

3.3.1 Equipment used

The GNSS Equipment, Pentax (G5 Series) was used during data collection for picking of corner boundary coordinates of few parcels of land within the study area. Some points which could easily be

identified both in Preliminary Index Diagrams and on the satellite imagery were also picked. The points were used to form framework for georeferencing of both P.I.D.s and Satellite imagery.

3.3.2 Software

ArcGIS Software (ArcMap Version 10.5) was used for georeferencing of P.I.D.s, mutation forms and satellite imagery and digitizing of both P.I.Ds and mutation forms. Overlaying and comparison of digitized land parcels from P.I.Ds onto the satellite imagery were carried out on the ArcGIS. ArcGIS was further used to carry out analysis of boundaries and determination of parcel areas.

3.4 Planning

Project planning included reconnaissance to identify and orient myself with the area of study. The points that were both identified on map and physically on the ground were marked in preparation for GNSS picking. The elaborate methods for both data collection and data identification were carried out at this stage. This stage was very essential to ensure the objectives of this project are met within the set time frame.

3.5 Data Collection

Datasets identified and collected for this project included;

3.5.1 Spatial Data

Spatial datasets used in this project included; Two Preliminary Index diagrams, Ragengni Registration section (sheets 17 and 21), satellite imagery (Birds Eye image of 2019) downloaded from *sasplane*t with spatial resolution of 20cm. Certified mutation forms (18 copies) which were used to register the subdivisions in the area of study were also used as an additional information to help in further analysis of the P.I.D.s and the area of study. Also key to this research was field data picking of GNSS coordinates.

Table 3.2 Spatial Data

No	**Dataset**	**Source**	**Format**
1	Preliminary Index Diagrams	Siaya county lands office	Hardcopy
2	Satellite imagery	***(****sasplanet.Nightly.171130.9738.link)*	Raster
3	Mutation forms	Siaya county lands office	Hardcopy
4	GNSS Coordinates	Field picking	Vector

3.5.2 Non-Spatial Data

The non-spatial data used to facilitate this research project included the introductory letter from the University of Nairobi, Department of Geospatial and Space Technology that identified me as a student of the University of Nairobi. This letter was presented to the district surveyor (Bondo Lands office) and the county surveyor (Siaya Lands office). Also important was my request letter to the district surveyor asking for copies of mutation forms.

3.6 Data Processing

Both the PIDs and Mutation forms were scanned, geo-referenced, and then digitized to generate parcel boundaries. The 23 image tiles downloaded from *sas.planet* were also mosaicked to form a single image for the study area. The image was also later georeferenced.

3.6.1 Geo-referencing

Geo-referencing the scanned PIDs, mutation forms and satellite imagery was key to orient them in the same direction. Both were assigned the spatial coordinates collected by GNSS Equipment by launching the ArcGIS software. Using the display panel, the add icon was used to connect the folder that had the scanned image.

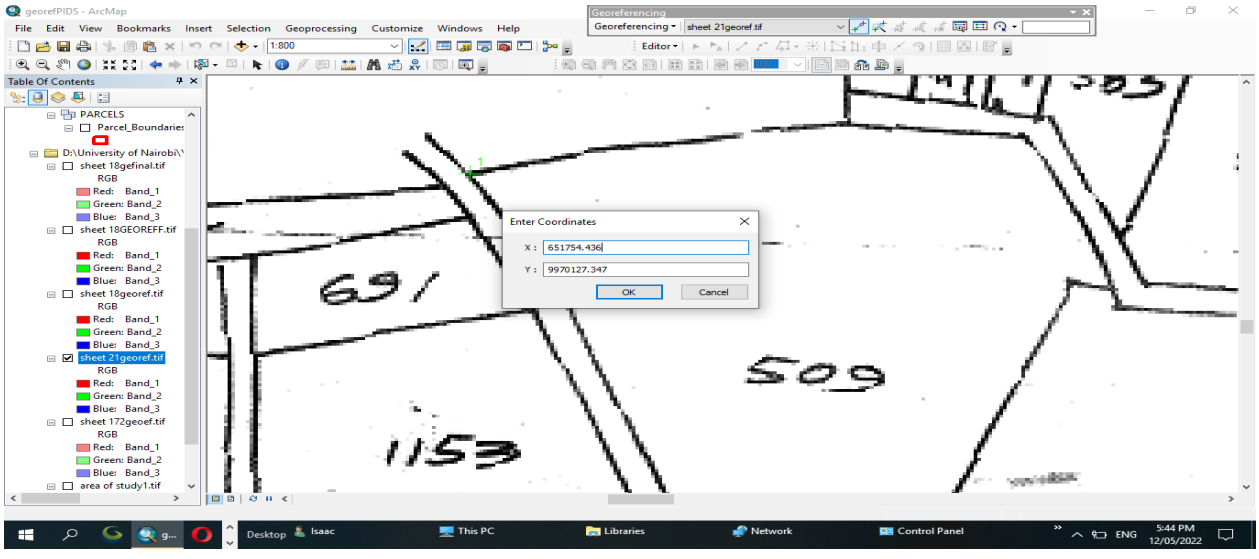


Figure 3. 4 *Georeferencing of PID in ArcGIS Software*

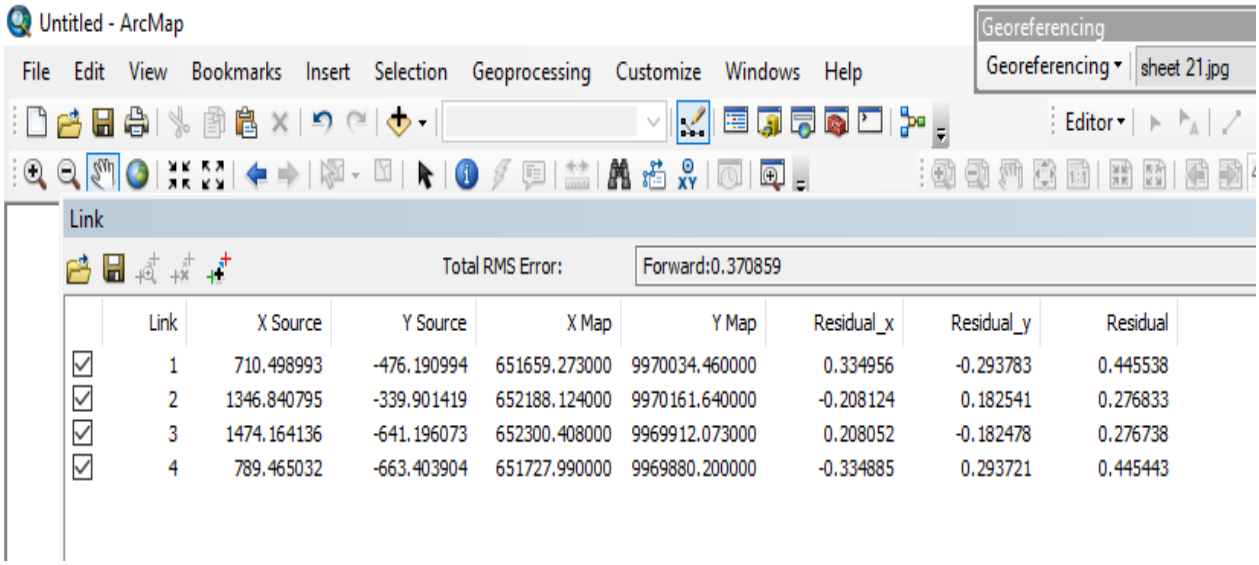


Figure 3. 5 *Georeferencing of PID in ArcGIS Software*

3.6.2 Digitizing

The polygons were digitized from both P.I.Ds and Satellite imagery are as shown below. The changes on the land parcel boundaries that came dueto more land subdivisions that have taken place in the area of study is shown below.

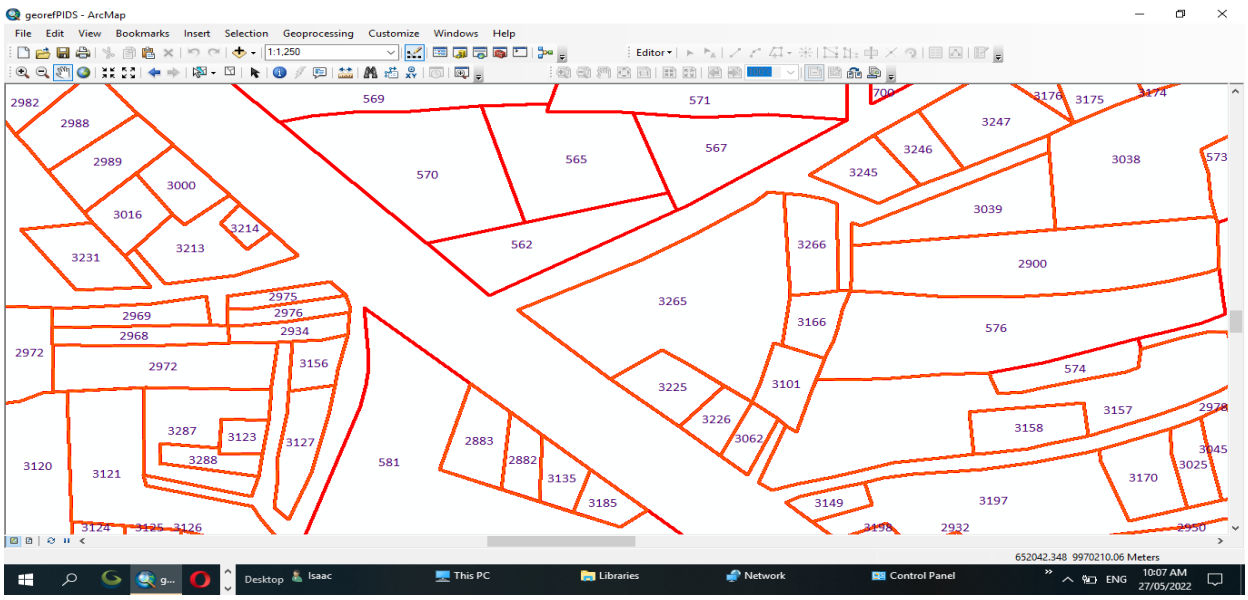


Figure 3. 6 *Digitizing of PIDs in ArcGIS Software*

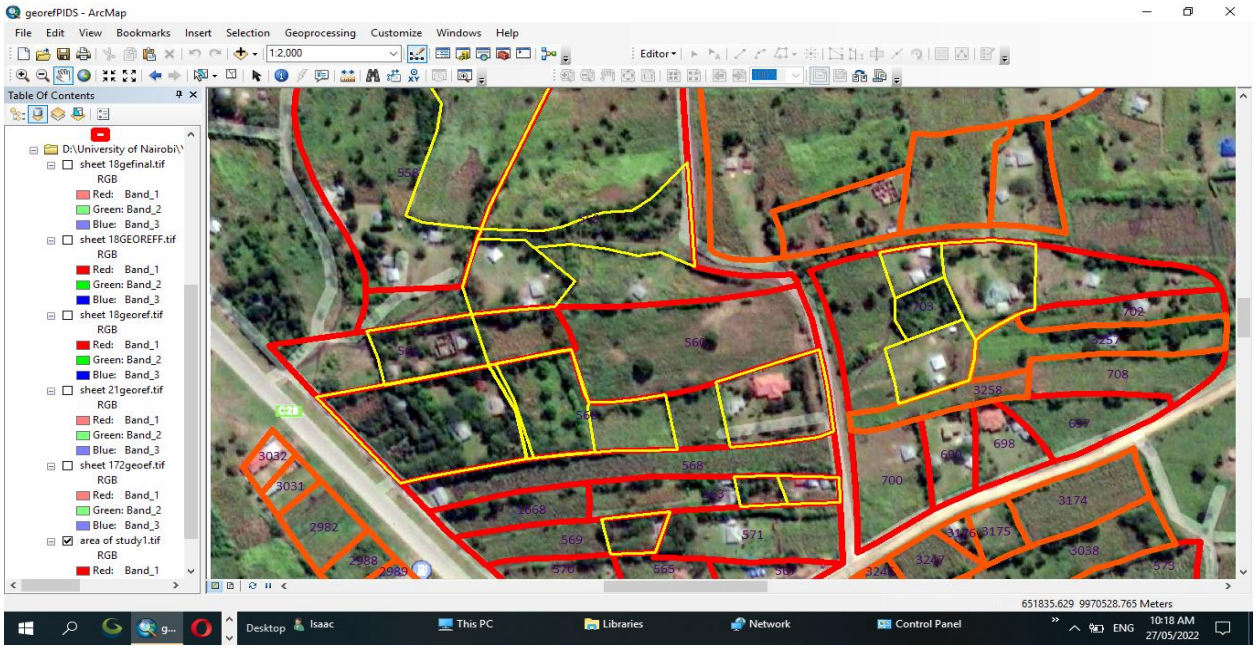


Figure 3. 7 *Physically visible parcellations on the ground*

3.6.3 Image Mosaicking

The individual image tiles downloaded from the *sasplanet* were finally joined together to form one image of the study area using data management tools in ArcGIS software.

