University of Nairobi

School of Engineering

Creation of a Digital Database for Preliminary Index Diagrams (PIDs): Case Study of Athiru / Ruujine / Ndoleli Adjudication Section, Meru County

BY

ISUMBA, STACEY REPHA

F56/88657/2016

A Project submitted in partial fulfillment of the requirements for the Degree of Master of Science in Geographic Information Systems, to the Department of Geospatial and Space Technology of the University of Nairobi

July 2018.

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DECLARATION

I, **Stacey Repha Isumba,** hereby declare that this project is my 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.

ISUMBA, STACEY REPHA	…….	……..
Name of student	**Signature**	**Date**

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

PROF. G. C. MULAKU	……	……..
Name of supervisor	**Signature**	**Date**

DEDICATION

I dedicate this work to my parents for the help and assistance they offered me through my education and studies both social and monetary. I will be forever grateful.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank the Almighty God for granting me the opportunity, time and resources to pursue the Master of Science in Geographic Information Systems (MSc. GIS) program.

My heartfelt gratitude goes to my supervisor, Prof. G. C. Mulaku for his outstanding commitment, guidance and counsel. The research benefited from his efforts to refine my ideas and to continuously evaluate the structure and content of this project through consistent consultations and discussions.

I am grateful to the lecturers and other members of staff at the Department of Geospatial and Space Technology for whatever role they played to enable me complete the program. Special thanks to Mary Gwena and Regina Ng'ang'a for their support and encouragement.

I wish to convey my appreciation to the staff at the Ministry of Lands and Physical Planning for providing most of the data and responding to my questions.

I am greatly indebted to various authors whose publications I have used and cited. I commend them for their superb works, which have enabled me to conceptualize the methodology of this project.

ABSTRACT

In the Kenyan rural areas (designated as adjudication areas), land ownership is through the process of land adjudication, in which the Preliminary Index Diagrams (PIDs) are the official map documents. The PIDs together with adjudication records constitute the adjudication registers that form the basis for determination of interests and rights over land and the subsequent issuance of titles.

A PID at a glance does not relay the information about the adjudication process; from the declaration of an adjudication area by a minister, declaration of the subsequent adjudication sections by the Land Adjudication Officers (LAOs), publication of the section, and other relevant information. The information is usually not readily available, as it exists in analogue form, that is, file based, and scattered over different departments and sections in the Ministry of Lands and Physical Planning.

This realization led to the creation of a digital platform in this project, which encapsulated all the information in one central place. It involved the use of database design rules (normalization), creation a spatial database using PostgreSQL, geo-referencing and digitizing the PID sheets using ArcGIS software, and posting the results on a digital platform.

Athiru / Ruujine / Ndoleli Adjudication section, in Meru County was used as a case study. Guided by the Land Adjudication Act (Cap.284), data needed for the creation of the database, such as declaration date of an adjudication area, the Minister who declared it, gazettement and gazette notices of the subsequent adjudication sections, publishing of an adjudication section, were identified.

The project has demonstrated how easy and fast it is to query and retrieve information using the digital database, by querying of the database, and data visualization on the web interface, as opposed to the cumbersome, time wasting and manual record-retrieving process that is prone to record mishandling/loss of information.

This approach is highly recommended to the relevant Ministry for adoption and implementation.

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LIST OF ACRONYMS

ASRO	Adjudication Section Records Office
BREAD	Browse-Read-Edit-Add-Delete
Dem-Date	Demarcation Date
ERD	Entity Relationship Diagram
GIS	Geographic Information System
INSPIRE	Infrastructure for Spatial Information in Europe (EU)
KMS	National Survey and Cadastre (Denmark)
LAIS	Land Administration Information System (Rwanda)
LAO	Land Adjudication Officer
LIS	Land Information System
LTR	Land Tenure Regularization (Rwanda)
LTRSS	Land Tenure Regularization Support System (Rwanda)
PID	Preliminary Index Diagram
RIM	Registry Index Map
RNRA	Rwanda Natural Resource Authority
SAD	Senior Assistant Director
SOK	Survey of Kenya

CHAPTER 1: INTRODUCTION

1.1 Background

With the promulgation of the new constitution in 2010, the National Land Policy came into effect. In regards to land information management, the policy recommends the establishment of computerized land information infrastructure that should be made available in a form and language that can be understood by most citizens. (Siriba, Voß and Mulaku, 2011)

Preliminary Index Diagrams (PIDs) are a form of Registry Index Maps (RIMs), which are produced from unrectified aerial photographs. PIDs are used in the registration of land under the Land Adjudication Act (Cap 284) of the laws of Kenya.

PIDs are used in the rural areas mainly for first registration of land. They are usually preferred since they are easy to produce and they only require simple survey techniques. This is meant to speed up the issuance of titles, but this has not been the case as it often takes more than 30 years for an adjudication section to be registered.

Data on how long this whole process takes; from the declaration of an adjudication area by the Minister to the publication of the section and hence issuance of title deeds, is not readily available as it exists in analogue form. This is usually so because the records are scattered in different files, in different departments of the Ministry of Lands and Physical Planning (Departments of Survey and Land Adjudication). Records pertaining to the adjudication registers, PID files and hard copies of the aerial photographs are also not readily available.

The Bogor Declaration recognizes that the key to a successful cadastral system is to ensure that the three main cadastral processes of adjudication of land rights, land transfer and mutation (subdivision or consolidation) are undertaken efficiently, securely and at affordable cost and speed, in support of an efficient and effective land market (FIG, 1996)

A digital database, when incorporated into the production of PIDs, will increase productivity, improve cataloging/ indexing of information, will save on time and costs, can be used to prevent the abuse, misuse, or harmful use of data.

1.2 Statement of the Problem

PID file and map storage has no defined and consistent cataloguing system, and occupies vast physical space. File access and retrieval is often slow and complicated, as information is scattered in different files, offices, sections and departments. In digital form, there won't be any qualms about lack of space, as the aerial photographs will be scanned, digitized and produced as hard copy maps when need be.

Files for the declaration of adjudication sections, gazettement of adjudication areas, photography information etc. are stored separately from their respective PID files, thus hindering full information retrieval. There is need to incorporate all these records at a central place, hence the need for digital database.

A database for PIDs in analogue form / file based is not easily accessible. An efficient storage system, free from such encumbrances was the motivation behind the proposed digital database.

Hence there is need to create digital database for PIDs for easy access and retrieval of PID records.

1.3 Objectives

1.3.1 General Objective

To create a digital database that will be used to search PID records.

1.3.2 Specific Objectives

i) To design a digital database for PIDs.
ii) To construct the digital PID database.
iii) To demonstrate information retrieval from the database
iv) To enable visualization of the database on the web.

1.4 Justification for the Study

Based on the scale of land transactions on the customary land that translate into amendments on the existing PIDs, there is a great need for the creation of a database that caters for the demands that emerge.

An integration of computerized concept in the production of PIDs will provide the option of avoiding information conflict issues, high flexibility, accuracy, consistency,

storage and retrieval resilience that creates a capacity commensurate with contemporary public and private database requirements.

It will also allow for the development of transparent procedures as one will now be able to follow the whole adjudication process, and any discrepancy will be noted.

1.5 Scope and Limitations

1.5.1 Scope of the study

PIDs are used in the vast majority of Kenyan rural lands, and the idea of this project was to develop a digital database system that encapsulates all the details that pertains an adjudication register, plus the spatial aspects of the aerial photographs in a central place.

This project was focused on integrating the graphical representation of PIDs together with the contents of their PID files and the respective adjudication registers for adjudication sections in a centralized database.

The study made use of the Land Adjudication Act (Cap. 284) to determine the key attributes of an adjudication register. Existing data from the Department of Surveys and the Land Adjudication Department (Ministry of Lands and Physical Planning) was used.

1.5.2 Limitations of the Study

(i) Due to time constraints, the project was limited to one adjudication section of Meru County.

(ii) The project did not consider the security of the database as it was purely for academic demonstration purposes.

(iii) There was inadequate data leading to simulation of some data elements, as some files were purported to be misplaced/lost. Details of the parcel owners and Ministry of Land's personnel was also simulated in order to safeguard their privacy.

1.6 Organization of the Report

Chapter One gives a general presentation of the project, which include the problem statement, objectives of the study, relevance of the project, scope of work and limitations encountered in the course of the project research.

Chapter Two discusses in the current of the status of PID storage and documentation at the Ministry of Lands and Physical Planning. It further explains limitations of using analogue / file-based record data retrieval and later examines the benefits of a digital database system. Examples of successful and digital land information systems are cited

Chapter Three gives a description of the study area, an overview of the methodology and brief procedures in database design and data integration are given.

Chapter Four summarizes the outcomes of chapter three, shows how the database functions and gives general comments about the results.

Chapter Five gives the conclusions derived from the results from the previous chapters and recommendations.

References and four appendices follow.

CHAPTER 2: LITERATURE REVIEW

2.1 Preliminary Index Diagrams (PIDs)

A Preliminary Index Diagram (PID) is a type of a Registry Index Map (RIM), but a PID is traced from unrectified and un-controlled aerial photographs, whereas an RIM is from rectified, controlled and hence accurate aerial photographs.

For a PID, parcel boundaries are established and marked by planting hedges. Aerial photography for the entire adjudication area is then carried out where these boundaries would be visible from the air. The aerial photographs are then enlarged to a scale of 1:2,500 so as to facilitate the production of representative diagrams on tracing paper.

For an RIM, acquisition of aerial photographs at the scale of 1: 12,500 is required so as to generate more accurate maps. The new acquisition / re-fly for the more accurate aerial photography is usually expensive, and thus the Government of Kenya abandoned this initiative; this is why PIDs are now the de facto maps in the adjudication process.

For PIDs, file based record keeping is the norm at the Ministry of Lands and Physical planning, but PID records have been expanding at a very fast rate. Because of the rapid expansion, file based record-keeping is already inefficient, time-consuming and prone to abuse.

Use of PIDs for first registration of land in Kenya has served the country well for half a century. However, if the country has to attain its vision of industrialization by the year 2030, there will be a need to modernize the land adjudication process so as to provide a reliable spatial data framework upon which the industrialization concept can be anchored. (Ondulo, 2010)

With the advancement of information technology, a digital database would ease the work of records management and also do away with corruption, incompetence and lack of transparency at the Ministry, leading to improvement of land related services to the general public.

2.2 Current Status of PIDs Records

The Government Mapping Agency (Survey of Kenya) currently produces Preliminary Index Diagrams manually. The Adjudication Section Records Office (ASRO) is the custodian for these PID records.

From the years 2014-2017, the ASRO office is holding an estimated 15,678 PID records. These records (aerial photographs) are stored in cabinets. At the moment, there are 60 cabinets, each holding an approximate of 100 records. Those that are not filed in cabinets for lack of storage space, can usually be seen rolled up, and heaped, one upon the other. Hence in the process, they get torn.

The cataloguing of the cabinets is as per the districts / counties, then the respective sub-locations/adjudication sections. As there are not enough storage cabinets for most of the PIDs and aerial photographs, tracking and retrieving of these records becomes a tedious, difficult and time-consuming task.

Plate 2. 1 PID Records at SOK

Files for the declaration of adjudication sections, gazette notices, date when demarcation and survey started, names of the surveyors involved, date of publishing of the section, are stored separately from their respective PIDs, at times, across the

different departments in the Ministry, and once archived, information is scattered. This is the type of information that can be encapsulated in the digital database.

The cataloguing system for the PIDs at SOK is poor to non-existent, as can be attested by misplaced or lost files/documents. Hence making retrieval complicated and slow.

Therefore, a database is of utmost importance, for keeping track of the details pertaining to PIDs and their respective adjudication sections.

2.3 The PID Production Process

The preparation of PIDs is a responsibility charged to the Director of Surveys as the head of the official government Agency for surveying and mapping.

The PIDs are produced using the conventional methods. An overview of the PID process entails:

a) Declaration of an Adjudication Area

The Minister for Lands declares an area an adjudication area.

An Adjudication officer appointed by the Minister for Lands, declares an area as an "Adjudication Section" *(An area within the Adjudication area which the rights and interests of a person(s) over land should be ascertained and registered).* In consultation with the District Commissioner, he appoints a committee of not less than 10 persons residing within the section. He then appoints Demarcation Officers, Survey Officers and Recording Officers (Government of Kenya, 2012)

b) Sensitization and Field Data Acquisition (Demarcation)

The Demarcation Officer sends out a notice giving the date, time and place where demarcation will begin. In the demarcation process land parcel may be identified in two ways;

- Physically marking on the ground with pegs or marking stones, or
- Pointing to physical features which define the boundary.

c) Compilation

After demarcation, the Survey Officer makes sure that every land parcel is identified by a number, except for roads, railways, lakes and waterways.

Parcel boundaries are then marked on the enlarged aerial photographs which are later used as base maps for the tracing and subsequent production of PIDs.

The Surveyor then computes the areas for every parcel, often by plannimeter.

