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DEPARTMENT OF GEOSPATIAL AND SPACE TECHNOLOGY

A PROTOTYPE LAND INFORMATION SYSTEM: CASE STUDY OF NEW TAVETA TOWN

BY

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A project report submitted in partial fulfillment of the requirement 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

I, Jattani Hussein Hirsi, 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.

Jattani Hussein Hirsi

……	……	……
Name of student	Signature	Date

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

Dr. S. M. Musyoka

……	…….	…….
Name of supervisor	Signature	Date

ABSTRACT

A land information system (LIS) is a computer based information system that enables the input, management, analysis, output and dissemination of spatially referenced, land parcel based data and information at mainly large (mapping) scales. This technology, which has matured in the developed countries, has been proven to be an invaluable tool for better land administration. The use of the technology is catching up in the developing countries Kenya included.

The project aims to demonstrate how a computerized land information system supports operations such as search on land, land transfer, land taxation, land use planning and land valuation. The main objective of the project is to develop a Land Information System by developing a geo-database that incorporates both spatial and non-spatial attributes of land parcels in the New Taveta Town.

The methodological approach applied in this study included; data collection and capture, data processing and verification, building a GIS database, joining of the spatial data to the GIS database, output of the results, analysis of the results and finally conclusions and recommendations..

The results of the study include search reports on different plots such as tax reports, ownership reports, property user reports, transfer reports among others; and query results by different users of the system such as investors, financial institutions, surveyors, planners among others. The Land Information System is easy to update, secure and facilitates quick retrieval of information. The security employed on the system include physical security, administrative controls and systems security.

The conclusions drawn from the results and analysis of the study was that the computerized land records are easy to update, process, analyze and retrieve and it will be useful for the County Government to set up such a system. The recommendations drawn from the research include design of a program to link the Local Authority Information and Financial Management System to the New Taveta Town LIS so that information on taxation can be updated in real time as payments are being made, security of the database to be enhanced through combination of security measures from 4 layers of security control namely hardware/software/ data security systems, physical security, administrative controls and laws relating to security and privacy.

DEDICATION

I dedicate this project to my dear wife Khadra Leyla Abdillahi and my son Hirsi Hussein. Thank you for your love and support.

ACKNOWLEDGEMENT

I want to thank my supervisor Mr. S.M. Musyoka, Chairman Department of Geospatial and Space Technology, University of Nairobi for his guidance and constant advice without which the research and writing of this project would not have been possible.

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LIST OF ABBREVIATIONS

ER diagram	Entity Relationship Diagram
FIG	International Federation of Surveyors
FR No	Folio Register number
GIS	Geographic Information System
GoK	Government of Kenya
ID No.	Identification card number
LAIFMS	Local Authority Information and Financial Management System
LIS	Land Information System
PIN No.	Personal Identification Number
RIM	Registry Index Map
SoK	Survey of Kenya
SQL	Structured Query Language
UN	United Nation
UTM	Universal Transverse Mercator

CHAPTER ONE

1.1 Introduction

Land is a very critical resource to the economic, social and cultural development of Kenya. Land was also a key reason for the struggle for independence and land issues remain politically sensitive and culturally complex (National Land Policy, 2009). Right from the pre-colonial period, land has been perceived as more than a piece of earth upon which one exercises his/her rights. In Kenya, it is viewed in many ways; as a factor of production, a show of economic status in the society, as well as cultural commodity owned by a community. These perceptions have made land a very emotive topic to many Kenyans.

The formulation of the National Land policy has sought to address critical issues on land administration, access to land, and resolution of historical injustices on land, environmental degradation, proper land use systems and unplanned proliferation of informal settlements in the urban areas. It recognizes all forms of tenure in Kenya as well as fostering equal access to land for all Kenyans. It also seeks to keep an up to date inventory of all government and public land in the country.

The policy has proposed the development of a Land Information Management System as a foundation upon which the policy will be implemented. Central to this development is the design, construction and maintenance of an up to date Land Information System (LIS). LIS is a computer based information system that enables input, management, analysis, output, and dissemination of spatially referenced, land parcel based data and information at mainly large mapping scale. It's a database that stores all land related datasets as generated or acquired in the pursuit of proper land management and administration. These datasets include the cadastral, topological and boundary information.

A Land Information System, once developed, plays an important role in land registration, land use planning, land valuation and taxation, tracking of all government and public land as well providing concrete analysis of data for timely decision making.

1.2 Problem Statement

Despite the fact that cadastral surveys in Kenya started in 1903 most of the land records are still in paper form and operated manually. This system of manual record keeping and maintenance is both slow, cumbersome, inefficient and also time consuming during retrieval of information.

In Kenya, as in most developing countries, it is difficult, time consuming and financially costly to identify what land is available, its ownership, rights therein and the conditions to its use and its value as compared to other parcels. Under such circumstances, necessary information is lacking, inadequate or contradictory. Therefore the current systems cannot support legitimate and efficient transactions on land.

The cadastre is in a constant state of change. Parcel information is in analogue form with paper maps and conventional land registers giving information on location, tenure, use, encumbrances, ownership and distribution of land. The classical cadastral system has become insufficient owing to the fact that land records have greatly increased in volumes, they are in paper form thus the process of storage, access and retrieval is a great challenge.

Therefore, there is need to develop modern cadastral infrastructures that will facilitate efficient land and property markets, protect the land rights of all, and support long term sustainable development and land management. The development of Land Information System (LIS) is a credible approach towards sound management of land and its resources. A LIS creates a comprehensive data on land ownership, land use, land valuation, land taxation, land statistics and management. Such a system is easy to update, secure and facilitates quick retrieval of information.

1.3 Project Objectives

1.3.1 Main objective

To develop a Land Information System for New Taveta Town, in Taveta Sub-county. This involves developing a geo-database that incorporates both spatial and non-spatial attributes of the study area.

1.3.2 Specific Objectives

a) To identify suitable spatial and non-spatial attributes about the land parcels that should be included in the database.

b) To study how information on registered land is retrieved for the purposes of supporting various operations such as search, transfer and valuation and how LIS can help stream line the procedure there in.

c) To compile some cadastral record that is complete, up to date, and reliable,

d) To implement and demonstrate the operation of the database in the study area.

1.4 Scope of study

The project involves development of a prototype Land Information System for the New Taveta Town based on cadastral survey with cadastral parcel as the fundamental unit and plot number as the primary key. It is based on fixed boundary survey although it can be used for general boundary survey. It captures information as contained in FR 359/21, 492/178 and RIMs New Taveta Town sheet 1-8, a total of 5407 parcels are captured. The LIS database developed supports land search, land taxation, land transfer and land use planning.

1.5 Organization of the report

This report is organized into five chapters. In chapter one, an overview of shortcomings of a manual LIS, the need of a computerized LIS, problem statement and objectives of the study are presented. Literature review is contained in chapter two while the methodology employed in the study is discussed in chapter three. Chapter four gives the project results and analysis. Finally conclusions and recommendations are covered in chapter five.

CHAPTER TWO

LITERATURE REVIEW

This chapter gives an overview of some important aspects such as land administration, land management, land administration system, the cadastre, land information system in Kenya and steps in setting up a LIS among others, which are exploited in coming up with this project using data on land and land ownership to attain the set objectives. Summary of these aspects are outlined below:

2.1 Land

Land is defined as an area of the surface of the earth together with the water, soil, rocks, minerals and hydrocarbons beneath or upon it and the air above it. It embraces all things which are related to a fixed area or point of the surface of the earth, including the areas covered by water, including the sea (Henssen, 1995).

2.2 Land Information

Land information consists of data for decision making in land administration and management. These include data on georeferencing, mapping, land ownership, land rights, land use planning, valuation and inventories of different categories of land. Land information is often referred to as “spatial information” because it relates to an object (land), which has a definite, fixed position geographically.

Land information is required by a wide range of users, ranging from government agencies at all levels through prospective or existing land owners to surveyors, lawyers, planners, valuers, real estate managers, and retailers. Access to this information is made possible by use of unique parcel reference numbers to identify each land and property unit.

2.3 Land Administration

Land administration refers to the process of determining, recording and disseminating information about ownership, value and use of land. An efficient land administration system guarantees the recording of land rights, promotes tenure security, and guides land transactions.

Further, it provides land users with appropriate forms of documentation to guarantee land rights and supports the processes of land allocation, land dispute resolution, and fiscal management of land.

The principal functions of land administration are:

a) Ascertainment and regulation of land rights.
b) Allocation and management of land.
c) Facilitating of efficient transactions in land.
d) Development and maintenance of an efficient and accurate Land Information System.
e) Establishment of mechanisms for the assessment of land resources for fiscal management and revenue collection; and
f) Establishment of efficient and accessible mechanisms for resolving land disputes.

The UN Economic Commission for Europe (1996) defines land administration as the processes of determining, recording and disseminating information about the ownership, value and use of land when implementing land management policies.

Dale and McLaughlin (1999) view land administration as a combination of routine processes that include "regulating land and property development and the use and conservation of land, the gathering of revenues from the land through sales, leasing, and taxation, and the resolving of conflicts concerning the ownership and use of land"

Steudler et al. (2004) describe land administration In terms of its functions.

They divided the functions of land administration into four components:

- Juridical: Land ownership
- Regulatory: Land development control and land use planning
- Fiscal: Land taxation
- Information management: Integral component fulfilling the information requirements of the other three components.

All the three definitions mention the key components of land administration as land ownership, land use, land valuation and land information management.

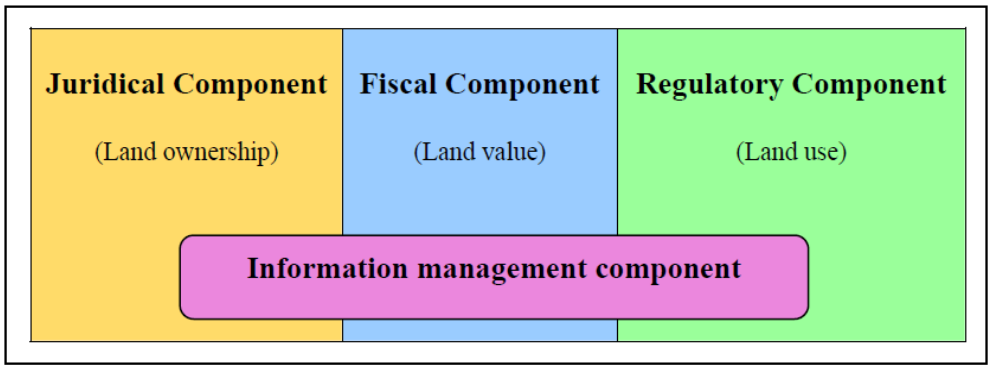


Fig 2.1 The Four Basic Components of Land Administration, Source: Steudler et al (2004).

The new approach to land administration system is to support land management and land markets. The key processes are those activities connected with the four fundamental functions in land management: land tenure, land value, land use and land development. The fundamental challenge for the land administrators is the management of the transcendental aspects of land to derive wealth out of the land-related interests and to manage these opportunities accordingly to sustainable development objectives (Wallace, Jude, 2009).

Efforts should be focused on land management processes for registration of land rights, indefeasible title, mortgage ability and compensation for compulsory acquisition. These reforms pose challenges to the land administration capacity to manage land holistically.
Land administration should focus on land management processes like adjudication, land transfer, subdivision, planning and valuation, rather than on institutions, legal and regulatory frameworks. The land administration system should incorporate a strategy for development reform in land administration according to global factors that can affect the processes. Furthermore, effective land administration systems need to manage the ever growing sophistication of rights, restrictions and ownership over land due to environmental and social pressures.

2.4 Land Management

According to Dale and McLaughlin (1988), land management is about decision making and the implementation of decisions about the use of land recourses. It entails the

processes which allocate land resources "over space and time according to the needs, aspirations and desires of man and within the framework of his technological inventiveness, his political and social institution, and his legal and administrative arrangements". It includes the formulation of land policy, the organization of land administration arrangements and the management of land information.

Drawing from this definition and business scheme described by Steudler and Williamson (2004), land management can be seen to play a coordinating role between land policy and administration. Its objectives are to fulfill the environmental, economic, and social goals of land policy by planning, promoting and controlling efficient land use through the process of land administration. The coordinating role of land management is depicted in Figure 2.2 below.

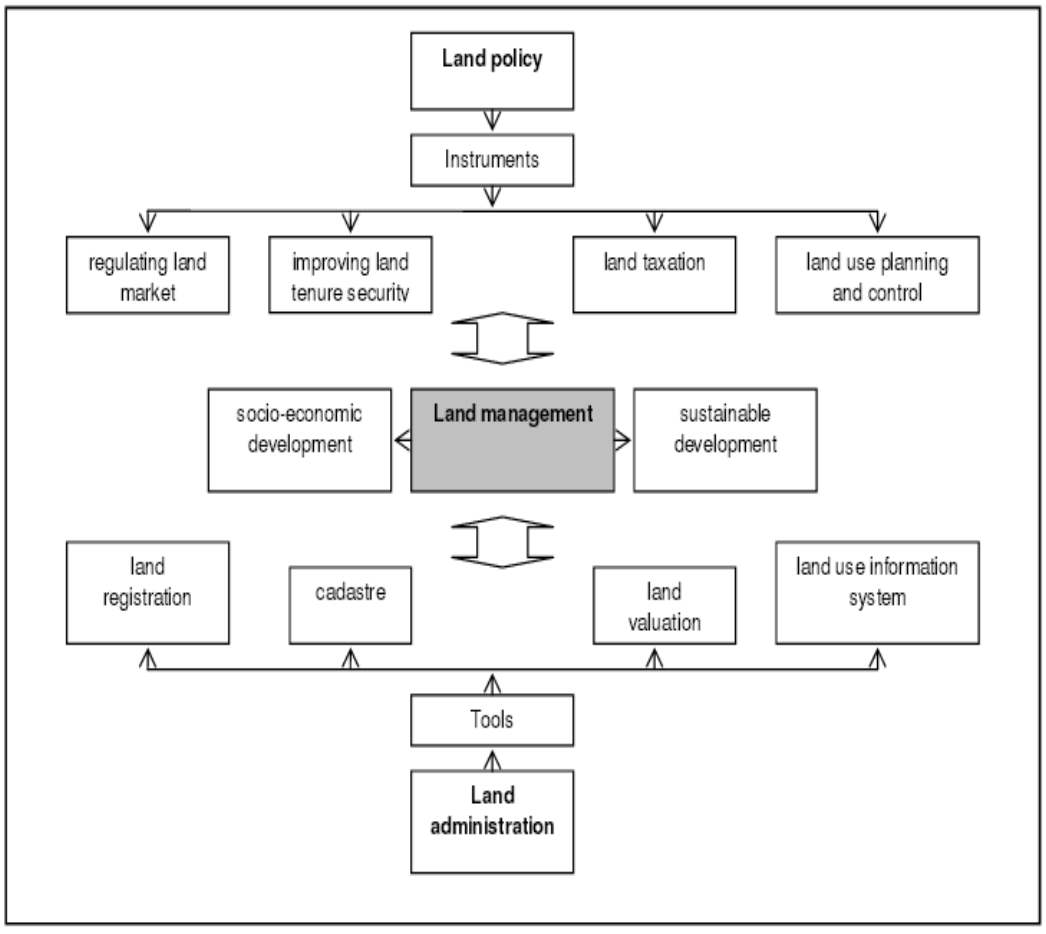


Fig. 2.2: The coordinating role of land management
Source: Steudler and Williamson (2004).

2.5 Land Administration System

Land administration systems are concerned with the social, legal, economic and technical framework within which land managers and administrators must operate (UN-ECE, 1996 cited in Enemark, 2004). Alongside the legal framework, land administration systems are the main instrument of land policy administration. They include organizations and procedures for the survey, demarcation and mapping of land, recording of land rights and transactions, provision of documentary evidence of land rights, as well as resolution of land disputes and competing claims. Land administration systems are generally managed by specialist formal land institutions, established by government. However, responsibilities for land allocation, documentation and the management of rights can be devolved to local, community or customary bodies and as some services may be delivered by the private sector (UN-Habitat, 2008). According to Enemark (2004) land administration systems support efficient land markets and are at the same time concerned with the administration of land as a natural resource to ensure its sustainable development.

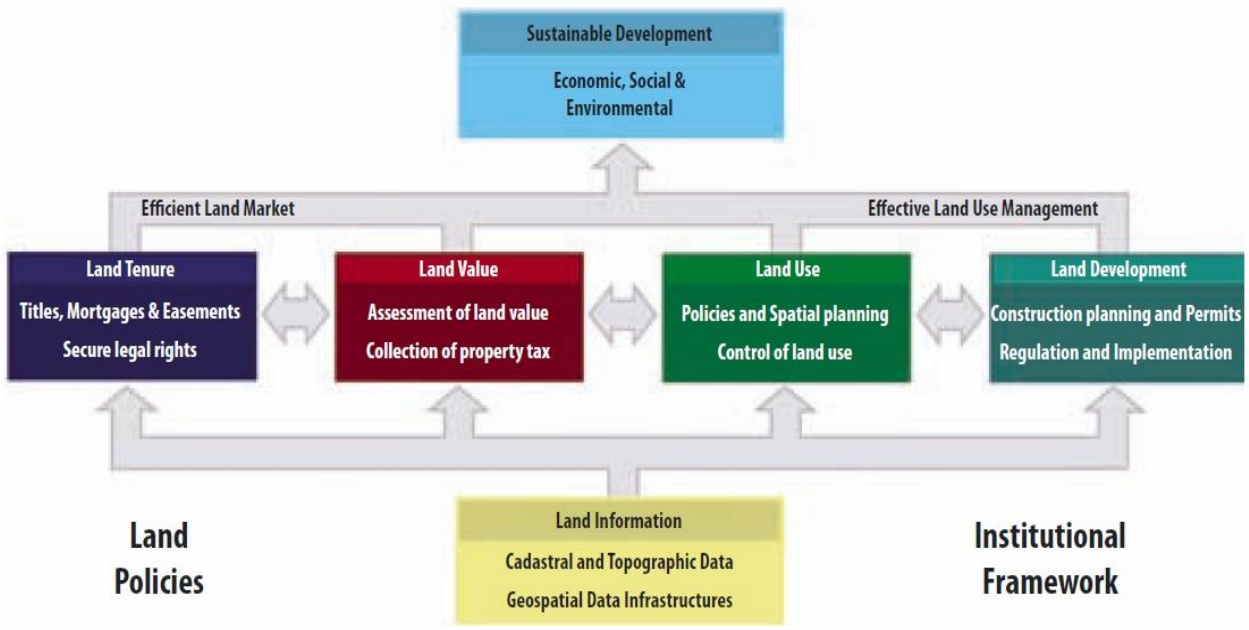


Fig. 2.3 A Global Land administration perspective, Source: Enemark (2004)

With reference to Figure 2.3, Enemark (2004) records that land administration comprises an extensive range of systems and processes to administer, which include the following:

Land Tenure: the allocation and security of rights in lands; the legal surveys to determine the parcel boundaries; the transfer of property or use from one party to another through sale or lease; and the management and adjudication of doubts and disputes regarding rights and parcel boundaries.

- *Land Value:* the assessment of the value of land and properties; the gathering of revenues through taxation; and the management and adjudication of land valuation and taxation disputes.
- *Land-Use:* the control of land-use through adoption of planning policies and land-use regulations at national, regional and local levels, the enforcement of land-use regulations and the management and adjudication of land-use conflicts.
- *Land Development:* the building of new infrastructure; the implementation of construction planning; and the change of land-use through planning permission and granting of permits.

These four systems namely; land tenure, land value, land-use and land development, are interrelated. The actual economic and physical use of land and properties influences the land value. The land value is also influenced by the possible future use of land as determined through zoning and land-use planning regulations and permit granting processes. And the land-use planning and policies will of course determine and regulate the future land development. The information on land and properties permeates through the overall system and provides the basic infrastructure for running the systems within the four interrelated areas. Land information infrastructure is the integral component fulfilling the information requirements of land tenure, land value, land use and land development. The essence of land administration is its land information system. The completeness, accuracy and currency of the information in the system determine how well the land information system will serve the society. The main tools that are used to generate and maintain land information are cadastre and land registration. The Land Information area should be organized to combine the cadastral and topographic data and thereby linking the built environment (including the legal land rights) with the natural environment (including environmental and natural resource issues). Land Information should be organized as a spatial data infrastructure at national, regional and local levels

based on relevant policies for data sharing, cost recovery, access to data, standards and the like (Enemark, 2004).

2.6 Land Information System

This refers to a computer based system that enables inputs, management, manipulation, output, and dissemination of land parcel based spatially referenced data and information at mainly large scale. It is, therefore, a subset of GIS.

The information relating to land may be acquired and held in alphanumeric form (e.g. surveyor's field notes), graphically (e.g. maps and aerial photographs) or digitally by electronic media. The raw information needs processing to be meaningful to a decision maker. A LIS provides good support to land management by providing information about land, resources upon it and the improvement made on it. Land management refers to the taking and implementation of decision about the acquisition, development and conservation of land resources.

The operation of a LIS includes the acquisition and assembly of data, its processing, storage, and maintenance. It also includes their retrieval, analysis, and dissemination. The optimal usefulness of this system largely depends upon it's up to datedness, accuracy, completeness, and accessibility, and upon the extent to which the system is designed for the benefit of the user rather than the producer of the information. Systems such as this should be designed largely to meet the users' needs which are normally identified beforehand.

LIS provides information in form of products such as maps or certificates and services (such as professional advice). It can also supply attribute or textual data which may be presented in verbal or numerical form. Attribute data give the description of existing phenomena as well as the activities that take place upon the land.

The spatial (location) components of the datasets are stored in terms of points, lines or polygons. These datasets incorporate three types of spatial relationships:

- Geometrical- the various datasets forming layers are referenced to a precise spatial framework such as coordinates or grid cells.

- Cartographical- Data is generalized and symbolized by a set of cartographic rules to ensure smooth flow of information therein.
- Topological- This entails the definition of the relative location and non-metric spatial relationships of various data elements.

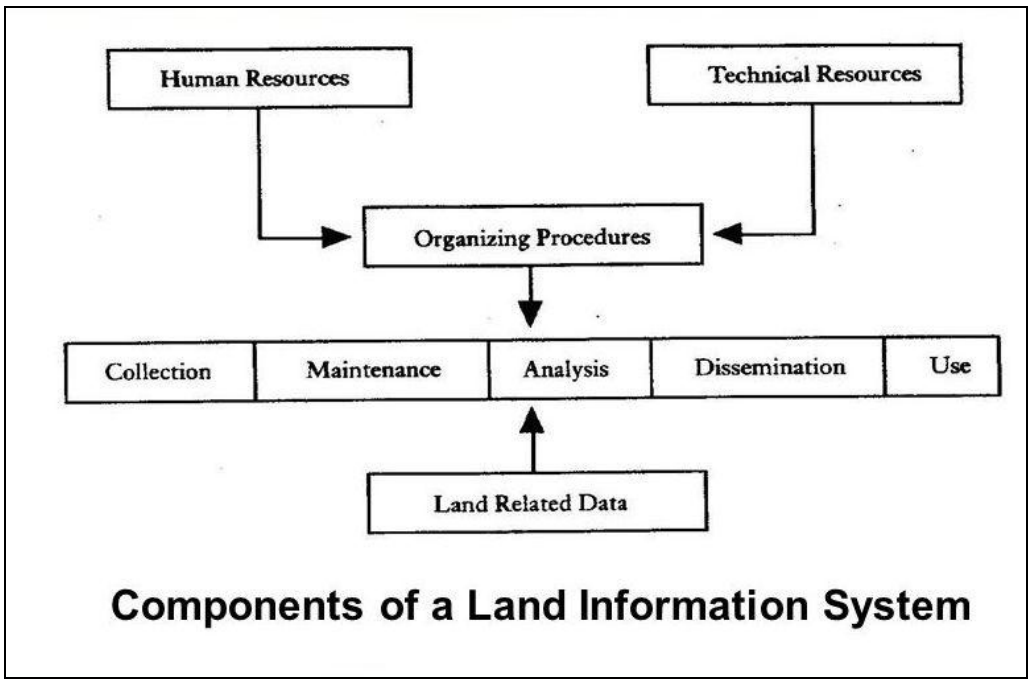


Fig 2.4 Components of a Land Information System

2.7 Cadastre

The International Federation of Surveyors (FIG, 1995) defines a cadastre as a parcel based and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, ownership or control of those interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (valuation and taxation), legal purposes (conveyancing), to assist in the management of land and land-use planning (planning and administration), and enables sustainable development and environmental improvement.

