University of Nairobi

School of Engineering

Development of GIS-based Tax Information System for Local Government.

CASE STUDY: CENTRAL BUSINESS DISTRICT.

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A Project submitted in partial fulfillment for the Degree of Master of Science in Geographical Information Systems, in the Department of Geospatial and Space Technology of the

University of Nairobi

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Declaration

I, Carol Kemboi, 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.

Caroline Jepkemboi Cheplong. 15/5/2013

…… ……

Name of student Date

This project has been submitted for examination with our approval as university supervisor(s).

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Name of supervisor Date

Dr D. Nyika

…… ……

Name of supervisor Date

Dedication

I dedicate this project to my family for the support they gave me during not only the period of doing this project but also during my entire academic journey. May the Almighty God bless them abundantly.

Acknowledgement

I thank God because of His guidance and strength, without which this would not have been possible.

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List of Abbreviations

DBMs Database Management Systems

GDP Gross Domestic Product

GIS Geographical Information Systems

JPEG Joint Photographic Expert Group.

NCBD Nairobi Central Business District

MS Microsoft

SQL Structured Query Language

TIFF Tagged Interface File Format.

UTM Universal Transverse Mercator

ESRI Environmental Social Research Institute.

Abstract

Property tax is one of the most important sources of income for the Nairobi County Council and accounts for nearly one third of its annual revenues. This source of revenue is the least tapped and supports urban governments in Africa. Rates are essentially a local tax paid by occupiers of land and buildings as a contribution towards local services. In Kenya, discussions on property taxation are becoming increasingly important within the various authorities as more responsibilities are devolved to county governments.

As Nairobi City is expanding rapidly, new structures are coming up along all the transportation corridors. Since rates are payable on immovable property it is impossible to avoid paying them and therefore local authorities have a stable form of income. So it is imperative to assess all these existing unimproved sites and maintain an effective database for easy collection of property taxes.

As far as Nairobi city is concerned, the property tax details are maintained manually and involves a lot of human interaction. The officials are not able to collect the property tax efficiently and hence they fall short of the budget estimate.. So if the tax details are maintained electronically (spatial details incorporated),many studies have indicated that the *efficiency of tax collection can be improved* and a higher degree of transparency achieved. Meaningful development activities can be taken up only by proper realization of property taxes.

The aim of the project is to develop a GIS based Tax Information System enabling spatial query, visualization, efficient updating and processing of property tax records. The spatial dimensions of the all structures can effectively be maintained in a GIS (Geographical Information System) environment. The Information system developed incorporates all the spatial and non-spatial details regarding the built up structures for effective maintenance, collection and updating of property tax information. The system entails the digitization of all maps with the inclusion of necessary information on every piece of land and the possibility of linkages with other offices.

This system will be used as an aid for inspection, *verification of owners for location of properties, generation of vicinity maps, identification of over-lapped properties* and to identify duplicate assessment of real properties and land rates defaulters.

During the study, various analysis were undertaken to verify the functionality of the database and the tasks it can perform in relation to various commands and queries (SQL) performed. To determine this, data analysis through selection by both attribute and location were performed. When queried the database through selection by attribute, rates defaulters, non defaulters and public lands (unrateable lands) could be highlighted graphically.

In conclusion, it can be evidently and confidently be conclude, that the objectives of the project were achieved. This research study looks how Geographical Information System (GIS) can be adopted by local authorities as an effective tool for managing, organizing and analyzing spatially related data. A large percentage of decisions made by Local Authorities are spatial based in nature. Local Authorities can benefit from the existence of a GIS to aid in decision making during the preparation of development plans such as structure plans, local plans, and layout plans.

CHAPTER 1: INTRODUCTION.

1.1 Background of the study.

The Kenyan Local Authorities are corporate entities that are established under the Local Government Act (Chapter 265), which is currently under review. In addition to the Act, the Local Authorities draw their legal powers from the Constitution of Kenya, other Acts of Parliament, Ministerial Orders and By-Laws. Local Authorities in Kenya are charged with the provision and management of infrastructure and services in their respective jurisdictions.

Local government authorities are mandated by two Acts of parliament for the purpose of valuation and rating of properties, the Valuation for Rating Act (Cap 266) and the Rating Act (Cap 267) Laws of Kenya. Valuation for Rating Act (Cap 266) empowers local government authorities to value land for rating purposes, while Rating Act (Cap 267) provides for the imposition of rates on land.

These taxes according to the City Council of Nairobi include the following: property rates. single business permit, parking fees, bill board charges, rents for city council owned houses, plans and inspection fees, market fees, city mortuary charges, tenant purchase schemes, hire of halls(social halls) hire of school facilities, sundry debtors etc.

In Kenya, real property taxes are recognized as the most important locally generated revenue source and contribute substantially to the locally generated income. Property taxes provide an average of 20% of the total recurrent revenue for local authorities and represent 1% of total government revenue and at least 0.23% of the Gross Domestic Product according to (Kelly, 2001).Property taxes are the major source of revenue that allows local governments to provide community services such as fire and police protection.

Land rates accrue from land as a result of land valuation by either the government or any Licensed Registered Land Valuer. Land rate is charged by local government authorities for the services rendered. Such services are provision of accessibility, provision of mobility, provision of education facilities, provision of security, provision of fresh and clean water, provision of street light, provision of sewerage facilities, etc. This mandate of service provision is vested on local government authorities by the Local Authority Act (Cap 265) Laws of Kenya.

Geospatial Information System (GIS) has proved application in many fields in human life i.e. medicine, social science, science and engineering. But a good number of sectors and like many local government authority have not fully embraced the use of this technology in Kenya. Nearly all the information needed to operate Local Authorities is geo-referenced e.g. zoning properties, roads, schools, parks, utilities.

Tax mapping is a method of identifying real property units, establishing property boundaries, determining actual use and discovering undeclared properties. Real property generally encompasses land, land improvements resulting from human efforts including buildings and machinery sited on land and various property rights over the preceding.

Tax mapping operations aims:

- To establish a complete inventory of all real property in an area.
- To provide a permanent link between real property and office record.
- To identify the ownership and location of every piece of land.

Tax mapping also provides opportunities to account for total land area of the municipality. It provides a way for the discovery and listing of unaccounted land parcel. Tax maps maintained as part of a GIS are more easily updated, organized, and shared across departments in a local government.

GIS is a very important tool that enhance implementation of policies in a more efficient and effective manner and has many applications to Local Authorities.

1.2 Problem Statement.

Most Local Authorities face a number of challenges in realizing their mandate. The challenges include: delivery of infrastructure and services, financial management, institutional and legal framework, human resource capacity and managing rapid growth (Republic of Kenya, 2004). Some of these challenges they have faced and still do are:

- Poor record keeping and management of information. Most Local Authorities rely on the old file based information storage and dissemination system which has got a lot of errors and omissions and pose major challenge while retrieving of information.
- Increasing land rates defaulters in many authorities in Kenya due to general poor revenue collection and information management.
- General poor provision and management of the services i.e. sustainable environment, health, water and sewerage, education facilities, social amenities, housing, road, town development plan, which highly relies on administration and revenue collection.
- Inadequate geospatial and non-geospatial data that are also not being updated as per ongoing land development (land subdivision). This is true as most of the authorities' information is geo-referenced, from infrastructure to utilities.

There is no visual link between the location of a property and its corresponding data, rendering all forms of visual analysis impossible. GIS application helps establish a complete inventory and identify ownership of every piece of real property.

These challenges have resulted in poor service provision and general management of Local Authorities activities. Many analysts have criticized the Local Authorities, and questioned their role in the newly formed devolved county governments (Republic of Kenya, 2004).

1.3 Objectives of the Study.

General Objective

The main objective of this study is to demonstrate the role of Geographic Information System (GIS), in creating Tax Information System for New Nairobi County Council.

Specific objectives

1. To investigate and identify the main type of taxes in the area of study.
2. To come up with a GIS Geo-database of the situation on the ground.
3. To identify the ownership of each piece of real property.
4. To enhance land rates collection by so highlighting the rates defaulters.
5. To generate maps situation on the ground with reference defaulter and rates areas

1.4 Justification of the study

The justifications of this research study are stipulated below;

- Land rate is the backbone of many Local Authorities and therefore calls for proper management. Property Rate is as wide since it includes residential, commercial and industrial properties within Local Authority jurisdiction.

- Local Authorities in Local Authority Act (Cap 265) are meant to be service providers and of course these services must be properly backed by a strong finance background, which is revenue generated i.e. from land rates and other sources. Poor service provision in Local Authority, that have left many asking the reasons for their formation, existence and why they should not be dissolved.

- Increasing number of land rates defaulters that have made some Local Authorities to be bankrupt and cannot provide the necessary services to the residence including other institutional obligations.

- It will enhance free flow of information to employees in the organization that will increase transparency and accountability. Information Communication Technology (ICT) is in high demand in Local Authorities and economic growth of our Nation.

The above limitation can be overcome by integrating the applications with geographical information systems (GIS).Appropriate technology i.e. GIS and ICT are cost effective, efficient, and accurate.

1.5 Scope and limitation

This research encompasses the Central Business District, plots and improved land (Buildings) details were used in the GIS system. The transport network was included to demonstrate the accessibility of the area of study.

Limitation

The limitation of the study included: Sourcing data from the County Council of Nairobi required very long time and strict bureaucracy; for confidential reasons not all information was acquired pertaining ownership of land.

CHAPTER 2: LITERATURE REVIEW

2.1 Land valuation

According to the , Valuation for Rating Act (Cap 266) ratable property includes land, except any land used or reserved for roads, streets (including private streets), car parks, squares, parks, gardens or other open or enclosed spaces vested in a local authority; public land , and community land.