Figure 3. 8 *Sample Image tiles of the study area before mosaicking*

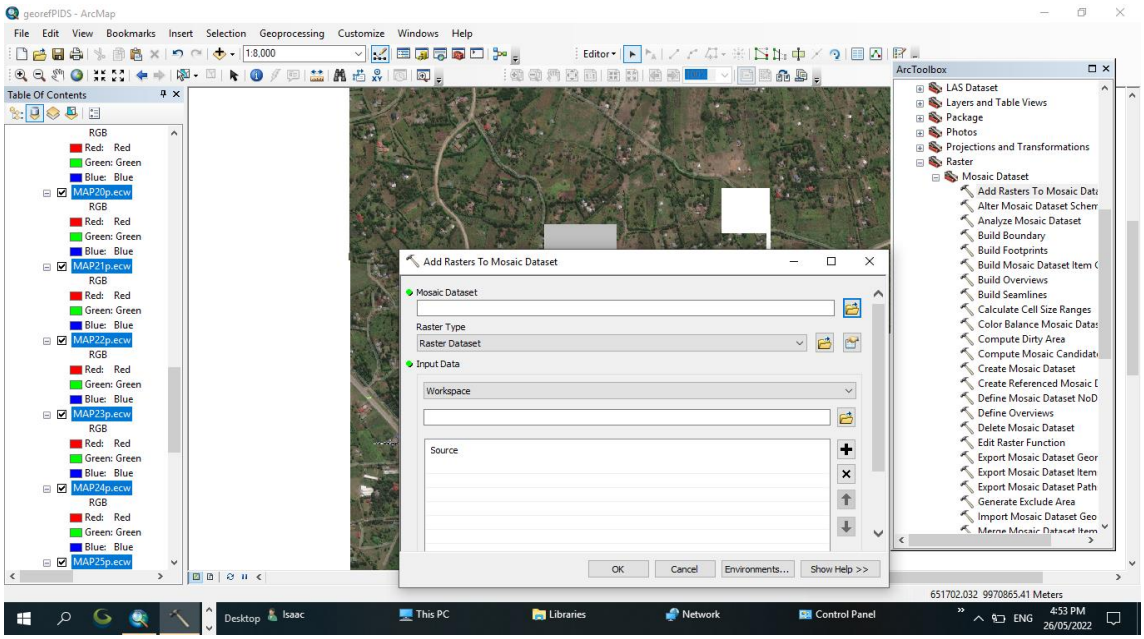
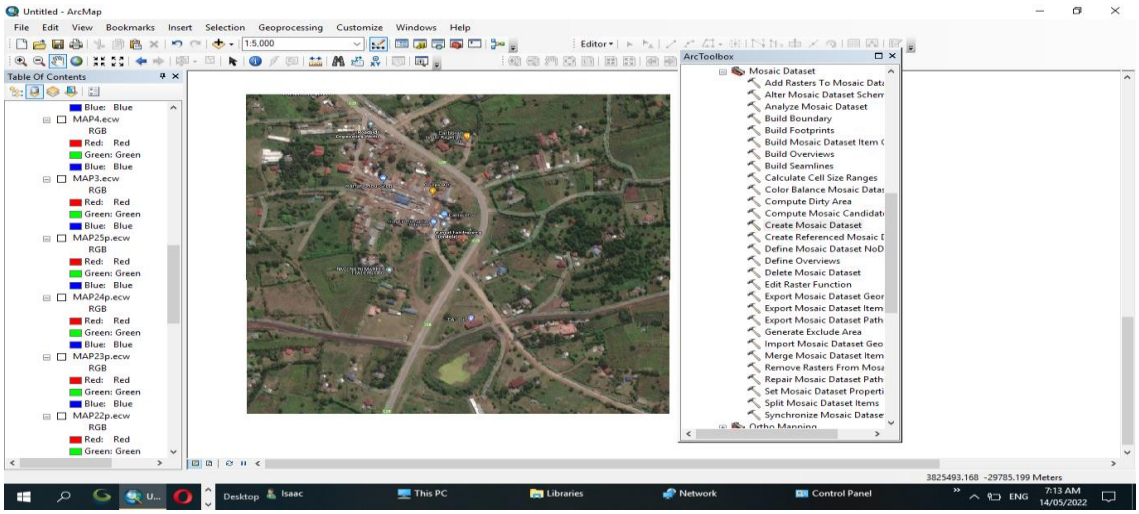


Figure 3.8. 1 *Image Mosaicking in ArcGIS Software*



3.8. 2 *Mosaicked image of the study area in ArcGIS Software*

3.6.4 Data Overlay

The georeferenced satellite imagery was overlaid with P.I.Ds boundaries to enable comparison of the boundary lines from the P.I.Ds with the satellite imagery. The parcellationss derived from the satellite imagery were also digitized and then compared with those from P.I.Ds in terms of area.

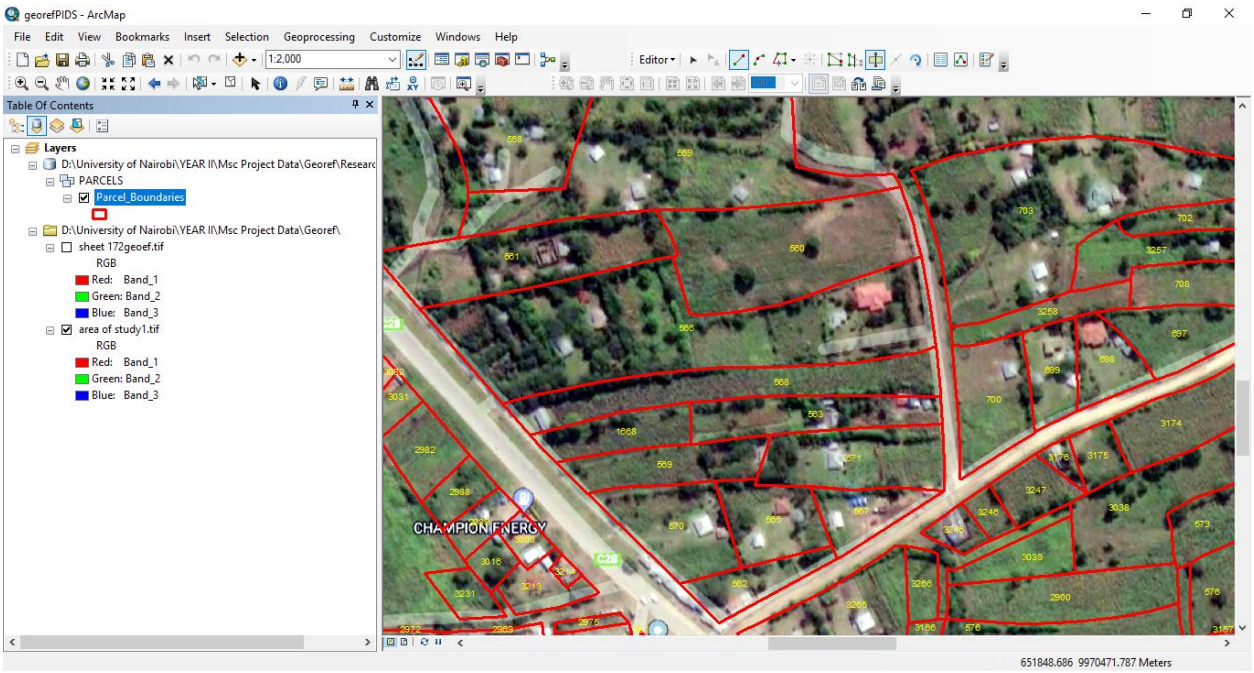


Figure 3.9: *Data Overlay*

3.7 Data Analysis

The parcel boundaries generated from PIDs when overlaid on the satellite imagery, it was noted that there were several boundary demarcations on the satellite imagery that are not reflected on the PIDs.

Table 3.3 Summary of updates in the study area

Parcel No	Year	No of Portions	Area (Ha)	Mutation Entry No	New Numbers issued	Status	P.I.D Sheet No
UYOMA/RAGENGNI/2978	2020	3		142/699	3245, 3246, 3247	Updated	17
UYOMA/RAGENGNI/2983	2014	2	0.12	142/4457	3031, 3032	Updated	17
UYOMA/RAGENGNI/3224	2021	2	0.52	142/745	3265,3266	Updated	17
UYOMA/RAGENGNI/2933	2010	2	0.08	142/4295	2975, 2976	Updated	17
UYOMA/RAGENGNI/2912	2010	2	0.13	142/4277	2968, 2969	Updated	17
UYOMA/RAGENGNI/511	2016	8	1.1	142/4621	3120,3121,3122,3123,3124,3125,3126,3127	Updated	17
UYOMA/RAGENGNI/2927	2015	3	0.41	142/569	3174, 3175,3176	Updated	17
UYOMA/RAGENGNI/3122	2021	2	0.17	142/783	3287, 3288	Updated	17
UYOMA/RAGENGNI/2981	2012	4	3.62	142/4317	2987, 2988, 2989, 2990	Updated	17
UYOMA/RAGENGNI/1038	2017	2	0.25	142/525	3155, 3156	Updated	17
UYOMA/RAGENGNI/701	2020	2	0.5	142/718	3257, 3258	Updated	17

UYOMA/RAGENGNI/580	1990	3	0.22	142/125	2881,2882,2883	Updated	17
UYOMA/RAGENGNI/3165	2019	3	0.62	142/664	3224,3225,3226	Updated	17
UYOMA/RAGENGNI/2990	2012	3	0.3	142/4354	2999,3000	Updated	17
UYOMA/RAGENGNI/3024	2014	2	0.68	142/4508	3044, 3045	Updated	17
UYOMA/RAGENGNI/3102	2017	2	0.90	142/536	3157,3158	Updated	17
UYOMA/RAGENGNI/2971	2012	2	0.23	142/4238	2993,2994	Updated	17
UYOMA/RAGENGNI/3169	2018	2	0.45	142/617	3197, 3198	Updated	17

3.8 Results

The Preliminary Index Diagrams which were obtained were scanned, georeferenced and digitized to generate parcel boundaries that were compared with the visible demarcations on the satellite imagery. The analysis of the extents of updates in terms of areas were computed and shown on the charts.

Table 3.4: Map Amendment by areas for the last five areas

Year	Area (Ha)	% Areas
2017	1.15	33.05
2018	0.45	12.93
2019	0.62	17.82
2020	0.57	16.38
2021	0.69	19.83
Total	**3.48**	

3.9 Chapter Summary

This chapter has described a detailed methodology that was used in answering the objectives of this research project. The first part outlined the flow chart diagram of the methodology. The detailed description of each step of the flow chart diagram then followed. The stages in this analysis included; planning, Data collection, Data Processing, Data Overlay, Data analysis and finally discussion of Results.

The next chapter will discuss the outcomes of this chapter.

4. RESULTS AND ANALYSIS

4.1 Introduction

This chapter will discuss the results of the specific objectives. The discussions will be based on the comparisons of boundaries on PID with demarcations on the satellite imagery and investigating the spatial extent updated on cadastral maps.

4.2 Comparison of Preliminary Index Diagram with Satellite Imagery

4.2.1 Scanning of P.I.Ds

The hardcopy Preliminary Index Diagrams (sheet 17 and 21, Rageng'ni Registration Section) were scanned to obtain a raster image in JPEG format. JPEG format can be easily opened by several softwares.

4.2.2 Importing PID into ArcMap

Using the insert menu, the scanned JPEG image of PID sheets 17 and 21 were uploaded on ArcMap environment.

