University of Nairobi

School of Engineering

DEPARTMENT OF GEOSPATIAL AND SPACE TECHNOLOGY

CREATING A LAND INFORMATION SYSTEM

CASE STUDY: KAMITI/ANMER BLOCK 4, KIAMBU.

BY

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F56/12361/2018

A project report submitted in partial fulfillment for the Degree of Master of Science in Geographic Information Systems, in the Department of Geospatial and Space Technology of the University of Nairobi.

August 2020

DECLARATION

I, Kithui Lydia Mwari, 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 thesis in any other university.

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Kithui Lydia Mwari   Date

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

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Dr. C.M Mwange   Date

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DEDICATION

This project is dedicated to the Almighty God and to my family members who have been of great help throughout my academic journey.

ABSTRACT

A Land Information System (LIS) is a computer-based information system that enables the input, storage, management, analysis, output and dissemination of geographically referenced parcel-based data and information that is mainly at large mapping scales.

In Kenya, most of the land records are maintained in paper-based, manual form. This system of manual record keeping and maintenance is slow, cumbersome and inefficient, as the records exist in paper form thus the storage, access and retrieval process is a challenge.

The project aims to show how LIS supports processes such as ownership, land valuation and land use. The main objective of the research is to create a LIS, supported by a geo-database that combines both non-spatial and spatial features of land parcels.

The methodology encompasses identification of spatial and non-spatial data, data collection, data processing and verification i.e. georeferencing, digitizing and topology, and finally the creation of a geo-database.

Kamiti/Anmer Block 4 estate, which is a part of Kiambu town, was used as a case study. Kiambu County has an urban population of 88,869 as of the 2019 census. Kiambu town is the capital of Kiambu County, which bounds the northern border of Nairobi.

A number of results were obtained from this study, namely; a designed database in Microsoft Access, a land use map, a cadastral map of the area of study showing parcels and their acreage, integrated database from Microsoft Access and ArcGIS software, and an overlay of cadastral data with road networks.

The study demonstrates the ease with which information can be retrieved using a digital LIS as opposed to the cumbersome manual-based process that is costly and error-prone. A number of queries were performed using the structured query language to illustrate the ease of access of information. Survey plan data such as area, spatial data and associated land information such as value, rates, rent, land-use and ownership were used to create the LIS database system.

The study concludes that the system provides reliable and easy system for collecting information, analysis, retrieval and updating pertaining to any particular plot of land, which is invaluable for efficient land management in Kenya.

The project should be extended to cover the whole of Kiambu County and later to the other counties of Kenya to be used to digitize and manage large datasets. The LIS across counties should be networked to enable sharing of data and reduce redundancy.

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CHAPTER 1: INTRODUCTION

1.1   Background

In Kenya, land is the most important factor of production, besides labour and capital. It is not only a critical resource, but also the foundation of economic development for the country. The national land policy (NLP, 2009) has a vision to guide the country towards the sustainable and equitable use of land. The NLP designates all land in Kenya as public, private or community land. This land policy has been formulated to address the critical issues of land administration, access to land, land use planning, restitution of historical injustices, environmental degradation, conflicts, unplanned proliferation of informal urban settlements, out-dated legal framework, institutional framework and information management. It also seeks to keep an up to date inventory of all government and public land in the country.

In the new 2010 constitution, devolution of some national government functions and formation of county government was provided for. These invoked the development of new land laws to guide the devolution process and procedures. According to the County Government Act 2012, all county governments are supposed to develop Geographic Information System (GIS) based spatial plans and these call for the creation of a Land Information Management System (LIMS).

The policy has proposed the development of a LIMS 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 LIS.

LIS is a geographic information system for cadastral and land use mapping. Typically consisting of an accurate, current and reliable land record cadastre and associated attributes. A LIS provides a typical solution that permits users to retrieve, create, update, store, view, analyse and publish land information.

Like any other Computer-Based Information System, the development of LIMS follows standard processes, including analysis (identifying and specifying system requirements), design (determining the best way to construct the system) and implementation (constructing and testing of the system) (Mwange, 2020).

During the recent past, Kenya has initiated several LIMS initiatives, most notably the National Land Information Management System. These initiatives have only been partially successful, which is attributable to, among other factors, the absence of an accepted cadastral data model. As

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a result, the country risks non-standard data and processes, poor quality land information and increased cost of land information management (Mwange, 2020).

Worldwide, leading agencies are realizing the importance of bettering the management and operations in cities that are in developing nations. An important feature to this improvement is the use of LIMS (Willie, 1998). Land administration systems are about addressing problems such as those experienced in countries without any basic administration of land, countries whose tenure to land and property cannot be secured and where mortgage loans cannot be established as a basis for property improvement and business development. Those countries whose use and development of land is not controlled through overall planning policies and regulations by providing a basic infrastructure for implementing land related policies and land management strategies to ensure social equity, economic growth and environmental protection can also be addressed by this system (Williamson, 2010).

1.2   Problem Statement

In most developing countries, Kenya included, it is generally difficult, time consuming and 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, the necessary information is lacking, inadequate or contradictory.

Despite the fact that cadastral surveys in Kenya started in 1903, most of the land records are still kept in paper form and operated manually. This system of manual record keeping and maintenance is slow, cumbersome and inefficient. The old cadastral systems have become inadequate due to the fact that the number of land records has increased greatly, they exist in paper form thus the storage, access and retrieval process is a very big challenge.

The development of 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 facilitates quick retrieval of information, easy updatability and secure, since there is a need to enhance modern cadastral infrastructure that will; protect land rights of all, support land management and long term sustainable development goals and facilitate efficient property and land markets.

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1.3   Objectives

1.3.1 Main Objective

To develop a Land Information System for part of Kiambu town, in Kiambu county. Area, Kamiti/Anmer Block 4.

1.3.2 Specific Objectives

a) To create a database register containing information on land use and ownership of every parcel of land in the study area.

b) To generate digital copies of cadastral and land use maps showing boundaries, roads, sewer line and power line of study area.

c) To demonstrate the operation of the LIS in the study area.

1.4   Justification for the Study

Land remains a sensitive issue which often comes up in almost all economic and civic processes in the country. This is unsurprising since land is an important factor of production in Kenya's agricultural based economy. Consequently, many Kenyans work to own land and others acquire land by other criminal or illegal means which revolve around the falsification of land records and transactions.

To address such issues, there has been a need to computerize all the land records and transactions in the country by creating a National Land Management Information System (NLMIS) which is able to hold and support huge and diverse datasets on ownership and transactions of lands. Computerized LIS would provide access to current land records to the public.

1.5   Scope of Study

The scope of the work entails detailed procedures for development of LIS of a part of Kiambu town, Kiambu County. The project is limited to showing parcel boundaries, road network, survey plans of each plot; and the attributes includes instruments to land title, land registry data such owner Identity and parcel area. All these entities and attributes will form the base of database creation.

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Figure 1.2 Map of Kiambu County

Figure 1.1 Map of Kenya Counties

KAMITI/ANMER BLOCK 4
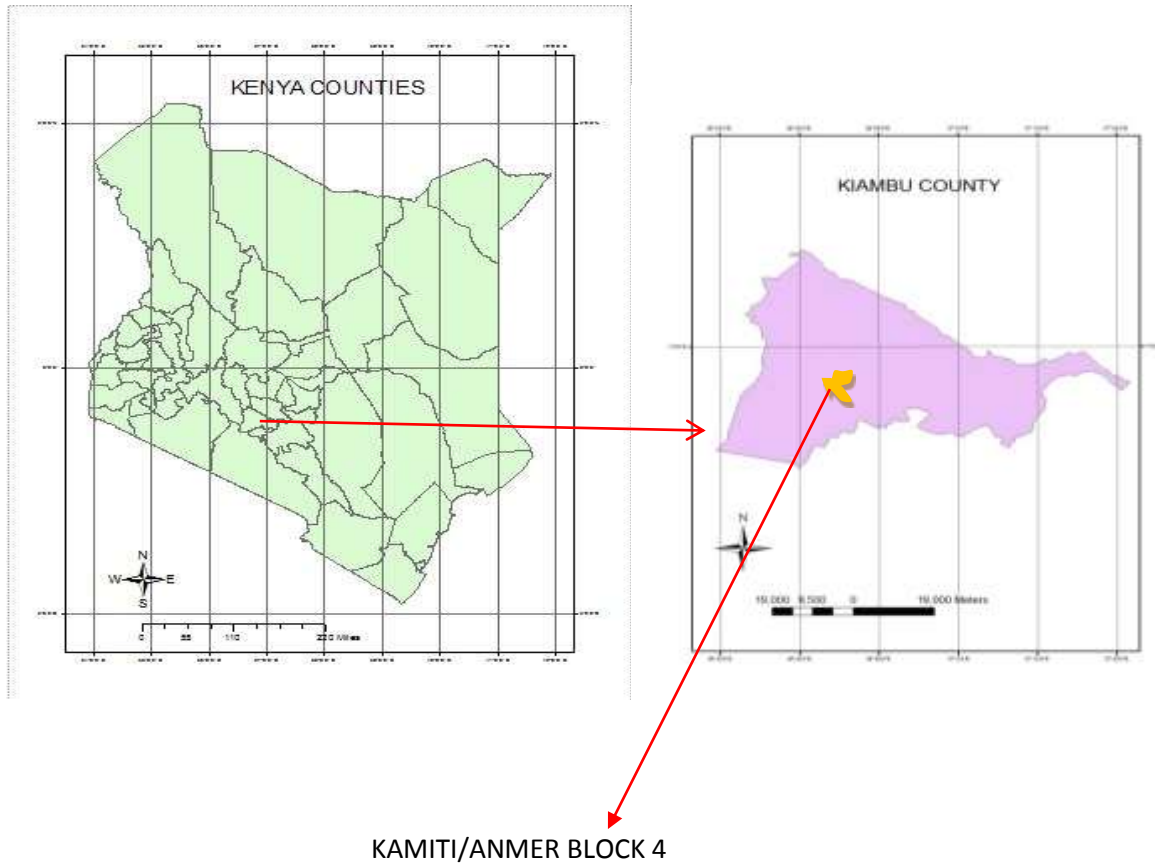
1.6 limitations of the study

a) Access to data- Difficulty acquiring some data such as land owners data
b) Restriction of movement due to COVID 19 pandemic
c) Financial constraints
d) Time

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CHAPTER 2: LITERATURE REVIEW

2.1 Land

In the works of Henssen (1995), 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.

Life on earth cannot exist without land and consequently making it the greatest asset. Land is a crucial asset for cultural, economic and social developments in a nation. Land is both an abstract concept and a physical commodity in that, the rights to use or own it are as much part of the land as items rooted in its soil. (UN ECE, 1996).

Lands provide the basis for religious, social and cultural practices and the platform for shelter, economic and food production. Secure access to land and any other naturally occurring resources is vital to; poverty, environmental protection and hunger mitigation (Steudler, 2010).To accommodate the coming and current generations, suitable land management practices are of great importance. Land is becoming a very valuable asset in the societies due to the ever reducing people to land ratio since the world population is rising and land is a fixed asset.

Shipton (2011) argued that Africa has the sparsest overall population, but to infer that Africa has no problem of rural land shortage would be quite wrong. The continent has the highest and fastest rising rate of population growth lately at 3% per year and the distribution is uneven. This puts immense pressure on the small lands available for production purposes.

2.2 Land Information

These comprise data on geo-referencing, land use, mapping, land ownership, valuation and listings of different categories of land. Land information is oftenly termed as having "spatial information" because it pertains to an object – land, which possess a definitive, fixed position on the surface of the earth. Land information is used by a wide variety of users, varying from government organizations and departments at all levels through to prospective or existing land owners to surveyors, planners, lawyers, valuers, retailers and real estate managers. Accessibility to this information is made attainable by making use of unique parcel reference numbers as identifiers to single out each property unit and land.

2.3 Land Administration

Land administration refers to the process of establishing, making a record and distribution of information about use of land, ownership and value (Land admistration guidelines 1996), states, a

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land administration system should provide stability and order in the society by providing security to traders, dealers, money lenders, national and international investors, land owners and their partners . Further, it provides land users with necessary documents and certificates to assure land rights and assists in the processes of; land dispute resolution, fiscal land management and allocation of land.

McLaughlin (1999) in his view, land administration is the integration of common 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 (2004), described land administration according to its functions. They divided the functions into four:

a) Juridical to oversee land ownership.
b) Regulatory in charge of land use planning and Land development control.
c) Fiscal takes care of land taxation.
d) Management of information: Fundamental constituent that fulfills the information requirements of the above three components.

Efforts should mainly focus on land management procedures for compensation for requisite acquisition, registration of land rights and indefeasible titles. These reforms present huddles to the land administration's ability to govern land comprehensively. Administration of land should put emphasis on management procedures like; transfer of land, adjudication, valuation, sub-division and planning in preference to institutional, legal and regulatory framework.

2.4   Land Management

Land management is the procedure of managing development and use of land resources in a tenable manner. According to McLaughlin (1999), land management concerns with making decisions and the execution of the said decisions regarding the utilization of land resources. It consists of the procedures by which land resources are allocated "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"

Land supports various sectors of the economy including manufacturing, infrastructure development and agriculture. Approximately 70% of Kenyans are dependent on agriculture for their livelihoods as a source of both employment and food (KIHBS 2016).

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2.5 Land Tenure Principle

As much as it can be allowed, the LIS should be inclusive of all; reserved, forests, customary and private lands. Adopting a complete cadastre is necessary for the most efficient land resource management for the wellbeing of a country and its citizens, land matters are open to enhance governance. Issues about land tenure and its effects on land use together with land resource management is not recent not only in Kenya but also the whole of Africa. Before and after independence, thorough changes have been commenced in tenure arrangements. They have been justified mainly based on the improvements expected in land use planning, productivity and decision making which would be generated. (Ogolla, 1996).

The focus of an effectual land administration should be to set forth a LIS to manage land development sustainability. It's paramount to completely understand that land management systems should create ownership and restriction of land and inventory of rights. Land management reforms must identify a land tenure which is able to adopt sustainable development objectives and principles with transparency, legal recognition, fair compensation, documentation of native rights and adjudication. Sustainable development objectives needs all lands recorded in the land management system to include; ownership, restrictions all rights in relation to all lands.

2.5.1 Land Tenure Systems in Kenya

Interests in land largely fall into two categories. Rights that are attained through customary tenures and rights that are obtained from the English system initiated and maintained through laws created by the colonial power and then subsequently the legislature.

The first is lightly termed as customary tenure is bounded through customary law (traditional rules). The second body of the law known to as statutory tenure is safeguarded and articulated through various acts of parliament to national law.

a) Customary Land Tenure

Refers to the unwritten land procedures by certain communities under traditional laws.

A diverse country like Kenya, in view of its ethnic composition has several traditional land tenure systems which are different due to mainly; cultural practices, climatic conditions and agricultural practices.

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b) Statutory Tenures

Under these tenures, we have two categories namely freehold and leasehold tenure.

i) Freehold Tenure

This tenure holds the largest interest in land known as absolute right to possession or ownership of land for an undefined duration of time or in perpetuity. Generally free hold have no restrictions to the use of and occupation, but in real practice there exist conditional freeholds which limit the use, say for ranching or agricultural practices only.

ii) Leasehold Tenure

Leasehold is an interest in land for a definite term of years and may be granted by a freeholder usually subject to the payment of a fee or rent and is subject also to certain conditions which must be observed such as relating to developments and usage. Leases are also granted by the government for government land, the local authorities for trust land and by individuals or organizations owning freehold land

2.6 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 such as 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 control (planning and administration), to enable sustainable development and environmental improvement".

A cadastre is a complete and up-to-date official register or inventory of land parcels in any state or jurisdiction containing information about the parcels regarding ownership, valuation, location, area, land use and any buildings or structures thereon (Williamson, 1985). The land parcel is usually the smallest parcel having individual ownership, which may be termed the legal parcel. This parcel is the basic building block of the cadastre. There are some cases, however, when this parcel is not suitable and it must be divided into smaller units. This is usually for valuation, assessment, or rating (fiscal) purposes or for land use classification. In a considerable number of cases the legal parcels must be aggregated to form the larger land use parcel.

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2.6.1 Cadastral maps in Kenya

According to Siriba 2011, Different types of maps are used to support land registration in Kenya, and some of them include;

i. Survey and deed plans

A deed plan, usually produced for each parcel of land in urban areas, is traced from a survey plan based on fixed boundaries. A fixed-boundary is an invisible line defined geometrically through an accurate survey. Survey plans and the subsequent deed plans are of the highest positional accuracy compared to the other cadastral maps; this is because survey plans are based on fixed-boundary (coordinated) surveys. Survey plans are based on ground survey methods that ensure that the requirements of fixed-boundary surveys are met. The methods employ precise equipment and techniques to obtain accurate and reliable mathematical data from which the numeric cadastre is created.

ii. The Registry Index Map (RIM)

According to the Registered Land Act of 1963, a RIM is the main cadastral map created for the initial registration of land and amended during following land sub-divisions. It is used to identify on the field a plot shown on the register; aid in the realignment of a boundary, should it be lost; enable sub-division to be effected; and for calculation of areas.

Provisional cadastral maps

a) Demarcation maps

The Registered Land Act of 1963 allows the use of provisional cadastral maps for land registration prior to the preparation of more accurate RIMs.

For example, during the land consolidation programme, cadastral surveying and mapping was based on aerial photography at a scale of 1/12500, from which base maps at a scale of 1/5000 are prepared.