Time for valuation is decided upon by Council resolution and valuation roll approved by the Minister before implementation by the local authority At least once in every five years or such longer period as the Minister may approve, every local government shall cause a valuation to be made of every ratable property within the area of the local authority in respect of which a rate on the value of land is, or is to be imposed, and the values to be entered in a valuation roll.

2.1.1 Draft valuation roll or draft supplementary valuation roll

During preparation of a draft valuation roll or draft supplementary valuation roll, the Valuer shall, on production of written authority signed by the Town Clerk, have power to enter at all reasonable hours by day into and inspect, any land within the area of the local authority in respect of which a rate on the value of land is, or is to be, imposed.

The Valuer shall also have power to inspect and make extracts from all registers, other records, any deeds or instrument belonging to, in the custody of or possession of any public officer or any person, in which are contained particulars of any land, whether that person is or is not interested in the land.

Every Valuer shall prepare draft valuation roll or draft supplementary valuation roll in such manner as to show to the best of his knowledge and opinion in respect of every ratable property included therein;

- The description, situation and area of the land valued
- The name and address of the ratable owner
- The value of the land
- The value of the unimproved land
- The assessment for improvement rate

2.1.2 Deposit of Draft Valuation and Supplementary Valuation Rolls

When the draft valuation roll or draft supplementary roll has been completed, the Valuer shall sign roll and insert therein the date of completion thereof, and shall transmit the roll to the Town Clerk who lays the roll before a meeting of the local authority. The roll shall thereafter be available at the office of the local authority for public inspection, and any person may, during ordinary business hours, inspect it and take copies or extracts from it.

The Town Clerk shall publish notice in respect of every draft valuation roll or draft supplementary valuation roll that it has been so laid and may be inspected, and such notice shall state the manner in which and the latest date by which objections to the same may be made. Every local authority shall, within twenty-one days after the laying before a meeting of the local authority of a draft valuation roll or draft supplementary valuation roll, send to every ratable owner of a ratable property comprised in the roll, a notice of the valuation thereof inserted in the roll, whether or not the new valuation make any change.

Any person (including the local authority or any person generally or specially authorized on behalf by the local authority) who is aggrieved;

- By the inclusion of any ratable property in or by the omission of any ratable property from any draft valuation roll or draft supplementary valuation roll. or
- By any value ascribed in any draft valuation or draft supplementary valuation roll to any ratable property, or by any other statement made or omitted to be made in the same with respect to any ratable property.

May lodge an objection with the Town Clerk at any time before the expiration of twenty- eight days from the date of publication of the notice referred to in section 9 (3) of Valuation for Rating Act (Cap 266).If, on the expiration of the period of twenty- eight days referred to in section 10 (1), no objections have been received, or if all objections duly received have been withdrawn before the day fixed for the first sitting of the valuation court, the town clerk shall endorse upon the draft valuation roll or draft supplementary valuation roll and sign a certificate to that effect (Valuation for Rating Act, 1984).

2.1.3 Properties Exempted from Valuation

No valuation for the purposes of any rate shall be made in respect of any land which is used, or, is bona fide intended to be used within a reasonable time, directly and exclusively for any of the following purposes;

- Public religious worship, Cemeteries, crematoria and burial or burning grounds, Hospitals or other institutions for the treatment of the sick,Educational institutions (including public schools with the meaning of Education Act)
- Charitable institutions, museums, art galleries ancient monuments (including Fort Jesus at Mombasa) and libraries
- National Parks and National Reserves within the meaning of the Wildlife (Conservation and Management) Act
- Outdoor sports , parks and open areas managed and controlled by the a local authority for the use of the public ,Botanical gardens and arboreta, All State House and all President's Lodges
- Aerodromes within the meaning of the Civil Aviation Act which are managed and controlled by the Government, excluding areas used by passenger reception or the handling or storage of goods, the offices of airline companies or agencies, immigration and customs offices and premises, restaurant, lounges, bars, shops, hangars, workshops, posts and telecommunications installations and stores, police stations, animal holding grounds, freight sheds and dumps
- Railway tracks, including tracks in sidings and marshalling yards and signal boxes, water towers and other such buildings or structures essential to the operation of the railway tracks, but excluding areas used for passenger or goods station, offices, workshops, servicing areas, sheds and depots
- wharves, piers, jetties, berths and navigational aids in a harbor within the meaning of Kenya Ports Authority Act, and the loading or unloading vessels and the storage of cargoes in transit at or adjacent to those wharves, piers, jetties, and berths, and any land below high-water mark in a harbor. Valuation for Rating Act Chapter 266. (Government of Kenya, 1984).

2.2 Land Rating.

In Kenya, the Rating Act allows local authorities to tax either land or land and improvements (e.g., buildings). Although the first application of "Rating" in Mombasa in 1921 was based on land and improvements (i.e., the annual rental value of occupied premises), all property Rates in Kenya are currently levied only on land but improvements (e.g., buildings and structures) are not taxed.

Rating has been described as the assessment of property tax payable by applying a monetary charge in the form of a rate to the value or values appearing in a Valuation Roll. Rating systems differ depending on whether the rate is applied on land only or on land and improvements. The Government of Kenya, *The Rating Act (Cap 267),* 1972 and *the Valuation for Rating Act (Cap 268),* 1972 provides for three types of rates***:*** **area rate** *based on the size and use of the land*; **unimproved site value rate** *based upon the capital value of the bare land and the site value;* and **improvement rate** *which is based on the land and improvements separately*.

The Rating Act, 1972, provides extreme flexibility in defining the tax base. Rating authorities may use an area rating, an agricultural rental value rate, a site value rate or a site value rate in combination with an improvement rate. For area rating, *The Rating Act* (Section 5) again provides flexibility to use one of five different options, including the use of a flat rate or a graduated rate upon the area of land, differentiated flat or graduated rates according to land use or any other method of rating upon land or buildings that the rating authority may resolve (Olima and McCluskey, 1999).

2.2.1 Management of rates.

Rate like any other revenue in local government authorities has not been satisfactorily managed (or fully been exploited) and this has made the returns from rates to be too low considering the number of properties (both unimproved and improved) within their jurisdiction.

Many local authorities are in debts and huge bank overdrafts because of poor management of revenue among other reasons such as;

- **Inadequate geo-spatial and non-spatial information.**

In most local government authorities there has not been enough mechanism put in place to acquire or capture data that would enable them manage rates well. This has made many local authorities lose a lot of revenue, since whatever records they based their valuation on and subsequent rating is not the real picture on the ground. Land development is a continuous process and every day new parcels of land is being registered at lands office that is not reflected in the local authority records. Because there is no mechanism, many local authorities wait until a client submits a building plan and that is the point you are asked to clear rates and any outstanding due of the local authority for the plan to be approved. So until a client submits a building plan for approval, the local authority will tend to lose and cannot meet its budget for that financial year.

- **Lack of awareness.**

There has always been misconception about legibility in payments of rates. Quite a good number people believe that land rates are meant for leasehold properties and not freehold property. So long as you have a freehold property within the local authority jurisdiction, one is not legible to pay land rates. But it is clearly stated in the Valuation for Rating Act (Cap 266), that all lands (Leasehold or Freehold) shall attract some valuation for purpose of rating except land reserved for public use and local authority. Citizens should be made aware of the need for rates payments for many do not know the impact of land rate and how it operates.

- **Lack of appropriate Technology.**

The world has gone digital in its operations and many complex social and scientific tasks can easily be manipulated by computer software depending on the task. Geospatial Information System (GIS) has proved application in many fields in human life i.e. medicine, social science, engineering etc. A good number of sectors and many local government authorities have not taken the use of new technology serious. This is a very important tool that enhance implementation of policies in a more efficient and effective manner.

- **Lack of valuation roll.**

According to an Act of Parliament, Valuation for Rating Act (Cap 266), local government authorities are empowered to value property for purposes of rating and for incidental to or connected therewith. It is therefore within the law for local government authorities to prepare their respective draft valuation rolls and draft supplementary valuation rolls that will make them realize their objectives and goal. This valuation roll may be prepared by the Government or Registered Land Valuer at the request of that particular local government authority.

2.2.2 Property tax rates

In Kenya, the Rating Act gives the local authority the power to set the tax rate. The tax rate can be set either as a *per unit rate* in the case of **area rating** or as a *per value rate* in the case of **valuation rating**. The unit area or the value rate can be either uniform or differential. The differential rates can either be proportional or graduated based on land use, value, or size.

Local authorities are allowed to choose a valuation rate of up to ***four per cent*** without central government approval. The Minister of Local Government must approve all tax rates higher than 4 percent as a precautionary measure to protect the interests of the taxpayers. In general, local authorities in Kenya tend to use a uniform area rate or a uniform tax rate structure. As Table 2.1 indicates, the tax rates range from 2 to 22 percent applied to the values contained on the valuation rolls. The median tax rates are 6 percent for both municipalities and towns and 5 percent for counties. City Council Nairobi also uses differential rates based on land use (e.g., residential, commercial and industrial).

Table 2.1 Range of Tax Rates by Type of Local Authority, 2000

Type of Local Authority	**Range of Tax Rates (%)**	**Median Tax Rates**
Nairobi City Council	14%	14%
Municipality	2% to 10%	6%
Towns	2% to 8%	6%
Counties	2% to 22%	5%

Source: Ministry of Local Government, 2001.

2.3 Rating properties in different parts of Nairobi

Currently, the city council levy different taxes which are governed by different laws and by-laws. These laws and by-laws dictate how property is rated and valued. There are two approaches being used at the moment to rate properties in different parts of the city of Nairobi. They include;

1. ***Unimproved site value rating approach.*** This is currently levied at 17% on 1982 valuation roll. This is applied to serviced areas e.g. the Nairobi central business district(NCBD)

2. ***Flat rating/area rating approach***. This is applied mainly on Nairobi extended areas that are unserviced e.g. by sewer, tarmac roads or water by the County Cuncil of Nairobi. The following are the charges for different sizes of land:

    - Upto1/4 acre -Ksh.640 per plot per year.
    - 1/4-1/2 acre –Ksh.800 per plot per year.
    - 1/2-3/4 acre –Ksh.1000 per plot per year.
    - 3/4-1 acre –Ksh.1200 per plot per year.