The adjudication process is illustrated in Figures 2.1 and 2.2

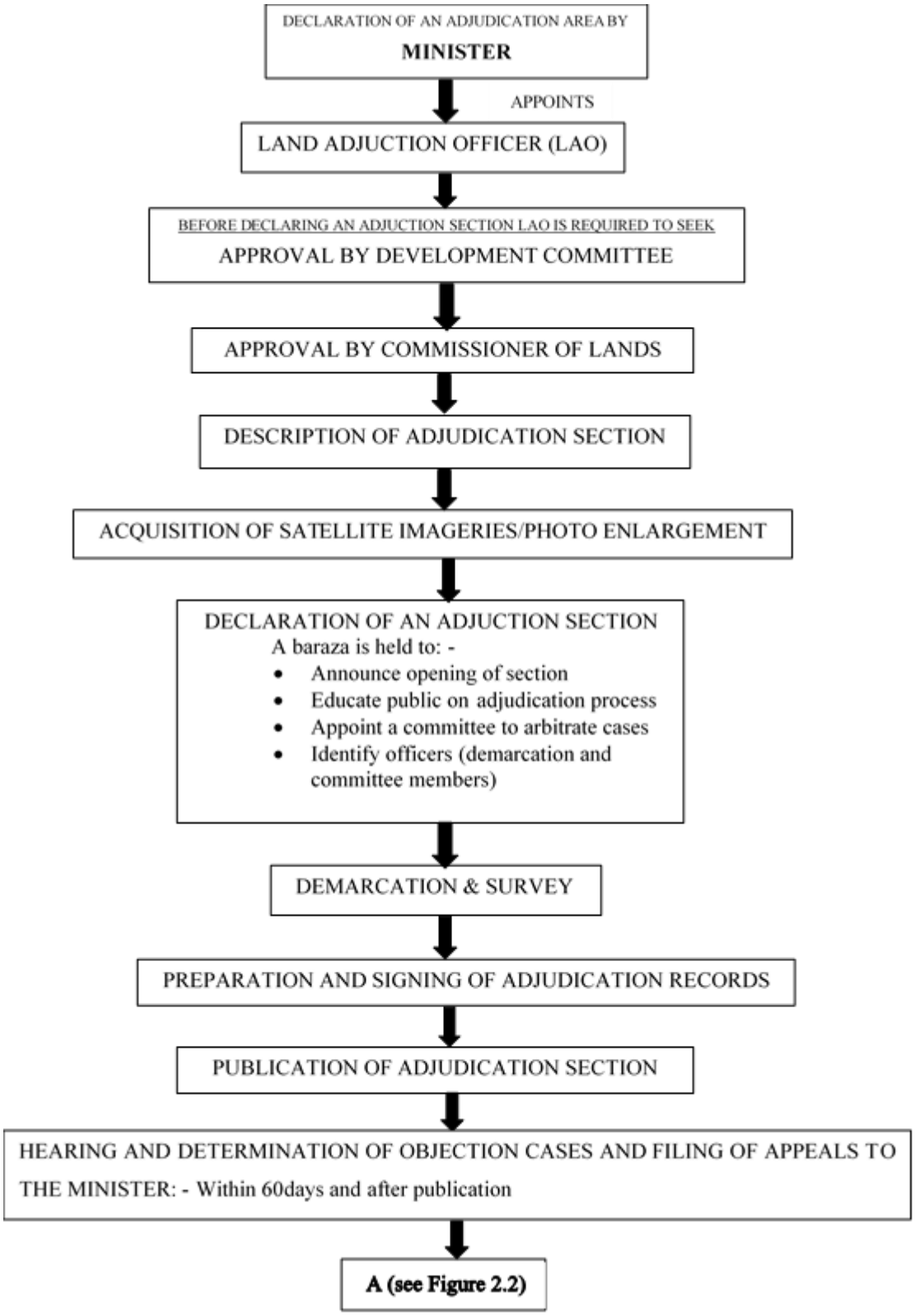


Figure 2. 1 Conveyor Belt for the Adjudication process and PID Production

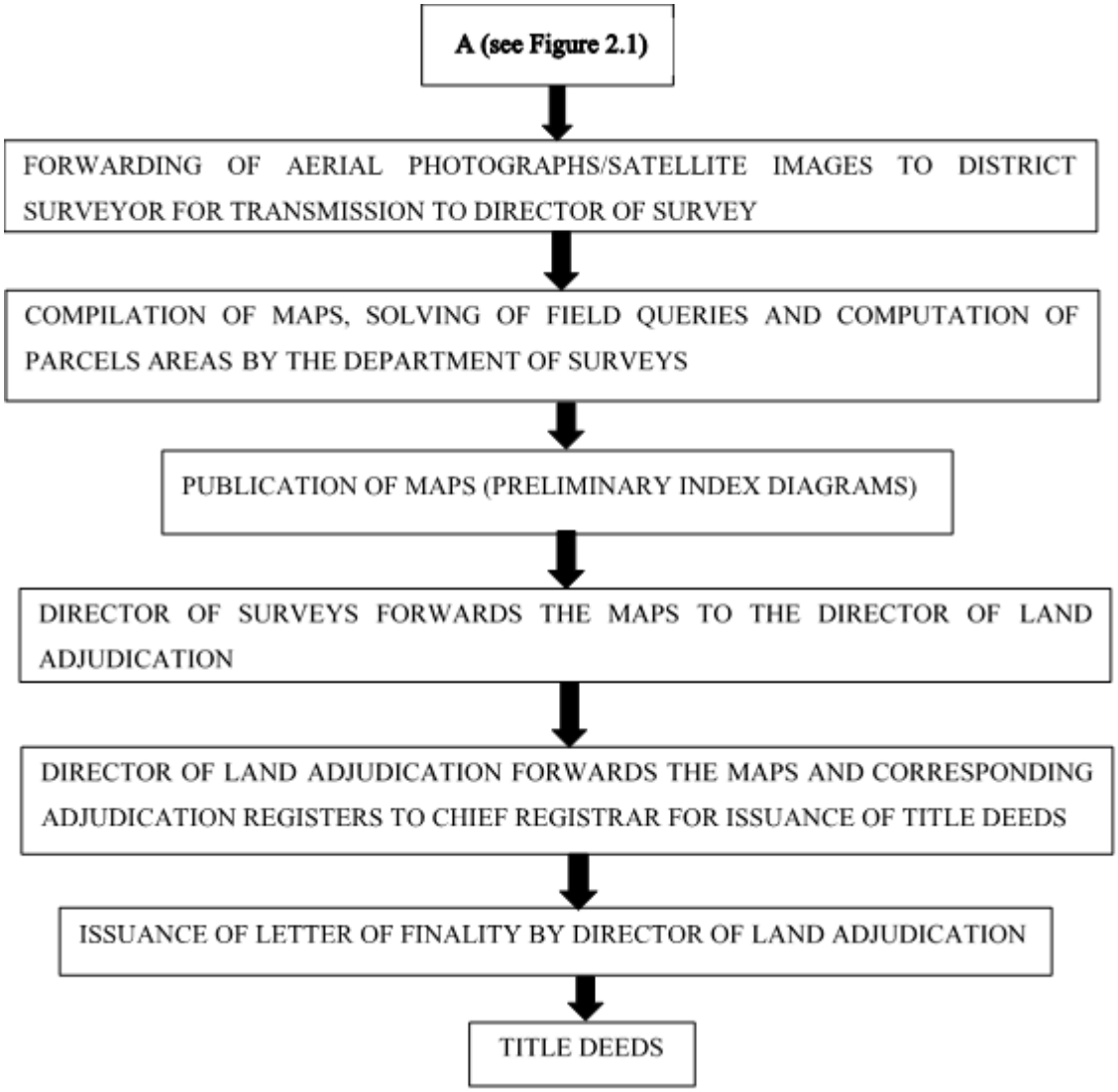


Figure 2. 2 Continuation of the Conveyor Belt

2.4 Drawbacks of the Analogue / File-based System

The current PID file based system at the Departments of Surveys and Land adjudication are outdated and prone to damage and misplacement/loss. It lacks the utilization of technological advancements as record retrieval is done manually, without any modern technological concepts.

- The file based system has created opportunities for corruption, as bribery is the norm when one wants retrieval of any type of record or map.
- There usually arises quarrels and disputes after the issuance of title deeds. As they are usually settled in court, a judge may request for the original PID aerial photograph, which most of the time can't be traced at the Survey of Kenya's ASRO office.

- The adjudication and PID process usually takes longer than usual to finalize, as there are no checks to ensure that the process is on track, running as per schedule. For example, for this case study, the section was declared in December 1990, but demarcation started in 1997, and titles were finally issued in 2017. The process shouldn't take 27 years, but 2 years at most.

2.5 Transitioning to Digital Land Information Systems

Many research initiatives have tried to study land management systems worldwide, and tried to come up with plans and techniques of upgrading land information systems.

Mabruka *et al*. (2008), have discussed about a system that can handle an existing land management system under an IT infrastructure. But the challenge their system faces is the representation of the maps in a database, as querying and updating of the maps is not possible. They have proposed aerial photography and data collection using GPS for representation of land in the digitized system, which would be viable for a country like Kenya, as the costs will be less and the already available resources such as already existing paper maps, will be made use of.

Zhao (2010) writes about a 'One-Map' project for land information system and implementation of E-Governance. It is an online, open-access spatial data platform that avails land data from both the government and non-governmental entities. By supporting multiple data sources, One-Map highlights in a spatially explicit manner the multiple – and sometimes contradictory – claims on land that must be addressed to shift towards a more sustainable use of land resources. (Choudhury *et al.*, 2011)

Wanjohi *et al*. (2015) talks about developing a web based Land Information System for the Ministry of Lands and Physical Planning, a shift from the paper-based system. They argue that the file-based system has posed a great challenge and difficulty in effectively referring to records and timely retrieval, and hence the entire process has become inefficient, time consuming, unreliable, restrictive, and costly, thereby undermining efficiency and effectiveness in service delivery. They proposed an integrated and centralized GIS-based Land Information Management System, whose main objective would be to provide land details on ownership, land use, encumbrances, taxation among other details, and to disseminate this information via the web.

2.6 Case Studies

Most developing countries are digitizing their land records and creating large, national databases. Land-related data are now being integrated, analyzed, and distributed in multi-disciplinary ways. (Dale and McLaren, 2005)

2.6.1 Denmark

Denmark is among the countries presently in a leading position internationally in regards to e-government development. The Danish government has been successfully using digitized systems to improve administrative services in the public sector. (The Danish E-government, 2010)

The Danish cadastre consists of the cadastral maps and register.

The National Survey and Cadastre (KMS) is Denmark's responsible authority for the implementation of the European directive INSPIRE. KMS transitioned from the traditional mapping techniques, and embraced the digitization of their spatial records in response to the rapidly advancing technological breakthroughs.

The cadastre being the basis for property registration in Denmark, a restructure of the cadastral systems and procedures was done and it has improved efficiency of land administration in the country. The cadastre and cadastral map have a fully integrated component of the national spatial data infrastructure, and it meets the criteria of a multifunctional cadastre, thus having a paperless system and hence paperless processes. The cadastral archives have also been digitized and integrated into the NSDI where they complement other online services, thereby increasing access to KMS' records to all. (Dael *et al.*, 2007)

Ting, L. (2002) describes the integrated land information as a network of interactive subsystems containing the most relevant information, which contains all key identifications within each of the subsystems such as parcel number, building number and address, and the cross-reference between these identifications. Thus it is possible to obtain all available information on a specific property or building by knowing only one of the keys. The identification-keys are also linked into the relevant physical element represented in the digital cadastral and topographic maps. (Buentjen, Lourdes Reyes and Serrat, 2015)

Presently, the Danish cadastre is a basic digital infrastructural tool in the country's Land Information System assisting in all matters related to land and supporting e-governance via use of spatial data. (Yomralioglu and Mc Laughlin, 2017)

2.6.2 Rwanda

Rwanda is the only country in Africa that has succeeded in documenting all rights to land. Following passage of the 2005 Organic Land Law, Rwanda embarked on a process to adjudicate and subsequently register rights to all urban and rural land parcels. By 2015, all land parcels were demarcated using general boundaries and entered into the land information system. (Hilhorst, Dorothea Huberta Maria; Meunier, 2015)

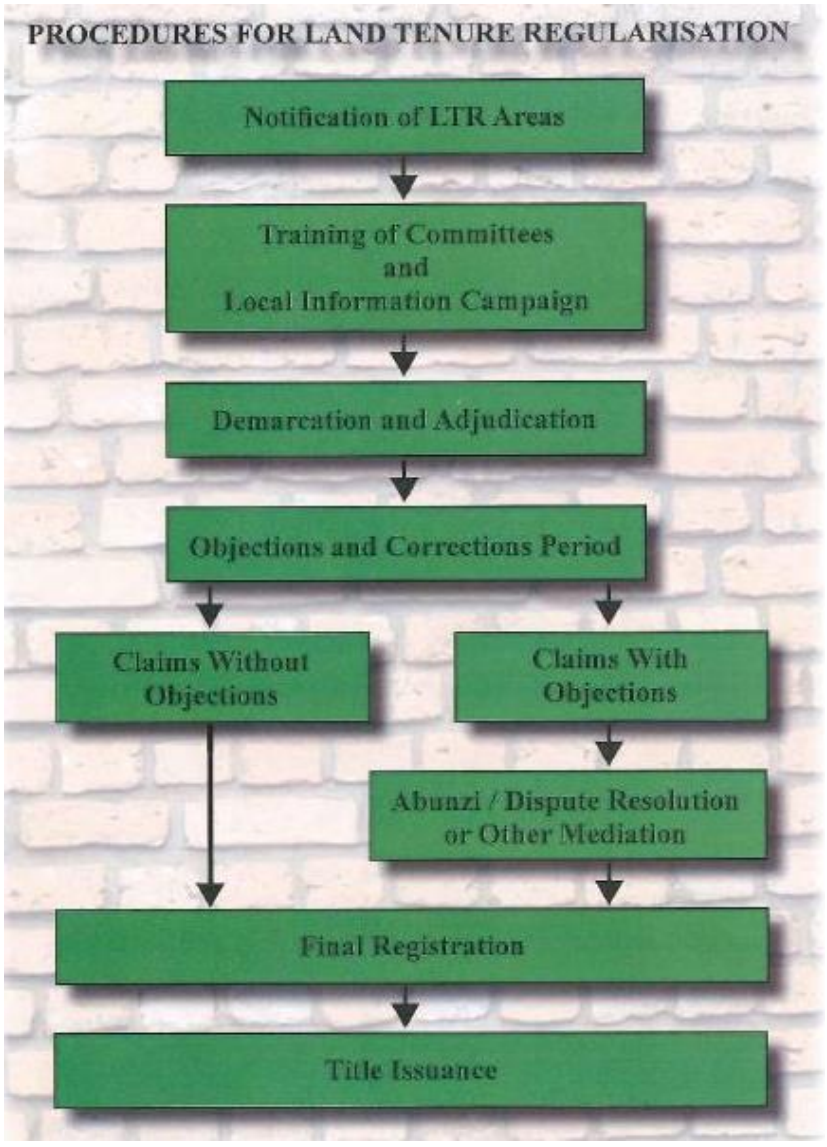


Plate 2. 2 The Adjudication Process in Rwanda

Source: (Gillingham and Buckle, 2014)

Rwanda's Land Information System was put in place through a program called Land Tenure Regularization, where general boundaries were used to demarcated parcels on ortho-rectified photos or satellite images. Both spatial and non-spatial land information were recorded using the Geographic Information System (GIS) and the Land Tenure Regularization Support System. The two systems were connected by a unique Parcel Identifier linking the parcel information to its owner. Presently, the non-spatial information stored in the Land Tenure Regularization Support System (LTRSS) has been migrated into a web-based land registration tool known as Land Administration Information System (LAIS). The spatial component has been added into the LAIS to form a complete digital National Land Register. (RNRA, 2012) (Biraro, 2014)

Rwandans can now easily check the status of a particular plot of land by using their mobile phones, as opposed to the long queues at land offices. Subscribers need to dial a short code, which brings up a menu from where one selects the language to be used and enters the plot number. The system then fetches and displays information about the requested plot number. (Bigabo, 2016)

Plate 2. 3 Phone menu that leads to Land Information access

Source:http://ktpress.rw/2016/04/new-phone-system-now-allows-rwandans-to-access-status-of-land/

CHAPTER 3: MATERIALS AND METHODS

3.1 Study Area

Meru as a county, has four (4) adjudication areas namely; Imenti, Buuri, Tigania and Igembe. Each adjudication area has several adjudication sections. Typically, an adjudication section is defined by a sub-location.

The scope of this study was Athiru/Ruujine/Ndoleli Adjudication Section, in Igembe adjudication area, within Meru County. (See Figures 3.1 and 3.2)

Athiru/Ruujine/Ndoleli Adjudication section was declared in December 1990.
Forty (40) enlarged aerial photographs at the scale of 1: 2,500 cover the section. The section has a total of 14, 541 demarcated parcels.