The principal purpose of a cadastre is provision of information about land ownership, value and use. The information contained in the register is organized around a cadastral parcel i.e. the proprietary land unit but can be any tract of land that is part of an estate and has separable identity. This information is collected, stored, referenced, and retrieved

primarily at the land parcel level. Referencing systems such as use of geo-codes and Unique Parcel Reference Numbers (UPRN) facilitate data access, manipulation and exchange with other users.

A cadastral vision of the future presented in the UN Bogor Declaration 1996, is to: "develop modern cadastral infrastructures that facilitate efficient land and property markets, protect the land rights of all, and support long term sustainable development and land management. The cadastral system is seen as the basic infrastructure to support the different systems in the area of land management.

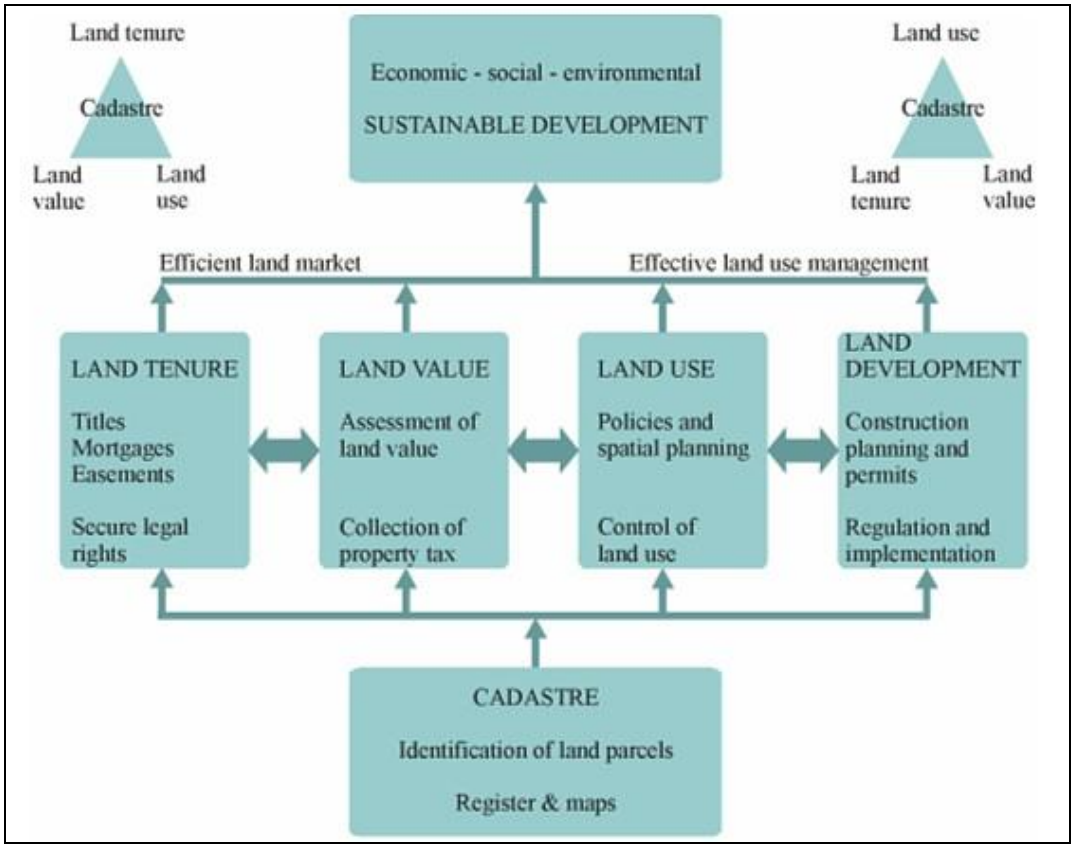


Fig 2.5 The role of the cadastre to facilitate efficient land market effective land use administration, Source: Enemark (2004).

The systems supported by the cadastral infrastructure are:

- Land Tenure System, to secure legal rights in land such as titles, mortgage and easements.

- Land Value Systems, to access the value of land and properties and to levy land taxes.
- Land-Use Control Systems, to enable comprehensive and detailed land use planning.
- Land Development System, to enable regulation and implementation in change of use.

These systems are interrelated. The actual economic and physical use of land and properties influences the land value. The land value is also influenced by the possible future use of land as determined through zoning and land-use planning regulations. And the land-use planning and policies will, of course, determine and regulate the future land development.

2.7.1 Component of a cadastre:

A cadastre comprises of the following components:

a) Cadastral parcel

This is the proprietary unit of land. It is defined as a continuous volume of land within which unique and homogeneous interests are recognized.

Land is finite in extent and permanent in nature. This quality of permanence is ideal for recording information (rights and interests) since the rights, owners, and usage may change but the land remains forever. Even when parcels are subdivided or amalgamated with adjoining parcels into larger Ones, the land which they cover remains unchanged.
The need to record details of land emanates from the need for better land administration and management since land is the ultimate resource from which all wealth comes.

b) Parcel identifier

This is a unique code that uniquely refers to specific parcel whose limits are defined. The parcel indicators also referred to as PID or Unique Parcel Reference Numbers (UPRN) identifies the parcel and allows for cross referencing with registers and any other filing systems. That's to mean, with a parcel reference numbers is possible to access all the details of the parcel, including attribute information and its spatial description (from

maps and plans). There is various parcel reference systems adopted by various jurisdictions depending on what is available. For instance, street index and parcel address cannot be used in an area where streets are not properly named. The system adopted should generate identifiers that easily link data related to parcels.

c) Parcel record

This is a combination of technical record of parcellation of the parcel through any given territory usually represented on plans of suitable scale and authoritative documentary record, whether of a fiscal or proprietary nature or of the two combined, usually embodied in appropriate associated registers (Dale and McLaughlin, 1988).

d) Cadastral index map

This is a map that depicts all parcels in a given region and associates each parcel with its unique property identifier. This graphic record has a recognized legal status for property description besides sewing as an index to other legal records.

2.7.2 Some forms of cadastres

a) Juridical Cadastres

This is the cadastre that underpins registration of land. Parcel registration cannot be effective without a form of cadastre. This cadastre has two vital components. First, is a written record containing parcel information such as name and address of the owner and the rights that exit in the parcel. The other part contains a detailed description of the parcel in form of maps, plans or survey measurements. To thoroughly achieve the requirements of a juridical cadastre, the following operations are undertaken:

Land adjudication process entails the official determination of rights to land as guided by the tenure systems in existence. This process establishes what rights exist, who is meant to exercise them and to what limitations if any they are subject. It does not create new rights or alter the existing ones.

Land demarcation entails actual marking of the limits of each land parcels on the ground by placing corner beacons and pegs in the ground or the construction of linear features such as walls and fences or growing of hedges.

Then there is the actual survey on the ground which entails measurements and mapping of the actual extents of the various parcels on the ground. This could be done in a systematic or sporadic ways. However much preference is given to the systematic approach due to its methodical and orderly manner in which all parcels are brought on to the register area by area. Cadastral surveying is carried out within the provisions of the law and under strict accuracy controls. The information generated by the above procedures is used to quantify registration of a parcel. Registration entails official recording of rights that prevails in land and the person who enjoys them in a register.

b) Fiscal cadastre

This is an inventory of land parcels that produce information necessary to determine the value of the land and the tax due on it. J/therefore serves as an information base for property taxation, helps in monitoring and support of land market, land use development control, supporting financial allocation programs and provision of land information (McLaughlin, 1988).

The concept of property taxation emanated from the fact that laud forms the basis of all wealth and hence revenue from its administration should be derived from it. Revenue on land is raised through two principles; Property rating where government raise revenue by assessing and taxing improvements on land, such as building and the uses they are put. The other method is the land value taxation where value of the land itself as derived from its improved or unimproved state. Property valuation can be imposed on land, improvements on it or both. The taxation system adopted by authorities determines how land is used and made available for use. Normally there are two of taxes levied on land: Property and land taxes. Taxes can be based on the rental value or capital value of the property.

The operation of a fiscal cadastre requires the identification of all parcels that are to be valued, and the person(s) to pay taxes. It should be noted that not always that the owner of a parcel is also responsible for paying taxes on it. Parcels should be classified according to their uses and their values determined accordingly.

A fiscal cadastre entails identification and mapping of all properties that are subject to tax, classification of each property with respect to such factors as size, type, type of construction and improvement, collection and analysis of market data, valuation of each parcel/property, identification of persons responsible for paying taxes (property owner should also be determined in case the property is forfeited due to non-compliance to taxation rules), preparation of valuation rolls and then billing and collection of the appropriate taxes. This should also include prior notification of the taxpayer before actual collection. Appropriate appeal procedure should be put in place.

c) Multipurpose cadastre

As documented above, juridical cadastre support land registration, fiscal cadaster supports property valuation and taxation while other information systems support planning and enforcement of regulations. The concept of multi-purpose cadaster resulted from the recognition that these components share some common information requirements.

According to FIG (2008), a multi-purpose cadastre refers to large scale, community-oriented parcel-based information system designed to serve both the public and private organization and individual citizens. It is therefore a comprehensive set of land records, based upon the land parcel as its fundamental unit. Its distinguishing characteristics include: the use of cadastral parcel as the fundamental unit of organization; possibility referring related land records to this parcel; it is whenever possible complete in terms of spatial cover and provides a ready and efficient means of access to the data. It thrives upon a continued compilation, updating and maintenance of cadastral overlays.

It comprises of records relevant to land ownership, land valuation and other land related information. It therefore designed to support land transfer, land registration, land taxation and general land administration. Its primary components include geodetic reference framework, base maps, series of files relating various types of parcel related information and a linkage system to the various types of information to each parcel.

2.8 LIS in Kenya

For effective and efficient land administration, good land information management is necessary. At the government and corporate level, effective planning, zoning and overall management of urban and rural land cannot be efficiently done. The following are some specific problems with our country's land information management today:

i) There are no agreed standards to which land information, the systems that manage it or the people that handle it should conform;

ii) Most of the country's accurately positioned survey points, which act as a foundation for mapping have been destroyed (The white cylindrical pillars on tops of hills were dug up by vandals when false word went around that mercury could be found beneath them.) There was no evidence of mercury found after the distractions.

iii) There are no policies or laws to deal with the legal issues associated with land information. Some of these issues include questions on whether it is right for the government to commercialize land information that has been collected using public funds, and if so, at what price; who should have access to land information in government custody; and whether this access should include personal information about other people, e.g., how many farms or urban plots so and so owns. It is worth noting that lately there has been a lot of debate on whether the Official Secrets Act, which is often used to restrict access to a lot of public information, should be repealed or not;

iv) The way land information is kept and handled manually makes it prone to tampering with and to enhanced wear and tear; even if it were computerized, the country is least prepared to deal with the computer and cybercrime that may be directed at such information;

v) The necessary infrastructure for computerizing land information and making it widely available (such as access to electricity, computers and telephones and internet) is still very limited;

vi) There are no adequate laws to protect those who might want to invest in the creation of land information from piracy of their products;

vii) There is still a lot of unregistered land in Kenya on which there are no records at all.

The prescriptions of the draft national land policy in respect of land information management, to address some of the problems of our country's land information management include:

a) Land information to be computerized and made widely available in a language most citizens can understand and at an affordable price, to at least the divisional level;
b) Existing paper land records to be reorganized, updated and authenticated in readiness for their computerization;
c) Standards to be developed to guide the generation and dissemination of land information, the training of relevant professionals and awareness creation among citizens;
d) Land surveys, including the re-establishment of the framework of accurate survey points (control points), to be carried out more efficiently and accurately using modern technology and any necessary laws to be enacted or amended.
e) Kenya's land information management system to be in harmony with those of other countries in the region in order to facilitate regional trade in land information and execution of regional projects, e.g. those of the Lake Victoria basin.
f) A law to be enacted to provide for all aspects of land information access and management, including the protection of intellectual property rights;
g) The country to develop capacity for dealing with information technology and cybercrimes;
h) The National Spatial Data Infrastructure (NSDI), through which all agencies that produce and use land information will be networked, to be implemented without delay.

With computerized land records it will also be feasible to have a one stop shop for land transactions since from any computer terminal on the network, all land information including valuation, planning, survey and registration will be accessible; even Kenya

Gazette announcements of public land to be allocated will be more accessible to more Kenyans this way. The problems of "lost" files will largely disappear in the computerized environment due to the increased security and options for making stand by copies. With the computerized LIMS it will also be much easier to update records and maps once land transactions take place and there will also be increased possibilities for serving the blind through facilities such as computer voice prompts and braille keyboards. Lastly, the increased security and reliability of land information that a computerized LIMS will bring will result in Kenyans developing their land in confidence and in banks' lending money for such development without fear. This can be expected to result in job and wealth creation and alleviation of poverty.

With the systematic development of a computerized Land Information Management System (LIMS), land information will be efficiently made widely available for timely decision making; this will lead to more productive land and a better managed environment for all. When the National Spatial Data Infrastructure is implemented, it will be an infrastructure in the public domain, much like the road infrastructure or health infrastructure. An average citizen will be able to tap into the network from any designated point, much like you are now able to access your bank account information and withdraw money at any corresponding ATM countrywide. He/she will be able to obtain details of their land parcel, buy a map of an unfamiliar town, get directions to the nearest restaurant, and evaluate a piece of land for purchase, etc. all by him/herself at the touch of a computer button.

2.9 Steps in setting up a LIS

Setting up a LIS consists of the entire process from when an organization becomes aware of this technology to when it adopts it; i.e. uses it regularly in its day to day activities. The steps in setting up a LIS are summarized below:

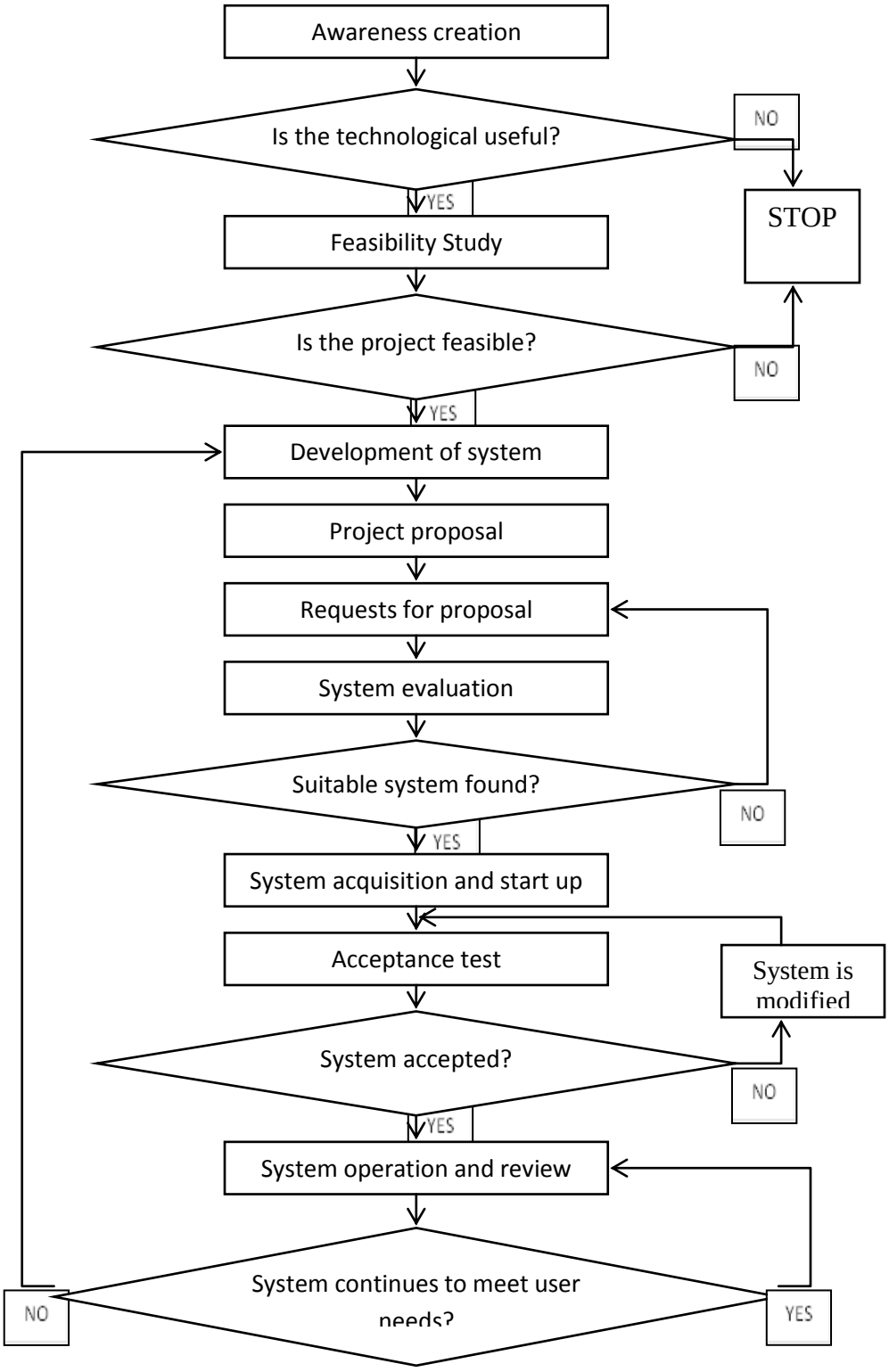


Fig 2.6 Steps in setting up a LIS

2.9.1 Awareness Creation

At this important first stage, awareness is created amongst the potential managers and users of the system as to what LIS is all about and how it can benefit the organization. This can be done through various techniques, such as the distribution of brochures and the holding of workshops and demonstration; the experience of others that have already set up such technology are also useful. Awareness creation is primarily aimed at overcoming the phenomena of resistance to change, which changes because changes threaten stability; if carried out well, it should largely remove any opposition to the project that is based merely on the fact that the technology is unfamiliar.

2.9.2 Feasibility Study

Once the organization is aware of and interested enough in LIS to want further investigation, a feasibility study should be carried out. The aim of this study is to determine whether the organization has the capacity to acquire and maintain LIS. The maintenance aspect is especially important if the LIS will be donor funded a common scenario in developing countries. It should be pointed out that apart from the economic aspect of the feasibility study, usually carried out via a cost/benefit analysis, other aspects such as technical (e.g. what is the state of base mapping?),social (e.g. how will the technology influence working practices?) and others should also be investigated (Allan,1998).Some documented cost/benefit analyses in respect of GIS ,such as Dickson and Calkins (1998) ,De Mers and Fisher (1991) and Smith and Tomlinson (1992) place the long term benefit/cost ration for such systems at about 3:1 on average.

2.9.3 Development of Systems Requirements

By this stage, the organization has determined that the GIS project is feasible and now wishes to determine what kind of system would be suitable for it. According to an old Harvard Business School adage – Any organization, private or public, must be driven only by the present and latent needs of users, and not by its own traditions, its preference or even its special competence –In the case of LIS project, this simply means that a LIS that is not based on the expressed needs of its potential users is u7nlikely to stand. LIS system requirements are therefore normally determined by carrying out a user needs assessment of the present system and the anticipated future needs. The user needs

assessment may be carried out through interviews and analysis of the information products and services handled by the organization, plus the systems and procedures used to provide them. This assessment should help determine what applications, information products, data and procedures will be needed and hence what hardware, software and organizational changes will be necessary.

2.9.4 Project Proposal

Once the system requirements have been established, the organization should now be in a position to develop a project proposal; if the LIS donor funded, staff from both the organization and the donor should be involved in drawing up this document. The proposal should be state the objectives of the project, the expected activities to meet those objectives, plus expected inputs, outputs and sources of finance. Any expected short and long term training programs should be given careful attention; note should be made of the fact, which has been documented in a number of studies, .eg. Hastings and Clark (1991) and Abiodun (1998) that highly trained LIS personnel often leave their organization for greener pastures, thus frustrating implementation efforts. The proposal must include a time and financial budget. The financial budget must reflect the fact that database development will cost a lot more than hardware and software, taking over 70% of total set up costs. The budget should also include a significant sustainability component, which will be used to run the project once initial set up is over. This component could be critical to survival of the project in a developing country. Aronoff (1989) and Waters (1996) suggest 10-20 % of total set up cost for maintenance.

2.9.5 Requests for proposal

Once the project proposal is complete, Requests for proposal (tender) documents, detailing the specifications of the required system, are then prepared and sent to a number of contractors (GIS Vendors),who may be selected on recommendation from unbiased experts, vendors literature or demonstration given at conferences and trade shows. Requests for proposal may also be published in business periodicals such as Development Business.

2.9.6 System Evaluation

The GIS vendors invited to quote submit their tenders proposing alternative systems. These are subjected to a preliminary evaluation against the specified system requirements for hardware and software; demonstration by the vendor may be required. User-friendliness of the software , though a relative and difficult-to-define term, is an important item to look for, since it will directly affect the time needed for training and how widely the system is used in the organization. Hardware and software security systems (e.g. hardware locks, password systems) should be carefully evaluated at this stage. From the preliminary evaluation, a few systems are selected for more rigorous testing in the process of benchmarking. This entails administering a standard test procedure to the short listed systems, using datasets supplied by the buyer.

Benchmarking should i8nclude every major processing function and output product that will be needed and should, if possible, be carried out in the actual environment where the proposed LIS will be installed. For donor funded projects, if such benchmarking takes place in the donor country, staff of the recipient country should be involved. At the end of benchmarking, an evaluation report stating the comparative technical suit abilities of the short listed systems should be produced.

2.9.7 System Acquisition and Start Up

Based on technical suitability and other factors that the organization considers relevant, (such as the ability of a vendor to also render database creation services, local availability of services agents, etc) one (preferably) or more vendors are selected to supply the system. In many donor funded projects it is often a requirement that the vendors be indigenous to the donor country. Needless to say, this severely limits choice flexibility for the recipient country. Once a vendor is selected, a contract is negotiated and executed. In negotiating the contract, note should be made of the fact that such system purchases usually include hardware, software (including the possibility of upgrades), documentation, installation, some training and maintenance, plus any other service agreed upon. It is the responsibility of the agents of the recipient organization to ensure that all these are clearly provided for in the contract. The system is then delivered, installed and customized as necessary. An acceptance test, in which all the critical

functions of the system are again evaluated using the buyer's data, is carried out. Only when the system passes this test should it be accepted. The database is now designed and implemented. Data standards, quality control and on-site security and accountability measures (e.g. physical security, system use protocols, and database responsibility) are also put in place at this stage.