Preliminary Index Diagram (PID)

Cadastral survey and mapping for land adjudication in enclosure areas uses provisional maps called Preliminary Index Diagrams (PID). These maps are created by the land officers using enlarged aerial photographs or by ground methods or both. Although PID are prints of maps showing approximate parcel boundaries, their main weaknesses are the non-uniformity of scale

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within a particular index map sheet, unreliability of distances and areas calculated using these map sheets and sometimes distortion of the shapes of the land parcels

b) Registry Index Maps – range land (provisional)

In range lands where trust lands are converted to group ownership, natural features appearing on published 1/50000 topographical maps are accepted as boundaries. Boundary markers though coordinated to the nearest meter using approximate ground survey methods are marked on the 1:50000 maps but their coordinates are not often used to compute the areas (Siriba, 2011).

2.6.2   The Role of the Cadastre

A cadastral vision of the future, as 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 traditional surveying, mapping and land registration focus have moved away from being primarily provider-driven to now being clearly user-driven. However, each of those systems includes tasks and processes that impose quite different demands on the cadastral system. The success of a cadastral system is a function of how well it achieves these broad social and economic objectives. It is now recognized that an effective cadastral system is the basis for an efficient real estate market and fundamental for an efficient system of sustainable land use management (UN-FIG, 1996).

2.7 The Kenyan Cadastre and Modern Land Administration

In societies that are organized, land management and administration characteristics are the adoption of technology that offers improvements in; access, storage, collection, management and administration of information about land. Technology brings the possibility for spatial development by use of location as the foundation for incorporation of information about land. (Siriba, 2011).

2.7.1 Access to Cadastral Information

Accessible land information is necessary to expedite participatory democracy and land administration. The 5th declaration of cadastre 2014 proposes that both the private and public sectors will work jointly in initiating and managing the cadastral system. Currently, cadastral data such as RIMs and survey plans can be acquired by private surveyors at a small price. This also

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pertains to data from register of lands, from where independent people can acquire data through an official search. At this time, the method of obtaining information seem to be enough and will possibly continue into modern land management. (Siriba, 2011).

2.7.2 Digitizing the Cadastre

International inclination in land management systems is the dependency on computer and information technology (IT). The 4th declaration of cadastre 2014 proposes that the reliance on pen and paper in mapping will be outdated by information systems that bring forth computerization. Although there is noticeable progress in the use of information systems in some departments in charge of the cadastre, the cadastre is still manual. In addition the queue of cadastral surveys for imprimatur by the Director of Surveys is still needed to be done manually in spite of the utilization of digital surveying instruments to acquire to acquire data from the ground. To befit a modern LIMS both cadastre and land register have to be computerized, taking into consideration ordinary standards and data models. (Siriba, 2011).

2.8 LIS in Pakistan

LIS in Pakistan is based on customary system of land records and registers that are somehow complex, out of date and incompatible to new developments. Aside from being very inefficient, this land information system has many issues and barriers in the development process. The registry system is under the management of provincial governments where no data standards are maintained.

2.8.1 Challenges in Setting up Cadastral Database in Pakistan

The main aim of a cadastral database is to manage all parcels and ownership information, so that it can allow for precise, clear and structured system for property management. The utilization of GIS gives possibilities to store location data in digital forms, and interconnect them to co-relating attribute data to be used when required.

Problems being encountered in the implementation of GIS include;

a) Scarce resources
b) Majority of the manpower is untrained
c) Unawareness about functions of the system

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d) Enormous task of converting traditional data into new formats

e) No central administrative body

f) GIS implementation done with no framework

g) Limitations to a variety of data types

 (Shakir, 2012).

2.9   LIS in India

Land information in India is managed at tehsil offices. There are two categories of land records

 a) Alphanumeric data- includes data such as crop statistics and rights.

 b) Cadastral maps- shows the plots extent and boundaries and roads

2.9.1   Alphanumeric Data:

Numerous registers are managed holding the following information;

 a) Pedigree table- Information about family history and details of ownership.

 b) Crop details- possess information of area, cultivator and crop yield.

 c) Rights record- holds ownership data of plots, sub-divisions etc.

2.9.2   Survey Modes used

The aim of cadastral survey is the resolution of field and village boundaries, planning of village maps that shows; area-list and boundaries and planning of field registers. The area-list and maps show the physical boundary with area and field registers give land details such as revenue and ownership

Various survey modes were utilized. However, the records of Bombay Survey System and Madras Survey System, which evolved after various iterations, were used as a standard.

a) Bombay Survey method

This procedure entailed running an imaginary line called G-Line or Baseline across the field and measurement of plot boundary vertex locations with respect to this line.

b) Madras Survey methods.

In this method, the survey fields are first estimated by running triangulating lines through the area. The triangulated lines define the simple shape of the boundaries of the fields. The comprehensive description of the survey fields is defined by offsetting the local boundaries points onto the triangulating lines alongside the boundaries. (Thakur, 2003).

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2.0 LIS in Kenya

For effective and efficient land administration, good land information management is necessary.

At the corporate level as well as the government, effectual zoning, planning and the entire administration of rural and urban lands cannot be reliably done.

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

a) Computerization of land information and the information made accessible and at user friendly levies.

b) Paper records to be validated, organized and updated in preparation their digitization.

c) A law to be approved to provide for all angles of access to land information and management that includes the right to intellectual property

d) The development of the capacity to deal with new technologies and cybercrimes in the country

e) Creation of a National Spatial Data Infrastructure (NSDI), that will network all agencies and departments that require land information without delays.

The ministry of lands in conjunction with the National Intelligence Service (NIS) have come up with a new digital system of land management (Lands cabinet secretary, 2020). The new land information management system (LIMS) is anticipated to be functional in all 61 land registries in the entire country. Once active, all the land transactions in the country shall be performed on an online platform that is accessible from anyplace.

The system more secure from corrupt practices and human interference as it permits file tracking. The computerized land information shall be dispersed across a computer network.

This means that the information will not be centralized, the data will be decentralized. The platform is expected to end age long occurrences where files get lost or misplaced and information on documents such as title deeds and green cards altered resulting to irregular land transactions.

The following services are expected to go online;

a) Transfer of ownership (transfer of lease or land).

b) Issuance of consent.

c) Valuation requests.

d) Payment and issuance of Land Rent Clearance Certificate.

e) All payments.

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f) Withdrawal and application of caution/caveats/restrictions.

g) Searches.

The computerization of land dealings is in line with section 9 and 10 of Land Registration Act 2012, on preservation of documents and public gain to the registrar. Section 9 empowers the registrar of lands the responsibility to safeguard the register and any document needed in a reliable, secure and accessible format such as electronic files and a consolidated land resource register (Lands ministry press release, March 2018).

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Figure 2.2 coordinative roles of land management

Figure 2.2 coordinative roles of land management
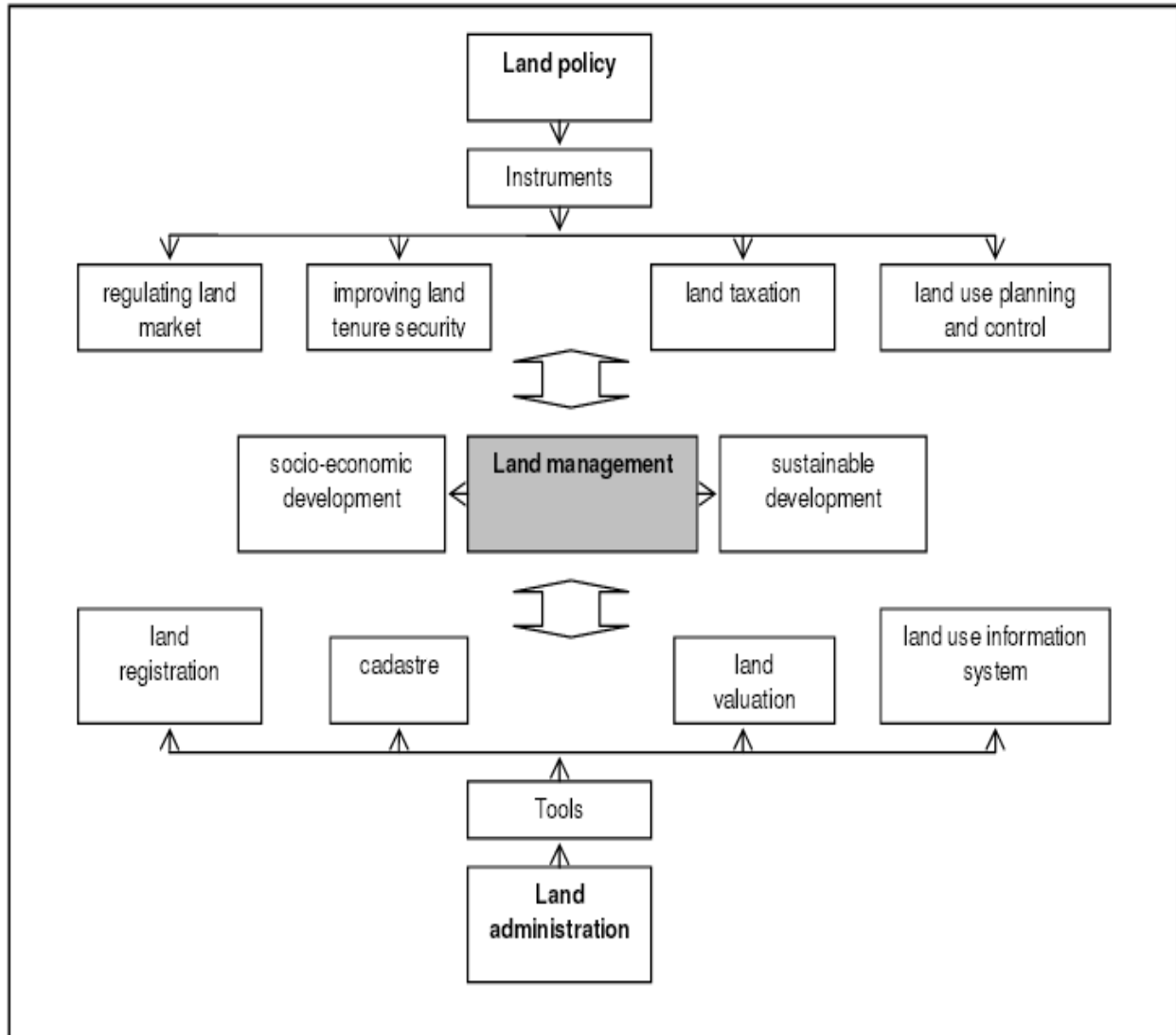
Source: (Steudler and Williamson, 2002

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CHAPTER 3: MATERIALS AND METHODS

3.1 Hardware and Software

The following hardware was used to execute processes in this project

   a) A computer; HP Intel core quad processor 2.15GHz 4GB Ram and 500GB hard disk.

   b) Scanner; SmartLF SC 42 Xpress A0/E size.

The following software was used for this project.

   a) Arc Map 10.6

   b) Ms Word 2016

   c) Ms Access 2016

   d) Ms Excel 2016

3.2 Data Collection

Table 3.1 represents the sources of data required to perform this project.

Table 3.1 Data Sources

RIM Sheets.	Quantity	Source
Kamiti/Anmer block 4	1- Scanned	Survey Of Kenya

3.3 Data identification

Two types of data will mainly be required in this project; spatial and non-spatial data

3.3.1 Spatial Data

Spatial data, also known as geospatial data is information about a physical object that can be represented in numerical values in a geographic coordinate system. Spatial data represents the location, size and shape of an object on the surface of the earth such as buildings, mountains or a township. Spatial data is usually recorded as coordinates and topologies, this is the data that can be mapped. This data type is usually, accessed analyzed and manipulated in a GIS surrounding

3.3.2 Non-spatial Data

Non-spatial data also known as attribute or characteristic data refers to information that gives details of a feature that is geographic but do not contain spatial data by itself i.e. it does not directly relate features on the ground. In GIS, this data is normally stored in tables and connected to the features by unique identifiers. It comprises parcel ownership data, encumbrances, land valuation and taxation data, land statistics, land use types, soil types and its characteristics and site data.

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3.4 Data Processing

In GIS, data processing involves transforming raw facts of spatial data into more usable information by use of GIS software and tools.

3.4.1 Georeferencing

Georeferencing is the process of allocating each pixel of the raster real world coordinates. Most times, coordinates are acquired through field surveys that is picking coordinates with a portable GPS of a few features that can be identified in the map or image. In this research project, looking at the scanned maps, coordinates can be acquired from markings on the map itself. Using these sample coordinates, the image can be warped and made to fit within the chosen coordinate system.

3.4.2 Georeferencing of the Scanned Image

    a) To display the Georeferencing toolbar, click the Customize menu and then click Toolbars > Georeferencing

    b) From the **Georeferencing** toolbar, click the **Layer** drop-down arrow and choose the raster layer you want to geo-reference.

    c) Click the **Georeferencing** drop-down menu and click **Fit to display**.

    d) From the Georeferencing toolbar, click the Layer drop-down arrow and click the raster layer you want to geo-reference.

    e) Left Click **Add Control Points** tool to add control points.

    f) On georeferencing drop down menu click update

3.4.3 Digitizing

Digitization in GIS is the procedure of turning location data from scanned map images into vector data by drawing over its features.

During the digitizing process, features from the traced image are coordinates in either point, line or polygon format.

Vector is a data structure used to store spatial data. Vector data is comprised of lines or arcs defined by beginning and end points, which meet at nodes. The locations of these nodes and the topological structure are usually stored explicitly.

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3.4.4 Digitization of the RIM sheet

Figure 3.1 was digitized in ArcGIS software to extract each plot boundaries as a polygon features and the road network crossing in the area.

As demonstrated in figure 3.2 and 3.3

Figure 3.1
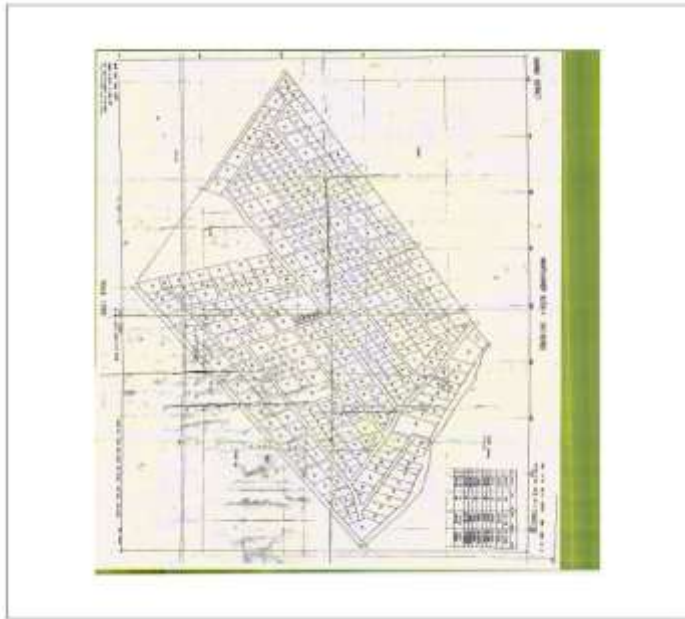
Procedure used for manual digitizing was:-

a. The raster data set (Survey plan) was added on ArcMap.

b. A geo-database was created in the working folder from arc catalogue.

c. From the geo-database new feature classes were created representing the road network and the land parcels.

d. Editing was enabled and a template; lines for roads and polygons for parcels each feature class was created.

e. The parcel boundaries were digitized onscreen using a mouse by tracing the boundaries of the parcels. A section of digitised parcels from one of the survey plan covering the area of study is shown in Figure 3.2. Road networks covering the area of study were also created and overlaid on the captured parcels as illustrated in the Figure 3.4 and 3.5.

`

3.4.5 Topological Building

A GIS topology is a set of rules and behaviour that model how points, lines, and polygons share coincident geometry, and the mechanism for establishing and maintaining spatial relationships between features. It is a vital component in parcel building and maintenance in the parcel fabric. Topological data models manage geographical relationships through representations of geographical objects as an underlying graph of topological primitives; nodes, faces and edges. Building topology accomplishes the following:-

i.   Merges coordinates within the tolerance of each other.

ii. Creates a list of arcs that define each polygons boundary, numbers the nodes, deletes dangling arcs that are shorter than the specified dangle length.

iii. Builds a polygon attribute table depending on the option used.

iv. Calculates the area and perimeter of each polygon used.

3.4.6 Map Topology

Map topology is temporary and only lasts for the duration of your edit session. Unlike geo-database topologies, map topologies are not stored permanently or represented as layers in the map. Map topologies have no rules and there is no validation process.

Creating a Map Topology

a) Click the **Editor** and then click **Start Editing**.

b) Click on **map topology** button on the Topology toolbar.

c) Check all the feature classes that will partake in the map topology.

d) Click OK.

e) Click the Topology Edit tool and click the features you want to edit using the map topology. The map topology is created for the features that are visible in the current display extent.

`

The figure below shows the complete digitized parcels within Kamiti block 4 Index Map.