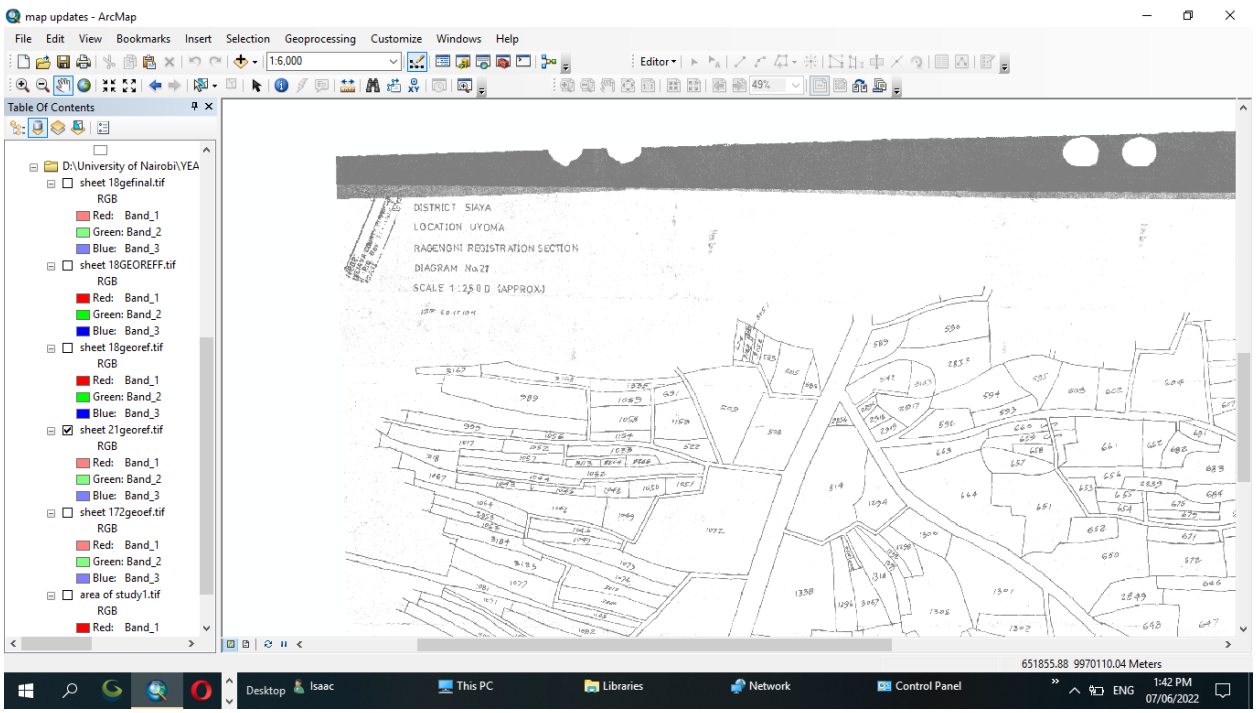


Figure 4.2.1 *Uploaded JPEG image of PID on ArcMap Environment*

4.2.3 Geo-referencing

By using the four control points that were picked in the field by GNSS Equipment, the image was geo-referenced. This is to ensure that the image was to be in the correct coordinate system for easy working in the same datum.

--Project Information----------

Project Name: RAG001
Creation Date: 10-02-2022
Creation Time: 09:34:29
Horizontal System: WGS84 UTM/36S:
Vertical System: EGM08Kenya.byn
Distance Unit: Meters

--Datum Parameters----------

Delta X: 0.000000
Delta Y: 0.000000
Delta Z: 0.000000

--Projection Parameters----------

UTM Zone: 36
Hemisphere: South

--Ellipsoid Parameters----------

Equitorial Radius (a): 6378137.000000
Polar Radius (b): 6356752.314000
Inverse Flattening (1/f): 298.257220

--Reference Information----------

Reference ID: 1
Latitude: S0°16'07.67561"
Longitude: E34°21'51.84190"
Ellipsoid Height: 1194.2700m
Antenna Height: 2.000m
Antenna NGS_ID: "TIAPENG5 NONE"
Northing: 9970281.1734m
Easting: 651836.4057m
Elevation: 1211.9999m
Description: BASE

--Reference Information----------

Reference ID: 2

Latitude: S0°16'07.67240"
Longitude: E34°21'51.86452"
Ellipsoid Height: 1194.6775m
Antenna Height: 2.000m
Antenna NGS_ID: "TIAPENG5 NONE"
Northing: 9970281.2720m
Easting: 651837.1053m
Elevation: 1212.4074m
Description: BASE

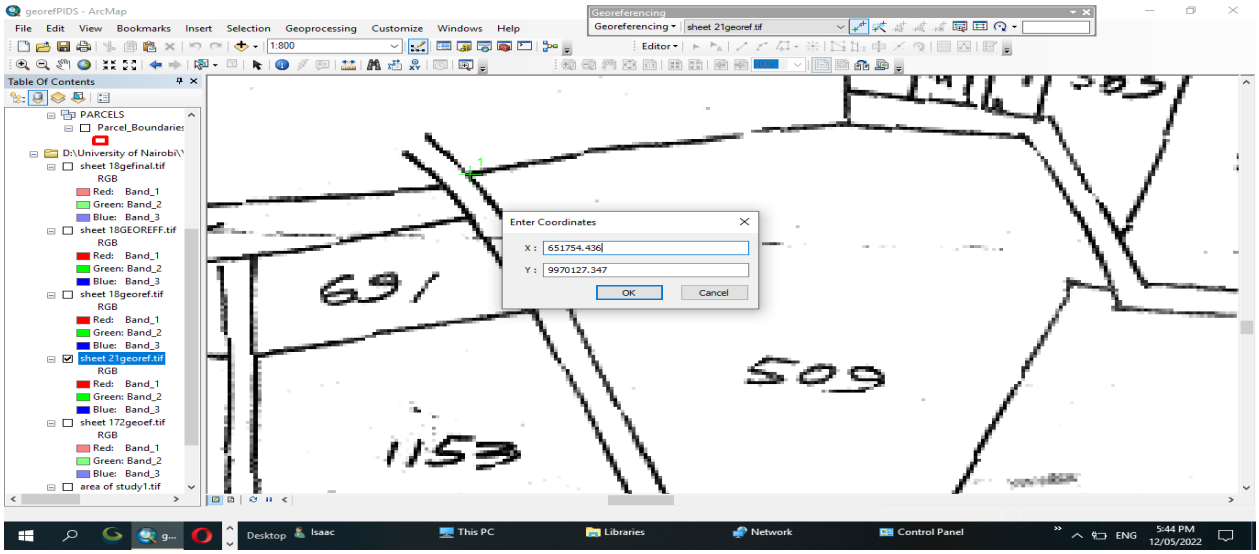
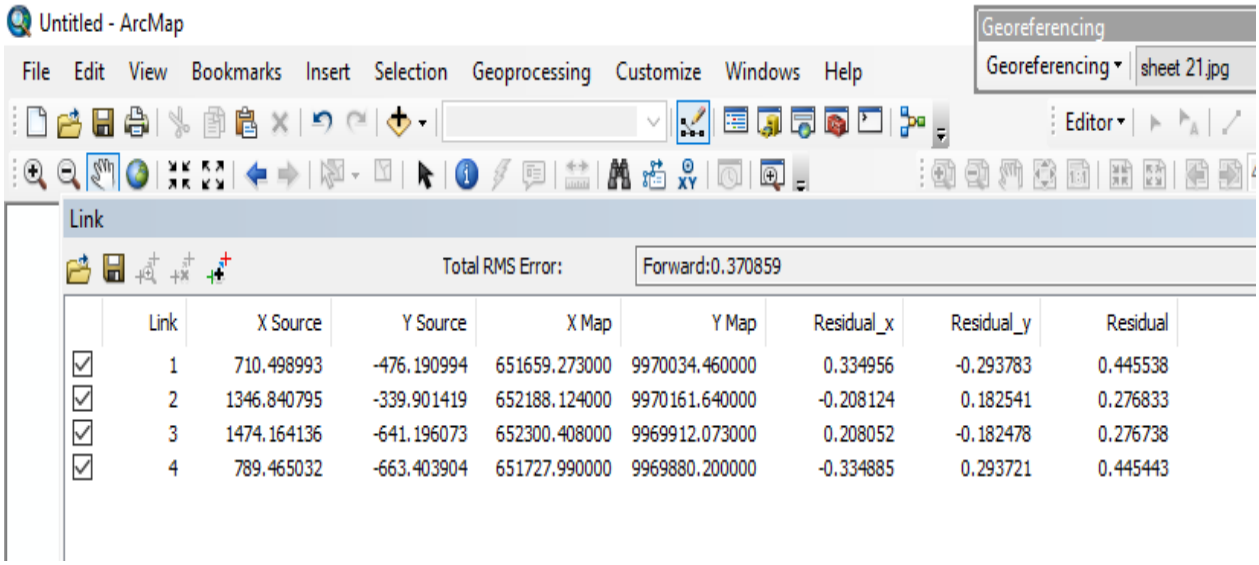


Figure 4.2. 2 *Georeferenced PID of the Study Area*



Link	X Source	Y Source	X Map	Y Map	Residual_x	Residual_y	Residual
1	710.498993	-476.190994	651659.273000	9970034.460000	0.334956	-0.293783	0.445538
2	1346.840795	-339.901419	652188.124000	9970161.640000	-0.208124	0.182541	0.276833
3	1474.164136	-641.196073	652300.408000	9969912.073000	0.208052	-0.182478	0.276738
4	789.465032	-663.403904	651727.990000	9969880.200000	-0.334885	0.293721	0.445443

Figure 4.2.3 *Data Link showing corrections for Georeferencing*

4.2.4 Digitizing

The parcel boundaries that were digitized from the PIDs are as shown in figure 4.2.4. This was later compared with the satellite imagery of the same area to enable further analysis on the boundaries. The areas of the digitized land parcels were determined both square meters and hectares. The total area digitized was 49.97 hectares and with a total of 136 land parcels.