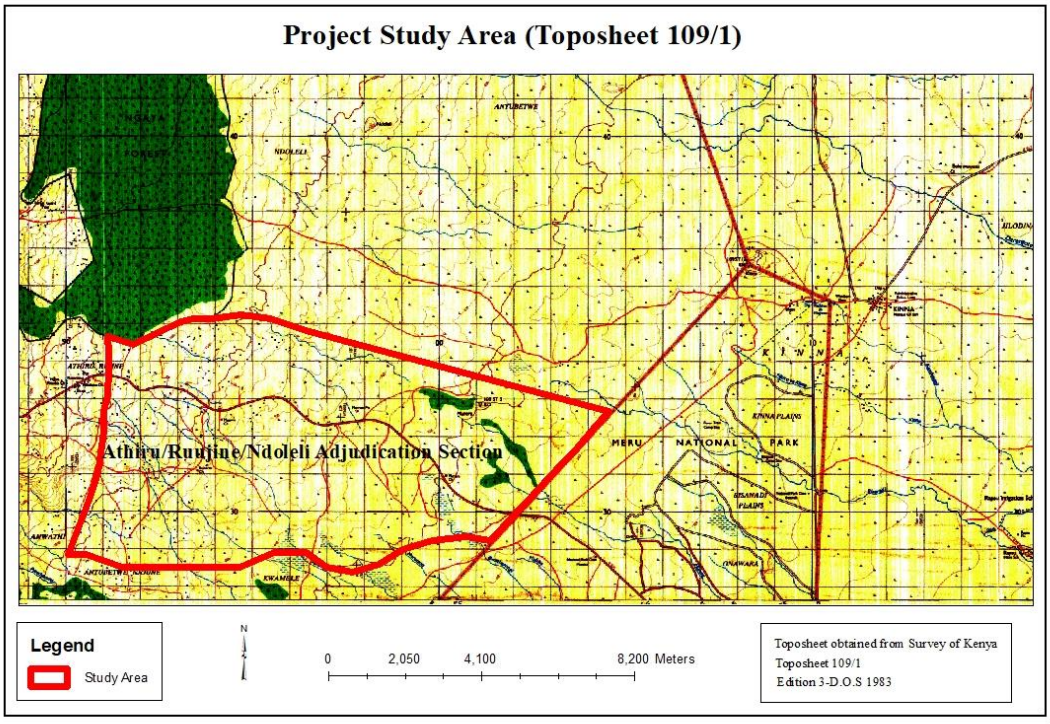
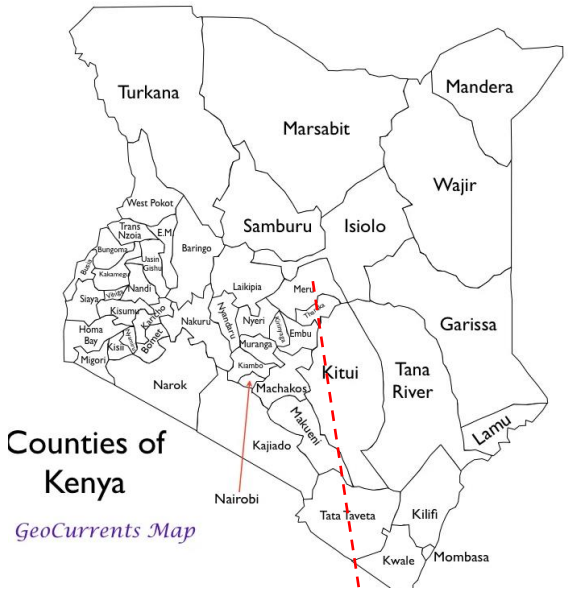
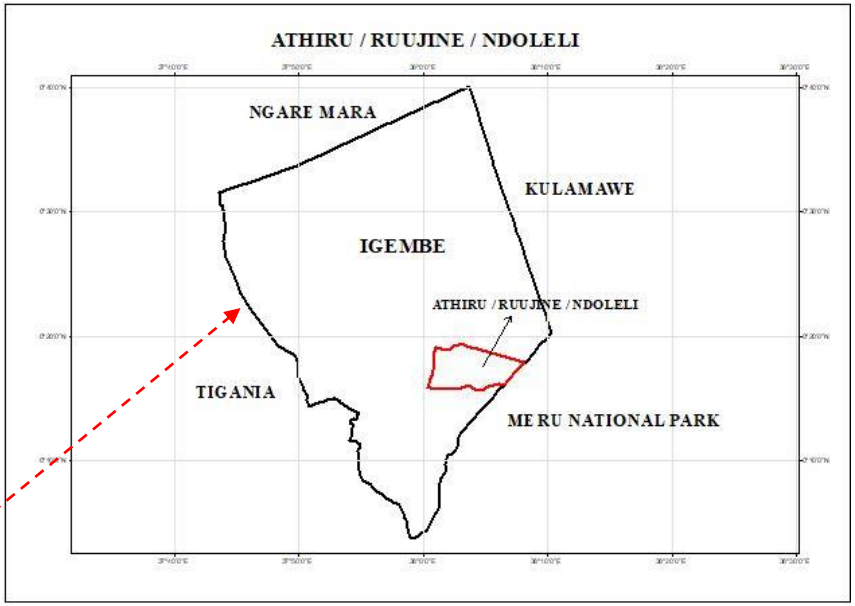


Figure 3. 1 Study Area with the Section boundary overlaid on topographical map





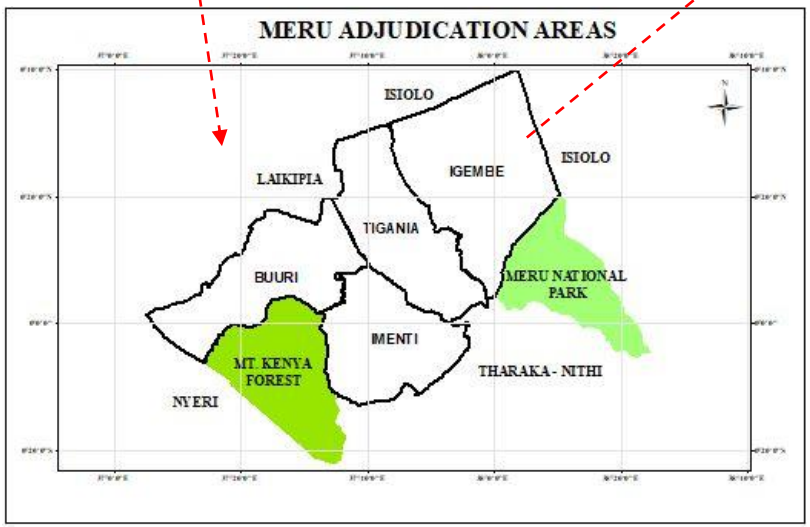


Figure 3. 2 Maps showing the study area

3.2 Overview of Methodology

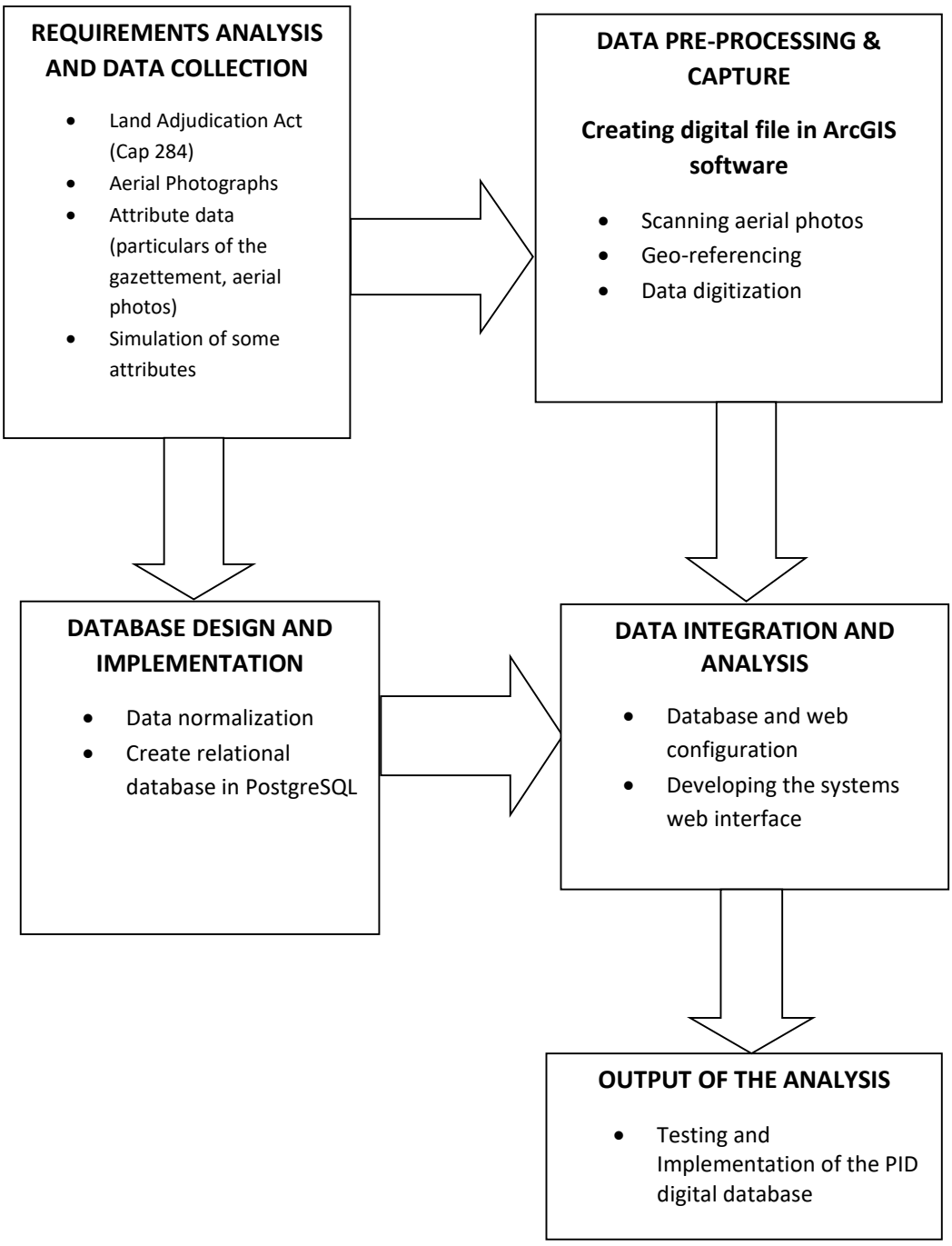


Figure 3. 3 Overview of Project methodology

3.3 Data Sources and Tools

3.3.1 Data Sources

1. **Attribute Data**

a) Land Adjudication Department

- Dates of declaration for adjudication areas and sections
- Gazettement details for declaration of adjudication sections
- Records of names of demarcation officers, LAO, committee members and chairpersons of sections.

b) Survey Department

- Aerial photographs details (photo ID, camera type, focal length, scale, date of capture)
- Parcel details (Parcel ID, Area, PID No)
- PID details

2. **Spatial Data**

Aerial photographs for the Adjudication section were obtained, at an enlarged scale of 1: 2,500 from the Survey of Kenya, Ruaraka.

These aerial photographs were scanned using a flatbed scanner, georeferenced and the parcels within each aerial photograph digitized.

3.3.2 Tools

Hardware

- HP Pavilion Laptop; Intel® Core ™ i7-4510U @2.60 GHz, 1 TB hard Disk, 8 GB RAM, 15.6" LED Display and running 64-bit Windows 10
- Map Master XL flatbed scanner
- A RICOH Aficio MP 9002 SP color printer
- 32 GB HP flash disk

Software

- ArcGIS version 10.x
- PostgreSQL
- Microsoft Office 2016 Suite
- Ubuntu 16.04

3.4 Database Design

The design focused on the user needs and involved the following stages: -

- Creation of an External model
- Creation of a Conceptual model
- Creation of a Logical model
- System Design and Development
- System Testing and Implementation

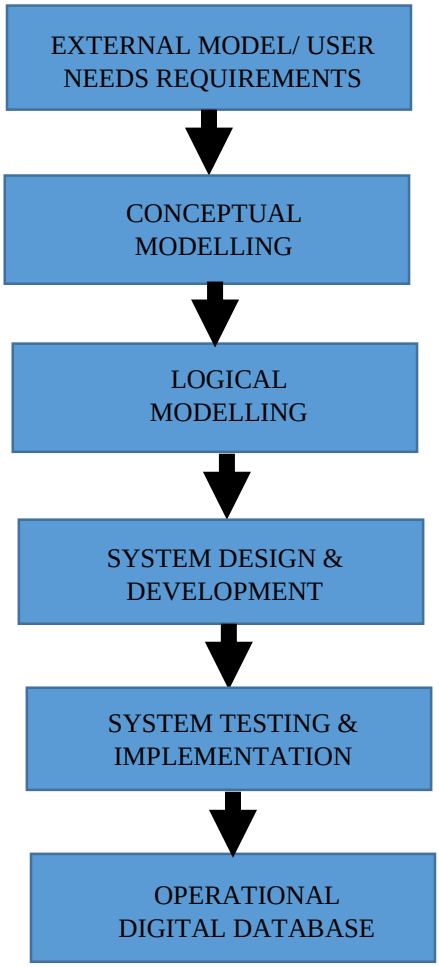


Figure 3. 4 Phases of Database Design

3.4.1 External Modelling / User Need Requirements

Potential users of the database were determined together with their information needs. The data that was required to satisfy those needs was identified through consultation and discussion with the various users of the proposed database.