Figure 3.2 Digitized plots of the study area

KAMITI LAND PARCELS

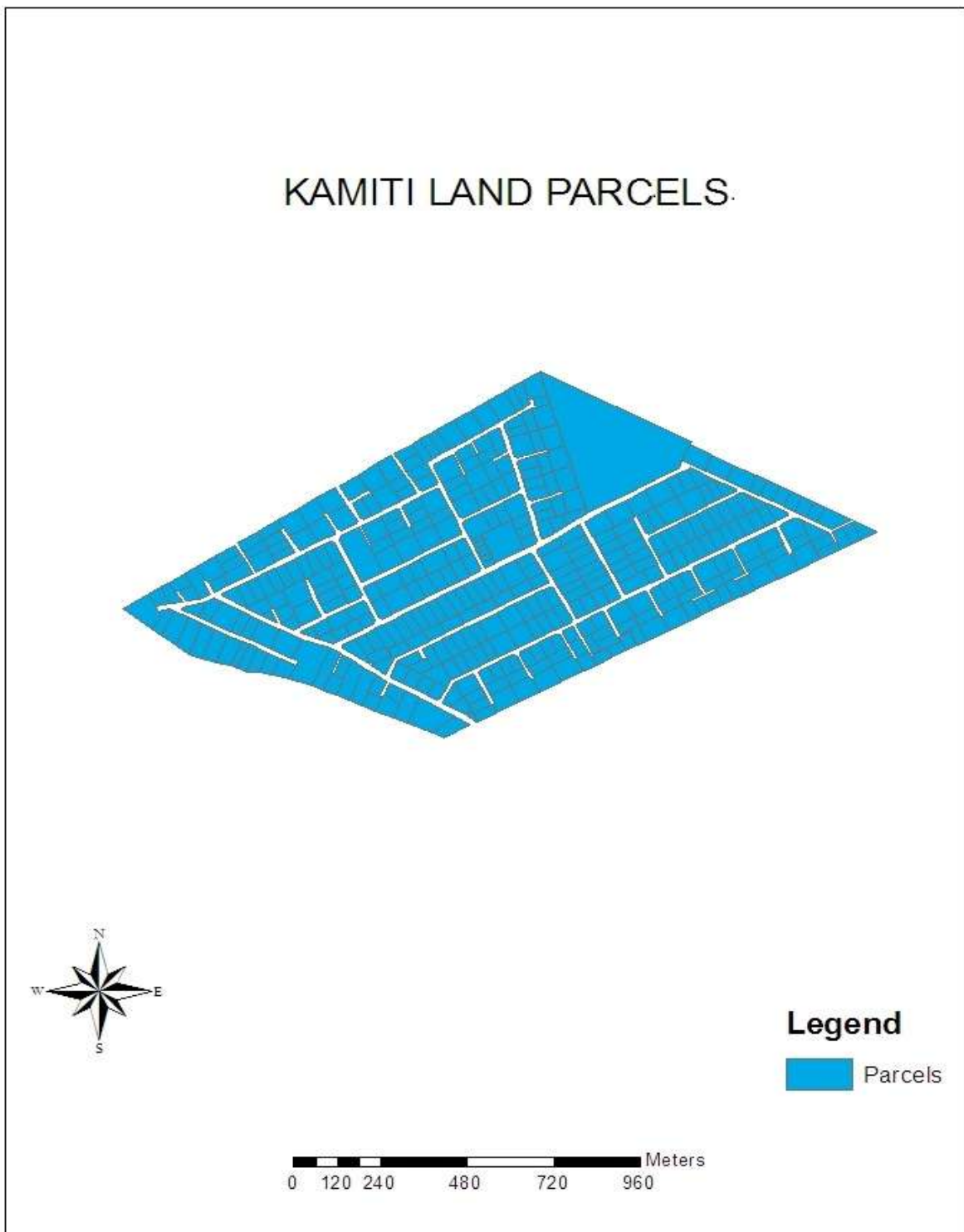Legend

Parcels

Meters

0 120 240   480   720   960

`

Figure 3.3 shows an extract of the attribute table developed in ArcMap for the polygons representing land parcels. The shape_length represents the perimeter of each parcel and the shape_Area represents the area of each parcel.

Figure 3.3 Attribute table

| OBJECTID *	SHAPE *	SHAPE_Length	SHAPE_Area
4	Polygon	749.608483	30675.583186
7	Polygon	2187.13129	70518.289068
8	Polygon	534.020688	17222.636442
9	Polygon	1309.873622	52720.390284
11	Polygon	736.416881	33167.410666
12	Polygon	745.325056	33962.916043
13	Polygon	608.399132	17880.761924
15	Polygon	573.852975	15018.326019
16	Polygon	547.317536	15301.052168
17	Polygon	554.87633	16467.089602
18	Polygon	576.797564	19299.203941
19	Polygon	799.27431	39876.317156
20	Polygon	560.520468	18073.456199
21	Polygon	781.838029	38010.579859
22	Polygon	811.521374	41093.493661
23	Polygon	565.576014	16510.237398
24	Polygon	475.203765	9226.311142
25	Polygon	555.77844	17216.251984
26	Polygon	560.519277	17494.204427
28	Polygon	566.335447	18644.296568
29	Polygon	573.240837	18152.324124
30	Polygon	566.239008	17676.321347
31	Polygon	566.212178	17414.345284
32	Polygon	575.228656	18420.668753
33	Polygon	564.025963	17622.009679
34	Polygon	584.019779	19129.893195
35	Polygon	581.170323	18535.683799
36	Polygon	572.444862	18823.196922

.

`

Road networks interconnecting and accessing the land parcels were also created as shown in the Figure 3.4.

Figure 3.4 Digitized roads layer
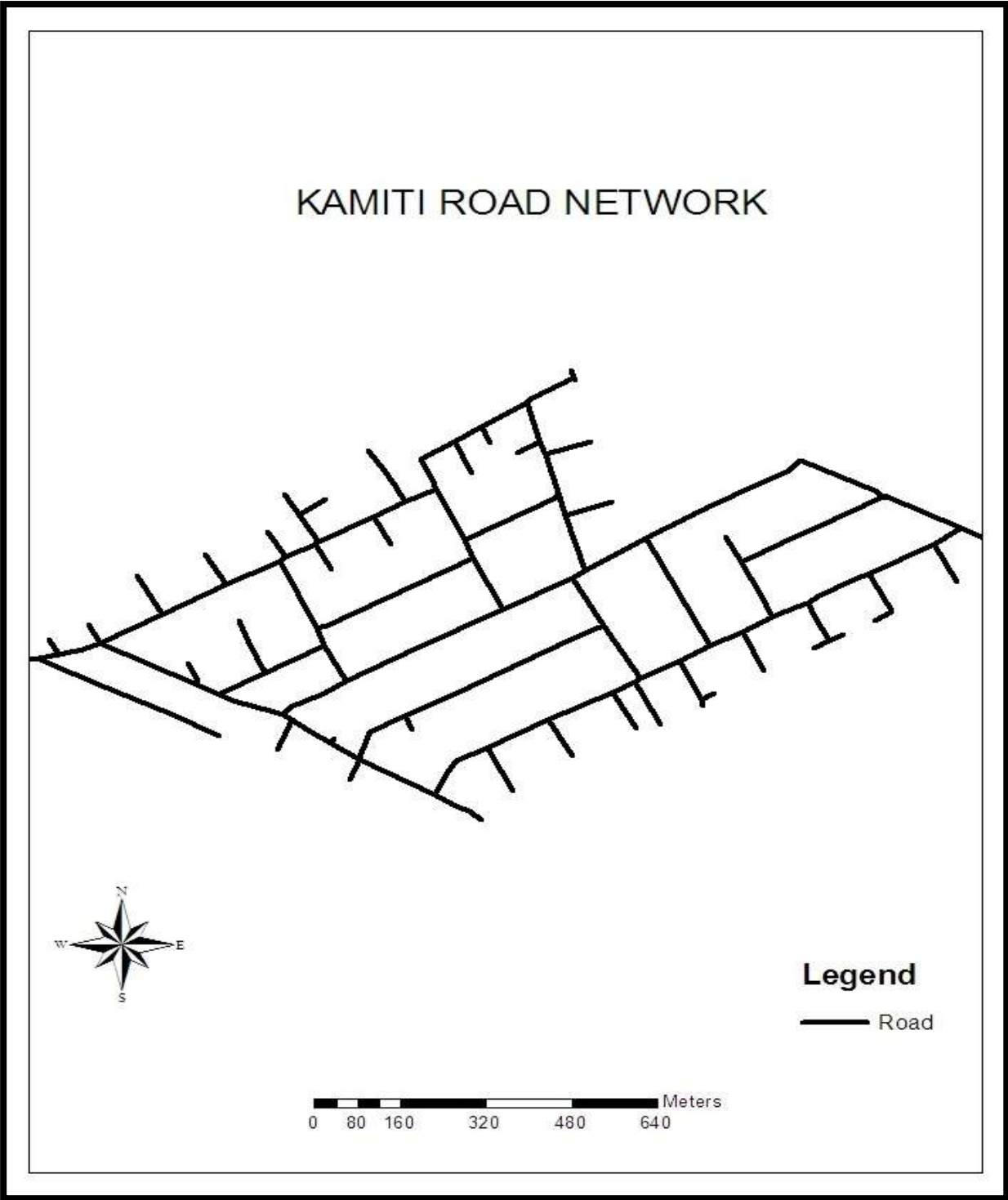
When both the road networks and the land parcels were overlaid, the following data image in Figure 3.5 was acquired.

Figure 3.5 Layered Digitized roads with digitized parcel

LAND PARCELS AND ROAD NETWORK

Legend
— Road
Parcels

Meters
0 120 240   480   720   960

`
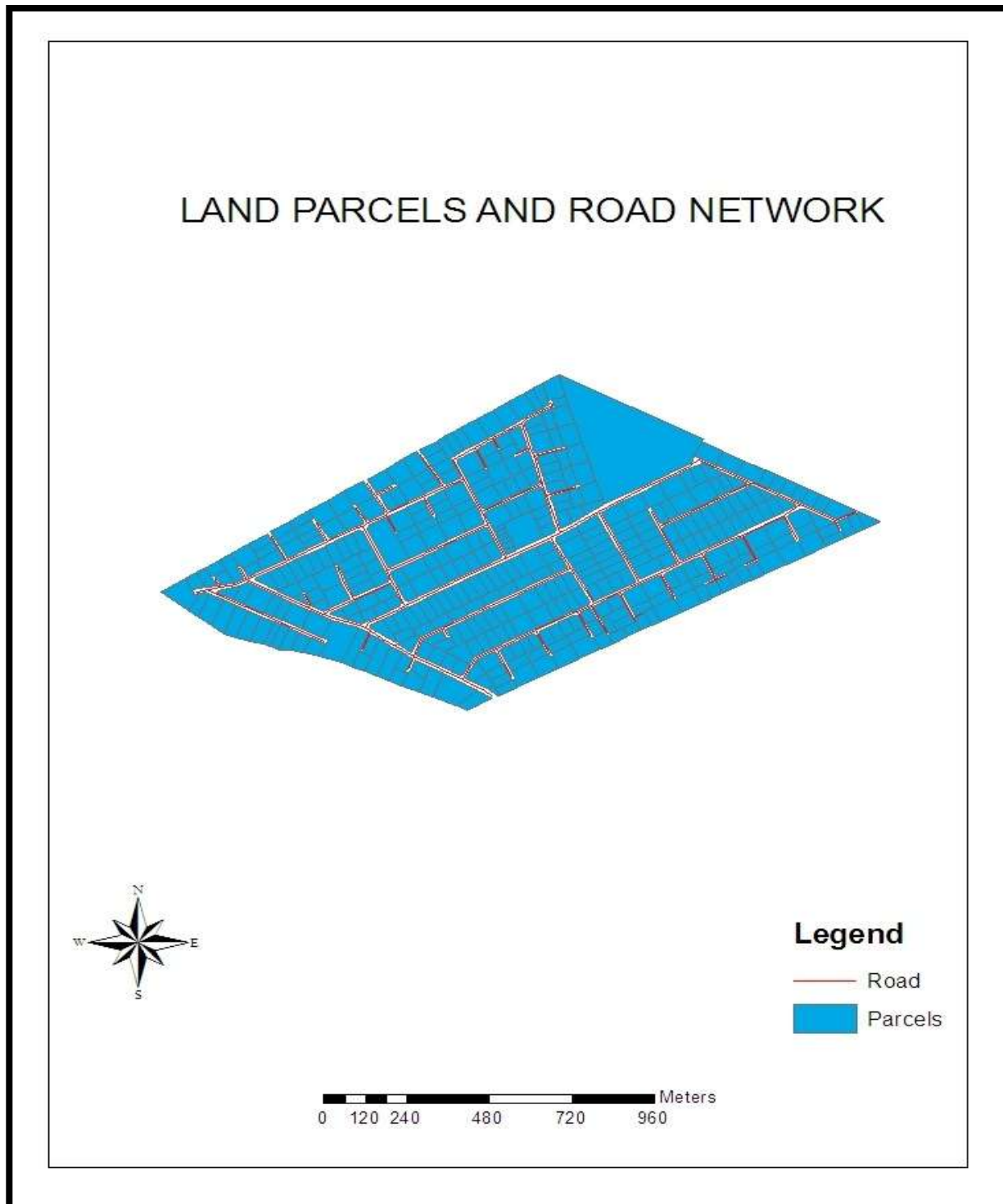
3.5 Database Design

A geodatabase is a database designed to store, query, and manipulate geographic information and data.

Database design is a collection of processes that facilitate the designing, development, implementation and maintenance of enterprise data management systems. The main objective of database designing is to produce logical and physical design model of the proposed database system.

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

a) User Needs assessment
b) Conceptual design
c) Logical design
d) Physical design
e) Pilot implementation
f) Full implementation
g) Operational GIS database

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

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

A database consists of four elements as given.

a) Data/Entity
b) Relationships
c) Constraints
d) Schema

`

Designing a database is the process of recognizing the data that will go in the database and how the data will be represented. The GIS database forms the grounds of all functions that will be undertaken in the database such as; data retrieval, modelling, analysis and map creation.

3.5.1 External Modeling

Potential users of the database were determined together with their user needs. The data that was required to satisfy those needs was also identified. The users of this LIS will be the land administrators, land owners and private surveyors and developers.

3.5.2 Conceptual Modeling

Conceptual modeling is the synthesis of all the external models into an ER diagram showing all the entities involved their attributes and relationships. ER diagram defines the entities, their relationship with each other and the constraints. Relationships in ER diagrams are interconnected between one unit and itself or two or more units

All relationships are two-way. It is essential to declare all relationships in either of the two directions. E.g., in the Chen-like model, it would informally be said, "owner owns a parcel" or "a parcel is owned by an owner/ individual." The number of entities that partake in the relationship make the degree of the relationship. Binary relationships are created when two entities partake in the relationship conceptual view of the database for this project is illustrated in Figure 3.6.

`

Figure 3.6 Conceptual view of the database
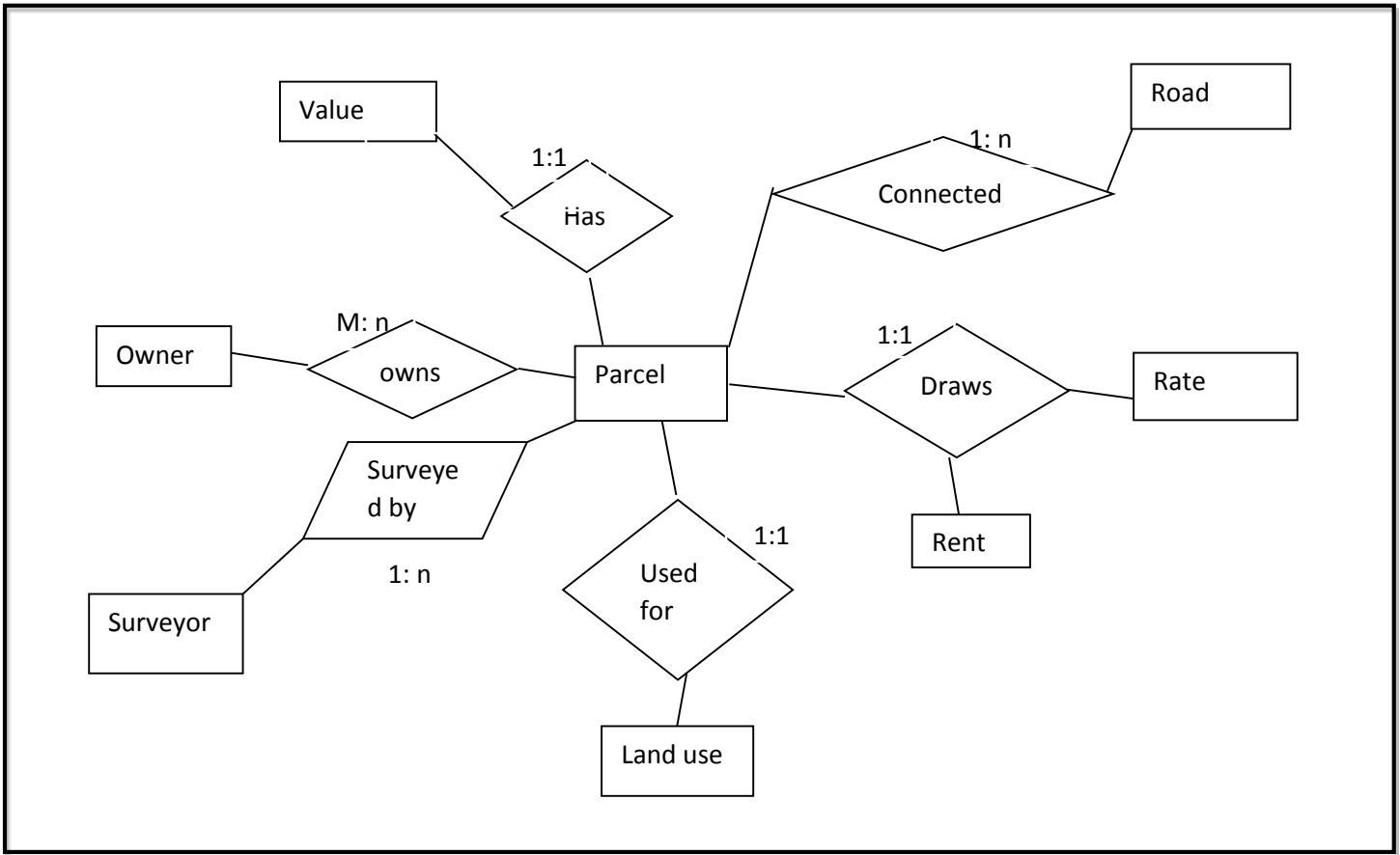
3.5.3 Logical Modelling

Logical data models add further information to the conceptual model. It defines the structure of the data elements and set the relationships between them.