2.9.8 System Operation and Review

The system is now operated, first on a pilot basis, then in full production. The pilot run area should be small but representative; for example, in the Bangkok Land Information System project, which was eventually cover an area of 1500 km2, a 25 km2 area was deemed sufficient for the pilot run (Williamson and Mathieson, 1992).A pilot run using a complete data set for such a small area helps the organization's staff to gain confidence in using the system and solving unexpected problems before significant resources have been committed. Once the LIS is operational, the staff responsible for it should be kept up to date with the fast changes in this technology through the availability of publications, attendance at conferences, software upgrades, and connection to the internet etc. The system should be regularly evaluated to see if it continues to meet user needs, which will change over time. If it is found not to satisfy these needs any more, system requirements should be reviewed and the system modified or replaced as necessary.

CHAPTER THREE
MATERIALS AND METHODOLOGY

3.1 Area of study

The project study area is the New Taveta Town in Taveta sub-county of Taita-Taveta County. It is situated within Cassini coordinates (-373374.41, 73999.43;-372718.95, 72168.37;-374782.36,70058.98;-375959.60,72543.33) with 37 degree as the central meridian.

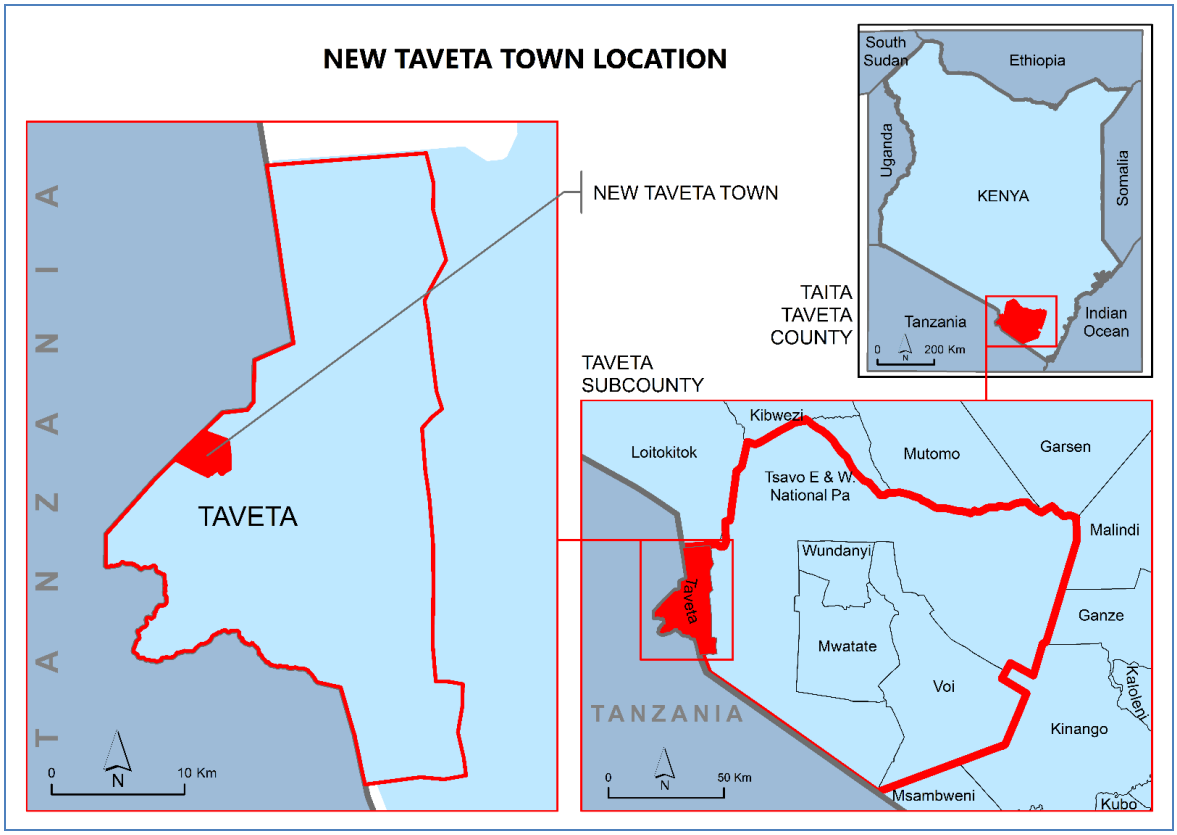


Fig 3.1 Area of study

Fig 3.1 shows the project study area. The study area was chosen because it is a planned New Town, an extension of Taveta Town and no study on Land Information System had been carried out in the area despite availability of the technology and also because of familiarity with the area and availability of the datasets to carry out the project.

The town is about 102km North from Voi via Nairobi-Mombasa road and is the main commercial and administrative centre of the newly created Taveta sub-county. It is situated in the south western part of the former coast province as shown by figure 3.1.

The Sub-county covers 4205.6 square kilometre under which 605 square kilometre is settled and 3560.6 square kilometer under Tsavo west National Park on the south. The Sub-county borders Wundanyi and Mwatate Sub-counties to the East, the Republic of Tanzania to the west, the county of Kajiado to the North and County of Kwale to the south. The major economic activity is trade, the town being a border town plays a vital role in facilitating cross border trade of both agricultural and manufactured products.

3.2 Data identification

Two types of data was collected namely spatial data and non-spatial data.

3.2.1 Spatial data

Spatial data also known as geospatial data or geographic information refers to the data or information that identifies the geographic location of features and boundaries on Earth, such as natural or constructed features, oceans, and more. Spatial data is usually stored as coordinates and topology, and is data that can be mapped. This type of data is often accessed, manipulated or analyzed in a GIS environment.

3.2.2 Non-Spatial data

Non-spatial data also known as attribute or characteristic data refers to information that describes a geographic feature but do not have location information itself i.e. it is not directly related to a feature on the ground (it is independent of all geometric considerations). In GIS this data is usually stored in tables and linked to the feature by a unique identifier. It includes parcel ownership data, encumbrances, land valuation and taxation data, land statistics, land use types, soil types and its characteristics and site data. A key element of this dataset is the unique identifier that provides the linkage mechanism to the main geographic dataset.

3.3 Data acquisition

Table 3.1 below summarizes the datasets that were used in the study.

Table 3.1: Dataset used

Dataset	Description	Source
Development plan New Taveta Town	Scanned plan, Scale 1:2500, Raster file format	Town Council of Taveta
Cadastral plans	Scanned plan, Scale 1:1000,Raster format	Survey of Kenya (SoK), Ruaraka.
RIM	Scanned	Survey of Kenya (SoK), Ruaraka.
Topographical map (Sheet 188_3 Series Y633, Edition 2-GSGS)	Digital map, Scale 1:50000, Raster file format	Survey of Kenya (SoK), Ruaraka.
Land Ownership Details	Tabular data, no-spatial reference	Town Council of Taveta

3.4 Hardware and software used

The following Hardware was used in carrying out the project:

i) A Personal Computer (Intel core 2 duo processor 2.0 GHz, 2GB RAM memory, 500 GB Hard Disk space).

ii) Drum Scanner.

iii) Printer (HP DeskJet 3740 series).

Table 3.2: Software used

Software	Use
Adobe Photoshop 7.0	Image cleaning
Global Mapper 10.0	Georeferencing
Arc Info	Spatial and non-spatial data capture and analysis.
Microsoft Office word 2013	Report typing and editing

Table 3.2 shows the software used in processing and analysis of data.

3.5 Methodological model overview

The following flow-chart gives a summary of the methodology that will be employed in realizing the objectives of this study.

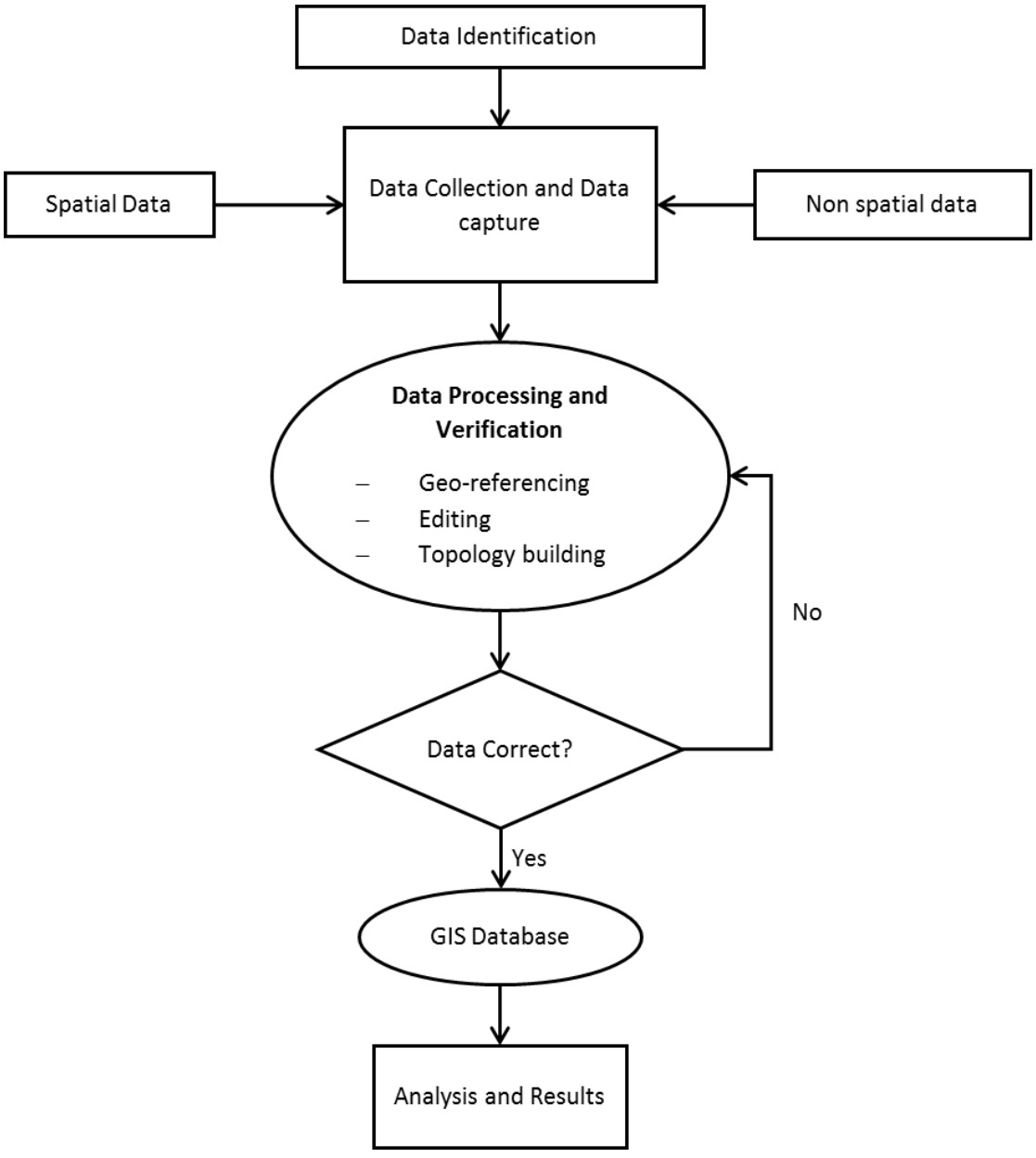


Fig 3.2 Flow chart showing methodology overview

3.6 Data preparation

3.6.1 RIM preparation

The RIMs were obtained from the survey of Kenya. They were first prepared before being scanned using wide image software at a resolution of 500 dpi (dots per inch). Preliminary preparation involved removal of unnecessary dirt, tape, ensuring the map was flat and clean.

3.6.2 Scanning of the RIMs

The RIMs of the area of study were acquired in Analogue form. To be able to use them in the computer they had to be converted to digital format. Scanning is a data capture process by which data is digitized in the raster format using a scanner. The scanner senses the binary grey tones or colour values of the analogue data and outputs them as a series of pixels in parallel scan lines.

Before using a scanner, the document must be well prepared to ensure that:

(i) Line widths are resolvable.
(ii) Line separations exceed pixel sizes.
(iii)Unwanted data is opaque out.

Scanning was done using a drum scanner with a resolution of 500 dpi (dots per inch) at the Survey of Kenya (SoK).The RIMs were fed into the scanner which used wide image as the scanning software. The resolution was set to 500 dpi (dots per inch) and 24 bit colour adopted. Scan button was pressed to execute the process and resultant images saved in Joint Photographic Expert Group (JPEG) format. The scanned images was then imported into Adobe Photoshop software as a Tagged Image File Format (TIFF) image format and further map cleaning performed, to remove unnecessary scanned features. The cleaned images were then exported to Global mapper software for geo-referencing after coordinate transformation.

3.6.3 Coordinates transformation

The cadastral plans for the area of study were in Cassini coordinate system, there is need to convert the coordinates into geographic coordinates to ensure proper integration with other data sets such as google earth maps. This conversion requires the use of coordinates

of four corresponding points both in Cassini and UTM projections. The coordinates are used as inputs of four parameter transformation equations that describe the relationship of both projections over the area of study. The four points, usually corner grid points of the topographical map in this case sheet 188_3, were purchased at Survey of Kenya.
The equations are as follows;

Transformation Parameters

$$E = aX - bY + Tx$$

$$N = bX + aY + Ty$$

where E and N are the UTM coordinates (Eastings and Northings) whereas X and Y are the Cassini coordinates of the corresponding point, a and b are constants, Tx is translation along the x-axis and Ty is translation along the y-axis.
While the points were provided as shown in table 3.3 below.

Table 3.3: Corner grid points in Cassini and UTM

DATUMS	188_3	TAVETA	
CASSINI (X)	**CASSINI (Y)**	**UTM (E)**	**UTM (N)**
182058.700	**-1179596.700**	**333332.200**	**9640682.900**
273198.900	**-1179654.900**	**361115.000**	**9640720.700**
182007.900	**-1270267.200**	**333374.800**	**9613042.500**
273126.100	**-1270333.100**	**361150.500**	**9613083.200**

Using the least squares adjustment, the four parameters were calculated and the results are as given below:

a= 0.304824218 b= 0.00063833801

Tx= 277083.8327 Ty= 10000135.4217

These parameters were used to compute the UTM coordinates of other points in the adjoining plans whose Cassini coordinates are known. This registration of an image into real-world coordinates allows one to digitize features directly in geographic space.

Table 3.4 below shows the corner beacons whose coordinates were converted into UTM coordinates, Arc Datum 1960.

Table 3.4: Boundary transformed to UTM.

	CASSINI (X m)	CASSINI (Y m)	CASSINI (X ft)	CASSINI (Y ft)	UTM (Em)	UTM (Nm)
NT1	73999.43	-373374.41	242780.282	-1224981.660	351871.095	9626886.321
NT2	72168.37	-372718.95	236772.867	-1222831.201	350038.516	9627537.998
NT3	70058.98	-374782.36	229852.297	-1229600.919	347933.280	9625470.007
NT4	72543.33	-375959.60	238003.051	-1233463.255	350420.293	9624297.876
NT5	73074.40	-375567.72	239745.407	-1232177.559	350950.585	9624690.899
NT6	73385.53	-375989.36	240766.175	-1233560.892	351262.622	9624269.877
NT7	73607.61	-375825.48	241494.783	-1233023.228	351484.377	9624434.235
NT8	73752.32	-375794.38	241969.554	-1232921.194	351629.033	9624465.641
T1	74116.11	-375794.38	243163.091	-1232921.194	351992.852	9624466.403

3.7 Georeferencing

This refers to the process of scaling, rotating, translating and deskewing the image to match a particular size and position i.e. the process of relating image coordinates to ground coordinates. The georeferencing process simply involves selecting a pixel on the raster image and specifying what coordinate it represents on the ground by use of known ground control points (GCPs). This registration must be accurate for proper representation of features as well as overlaying other layers. This is ensured by maintaining the RMS error to the minimum.

A total of four Ground Control Points(GCPs) were used in a four parameter transformation that takes care of rotation, scale and all translations in X and Y direction. The GCP were obtained from the survey plans.

The procedure was carried out in Global Mapper 10.0 as follows:

- The raster file (Development plans) was loaded into the software working space. Since it had no spatial reference, the software automatically launches the georeferencing wizard.
- Four corner points on the map were identified and their coordinates noted. These were the first intersections of the Northings and Eastings on the four corners of the combined RIM, and were to serve as the GCPs (Ground Control Points)

- The first point was marked on the rectifier window, and the coordinates. As printed on the grid, input into the GCP entry.
- The same procedure was done for the three subsequent GCPs, after which a projection was specified.
- The projection and datum were specified as they appeared on the marginal information of the topographical map, i.e. UTM and Arc 1960 respectively.
- Afterwards, the default settings were applied and the selected GCPs updated. The map was hence rectified with a first order polynomial transformation, yielding an RMS (Root Mean Square) of 0.00 metres.

The RMS obtained was well within the accepted accuracy levels of not greater than 0.00041 metres (Ted, 2005). The procedure was repeated for the FRs and RIM.

3.8 Digitization

It refers to the process of converting features on a paper map into digital format. The scanned georeferenced RIM was digitized using ArcMap 10.1 software. To obtain higher accuracy, point mode method of digitization was used to define the parcel boundaries.

3.8.1 Digitization of parcel boundaries

In ArcCatalog and prior to digitizing, a file geodatabase is created to provide for space to store and analyzing the various feature classes. Then a feature dataset is then created within the geodatabase. This allows for the definition of the projection and datum parameter that are going to be assumed by all the features in it. New feature classes are then created.

The georeferenced raster files (R.I.M) is loaded in ArcMap. The target feature class is also loaded. Digitization is done on-screen by tracing over the parcel boundaries as viewed in the underlying raster plans. This is done in an editing session. A snapping tolerance of 0.001 metres is set to ensure clustering of coincident corner points. All the parcels within the Estate are digitized accurately and the numbers entered as they appeared in the plans. A total 5407 plots were entered.

Once completed, the parcel polygons are used to generate parcel lines. Parcel lines are used to build the parcel boundaries as described by the survey records. The two are a prerequisite for building topology which must be validated before migration into a parcel fabric. Parcel fabric refers to a dataset for the storage, maintenance and editing of parcels. It is created under a feature dataset and inherits its spatial reference from the feature dataset. It stores a continuous surface of connected parcels or parcels network. Parcels in a fabric are defined by polygon features, line features, and point features. Polygons are defined by a series of boundary lines that store dimensions as attributes in the line table. Dimensions on parcel lines should ideally match recorded dimensions on the record or survey plan.

3.8.2 Data Editing

Digitizing invariably introduces errors. The main task include

- Error correction
- Entering missing data
- Building topology

Typical errors include gaps, silvers, misclosures overshoots and undershoot. Arc Info has editing capabilities that enable feature snapping, automatic detection and identification of the digitizing errors. This capability enabled the correction of the digitizing errors (Mulaku, 2008).

3.8.3 Topology and parcel building

Topology refers to the model used to describe how features share geometry and is the mechanism for establishing and maintaining spatial relationships between features. It is the arrangement that defines how point, line, and polygon features share coincident geometry. It is a vital component in parcel building and maintenance in the parcel fabric.
A geodatabase topology was created in the feature dataset containing the feature class of parcel lines and the feature class of parcel polygons.

The following set of rules structuring the relationship between a parcel polygon and parcel line feature classes in a feature dataset were defined;

- [Line feature class] Must Be Covered by Boundary of [Polygon feature class].
- [Line feature class] Must Not Self-overlap.
- [Line feature class] Must Not Self-Intersect.
- [Line feature class] Must Be Single Part.
- [Line feature class] Must Not Intersect or Touch Interior.
- [Polygon feature class]Boundary must be covered By [Line feature class].

The topology validation was done in ArcCatalog to allow for entire coverage of the dataset. Once the topology was clean, the data was then migrated to an already created parcel fabric using the *Load A topology To A Parcel Fabric* geoprocessing tool. The following procedure was followed:

1. In ArcMap, the target fabric and the topology containing both the parcel polygon feature class and the parcel line feature class is loaded.
2. Zoom to the area of data that you would like to load into the fabric.
3. In an Edit session the entire map extent is validated (This was done using the Topology toolbar)
4. Errors resulting from the topology validation were fixed appropriately. The lines or polygons that were selected and loaded into the fabric must be clean and have no errors.
5. The editing session is stopped and edits saved.
6. Using the Select By Rectangle tool on the Tools toolbar and the polygons that will be loaded into the fabric are selected. (Lines can also be selected)
7. ON the Catalog window, open the *Load A Topology To A parcel Fabric* geoprocessing tool located under Toolboxes.
8. The target parcel fabric is loaded in the map and the parcel polygon (or line) feature class as the Input (Topology) feature class. Other parameters necessary for your migration were entered. The tool is then executed.
9. Once the load is complete, the migrated fabric parcels are displayed in ArcMap.

The georeferenced digitized RIM was projected to UTM coordinates WGS84 to enable integration with the other datasets in ArcMap 10.1 software.

3.9 Database design

Database design is the process of identifying the data that will go into the GIS database and how it will be represented. The database forms the foundation of all activities that will be performed using the GIS, such as map creation, data retrieval and spatial analysis and modeling.

A good database design results in a well-constructed, functionally and operationally efficient database that:

- Satisfies user requirements and objectives
- Contains all necessary data but no redundant data unless some is explicitly planned for and properly documented.
- Has efficient data structures and retrieval mechanisms
- Supports maximum data sharing
- Accommodates different user views of the data
- Is easy to update and maintain

In summary, the process of database design consist of the following steps:

1. Needs assessment
2. Conceptual design
3. Logical design
4. Physical design
5. Pilot implementation
6. Full implementation
7. Operational GIS database

The same is illustrated in fig 3.3.

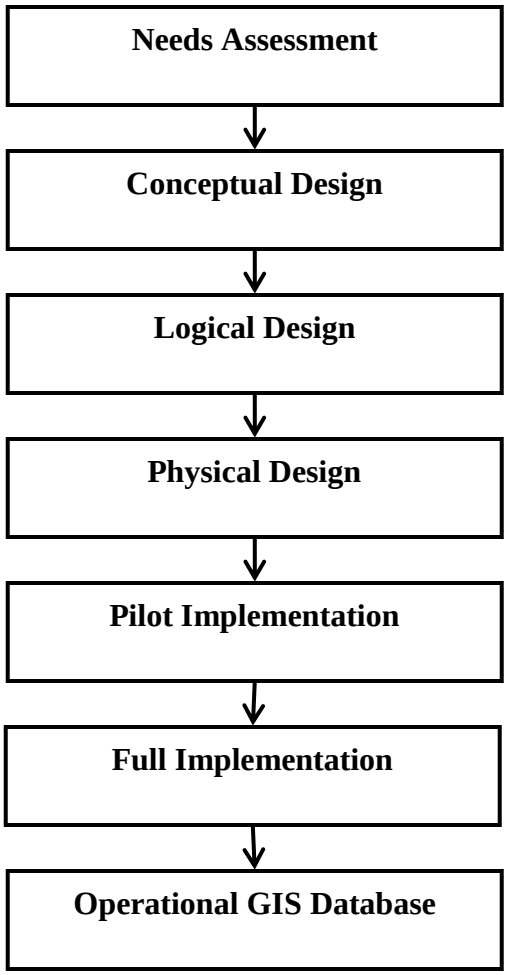


Fig 3.3 Summary of the database design

Database design normally consists of the following steps:

1. External modeling

This is also referred to as a 'user needs assessment'. Potential users of the database were determined, their information needs and the data that is required to satisfy those needs. Each user view is an external model. The users of this LIS include the County Government of Taita-Taveta, surveyors, planners, valuers, potential investors, financial institutions, land brokers and real estate companies. The data required to satisfy the users include plot numbers, ownership details, plot user, plot area, plot taxation, encumbrances. The objective of external modeling is to ensure a common understanding between the design team and those who have a vested interest in the setup of the database. The end result of external modeling is a user needs assessment report.