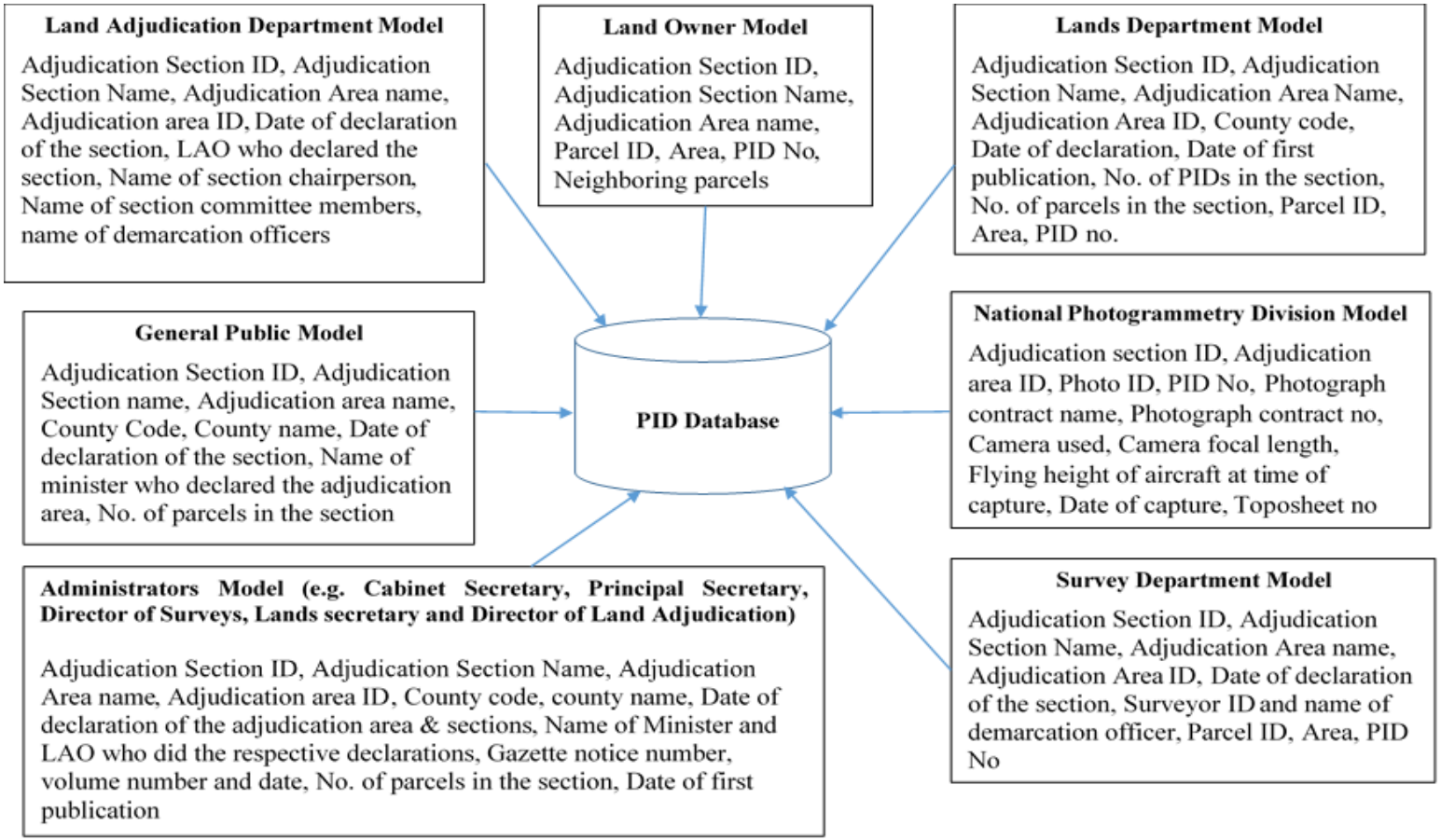


Figure 3. 5 External Model

3.4.2 Conceptual Modelling

Conceptual modelling is the use of Entity Relationship (E-R) diagrams which show all entities involved, their attributes and relationships.

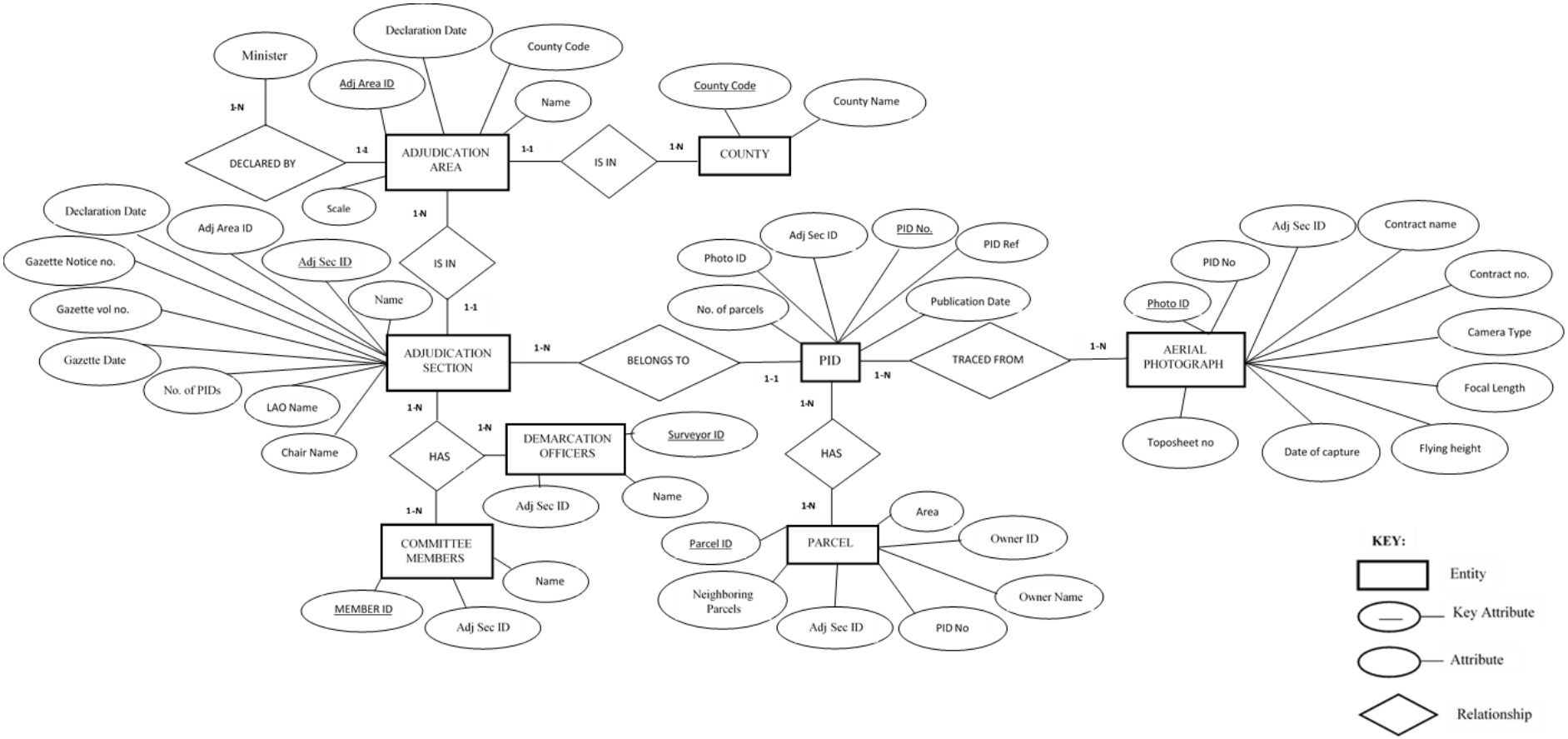


Figure 3. 6 Conceptual Model

3.4.3 Logical Modelling

Logical modelling is the design and normalization of the relational tables according to entities, attributes and relations identified from conceptual modelling.

Relation 1: Counties (County code, County Name)

Relation 2: Adjudication Areas (Adjctn area ID, Adjctn Area Name, County code, Date of declaration, Scale of the maps in the adjudication area, Minister who declared the adjudication area)

Relation 3: Adjudication Sections (Adjctn Sec ID, Adjctn Sec Name, Adjctn Area ID, County code, Date of declaration, LAO who declared the section, Gazette Notice no, Gazette Volume number, Gazette date, No. of PIDs in the section, No. of PIDs, Total parcels in the section, Name of chairperson of the section)

Relation 4: Aerial Photographs (Photo ID, PID No., Adjctn sec ID, Adjctn area ID, Photograph contract name, Photograph contract no, Camera used, Camera focal length, Flying height, Date of capture, Toposheet no)

Relation 5: Parcels (Parcel ID, PID No., Adjctn Sec ID, Area, Neighboring parcels, Owner ID, Owner Name)

Relation 6: Preliminary Index Diagrams (PIDs) (PID No., PID Ref No, Adjctn Sec ID, No. of parcels, Publication Date)

Relation 7: Demarcation officers (Surveyor ID, Surveyor name, Adjctn Sec ID)

Relation 8: Adjudication Section Committees (Committee member ID, Committee Member name, Adjctn Sec ID)

Relation 1: Counties

County Code	County Name

Relation 2: Adjudication Areas

Area_ID	Area_Name	County _Cod	Dec_Date	Scale	Minister

Relation 3: Adjudication Sections

Adj_Sec _ID	Sectn_ Name	Area_ID	County_Cod	Dec_Date	LAO_Name	Gazette_No	Gazete_Vol	Gazete_Dat

No_of_ PIDs	Total_Parc	Chair_Name

Relation 4: Aerial Photographs

Photo ID	PID_No	Adj_Sec _ID	Contract No	Contract Name	Camera Type	Focal Length(mm)	Flying Height (m)

Date of Capture	Toposheet No.

Relation 5: Parcels

Parcel_ID	PID_No	Adj_Sec _ID	Area_ha	Neighbors	Owner_ID	Owner_Name

Relation 6: Preliminary Index Diagrams (PIDs)

PID_No	PID Ref No	Adj_Sec _ID	No. of Parcels	Publication Date

Relation 7: Demarcation officers

Surveyor ID	Name	Adj_Sec _ID

Relation 8: Adjudication Section Committees

Member ID	Name	Adj_Sec _ID

3.4.4 System Design and Development

The system comprises of two user side modules: the public and a staff viewer. Both of them fetch data from a PostgreSQL database. The public viewer module shows a simple view of the data including maps, tables and a pdf viewer for the PID section while the staff viewer has a role-based view that shows specific tables for each staff department.

The sections that the system displays in the two modules are:

1. Adjudication Areas
2. Adjudication Sections
3. Aerial Photographs
4. Parcels
5. PIDs
6. Demarcation Officers
7. Committee Members

The system is set up on an Ubuntu Server version 16.04 with PHP version 7.2. The other libraries it uses are Laravel version 5.6 and Leaflet JS. Database support is offered by PostgreSQL.

The system was built up using a Model-View-Controller (MVC) architecture which separates these components into specific classes that are encapsulated in each of them which reduces duplication and increases interconnectivity. These three main logical components: model, view, and the controller, are built to handle specific development

aspects of an application. MVC is the most frequently used industry-standard web development framework for creating scalable and extensible projects.

There are 8 models in the system, of which 7 belong to each section mentioned above and the last one is for authorization. These models contain connection to specific database tables for each section as well as relationship bonds for related tables based on foreign keys.

There is one controller that interfaces with the models and controls how data is extracted and abstracted with each user's request. It also passes this data into the views which display information for each section. The views section holds the PHP – HTML – JavaScript (JS) - CSS scripts that are responsible for the visible features and their styling.

Laravel has a unique database creation feature called Migrations. These migrations hold instructions for table and schema alteration, creation and historical information that tracks all changes which enables for rolling back of the system to previous versions.

Voyager was used to build the administration panel that interfaces with the authorization model and has a feature for creation of roles including (Browse-Read-Edit-Add-Delete) BREAD permissions definition in the individual table fields as well as for each user role. The user roles that are within the system are:

1. Principal Land Adjudication Officer
2. County/District Surveyor/Director of Surveys
3. Senior Assistant Director for Photogrammetry
4. Director of Land Adjudication
5. Normal User
6. Administrator

The staff roles are assigned by the administrator for each of them otherwise they are signed in normal users which means they cannot log into the administration section.

3.4.5 System Testing and Implementation

The two users of this system who won't need log in credentials are the Land Owner and the General public, who have been categorized as 'Normal User'. As most of this data is usually collected on the tax payers' money, it is only fair that there aren't any

restrictions when it comes to accessing the said records. The normal user will only be able to browse/view data that is categorized as public information in the database but cannot make any changes on the data.

The other stakeholders will have to log in when need be as they have the rights to make changes on the database tables specific to their fields of expertise, as the Ministry of Lands and Physical Planning has a myriad of professions, each with different mandates.

Some of the BREAD Roles include: -

(i) Director of Land Adjudication / Principal Land Adjudication Officer – Have the right to view, edit and delete only the Adjudication Sections table.

(ii) SAD Photogrammetry – Has the right to make changes on only the Aerial Photograph table, and no other.

(iii) County / District surveyor – Can add or edit the Parcel table specific fields (Parcel ID, PID No, Area) and PID tables in case of a subdivision or boundary dispute.

(iv) Land Registrar – Can also make changes on the Parcel table in certain fields only (Owner ID and Owner Name). See Figure 3.7

Some of the information in the tables cannot be changed for accountability purposes. They include the Demarcation Officers and Committee members' tables. Only the Super admin can delete entries already entered into the database.

Note: - Only the fields that are of importance to the user can be viewed. Otherwise, the super admin and logged in users (staff) can view all the fields in the tables.

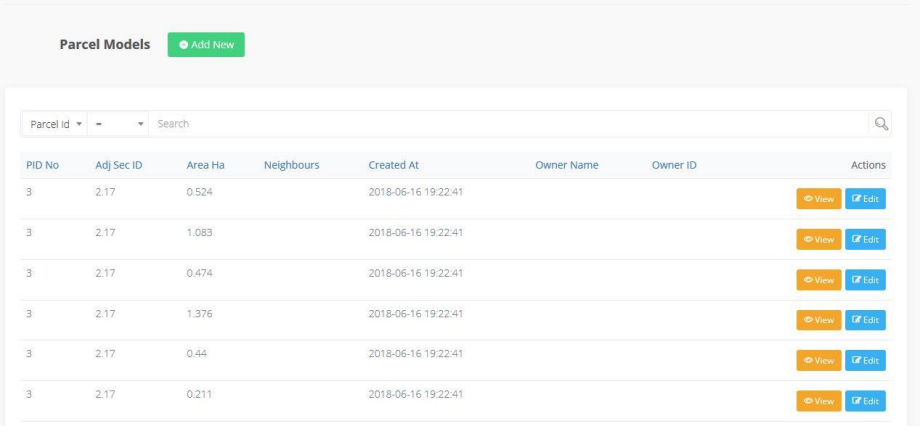


Figure 3. 7 Registrar BREAD Roles

3.5 Data Capture and Processing

3.5.1 Scanning

Each enlarged aerial photograph was scanned at Survey of Kenya offices using a flatbed scanner (Map Master XL). This enabled the conversion of hard copy to raster data model. Sample of a scanned aerial photo is shown in Plate 3.1

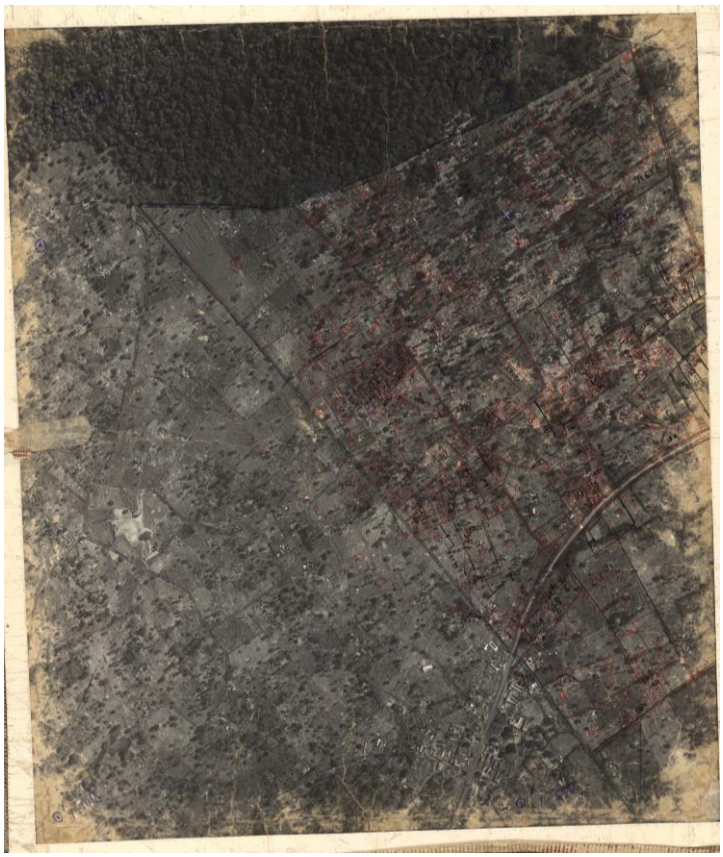


Plate 3. 1 Scanned PID, Original Scale 1:2,500

(Source: The National Titling Centre, Survey of Kenya)

3.5.2 Geo-referencing

This refers to assigning ground co-ordinates to a planar image or map. This enables the data to be viewed, queried and analyzed in relation to other geographic data.