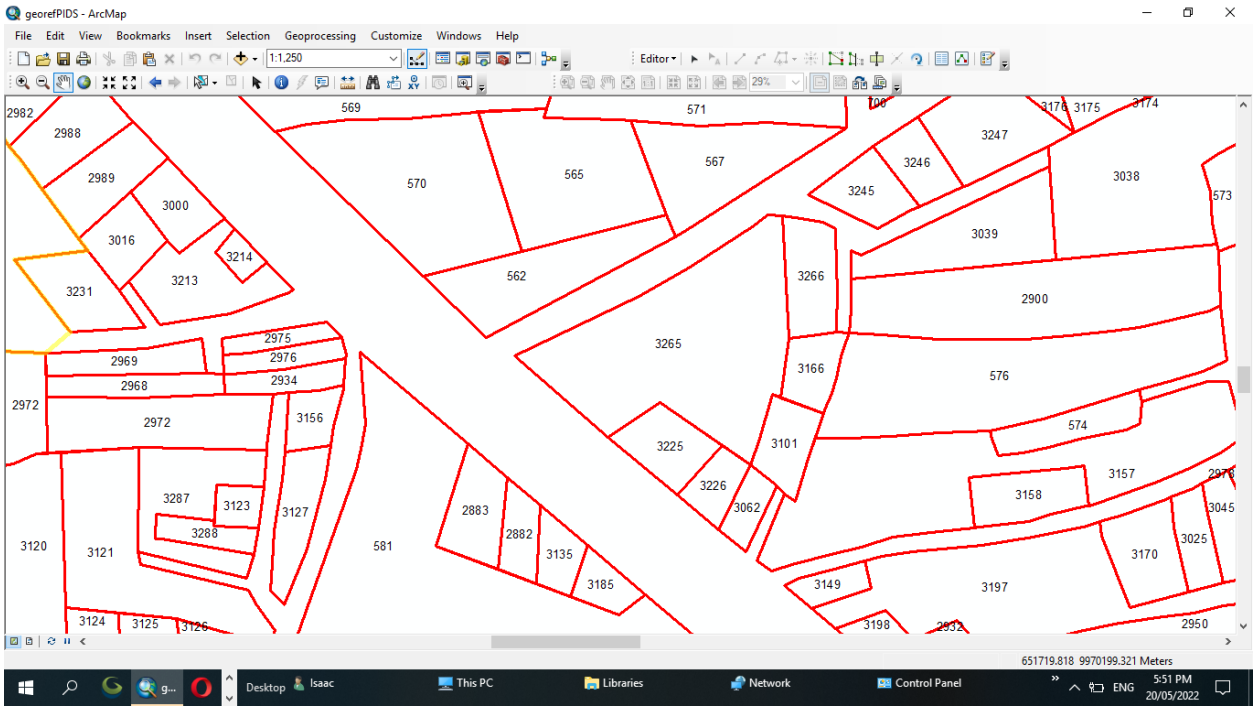


Figure 4.2. 4 *Digitized PID of Study Area*

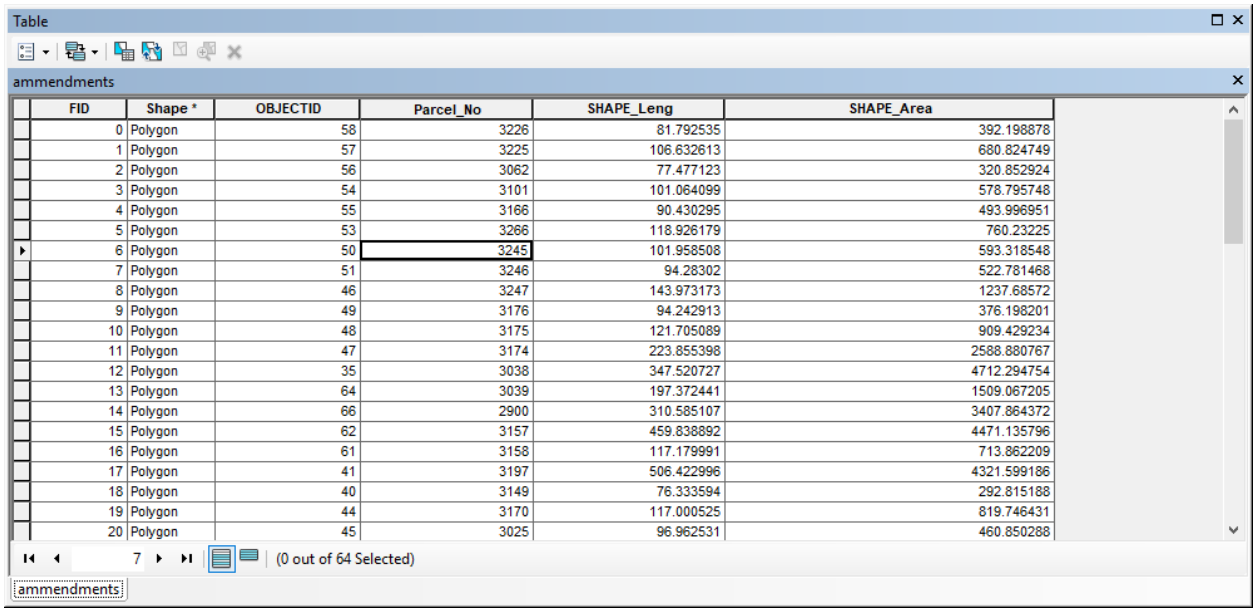


Figure 4.2. 5 *Attribute table of the digitized parcels*

4.3 Comparison of P.I.D.s with Satellite imagery

The digitized land parcels from PID was overlaid on the satellite imagery and parcel boundaries compared with the visible demarcations on the ground. The analysis was carried out to compare areas on the cadastral map and those on satellite imagery.

Figure 4.3. 1 *Comparison of boundaries on P.I.D.s with Satellite imagery (**Parcel No 509**)*

4.3.1 Comparison of areas on P.I.D.s with Satellite imagery for Land Parcel No 509

The comparision indicates that there is a variation of **317** square metres between areas on the PID and Satellite imagery. The area on the PID is **14456m^2** while the same parcel on the satelite imagery has an area of **14139m^2**.

Figure 4.3. 2 *Comparison of areas on P.I.D.s with Satellite imagery (**Parcel No 509**)*

Figure 4.3. 3 *Comparison of boundaries on P.I.D.s with Satellite imagery (**Parcel No 663**)*

4.3.2 Comparison of areas on P.I.D.s with Satellite imagery for Land Parcel No 663

The comparision of this parcel indicates that the area as measured on Satellite imagery is more by **968m^2** than that of the PID. The area on the PID is **6150m^2** while the same parcel on the satelite imagery has an area of **7118m^2**

Figure 4.3. 4 *Comparison of areas on P.I.D.s with Satellite imagery (**Parcel No 663**)*

Table 4.1 Summary comparisions of areas for sample parcels within the study area.

Parcel No	**Area Comparisions (m^2)**		**Variation**	**% Variation**
	PID	**Satellite Imagery**		
509	14456	14139	+317	+ 2.19
663	6150	7118	-968	- 15.74
2919	1494	1446	+48	+ 3.21

4.4 Extent of updates on the Cadastral Map

This research has established that out of the total area of study, the extent successfully updated on the cadastral map covers an area of 9.655 hectares. This translates to 19.32% of the total area fully updated on the map. 80.68% of the area of study has no evidence of updates.

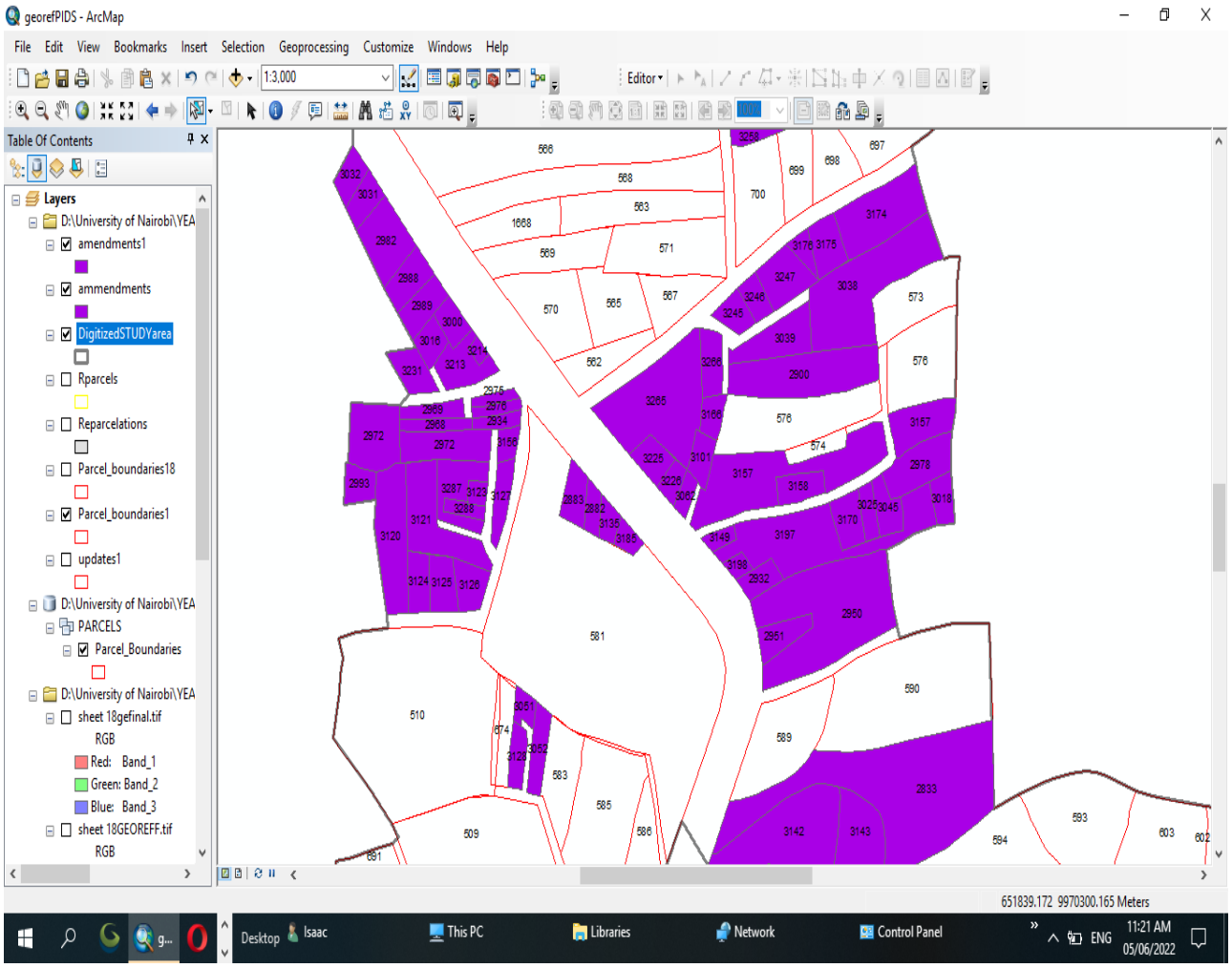


Figure 4.4. 1 *Extent of Map Updates on PIDs*

Table

ammendments

FID	Shape *	OBJECTID	Parcel_No	SHAPE_Leng	SHAPE_Area
0	Polygon	58	3226	81.792535	392.198878
1	Polygon	57	3225	106.632613	680.824749
2	Polygon	56	3062	77.477123	320.852924
3	Polygon	54	3101	101.064099	578.795748
4	Polygon	55	3166	90.430295	493.996951
5	Polygon	53	3266	118.926179	760.23225
6	Polygon	50	3245	101.958508	593.318548
7	Polygon	51	3246	94.28302	522.781468

1 (0 out of 64 Selected)