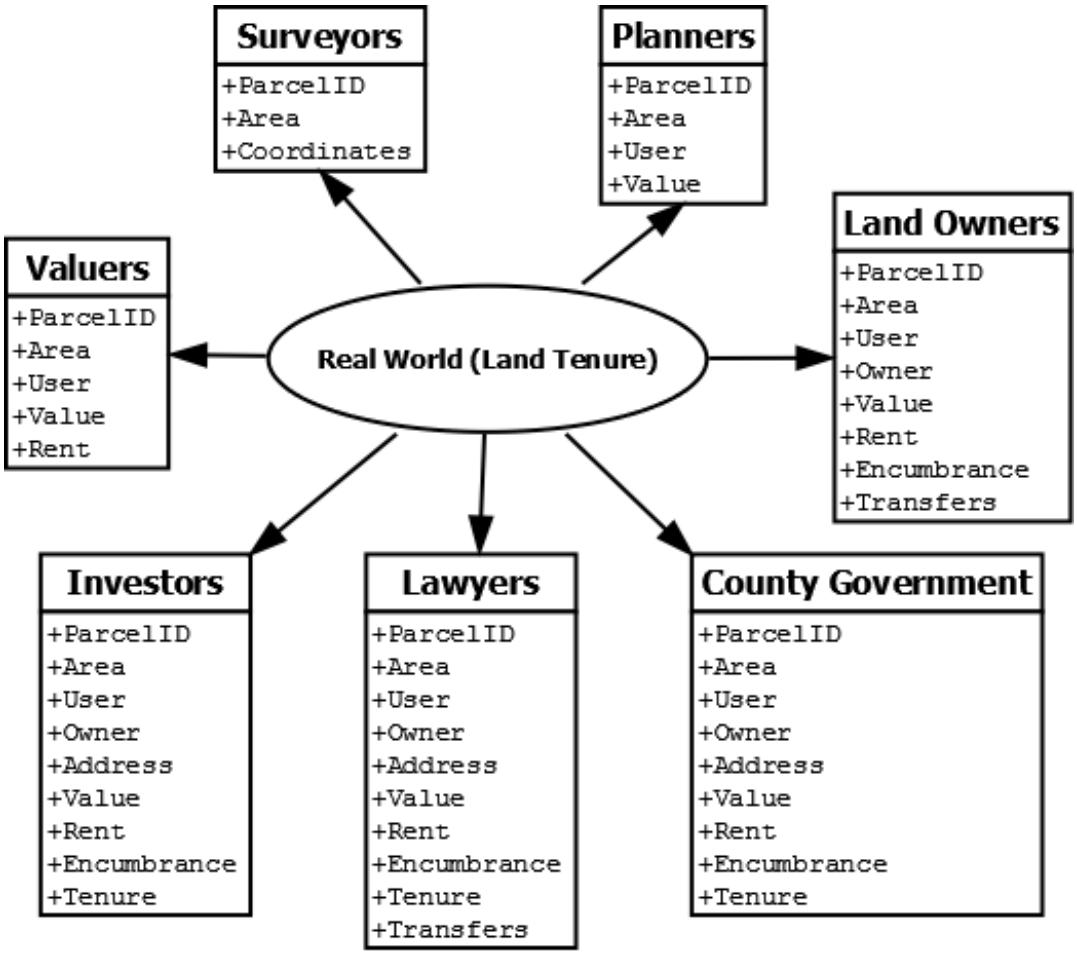


Fig 3.4 External model

2. Conceptual modeling

Conceptual modeling is the synthesis of all the external models into an E-R diagram showing all the entities involved, their attributes and relationships. The E-R model is based on the fundamental concepts of entities, attributes, domains, relationships and mapping (cardinalities). E-R diagram defines the entities, their relationship with each other and the constraints.

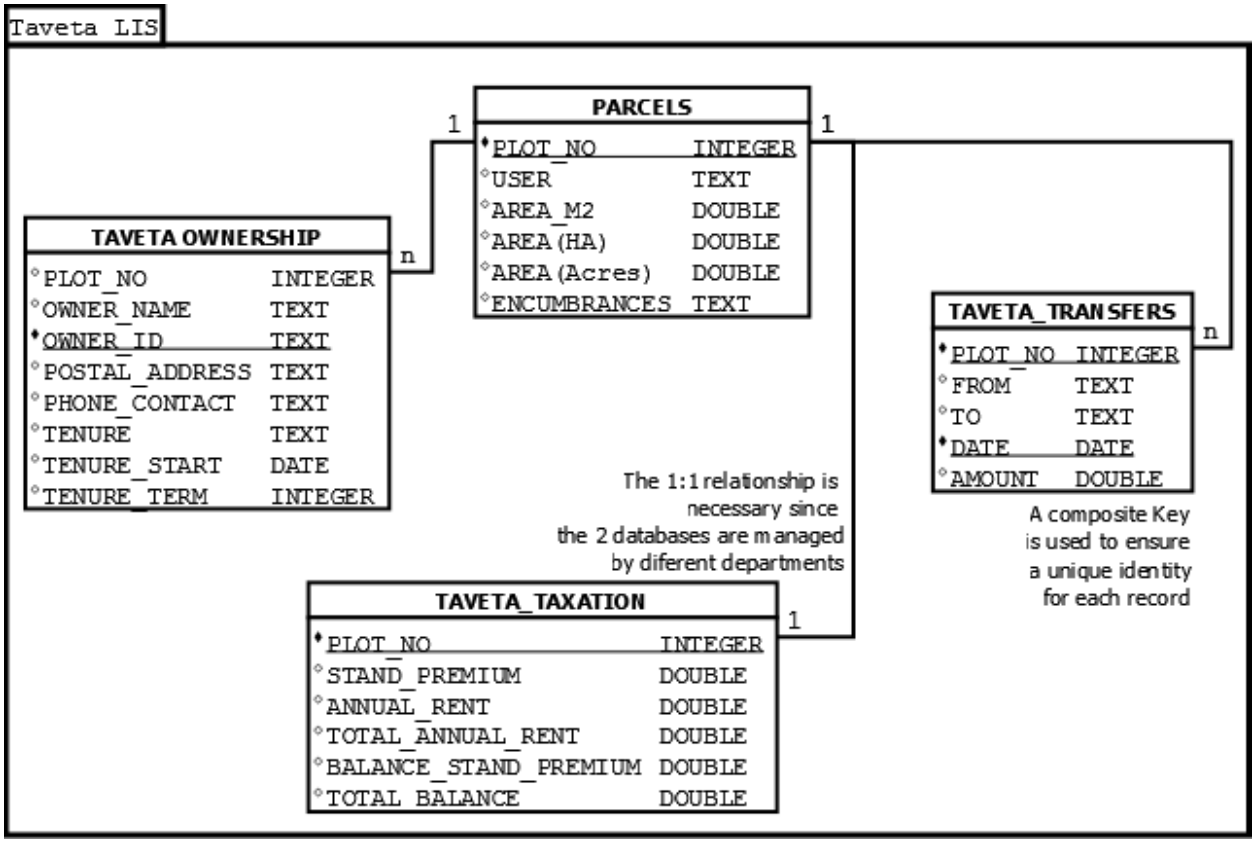


Fig 3.5 Conceptual model

3. Logical modeling

Logical modelling consists of the mapping of the conceptual design onto the logical model DBMS. Logical modeling comprises the design and normalization of the relational tables according to the entities, attributes and relations identified from conceptual modeling; several iterations will be necessary. Logical modeling is software dependent but it is still hardware independent.

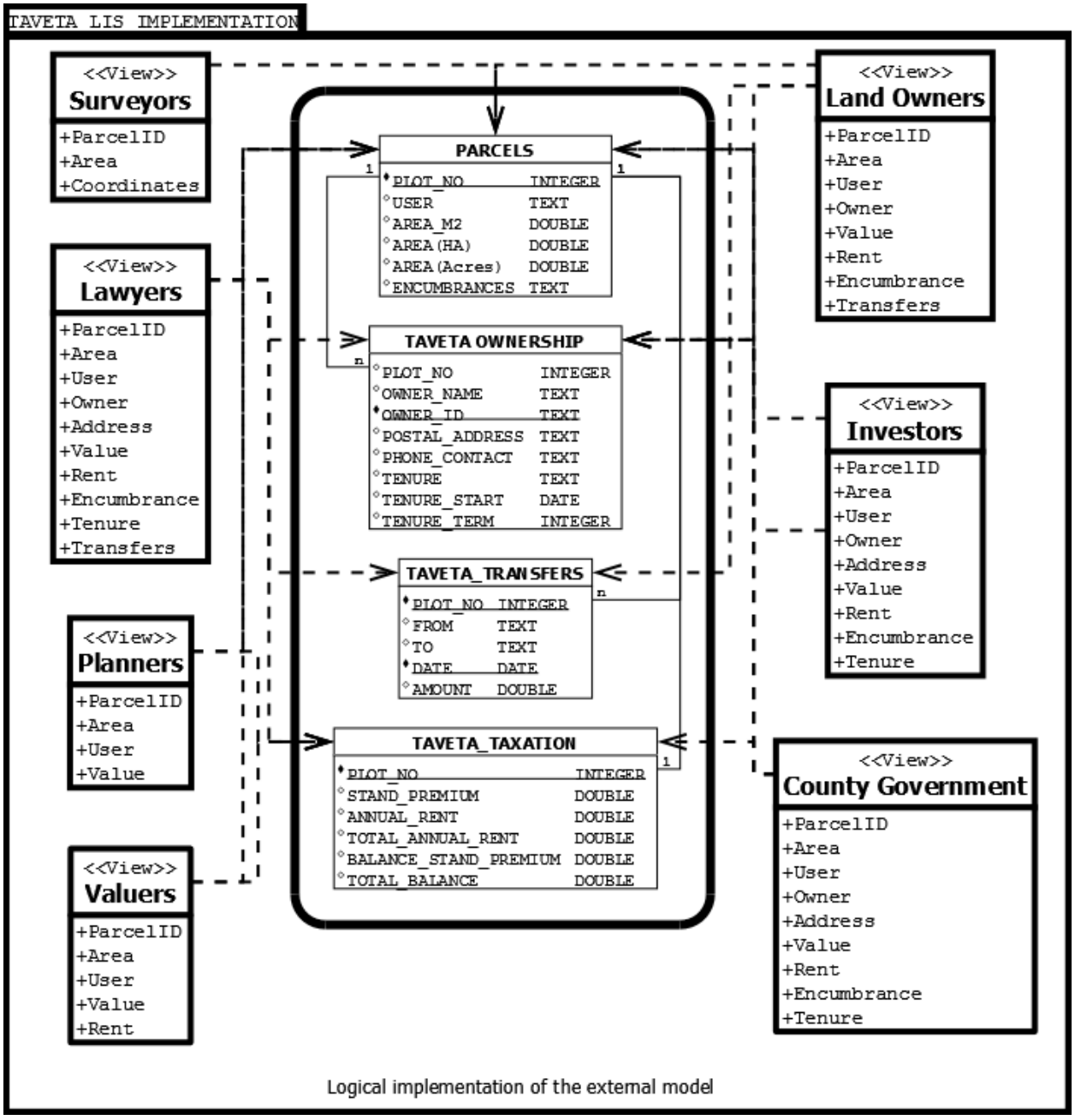


Fig 3.6 Logical Modelling Taveta LIS

4. Physical modeling

This is the design of efficient physical data storage structures for the data (e.g. arrays, trees, stacks, queues, etc.) where the data will actually reside on disc and also how the data may be efficiently accessed. The DBMS itself mostly handles this process. Physical modeling is both software and hardware dependent. The Physical Design involves the development of a geodatabase template that is a skeleton of the final geodatabase. Every field is given its data and will look like the tables below.

Table 3.5: Parcels

Plot_Number	User	Area_m2	Area(Ha)	Area (Acres)	Encumbrances

Table 3.6: Taveta_Ownership

Plot No.	Owner_Name	Owner_ID	Postal_Address	Phone Contact	Tenure	Tenure Start	Tenure_Term

Table 3.7: Taveta_Taxation

Plot_No.	Stand_Premium	Annual_Rent	Total_Annual_Rent	Balance_Stand_Premium	Total_Balance

Table 3.8: Taveta_Transfers

Plot_Number	From	To	Date	Amount

3.10 Joining and relating Tables

From the database design, the database is organized into multiple table/relation that can be split instead of one large table containing all the necessary fields. Having multiple tables prevents duplicating information in the database, because one stores the information only once in one table. When the information needed isn't in a current table, one can link the two tables together.

GIS allows one to associate records in one table with records in another table through a common field, known as primary key or primary identifier. These associations are made in several ways, including by joining or relating tables temporarily in ones map or by creating relationship classes in the geodatabase that maintain more permanent associations. For example, one can associate a table of parcel ownership information with the parcels layer, since they share a parcel ID field.

When one joins two tables, the attributes from one are appended onto the other based on a common field to both. Relating tables defines a relationship between two tables-also based on a common field-but doesn't append the attributes of one to the other; instead, one can access the related data when necessary.

Joining a table of data to a layer is based on the value of a field that can be found in both tables. The name of the field does not have to be identical but the type of information must be the same. Hence, a string can only be joined to a string, text to a text and so on. In ArcMap, the join-operation is performed by using the *Join Data dialog box*, accessed by right-clicking a layer. All join operations carried out in this project are based on one-to-one relationship between the layers attribute table and the table containing the information to be joined.

On the other hand, relating tables simply defines a relationship between two tables. Unlike for the join, the associated data isn't appended to the layers attribute table. Instead, one can access the related data when working with the layers attributes. For example, if one select a parcel, the user of the parcel can be found. Similarly, if one selects a user, the parcel can be found.

Both operations facilitate the use of any additional fields to symbolize, label, query, or analyze the layers features.

3.11 Database Query

To retrieve information from the database, SQL statements were used. SQL is a query language that enables data retrieval from relational databases. The syntax of SQL requires the specification of what attributes is to be retrieved, the relation involved, and any condition governing the retrieval. Such a condition is called a predicate.

The results of the statement is a new drawing that is viewed in the database and also in the map face. However, the result are not stored in the database but used specifically for the purpose of visualization. One can prompt the software to save the query result.

The basic components of the SQL statement:

Select: <attribute name>

From: <table names>

Where: <condition to pick rows>

CHAPTER FOUR
RESULTS AND ANALYSIS

4.1 Results of the Digitization process

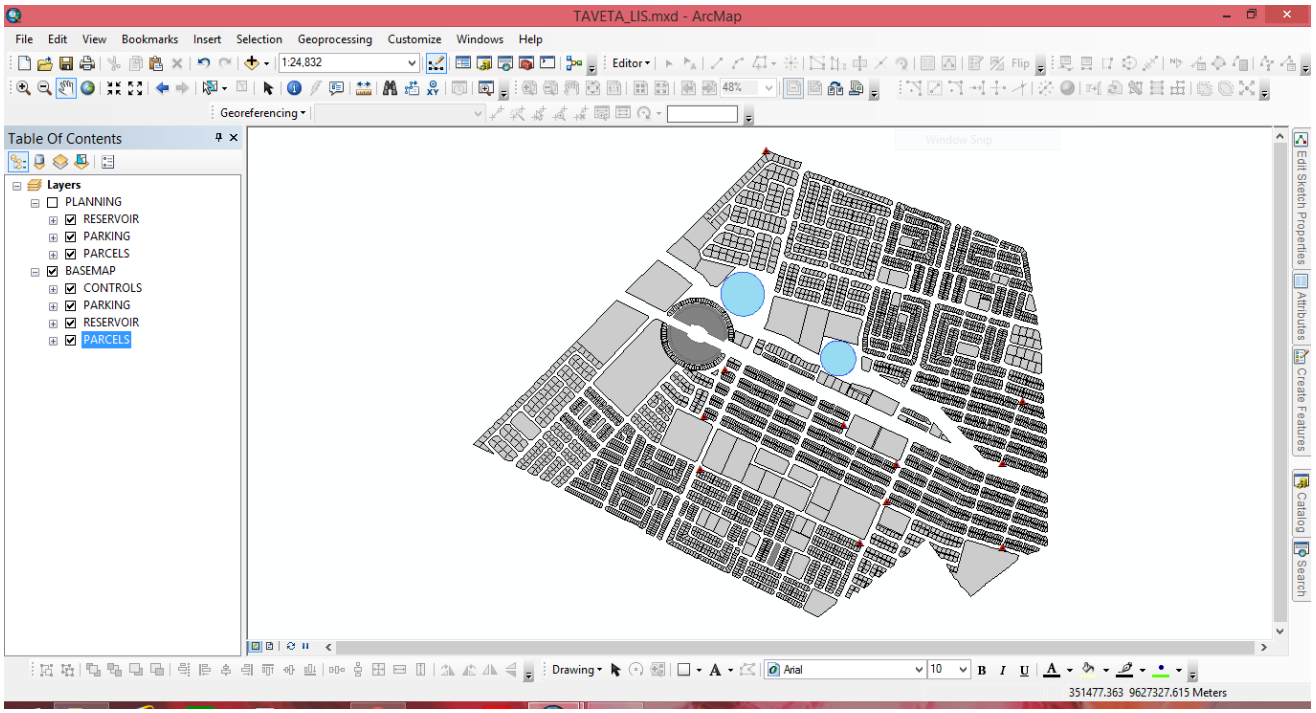


Fig 4.1 Digitization result

Figure 4.1 above shows the results of the process of digitization of the RIM after it has been georeferenced with coordinates in UTM Arc Datum 1960 and transformed to coordinates in UTM WGS 84. This was done so that integration with data such as google earth maps which are in UTM WGS 84 is possible. A total of 5407 parcels were digitized. The parcel numbers were then entered in to each digitized parcel. Figure 4.2 shows the parcel numbers of the digitized parcels.

4.2 Results of the Digitized RIM with the parcel numbers

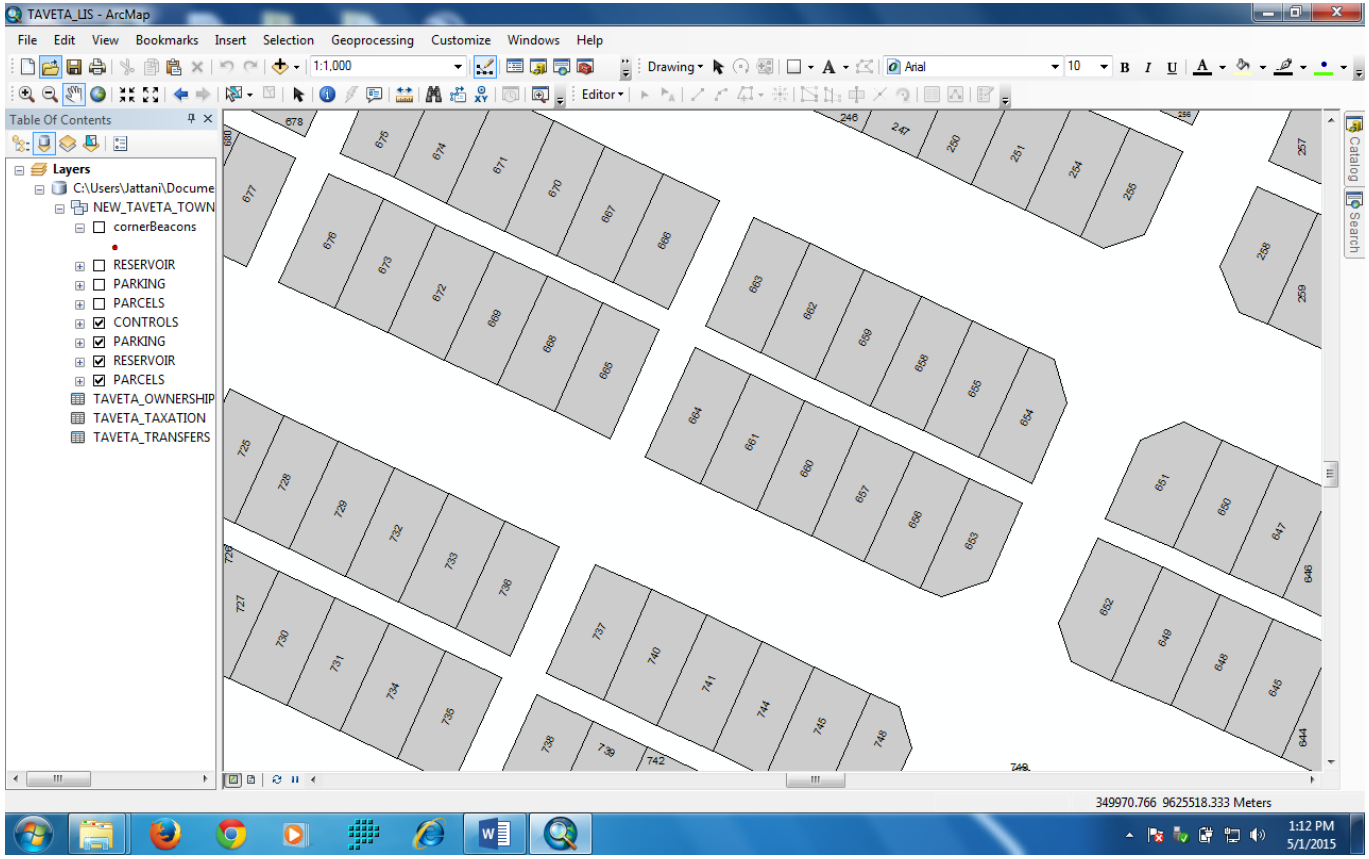


Fig 4.2 Results of the digitized RIM with the parcel numbers

There were 5407 parcels that were digitized, each of the parcel numbers were entered. Figure 4.2 above shows a section of the area of study that was identified to show the parcel numbering. The display of parcel numbers was set such that the parcel numbers are turned off at a scale of more than 1:2500. This was done so to avoid clutter on the map at scales of more than 2500.

4.3 Results of the designed relational database

Table 4.1 Parcels attribute table

Table

PARCELS

SHAPE *	PLOT_NUMBER	USER_	AREA_M2	AREA (Ha)	AREA (Acres)	ENCUMBEANCES	SHAPI
Polygon	1	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	2	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	3	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	4	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	5	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	6	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	7	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	8	COMMERCIA	450	0.045	0.111195	Charge to Jamii Bora Bank for Ksh. 270,000. Entry no. 1536. Date of registration 17-10-2012	
Polygon	9	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	10	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	11	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	12	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	13	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	14	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	15	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	16	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	17	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	18	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	19	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	20	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	21	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	22	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	23	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	24	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	25	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	26	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	27	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	28	COMMERCIA	450	0.045	0.111195	NIL	

13 (0 out of 5469 Selected)

PARCELS

Table 4.1 shows the attributes of the table parcels in the relational database. The attributes of the table parcels include; Plot Number, User, Area in m2, Area in Hectares, Area in Acres and Encumbrances.