The following was the procedure for geo-referencing: -

(i) ArcMap was launched and the topographical map in which the enlarged PID falls, was added.

(ii) The topographical map was geo-referenced using the coordinates provided on the map frame, then projected.

(iii) The PID raster data set was added.

(iv) Prominent features which were easily identifiable on the PID, and correspond to the topographical map were matched, e.g. the sharp edge of Ngaya forest or

the curvature of Farm-Murera road, are very distinct on both the topo map and the PID. This was matched from the PID to the topographical map i.e. from an unknown reference system to a known reference system. (See Figure 3.8)

The PID raster data set was rectified then saved in the working folder to create a new geo-referenced data set.

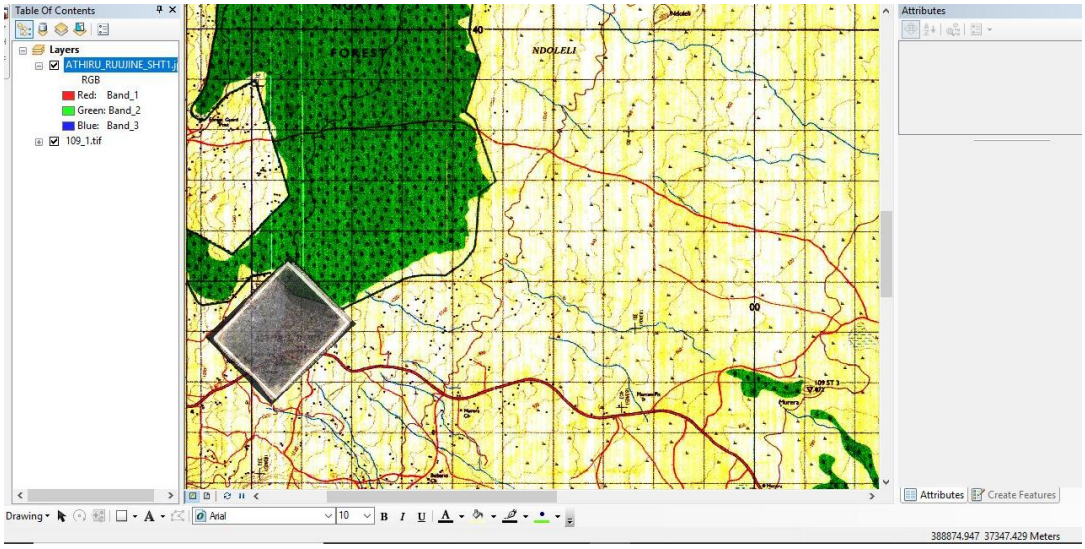


Figure 3. 8 Geo-referencing of the PID

The same was done for the other sheets, thus forming a mosaic of Athiru / Ruujine / Ndoleli Adjudication Section. (See Figure 3.9)

3.5.3 PID Referencing

This is usually done through the process of enlargement, where a toposheet is enlarged from a scale of 1: 50,000 to 1: 2,500, so as to conform with the scale of the PIDs.

The enlarged sheets are then overlain on the PIDs so as to get the toposheet reference for each PID. (Figure 3.10 and 3.11)

3.5.4 Digitizing

This is the process through which raster data is transformed to vector data format.

For the spatial data, attribute data associated with the adjudication section relating to the PIDs was input.

Table 3.1 lists the parameters used for the vector datasets.

Procedure for digitizing: -

(i) The geo-referenced raster dataset was added onto ArcMap.

(ii) The parcel boundaries were digitized onscreen by tracing the boundaries of the parcels. A section of digitised parcels and attribute table from one of the PIDs covering the area of study is shown in Figure 3.12

(iii)After all the sheets have been digitized, they form a seamless mosaic as shown in Figure 3.13

Figure 3. 9 Mosaic built from the geo-referenced and rectified PIDs

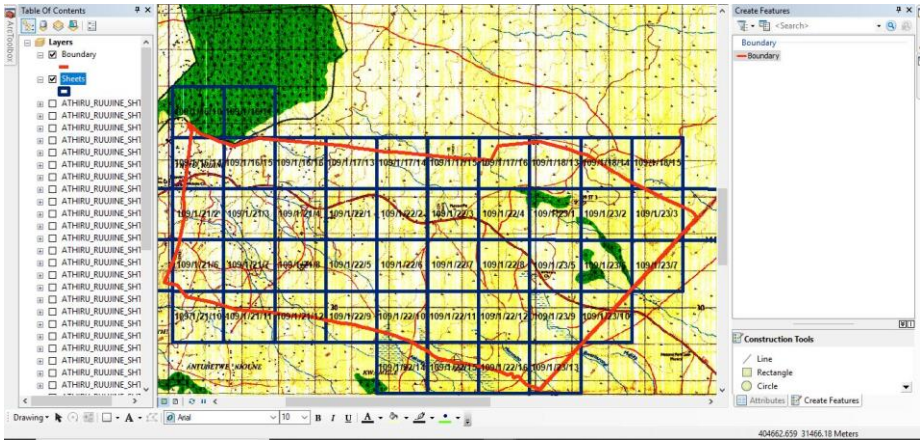


Figure 3. 10 Toposheet enlargement at scale 1: 2,500 and the section boundary overlain on Topo 109/1

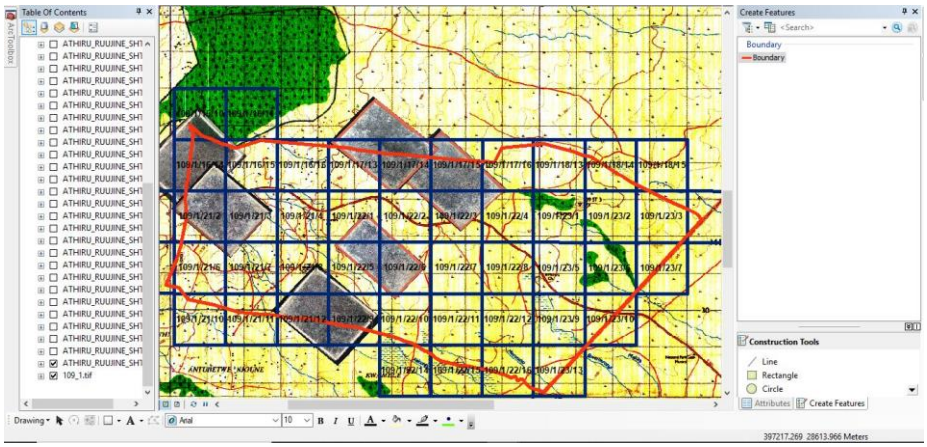


Figure 3. 11 PID referencing on Toposheet

Table 3. 1 Coordinate system parameters used

Grid	UTM zone 37N
Projection	Transverse Mercator
Spheroid	Clarke 1880
Unit of measurement	Meters
Central Meridian	39.0
Latitude of origin	Equator (0)
Scale factor at origin	0.9996
False coordinates	500 000 Easting 0 Northing
Datum	Arc 1960

3.5.5 Data Integration on the web

So as to integrate the spatial data into the database, the spatial files (shapefile) were converted into GeoJSON format. This was done using the http://mapshaper.org/ website.

The steps illustrated in Figures 3.14 to 3.16 were followed: -

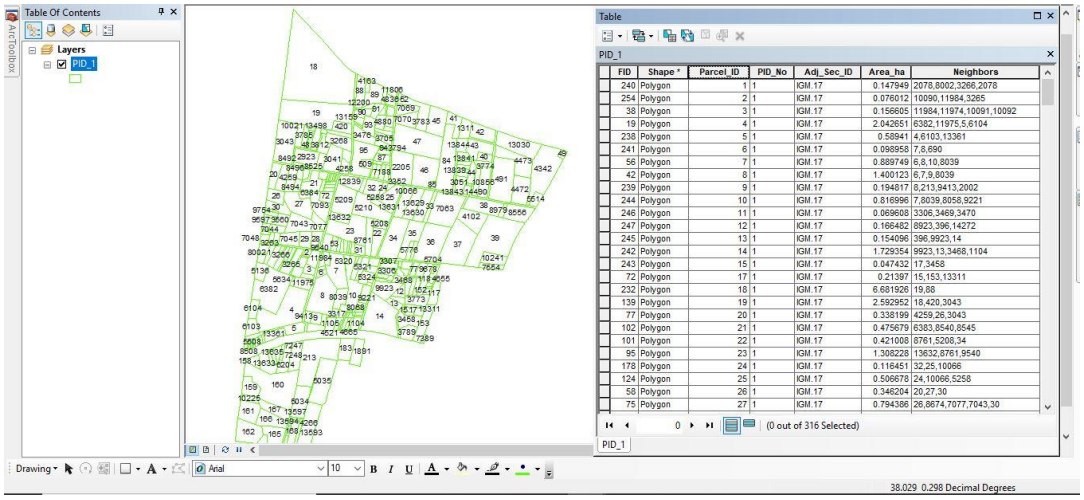


Figure 3. 12 A digitized PID with its attribute table

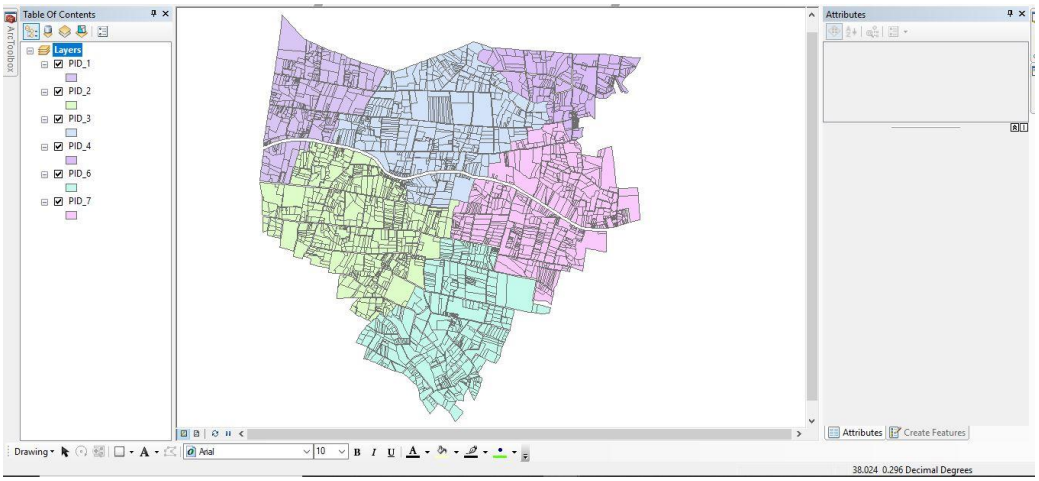


Figure 3. 13 Mosaic resulting from the digitized parcels from PIDs

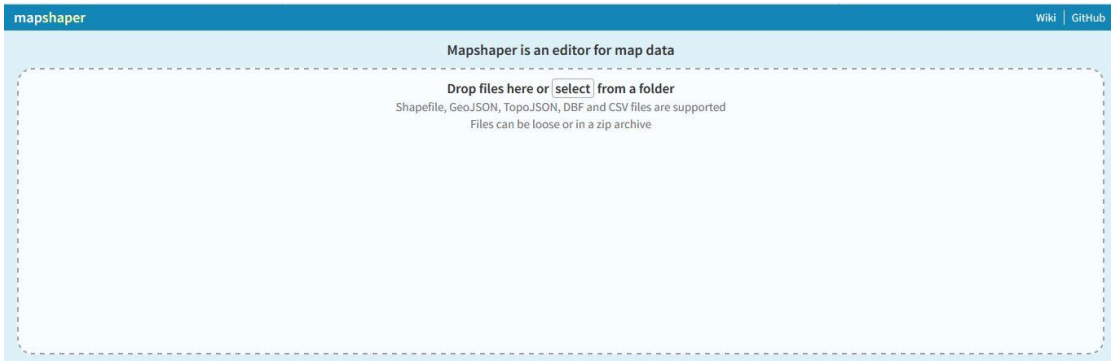


Figure 3. 14 The mapshaper.org, interface.