There are land rates exemptions on places of worship and charitable institutions which are granted to properties which qualify as per the Rating Act, Cap 266 section 27(2)(a).

2.4 Calculation of taxes

The formula for real property taxes is**:**

Site value (Unimproved site value) x Tax Rate = Tax.

After the assessment of the property has been made and any exemptions subtracted from the assessed value, the remaining value is known as *the net taxable value.* This is the starting point for the calculation of taxes. The valuation of the real property for the purposes of taxation is officially supposed to be done after every ***ten years*** but in reality it is not strictly followed as it was shown by the tax officers i.e. the County Council of Nairobi. has gone up to seventeen years without carrying out a real property valuation exercise. Total number of defaulters as per County Council of Nairobi records is 40,000 accounts and the amount owed by the defaulters is Ksh.10.5 Billion for the year 2008.

Table 2.2: Total yearly land rates collected between 2002 and 2006 in the Nairobi City.

YEAR	AMOUNT PAID (Ksh)
2002	1,011,979,141.00
2003	1,534,657,719.00
2004	1,251,900,753.00
2005	1,517,718,971.00
2006	1,635,102,026.00

Source: City Council of Nairobi, 2009

Table 2.3: Total Yearly Land Rates Outstanding Between 2002 and 2006 in the County Council of Nairobi

YEAR	AMOUNTS OUTSTANDING/DUE (Ksh)
2002	3,905,500,484.00
2003	6,464,481,449.00
2004	7,352,515,470.00
2005	8,051,850,017.00
2006	8,463,567,332.00

Source: City Council of Nairobi, 2009

Table 2.2: shows the total land rates that were collected for five year period and Table 2.3: shows the total land rates outstanding (due) for a stretch of the five. Comparing and analyzing the two tables it is inferred that the amount of taxes collected in terms of land rates are far less than the amount of taxes owed to the city council of Nairobi.

This brings forth the need for the tax officers to increase the amount of taxes collected (paid) to render services like repairs of the city roads, garbage collection, construction and maintenance of residential houses etc to the city residents.

Currently the County Council of Nairobi uses a tax system called **Local Authority Integrated Financial Operating Management system** (LAIFOMS).This system has strict conditions which hamper prompt revenue collection, it is not user friendly and therefore changes in names in case of change of ownership of the property is difficult, it does not track spatially the tax defaulters. Existing system at city council of Nairobi reveals that traditional methods are being followed and tax is being calculated manually. There is no evidence in the property taxation record for exact property location in the rating area and their condition and structure.

2.5 Geographic Information System (G.I.S.)

GIS has been defined and explained in various approaches but come to common conclusions. Environmental Systems Research Institute (1994) explains that GIS is an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze and display all forms of geographically referenced information.

On the other hand, a subsidiary definition describes GIS as a computer system that stores and links geographically referenced data with graphic map features to allow a wide range of processing, display operations, map production, analysis, and modeling (Antenucci et al., 1991).

Arnoff in 1989 defines GIS as, "a computer based system that provides four sets of capabilities to handle geo-referenced data: data input, data management (data storage and retrieval), manipulation and analysis and data output."

2.5.1 Components, Techniques and Applications of GIS

There are four integrated components of GIS; Data and Database Management Systems and Users. Geographic Information System handles large volumes of data that is either spatial or non-spatial. Spatial data is the information pertaining to where the objects of interest are located and consist of location; shape and size in earth, line, point etc.

A fully functional GIS must have hardware to support data in-put, out-put, storage, retrieval, display and analysis. Some of the most popular GIS software is Arc Info, Arc GIS Map Info, Geo Media each offering different levels of functionality. GIS is a tool that can be used in varied disciplines ranging from civil engineering to business.

Roughly two thirds of the total cost of implementing a GIS involves building the GIS database. Many GIS programs start with editing digital map data because of its relatively low cost. Subsequently, plans may be implemented to improve data with more accuracy and detail. Digitizing is the process of tracing paper maps into a computer format.
There are two most widely used types of GIS data structure, vector format and raster format. Vector digital map data is recorded as distinct points, lines, or areas. Raster data files consist of rows of uniform cells covered according to data values The vector and raster models for storing geographic data have unique advantages and disadvantages both of which can be handled by a full functional GIS.

Remote sensing data is often brought into GIS to have a complete data set in many natural resources application areas. Remote sensing and GIS technology is useful in the important fields of protection of environment, water resources management, urban planning and transportation, watershed management, surveying, coastal zone management, natural disaster management, agriculture, land use planning, forestry, geosciences, demography, town and country planning, oil, water and soil resources, oceanography, tax assessment and physical and social environment.

2.5.2 Selecting and Implementing GIS

The benefits of GIS for government agencies and urban management are substantial and well documented. However, adoption of GIS technology requires thorough planning and vigilant control.

The best way to begin a GIS program is to carefully review the organization's needs, and then develop a strategic plan that will systematically guide the selection and implementation of the system. A GIS Plan includes:

- Introduction and background of GIS,
- Existing operation;
- Existing needs and problems;
- General description of GIS;
- GIS hardware and software;
- GIS database,
- GIS data maintenance,
- Data communication;
- Staffing and organization;
- Training,
- Schedule;
- Financial analysis.

There are eight key components of a successful GIS operation. These are: management support, leadership and vision, data conversion and maintenance, hardware and software, user training, data communication, software customization, user support and funding.

There are three general ***types of costs*** associated with the implementation of a GIS: services, hardware and software purchases and database creation.

Data base creation is usually the largest cost component of a GIS program. This category comprises of all costs required to create the GIS data base. Importantly, ongoing cost of operations and the maintenance of the digital data base include: data management, data maintenance, user training, system support, and user support and system development.

2.6 GIS for Local Authorities.

Geographical Information System (GIS) has been rapidly adopted by many organizations as an effective tool for managing, organizing and analyzing spatially related data. A large percentage of decisions made by Local Authorities are spatial in nature. The decision largely involves spatial objectives such as land lots, buildings, roads, storm drains, planning zones, rivers, parks and management of markets. The management of these spatial objects can be facilitated with the use of GIS (Mitullah, 2005).

According to Dillinger (1988) municipalities that conducted tax-mapping operations have shown that their revenues remained stagnant because problems associated with collection administration and enforcement was not addressed.

GIS merely provides a tool for efficient tax collection through expedited billing and collection processes as well as a check on delinquent tax payers. The enforcement of necessary measures in order to collect taxes through administrative or judicial processes still remains in the hands of the local government.

2.6.1 Use of GIS in local authorities

The administration and management of Local Authorities are associated with many geographical data such as land lot, buildings, roads, drainages, hydrology, geology, planning zone and topography. The implementation of a GIS would provide an efficient way of storing and managing the data.

A Geographic Information System (GIS) would enable management of Local Authorities to have access to numerous data and information from one computer location. Data that were physically scattered at various units and departments are now stored in one place and information that were formally difficult and time consuming to generate can now be obtained in a matter of seconds.

Local Authorities can benefit from the existence of a GIS in the preparation of development plans such as structure plans, local plans, and layout plans of Local Authorities. Developments of structure plans require geographical data such as demographic trends, surrounding developments, transport network, socio-economic pattern etc.

These data can be made to reside in a GIS and thus, can be easily accessible during the process of structure plan development. There is no need for cross-reference various data in filing cabinets, maps hanging on walls etc.

For example, areas for heavy and high-risk industries must be located away from populated areas and on land unsuitable for other uses that would otherwise provide much better socio-economic and environmental returns; and land allocated for residential and non-residential must be optimally balanced to benefit all parties.

The development of local and layout plan require much more detailed data such as land ownership, land value, topography, drainage pattern, hydrology, geology, road network, water supply, electricity supply, etc of a specific location. These types of data are needed to plan for a development for a particular location.

For example, an area is planned for residential some of the pertinent questions are:

- What would be the area allocated for low, medium and high cost houses ?
- What is the minimum size of lots for each category of houses ?
- What is the parking requirement for the commercial area ?
- What is the density of the development ?
- How is the traffic out the area to be dispersed ?
- What would be the requirements for water and electricity ?
- How would the drainage for the area to be solve ?

CHAPTER 3: MATERIALS AND METHODS

3.1 Area of Study.

The area is NCBD which lies in Zone 37 according to Universal Transverse Mercator (UTM) approximately between longitudes 36˚48’35″E to 36˚50’06″E and Latitude 01˚16’28″ S and 01˚17’29″ S. The spatial extent of the area of study is approximately 5.37 km^2 at an altitude of 1676 m (5500 ft) above mean sea level and an average temperature of (21 – 22) ° C.

The selected study area covered the central business district. It takes a trapezium shape, around the Uhuru Highway, Haile Selassie Avenue, Moi Avenue and University Way. It includes many of Nairobi's important buildings, including the City Hall and Parliament Building.

The area is a centre for daily business transactions and many other services that are of benefits to the tourists. The study area was chosen on the basis that it has the highest land values in the Nairobi urban settlement. In case of high number of defaulters in this area, there will be large amount of loss of to the city council of Nairobi. This area of study (NCBD) is illustrated in in figure 1 below.

Area of Study.