The advantage of the Logical data model is to provide a foundation to form the base for the Physical model.

Three relations were identified for this project; they were owner table, parcel table and land use table whose logical views are shown in the Figures 3.7, 3.8 and 3.9.
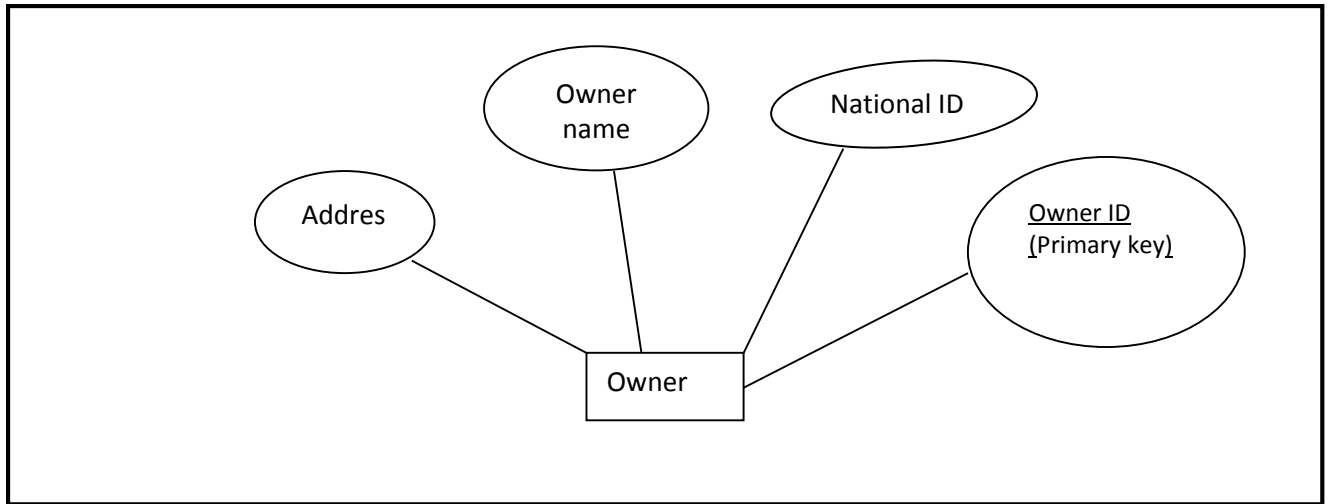
`

Figure 3.7 Logical View of Owner Table
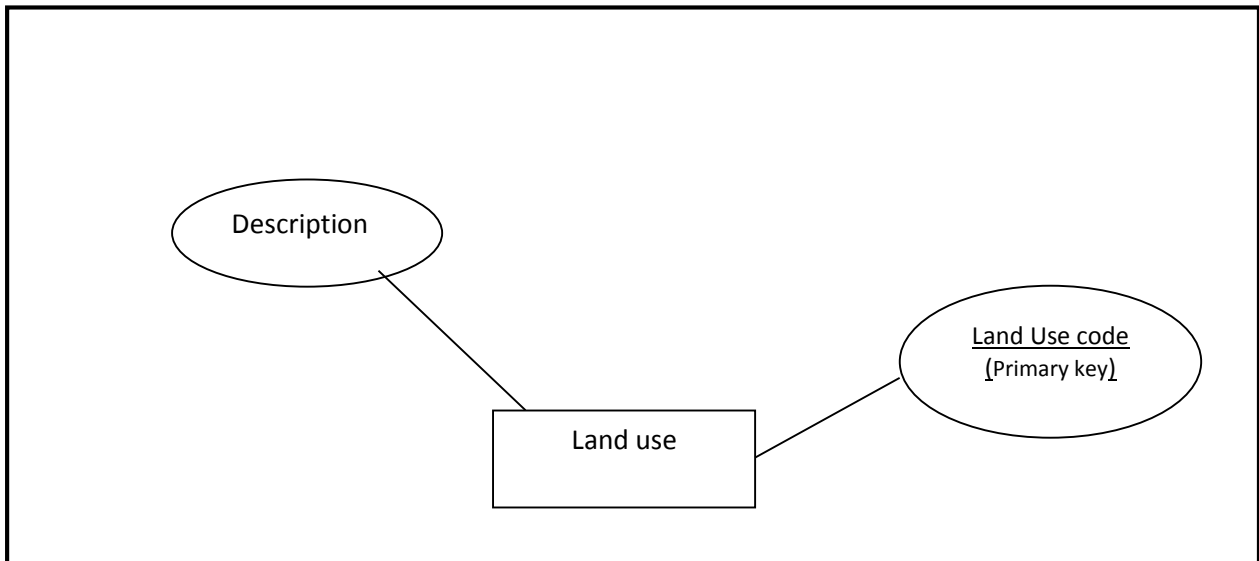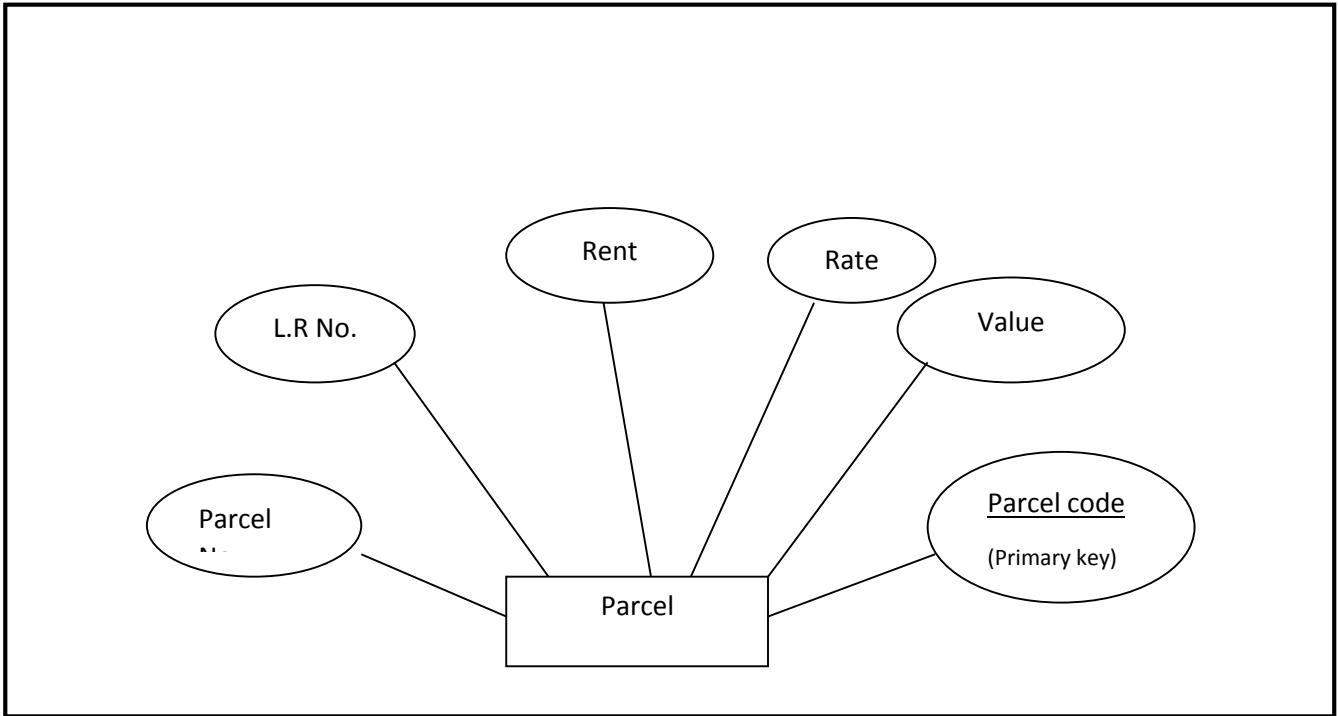

Figure 3.8 Logical View of Land Use Table

`

Figure 3.9 Logical View of Parcel Table

3.5.4 Physical Modelling

This is the design of efficient physical data storage structures for the data such as arrays, trees, stacks, queues and so on. Physical design involves the development of geo-database template. Data will be input in every field as shown below;

Table 3.2 Owner Table

Owner Code	Owner ID	Owner name	Address

Table 3.3 Land Use Table

Land use code	Description

`

Table 3.4 parcel table

Parcel code	Land value	L.R No.	Parcel No.	Land rate p.a	Land rent p.a

Key

Green color: represent Primary key field

3.5.5 Database and data types

Various data types such as numbers, text, currency and date were used for this project. The data types are shown in Tables 3.5, 3.6 and 3.7.

Table 3.5: Owner table data types

Data	Data types
Owner National Identification Number	Numeric
Address(P.O. Box number)	Numeric

Table 3.6: Land use table data types

Data	Data types
Land use code (Primary key)	Numeric
Description	Alpha numeric

Table 3.7: Parcel table data types

Data	Data types
Parcel Identifier(Block number)	Numeric
Parcel identifier(Parcel number)	Numeric
Area(Acreage)	Numeric
Land value	Currency - numeric
Land use	Alpha numeric

`

3.5.6 Mapping the Entity Diagram to a Relational Database

Mapping is the process of turning an ER diagram to a database**.**

Relational databases are made up of two dimensional tables known as "relations". The tables are comprised of columns and rows. The columns are referred to as **attributes** and the rows **tuples**. All attributes are requisite atomic and keys should not be null.

Table 3.8 illustrates the entities in a relation.

Table 3.8**:** Mapping the Entity Diagram to a Relational Database

Parcel No	Block No	Names	Owner ID	Address
3044	4	Bati Boru	846453	12350
478	4	Sarah Ndegwa	746433	655

3.6 Data entry into the Microsoft Access

Steps that were followed to enter data into Microsoft Access are as outlined below:

a) Microsoft Access was opened and a new database with the name 'AmberBlock4' created and saved as Microsoft Office Access databases in the working folder.

b) On the main menu, create icon was clicked and table design chosen.

c) The respective data types were chosen and attributes typed.

d) The create icon was clicked again and table design chosen. The attributes that were entered were the fields.

Figure 4.0 shows a screen shot of the data in Access that was used during database design in Microsoft Access.

`

Figure 4.0 Screenshot of data in Microsoft access.

| ID	Names	ID No	PO BOX Add	Block No	Land use	Value in Ksh	Land Rent (F	Land Rate (P	Parcel No	LR No	FR I
375	Becky Osang	664746	24670 Embu	4	Residential	$6,850,500.00	$68,505.00	$6,850.00	9922	Block 4/9922	148/2/
376	Aggie Labile	634364	1180 Nanyuki	4	Residential	$6,908,000.00	$69,080.00	$6,908.00	280	Block 4/280	148/2/
377	Shadrack Onge	423254	32576 Nairobi	4	Residential	$6,945,800.00	$69,458.00	$6,945.00	839	Block 4/839	148/2/
378	Bati Boru	846453	12350 Nakuru	4	Residential	$5,608,080.00	$56,080.00	$5,608.00	3044	Block 4/3044	148/2/
379	Sarah Ndegwa	746433	655 Maralal	4	Residential	$6,070,700.00	$60,707.00	$6,070.00	478	Block 4/478	148/2/
380	Babra Waithera	864548	7576 Nyeri	4	Residential	$6,908,900.00	$69,089.00	$6,908.00	7376	Block 4/7376	148/2/
381	Linda Wagera	753534	458 Nyeri	4	Residential	$6,908,950.00	$69,089.00	$6,908.00	5754	Block 4/5754	148/2/
382	Wanja Kagori	846454	36810 Kisumu	4	Residential	$7,000,500.00	$70,005.00	$7,000.00	4640	Block 4/4640	148/2/
383	Charlotte Nduk	946453	576 Kiambu	4	Residential	$6,905,050.00	$69,050.00	$6,905.00	7644	Block 4/7644	148/2/
384	Scarlet Adhiam	763537	9009 Ruiru	4	Residential	$5,907,070.00	$59,070.00	$5,907.00	3242	Block 4/3242	148/2/
385	Liam Karingi	673544	69098 Nairobi	4	Residential	$5,995,000.00	$59,950.00	$5,995.00	1322	Block 4/1322	148/2/
386	Hadija Salesa	745253	347 Meru	4	Residential	$6,120,280.00	$61,202.00	$6,120.00	5223	Block 4/5223	148/2/
387	Harry Omotti	353543	8035 Kakamega	4	Residential	$6,383,000.00	$63,830.00	$6,383.00	3833	Block 4/3833	148/2/
388	Angie Omogi	845474	7890 Nakuru	4	Residential	$6,494,000.00	$64,940.00	$6,494.00	8363	Block 4/8363	148/2/
389	Whitney Nyaki	545478	2109 Mombasa	4	Residential	$6,685,050.00	$66,850.00	$6,685.00	987	Block 4/987	148/2/
390	Rahma Abdul	354544	367 Garissa	4	Residential	$6,569,600.00	$65,696.00	$6,569.00	909	Block 4/909	148/2/
391	Judy Malemba	745448	7990 Kisii	4	Residential	$6,856,060.00	$68,560.00	$6,856.00	212	Block 4/212	148/2/
392	Benta Mueni	745463	35690 Machako	4	Residential	$7,001,020.00	$70,010.00	$7,001.00	2130	Block 4/2130	148/2/
393	Jossy Wainaina	467744	3566 Muranga	4	Residential	$6,000,110.00	$60,001.00	$6,000.00	312	Block 4/312	148/2/
394	Juliet Ouma	464644	5790 Embu	4	Residential	$7,007,000.00	$70,070.00	$7,007.00	423	Block 4/423	148/2/
395	Chacha Mochi	463734	3657 Ruiru	4	Residential	$5,909,090.00	$59,090.00	$5,909.00	4241	Block 4/4241	148/2/
396	Nicole Owiti	448463	47809 Nairobi	4	Residential	$6,600,900.00	$66,009.00	$6,600.00	2142	Block 4/2142	148/2/
397	Vanessa Cheru	846473	32657 Eldoret	4	Residential	$7,001,090.00	$70,010.00	$7,001.00	221	Block 4/221	148/2/
398	Francine Muiga	464724	8009 Kiambu	4	Residential	$6,700,050.00	$67,000.00	$6,700.00	253	Block 4/253	148/2/
399	Immaculate Na	484678	378 Thika	4	Residential	$6,007,000.00	$60,070.00	$6,007.00	3018	Block 4/3018	148/2/
400	Faith Nashpea	264734	9350 Nanyuki	4	Residential	$6,700,400.00	$67,004.00	$6,700.00	2901	Block 4/2901	148/2/
401	Erastus Wachir	282537	13790 Narok	4	Residential	$5,900,900.00	$59,009.00	$5,900.00	1443	Block 4/1443	148/2/

3.6.1 Creating relationship in Microsoft Access

Steps to create relationship in Microsoft Access were as follows:

a) On Microsoft Access database, the database tools icon was clicked in the main menu.

b) Relationships icon was clicked and on the table tab and the list of tables was shown.

c) The three tables were added and the dialog "show table" closed.

d) The primary key of one table was clicked and dragged on to the Primary key of the next table.

e) Create button was clicked and a relationship was created.

Steps (d) and (e) were repeated until all the tables had a relationship. Figure 4.1 shows the relationship among various tables in Microsoft access.