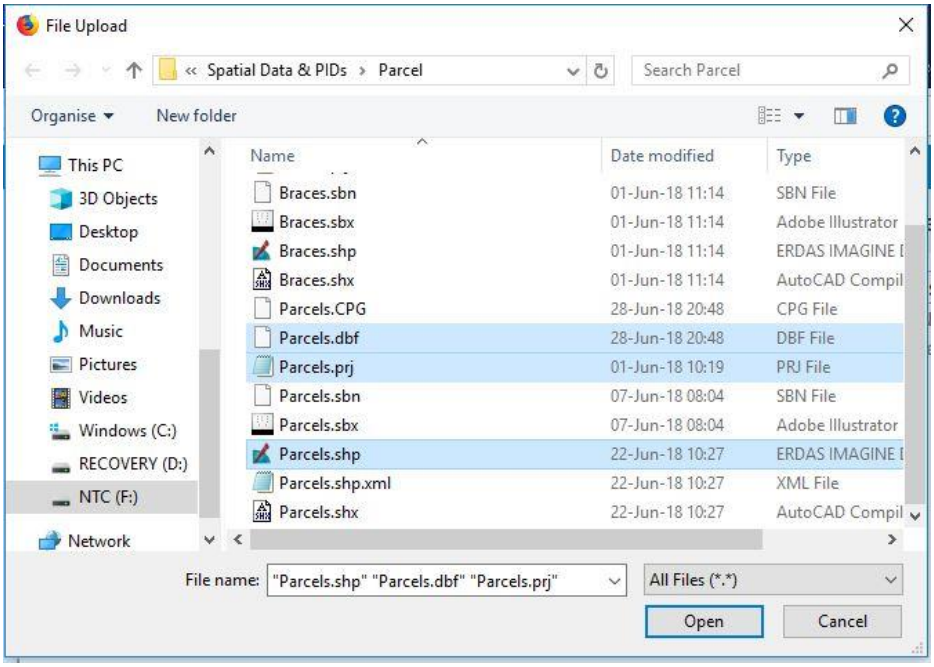


Figure 3. 15 Selection of the relevant file extensions

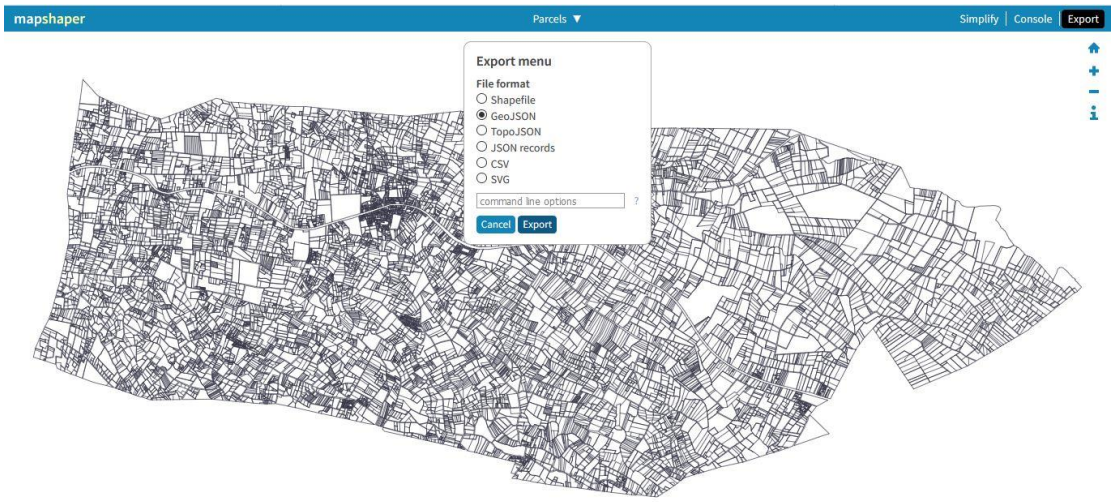


Figure 3. 16 Exporting the shapefile in GeoJSON format

The GeoJSON file format for spatial data is light, as the file size can be reduced to as much as 70% without affecting the map appearance, hence the most suitable for data visualization on the web.

The database and web platform can be accessed via http://landinfo.glenwell.com/

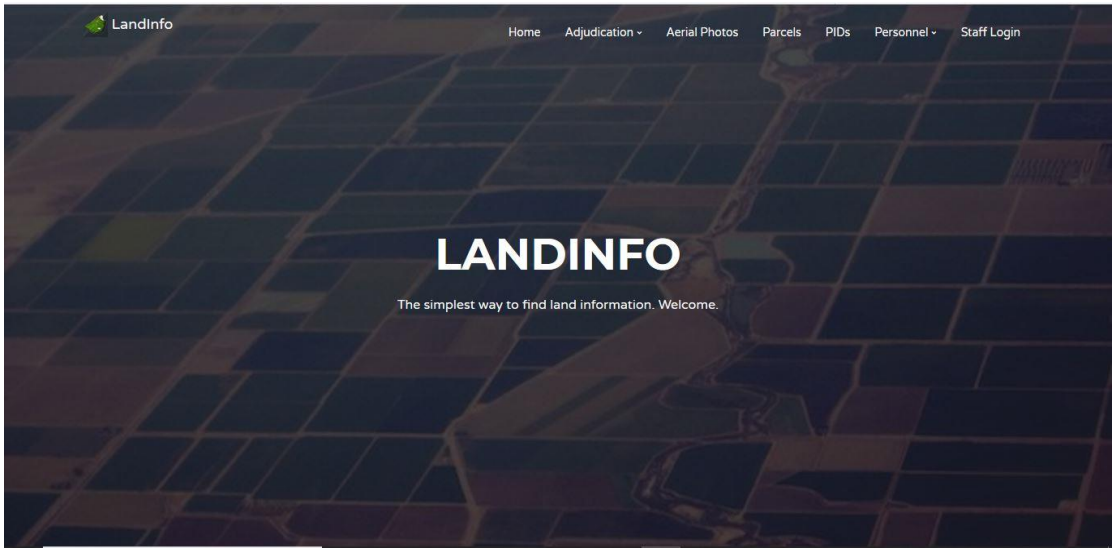


Figure 3. 17 Land Info Home Page

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Information Retrieval from the Database

Sample data was used to illustrate some of the major queries stakeholders may be interested in. The key stakeholders are:

- Land Owner
- General Public
- Survey Department
- Lands Department

4.1.1 Land Owner

Land owners who have parcels in an adjudication section can easily query and retrieve information pertaining to their parcels by simply keying in their National ID number.

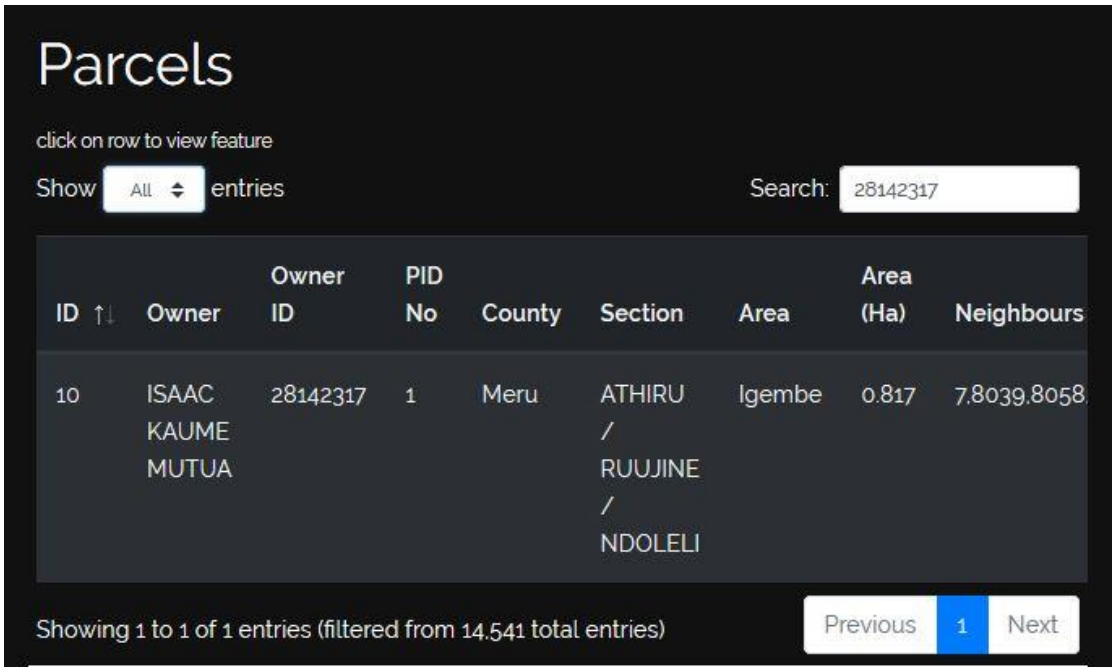


Figure 4. 1 Query displaying parcel details

All the parcels that the land owner owns will be listed, with the parcel ID (10), Owner Name, Owner ID, PID sheet on which the parcel falls on, area and neighboring parcels displayed as seen in Figure 4.1

4.1.2 General Public

As it is usually public information, the general public would like to know the adjudication section details, like how many parcels are in an adjudication section, who was the chairperson of the said section and who were the section committee members.

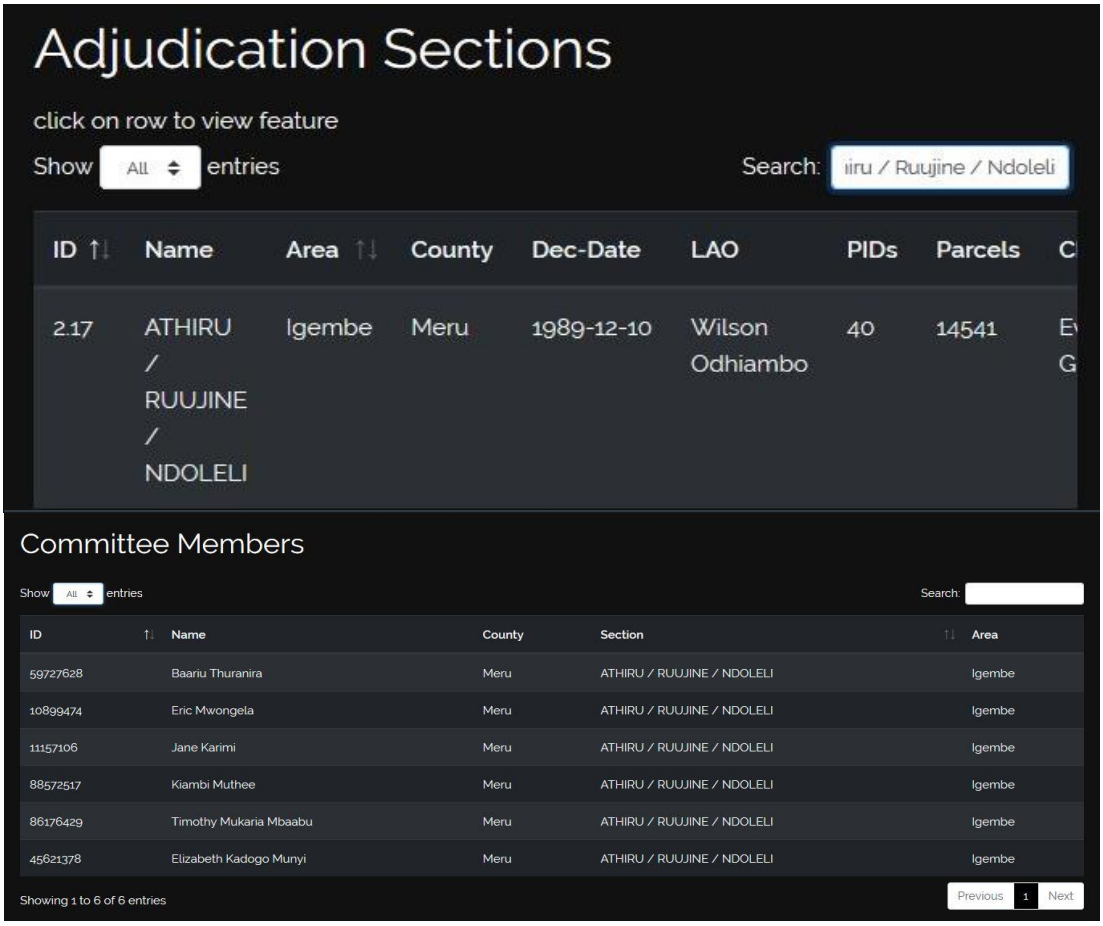


Figure 4. 2 Query displaying details for an adjudication Section and committee members

4.1.3 Survey Department

The survey department (Director of Surveys and or District Surveyor) may be interested in knowing who were the surveyors who demarcated a certain section in case any queries regarding an adjudication section arises. All they need to do is enter the adjudication section name, and all the demarcation officers for that section will be listed as shown in Figure 4.3

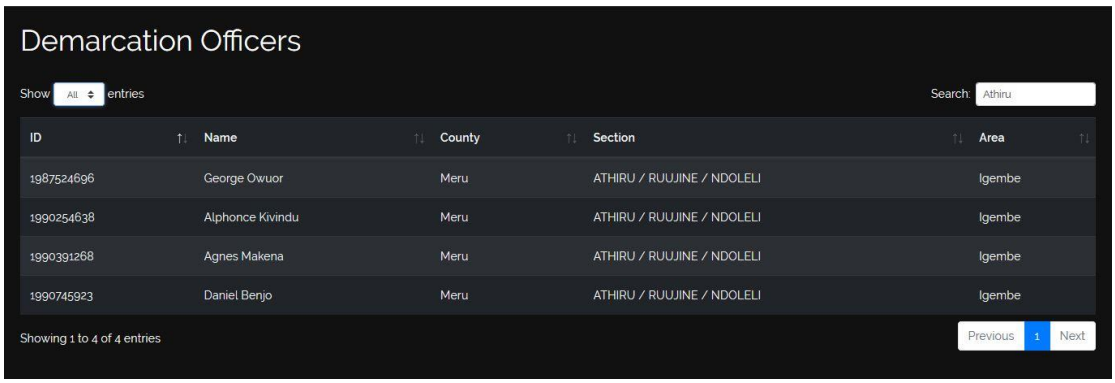


Figure 4. 3 Query listing demarcation officers of an adjudication section

4.1.4 Lands Department

A registrar at the Lands department will be interested in knowing details pertaining to a PIDs. For example, how many parcels a given PID has, date of first publication for PIDs of a section and would also like to have a copy of the PID map for resolution of queries arising after the titling process.

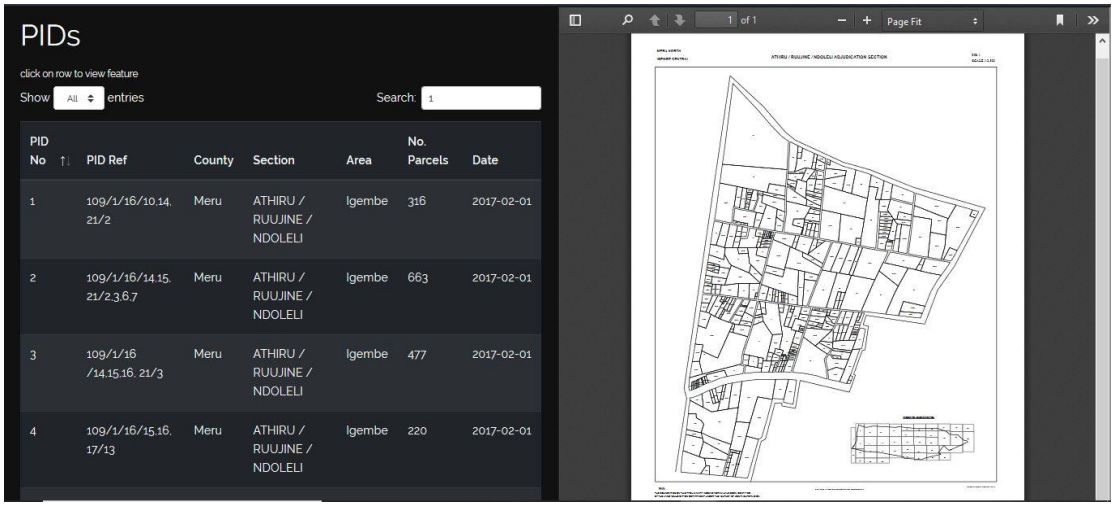


Figure 4. 4 Query displaying PID details and a downloadable format of the PID

4.2 Data Visualization on the Web

Data which had a spatial component, were converted to GeoJSON file format so that they could be viewed on the web, for easy spatial reference.

