A prototype land information system: case study of New Taveta Town in Kenya

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Key words: Land administration, Land management, Land Information System (LIS)

SUMMARY

Despite the fact that cadastral surveys in Kenya started in 1903 most of the land records are still in paper form and operated manually. This system of manual record keeping and maintenance is slow, cumbersome, inefficient and time consuming during retrieval of information.
In Kenya, as in most developing countries, it is difficult, time consuming and financially costly to identify what land is available, its ownership, rights therein and the conditions to its use and its value as compared to other parcels. Under such circumstances, necessary information is lacking, inadequate or contradictory. Therefore, the current systems cannot support legitimate and efficient transactions on land.
The cadastre is in a constant state of change. Parcel information is in analogue form with paper maps and conventional land registers giving information on location, tenure, use, encumbrances, ownership and distribution of land. The classical cadastral system has become insufficient owing to the fact that land records have greatly increased in volumes, they are in paper form thus the process of storage, access and retrieval is a great challenge.
Therefore, there is need to develop modern cadastral infrastructures that will facilitate efficient land and property markets, protect the land rights of all, and support long term sustainable development and land management. The development of Land Information System (LIS) is a credible approach towards sound management of land and its resources. A LIS creates a comprehensive data on land ownership, land use, land valuation, land taxation, land statistics and management. Such a system is easy to update, secure and facilitates quick retrieval of information.

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1. INTRODUCTION

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

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

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

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

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

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

2. MATERIALS AND METHODOLOGY

2.1 Area of Study

The project study area is the New Taveta Town in Taveta sub-county of Taita-Taveta County, Kenya.