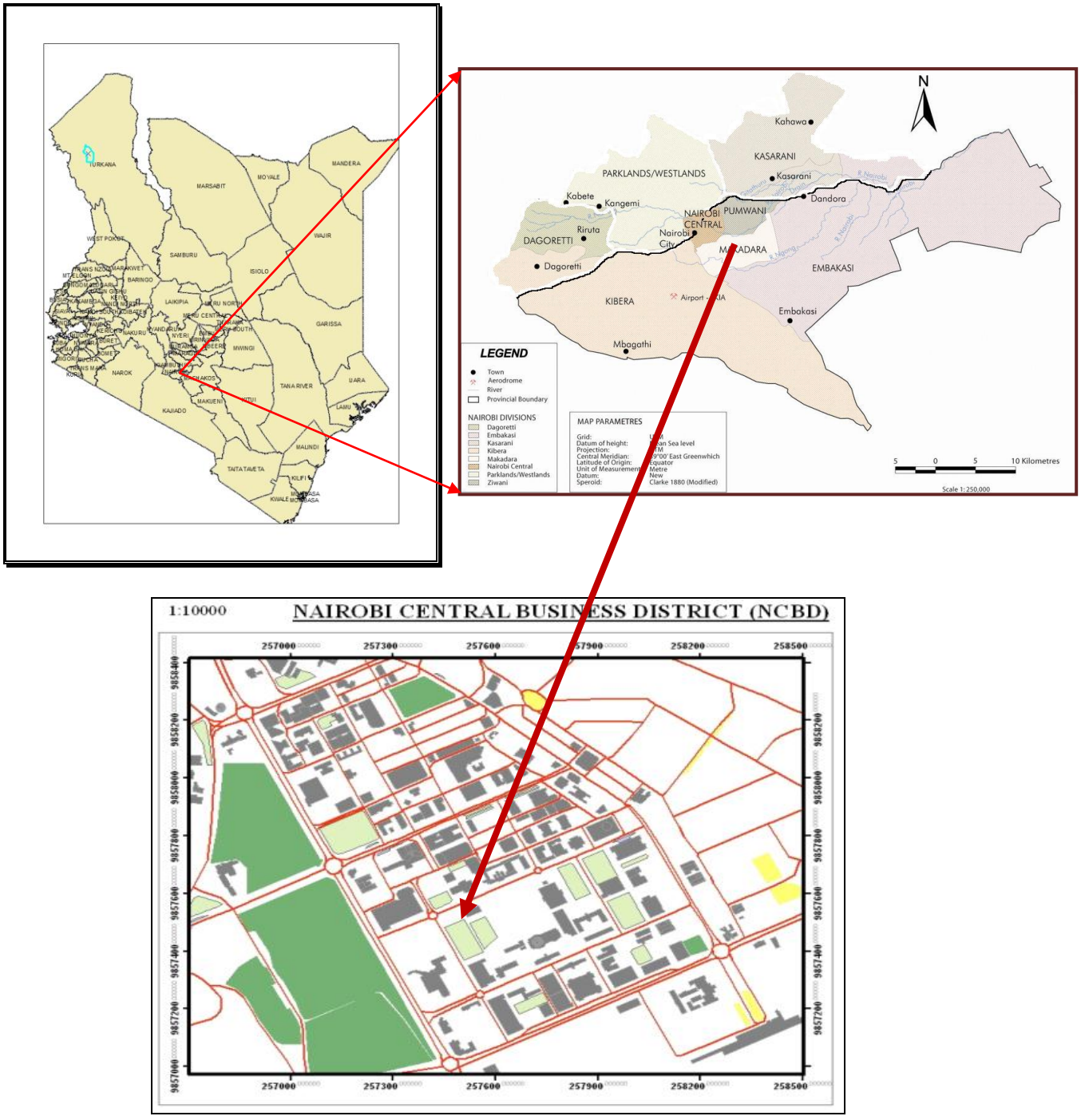

Figure 3.1: Area of Study

Source: World Resource Institute- Kenya GIS Data, 2013

3.2 Overview of the Methodology

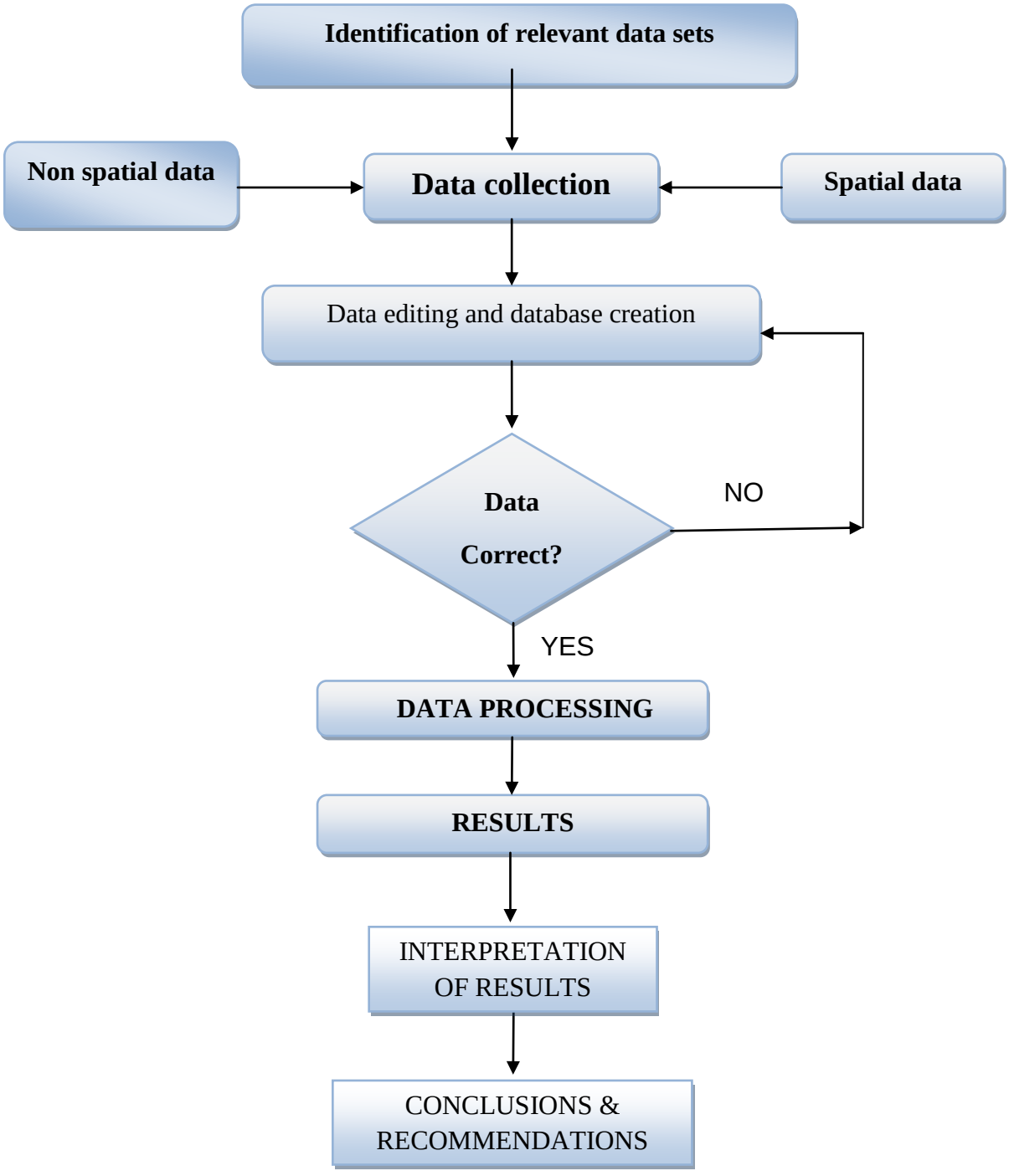

Figure 3.2: Overview of Methodology

3.3 Data sets and tools

DATA TYPE	CHARACTERISTICS	SOURCE
Nairobi city	Shape files	Survey Of Kenya
Attributes of Land ownership	Hard / Soft copy (Excel sheets)	Nairobi City Council
Topographic Map	Scale 1:2500 Produced and published In 2005.	Survey Of Kenya
Administrative Boundaries	Shape files	World Resource Institute- Kenya GIS Data

Table 3.1 Datasets and sources

3.3.1 Hardware:

- A personal computer with the following specifications;
    - 2.60 GHz Processing speed.
    - 512 RAM
    - 80 GB Hard Disk
- External storage
    - 4 GB Flash Disk
- Hp Laser Printer

3.3.2 Software:

- ArcGIS 9.3
- Global Mapper 12.0
- Ms Office (2010) suite

3.4 Data Collection and Capture.

This is one of the most important and antagonizing task in research study, since utmost care is required by the research to able to arrive at the expected result that is suitable and appropriate and also subsequent solution for the organization's problems. Project analyses as one of the most important area in research study also depend wholly on the right and up to date data and so is the conclusion.

3.4.1 Scanning of The Datasets

A large format scanner was used to create a raster digital file from existing paper map. As the scanning takes place the image is displayed on the computer screen as a raster digital file ready for the next process (digitization) to convert the raster image data to vector data that can be used by the computer software (ArcMap).

Adobe Photoshop software was used to clear any dirt within the resulting raster images and to enhance the color, contrast and brightness of the scanned raster image.

3.4.2 Data clipping

This was carried out to precisely extract the relevant data covering the study area. The clipping process followed the shape of the study area which is a trapezium. The clipped data included the transport (road) network. Before clipping the shapefiles for transportation network, buildings and that of the parcels were loaded into ArcGIS 9.2 software.

3.5 Data Processing and Manipulation

3.5.1 Data processing

This involves, data evaluation, georeferencing and finally digitization so to have digital data that is compatible to the computer software namely ArcMap and ArcCatalog. The various layers such as roads, buildings were verified by merging several sections (line pieces) of the feature (roads) to make them complete entities and give them one name. In the case of roads only the centre lines were considered for clarity.

3.5.2 Georeferancing of Maps

Scanned maps were obtained in the JPEG format with (UTM) as the projection used under zone (37S), Datum (Arc1960) and metres as units of measurement This is done by identifying some (not less than four) identical points (both in the topographical map and raster image) from the topographical base map and enter this co-ordinate to the point in the raster image. Repeat the same with other points until the image map (scanned map) is fully referenced. All the four corner points were used as the control points and registration applied. The georeferenced image was then exported in the Tagged Interface File (TIFF) format for further work.