ammendments

Figure 4.4. 2 *Attribute table for the updated parcels*

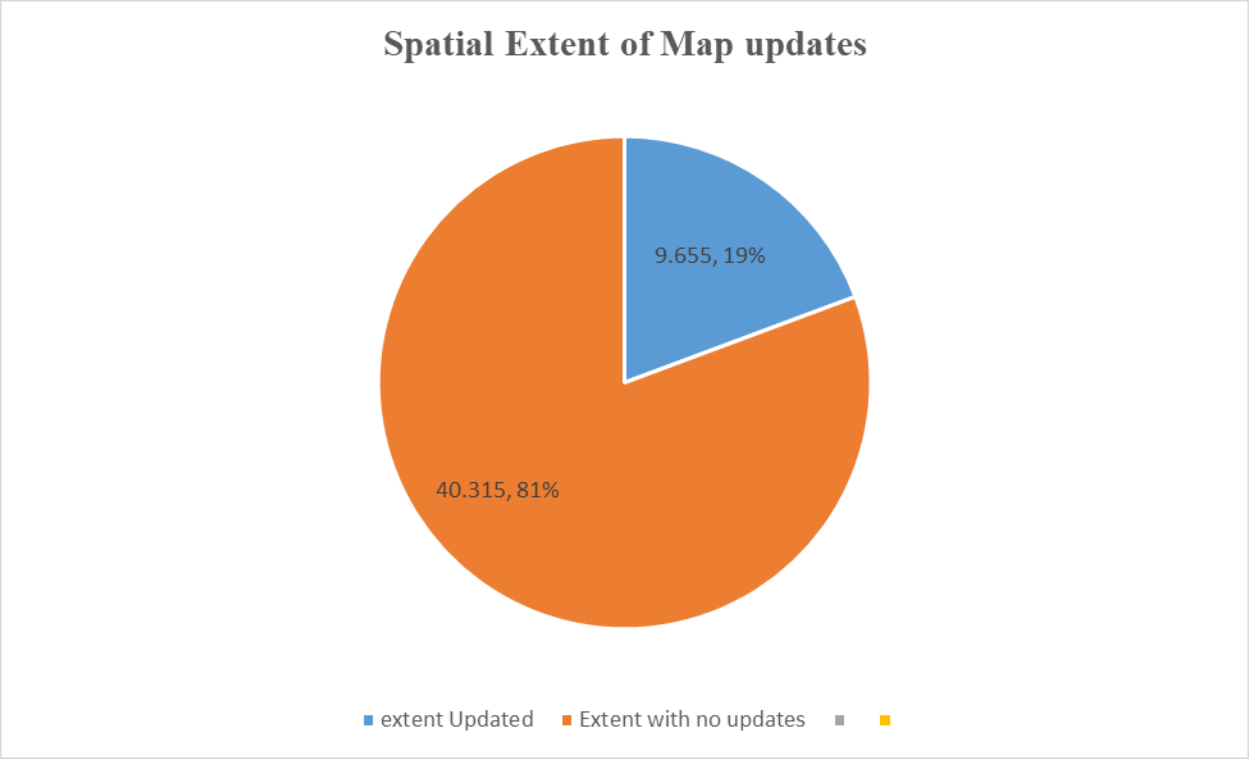


Figure 4.4. 3 *Spatial Extent of Map Updates*

Table 4.2: Analysis of map updates

Parcel No	Year	No of Portions	Area (Ha)	Mutation Entry No	New Numbers issued	Status	P.I.D Sheet No
UYOMA/RAGENGNI/2978	2020	3		142/699	3245, 3246, 3247	Updated	17
UYOMA/RAGENGNI/2983	2014	2	0.12	142/4457	3031, 3032	Updated	17
UYOMA/RAGENGNI/3224	2021	2	0.52	142/745	3265,3266	Updated	17
UYOMA/RAGENGNI/2933	2010	2	0.08	142/4295	2975, 2976	Updated	17
UYOMA/RAGENGNI/2912	2010	2	0.13	142/4277	2968, 2969	Updated	17
UYOMA/RAGENGNI/511	2016	8	1.1	142/4621	3120,3121,3122,3123,3124,3125,3126,3127	Updated	17
UYOMA/RAGENGNI/2927	2015	3	0.41	142/569	3174, 3175,3176	Updated	17
UYOMA/RAGENGNI/3122	2021	2	0.17	142/783	3287, 3288	Updated	17
UYOMA/RAGENGNI/2981	2012	4	3.62	142/4317	2987, 2988, 2989, 2990	Updated	17
UYOMA/RAGENGNI/1038	2017	2	0.25	142/525	3155, 3156	Updated	17
UYOMA/RAGENGNI/701	2020	2	0.5	142/718	3257, 3258	Updated	17
UYOMA/RAGENGNI/580	1990	3	0.22	142/125	2881,2882,2883	Updated	17
UYOMA/RAGENGNI/3165	2019	3	0.62	142/664	3224,3225,3226	Updated	17
UYOMA/RAGENGNI/2990	2012	3	0.3	142/4354	2999,3000	Updated	17
UYOMA/RAGENGNI/3024	2014	2	0.68	142/4508	3044, 3045	Updated	17
UYOMA/RAGENGNI/3102	2017	2	0.90	142/536	3157,3158	Updated	17
UYOMA/RAGENGNI/2971	2012	2	0.23	142/4238	2993,2994	Updated	17
UYOMA/RAGENGNI/3169	2018	2	0.45	142/617	3197, 3198	Updated	17

4.5 Parcellations

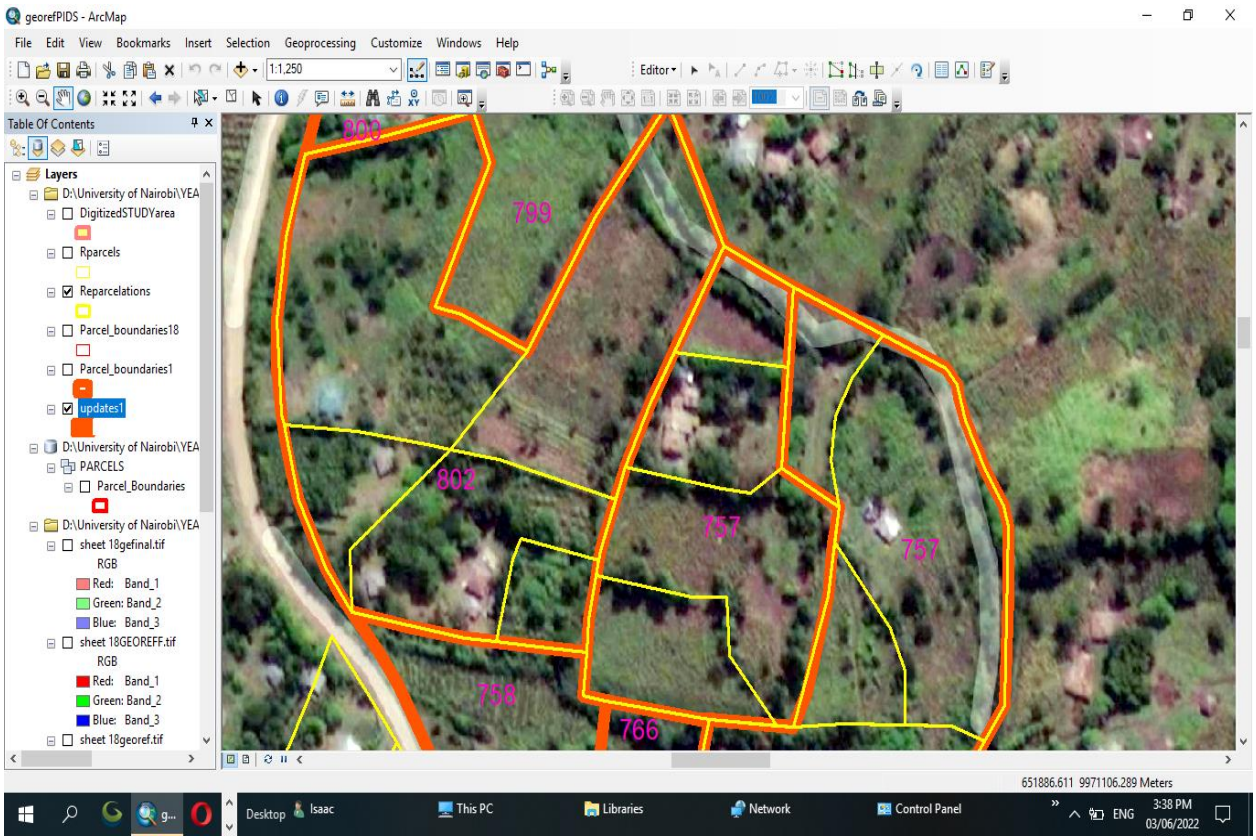


Figure 4.5. 1 *Some visible demarcations showing further subdivisions on the ground*

Table 4.3: Analysis of parcellations

Parcel_No	No. of Parcellations	Area	Sheet No
703	6	12184.05	17
802	5	17193.79	17
757	4	8767.02	17
770	2	3939.77	17
771	2	5510.47	17
781	2	2497.22	17
558	2	17048.03	17
559	5	20209.62	17
561	3	5436.23	17
566	5	14097.2	17
563	3	2983.99	17
569	2	2495.12	17
3265	2	4614.63	17
3157	4	5852	17
2950	2	6481	17
508	3	11860	21

661	3	10586	21
2839	2	2184	21
2917	2	3409	21
590	2	9145	21
756	4	15088.44	17

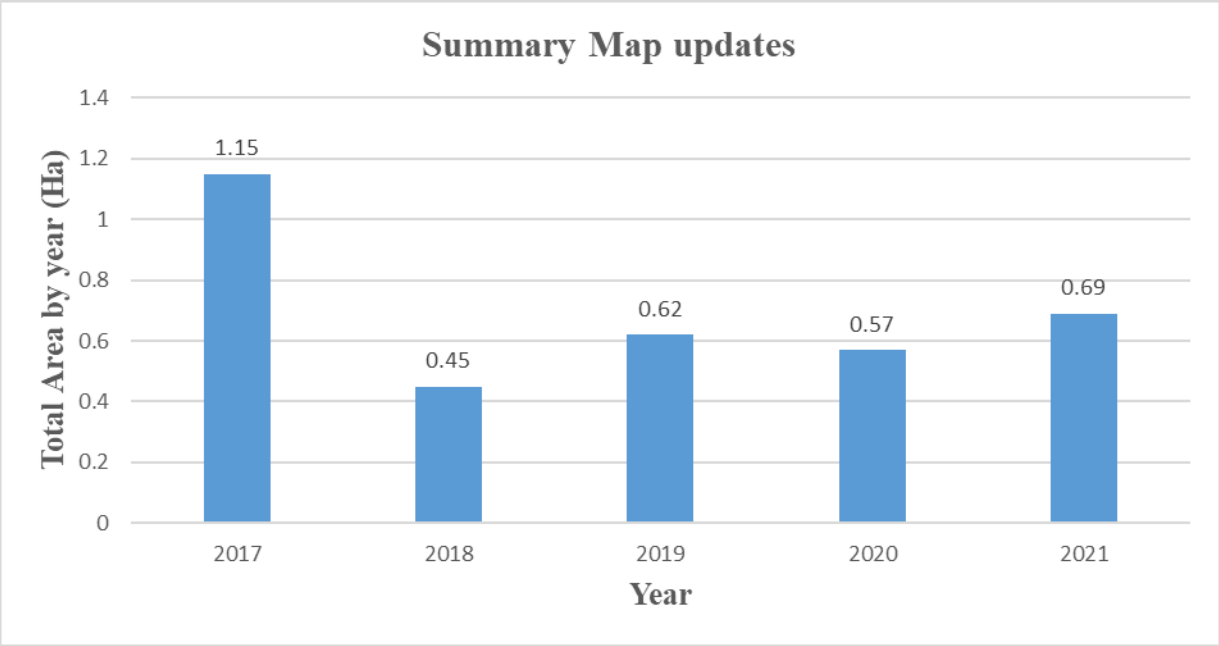
Table 4.4: Analysis of map updates

No	**Year**	**Total Areas subdivided (Ha)**	**No of Subdivisions**
1	1990	0.5	3
2	2010	0.21	2
3	2011	0	0
3	2012	3.943	3
4	2013	0	0
5	2014	0.8	3
6	2015	0.4	2
7	2016	1.1	8
8	2017	1.15	4
9	2018	0.45	2
10	2019	0.62	3
11	2020	0.54	5
12	2021	0.69	4
Total		**10.403**	

Table 4.5 Analysis of map updates

Year	**Area (Ha)**
2017	1.15
2018	0.45
2019	0.62
2020	0.57
2021	0.69

The bar chart showing the total area subdivided and amendments fully updated on the cadastral survey maps for the period between 2017-2021.



4.6 Analysis of the Extents of Updates in terms of Areas by Percentages

The Preliminary Index Diagrams which were obtained were scanned, georeferenced and digitized to generate parcel boundaries that were compared with the visible demarcations on the satellite imagery. The analysis of the extents of updates in terms of areas were computed and shown on the charts.

Table 4.6 Analysis of map updates

Year	Area (Ha)	% Area
2017	1.15	33.05
2018	0.45	12.93
2019	0.62	17.82
2020	0.57	16.38
2021	0.69	19.83
TOTAL	**3.48**	