`

Figure 4.1 Relationships in the database
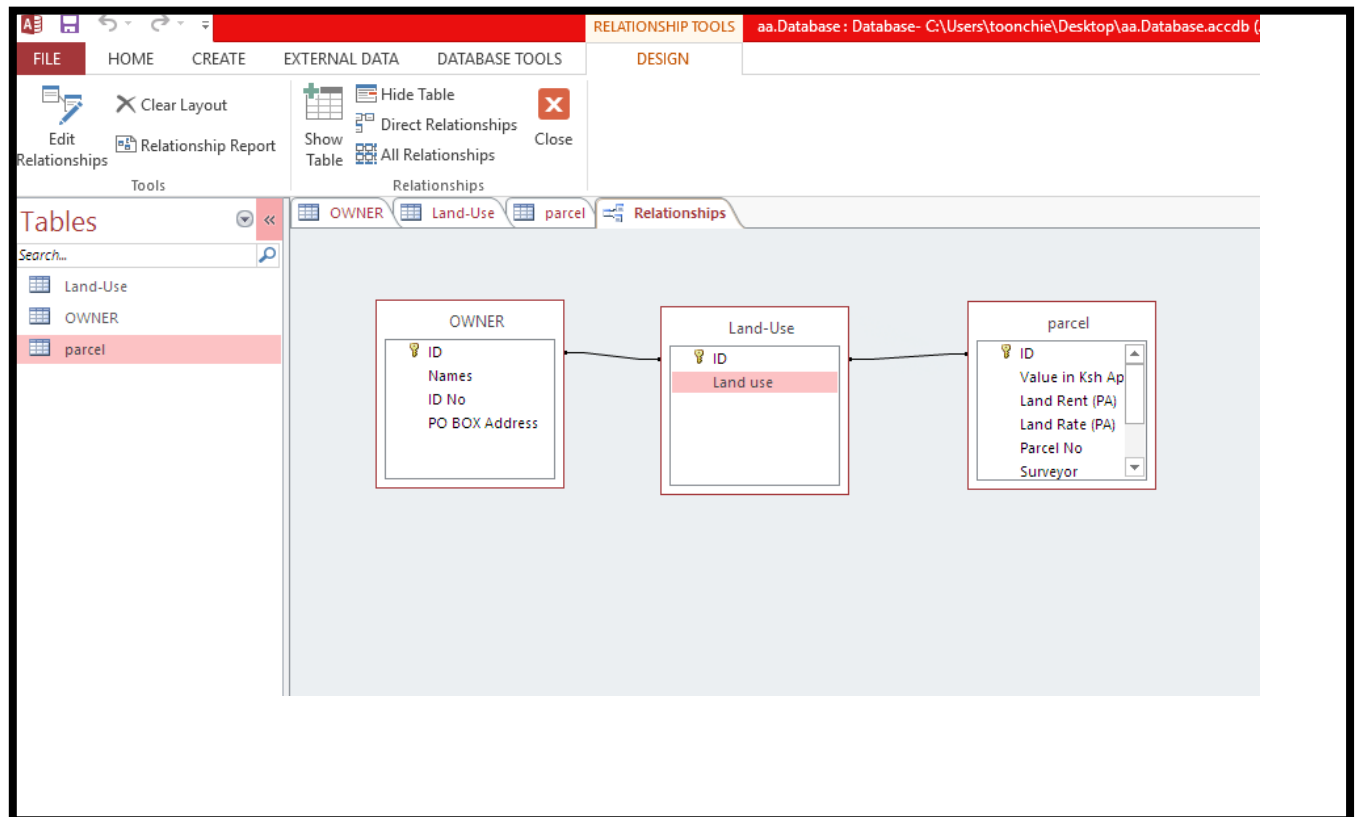
3.6.2 Joining the Microsoft Access database and the ArcMap geodatabase

Procedure for joining the Microsoft Access database and ArcMap geodatabase is summarized as follows. In ArcMap,

a) The Parcel layer was right-clicked and Joins and relates chosen > Join….

b) The join data dialog was filled by choosing the field in the parcel layer that join will be based on, the table to join parcel layer from the Microsoft Access database and its field to base the join on.

c) Ok was clicked and the Parcel attribute table had the data for the Microsoft Access database table.

`

The process was repeated for all the tables in Microsoft Access database. Figure 4.2 shows the joined tables in ArcGIS.

Figure 4.2 Joined attributes in Arc-Gis

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CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 Results

A functional LIS for Kamiti/Anmer block 4 Estate was developed. The database would enhance improved retrieval and access to records in the registries because the process is automated. Outdated records can easily be discarded hence more space created ensuring economy and efficiency in management of public records. The database ensures investment confidence among its users because it provides more secure land tenure since the information is trustworthy and free from tamper if properly secured. This system would enable proper land management in the County of Kiambu by providing more adequate spatial data for decision making and proper planning when properly implemented.

A number of results were obtained from this study, namely;

a) A designed database in Microsoft Access,

b) Land use map of the area of study,

c) Cadastral map of the area of study showing parcels and their acreage,

d) Integrated database from Microsoft Access and ArcGIS software, and

e) An overlay of cadastral data with road networks.

 A number of queries were also performed to illustrate the ease of access of information from the system. The results obtained from the study are outlined in the subsequent subsections.

4.1.1 Microsoft Access Database

Three relations were designed in Microsoft Access: parcel, ownership and land-use. The attributes in Microsoft Access were linked to the digitized parcels in ArcMap using a common identifier. For instance, a special code was generated and used to link the parcel table to the attributes on ArcMap. Owner code was used to link the owner relation to the attributes on ArcMap and land use Code was used to join the land use table to the attributes on ArcMap. Figure 3.3 shows the attribute table of parcels that were digitized in ArcMap software. Table 4.1 shows the three relations in Microsoft Access. Figure 4.2 shows the joined attributes in ArcMap.

4.1.2 Land Use Map

Land use map for Kamiti/Anmer block 4 Estate was created. The map was presented by use of symbolization as shown in Figure 4.3. Use of different color patterns was employed. Various land

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patterns were identified. They included residential, commercial, services such as religious and educational. Figure 4.8 shows the land use map of Kamiti/Anmer block 4. From the land use map, a great percentage of Anmer block 4 is occupied by residential parcels (69%) and the least being medical facilities and religious grounds at (4%) each and Commercial occupying 18% of the estate. The procedure for adding symbologies was as follows

a) Open the **layer properties** dialog box. Click symbology tab.
b) Click **events** and ensure the check box next to **events** is checked.
c) Under the **categories** heading on the **drawn as** panel, click **unique values**.
d) Click **value field**
e) Click **add all values** button to add a unique symbols

4.1.3 Cadastral Map

It was necessary to create a cadastral map of the Estate because cadastral dataset forms the core dataset for an LIS. The map was created from survey plans acquired from Survey of Kenya. The cadastral datasets include the areas and spatial location of the land parcels. Some of the attributes that are contained in the survey plan that were included in the database were; the land registration numbers of the parcels, the survey plan numbers, the name of licensed surveyor who did the survey and the area of the parcels. The cadastral map of Kamiti/Anmer block 4 Estate is shown in Figure 4.6

4.1.4 Cadastral overlay with road networks

Kamiti/Anmer block 4 cadastral map was overlaid with roads networks to show how those parcels that have been given access to a road. The status of the connection in relation to network was input in the database. With such a database, it is easy to update once the fault status of the networks is rectified in the field by county officers. Figure 4.9 shows the overlay. The purpose of the overlay was to enrich the LIS database and since other services such as electric lines and drainage follow the same path as the roads, road network overlay can be used to show the same.

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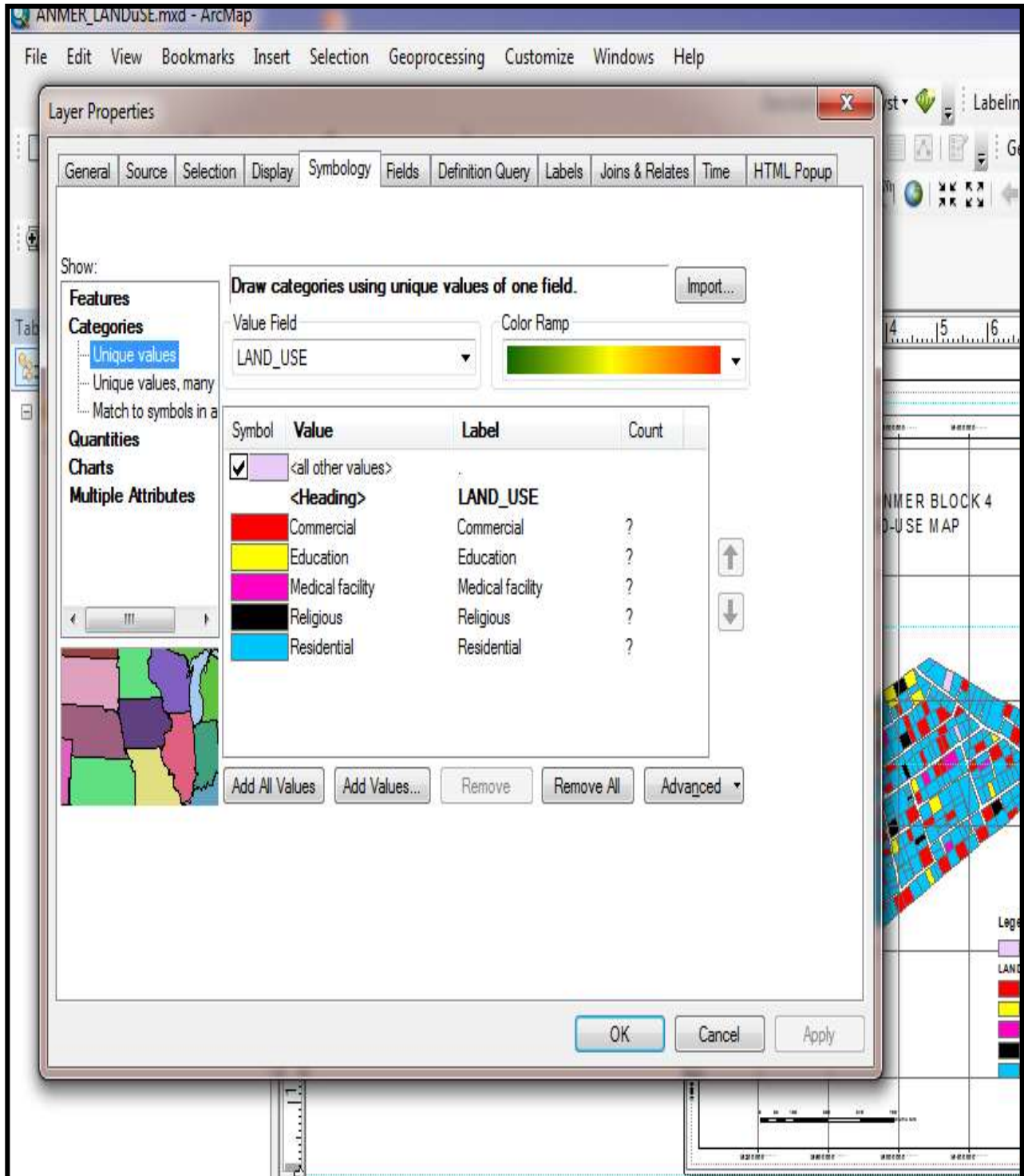Figure 4.3 Adding Symbology to the Map
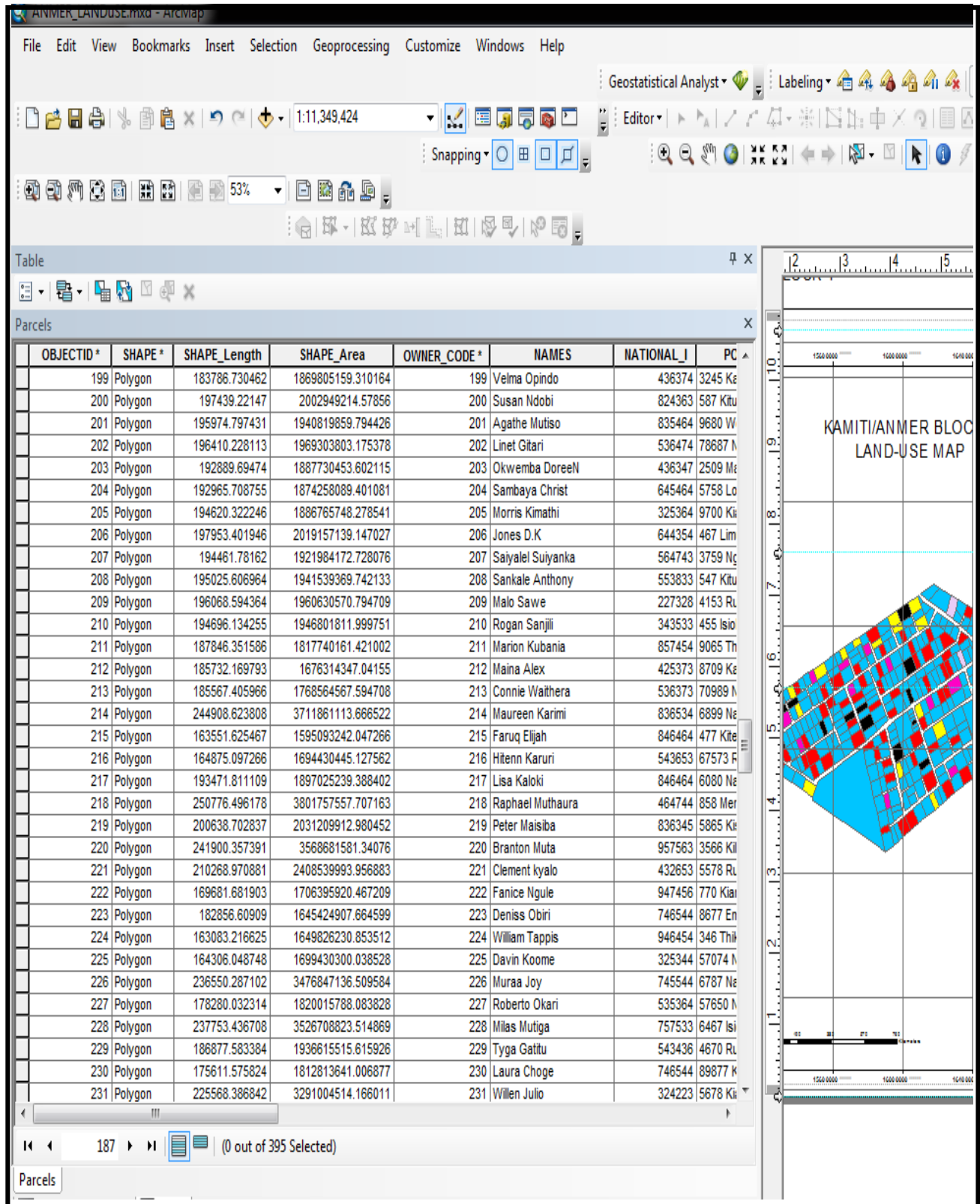
`

Figure 4.4 Attribute Table for Parcel Layer

OBJECTID *	SHAPE *	SHAPE_Length	SHAPE_Area	OWNER_CODE *	NAMES	NATIONAL_I	PC
199	Polygon	183786.730462	1869805159.310164	199	Velma Opindo	436374	3245 Ka
200	Polygon	197439.22147	2002949214.57856	200	Susan Ndobi	824363	587 Kitu
201	Polygon	195974.797431	1940819859.794426	201	Agathe Mutiso	835464	9680 W
202	Polygon	196410.228113	1969303803.175378	202	Linet Gitari	536474	78687 N
203	Polygon	192889.69474	1887730453.602115	203	Okwemba DoreeN	436347	2509 Ma
204	Polygon	192965.708755	1874258089.401081	204	Sambaya Christ	645464	5758 Lo
205	Polygon	194620.322246	1886765748.278541	205	Morris Kimathi	325364	9700 Ki
206	Polygon	197953.401946	2019157139.147027	206	Jones D.K	644354	467 Lim
207	Polygon	194461.78162	1921984172.728076	207	Saiyalel Suiyanka	564743	3759 Ng
208	Polygon	195025.606964	1941539369.742133	208	Sankale Anthony	553833	547 Kitu
209	Polygon	196068.594364	1960630570.794709	209	Malo Sawe	227328	4153 Ru
210	Polygon	194696.134255	1946801811.999751	210	Rogan Sanjili	343533	455 Isio
211	Polygon	187846.351586	1817740161.421002	211	Marion Kubania	857454	9065 Th
212	Polygon	185732.169793	1676314347.04155	212	Maina Alex	425373	8709 Ka
213	Polygon	185567.405966	1768564567.594708	213	Connie Waithera	536373	70989 N
214	Polygon	244908.623808	3711861113.666522	214	Maureen Karimi	836534	6899 Na
215	Polygon	163551.625467	1595093242.047266	215	Faruq Elijah	846464	477 Kite
216	Polygon	164875.097266	1694430445.127562	216	Hitenn Karuri	543653	67573 F
217	Polygon	193471.811109	1897025239.388402	217	Lisa Kaloki	846464	6080 Na
218	Polygon	250776.496178	3801757557.707163	218	Raphael Muthaura	464744	858 Mer
219	Polygon	200638.702837	2031209912.980452	219	Peter Maisiba	836345	5865 Ki
220	Polygon	241900.357391	3568681581.34076	220	Branton Muta	957563	3566 Kil
221	Polygon	210268.970881	2408539993.956883	221	Clement kyalo	432653	5578 Ru
222	Polygon	169681.681903	1706395920.467209	222	Fanice Ngule	947456	770 Kiar
223	Polygon	182856.60909	1645424907.664599	223	Deniss Obiri	746544	8677 En
224	Polygon	163083.216625	1649826230.853512	224	William Tappis	946454	346 Thik
225	Polygon	164306.048748	1699430300.038528	225	Davin Koome	325344	57074 N
226	Polygon	236550.287102	3476847136.509584	226	Muraa Joy	745544	6787 Na
227	Polygon	178280.032314	1820015788.083828	227	Roberto Okari	535364	57650 N
228	Polygon	237753.436708	3526708823.514869	228	Milas Mutiga	757533	6467 Isi
229	Polygon	186877.583384	1936615515.615926	229	Tyga Gatitu	543436	4670 Ru
230	Polygon	175611.575824	1812813641.006877	230	Laura Choge	746544	89877 K
231	Polygon	225568.386842	3291004514.166011	231	Willen Julio	324223	5678 Ki

Figure 4.5 MS Access Table of Relations

`

Figure 4.6 Cadastral map of Anmer Block4

KAMITI/ANMER BLOCK 4
CADASTRAL MAP

Coordinate System: World Cassini
Projection: Cassini
Datum: WGS 1984
False Easting: 0.0000
False Northing: 0.0000
Central Meridian: 0.0000
Scale Factor: 1.0000
Latitude Of Origin: 0.0000
Units: Meter