3.5.3 Creation of Geodatabase

A geodatabase is a collection of geographic datasets of various types, the native data model in ArcGIS for storing geographic information, including raster datasets and raster catalogs. It is the primary mechanism used to organize and use geographic information in ArcGIS. The geodatabase contains three primary dataset types: *feature classes, raster datasets and tables*. In the ArcGIS ArcCatalog environment a new folder was created in which the new personal geodatabase was inserted and given a name.

An ArcGIS geodatabase is a collective of geographic datasets of various type held in a common file system folder, a Microsoft Access database, or a multiuse relational database (such as Oracle, Microsoft SQL server, or IBM DB2).The database contains three primary database types

- Feature classes
- Raster database
- Tables

Database model

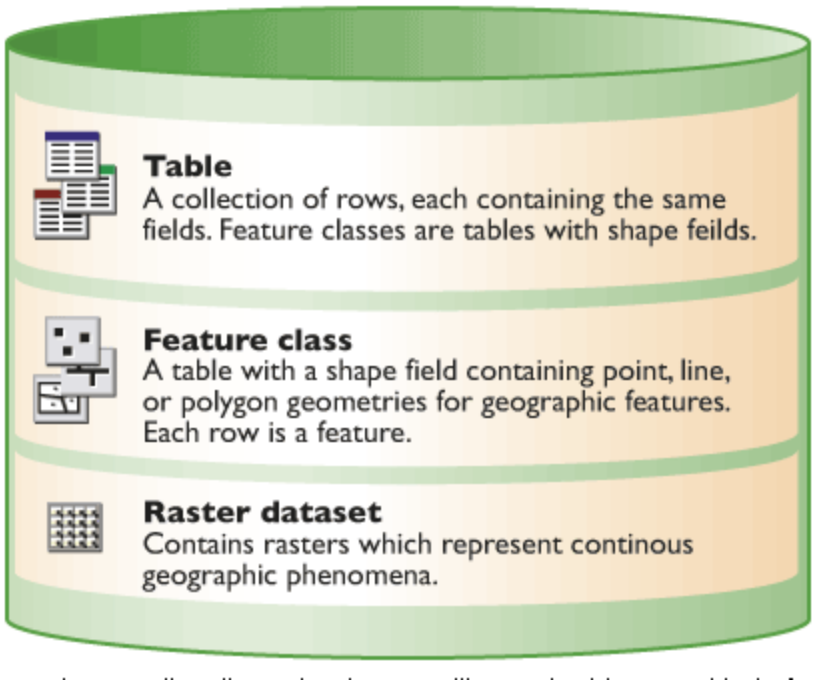

Figure 3.3. Example of Database model.

The first step in creating a geodatabase is to create the database itself using ArcCatalog. There are two kinds of geodatabases: Personal geodatabases and • ArcSDE geodatabases.

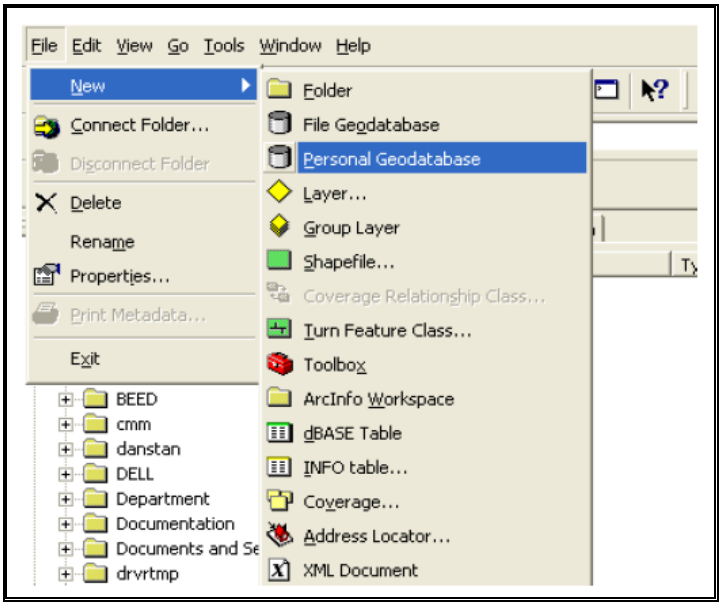

Figure 3.4: Creation of a Personal Geodatabase

Persoonal Geodatabase Directory

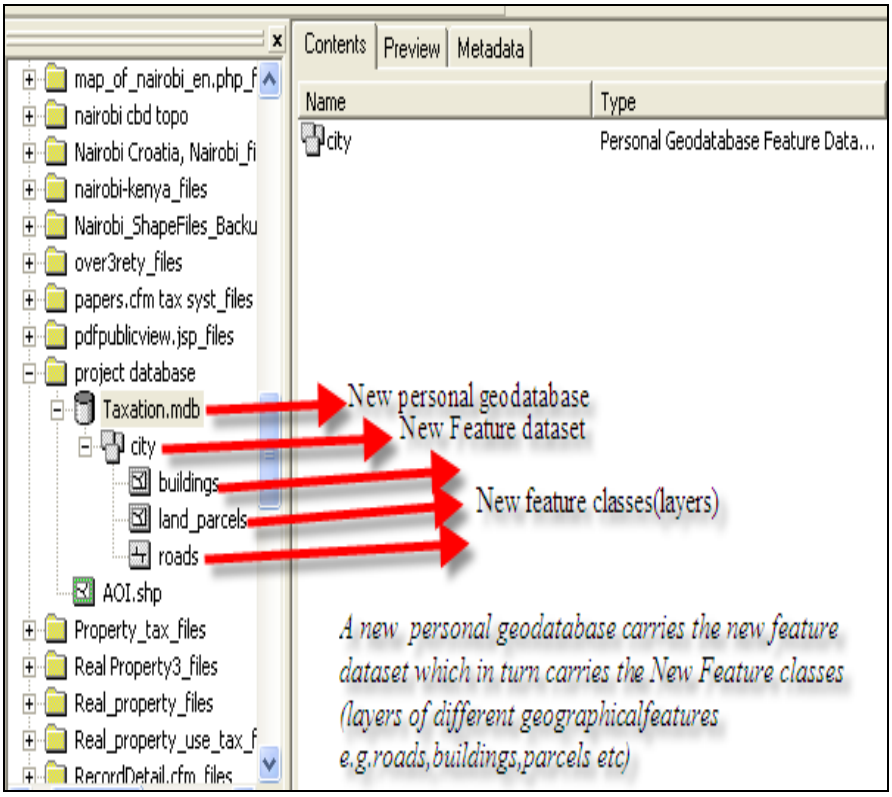

Figure 3.5: Taxation Personal Geodatabase

3.5.4 Importing Data into the Geodatabase

There tools to be used to import existing data into geodatabase both in Arctoolbox and ArcCatalog. These tools are capable of importing, shape files, coverage, CAD data, or tables as new feature classes or tables in the geodatabase.

3.5.5 Digitizing of the spatial data

This is one of the most important stages in map production since the quality of the final work and also the subsequent analysis and results are relatively depending on the accuracy of the digitized data. All the features were digitized either as polygons features, line features or point features. An on screen approach by an interactive process after displaying the raster images in ArcMAP window was then to be used in the process of vectorizing.

Digitizing is the process of converting features on a paper map or imagery (analogue/scanned) into digital format. One can perform on screen digitizing or use a digitizer (digitizing tablet) connected to the computer. As one traces over the features of interest the X - Y coordinates of these features are converted to spatial data. This involved the use of a georeferenced map of the study area in which features like roads, buildings and special landmarks were picked.

During this process, point and line data are entered by human interpretation who measures the co-ordinates position using a manual digitizing device and enters the associated text, codes or attribute information related to that feature layer (i.e. plot, building and road).Once, completed the scanned image may be archived or discarded.

Digitized Land parcels and roads from the Map

Figure 3.7: Digitized Land parcels and roads

3.5.6 Attribute Entering

Attribute is the non-spatial data that the GIS link to the spatial features in the geodatabase. It the descriptive information related to the features included the GIS.

Editing data.

Digitizing invariably introduces errors. The main task include :

- Error correction
- Entering missing data
- Building topology

Typical errors include gaps between lines that should be continuous but fail to meet or dangle, unclosed polygons, lines meeting at the wrong point or intersecting each other, objects with improper or missing codes and missing labels .When the clean command is used all these errors are highlighted. ArcInfo has editing capabilities that enable feature snapping, automatic detection and identification of the digitizing errors. This capability enabled the correction of the digitizing errors.

Entering missing data

Interactive digitizing was used to do the study, the digitized feature were immediately "echoed" on the monitor screen hence making it easy to follow the digitizing process. The details left out accidentally during digitizing were verified visually on screen. The missing data was entered in the digitizing program.

3.5.7 Designing of relational tables

Like a map, a GIS is layer-based. And like the layers in a map, GIS datasets represent collections of individual features with their geographic locations and shapes as well as with descriptive information stored as attributes.

There are four fundamental types of geographic representations:

- Features (collections or points, lines, and polygons)
- Attributes
- Imagery
- Continuous surfaces (such as elevation)

All of the rich GIS behavior for representing and managing geographic information is based on these fundamental types. In this case the fundamental type of geographical representation was used to relate tables for example the object id (for the parcels) and the id no(for the buildings)In a GIS, descriptive attributes are managed in tables, which are based on a series of simple, essential relational database concepts. A relational database provides a simple, universal data model for storing and working with attribute information. DBMSs are inherently open because their simplicity and flexibility enables support for a broad range of applications. Key relational concepts include:

- Descriptive data is organized into tables.
- Tables contain rows.
- All rows in a table have the same columns.
- Each column has a type, such as integer, decimal number, character, date, and so on.
- A series of relational functions and operators (SQL) is available to operate on the tables and their data elements.