Table 4.2 Plot ownership attribute table

Table

TAVETA_OWNERSHIP

OBJECTID *	PLOT_NO *	OWNER_NAME	OWNER_ID	POSTAL_ADDRESS	PHONE_CONTACT	TENURE	TENURE_START	TENURE_TERM
1	1	MNGANDE Z. ABDALLAH	0	195 TAVETA	254721000001	LEASEHOL	5/18/2009	99
2	2	LUMAZO ZUHURA &	9714	3 TAVETA	254721000001	LEASEHOL	5/18/2009	99
3	3	LALDSERI ZUHURA &	12646	440 TAVETA	254721000002	LEASEHOL	5/18/2009	99
4	4	DAVID ZUBERIJUMANNE &	12646	303 TAVETA	254721000003	LEASEHOL	5/18/2009	99
5	5	MUTHYA ZMIRI &	13238	402 TAVETA	254721000004	LEASEHOL	5/18/2009	99
6	6	HARRISON ZILILI A	13238	233 TAVETA	254721000005	LEASEHOL	5/18/2009	99
7	7	WISDOM ZILA A.	15390	195 TAVETA	254721000006	LEASEHOL	5/18/2009	99
8	8	SIMON ZIGHE A.	18461	245 TAVETA	254721000007	LEASEHOL	5/18/2009	99
9	9	SUNDE ZIGHE A. SURUMO	22653	195 TAVETA	254721000008	LEASEHOL	5/18/2009	99
10	10	ANNAH ZENGE A.	26516	40 TAVETA	254721000009	LEASEHOL	5/18/2009	99
11	11	AMINA ZEMBA A.	38073	195 TAVETA	254721000010	LEASEHOL	5/18/2009	99
12	12	OMINGO ZEMBA A.	44536	34 TAVETA	254721000011	LEASEHOL	5/18/2009	99
13	13	JACOB ZAWADI ABASS	45258	303 TAVETA	254721000012	LEASEHOL	5/18/2009	99
14	14	CRISPUS ZAKAYO ABDALA	71054	195 TAVETA	254721000013	LEASEHOL	5/18/2009	99
15	15	MNGANDE Z. ABDALLAH	71054	195 TAVETA	254721000014	LEASEHOL	5/18/2009	99
16	16	HERBERT Z. ABDI	71054	195 TAVETA	254721000015	LEASEHOL	5/18/2009	99
17	17	KAREGA Z. ABDI	71317	195 TAVETA	254721000016	LEASEHOL	5/18/2009	99
18	18	ZEBEDAYO Z. ABDI	78728	2029 TAVETA	254721000017	LEASEHOL	5/18/2009	99
19	19	WILFRED Z. ABDI	84921	112 TAVETA	254721000018	LEASEHOL	5/18/2009	99
20	20	PATRICK Z. ABDI	89765	81 MARSABIT	254721000019	LEASEHOL	5/18/2009	99
21	21	JARRED Z. ABDI	93866	100 TAVETA	254721000020	LEASEHOL	5/18/2009	99
22	22	JACOB Z. ABDI	122354	16626-00620 NAIROBI	254721000021	LEASEHOL	5/18/2009	99
23	22	SOLOMON Z. ABDI	124356	467 ISIOLO	254721000022	LEASEHOL	5/18/2009	99
24	23	ELIZABETH Z. ABDI	142567	66 TAVETA	254721000023	LEASEHOL	5/18/2009	99
25	24	DIANA YUSSUF ABDI	149651	50 TAVETA	254721000024	LEASEHOL	5/18/2009	99
26	25	TERESIA YUKA ABDI	150164	3 TAVETA	254721000025	LEASEHOL	5/18/2009	99
27	26	JAFFERSON YOUTH ABDILE	150899	42 TAVETA	254721000026	LEASEHOL	5/18/2009	99
28	27	JOSHUA YOUTH ABDILLE	150899	42 TAVETA	254721000027	LEASEHOL	5/18/2009	99
29	28	JOHN YONA ABDILLE	150969	114 TAVETA	254721000028	LEASEHOL	5/18/2009	99

1 (0 out of 5470 Selected)

TAVETA_OWNERSHIP

Table 4.2 shows the attributes of the table TAVETA_OWNERSHIP in the relational database. The attributes of the table TAVETA_OWNERSHIP include; Plot No, Owner name, owner ID, postal address, phone contact, tenure, tenure start date and tenure term.

Table 4.3 Plot taxation attribute table

Table

TAVETA_TAXATION

OBJECTID *	PLOT_NO_*	STAND_PREM	ANNUAL_RENT_2009	ANNUAL_RENT_2010	ANNUAL_RENT_2011	ANNUAL_RENT_2012	ANNUAL_RENT_2013	ANNUAL_RENT_2014	ANNUAL_RENT_2015	T
1	1	50000	10000	4000	4000	4000	4000	4000	4000	
2	2	50000	4000	4000	4000	4000	4000	4000	4000	
3	3	50000	4000	4000	4000	4000	4000	4000	4000	
4	4	50000	4000	4000	4000	4000	4000	4000	4000	
5	5	50000	4000	4000	4000	4000	4000	4000	4000	
6	6	50000	4000	4000	4000	4000	4000	4000	4000	
7	7	50000	4000	4000	4000	4000	4000	4000	4000	
8	8	50000	4000	4000	4000	4000	4000	4000	4000	
9	9	32000	2560	2560	2560	2560	2560	2560	2560	
10	10	32000	2560	2560	2560	2560	2560	2560	2560	
11	11	32000	2560	2560	2560	2560	2560	2560	2560	
12	12	32000	2560	2560	2560	2560	2560	2560	2560	
13	13	32000	2560	2560	2560	2560	2560	2560	2560	
14	14	32000	2560	2560	2560	2560	2560	2560	2560	
15	15	32000	2560	2560	2560	2560	2560	2560	2560	
16	16	32000	2560	2560	2560	2560	2560	2560	2560	
17	17	32000	2560	2560	2560	2560	2560	2560	2560	
18	18	32000	2560	2560	2560	2560	2560	2560	2560	
19	19	32000	2560	2560	2560	2560	2560	2560	2560	
20	20	32000	2560	2560	2560	2560	2560	2560	2560	
21	21	32000	2560	2560	2560	2560	2560	2560	2560	
22	22	50000	4000	4000	4000	4000	4000	4000	4000	
23	23	50000	4000	4000	4000	4000	4000	4000	4000	
24	24	32000	2560	2560	2560	2560	2560	2560	2560	
25	25	32000	2560	2560	2560	2560	2560	2560	2560	
26	26	50000	4000	4000	4000	4000	4000	4000	4000	
27	27	50000	4000	4000	4000	4000	4000	4000	4000	
28	28	32000	2560	2560	2560	2560	2560	2560	2560	

1 (0 out of 5624 Selected)

TAVETA_TAXATION

Table 4.3 shows the attributes of the table TAVETA_TAXATION in the relational database. The attributes of the table TAVETA_TAXATION include; Plot no., stand premium, annual rent 2010,2011,2012,2013,2014,2015, total annual rent, balance stand premium and total balance.

Table 4.4 Plot transfers attribute table

Table

TAVETA_TRANSFERS

OBJECTID *	PLOT_NUMBER	FROM_	TO	DATE	AMOUNT
1	100	THOMAS CHEGE	ALPHONCE GREY	15-5-2013	180000
2	150	SAMUEL KABUI KIRAITHE	THOMAS GOODWILL	20-6-2013	200000
3	200	ALEXANDRINE KAGURU	JOHN GONZI	15-5-2014	220000
4	250	DAN M. NDONYE KALAMBA	SIMION.M.KIDAI GONJOBE	20-6-2014	240000
5	300	KHALIFA MUSA SIANGA	KINANJA GONA	15-5-2013	260000
6	350	JONATHAN KAMUNDE MWAKACHOLA	DENIES GOMBANIA	20-6-2013	280000
7	400	THOMAS KAHOGE BOSIRE	RUTH GOLICHA	15-5-2014	300000
8	450	JAMES NYATIGO	IBRAHIM GOI	20-6-2014	320000
9	500	LEAH KANINI JUSTUS	MICHAEL GOGOI	15-5-2013	340000
10	550	SAMUEL MAUNDU MWEU	JOHNES GOGA	20-6-2013	360000
11	600	MARY AMINA MGENYI	JOSPHANT.H.MWAMBURI GOERG	15-5-2014	380000
12	650	LEONARD NGALUMA	NELSON GODAWA	20-6-2014	400000
13	700	ISACK SAURI SAYETI	JOYCE GITHINJI	15-5-2013	420000
14	750	JANE WAMBUI MUCHIRI	KALINGE.A.MELUKI GITHAE	20-6-2013	440000
15	800	ROSINA KILINZO	ALFRED GIMOI	15-5-2014	460000
16	850	JOSPHAT J.R. MRUTTU	HAMISI GILIAD	20-6-2014	480000
17	900	KYALO KITONGA	STEPHEN GIFT	15-5-2013	500000
18	950	HESBON O. SIKO	GRACE GICHURU	20-6-2013	520000
19	1000	NICHOLAS BARAKA SAUKA MRUTTU	RACHAEL GICHUNGE	15-5-2014	540000
20	1050	MOHAMUD MOHAMED SIRAT	SAMWEL GICHOHI	20-6-2014	560000
21	1100	ABDIRASHID M. HAJO	AYUBU GICHERU	15-5-2013	580000
22	1150	LIVERSON J. MGHENDI	JAPHETH GEROGAN	20-6-2013	600000
23	1200	ALEX HATIBU	SHADRACK GERALD	15-5-2014	620000
24	1250	STEPHEN HATIBU	GALTONE GENERAL	20-6-2014	640000
25	1300	DAVID HASSSAN	EMMANUEL GEDI	15-5-2013	180000
26	1350	LYDIAH HASSAN	NICANORI GEDI	20-6-2013	200000
27	1400	VINCENT HASSAN	ERNEST GEDI	15-5-2014	220000
28	1450	MATANO HASSAN	JOSEPH GATHUTWA	20-6-2014	240000
29	1500	PETER HASSAN	EMMANUEL GATHU	15-5-2013	260000

1 (0 out of 109 Selected)

TAVETA_TRANSFERS

Table 4.4 shows the attributes of the table TAVETA_TRANSFERS in the relational database. The attributes of the table TAVETA_TRANSFERS include; plot no, transfer from, transfer to, date of transfer and the amount.

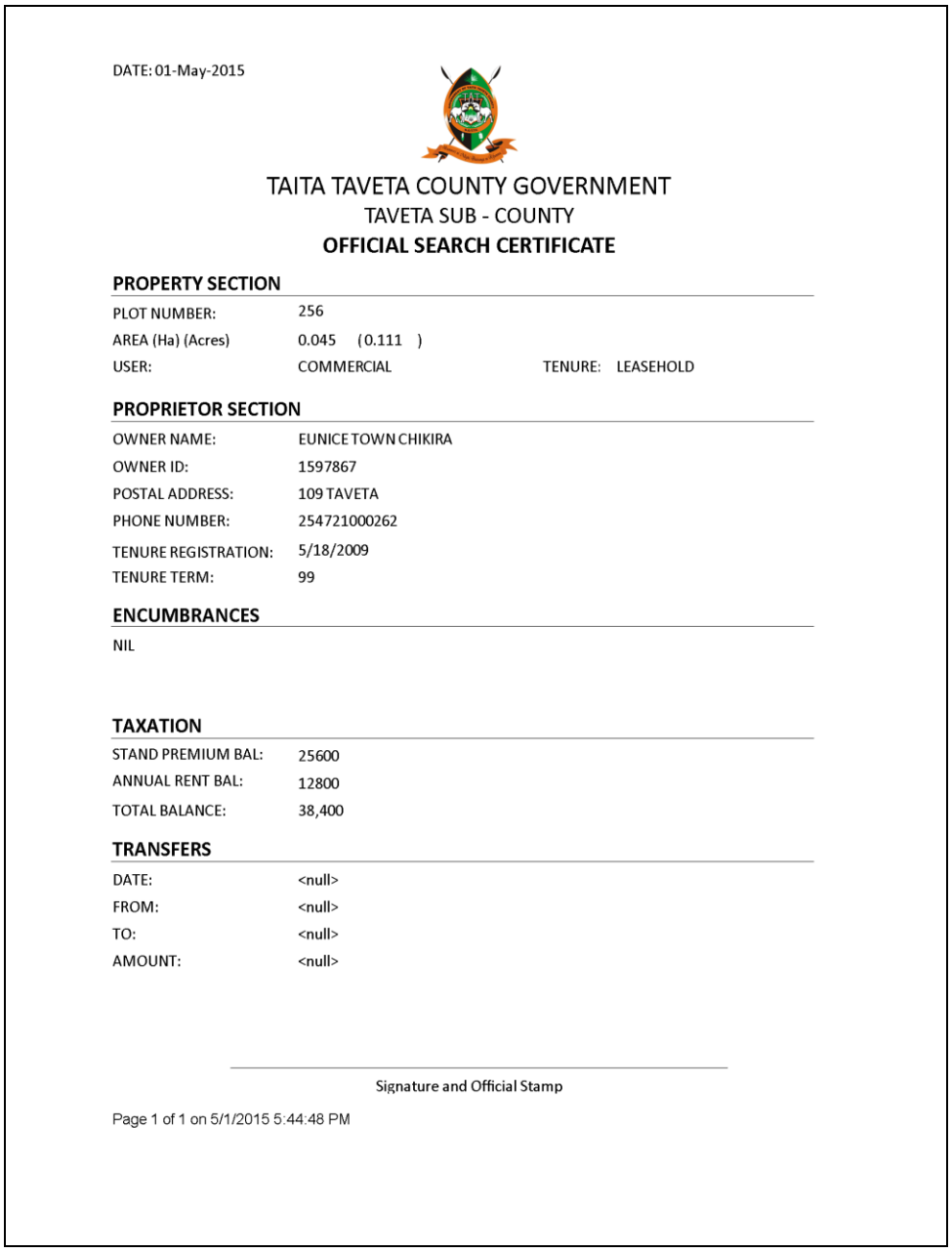
4.4 Discussion of the designed relational database

The parcels attribute table, plot ownership attribute table, plot taxation attribute table and plot transfers attribute table have plot numbers as the common field. The tables can be joined or related using plot numbers as the unique identifier or primary key. When tables are joined, the result is a new table with records in one table appended to another. The tables were designed to include data and information to satisfy the identified user needs in the user needs assessment step of database design.

4.5 Search results

In carrying out a search on a parcel of land in the New Taveta Town Land Information System, one has to provide copies of the letter of allotment of the parcel, photocopy of ID and PIN no. of the person doing the search and fill in the requisite forms.

4.5.1 Result Search Plot No. 256



DATE: 01-May-2015

TAITA TAVETA COUNTY GOVERNMENT

TAVETA SUB - COUNTY

OFFICIAL SEARCH CERTIFICATE

PROPERTY SECTION

PLOT NUMBER:	256		
AREA (Ha) (Acres)	0.045 (0.111)		
USER:	COMMERCIAL	TENURE:	LEASEHOLD

PROPRIETOR SECTION

OWNER NAME:	EUNICE TOWN CHIKIRA
OWNER ID:	1597867
POSTAL ADDRESS:	109 TAVETA
PHONE NUMBER:	254721000262
TENURE REGISTRATION:	5/18/2009
TENURE TERM:	99

ENCUMBRANCES

NIL

TAXATION

STAND PREMIUM BAL:	25600
ANNUAL RENT BAL:	12800
TOTAL BALANCE:	38,400

TRANSFERS

DATE:	<null>
FROM:	<null>
TO:	<null>
AMOUNT:	<null>

Signature and Official Stamp

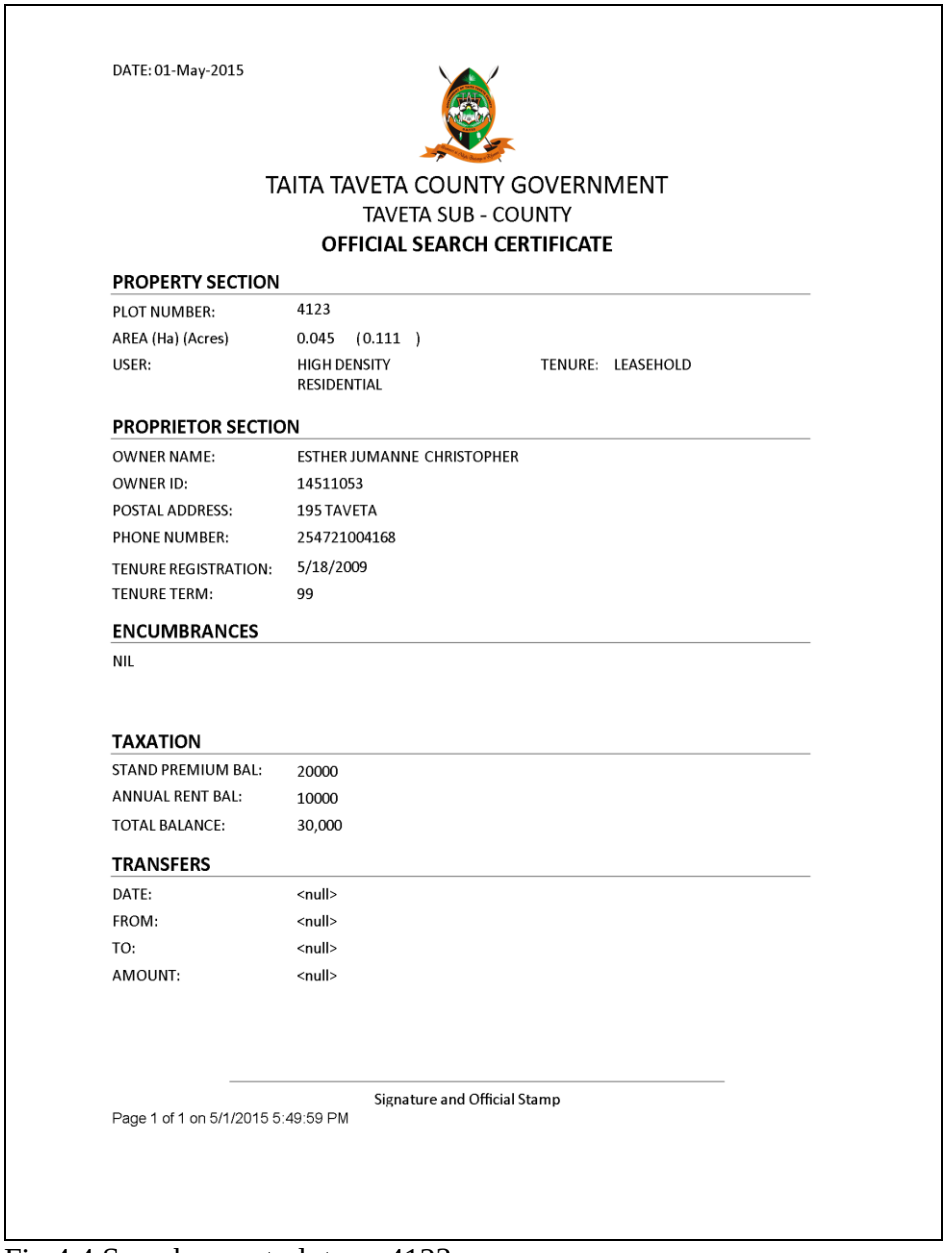
Page 1 of 1 on 5/1/2015 5:44:48 PM

Fig 4.3 Search report plot no. 256.

Figure 4.3 shows the search report on plot no. 256. The search report shows that plot no.256 has an area of 0.045 Hectares, the user of the parcel is commercial, the tenure is leasehold of 99 years with start date on18th-May-2009, the name of the owner is Eunice Town Chikira of ID no. 1597867 and address 109 Taveta, the plot has an no encumbrance, Balance of Ksh. 25,600 stand premium, annual rent balance of Ksh. 12,800

and a total balance of Ksh. 38,400. The search was carried out on 1st-May 2015 at 5.45 PM.

4.5.2 Result Search Plot No. 4123



DATE: 01-May-2015

TAITA TAVETA COUNTY GOVERNMENT
TAVETA SUB - COUNTY
OFFICIAL SEARCH CERTIFICATE

PROPERTY SECTION

PLOT NUMBER:	4123	
AREA (Ha) (Acres)	0.045 (0.111)	
USER:	HIGH DENSITY RESIDENTIAL	TENURE: LEASEHOLD

PROPRIETOR SECTION

OWNER NAME:	ESTHER JUMANNE CHRISTOPHER
OWNER ID:	14511053
POSTAL ADDRESS:	195 TAVETA
PHONE NUMBER:	254721004168
TENURE REGISTRATION:	5/18/2009
TENURE TERM:	99

ENCUMBRANCES

NIL

TAXATION

STAND PREMIUM BAL:	20000
ANNUAL RENT BAL:	10000
TOTAL BALANCE:	30,000

TRANSFERS

DATE:	<null>
FROM:	<null>
TO:	<null>
AMOUNT:	<null>

Signature and Official Stamp

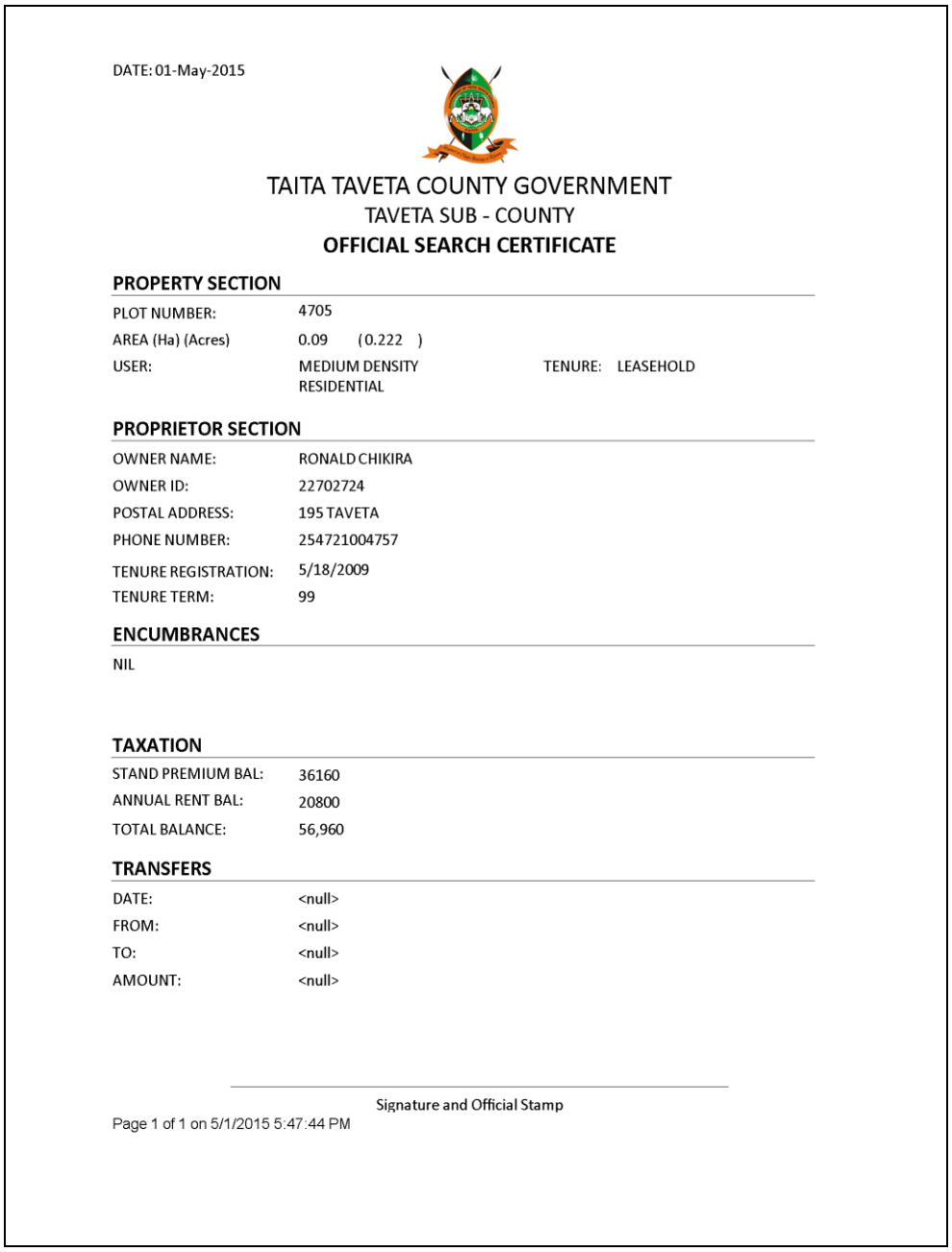
Page 1 of 1 on 5/1/2015 5:49:59 PM

Fig 4.4 Search report plot no. 4123.