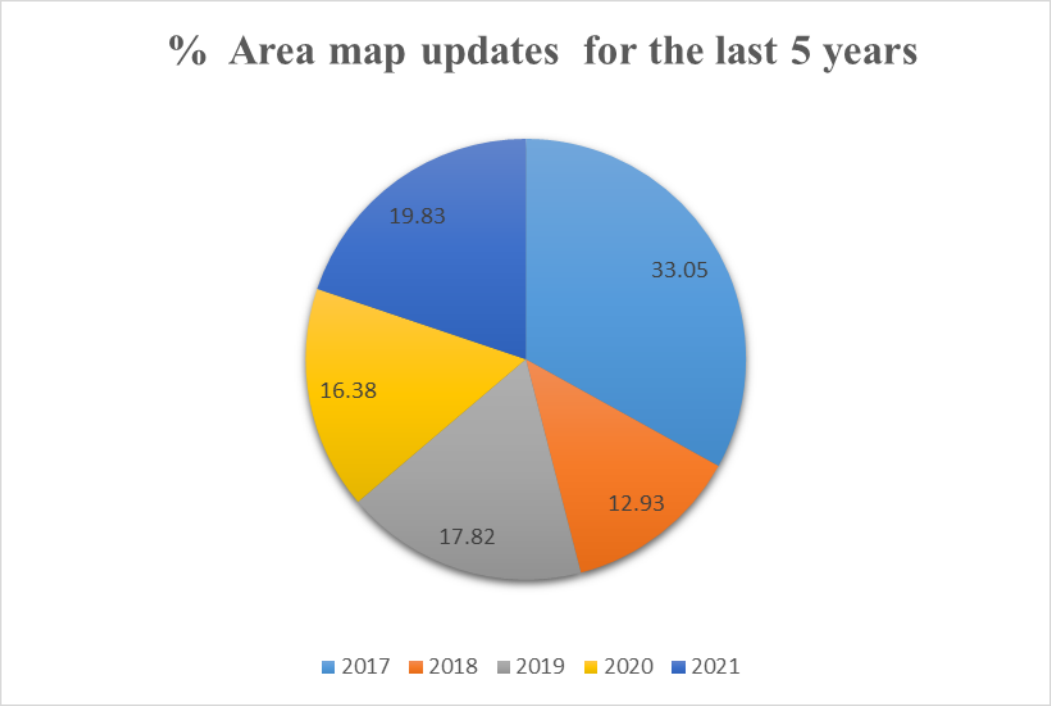


Figure 4.6. 1 *Percentage Map updates for the last five years*

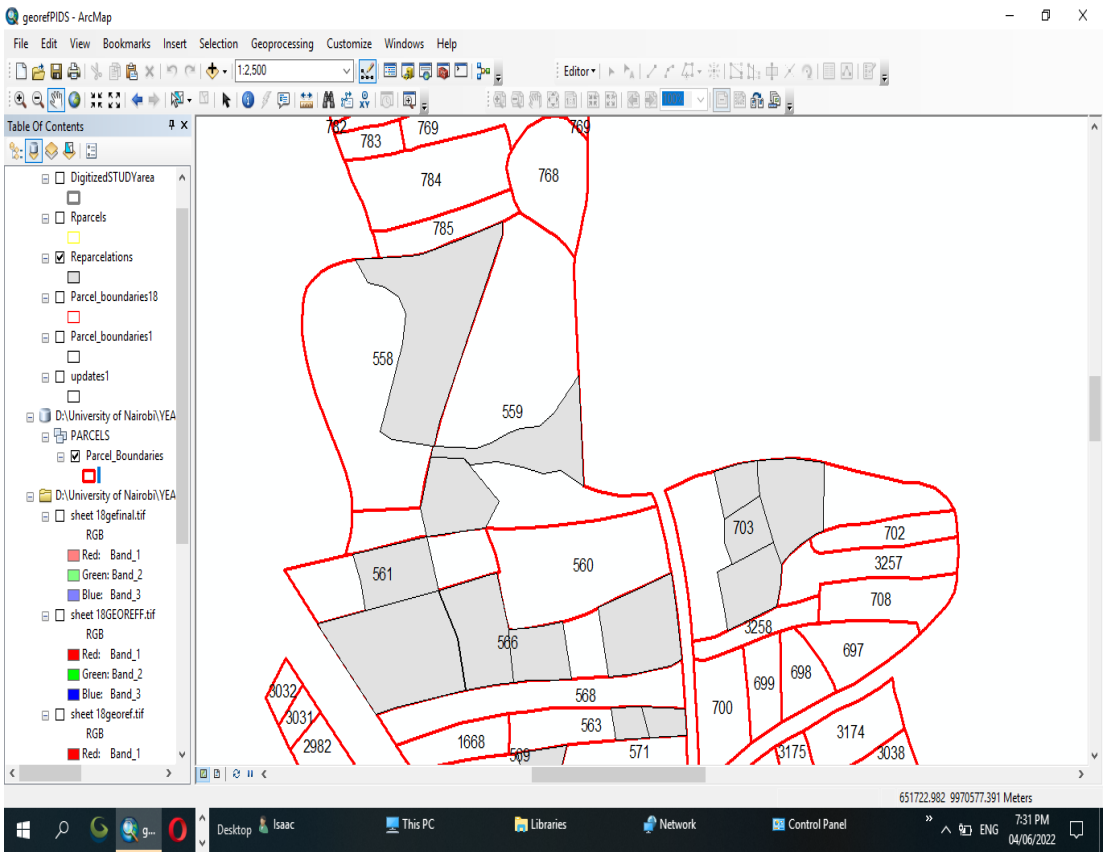


Figure 4.6. 2 *Visible Parcellations on the satellite imagery*

Comparison between updated extents and non-updated extents

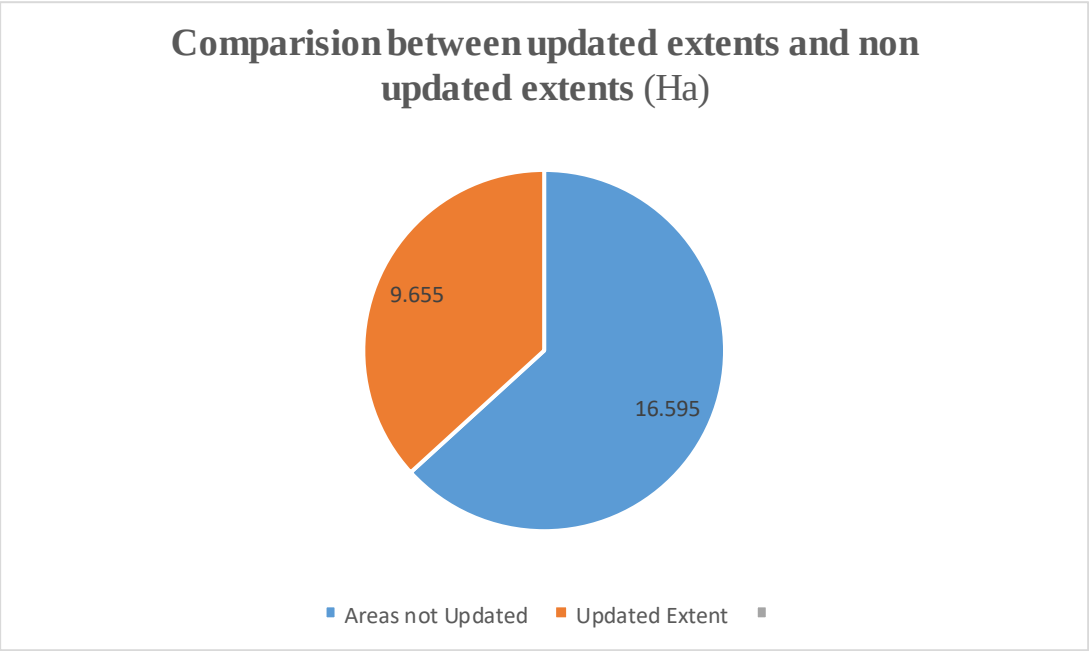


Figure 4.6. 3 *Comparison between updated extents and non-updated extents*

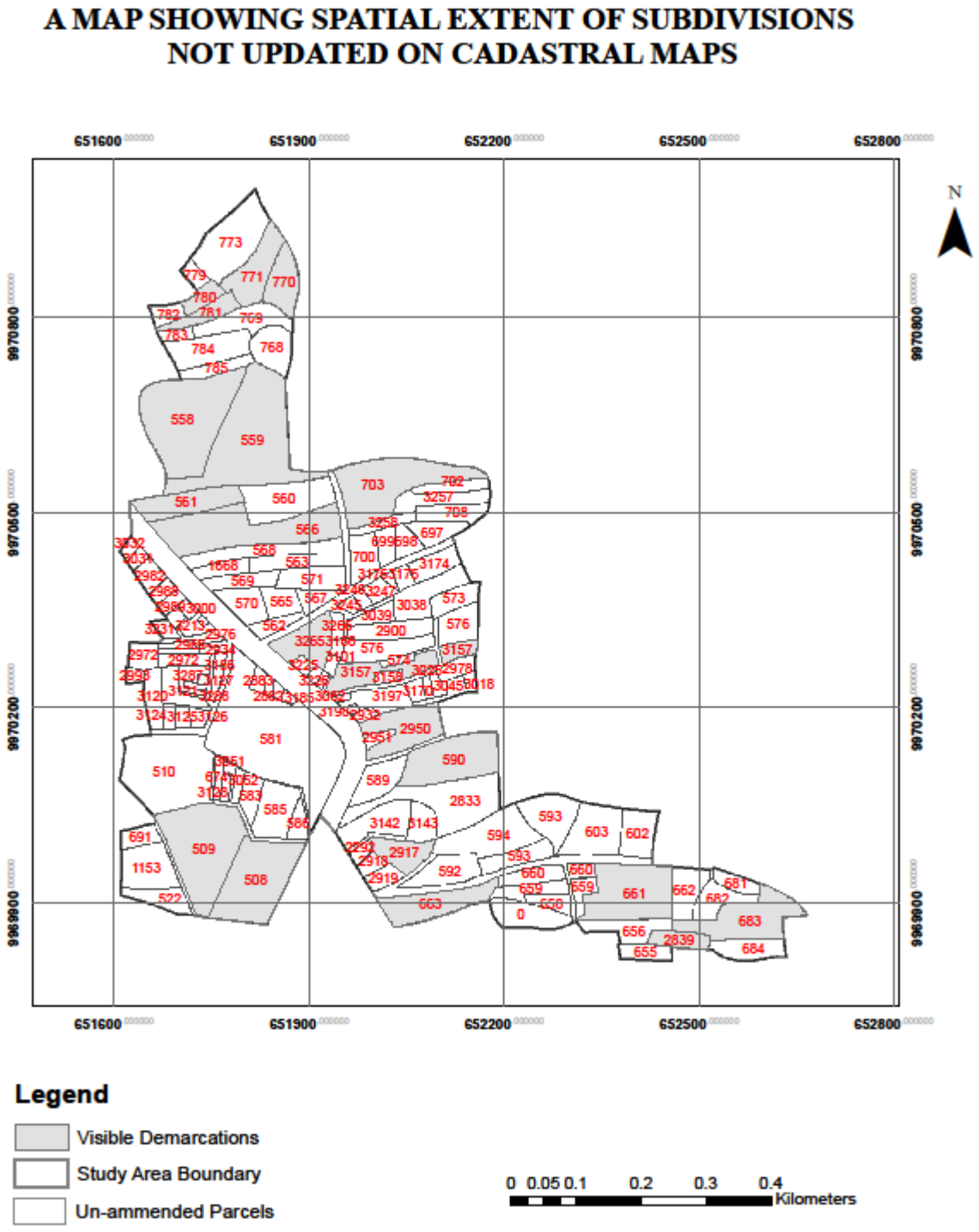


Figure 4.6. 4 *Map showing the Spatial Extent of subdivisions not updated on cadastral maps*

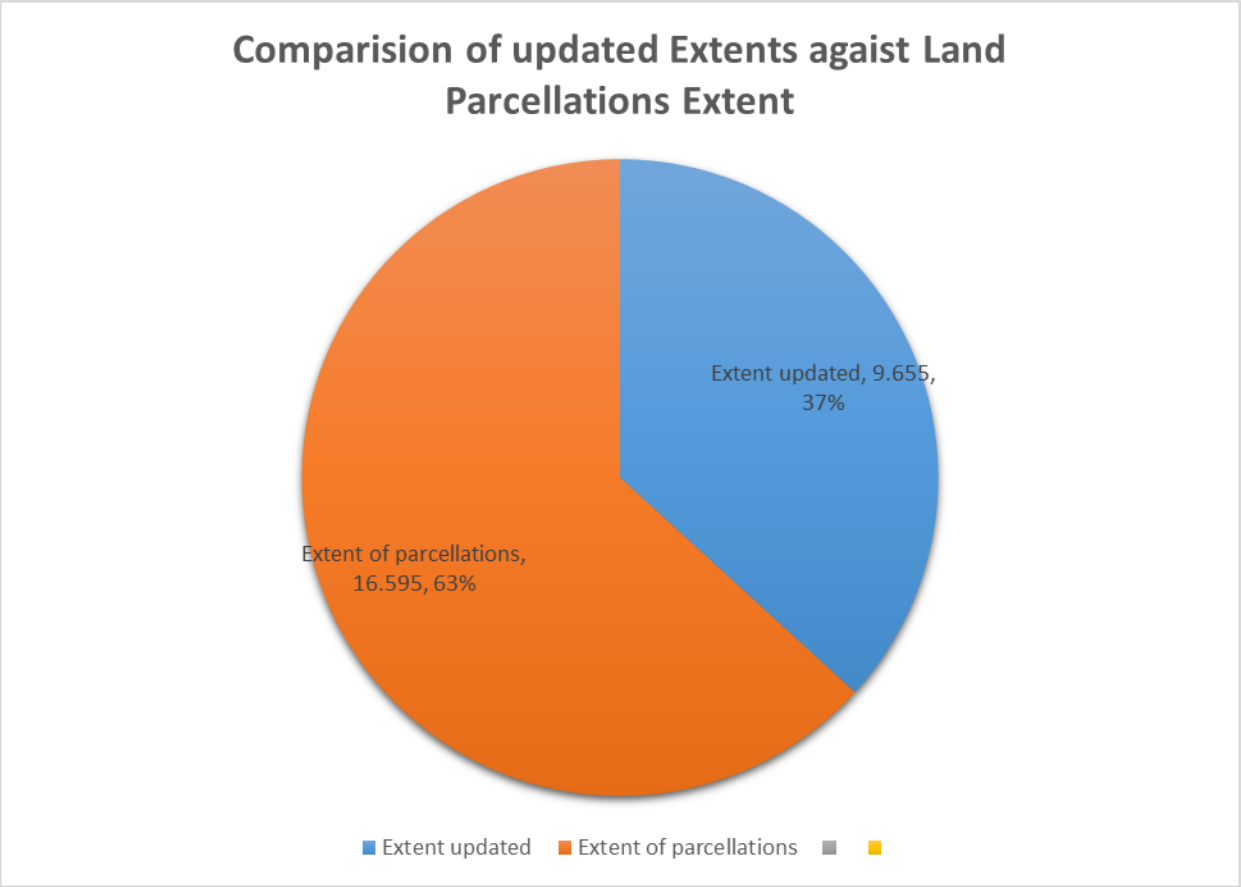


Figure 4.6. 5 *Comparison updated extents against land parcellations extent*

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

i) Review of status of cadastral maps update

According to the study area, all the amendments carried out are fully updated on the cadastral map. According to the research, the study area has registered 68 map amendments since the year 1990 – 2021. This means that averagely there are only two registered amendments within the study area annually for the last thirty one years.