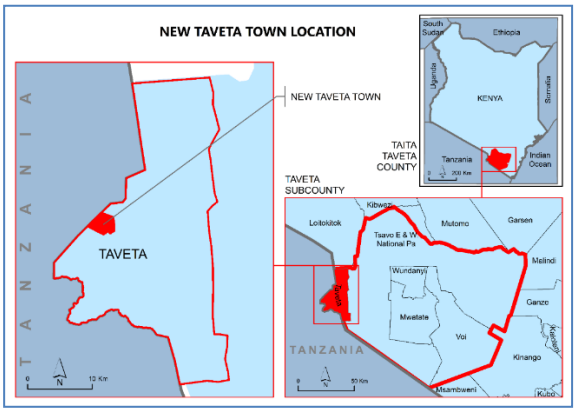


Fig 2.1 Area of study

2.2 Data identification

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

2.2.1 Spatial data

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

2.2.2 Non-Spatial data

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

2.3 Methodological model overview

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

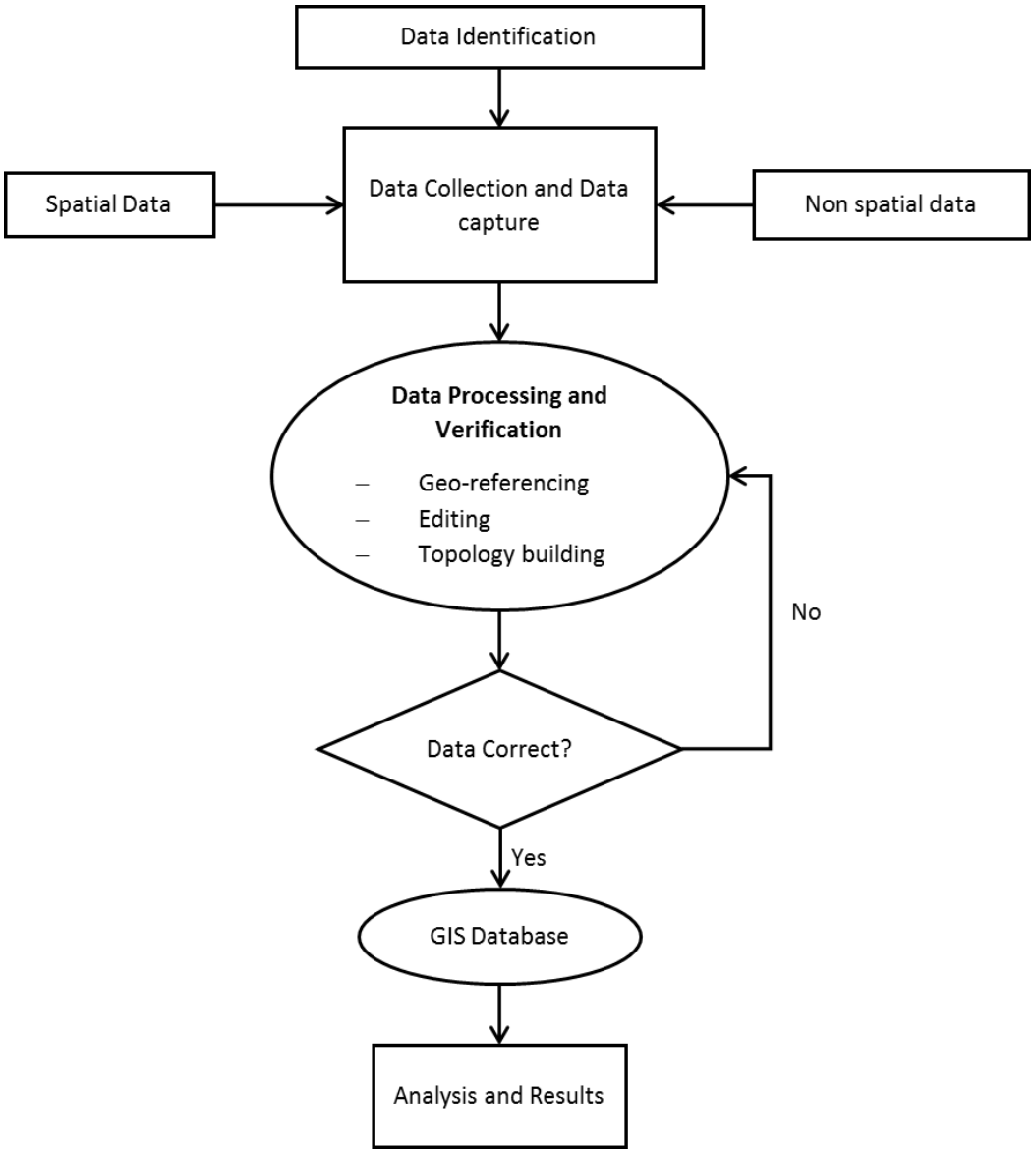


Fig 2.2 Flow chart showing methodology overview

2.4 Database design

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

A good database design results in a well-constructed, functionally and operationally efficient database that: satisfies user requirements and objectives, contains all necessary data but no redundant data unless some is explicitly planned for and properly documented, has efficient data structures and retrieval mechanisms, supports maximum data sharing, accommodates different user views of the data and is easy to update and maintain (Mulaku, 1998).
In summary, the process of database design consist of the following steps:

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

2.5 Joining and relating tables

From the database design, the database is organized into multiple table/relation that can be split instead of one large table containing all the necessary fields. Having multiple tables prevents duplicating information in the database, because one stores the information only once in one table. When the information needed isn't in a current table, one can link the two tables together. GIS allows one to associate records in one table with records in another table through a common field, known as primary key or primary identifier. These associations are made in several ways, including by joining or relating tables temporarily in ones map or by creating relationship classes in the geodatabase that maintain more permanent associations. For example, one can associate a table of parcel ownership information with the parcels layer, since they share a parcel ID field.
When one joins two tables, the attributes from one are appended onto the other based on a common field to both. Relating tables defines a relationship between two tables-also based on a common field-but doesn't append the attributes of one to the other; instead, one can access the related data when necessary.
Joining a table of data to a layer is based on the value of a field that can be found in both tables. The name of the field does not have to be identical but the type of information must be the same. Hence, a string can only be joined to a string, text to a text and so on. In ArcMap, the join-operation is performed by using the *Join Data dialog box*, accessed by right-clicking a layer. All join operations carried out in this project are based on one-to-one relationship between the layers attribute table and the table containing the information to be joined.
On the other hand, relating tables simply defines a relationship between two tables. Unlike for the join, the associated data isn't appended to the layers attribute table. Instead, one can access the related data when working with the layers attributes. For example, if one select a parcel, the user of the parcel can be found. Similarly, if one selects a user, the parcel can be found.
Both operations facilitate the use of any additional fields to symbolize, label, query, or analyze the layers features.