0   100 200   400   600   800 Meters

Legend

Parcels

Parcels

`
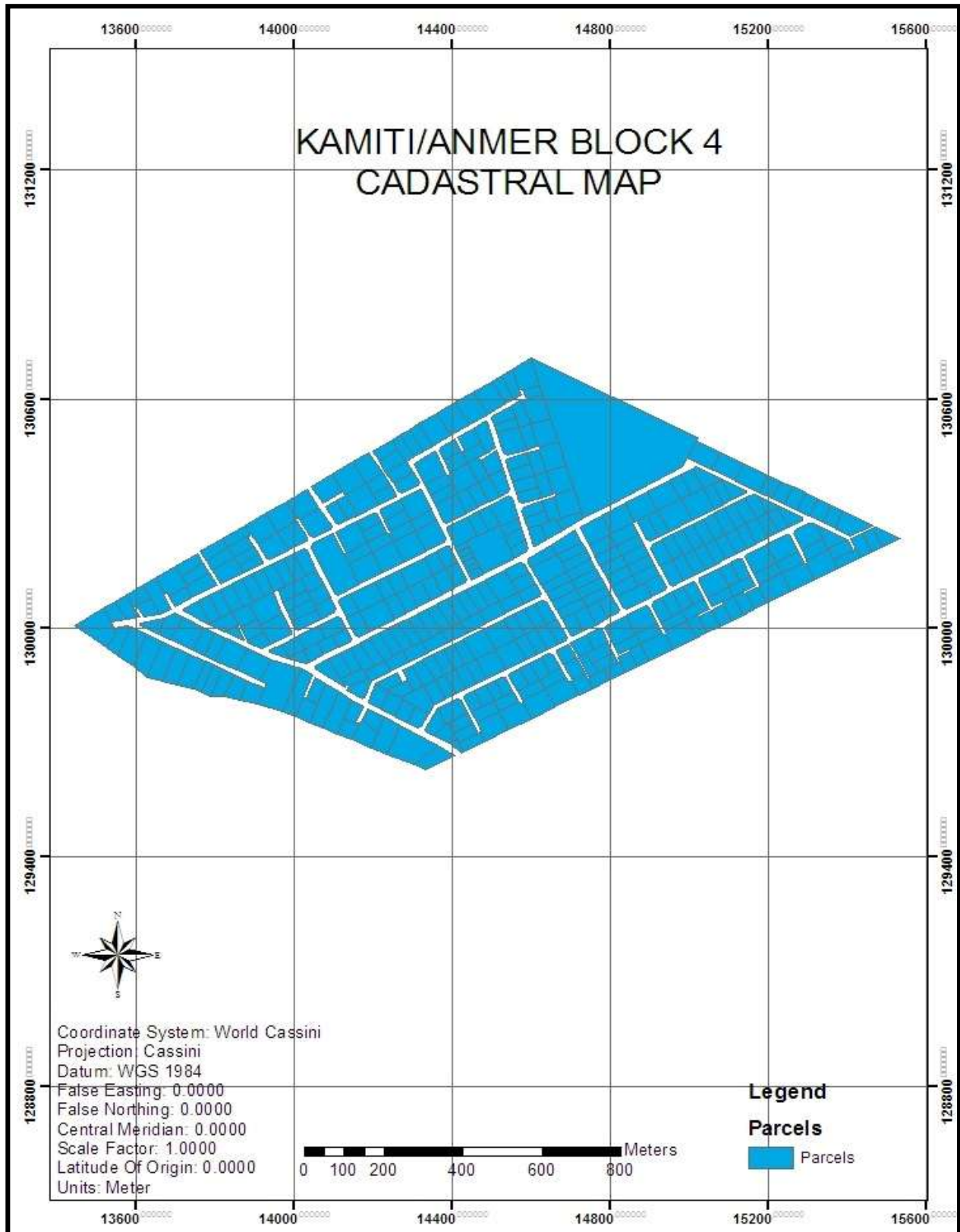
Figure 4.7 land use pattern in Anmer block 4 estate

LAND USE PATTERN IN KAMITI/ANMER BLOCK 4

Legend:
- ☐ Residential
- ■ Commercial
- ☐ Education
- ☐ Religious
- ■ Medical facility

Chart labels: 4%, 4%, 5%, 17%, 70%

`
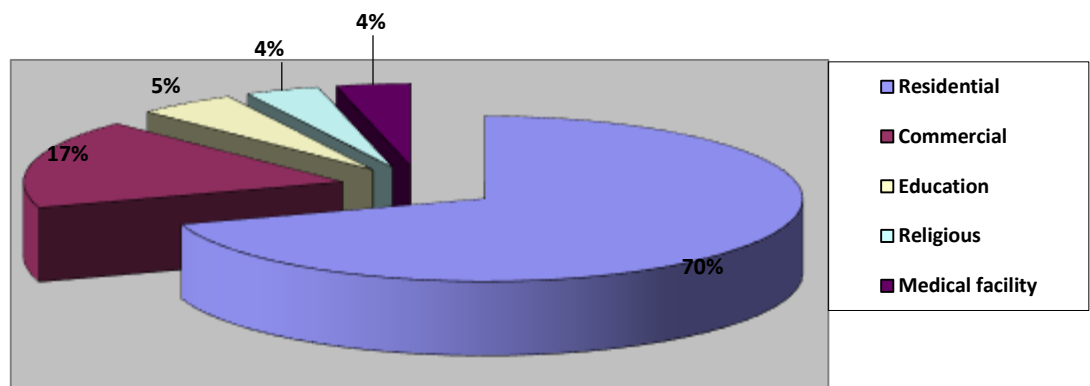
Figure 4.8 land use map of Kamiti/Anmer block 4
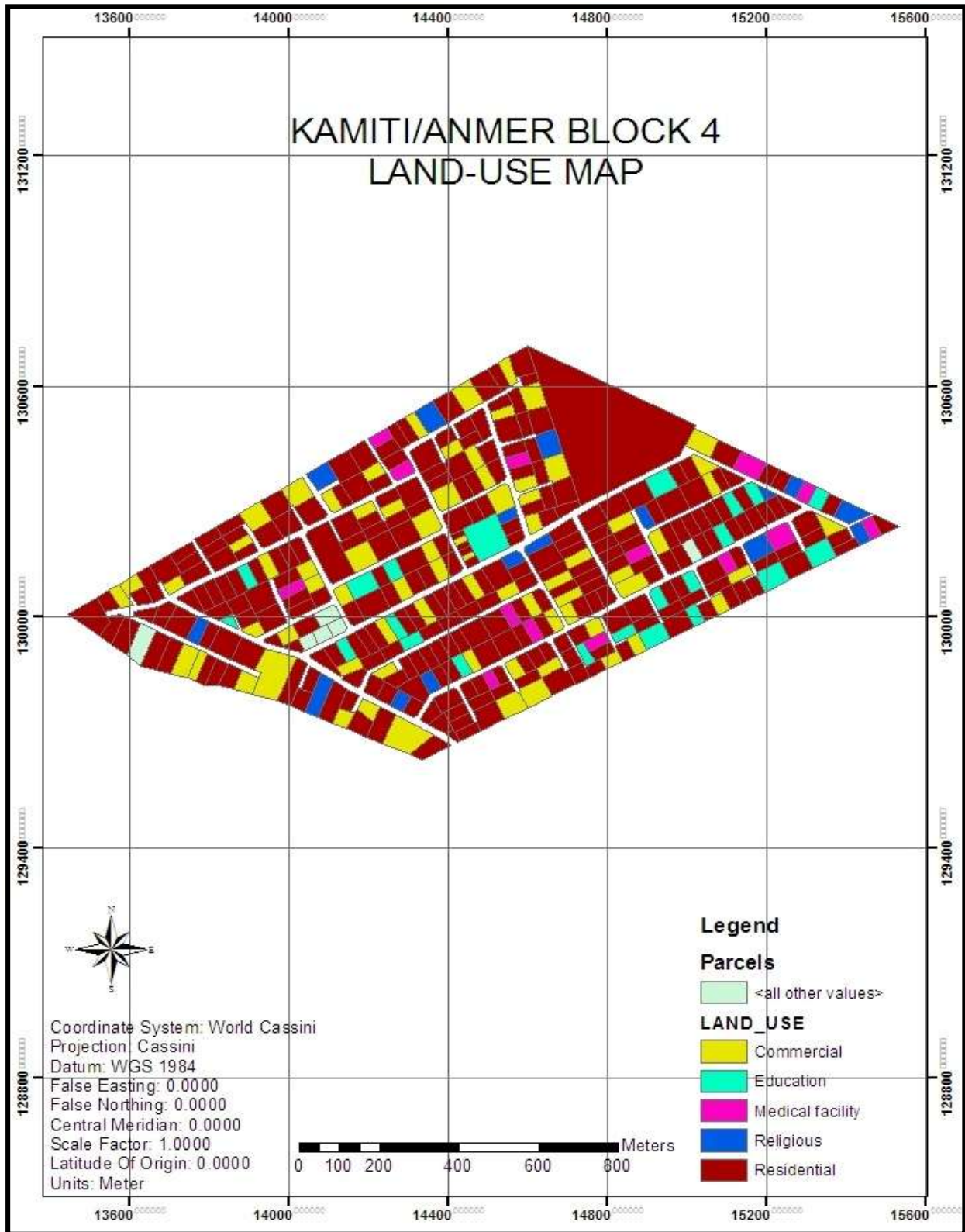
Figure 4.9 Road and cadastral map overlay

KAMITI/ANMER BLOCK 4 PARCELS
AND ROADS CADASTRAL MAP

Coordinate System: World Cassini
Projection: Cassini
Datum: WGS 1984
False Easting: 0.0000
False Northing: 0.0000
Central Meridian: 0.0000
Scale Factor: 1.0000
Latitude Of Origin: 0.0000
Units: Meter

Legend
—— Road
Parcels

Meters
0   100 200   400   600   800

`
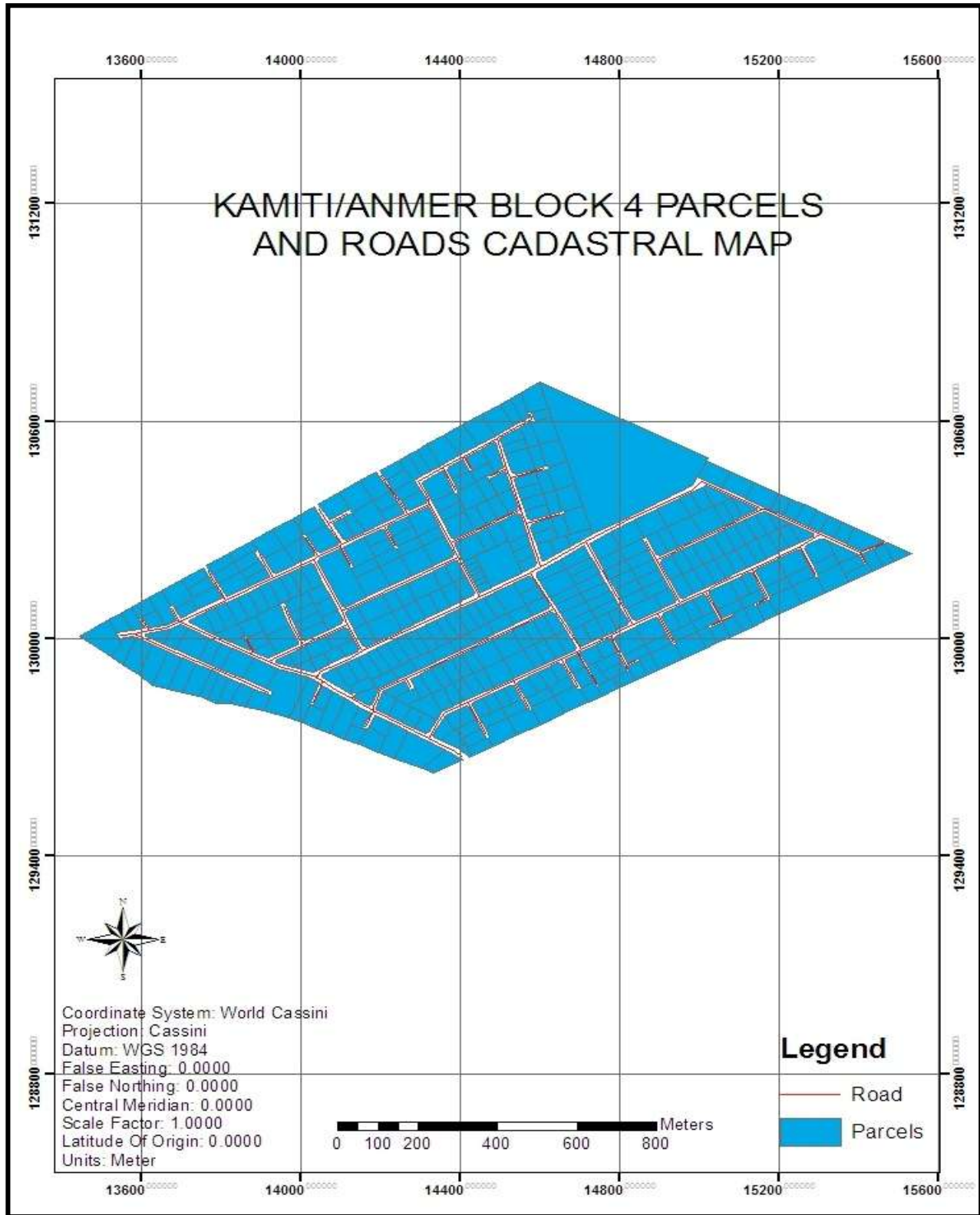
4.2 Data retrieval from LIS database

With the created LIS database, a lot of queries can be done depending on the kind of information one requires. For this project, a selected few queries were conducted as demonstrated below:

4.2.1 Querying parcels within a range of values

To show parcels whose value range between Ksh 6.5 to Ksh 7.0 million, the following query was used
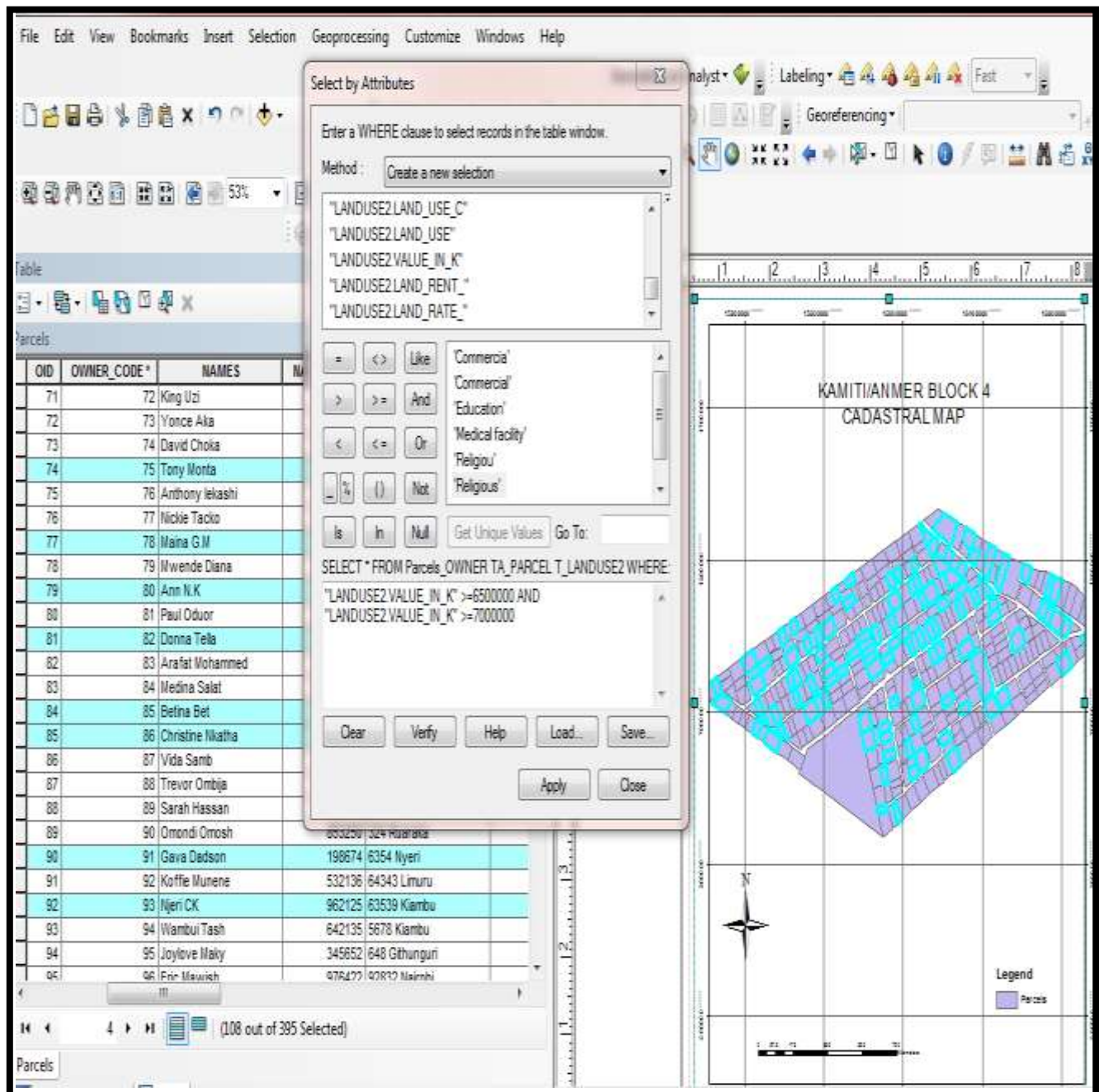
SELECT: LANDUSE2.VALUE_IN_K

FROM: Parcels

WHERE: " LANDUSE2.VALUE_IN_K >= 6500000 AND "LANDUSE2.VALUE_IN_K" <= 7000000

Figure 5.0 displays all the parcels valued between 6.5 to 7.0 million. Such results can be used by investors who would want parcels valued at their preferred range.