ii) Extent of Map Amendments updated on the cadastral map

The area of study covered a total area of 49.97 hectares. Out of this area, the extent successfully updated on the cadastral map covers an area of 9.655 hectares. This translates to 19.32% of the total map area fully updated. 33.21% of the area of study has no evidence of the map updates. Out of a total 136 land parcels investigated only 18 have been subdivided and successfully updated on the PID.

iii) Extent of Parcellations

The total area covered by parcellations was 16.595 Ha which translates to a total percentage of 41%. According to the investigations the research indicated that the total area has no evidence of map updates on the cadastral map.

5.2. Recommendations

i) The same research to be carried out using a larger dataset of different regions to be able to investigate further whether there will be a better results than this.

ii) Since the study area was fully covered under general boundaries category, it is recommend that the same research to be carried out on areas purely covered under fixed boundaries to be able to compare the results for further analysis.

iii) This research was based on quantitative analysis of data, it is therefore recommend that use of qualitative approach to be able to see whether there will be a better result than this.

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The SAS.Planet Open Source Project on Open Hub

APPENDICES

Appendix I: Data Research letter

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Email: surveying@uonbi.ac.ke

Our Ref: UoN/FoE/GST/8/20

16th March 2022

To Whom It May Concern,

RE: ODERA ISAAC ANG'INA OSURI – F56/37016/2020

This is to confirm that the above mentioned is a Masters student in the Department of Geospatial and space Technology, University of Nairobi. He is carrying out research for Msc. Geographical Information Systems (GIS) degree qualification entitled: ***"Spatial Analysis of the Extent to which Cadastral Survey Maps are updated in Kenya (Case Study of Ragengni Registration Section"***.

Any assistance you may offer him in respect of the said research will be highly appreciated by us. Should you have any questions regarding his research, please contact the Department.

Yours faithfully,

CHAIRMAN
DEPT OF GEOSPATIAL & SPACE TECHNOLOGY
UNIVERSITY OF NAIROBI
P.O. Box 30197 NAIROBI

Dr. David N. Sciba
Ag. Chairman
Department of Geospatial & Space Technology

Appendix II: Data Request Letter

Isaac Angina O. Odera,
P.O.Box 48 -40604,
Ragengni.

SURVEY OF KENYA
RECEIVED
29 MAR 2022
BONDO / RARIEDA

29.03.2022.

To
The Sub-County Surveyor (National Government),
P.O Box 511 -40601,
Bondo.

Dear Sir/Madam

RE: REQUEST FOR COPPIES OF MUTATION FORM.

I write to request for copies of mutation forms covering Ragengni Registration Section (Map Diagrams 17, 18, 19 and 21) to assist me in carrying out my masters of Science in Geographic Information Systems research project.

I am currently undertaking my masters research project entitled "***SPATIAL ANALYSIS OF THE EXTEXT TO WHICH CADASTRAL MAPS ARE UPDATED IN KENYA , A CASE STUDY OF RAGENGNI REGISTRATION SECTION***" at the University of Nairobi.

Attached kindly find a supporting letter from the university.

Yours Sincerely,

Isaac Angina O. Odera.

Appendix III: Field Data

<html>
<head>
<title>GNSS Survey Report</title>
<style> html {min-width:800px;}
html {min-width:800px;}
body {font-size:14px;}
.container {width:800px; margin:0 auto; position:relative; overflow:hidden;}</style>
</head>
<body>
<h1><pre>GNSS Survey Report
MicroSurvey Pentax FieldGenius Version: 9.2.22.3</pre></h1>
<pre>
--Project Information----------

Project Name: RAG001
Creation Date: 10-02-2022
Creation Time: 09:34:29
Horizontal System: WGS84 UTM/36S:
Vertical System: EGM08Kenya.byn
Distance Unit: Meters

--Datum Parameters----------

Delta X: 0.000000
Delta Y: 0.000000
Delta Z: 0.000000

--Projection Parameters----------

UTM Zone: 36
Hemisphere: South

--Ellipsoid Parameters----------

Equitorial Radius (a): 6378137.000000
Polar Radius (b): 6356752.314000
Inverse Flattening (1/f): 298.257220

--Reference Information----------

Reference ID: 1
Latitude: S0°16'07.67561"
Longitude: E34°21'51.84190"
Ellipsoid Height: 1194.2700m
Antenna Height: 2.000m
Antenna NGS_ID: "TIAPENG5 NONE"
Northing: 9970281.1734m

Easting: 651836.4057m
Elevation: 1211.9999m
Description: BASE

--Reference Information----------

Reference ID: 2
Latitude: S0°16'07.67240"
Longitude: E34°21'51.86452"
Ellipsoid Height: 1194.6775m
Antenna Height: 2.000m
Antenna NGS_ID: "TIAPENG5 NONE"
Northing: 9970281.2720m
Easting: 651837.1053m
Elevation: 1212.4074m
Description: BASE

--Measured Points----------

Antenna NGS_ID: "TIAPENG5 NONE"
NGS_L1: 86.3mm NGS_L2: 91.8mm

Point ID: 3 Description: BASE
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 13 No. Epochs: 2
GPS Start Time: 10:16:45
Northing: 9970834.4659 RMS North: 0.0075
Easting: 651893.8499 RMS East: 0.0096
Elevation: 1212.6963 RMS Elev: 0.0222
HDOP: 0.8 VDOP: 1.3 PDOP: 1.52

Point ID: 4 Description: BASE
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 13 No. Epochs: 2
GPS Start Time: 10:16:54
Northing: 9970834.4874 RMS North: 0.0058
Easting: 651893.8881 RMS East: 0.0069
Elevation: 1212.6963 RMS Elev: 0.0159
HDOP: 0.8 VDOP: 1.3 PDOP: 1.52

Point ID: 5 Description: BASE
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 11 No. Epochs: 2
GPS Start Time: 10:19:46
Northing: 9970468.0853 RMS North: 0.0077
Easting: 651958.0782 RMS East: 0.0099
Elevation: 1214.6917 RMS Elev: 0.0219
HDOP: 0.8 VDOP: 1.5 PDOP: 1.71

Point ID: 6 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed

No. Satellites: 12 No. Epochs: 2
GPS Start Time: 10:23:10
Northing: 9970395.7761 RMS North: 0.0063
Easting: 651967.7676 RMS East: 0.0070
Elevation: 1213.9830 RMS Elev: 0.0176
HDOP: 0.8 VDOP: 1.6 PDOP: 1.82

Point ID: 7 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 13 No. Epochs: 2
GPS Start Time: 10:23:36
Northing: 9970395.7053 RMS North: 0.0121
Easting: 651967.7862 RMS East: 0.0134
Elevation: 1213.9745 RMS Elev: 0.0336
HDOP: 0.8 VDOP: 1.6 PDOP: 1.77

Point ID: 8 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 13 No. Epochs: 2
GPS Start Time: 10:26:12
Northing: 9970611.1787 RMS North: 0.0061
Easting: 652561.5688 RMS East: 0.0065
Elevation: 1213.7336 RMS Elev: 0.0185
HDOP: 0.8 VDOP: 1.6 PDOP: 1.77

Point ID: 9 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 13 No. Epochs: 1
GPS Start Time: 10:26:15
Northing: 9970611.1738 RMS North: 0.0094
Easting: 652561.5833 RMS East: 0.0096
Elevation: 1213.7366 RMS Elev: 0.0273
HDOP: 0.8 VDOP: 1.6 PDOP: 1.77

Point ID: 10 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 13 No. Epochs: 2
GPS Start Time: 10:26:23
Northing: 9970611.1917 RMS North: 0.0063
Easting: 652561.6098 RMS East: 0.0064
Elevation: 1213.7291 RMS Elev: 0.0164
HDOP: 0.8 VDOP: 1.6 PDOP: 1.77

Point ID: 11 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 15 No. Epochs: 2
GPS Start Time: 10:32:13
Northing: 9969902.3504 RMS North: 0.0056
Easting: 651997.8914 RMS East: 0.0063
Elevation: 1208.0500 RMS Elev: 0.0145
HDOP: 0.7 VDOP: 1.5 PDOP: 1.66

Point ID: 12 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 14 No. Epochs: 2
GPS Start Time: 10:33:36
Northing: 9969914.9384 RMS North: 0.0059
Easting: 652004.2808 RMS East: 0.0066
Elevation: 1207.9534 RMS Elev: 0.0149
HDOP: 0.8 VDOP: 1.5 PDOP: 1.68

Point ID: 13 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 13 No. Epochs: 2
GPS Start Time: 10:45:47
Northing: 9969956.1799 RMS North: 0.0062
Easting: 652582.3182 RMS East: 0.0083
Elevation: 1203.6849 RMS Elev: 0.0155
HDOP: 0.8 VDOP: 1.5 PDOP: 1.73

Point ID: 14 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 15 No. Epochs: 2
GPS Start Time: 10:47:31
Northing: 9969976.5009 RMS North: 0.0087
Easting: 652446.1335 RMS East: 0.0110
Elevation: 1208.8256 RMS Elev: 0.0219
HDOP: 0.7 VDOP: 1.4 PDOP: 1.58

Point ID: 15 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 17 No. Epochs: 2
GPS Start Time: 10:51:35
Northing: 9969865.2183 RMS North: 0.0058
Easting: 651844.6540 RMS East: 0.0066
Elevation: 1205.2473 RMS Elev: 0.0141
HDOP: 0.7 VDOP: 1.4 PDOP: 1.57

Point ID: 16 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 16 No. Epochs: 2
GPS Start Time: 10:53:25
Northing: 9969877.5561 RMS North: 0.0048
Easting: 651760.0654 RMS East: 0.0060
Elevation: 1203.6078 RMS Elev: 0.0111
HDOP: 0.7 VDOP: 1.4 PDOP: 1.58

Point ID: 17 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 15 No. Epochs: 2
GPS Start Time: 10:58:01
Northing: 9969919.8021 RMS North: 0.0056

Easting: 651626.2153 RMS East: 0.0067
Elevation: 1201.6915 RMS Elev: 0.0132
HDOP: 0.7 VDOP: 1.3 PDOP: 1.45

Point ID: 18 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 18 No. Epochs: 2
GPS Start Time: 11:01:55
Northing: 9969917.9749 RMS North: 0.0049
Easting: 651865.3369 RMS East: 0.0060
Elevation: 1206.1099 RMS Elev: 0.0112
HDOP: 0.7 VDOP: 1.2 PDOP: 1.39

Point ID: 19 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 14 No. Epochs: 2
GPS Start Time: 11:03:06
Northing: 9969926.3976 RMS North: 0.0061
Easting: 651839.7939 RMS East: 0.0067
Elevation: 1205.5564 RMS Elev: 0.0138
HDOP: 0.8 VDOP: 1.5 PDOP: 1.64

Point ID: 20 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 16 No. Epochs: 2
GPS Start Time: 11:04:47
Northing: 9969974.9749 RMS North: 0.0052
Easting: 651856.2485 RMS East: 0.0065
Elevation: 1206.3844 RMS Elev: 0.0125
HDOP: 0.7 VDOP: 1.2 PDOP: 1.40

Point ID: 21 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 18 No. Epochs: 1
GPS Start Time: 11:06:13
Northing: 9970000.4755 RMS North: 0.0079
Easting: 651809.2519 RMS East: 0.0094
Elevation: 1205.9339 RMS Elev: 0.0185
HDOP: 0.7 VDOP: 1.2 PDOP: 1.40

Point ID: 22 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed
No. Satellites: 16 No. Epochs: 2
GPS Start Time: 11:07:53
Northing: 9969943.7393 RMS North: 0.0052
Easting: 651784.5640 RMS East: 0.0063
Elevation: 1204.8932 RMS Elev: 0.0123
HDOP: 0.7 VDOP: 1.3 PDOP: 1.44

Point ID: 23 Description: 001
Antenna Height: 2.000 Solution: RTK Fixed

No. Satellites: 14 No. Epochs: 2
GPS Start Time: 11:30:44
Northing: 9970482.0391 RMS North: 0.0059
Easting: 651655.9548 RMS East: 0.0075
Elevation: 1211.6517 RMS Elev: 0.0160
HDOP: 0.7 VDOP: 1.4 PDOP: 1.52
</pre>

</body>
</html>

Appendix IV: Mutation Form

Date received for registration | Presentation book | Registration Fees: Shs.....