Figure 4.4 shows the search report on plot no. 4123. The search report shows that plot no.4123 has an area of 0.045 Hectares, the user of the parcel is high density residential, the tenure is leasehold of 99 years with start date on18th-May-2009, the name of the

owner is ESTHER JUMANNE CHRISTOPHER of ID no. 14511053 and address 195 Taveta, the plot has an no encumbrance, Balance of Ksh. 20,000 stand premium, annual rent balance of Ksh. 10,000 and a total balance of Ksh. 30,000. The search was carried out on 1st-May 2015 at 5.50 PM.

4.5.3 Result Search Plot No. 4705



DATE: 01-May-2015

TAITA TAVETA COUNTY GOVERNMENT
TAVETA SUB - COUNTY
OFFICIAL SEARCH CERTIFICATE

PROPERTY SECTION

PLOT NUMBER:	4705	
AREA (Ha) (Acres)	0.09 (0.222)	
USER:	MEDIUM DENSITY RESIDENTIAL	TENURE: LEASEHOLD

PROPRIETOR SECTION

OWNER NAME:	RONALD CHIKIRA
OWNER ID:	22702724
POSTAL ADDRESS:	195 TAVETA
PHONE NUMBER:	254721004757
TENURE REGISTRATION:	5/18/2009
TENURE TERM:	99

ENCUMBRANCES

NIL

TAXATION

STAND PREMIUM BAL:	36160
ANNUAL RENT BAL:	20800
TOTAL BALANCE:	56,960

TRANSFERS

DATE:	<null>
FROM:	<null>
TO:	<null>
AMOUNT:	<null>

Signature and Official Stamp

Page 1 of 1 on 5/1/2015 5:47:44 PM

Fig 4.5 Search report plot no. 4705.

Figure 4.5 shows the search report on plot no. 4705. The search report shows that plot no.4705 has an area of 0.09 Hectares, the user of the parcel is medium density residential, the tenure is leasehold of 99 years with start date on18th-May-2009, the name of the owner is Ronald Chikira of ID no. 22702724 and address 195 Taveta, the plot has no encumbrance, Balance of Ksh. 36,160 stand premium, annual rent balance of Ksh. 20,800 and a total balance of Ksh. 50,000. The search was carried out on 1st-May 2015 at 5.48 PM.

4.5.4 Result Search Plot No. 1500

DATE: 01-May-2015

TAITA TAVETA COUNTY GOVERNMENT
TAVETA SUB - COUNTY
OFFICIAL SEARCH CERTIFICATE

PROPERTY SECTION

PLOT NUMBER:	1500		
AREA (Ha) (Acres)	0.045	(0.111)	
USER:	COMMERCIAL	TENURE:	LEASEHOLD

PROPRIETOR SECTION

OWNER NAME:	ELFAS N. LESHAMTA
OWNER ID:	8457959
POSTAL ADDRESS:	50 TAVETA
PHONE NUMBER:	254721001523
TENURE REGISTRATION:	5/18/2009
TENURE TERM:	99

ENCUMBRANCES

NIL

TAXATION

STAND PREMIUM BAL:	0
ANNUAL RENT BAL:	4000
TOTAL BALANCE:	4,000

TRANSFERS

DATE:	15-5-2013
FROM:	PETER HASSAN
TO:	ELFAS N. LESHAMTA
AMOUNT:	260000

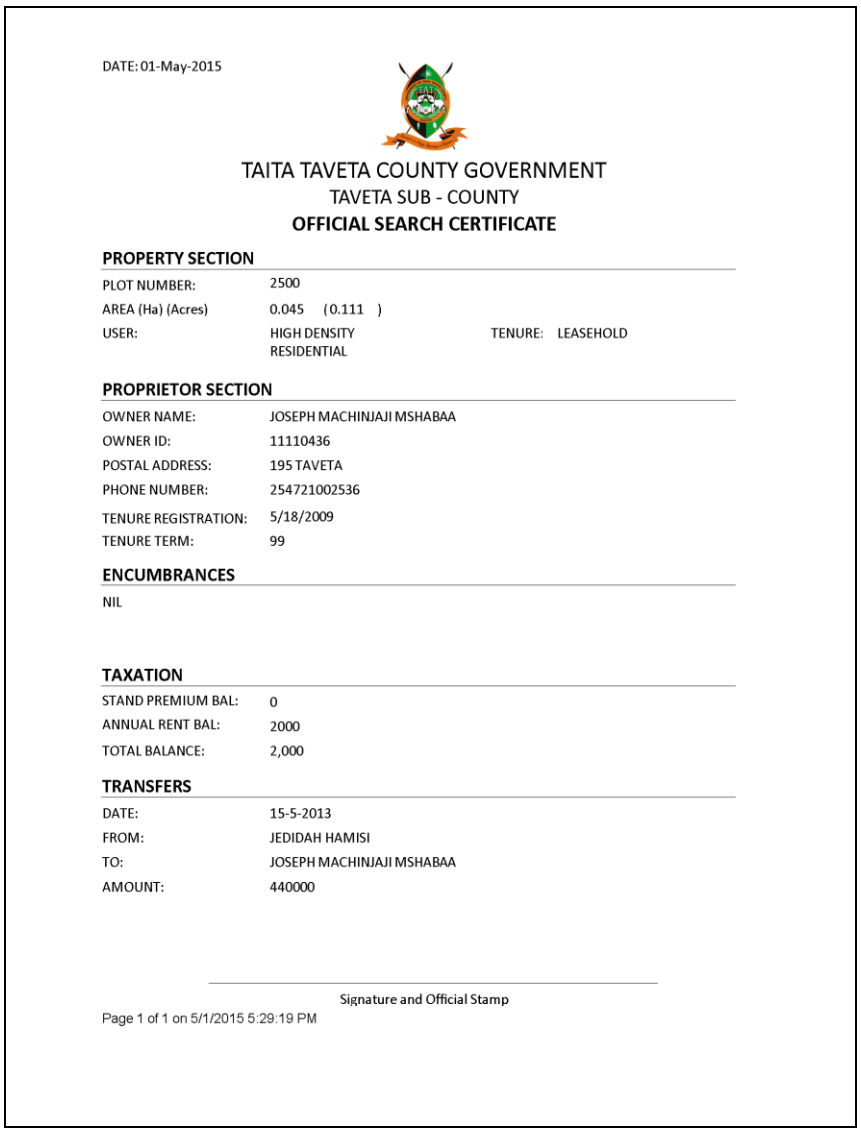
Signature and Official Stamp

Page 1 of 1 on 5/1/2015 5:21:32 PM

Fig 4.6 Search report plot no. 1500.

Figure 4.7 shows the search report on plot no. 1500. The search report shows that plot no.1500 has an area of 0.045 Hectares, the user of the parcel is commercial, the tenure is leasehold of 99 years with start date on18th-May-2009, the name of the owner is Elfas N. Leshamta of ID no. 8457959 and address 50 Taveta, the plot has no encumbrance,Balance of Ksh. 0 stand premium ,annual rent balance of Ksh. 4,000 , total balance of Ksh. 4,000, the plot was transferred from Peter Hassan to Elfas N. Leshamta on 15th-May-2013 for a sum of Ksh.260,000. The search was carried out on 1st-May 2015 at 5.22 PM.

4.5.5 Result Search Plot No. 2500



DATE: 01-May-2015

TAITA TAVETA COUNTY GOVERNMENT
TAVETA SUB - COUNTY
OFFICIAL SEARCH CERTIFICATE

PROPERTY SECTION

PLOT NUMBER:	2500		
AREA (Ha) (Acres)	0.045 (0.111)		
USER:	HIGH DENSITY RESIDENTIAL	TENURE:	LEASEHOLD

PROPRIETOR SECTION

OWNER NAME:	JOSEPH MACHINJAJI MSHABAA
OWNER ID:	11110436
POSTAL ADDRESS:	195 TAVETA
PHONE NUMBER:	254721002536
TENURE REGISTRATION:	5/18/2009
TENURE TERM:	99

ENCUMBRANCES

NIL

TAXATION

STAND PREMIUM BAL:	0
ANNUAL RENT BAL:	2000
TOTAL BALANCE:	2,000

TRANSFERS

DATE:	15-5-2013
FROM:	JEDIDAH HAMISI
TO:	JOSEPH MACHINJAJI MSHABAA
AMOUNT:	440000

Signature and Official Stamp

Page 1 of 1 on 5/1/2015 5:29:19 PM

Fig 4.7 Search report plot no. 2500.

Figure 4.7 shows the search report on plot no. 2500. The search report shows that plot no.2500 has an area of 0.045 Hectares, the user of the parcel is a high density residential, the tenure is leasehold of 99 years with start date on18th-May-2009, the name of the owner is Joseph Machinjaji Mshabaa of ID no. 11110436 and address 195 Taveta, the plot has no encumbrance, Balance of Ksh. 0 stand premium ,annual rent balance of Ksh. 2,000,total balance of Ksh. 2,000, the plot was transferred from Jedidah Hamisi to Joseph Machinjaji Mshabaa on 15th-May-2013 for a sum of Ksh.260,000. The search was carried out on 1st-May 2015 at 5.29 PM.

4.5.6 Result Search Plot No. 8

DATE: 01-May-2015

TAITA TAVETA COUNTY GOVERNMENT
TAVETA SUB - COUNTY
OFFICIAL SEARCH CERTIFICATE

PROPERTY SECTION

PLOT NUMBER:	8		
AREA (Ha) (Acres)	0.045 (0.111)		
USER:	COMMERCIAL	TENURE:	LEASEHOLD

PROPRIETOR SECTION

OWNER NAME:	SIMON ZIGHE A.
OWNER ID:	18461
POSTAL ADDRESS:	245 TAVETA
PHONE NUMBER:	254721000007
TENURE REGISTRATION:	5/18/2009
TENURE TERM:	99

ENCUMBRANCES

Charge to Jamii Bora Bank for Ksh. 270,000. Entry no. 1536. Date of registration 17-10-2012

TAXATION

STAND PREMIUM BAL:	0
ANNUAL RENT BAL:	0
TOTAL BALANCE:	0

TRANSFERS

DATE:	<null>
FROM:	<null>
TO:	<null>
AMOUNT:	<null>

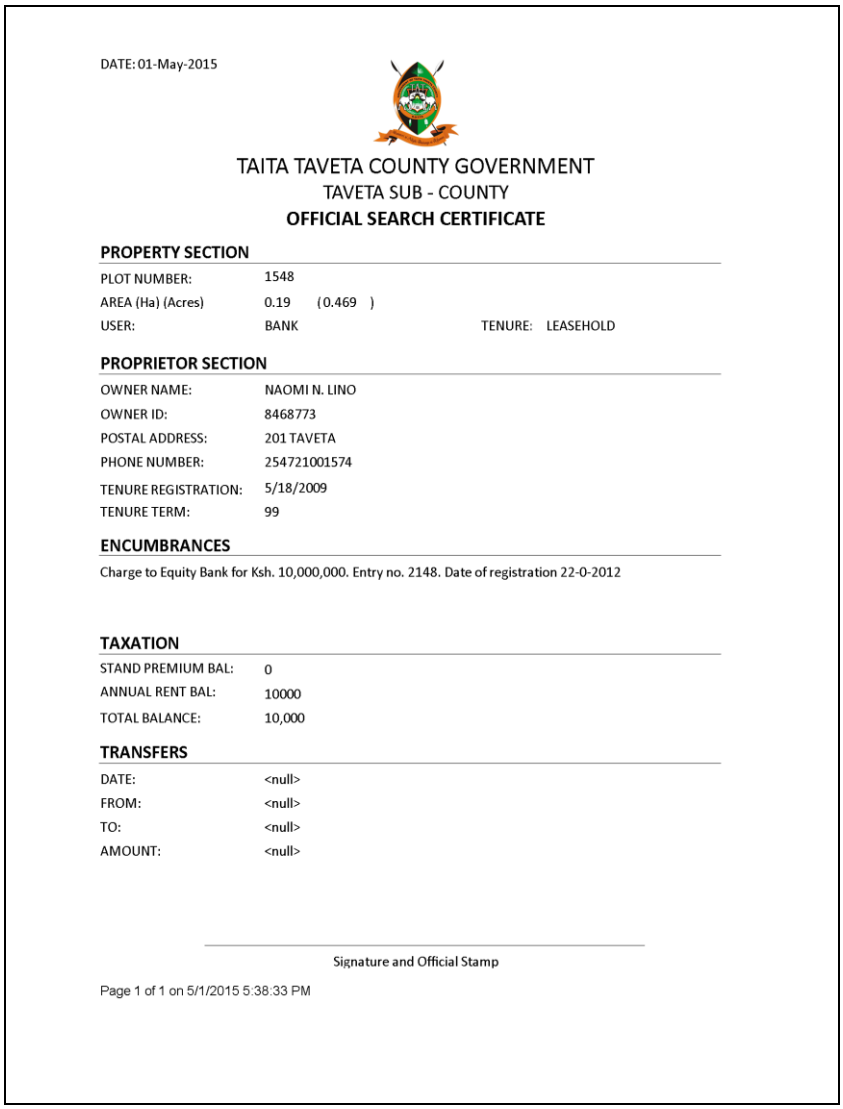
Signature and Official Stamp

Page 1 of 1 on 5/1/2015 5:40:56 PM

Fig 4.8 Search report plot no. 8.

Figure 4.8 shows the search report on plot no. 8. The search report shows that plot no. 8 has an area of 0.045 Hectares, the user of the parcel is commercial, the tenure is leasehold of 99 years with start date on18th-May-2009, the name of the owner is Simon Zighe S. of ID no. 18461 and address 245 Taveta, the plot has an encumbrance (Charge to Jamii Bora Bank Limited registered as entry no. 1536 on 17th-October-2012),Balance of Ksh. 0 stand premium ,annual rent balance of Ksh. 0 and a total balance of Ksh. 0. The search was carried out on 1st-May 2015 at 5.41 PM.

4.5.7 Result Search Plot No. 1548



DATE: 01-May-2015

TAITA TAVETA COUNTY GOVERNMENT
TAVETA SUB - COUNTY
OFFICIAL SEARCH CERTIFICATE

PROPERTY SECTION

PLOT NUMBER:	1548		
AREA (Ha) (Acres)	0.19	(0.469)	
USER:	BANK	TENURE:	LEASEHOLD

PROPRIETOR SECTION

OWNER NAME:	NAOMI N. LINO
OWNER ID:	8468773
POSTAL ADDRESS:	201 TAVETA
PHONE NUMBER:	254721001574
TENURE REGISTRATION:	5/18/2009
TENURE TERM:	99

ENCUMBRANCES

Charge to Equity Bank for Ksh. 10,000,000. Entry no. 2148. Date of registration 22-0-2012

TAXATION

STAND PREMIUM BAL:	0
ANNUAL RENT BAL:	10000
TOTAL BALANCE:	10,000

TRANSFERS

DATE:	<null>
FROM:	<null>
TO:	<null>
AMOUNT:	<null>

Signature and Official Stamp

Page 1 of 1 on 5/1/2015 5:38:33 PM

Fig 4.9 Search report plot no. 1548.

Figure 4.9 shows the search report on plot no. 1548. The search report shows that plot no.1548 has an area of 0.19 Hectares, the user of the parcel is a bank, the tenure is leasehold of 99 years with start date on18th-May-2009, the name of the owner is Naomi N. Lino of ID no. 8468773 and address 201 Taveta, the plot has an encumbrance (Charge to Equity Bank Limited registered as entry no. 2148 on 22nd-June-2012),Balance of Ksh. 0 stand premium, annual rent balance of Ksh. 10,000 and a total balance of Ksh. 10,000. The search was carried out on 1st-May 2015 at 5.39 PM.

4.6 Discussion search results

The search reports generated on plots 256, 4123, 4705, 1500, 2500, 8 and 1548 each have five sections. The five sections are: property section, proprietor section, encumbrance section, taxation section, and transfers section. The property section gives information on the plot number, the area of the plot in hectares and acres, the official user of the plot and the land tenure system. The proprietor section gives information on the name of the owner, the ID No. of the owner, postal address, phone number, date of tenure registration and the tenure term. The encumbrances section gives information on any encumbrances on the plot, for example in the case of plot no. 8 the report shows an encumbrance on the plot by way of a charge to Jamii Bora bank , the entry no. and the date the charge was registered. The taxation section gives information on the stand premium outstanding for the plot, the annual rent balance and the total balance due. The County Government use the taxation information to generate demand notices to plot owners having balances. The transfers section gives information on the date a plot transfer has taken place, the transfer from person A to person B and the amount registered as the purchase price. This gives information on stamp duty to be paid. At the bottom part of the search report there is a section for signature and official county government stamp, to show that the search is generated by the county government and also the date and time the search was generated from the database. The generated search report was compared with the classical search and it was found that the generated report gives more information as compared to the classical search which will benefit the users more.

4.7 Results Queries

SQL Query Statements were carried out on the database through query interface as shown in the results following pages.

4.7.1 Environmentalists Query on the database

An environmentalist may want to find all the plots that are within 100 metres of the water reservoirs which will have direct impact on pollution of the reservoirs. The water reservoirs are selected on the map, and a query by location on the database stating the constraint plots within 100 metres of the selected feature.

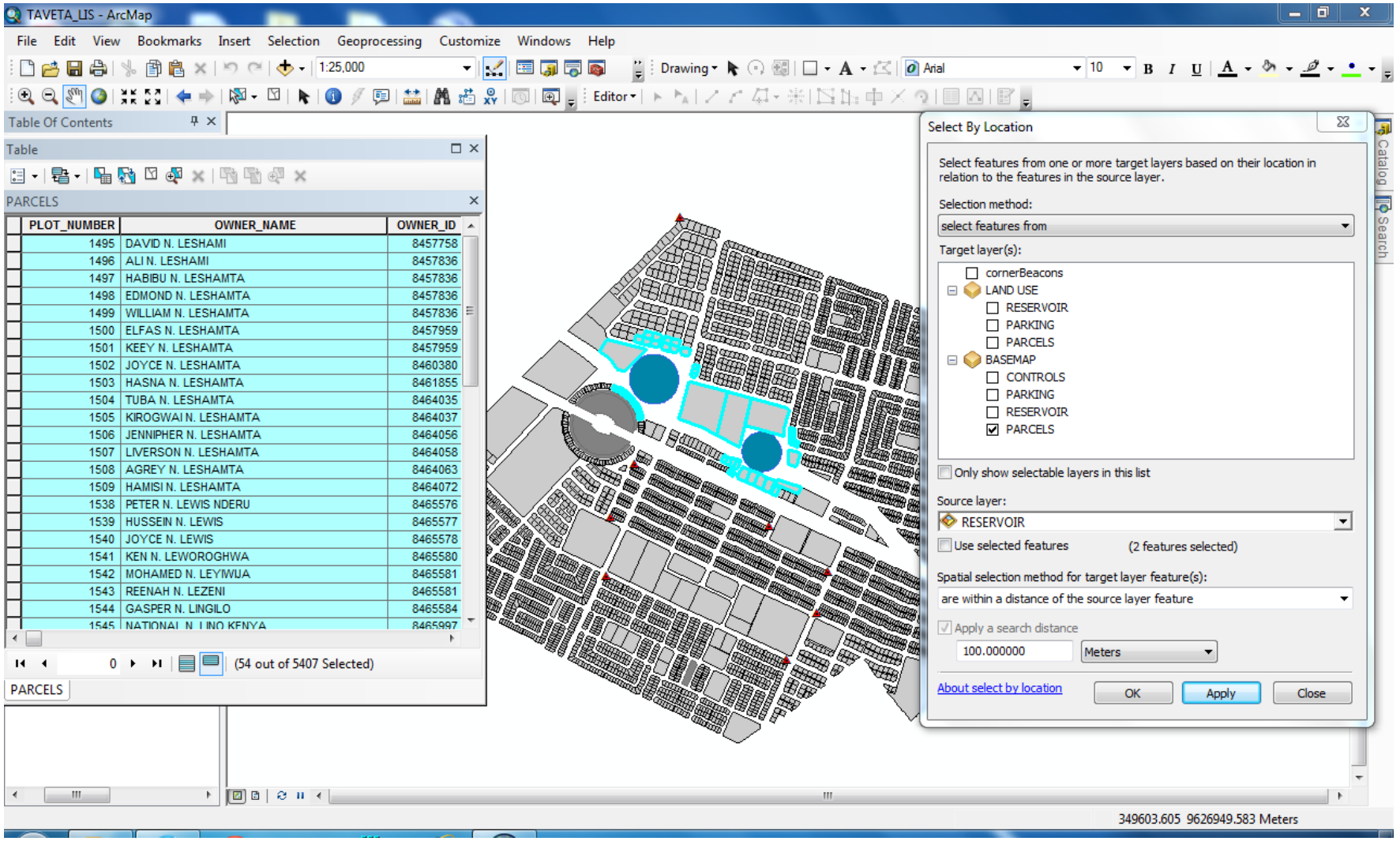


Fig 4.10 Query result plots within 100 metres of the water reservoirs

Fig 4.10 shows query results for an environmentalist who wants to find all the plots that are within a distance of 100 metres from the water reservoirs. From the result in the attribute table, we can see that there are 54 plots out of the 5407 plots in the New Taveta Town that are within that distance and they are displayed on the map highlighted in light blue colour.

4.7.2 Planners Query on the database

A planner may want find all the parcels where the user is industrial. In the New Taveta Town there are 3 categories of industrial plots: Light Industrial, Medium Industrial and Heavy Industrial plots. The SQL statement will be:

Select: Plot numbers

From: Parcels

Where: Parcels User is light industrial or medium industrial or heavy industrial.