`

Figure 5.0 Query showing value of all parcels between Ksh 6.5 to Ksh 7.0 million

4.2.2 Querying about a specific parcel number

To demonstrate, a query for parcel number 9364 was written as follows
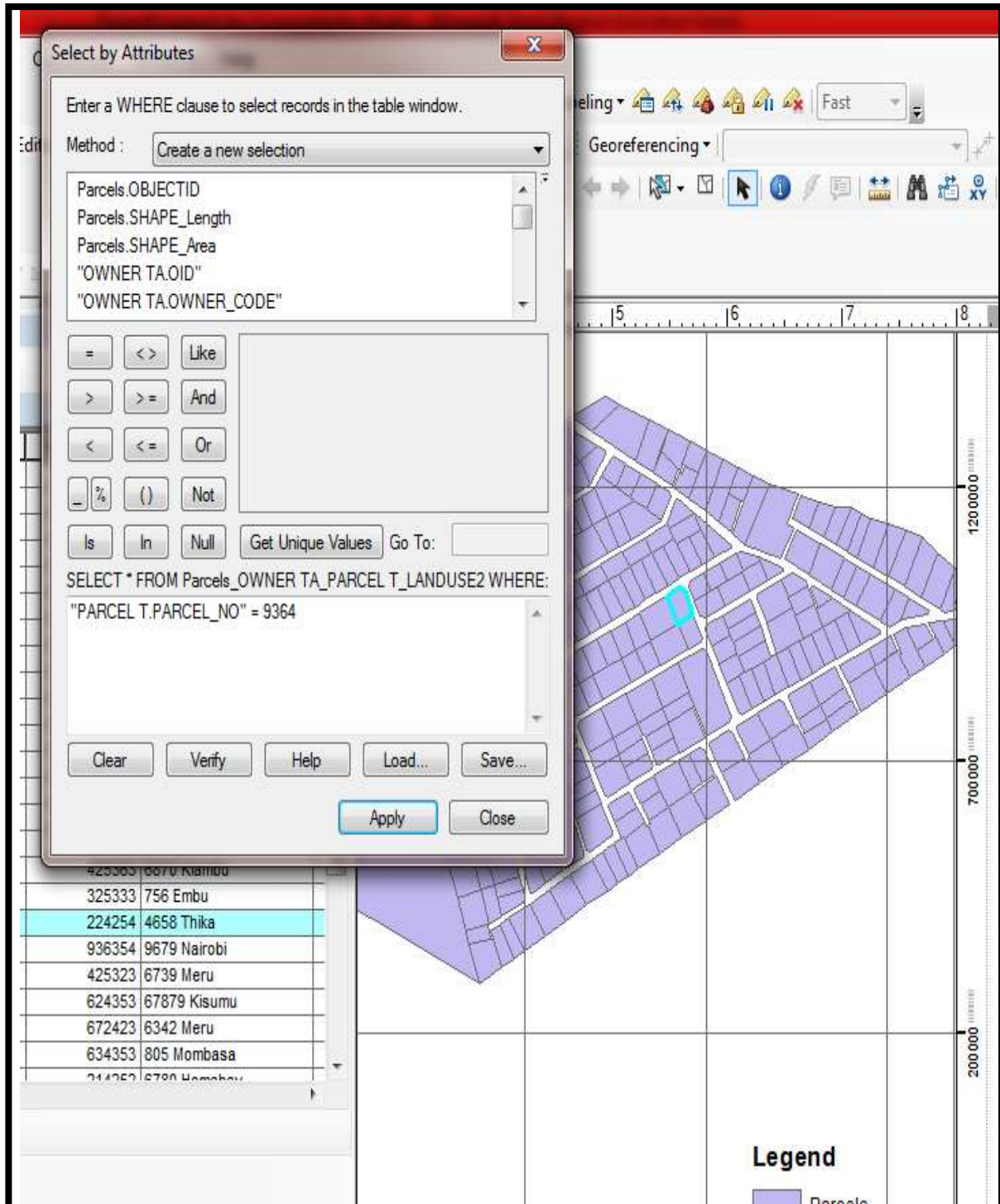
SELECT: PARCEL T.PARCEL_NO

FROM: parcels

WHERE: "PARCEL T.PARCEL_NO" = 9364

`

The results of the above query are shown in figure 5.1

Figure 5.1 show a query for parcel number 9364

`

4.2.3 Querying parcels of particular values and land use

To demonstrate how to query the value of parcels between say 6.5 to 7.0 million that are only residential, the following query was used. The query was written as follows

SELECT: LANDUSE2.LAND_USE

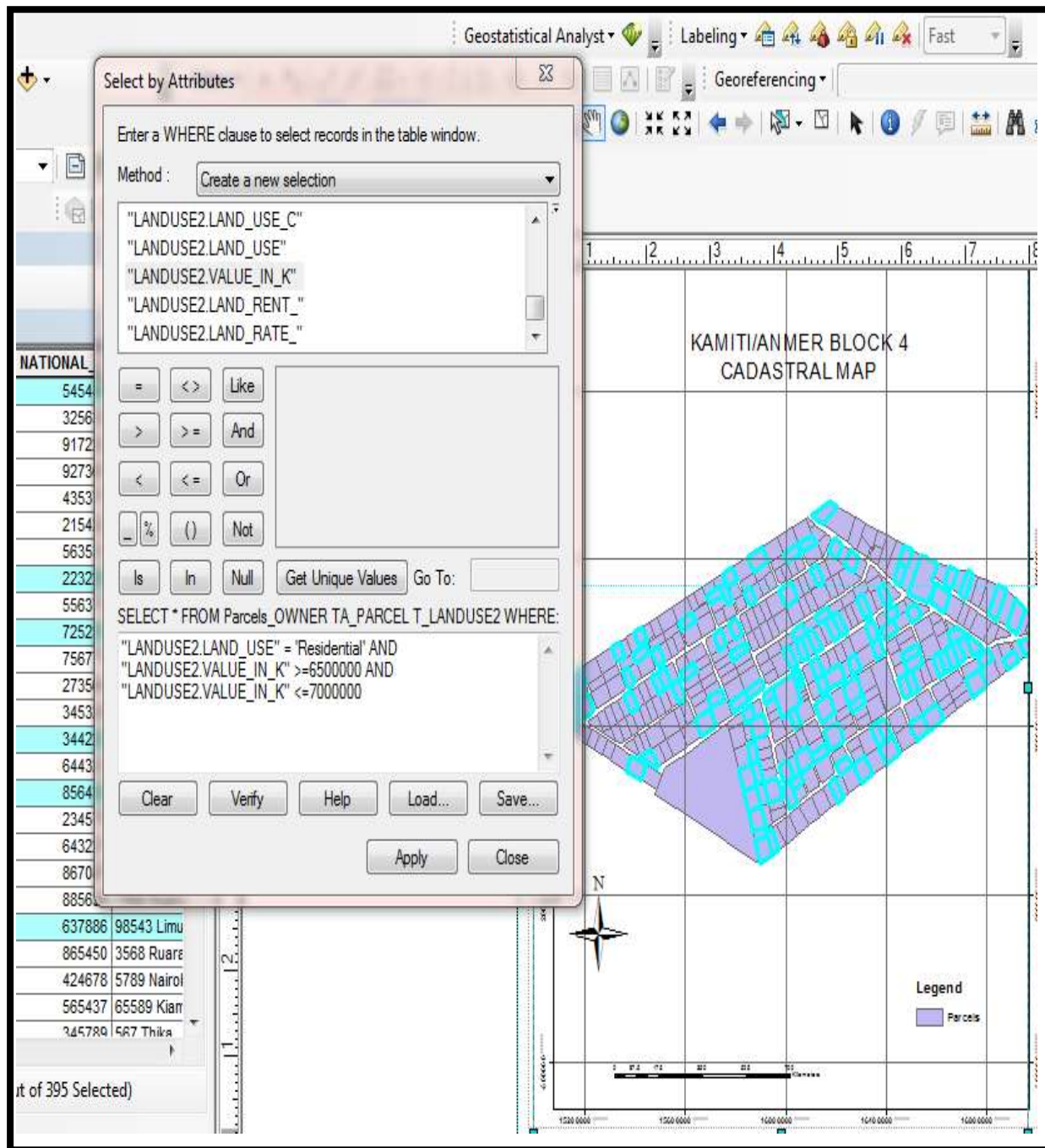**FROM:** Parcel**s**

WHERE: "LANDUSE2.LAND_USE" = 'Residential'

SELECT: LANDUSE2.VALUE_IN_K

FROM: Parcels

WHERE: "LANDUSE2.VALUE_IN_K >= 6500000 AND "LANDUSE2.VALUE_IN_K" <= 7000000

The result of the above query is shown in Figure 5.2 Such information can be used by real Estate developers and planners.

`

Figure 5.2 query showing residential parcels from 6.5 to 7.0 million values in Ksh

4.2.4 Querying commercial parcels for land rent

To demonstrate, the following query for Land rent from Ksh 50000 to 60000 was used

SELECT: LANDUSE2.LAND_USE

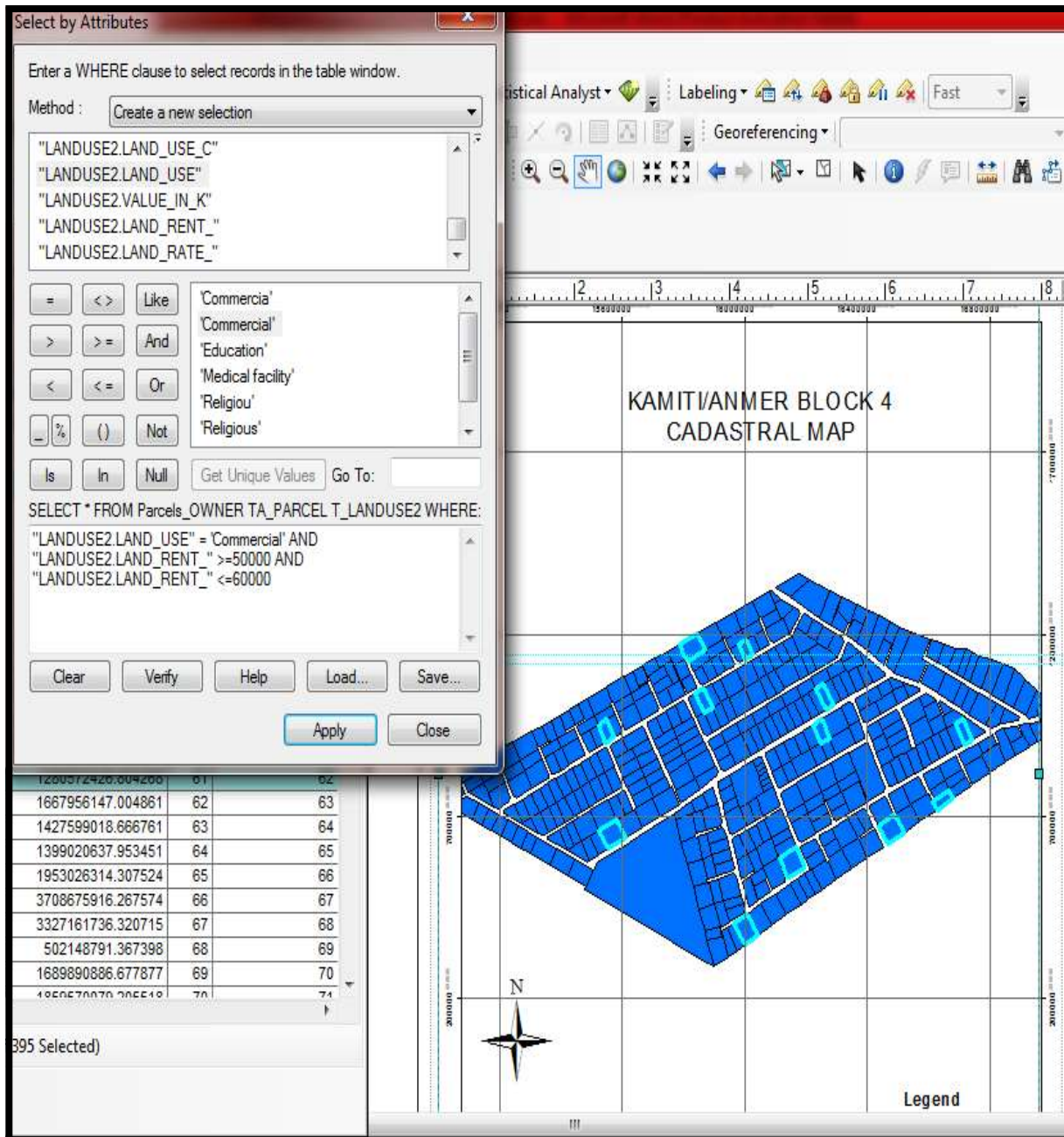**FROM:** parcels

WHERE:"LANDUSE2.LAND_USE"='Commercial'

`

SELECT: LANDUSE2.LAND_RENT_

FROM: parcels

WHERE: "LANDUSE2.LAND_RENT_" >= 50000 AND "LANDUSE2.LAND_RENT_" <= 60000

Figure 5.3 shows the result of the above query. Such information can be used by investors used to rent

Figure 5.3 query showing commercial parcels with rent between Ksh50000 and Ksh. 60000

`

4.2.5 Use of Identifier tool

Another simple and faster way of information retrieval is by use of identifier tool. This function provides a quick way of retrieving information on single plot at a time. The identifier tool was used to show all the information on a particular plot. As illustrated in Figure 5.4, all the information on Parcel code 278 is shown.

Figure 5.4 Information retrieval by identifier tool
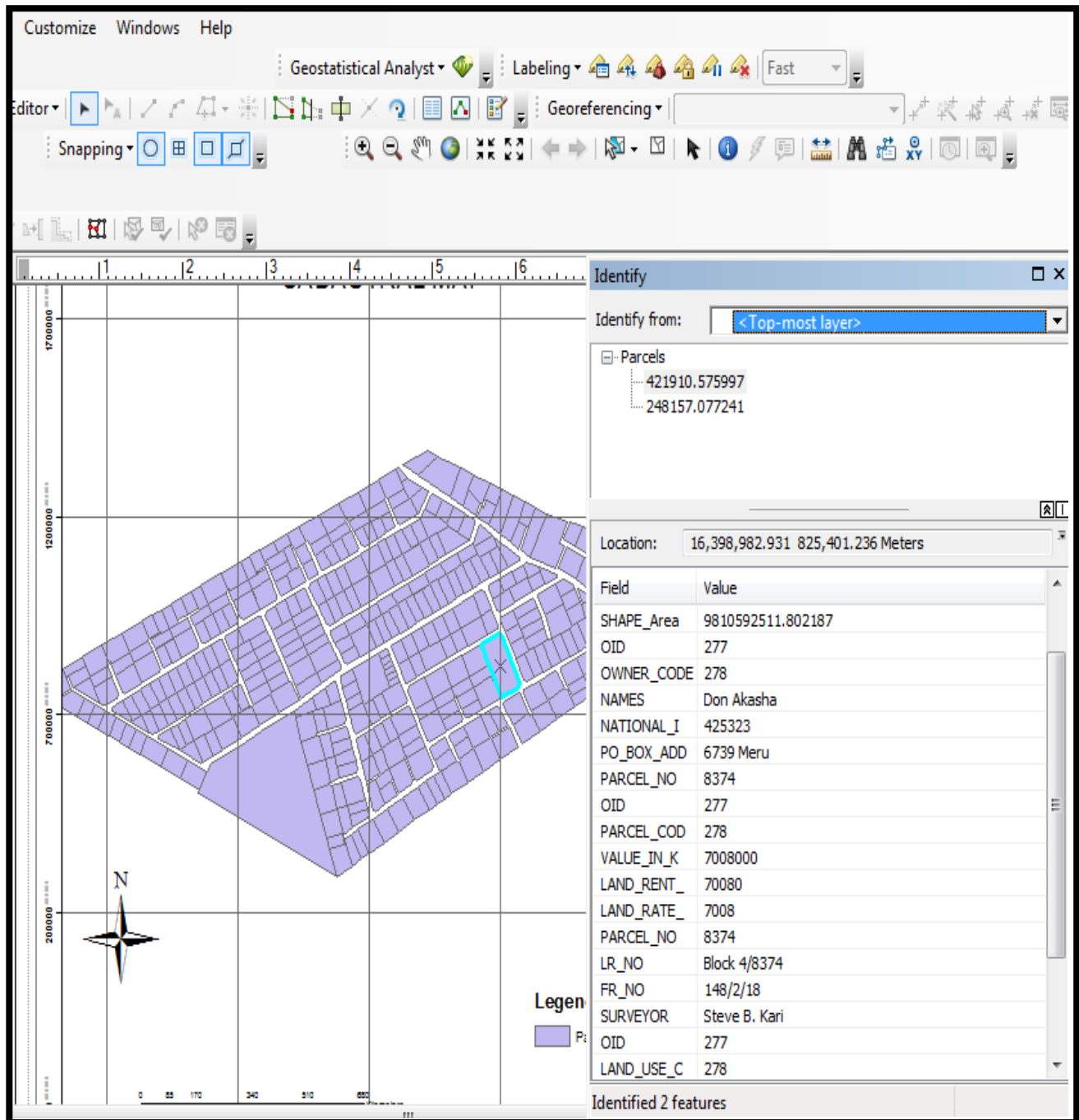
4.2.6 Querying for school parcels a surveyor surveyed