Relating tables one is able to know the details of the tax payers i.e. the location, their names ,the land registration numbers of their parcels, their postal addresses and telephone numbers. area of their parcels, the landuse of the parcels, name of the buildings, the number of floors(which is essential when collecting the single permit charges) and the land rate status (i.eif he/she is a defaulter or not a defaulter).

Designing relational tables

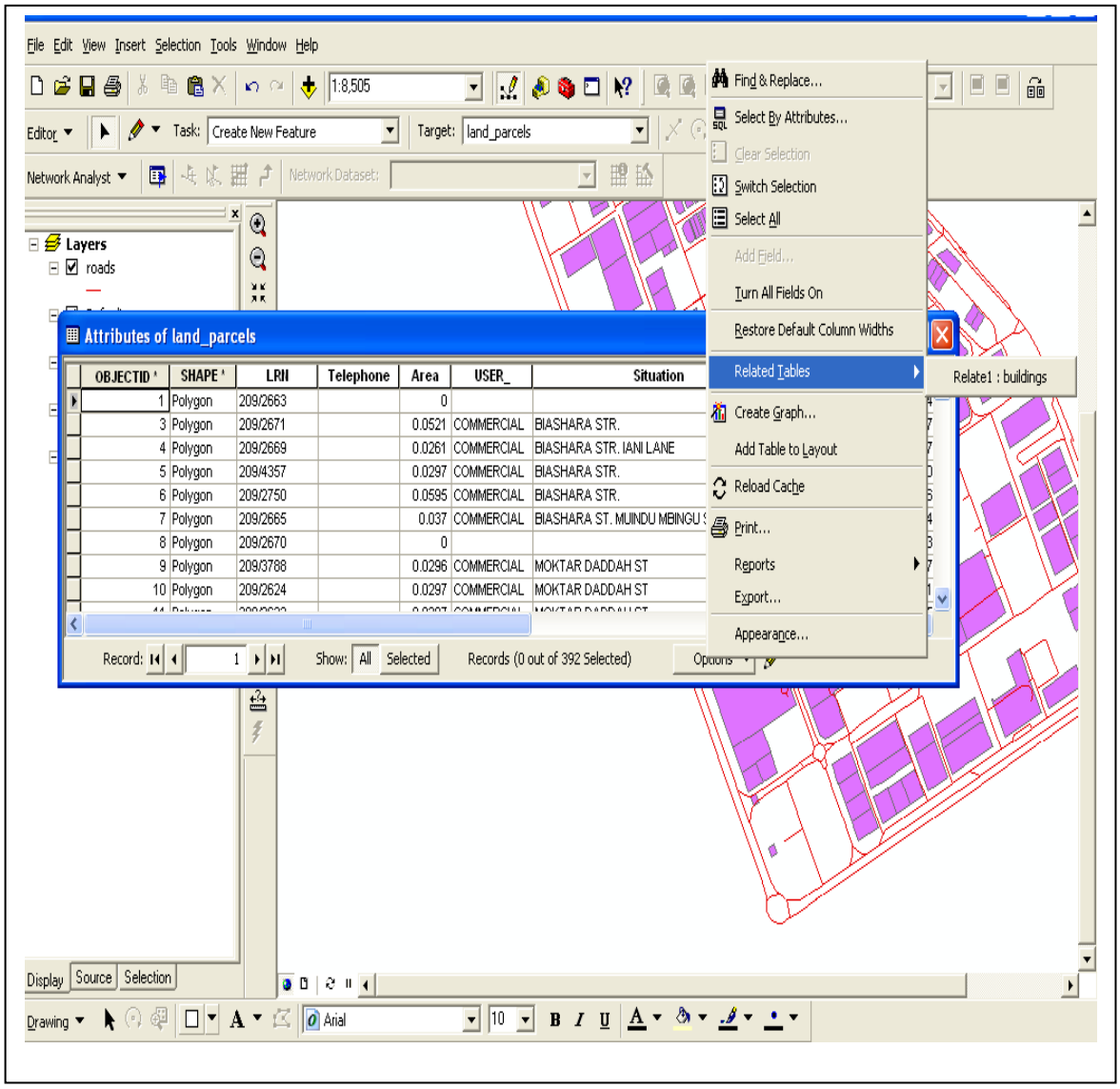

Figure 3.8: Designing relational tables

Figure 3.8 shows how the relational tables were created; that are relating the land parcel attributes to those of the buildings. This kind of arrangement enabled the querying by attributes e.g. when one selects the name of a building (on building attributes), its position is highlighted on the attributes of land parcels showing whether the building belongs to a defaulting land parcel or not.

The building is also highlighted on the map thus enabling the tax officers to link the graphic representation of the property and the attribute data. Figure 3.9 below shows how tables are related. For example if Utalii house is selected, the land parcel on which is built is highlighted (on attributes of land parcels) and consequently on the digital map displayed.

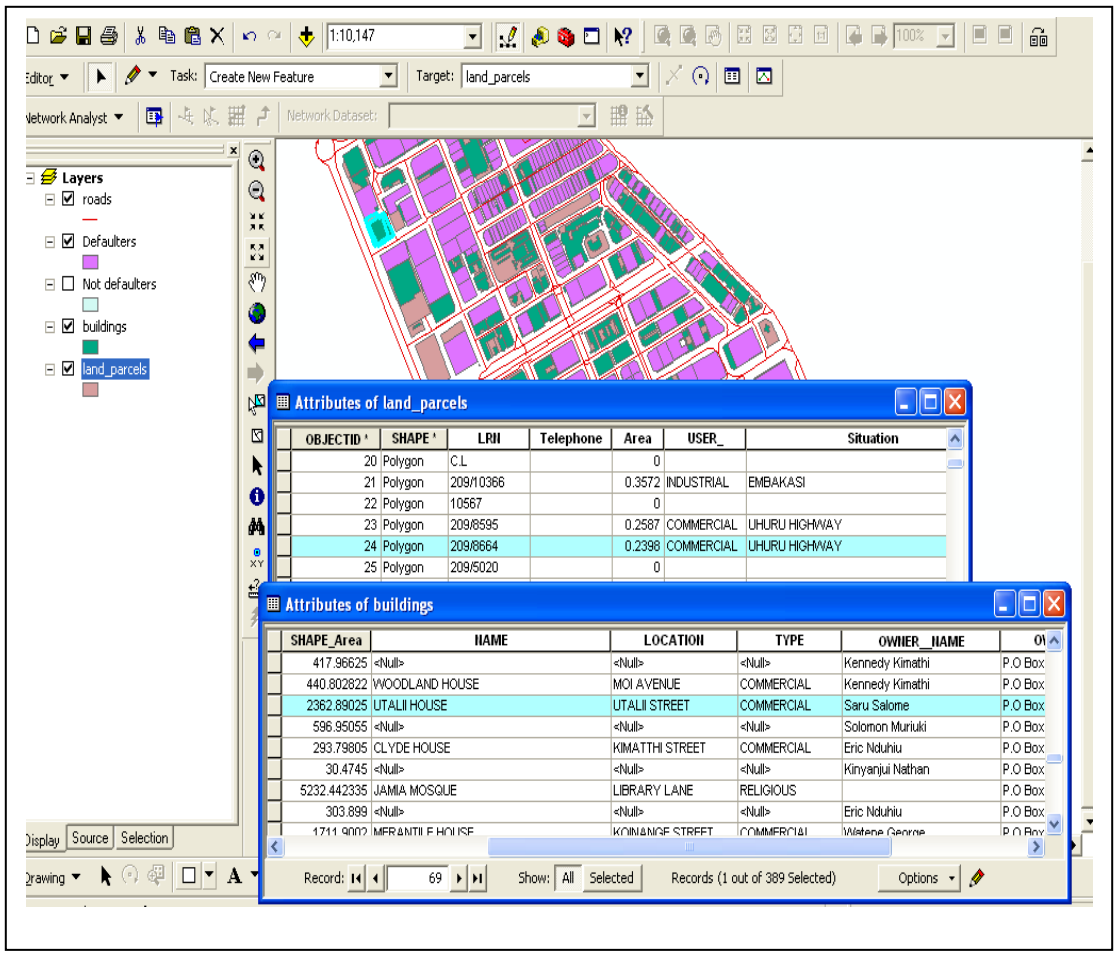

Figure 3.9: Relational tables

After designing relational tables, the maps are showing the levels of tax arrears and the taxation areas comprising defaulters, non defaulters and areas exempted by land rates (parks, charitable institutions, churches among others).

Figure 3.7 elaborates on how the land parcels (defaulters) in the area of study were classified according to the levels of tax due, showing the minimum to the maximum amount of money owed. This map will enable the tax officers to know the areas which have the highest amount rates arrears in order to enable proper and sound planning of the budgeting of the city council of Nairobi.