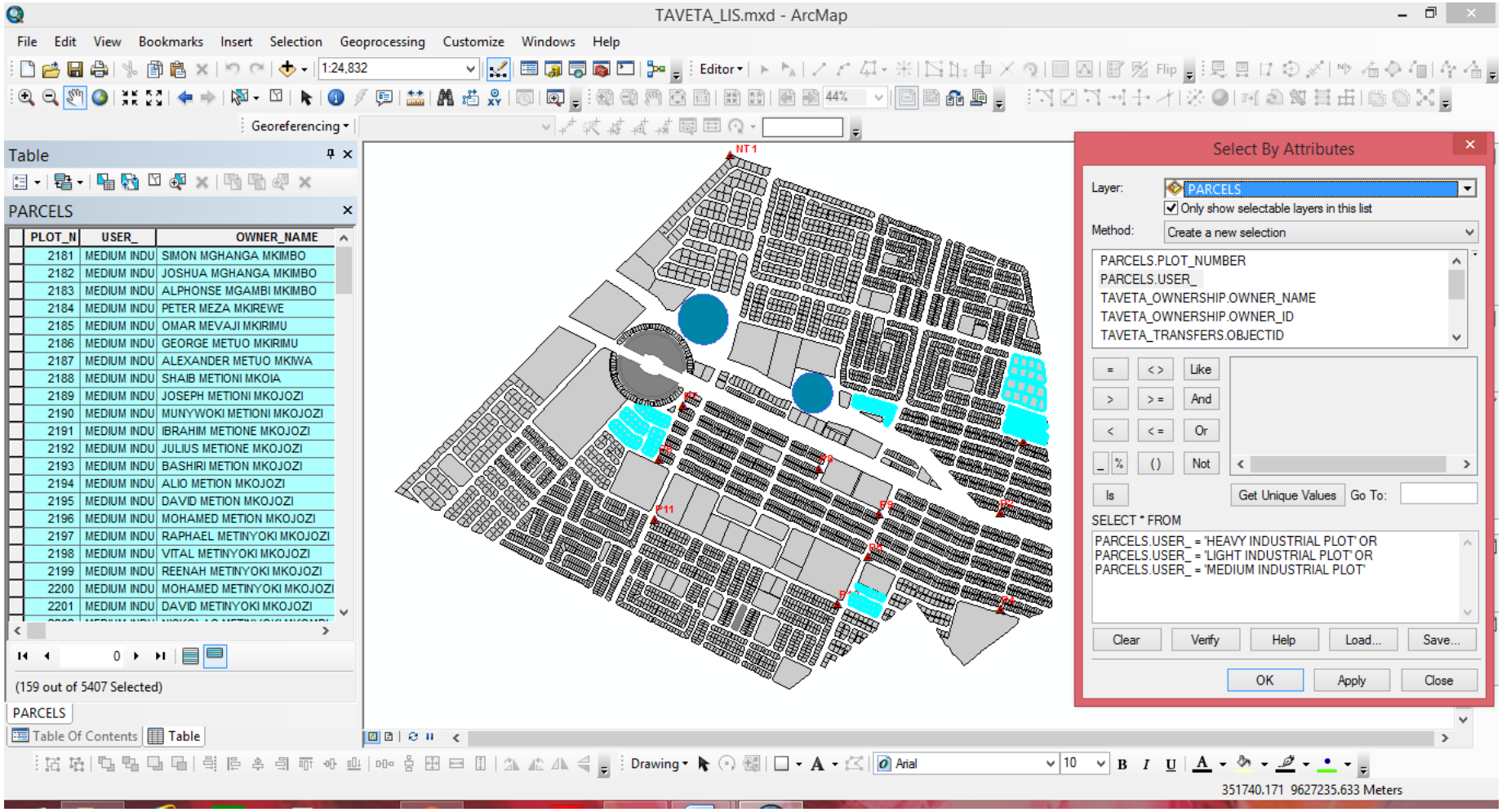


Fig 4.11 Query result all Industrial plots

Fig 4.11 shows query results for a Planner who wants to find all industrial plots in the New Taveta Town. From the results we can see that there are 159 plots whose user is industrial out of the 5407 plots in the New Taveta Town. The Ownership details of the 159 plots is also displayed on the attribute table.

4.7.3 Investors query on the database

A potential investor may want to purchase plots that are within a distance of 50 metres from the open air market. The open air market is selected on the map, and a query by location on the database stating the constraint plots within 50 metres of the selected feature.

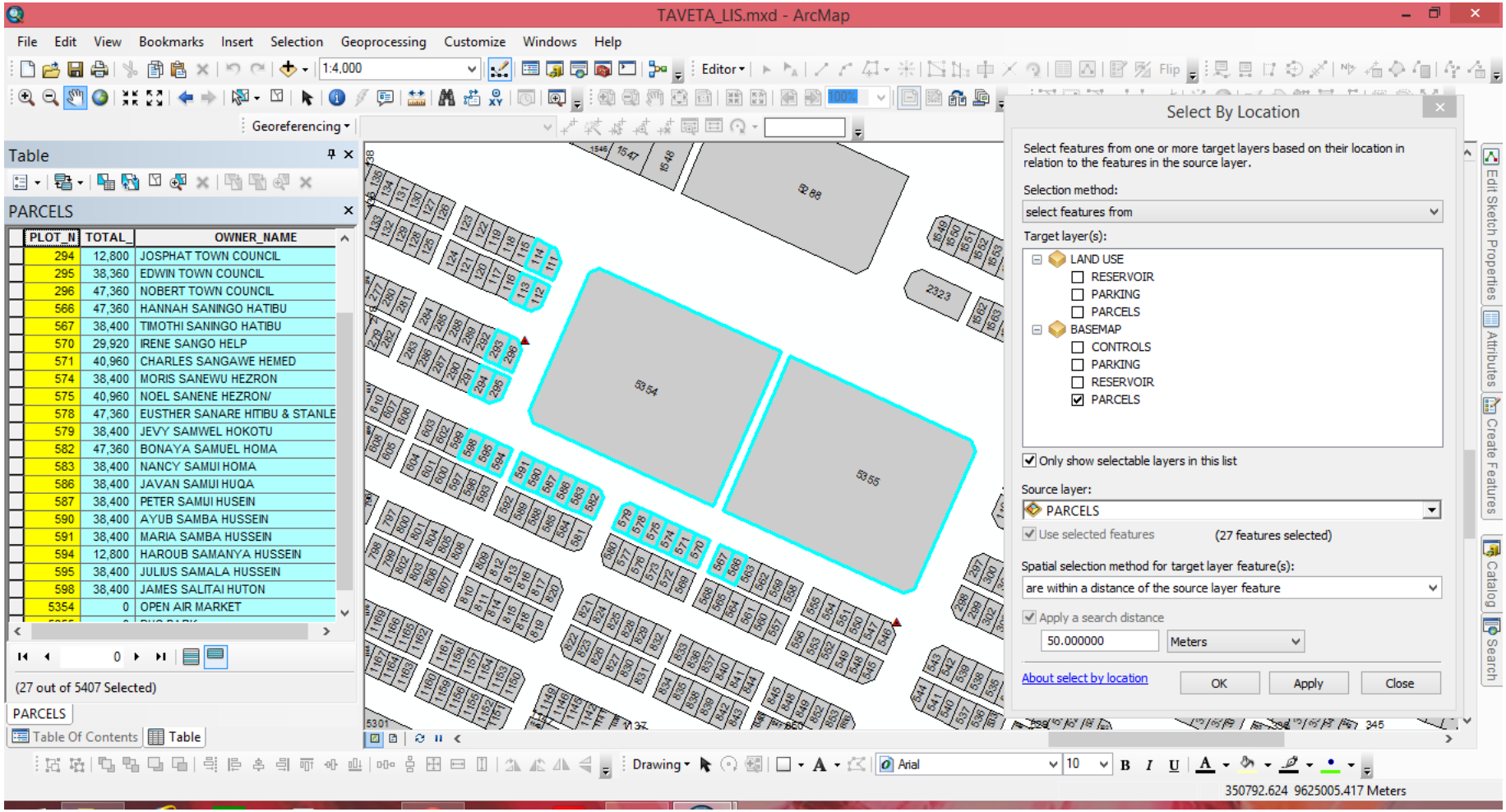


Fig 4.12 Query result plots within 50 metres of the open air market

Fig. 4.12 shows results of a query by a potential investor who wants to find all plots that are within 50 metres of the open air market. There are 27 plots that are within 50 metres of the open air market, which is highlighted in light blue colour on the map. The Ownership details of the 27 plots is also displayed in the attribute table.

4.7.4 County Government query, taxation on the database

The county government may want to find all plots that have a balance of more than or equal to Ksh. 200,000 so that they can send demand notices to the plot owners. The SQL statement to retrieve the information from the database will be:

Select: Plot numbers

From: Parcels

Where: Taveta Taxation Total Balance is greater than or equal to Ksh. 200,000.

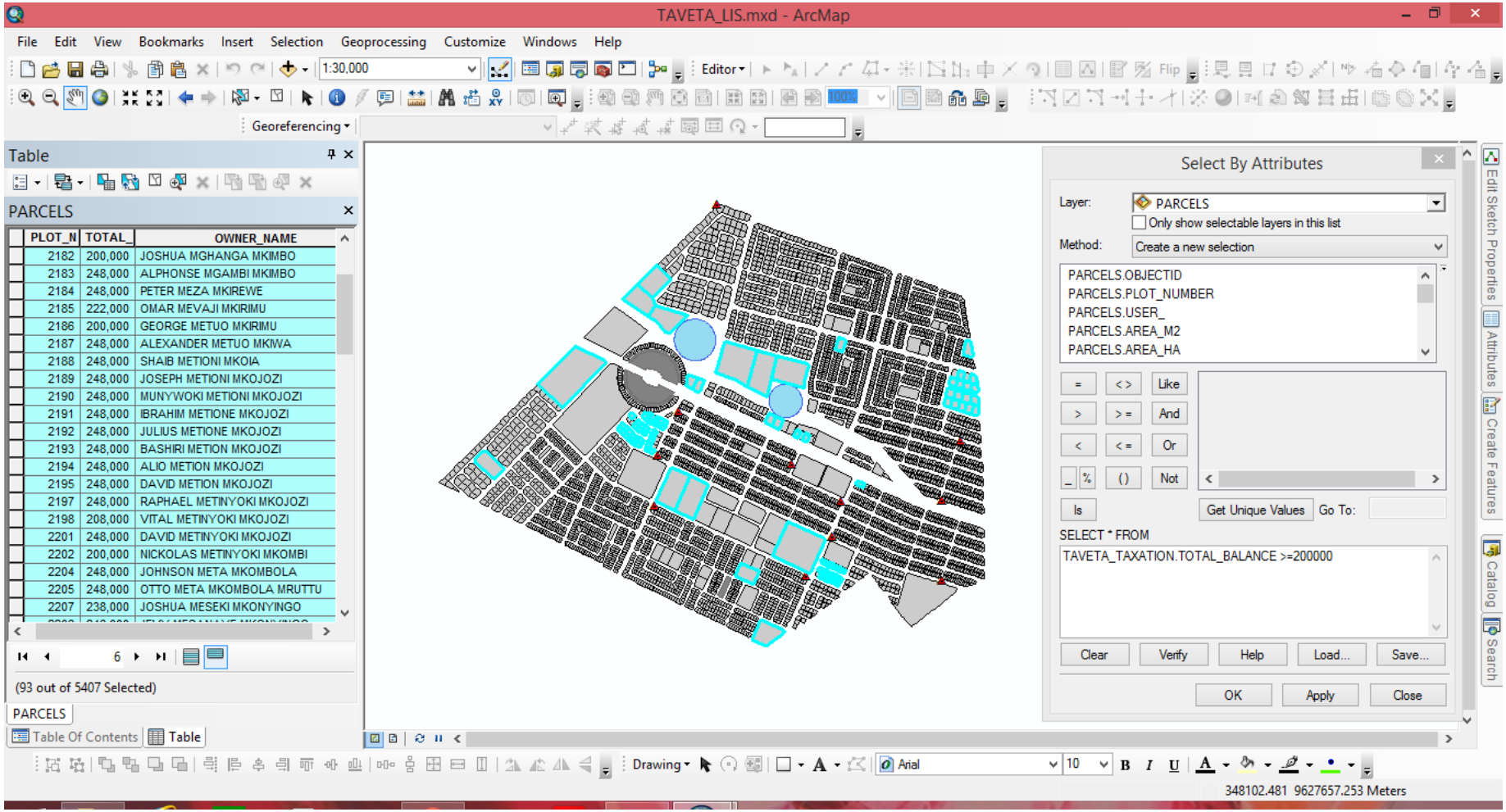


Fig 4.13 Query result taxation balance equal or greater than 200,000

Fig. 4.13 shows results of a query by the county government to find all plots that have a total balance of greater than or equal to Ksh.200, 000. A total of 93 plots have balances of Ksh.200, 000 or more, the results are displayed on the map and the details of the ownership are shown in the attribute table.

4.7.5 County Government query, transfers on the database

The county government may want to find all plots where transfers have taken place. The SQL statement to retrieve the information from the database will be:

Select: Plot numbers

From: Parcels

Where: Taveta Transfers date is not Null.

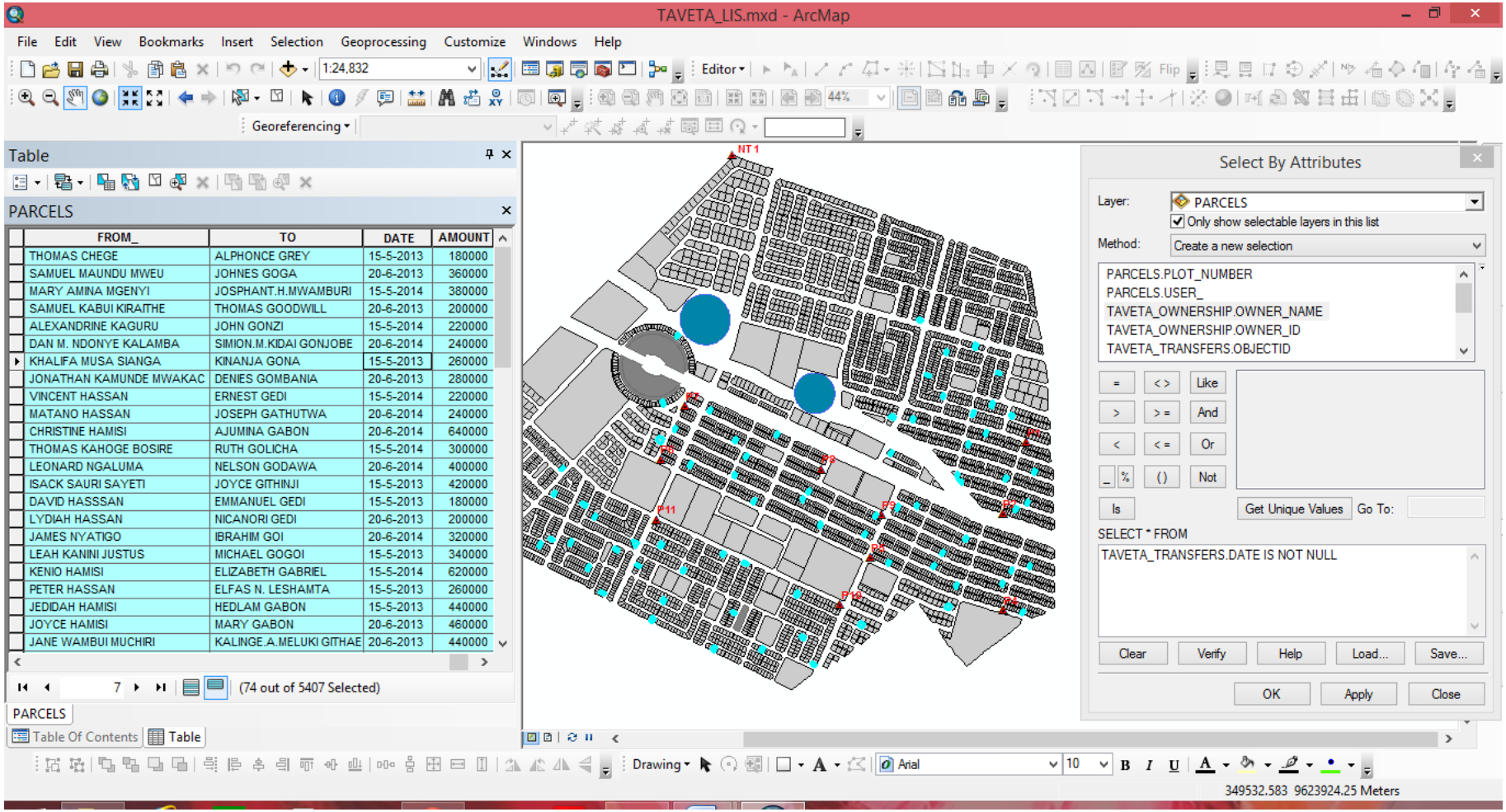


Fig 4.14 Query result all transfers

Fig. 4.14 shows results of a query by the county government to find all plots where transfers have taken place. A total of 74 plots out of the 5407 plots in the New Taveta Town have been transferred. The transferred plots are displayed on the map and the details of the transfers are shown in the attribute table.

4.7.6 Surveyors query, Corner beacons on the database

A surveyor may want to find the coordinates of the corner beacons of say plot 100, to carry out a due diligence for a potential investor who wants to purchase the plot. The SQL statement to retrieve the information from the database will be:

Select: Corner beacons

From: Corner beacons

Where: Plot number is equal to 100.

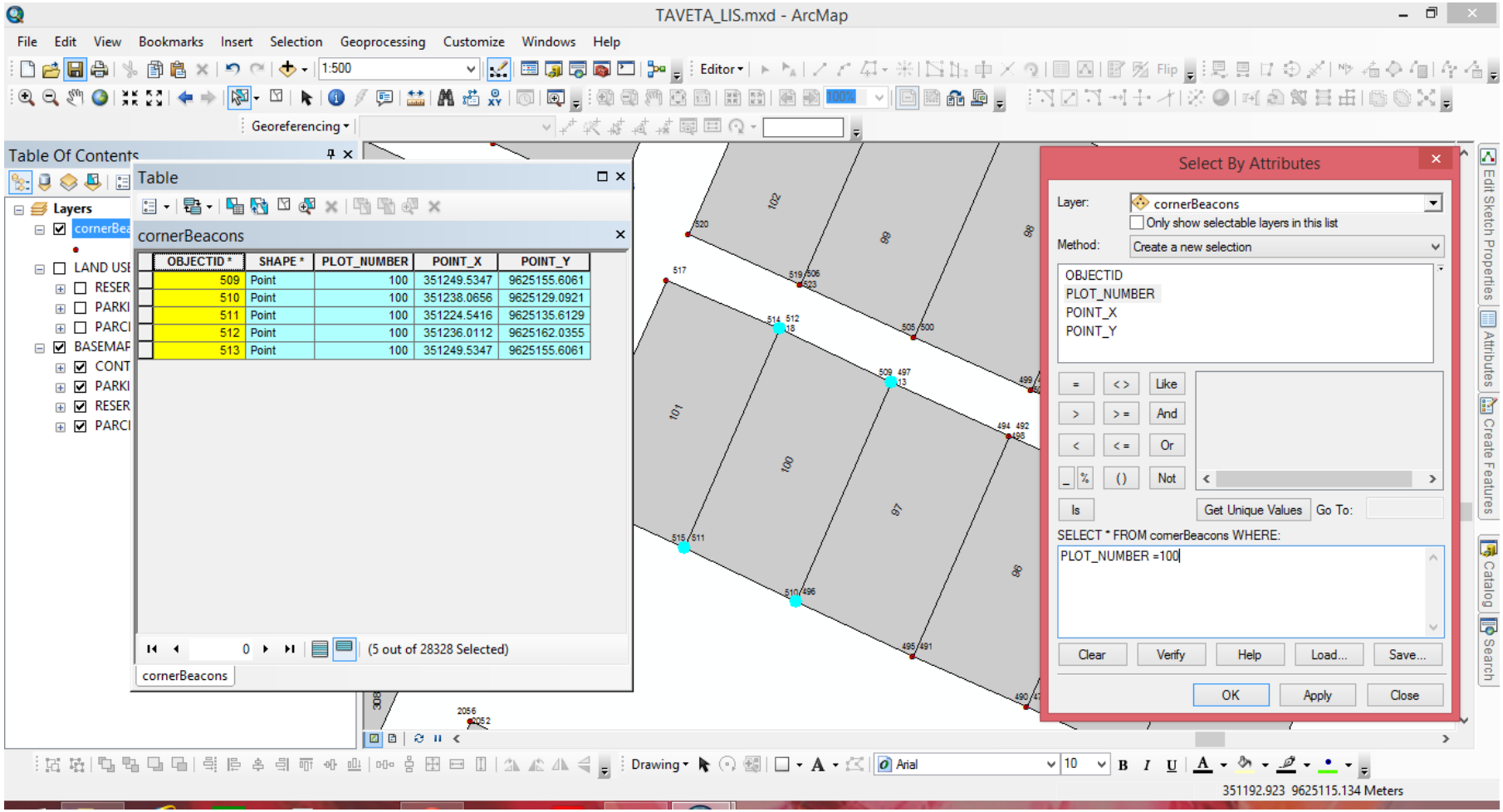


Fig 4.15 Query result corner beacons of plot no. 100

Fig 4.15 shows query results for a surveyor who wants to find out the corner beacons coordinates of plot no. 100. Plot No. 100 is highlighted on the map and the corner beacons coordinates are displayed in the attribute table. The coordinates are in UTM Datum WGS 84, the coordinates assist the surveyor in carrying out a survey on the property.

4.7.7 Surveyors query, controls on the database

A surveyor who is surveying say plot no 857, may want to find control points that are within 150 meters of plot 857. Plot number 857 is selected on the map, and a query by location on the database stating the constraint controls within 150 metres of the selected feature.