..... | No..... | Paid Receipt No. .....

Survey Fees: Shs..... | Receipt No..... | Date .....

R.I.M Amendment Fee: Shs. 400/- 200/- 700/- | Receipt No. B5573696 | Date 13-4-2021

REPUBLIC OF KENYA 142/745

Form R.L. 29

THE REGISTERED LAND ACT, 1963

04226367

MUTATION FORM

(This form is to be completed in triplicate)

Title No. SIAYA/RABUNGU/3224

Approximate Area 0.52 Hectares.

Registry Map Sheet No. 17

Registered Proprietors' Instructions to the Surveyor

1. Present boundaries of parcel are shown on the sketch on page 2.

(a) (i) The proprietor wishes to subdivide the parcel as shown by the dotted lines on the sketch.

or

(ii) The proprietors wish to change their common boundary as shown by dotted lines on the sketch

or

(iii) The proprietors wish to partition the parcel as shown by the dotted lines on the sketch.

or

(iv) The proprietor wishes to combine his parcels as shown by the brace on the sketch.

(b) The new parcel numbers will be:

A	B					
3265	3266	ha				
relevant approximate area	0.44	0.08				

SUB-COUNTY SURVEYOR SIAYA 23/4/21

(c) The relevant Letter or Consent to subdivide/partition the parcel is attached.

(d) The persons interested, and their addresses are:

PAMELA JUMA ONGITI

ID No 40418446

P.O BOX 84

RABUNGU

I Certify this to be a true copy of the Original

COUNTY SURVEYOR SIAYA

DATE 19/4/21

ES/SP/9/10/2/199

7/06/21

166

They will meet the Surveyor at THE SITE

on 13/03/2020 at 10:00 a.m/p.m. or on the land at a time appointed by him.

(e) Please advise the Land Registrar when the mutation is surveyed and Registry Index Map amended.

Mutation form, PAGE ONE (Source: Survey of Kenya, Siaya County office)

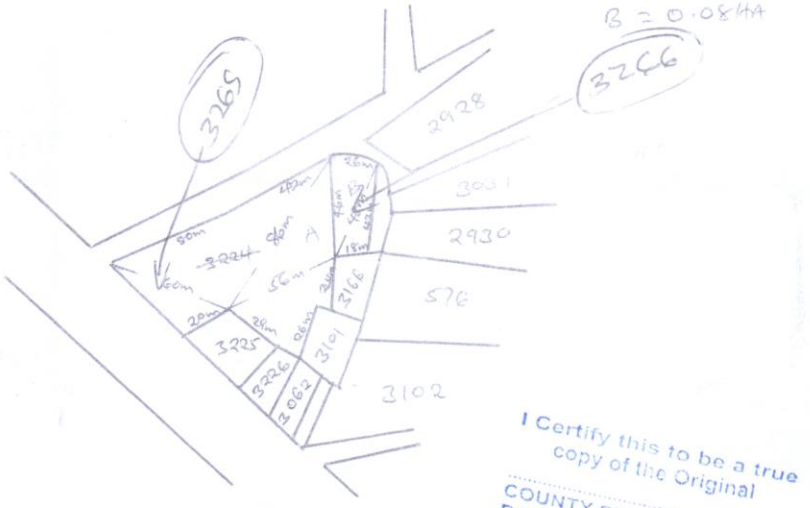
Page Three

FIELD DIAGRAM AND OBSERVATIONS ON SITE

To be completed by the Surveyor
(Attach a tracing to scale where appropriate)

SIAYA/RAGENGNI/3224
SCALE 1:2500 (APPROX
DIAGRAM : 17

AREAS
A = 0.44 HA
B = 0.08 HA



I Certify this to be a true copy of the Original
COUNTY SURVEYOR SIAYA
DATE.....

This is to certify that this field sketch contains the actual figures recorded by me at the time of observation and measurements in the field.

Certificate under Schedule 9 of the Survey Regulations to be provided in case the survey has been done by an Approved Assistant.

Date..... 13/03/2020

Surveyor

Mutation form, PAGE THREE (Source: Survey of Kenya, Siaya County office)

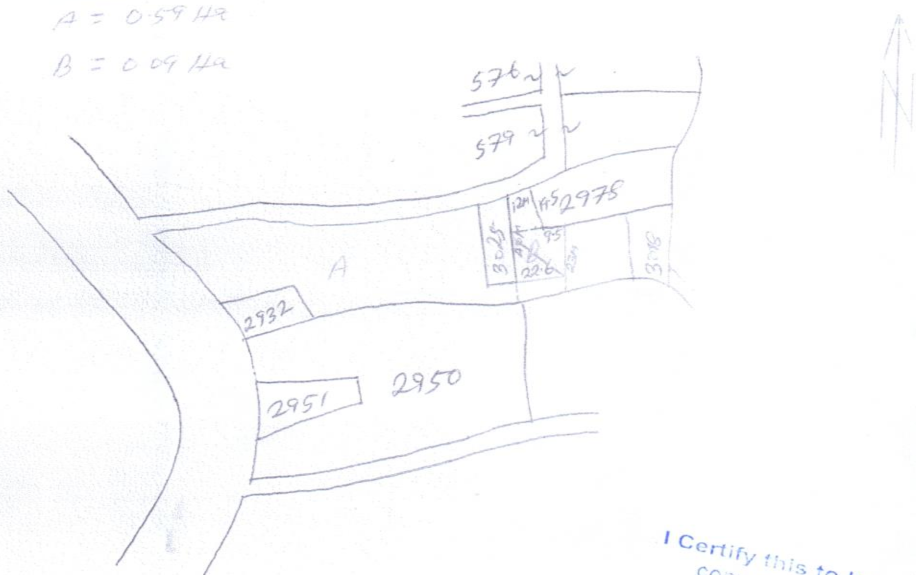
MUT/142/4508

FIELD DIAGRAM AND OBSERVATIONS ON SITE

To be completed by the Surveyor
(Attach a tracing to scale where appropriate)

UYOMA/RAGENGNI/3024
DIAGRAM 17
SCALE 1:2500

AREAS
A = 0.59 Ha
B = 0.09 Ha



I Certify this to be a true copy of the Original
....
COUNTY SURVEYOR SIAYA
DATE..

This is to certify that this field sketch contains the actual figures recorded by me at the time of observation and measurements in the field.

Certificate under Schedule 9 of the Survey Regulations to be provided in case the survey has been done by an Approved Assistant.

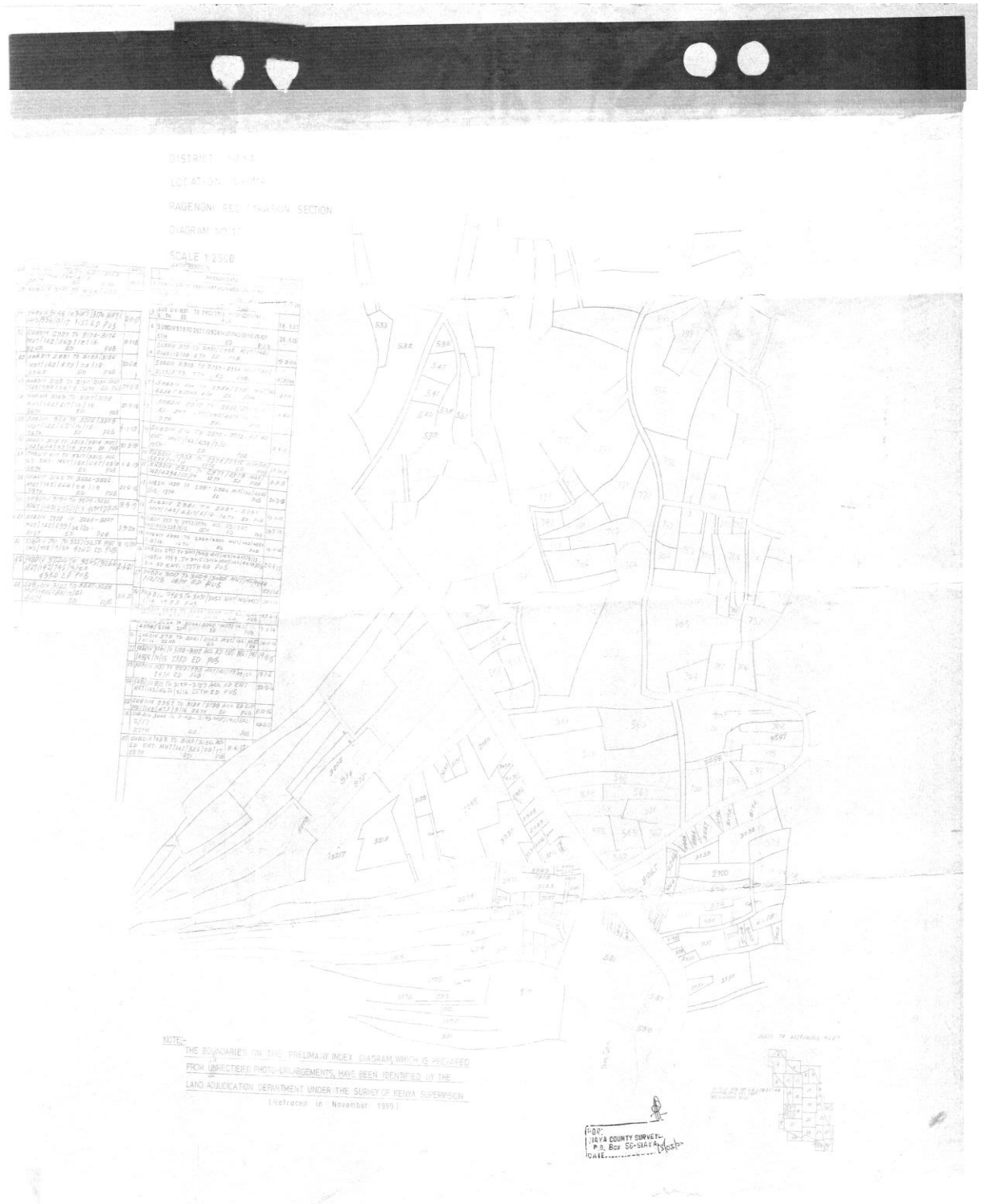
I certify that all the work performed in the field and in the office by my Approved Assistant SOLOMON NYAGA has been carried out under my personal supervision and I take full responsibility of all the work so performed

Date 19/06/2014 .... Surveyor

Checked & stenciled – Gelastine 8/7/14

Jackso Osama 17/7/14

Appendix V: Preliminary Index Diagram (sheet 17)



Appendix VI: Preliminary Index Diagram (sheet 21)

Appendix VII: Instrument set up before the start of data collection

Appendix VIII: Data collection