To demonstrate, the following query was followed;

SELECT: LANDUSE2.LAND_USE

FROM: parcels

WHERE: "LANDUSE2.LAND_USE" = 'Education'

SELECT: PARCEL T.SURVEYOR
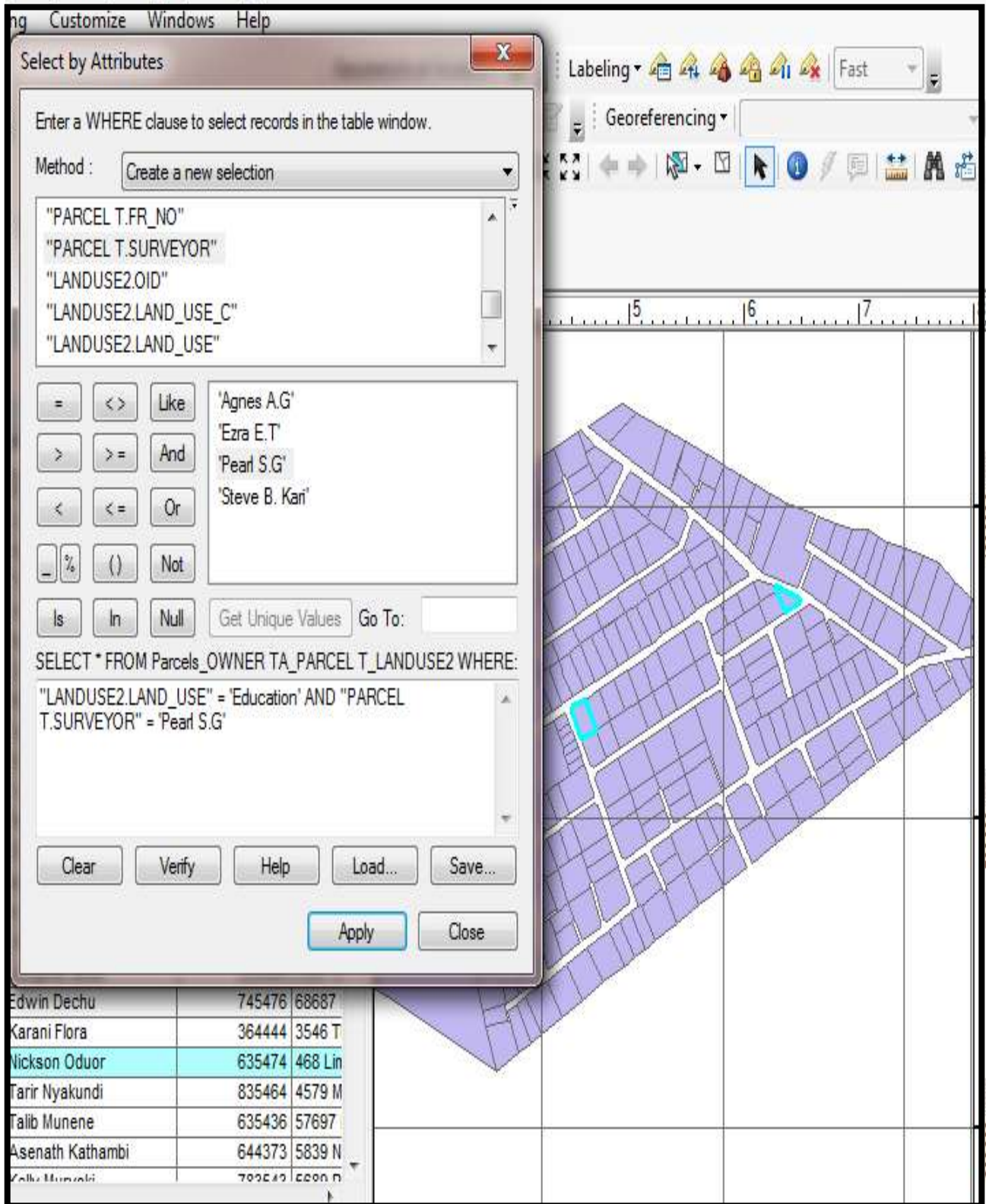
FROM: parcel

WHERE: "PARCEL T.SURVEYOR" = 'Pearl S.G'

The results of the query are shown in the Figure 5.5

`

Figure 5.5 Query for Education parcels surveyed by Pearl S.G

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4.3 Discussion of results

Various results were obtained and illustrated in the project as shown in the previous sections. Maps and a register containing selected land information were developed in the LIS. A number of queries were performed on the database to validate its use. With few queries and some analysis, one is able to highlight surveys conducted by individual surveyors, see current owners of specified parcels and also see the value rate and rent for specified parcels. This makes it easier and faster to acquire data by investors, land owners and government officials,

Two maps were produced from this study, the land use map and the cadastral parcel map of the study area.

The land use map was presented by use of symbolization, and more specifically by use of different color patterns. Various land use patterns were identified in the study area. This included residential, commercial, education and medical facilities. The detailed land uses have been captured in the database and has shown land use as is common in planning practice.

In future there might be changes on the land use of the parcel, change of owner, change of owner address, and others. There might be also subdivision of a parcel which therefore requires an update. Updating this information has been made easy with the data base created.

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CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The design of the prototype Land Information System database of Kamiti/Anmer block 4 estate was achieved. The identification and collection of the required data and analysis was done. Depending on the requirement analysis, the implementation was done in Microsoft Access for the attribute data and in ArcGIS for spatial data. The Land Information System database was validated by running some test queries. The entry of data in the designed database in Microsoft Access for the attribute data was done. In ArcGIS, the raster data was geo-referenced and on-screen digitization was done in order to come up with spatial data. Attribute table for parcel, ownership and land use layer in ArcGIS was attributed and later linked to the Microsoft Access tables to form the LIS database. A register containing information that included land ownership, valuation, land use, land rate and land rent was developed for every parcel and integrated with spatial information for the respective parcels in the ArcGIS environment.

The LIS has created a lasting link between office and land data and can expedite fast and easier retrieval of information. Geographic information systems have proved to possess capable tools for creating geographic databases which no other software can outperform.

Money lost annually due to the inefficient manual record keeping practices can significantly be reduced due to faster information retrieval by LIS. The designed system can be utilized to preserve land records and hence further aid in land information management. It is also easy to update any changes on the land.

Land information system was verified by executing a few queries from the study various queries in the database are possible and decision making process is efficient as compared to the other analogue process. It will also reduce duplication and increase availability of data among departments, improve the quality and reduce costs related to land data and help in decision making.

5.2 Recommendations

To ensure the full potential of this prototype LIS, the research led to the following recommendations:

a) Users should have basic training on the use of ArcGIS Software to be able to operate, maintain and discover database.

b) The project should be extended to cover the whole of Kiambu County and later to the other counties in Kenya to be used to digitize and manage large datasets. Since land information is bulky which leads to a lot of time wasting during information retrieval and updating, LIS can provide a permanent solution when it comes to information storage and dissemination

c) The LIS should be networked to all the counties to enhance data sharing and redundancy reduction. Same data collected by different counties leads to duplication and consequently large amounts of data.

d) The research should be enhanced to allow for tracking of land rent and rate defaulters. Land rate and rent are the single most important source of revenue for local authorities.

e) Since it will not be easy to alter the information in the database. Corrupt practices such as alteration of documents or document disappearance can be reduced.

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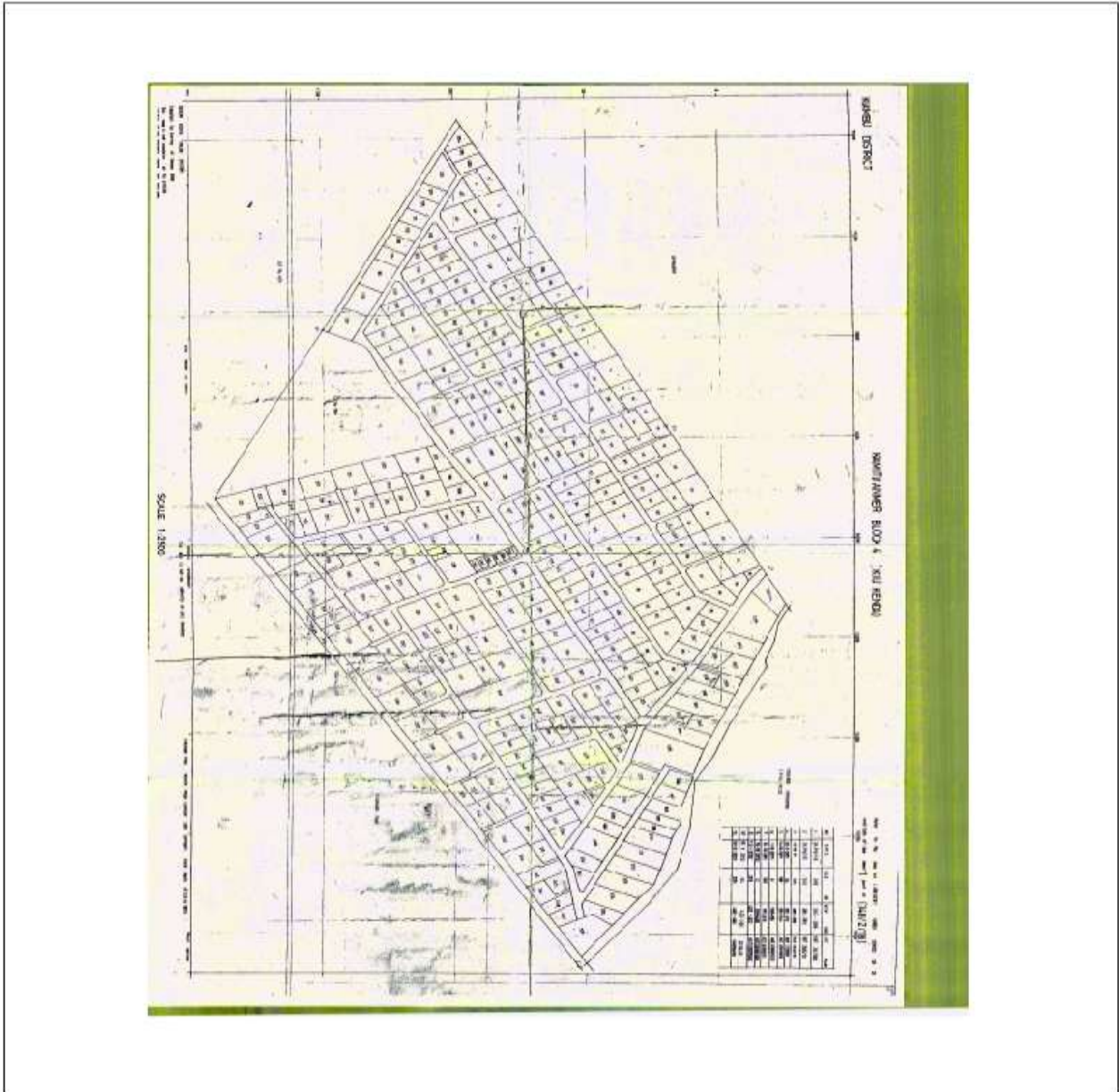
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Appendix 1: Sample of scanned RIM plan

Source: Survey of Kenya

Appendix 1: Ownership Data in MS access

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Land Use co⤷	Value in Ksh	Land Rent (F ⤷	Land Rate (P ⤷	Land use ⤷	Cl⤷
376	$6,908,000.00	$69,080.00	$6,908.00	Residential	
377	$6,945,800.00	$69,458.00	$6,945.00	Residential	
378	$5,608,080.00	$56,080.00	$5,608.00	Residential	
379	$6,070,700.00	$60,707.00	$6,070.00	Residential	
380	$6,908,900.00	$69,089.00	$6,908.00	Education	
381	$6,908,950.00	$69,089.00	$6,908.00	Residential	
382	$7,000,500.00	$70,005.00	$7,000.00	Commercial	
383	$6,905,050.00	$69,050.00	$6,905.00	Residential	
384	$5,907,070.00	$59,070.00	$5,907.00	Residential	
385	$5,995,000.00	$59,950.00	$5,995.00	Residential	
386	$6,120,280.00	$61,202.00	$6,120.00	Commercial	
387	$6,383,000.00	$63,830.00	$6,383.00	Residential	
388	$6,494,000.00	$64,940.00	$6,494.00	Medical facility	
389	$6,685,050.00	$66,850.00	$6,685.00	Residential	
390	$6,569,600.00	$65,696.00	$6,569.00	Residential	
391	$6,856,060.00	$68,560.00	$6,856.00	Commercial	
392	$7,001,020.00	$70,010.00	$7,001.00	Residential	
393	$6,000,110.00	$60,001.00	$6,000.00	Residential	
394	$7,007,000.00	$70,070.00	$7,007.00	Residential	
395	$5,909,090.00	$59,090.00	$5,909.00	Education	
396	$6,600,900.00	$66,009.00	$6,600.00	Residential	
397	$7,001,090.00	$70,010.00	$7,001.00	Commercial	
398	$6,700,050.00	$67,000.00	$6,700.00	Residential	
399	$6,007,000.00	$60,070.00	$6,007.00	Residential	
400	$6,700,400.00	$67,004.00	$6,700.00	Residential	
401	$5,900,900.00	$59,009.00	$5,900.00	Commercial	
402	$6,008,000.00	$60,080.00	$6,008.00	Residential	

Appendix 3: Land Use Data in MS access

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Parcel Code	Parcel No	Value in Ksh	Land Rent (F	Land Rate (P	FR No		Surveyor	LR No
376	280	$6,908,000.00	$69,080.00	$6,908.00	148/2/18		Ezra E.T	Block 4/280
377	839	$6,945,800.00	$69,458.00	$6,945.00	148/2/18		Ezra E.T	Block 4/839
378	3044	$5,608,080.00	$56,080.00	$5,608.00	148/2/18		Ezra E.T	Block 4/3044
379	478	$6,070,700.00	$60,707.00	$6,070.00	148/2/18		Ezra E.T	Block 4/478
380	7376	$6,908,900.00	$69,089.00	$6,908.00	148/2/18		Ezra E.T	Block 4/7376
381	5754	$6,908,950.00	$69,089.00	$6,908.00	148/2/18		Ezra E.T	Block 4/5754
382	4640	$7,000,500.00	$70,005.00	$7,000.00	148/2/18		Pearl S.G	Block 4/4640
383	7644	$6,905,050.00	$69,050.00	$6,905.00	148/2/18		Pearl S.G	Block 4/7644
384	3242	$5,907,070.00	$59,070.00	$5,907.00	148/2/18		Pearl S.G	Block 4/3242
385	1322	$5,995,000.00	$59,950.00	$5,995.00	148/2/18		Pearl S.G	Block 4/1322
386	5223	$6,120,280.00	$61,202.00	$6,120.00	148/2/18		Pearl S.G	Block 4/5223
387	3833	$6,383,000.00	$63,830.00	$6,383.00	148/2/18		Pearl S.G	Block 4/3833
388	8363	$6,494,000.00	$64,940.00	$6,494.00	148/2/18		Pearl S.G	Block 4/8363
389	987	$6,685,050.00	$66,850.00	$6,685.00	148/2/18		Pearl S.G	Block 4/987
390	909	$6,569,600.00	$65,696.00	$6,569.00	148/2/18		Pearl S.G	Block 4/909
391	212	$6,856,060.00	$68,560.00	$6,856.00	148/2/18		Pearl S.G	Block 4/212
392	2130	$7,001,020.00	$70,010.00	$7,001.00	148/2/18		Pearl S.G	Block 4/2130
393	312	$6,000,110.00	$60,001.00	$6,000.00	148/2/18		Pearl S.G	Block 4/312
394	423	$7,007,000.00	$70,070.00	$7,007.00	148/2/18		Pearl S.G	Block 4/423
395	4241	$5,909,090.00	$59,090.00	$5,909.00	148/2/18		Pearl S.G	Block 4/4241
396	2142	$6,600,900.00	$66,009.00	$6,600.00	148/2/18		Pearl S.G	Block 4/2142
397	221	$7,001,090.00	$70,010.00	$7,001.00	148/2/18		Pearl S.G	Block 4/221
398	253	$6,700,050.00	$67,000.00	$6,700.00	148/2/18		Ezra E.T	Block 4/253
399	3018	$6,007,000.00	$60,070.00	$6,007.00	148/2/18		Ezra E.T	Block 4/3018
400	2901	$6,700,400.00	$67,004.00	$6,700.00	148/2/18		Ezra E.T	Block 4/2901
401	1443	$5,900,900.00	$59,009.00	$5,900.00	148/2/18		Ezra E.T	Block 4/1443
402	2982	$6,008,000.00	$60,080.00	$6,008.00	148/2/18		Ezra E.T	Block 4/2982

Record: 1 of 407   No Filter   Search

Appendix 4: Parcel Data in MS access

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