Data that had spatial reference were the adjudication areas, adjudication sections and parcel tables.

4.2.1 Adjudication Areas

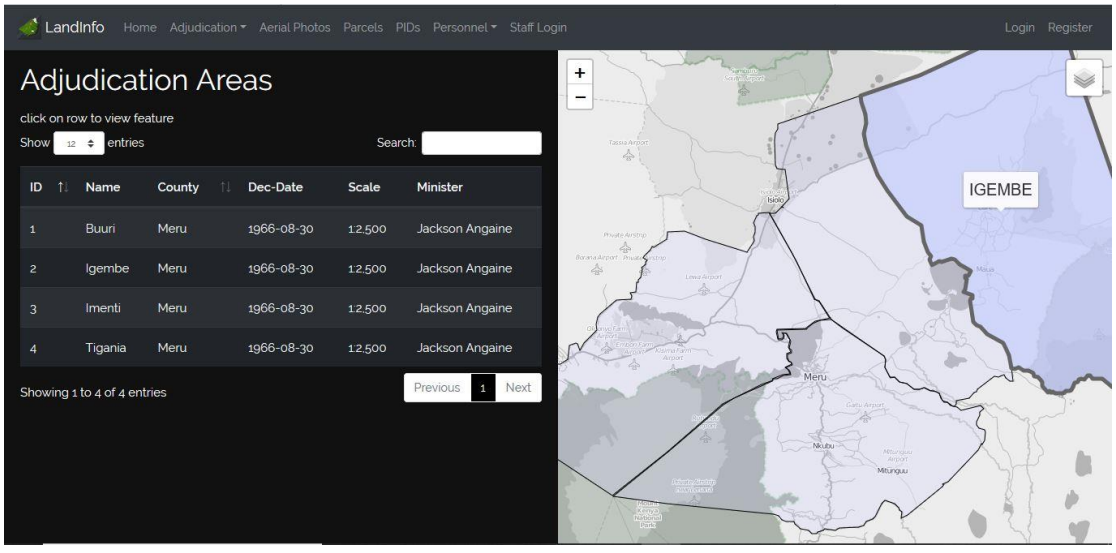


Figure 4. 5 Web visualization of Adjudication Areas

4.2.2 Adjudication Sections

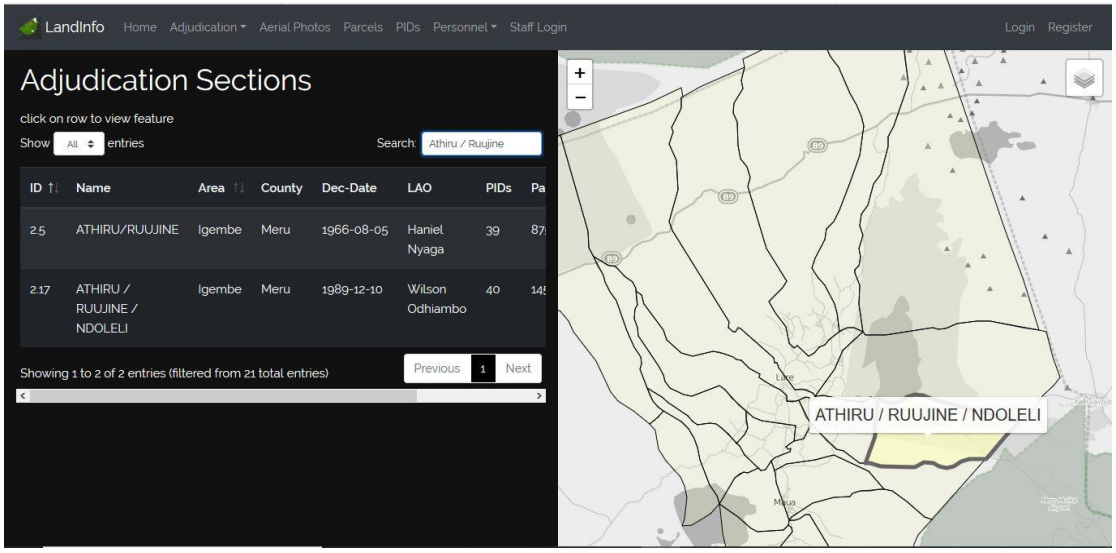


Figure 4. 6 Web visualization of Adjudication Sections

4.2.3 Parcel

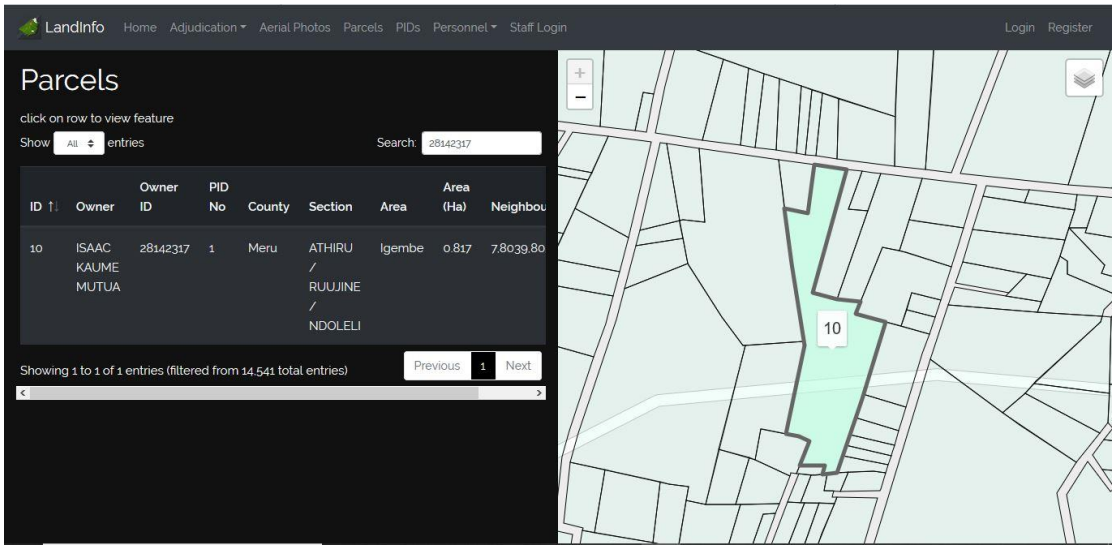


Figure 4. 7 Web visualization of Parcel details

4.3 Discussion

The public always lament on how records, more so at the Ministry of Lands and Physical Planning are usually inaccessible. To get access to what is considered as public information, one has to part with some amount of money (bribe), which is usually never accounted for. At times, the records are genuinely not accessible due to misfiling or even loss. For a government body, this is usually a disgrace.

The proposed system offers a way out for such inconveniences, as the data / records will now be in digital format, thus easily accessible and can be retrieved by anyone.

The public has the right to know most of the information and thus these records can be retrieved by simply keying in a query and the results will be displayed. For example: -

Figure 4.1 – A land owner enters his National ID number in the search box and presses enter. The results displayed shows his parcel ID, area, PID No and neighboring parcels. On the web (**Figure 4.7**), he can zoom to said parcel and see it's spatial location and how it relates to the neighboring parcels.

Figure 4.2 – A member of the public who has no parcel in the said adjudication section can also make queries in regards to any adjudication section and see all the details pertaining to the adjudication section like when the section was declared, which LAO did the declaration, when demarcation started, no. of parcels in the section and who was the section chairperson, also including the committee members. The chairperson and committee members are usually elected by the local people, and hence there's no harm in the records being public.

Figure 4.3 – A query result listing all the demarcation officers who surveyed the queried section. This is very important for accountability and transparency, so that if any disputes arise, the said demarcation officers can be consulted and help in resolving of disputes. As they have traversed the area, they are familiar with most of the local inhabitants and if the District surveyor or Land Registrar have any inquiries, they are the best people to help.

Figure 4.4 – Shows a downloadable (PDF) format of a PID map, also publicly available as the provision cost has now been transferred to the person who wants the map and not the government. The Land Owner, member of the public, District Surveyor and Land Registrar can access the same map, thus there won't be need for travelling to the survey provincial headquarters to have your PID map stamped and signed by the county surveyor. PDF maps are usually not editable, thus there won't be room for alterations, unless it is updated officially.

Figures 4.5 to 4.7- show data visualization on the web interface. The visualization is an important spatial aspect for relating to land matters.

These sample query results clearly demonstrate the utility of the developed database.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The overall objective of this study was to create a digital database that will be used to search PID records thus enabling easier access and retrieval of PID records.

The digital database system was successfully developed and various interactive maps were generated and used to demonstrate the system's functionality as a visualization and monitoring tool. For instance, with just a few clicks of a button, staff at the Ministry of Lands and Physical Planning (right from the comfort of their offices) can see the details pertaining to an adjudication section, know the parcel details of a land parcel, its location and its topological relationship with the neighboring parcels.

The target user of the digital database was the Ministry of Lands and Physical Planning and the public at large. The easy to understand user interface and online map products demonstrated that the system could also be used as an information sharing and dissemination tool among the Adjudication, Lands and Survey departments.

The overall finding of this study was that a digital database is a viable proposition for the relevant Ministry, and the geographic / spatial dimension depicted is an added bonus.

It can therefore be concluded that the study met its stipulated objectives.

5.2 Recommendations

From the study, it is recommended that;

The possibility of adopting and implementing the proposed database should be explored.

The database, if adopted, should be nationwide, decentralized and networked across all the relevant departments in the relevant Ministry, so as to enable sharing and faster retrieval of records.

Sufficient infrastructure to maintain such a database should be provided for better performance. These may include but not limited to servers with high capacity that uses SSD technology.

E-service delivery should be embraced, to be in line with the digital age as presently, most government services are online based, for instance the E-citizen platform.

For further study, it is recommended that;
All pertinent stakeholders should be identified and a satisfactory needs assessment conducted.

The conceptual design should be expanded so as to identify requirements which may have been overlooked in this project.

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APPENDICES

Appendix A: Database Tables

Some of the database tables were too large, and thus images have been shown.

Table A. 1 Adjudication Areas Table

Area ID	Area Name	County Code	Declaration Date	Scale	Minister
1	Buuri	012	30-08-66	1:2,500	Jackson Angaine
2	Igembe	012	30-08-66	1:2,500	Jackson Angaine
3	Imenti	012	30-08-66	1:2,500	Jackson Angaine
4	Tigania	012	30-08-66	1:2,500	Jackson Angaine

Table A. 2 Adjudication Sections Table

Sectn_ Name	Area_ID	County_Cod	Dec_Date	LAO_Name	Gazette_No	Gazete_Vol	Gazete_Dat	No_of_ PIDs	Total_Parc	Chair_Name
AMWATHI II	2	012	1-Jul-66	Eustace Kithumbu	7432	XXXI No.67	1-Jul-66	23	4536	Koome Kaaria M'Laikuru
ANTUAMBUI	2	012	1-Jul-66	Eustace Kithumbu	7433	XXXI No.67	1-Jul-66	36	2596	Muriithi Kubania M'Ithali
KANGETA	2	012	1-Jul-66	Eustace Kithumbu	7434	XXXI No.67	1-Jul-66	20	7826	Cypriano Ncaili M'Nabea
AUKI	2	012	5-Aug-66	Haniel Nyaga	3835	LXXI No.65	5-Aug-66	42	9651	Leone Baariu Amuru
ATHIRU/RUUJINE	2	012	5-Aug-66	Haniel Nyaga	3836	LXXI No.65	5-Aug-66	39	8752	Joseph Thuranira
NTUNENE	2	012	2-Feb-68	Haniel Nyaga	2548	XXVI No.87	2-Feb-68	27	3756	Sebastian Gitonga Laibuni
NJIA-CIA-MWENDWA	2	012	2-Feb-68	Daniel Munyalo	2549	XXVI No.87	2-Feb-68	14	8429	Joseph Kainga Maitai
KIEGOI	2	012	2-Feb-68	Daniel Munyalo	2550	XXVI No.87	2-Feb-68	37	1493	Ciolingera M'maitai
ANTUBETWE-NJOUNE	2	012	15-Sep-68	Faith Njeri	6547	LXII No.58	15-Sep-68	25	6394	Adriano Aciata M'itome
AMWATHI MAUA	2	012	15-Sep-68	Faith Njeri	6548	LXII No.58	15-Sep-68	32	11485	Rumano Kobia Imuti
AMUNG'ENTI	2	012	15-Sep-68	David Opiyo	6549	LXII No.58	15-Sep-68	46	18196	Pamela Makena Aritho
BUURIERURI	2	012	21-Dec-69	David Opiyo	5476	XVI No.21	21-Dec-69	18	4897	Stephen Mwiti Landu
AKIRANG'ONDU	2	012	23-Apr-72	Purity Mwangi	2146	VII No.68	23-Apr-72	74	24564	Isaiah Kinoti M'lichira
NAATHU	2	012	27-Dec-74	Purity Mwangi	5036	LX No.56	27-Dec-74	16	9854	Emily Wanja Kiruki
AMWATHI I	2	012	10-Dec-89	Wilson Odhiambo	1489	XXI No.54	10-Dec-89	21	5849	Ken Kinoti Marete
NDOLELI / ANTUBETWE / KIONGO	2	012	10-Dec-89	Wilson Odhiambo	1490	XXI No.54	10-Dec-89	68	3864	Jacob Kirimi Kinyua
ATHIRU / RUUJINE / NDOLELI	2	012	10-Dec-89	Wilson Odhiambo	1491	XXI No.54	10-Dec-89	40	14541	Eva Kanana Gitonga
KANJOO	2	012	4-Jan-90	Paul Chemasuet	563	LXI No.75	4-Jan-90	25	13547	David Muirigi Kaburu
ATHIRU-GAITI	2	012	4-Jan-90	Paul Chemasuet	564	LXI No.75	4-Jan-90	24	2548	Ziporah Mukokinya
KIRINDINE	2	012	11-Sep-93	Julius Korir	323	XXI No.75	11-Sep-93	13	2459	Gladys Kananu
LILIABA	2	012	13-Aug-02	Julius Korir	245	LXXII No.32	13-Aug-02	29	6542	John Rugiri M'rwiri