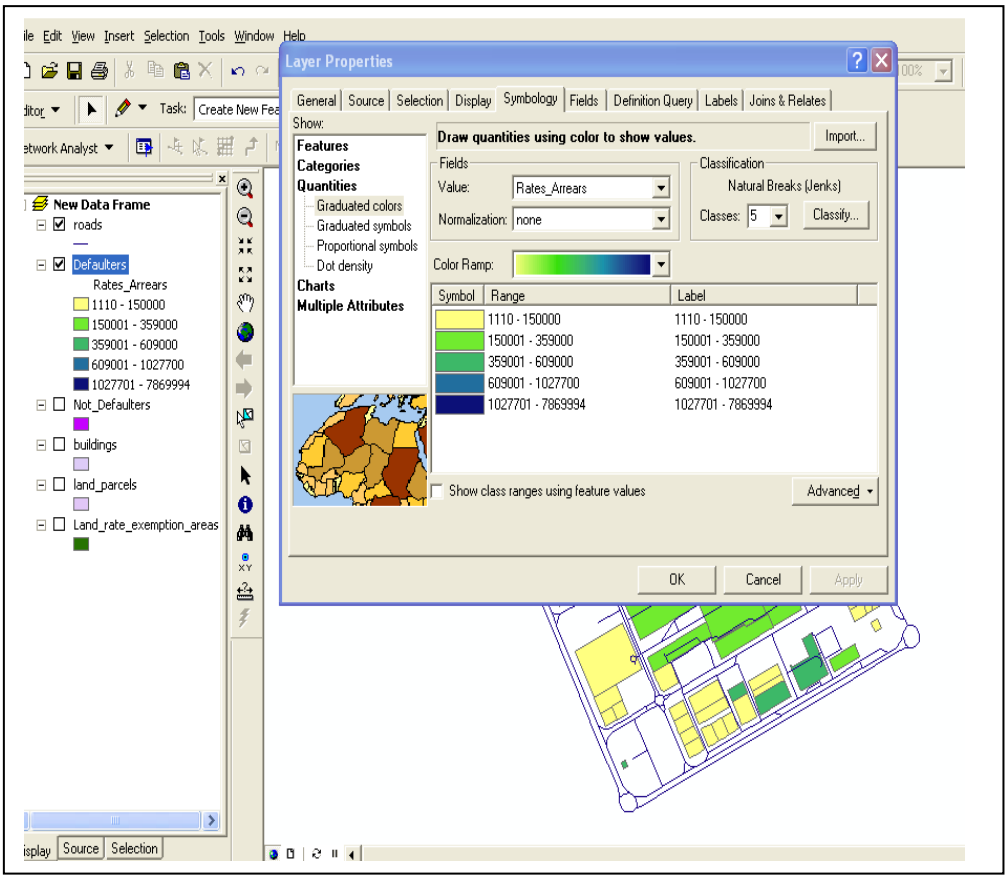

Figure 3.7: classification of rates arrears

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 General Map

The final map product of the area is shown in figure 4.1 below.

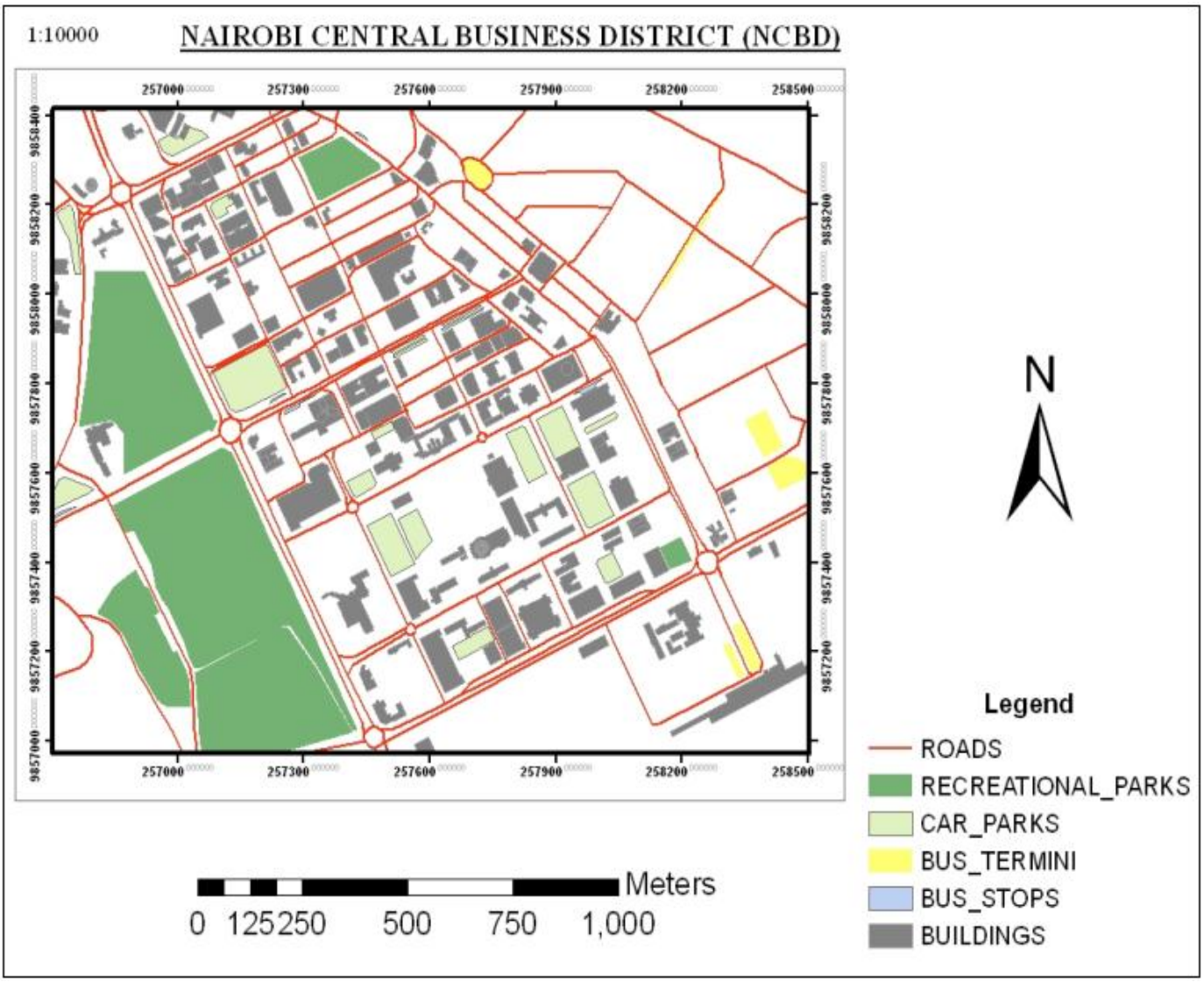

Figure 4.1: General Map of the area of study

4.2 Querying Rates Arrears

By Querying one gets to know the number of defaulters and the amount of money they owe the city council of Nairobi. This will assist in the effective usage and planning all the activities of the city council of Nairobi. This type of querying by attributes is meant for geographical information system professionals.

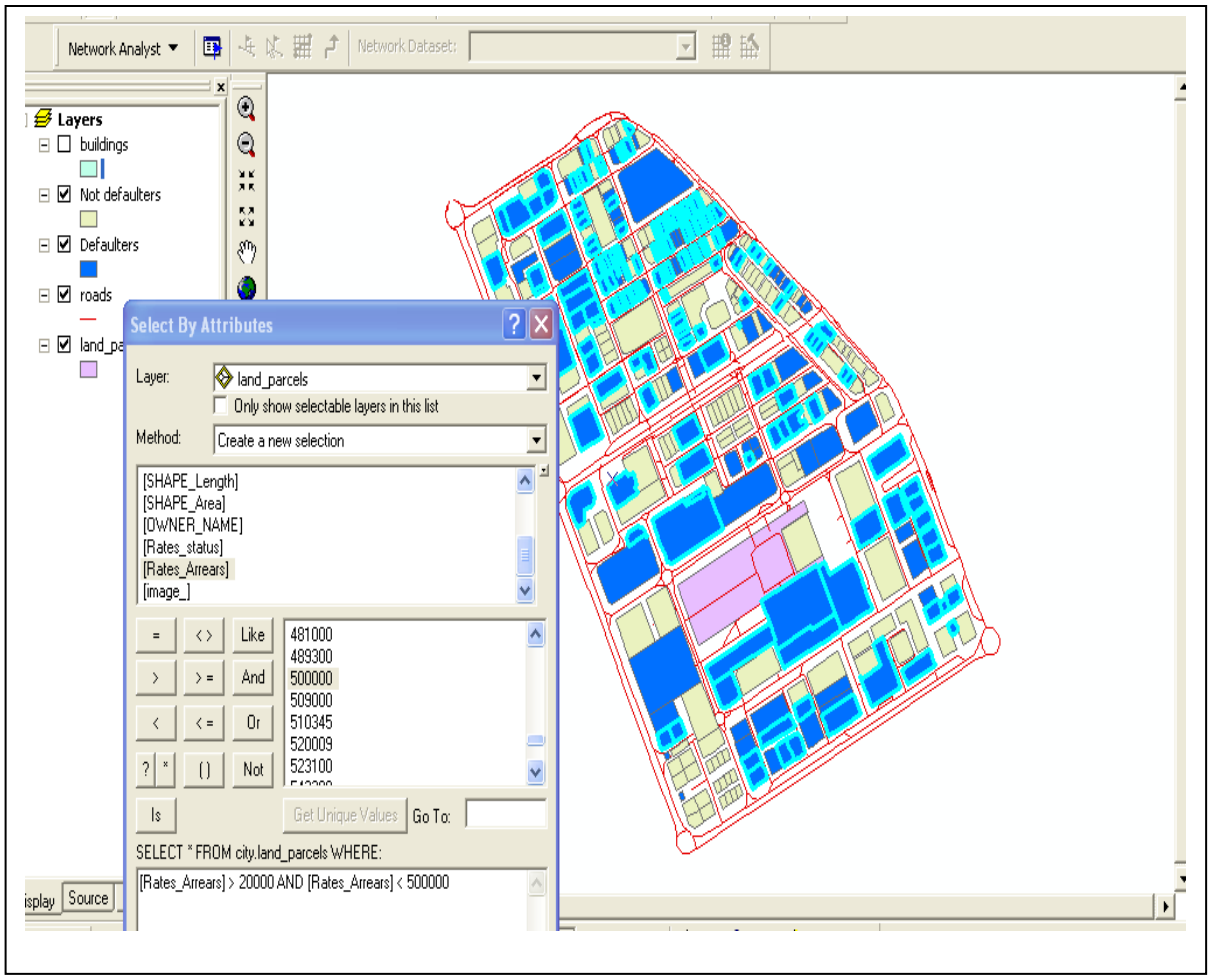

Figure 4.2: Querying rates arrears

The query was performed by select by attributes to determine the parcels with the rate arrears between Kshs.200000 and 500000 and the results of the query was higlighted as shown in the figure below.