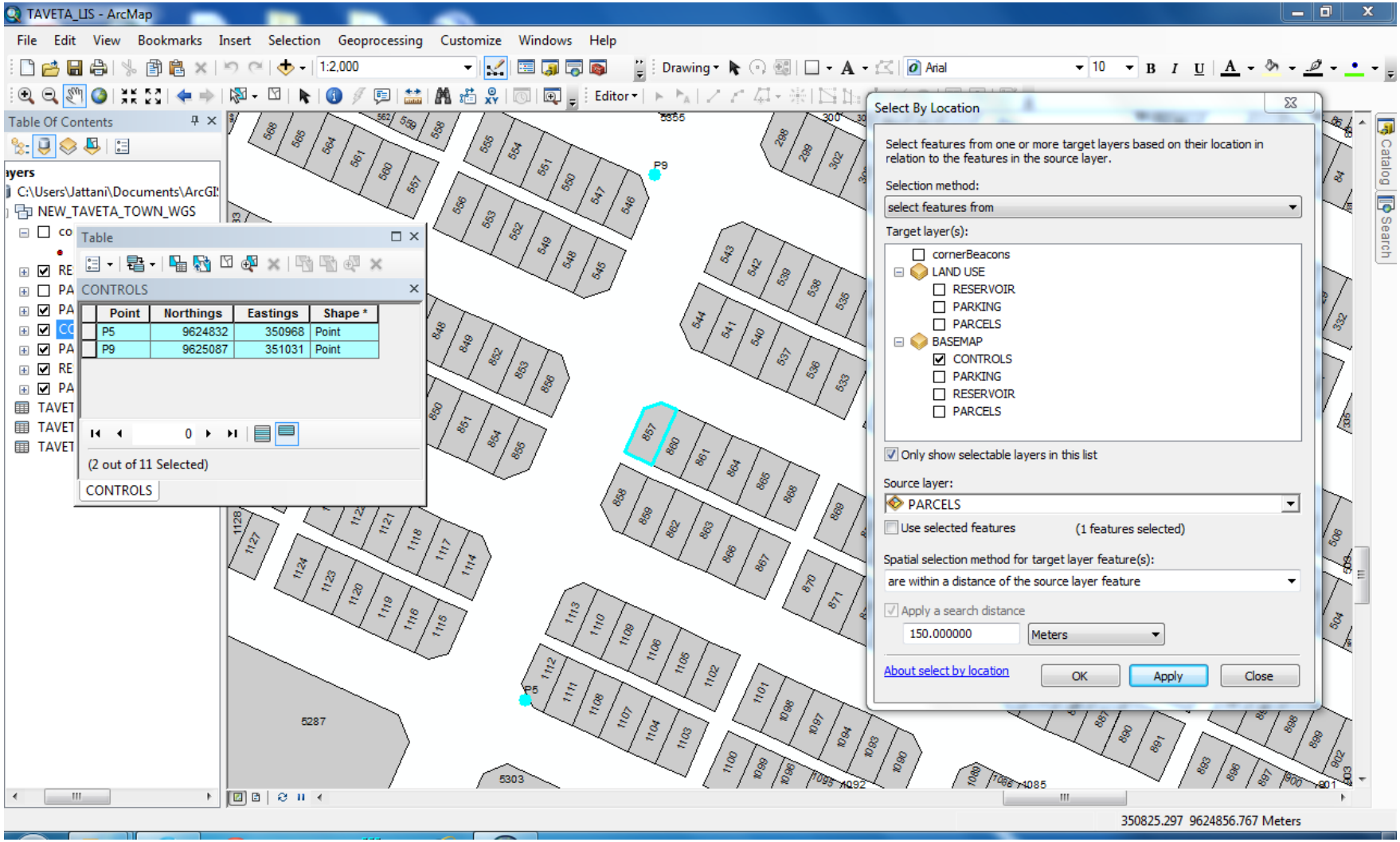


Fig. 4.16 Query results control within 150 metres of plot 857

Fig 4.16 shows query results for a surveyor who wants to find the control points within 150 metres of plot no. 857. The Control points P5 and P9 (which are within 150 metres of plot no. 857) are highlighted on the map, the coordinates of the control points are displayed in the attribute table.

4.8 Discussion query results

In the database design process the first step involved the external modelling also referred to as a 'user needs assessment'. The potential users of the database were determined, their information needs and the data that is required to satisfy those needs. The users of the LIS identified included the County Government of Taita-Taveta, land owners, surveyors, planners, valuers, potential investors, financial institutions, land brokers and the real estate companies. The different users of the database have different data and information needs. The information needs of a surveyor for example is information on plot numbers, plot area, coordinates and control points near the area of interest. The surveyors query on the database returns result on coordinates of the plot of interest and controls near the plot of interest. In the case of the environmentalist the query on the database returns the plot numbers and owners of plots that are within 100 metres of the water reservoir and the same is displayed on the map. With the results from query, appropriate mitigating factors can be put in place to control pollution as the cause has been identified. The planners query on the database returns results of all the industrial plots in the new taveta town, the result is also displayed on the map. With the displayed result power, water, telephone and other utilities important in an industrial zone can be well planned. The investors query on the database returns results of plots within a distance of 50 metres from the open air market and the same result is also displayed on the map. The displayed result will enable potential investor to identify the plots to purchase for investment. The County Government query on the database returns results of plots whose total balance is greater than or equal to Ksh. 200,000 which is also displayed on the map. The result enables the County Government to identify the plots with the stated balance and to send out demand notices.

The database can be queried for other information requirements of the users of the database by putting different constraints and query inputs.

4.9 Distribution map plot sizes

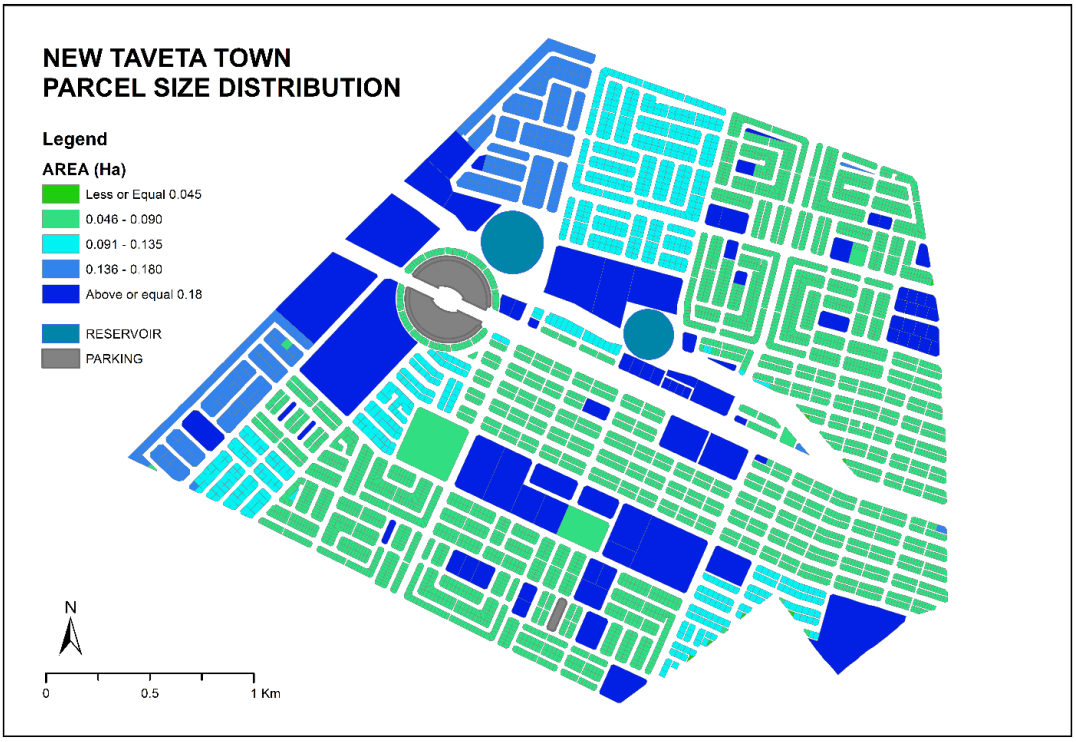


Fig 4.17 Plot sizes distribution map

Fig 4.17 shows the distribution map of plot sizes in the New Taveta Town. From the map, most of the plots in the town are between 0.045 and 0.090 Hectares in size.

4.10 Discussion distribution map plot sizes

The plots in the study area are zoned according to plot user. The different plot users have different plot sizes. All commercial plots for example have an area of 0.045 hectares while the residential plots zoned according to high density, medium density and low density have an area of 0.045 hectares, 0.090 hectares and 0.1350 hectares respectively. The map on distribution of plot sizes shows how the plot sizes are distributed in the entire study area.

4.11 Land Use map

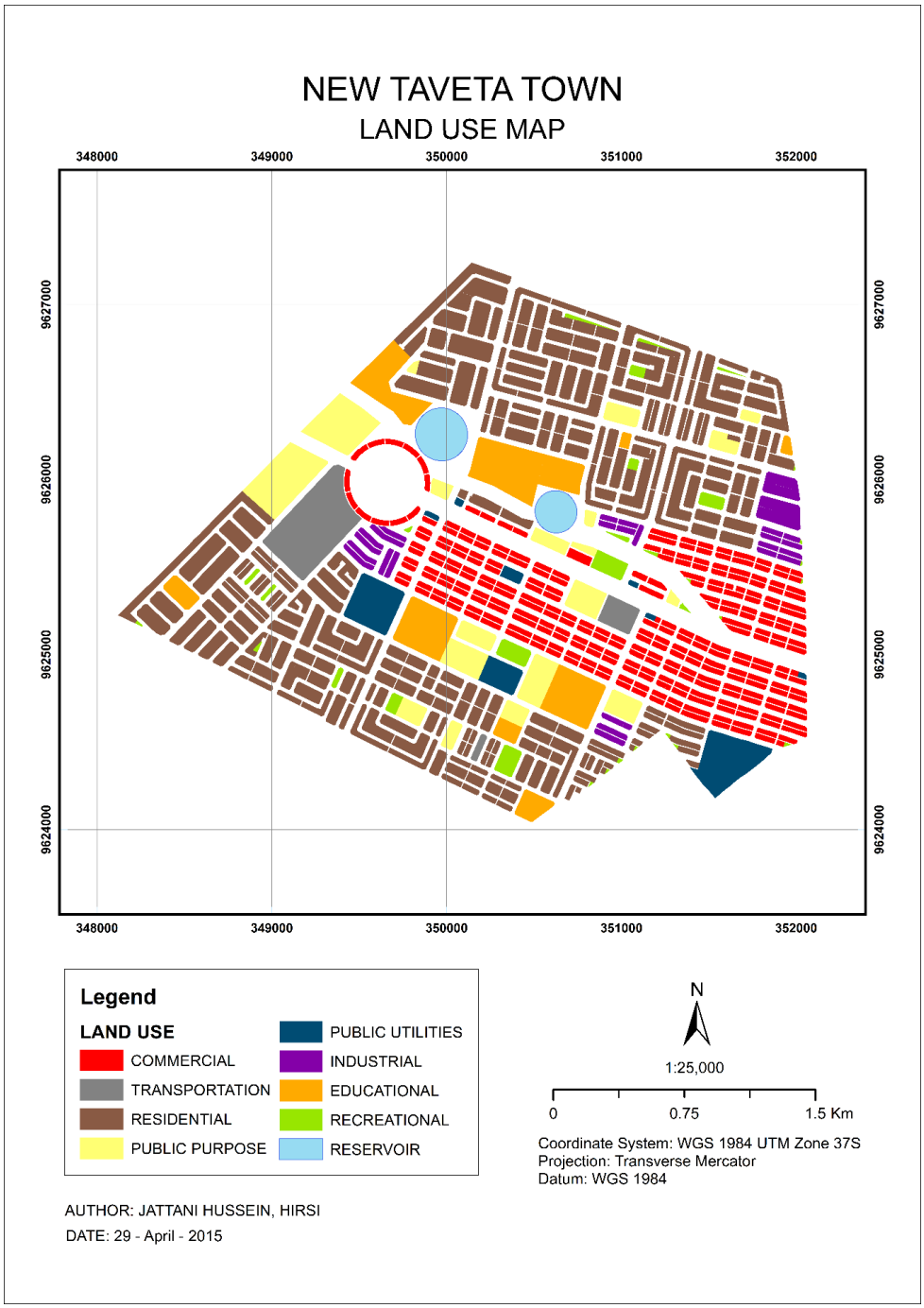


Fig 4.18 Land use map New Taveta Town

Fig 4.18 shows a Land use map of the New Taveta Town, the different users of the plots in the town include commercial, residential, industrial, educational, recreational, public purpose and transportation.

4.12 Discussion land use map

The development plan of the New Taveta Town identified the zones and official permitted users of the zoned areas. The users included commercial, residential, industrial, transportation, educational, public purpose, public utilities, recreational and reservoir. The land use map was generated using the traditional colour coding standard for different land uses. In the land use map of the New Taveta Town, red shows the commercial zoned plots, brown the residential zoned plots, purple the industrial zoned plots, yellow public purpose, orange the educational zoned plots among others. The land use map visualizes the land use zones over the entire study area.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The primary objective of this study was to develop a Land Information System for the New Taveta Town. In accomplishing the primary objective the specific objectives were set as follows:

i. To identify suitable spatial and non-spatial attributes about the land parcels that should be included in the database.

ii. To study how information on registered land is retrieved for the purposes of supporting various operations such as search, transfer and valuation and how LIS can help stream line the procedure there in.

iii. To compile some cadastral record that is complete, up to date, and reliable,

iv. To implement and demonstrate the operation of the database in the study area.

It can therefore be concluded that in this project:

i. Suitable spatial and non-spatial attributes about the land parcels in the New Taveta Town for inclusion in the database have been developed.

ii. Retrieval of information on registered land to support operations such as search, transfer, valuation has been demonstrated and how LIS streamlines the procedure there in.

iii. Cadastral record that is complete, up to date, and reliable has been compiled.

iv. Implementation and functioning of the database operation in the study area has been demonstrated.

In the introduction the shortcomings of manual record keeping were highlighted as well as the growing need for a computerized LIS as put forward in the National Land Policy. The search results from the LIS was compared against the classical search from the

ministry of lands, housing and urban development, the results showed that the search is sufficient in support of land transactions in the town. Input from professionals such as lawyers, planners, valuers and surveyors was obtained on information they required from a computerized LIS. Audits were carried out to determine whether the system provides the required information. From the audits it was found that the New Taveta Town Land Information provides the information required by the professionals.

The results of the study has shown the importance of acquiring a computerized LIS for the New Taveta Town.

5.2 Recommendations

From the results obtained from the study, it is recommend that:

i) Data on utilities such as power from Kenya Power, Water and Sewerage from Taveta Voi Water and Sewerage Company Ltd be included in the LIS to add more value.

ii) Design of a program to link the payment system used by the County Government-LAIFMS (Local Authority Information and Financial Management System) to the New Taveta Town LIS so that information on taxation can be updated in real time as payments are being made.

iii) The LIS to be made web based, where it can be accessed online without the need to get to Taveta Town to be able to use the system.

iv) Data on developments in the town to be included in the database to enable the county Government to approve and monitor the development as they place.

v) Security of the database to be enhanced through combination of security measures from 4 layers of security control i.e. hardware/software/data security systems, physical security, administrative controls and laws relating to data security and privacy.

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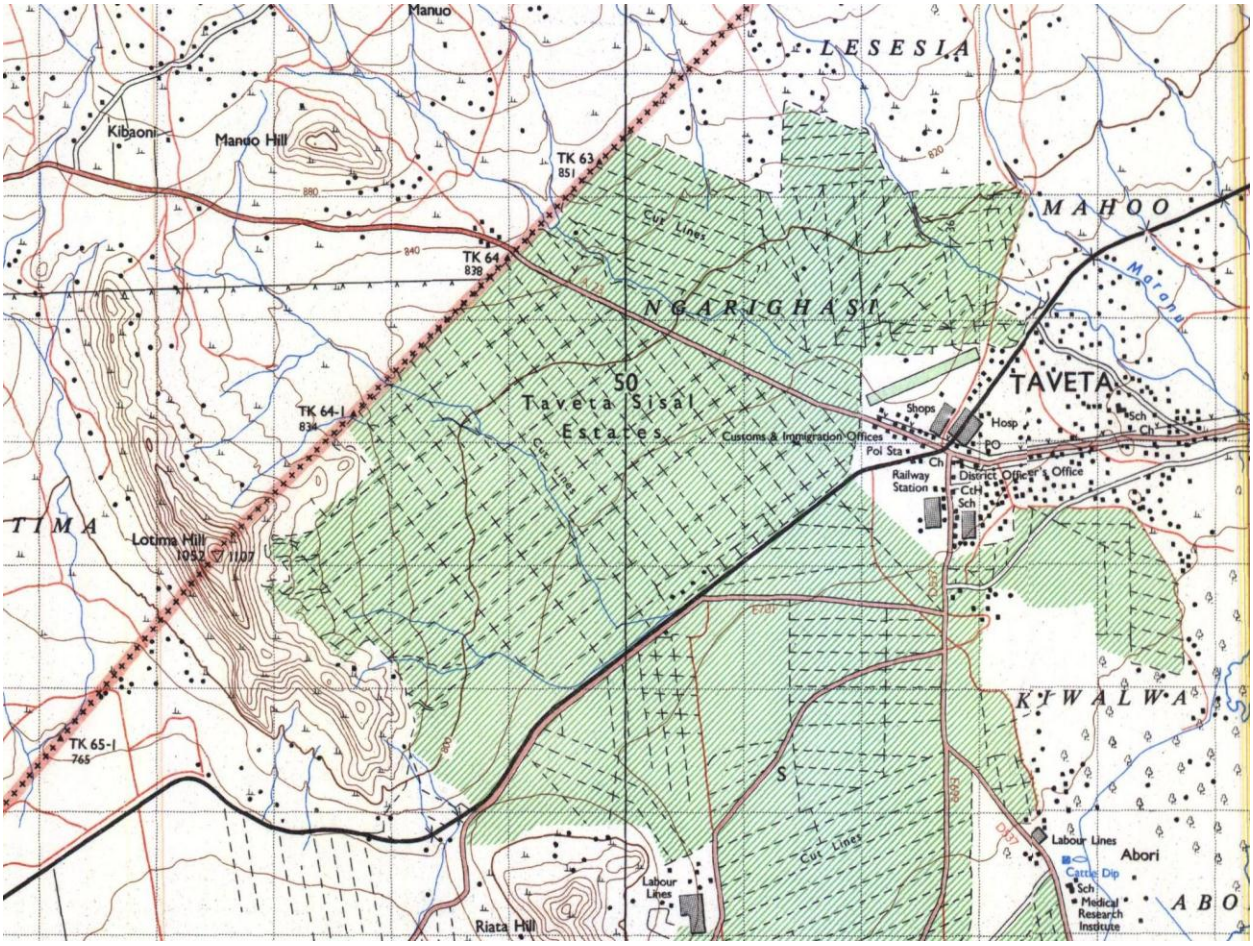
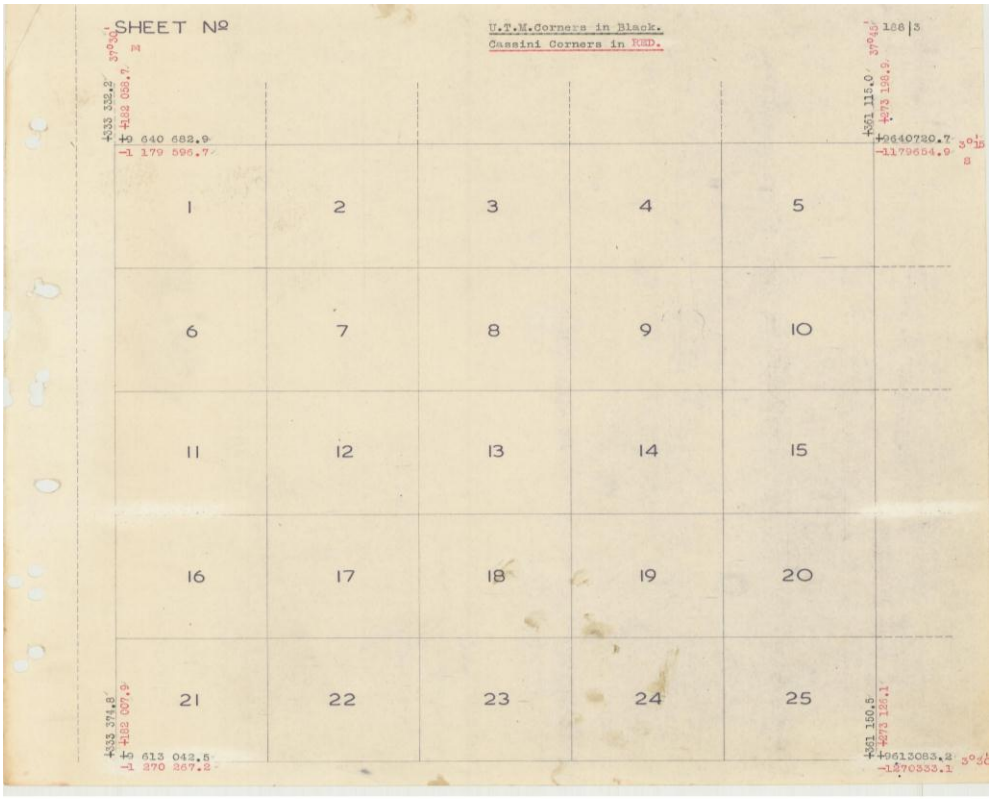
APPENDICES

Appendix A1: Topo Sheet 188_3



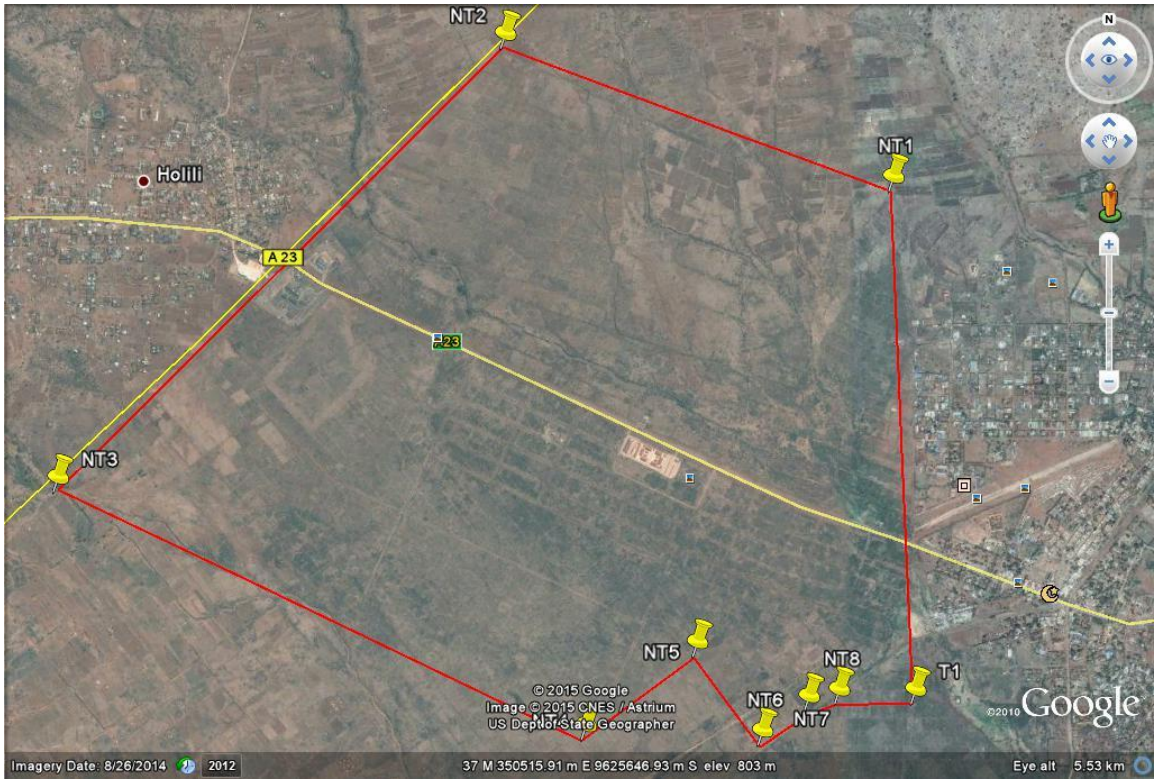
Appendix A2: Corner Grids Cassini and UTM



Appendix B1: Development one stop border shop

Appendix B2: Development open air market and bus park

Appendix B3: Google image new Taveta town boundary



Appendix B4: Classical Search

Ref No : 4305

Ministry of Lands, Housing and Urban Development

Offical Search Certificate

Part A : Property Section

Registration Section :	DAGORETTI/WAITHAKA
Parcel No :	373
Area Size :	1.08 Ha
Nature of Title :	ABSOLUTE

Part B : Proprietor Section

Entry No	Entry Date	Registred Propriertor Name and Address
1	18-08-1973	NJOROGE KUBIU ID/KBU.14725435
2	18-08-1973	KIGONDU KAMAU ID/K/MKS.3633
3	18-08-1973	LAND CERTIFICATE ISSUED.

Part C : Encumberance Section

NIL

Registrar Signature .....

S. N. Kaibia *282

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