Table A. 3 Parcel Table

Parcel ID	PID No	Adj Sec ID	Area ha	Neighbors	Owner ID	Owner Name
1	1	2.17	0.148	2078,8002,3266	9855402	ELIJAH LAICHENA MUGANIA
2	1	2.17	0.076	10090,11984,3265	9855402	ELIJAH LAICHENA MUGANIA
3	1	2.17	0.157	11984,11974,10091,10092	25462282	JOSEPH LUKES EKOTHA
4	1	2.17	2.043	6382,11975,5,6104	64187448	JAMES MUNENE MUTHAMIA
5	1	2.17	0.589	4,6103,13361	24373706	NICHOLAS MWINGIRWA
6	1	2.17	0.099	7,8,690	46854549	VIRGINIA GACHERI MUGUNA
7	1	2.17	0.890	6,8,10,8039	20624957	TIMOTHY MBAABU
8	1	2.17	1.400	6,7,9,8039	22855746	MORIS MUTUA MAITHIRA
9	1	2.17	0.195	8,213,9413,2002	2584763	STANLEY MBUTURA KILINGO
10	1	2.17	0.817	7,8039,8058,9221	28142317	ISAAC KAUME MUTUA
11	1	2.17	0.070	3306,3469,3470	22359470	JOHN NTIRITIMI IMUTI
12	1	2.17	0.166	8923,396,14272	13402351	FAITH MAKENA
13	1	2.17	0.154	396,9923,14	54792001	KUAMBI VIRGINIA NKIROTE
14	1	2.17	1.729	9923,13,3468,1104	22165902	REGINA GATUMWA MBERIA
15	1	2.17	0.047	17,3458	6547892	BEATRICE NDUTA
16	3	2.17	0.640	153,7389,,7379	9214634	REBECCA MWARI
17	1	2.17	0.214	15,153,13311	23138803	JOHN KIRIMI KABURU
18	1	2.17	6.682	19,88	23138803	JOHN KIRIMI KABURU
19	1	2.17	2.593	18,420,3043	27116208	REBECCA KOSGEI
20	1	2.17	0.338	4259,26,3043	14863258	ELIZABETH WANJIRU MBURU
21	1	2.17	0.476	6383,8540,8545	23749571	ERIC MURIUKI
22	1	2.17	0.421	8761,5208,34	11257111	SAMUEL KIMATHI M'MUGWIKA
23	1	2.17	1.308	13632,8761,9540	10148250	JANE WANGARI
24	1	2.17	0.116	32,25,10066	32333588	JOSHUA LARAMA ISERIA
25	1	2.17	0.507	24,10066,5258	4517442	AGNES NAITORE
26	1	2.17	0.346	20,27,30	25478153	LUCY KARIMI JOSEPH
27	1	2.17	0.794	26,8674,7077,7043,30	23823665	ERIC M'NGEERA
28	1	2.17	0.251	29,7346,7043	23827928	CHARLES KINYUA KIARA
29	1	2.17	0.302	28,7043,7045	11258089	JASPHER MWENDA IKIARA
30	1	2.17	0.344	26,27,3560,3154	594446	CHARLES NJATI IBUATHU
31	1	2.17	0.171	31,8761,3047,23	21762756	KAILIKIA TIMOTHY KINYUA
32	1	2.17	0.424	12903,24,5210	56872394	WILSON KINYUA MUTAI

Table A. 4 Aerial Photograph Table

Photo ID	PID_No	Adj_Sec _ID	Contract No	Contract Name	Camera Type	Focal Length(mm)	Flying Height (m)	Date of Capture	Toposheet No.
134 SW	1	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
142 SW	2	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
296 SE	3	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4300	1-Mar-90	109/1
349 SE	4	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4300	1-Mar-90	109/1
458 SW	6	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
459 SW	7	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
460 SW	8	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
461 SW	9	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
462 SW	10	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
135 SW	11	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
136 SW	14	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
137 SW	15	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
138 SW	16	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
139 SW	17	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
140 SW	18	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
141 SW	19	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
143 SW	20	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
145 SW	23	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4450	1-Mar-90	109/1
261 SE	24	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4300	1-Mar-90	109/1
262 SE	25	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4300	1-Mar-90	109/1
292 SE	26	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4300	1-Mar-90	109/1
294 SE	27	2.17	90/32,33	Igembe Central (Ndoleli)	RTK TOP	150.12	4300	1-Mar-90	109/1

Table A. 5 PID Table

PID_No	PID Ref No	Adj_Sec _ID	No. of Parcels	Publication Date
1	109/1/16/10,14, 21/2	2.17	316	Feb-17
2	109/1/16/14,15, 21/2,3,6,7	2.17	663	Feb-17
3	109/1/16/14,15,16, 21/3	2.17	477	Feb-17
4	109/1/16/15,16, 17/13	2.17	220	Feb-17
6	109/1/21/3,4,6,7,8	2.17	457	Feb-17
7	109/1/16/16, 21/3,4	2.17	539	Feb-17
8	109/1/21/7,8,11,12	2.17	720	Feb-17
9	109/1/21/4,8, 22/1,5	2.17	554	Feb-17
10	109/1/16/16, 17/13,14, 22/1,2	2.17	1455	Feb-17
11	109/1/17/13,14	2.17	216	Feb-17
14	109/1/21/8,12, 22/5,9	2.17	363	Feb-17
15	109/1/21/8,22/5,6,9,10	2.17	457	Feb-17
16	109/1/22/1,2,5,6	2.17	420	Feb-17
17	109/1/17/13,14, 22/1,2,3,6	2.17	793	Feb-17
18	109/1/22/2,3,6,7	2.17	358	Feb-17
19	109/1/17/14,15, 22/2,3	2.17	494	Feb-17
20	109/1/17/15,16	2.17	117	Feb-17
23	109/1/22/9,10,14	2.17	113	Feb-17
24	109/1/22/6,10,11	2.17	460	Feb-17
25	109/1/22/6,7,8,10,11	2.17	582	Feb-17
26	109/1/22/3,4,7,8	2.17	345	Feb-17
27	109/1/17/16, 18/13, 22/4, 23/1	2.17	381	Feb-17
28	109/1/23/1	2.17	66	Feb-17
32	109/1/22/10,11,12,14,15,16	2.17	368	Feb-17

Table A. 6 Demarcation Officers Table

Surveyor ID	Name	Adj_Sec _ID
1987524696	George Owuor	2.17
1990391268	Agnes Makena	2.17
1990254638	Alphonce Kivindu	2.17
1990745923	Daniel Benjo	2.17

Table A. 7 Committee Members Table

Member ID	Name	Adj_Sec _ID
59727628	Baariu Thuranira	2.17
10899474	Eric Mwongela	2.17
11157106	Jane Karimi	2.17
88572517	Kiambi Muthee	2.17
86176429	Timothy Mukaria Mbaabu	2.17
45621378	Elizabeth Kadogo Munyi	2.17

Appendix B: Gazette Notice

GAZETTE NOTICE No 3453

THE LAND ADJUDICATION ACT, 1968

(*No* 35 *of* 1968)

NOTICE OF DECLARATION OF KAGWA ADJUDICATION SECTION IN SIAYA ADJUDICATION AREA

IN EXERCISE of the powers conferred by the Land Adjudication Act (No 35 of 1968, section 5, subsection (1), para (*c*)), I, the Land Adjudication Officer for Siaya Adjudication Area, do hereby declare Kagwa Sub location of Uyoma Location in Siaya Administrative District an Adjudication Section

The boundaries of Kagwa run as follows —

From a point on the shore of Lake Victoria the northern boundary of Kagwa Sub-location which is the Uyoma Sakwa locational boundary runs towards the east for a short distance to cross Bondo Misori road to a footpath to Madiany From here it slightly turns its course to south-eastern direction and runs past Ndati seasonal stream, runs further to meet it, runs past it and meets it again and runs further until it makes a sharp bend to the south

The eastern boundary begins at this point and runs for a short distance to remeet Ndati seasonal stream It then follows it for about 1½ metres to make another sharp turning The southern boundary begins at this point and runs down to the west to recross Bondo Misori road at Ndati bridge further down to Nyakayewe seasonal stream Along the stream and further down past Manyuando market to Lake Victoria Along Lake Victoria to the north starting point

All rights and interests in land within this Adjudication Section will be ascertained and recorded in accordance with the provisions of the Land Adjudication Act and any person claiming any such right or interest is requested to present his claim to the Recording Officer either in person or by duly authorized agent not later than 15th April, 1973

In accordance with section 30 of the Act, with effect from the date of this notice, except with the prior consent in writing of the Adjudication Officer, no person shall institute and no court shall hear any proceedings whatsoever, in which any right or interest in land within this Adjudication Section is in question until the Adjudication Register for this Adjudication Section has become final in all aspects under section 29 of the Act

Dated this 29th day of September, 1972

J S G MOGENI,
Adjudication Officer,
Siaya Adjudication Area

Plate B. 1 Gazette notice for the declaration of an adjudication section

Source: The Kenyan Gazette 17th November 1972, Vol LXXIV-No.55

Appendix C: Aerial Photograph

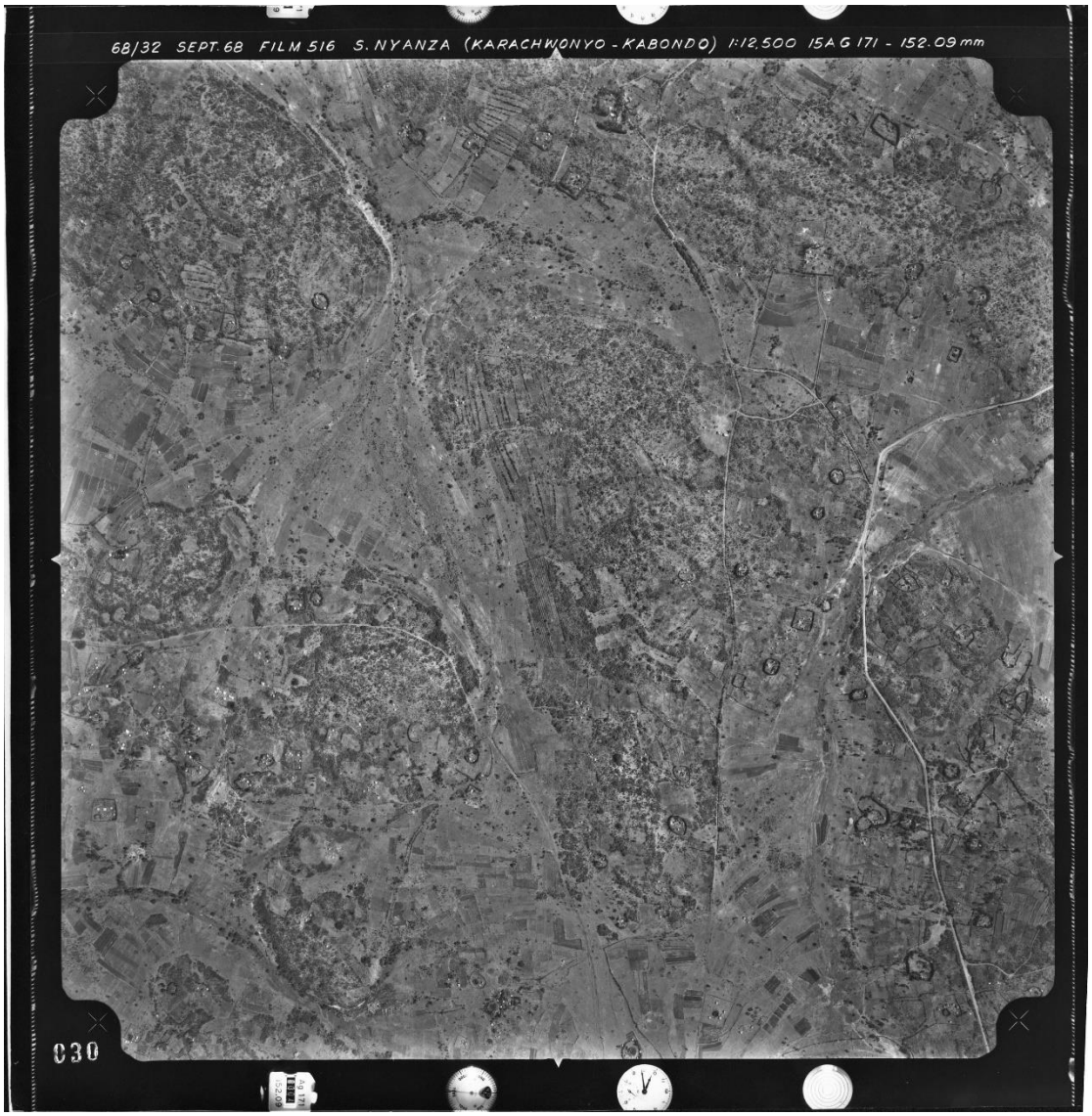

Plate C. 1 An aerial photograph (Original Scale 1:12,500)

Courtesy of: Adjudication Section Records Office (ASRO), Survey of Kenya.

Appendix D: Database SQL Schema Code

```
CREATE TABLE public.adj_area_models (
    "Adj_Area_ID" integer NOT NULL,
    "Area_Name" character varying(50) NOT NULL,
    "Dec_Date" date NOT NULL,
    "Scale" character varying(30) NOT NULL,
    "Minister" character varying(30) NOT NULL,
    "County_Cod" character varying(3) NOT NULL,
    created_at timestamp(0) without time zone,
    updated_at timestamp(0) without time zone
);
CREATE TABLE public.adj_section_models (
    "Adj_Sec_Index" integer NOT NULL,
    "Adj_Sec_ID" character varying(255) NOT NULL,
    "Adj_Area_ID" integer NOT NULL,
    "County_Cod" character varying(3) NOT NULL,
    "Sectn_Name" character varying(100) NOT NULL,
    "Dec_Date" date NOT NULL,
    "LAO_Name" character varying(50) NOT NULL,
    "Gazette_No" integer NOT NULL,
    "Gazette_Vol" character varying(30) NOT NULL,
    "Gazette_Date" date NOT NULL,
    "No_PIDs" integer NOT NULL,
    "Total_Parc" integer NOT NULL,
    "Chair_Name" character varying(50) NOT NULL,
    created_at timestamp(0) without time zone,
    updated_at timestamp(0) without time zone
);
CREATE TABLE public.aerial_photo_models (
    "Photo_ID" character varying(10) NOT NULL,
    "PID_No" integer NOT NULL,
    "Adj_Sec_ID" character varying(255) NOT NULL,
    "Contract_No" character varying(30) NOT NULL,
```

```
    "Contract_Name" character varying(100) NOT NULL,
    "Camera_Type" character varying(30) NOT NULL,
    "Focal_Length" double precision NOT NULL,
    "Flying_Height" integer NOT NULL,
    "Capture_Date" date NOT NULL,
    "Toposheet_No" character varying(50) NOT NULL,
    created_at timestamp(0) without time zone,
    updated_at timestamp(0) without time zone
);
CREATE TABLE public.categories (
    id integer NOT NULL,
    parent_id integer,
    "order" integer DEFAULT 1 NOT NULL,
    name character varying(255) NOT NULL,
    slug character varying(255) NOT NULL,
    created_at timestamp(0) without time zone,
    updated_at timestamp(0) without time zone
);
CREATE TABLE public.com_members_models (
    "Member_ID" integer NOT NULL,
    "Member_Name" character varying(50) NOT NULL,
    "Adj_Sec_ID" character varying(255) NOT NULL,
    created_at timestamp(0) without time zone,
    updated_at timestamp(0) without time zone
);
CREATE TABLE public.dem_officers_models (
    "Surveyor_ID" integer NOT NULL,
    "Surveyor_Name" character varying(50) NOT NULL,
    "Adj_Sec_ID" character varying(255) NOT NULL,
    created_at timestamp(0) without time zone,
    updated_at timestamp(0) without time zone
);
```