4.3 Tax Analysis

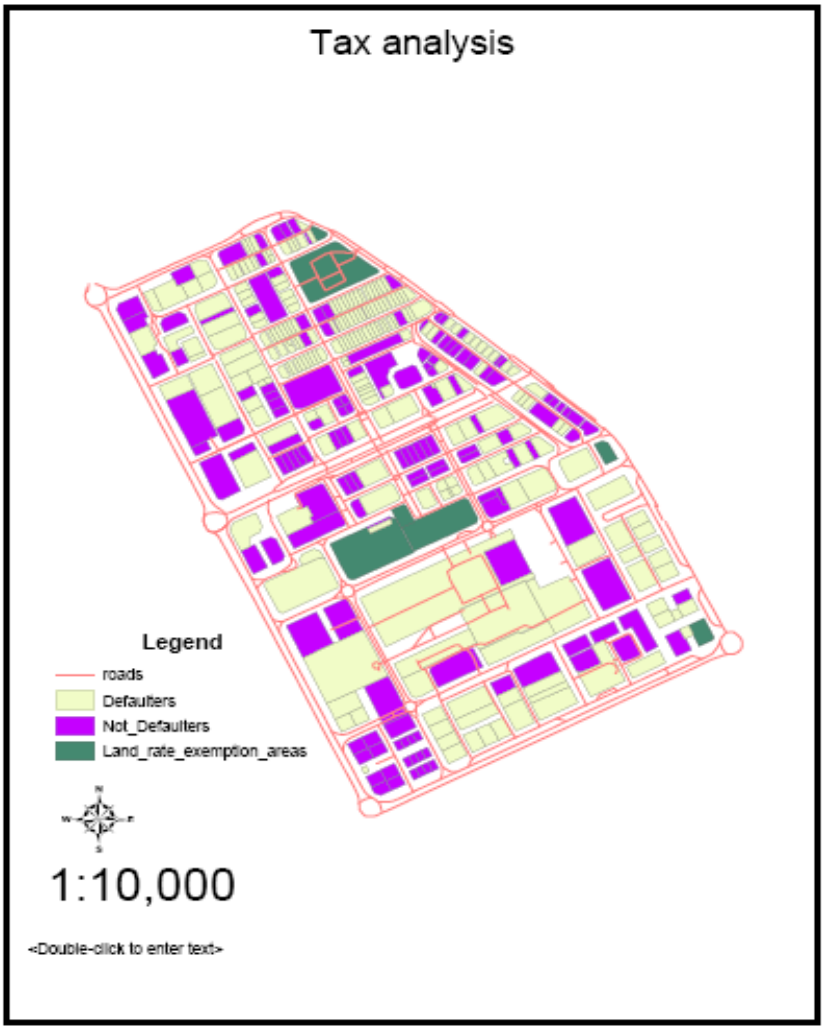

Figure 4.3: Tax analysis

Figure 4.3 shows the distribution of tax defaulters, and those who have not paid i.e. delinquent tax payers) and land rate exempted areas. This map will enable the tax officers to track down the tax defaulters by each parcel are displayed. This map display shows that the number of defaulting parcels is many as compared to other layers such as those not defaulting and land rate exempted areas. This number of defaulters calls for necessity to track them down in order to recover the tax dues. The defaulters are graphically represented by yellow colour, not defaulters are represented by purple colour and the land exempted areas are represented by the green colour.

4.4 Tax Arrears

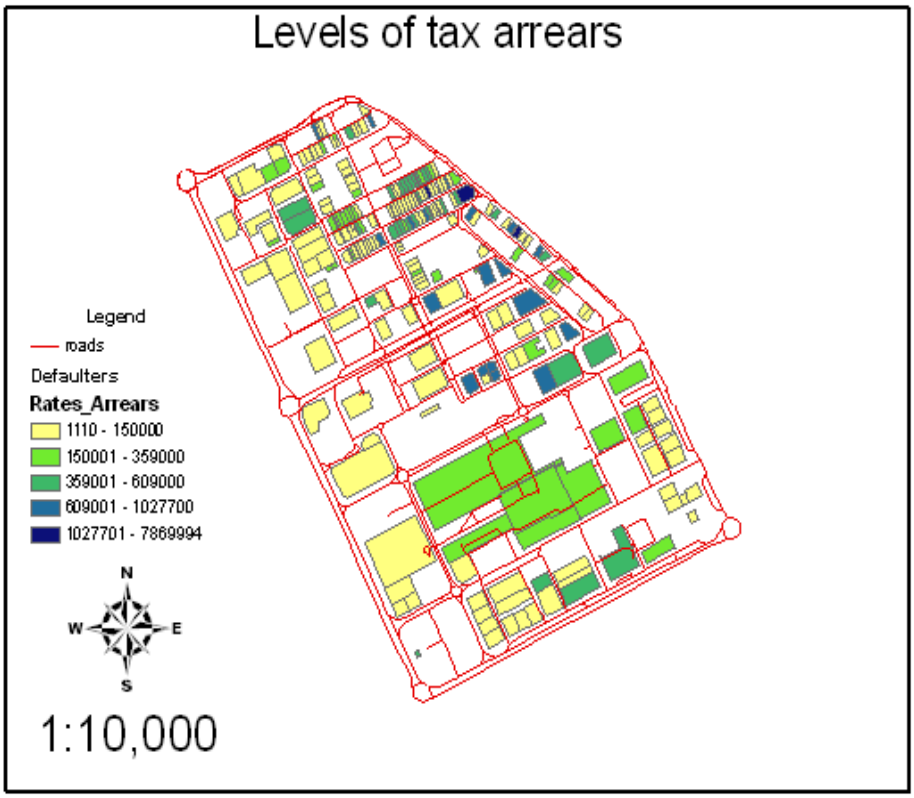

Figure 4.4: Tax arrears

Figure 4.4 shows the way rates arrears vary with different land parcels. The dark blue region shows the defaulters who have the highest amount arrears i.e. between Ksh. 1,027,701and Kshs.7, 869,994.

The green colour (regions) display areas with moderate rates arrears. The city council of Nairobi needs to first target the tax payers who owe the council the largest arrears and narrowing down to those who owe the council the small amount of tax arrears.

After identification of land rate defaulters up to their location, they are supplied with summons and court orders to pay up their land rate areas as quickly as possible, if not they will be sued in a court of law. From the above map it is clearly illustrated that most people owe the city council the rates arrears between Ksh.1, 110 and Ksh.150, 000.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The main objective of this study was to demonstrate the role of Geographic Information System (GIS), in creating Tax Information System for County Council of Nairobi and have been achieved.Geographical information systems have proven to be power tools in the collection of taxes (land rates) and tracking delinquent tax payers thus assisting in raising the revenue collection. This shown by locating the tax defaulters where they are geographically located and other related details which proves to be useful.

Geographic Information System (GIS), with proper good will from the workers can improve revenue collection and subsequently increase in service provision. This is very true with Local Authorities where most of their services and facilities they provide are geospatial based (i.e. water, sewer lines, road, schools, social amenities, etc).

However, in terms of property valuation, Geographic Information System (GIS) is a technology which is ideally suited to analysis of the market values of properties, since such values are based upon spatial comparisons as well as individual property atributes. Also for this system to work efficiently there is need for free flow of information from lands office in relation to the new land development (land subdivision), to update the council geodatabase. A proposed e-Government programme (2005) is the best way forward for free flow of information within various government departments. It will set the foundation for increased realization of the key outputs in the e-Government strategy as its primary objective is to promote the use of modern technology to improve services and communication processes within government departments.

Local Authorities have high demand for information services, but their file based information storage is poor and not up to date. Some Local Authorities have begun embracing ICT, but limited to financial management and word processing. Local Authorities can benefit from the existence of a GIS in the preparation of development plans such as structure plans, local plans, and layout plans of Local Authorities.

Developments of structure plans require geographical data such as demographic trends, surrounding developments, transport network, and socio-economic pattern.

Geographic Information System (GIS) is developed and built to equip institutions like local government with the ability to deploy standardized and best practices of management to improve overall administration of local authorities. By bringing ICT to local authorities, they are expected to keep up with swift changes in ICT and implement changes from traditional methods to new ways of thinking and doing things will enhance and update clients promptly.

5.2. Recommendations

The future scope of study need to incorporates the following suggested tasks in order to enable the County Council of Nairobi collect enough revenue in order to cater for the needs of the Nairobi city residents. Some of these tasks will aid in stamping out or minimizing corruption which is rampant in the city hall at the moment. Corruption in the city council of Nairobi has shrunk the budget for development activities and requisite services. The Ministry in charge of local authorities need to address the problems associated with tax collection administration and enforcement and unless this is done, the revenue collection will remain stagnant.

Since Local Authority's facilities and services are geospatially based and also from many complex analysis that Geographic Information System (GIS) can perform, It is highly recommended that Local Authorities automate their services through GIS for the realization of their goals. The development of a Geodatabase will save them from the many risks of losing important documents either through malice or mistake.

Also in light of tremendous pressure of rapid development while having no local plan to precisely guide the development control in local authorities, necessitates an information system which not only keep and display data pertaining to planning application for the purpose of administrative functions but it should also be designed to facilitate planning at strategic level. The control of development which involves the process of analyzing the appropriateness of planning application requires various data from the relevant government department. For more efficient and effective communication to be put in place, local authorities should include in their records (clients) more contact address information like mobile telephone numbers and e-mail addresses. This will enhance Information Communication Technology (ICT) between them and their clients especially the use of mail automation method (automatic alert system).

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