2.6 Database Query

To retrieve information from the database, SQL statements were used. SQL is a query language that enables data retrieval from relational databases. The syntax of SQL requires the specification of what attributes is to be retrieved, the relation involved, and any condition governing the retrieval. Such a condition is called a predicate.
The results of the statement is a new drawing that is viewed in the database and also in the map face. However, the result are not stored in the database but used specifically for the purpose of visualization. One can prompt the software to save the query result.
The basic components of the SQL statement:

Select: <attribute name>
From: <table names>
Where: <condition to pick rows>

3. RESULTS AND ANALYSIS

3.1 Results of the digitization process

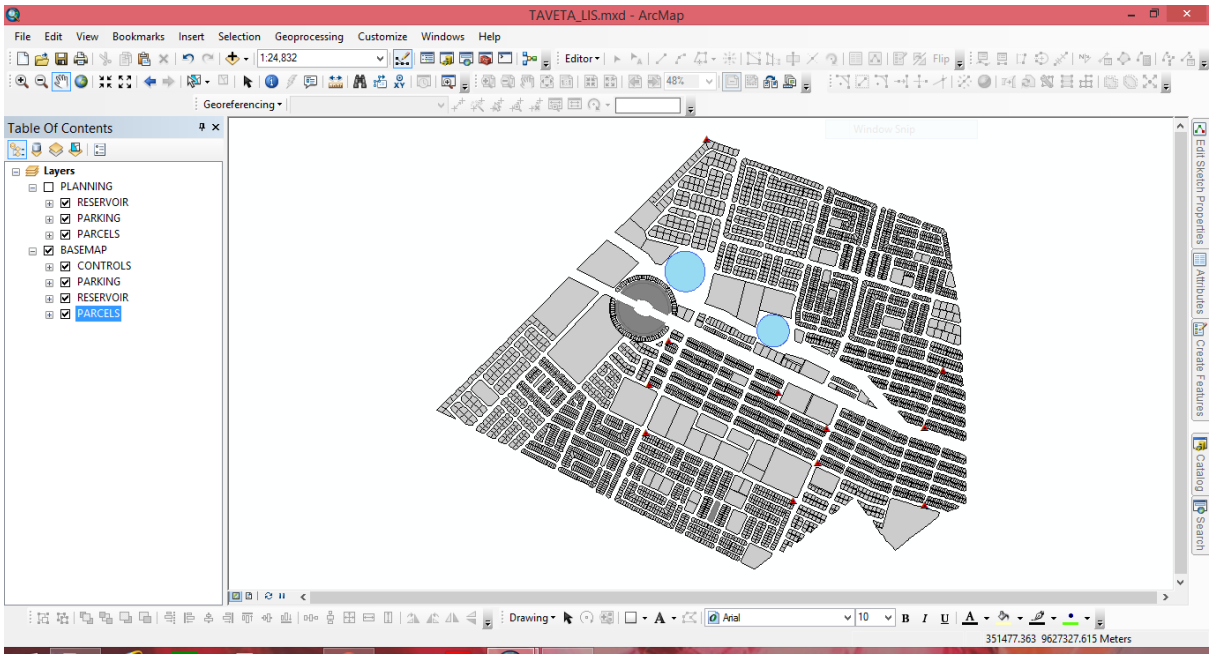


Fig 3.1 Digitization result

Figure 3.1 above shows the results of the process of digitization of the RIM after it has been georeferenced with coordinates in UTM Arc Datum 1960 and transformed to coordinates in UTM WGS 84. This was done so that integration with data such as google earth map, which is in UTM WGS 84, is possible. A total of 5407 parcels were digitized. The parcel numbers were then entered in to each digitized parcel.

3.2 Results of the designed relational database

Table 3.1 Parcels attribute table

Table

PARCELS

SHAPE *	PLOT_NUMBER	USER_	AREA_M2	AREA (Ha)	AREA (Acres)	ENCUMBEANCES	SHAPI
Polygon	1	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	2	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	3	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	4	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	5	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	6	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	7	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	8	COMMERCIA	450	0.045	0.111195	Charge to Jamii Bora Bank for Ksh. 270,000. Entry no. 1536. Date of registration 17-10-2012	
Polygon	9	COMMERCIA	450	0.045	0.111195	NIL	
Polygon	10	COMMERCIA	450	0.045	0.111195	NIL	

Table 3.1 shows the attributes of the table parcels in the relational database. The attributes of the table parcels include; Plot Number, User, Area in m2, Area in Hectares, Area in Acres and Encumbrances.

Table 3.2 Plot ownership attribute table

Table

TAVETA_OWNERSHIP

OBJECTID *	PLOT_NO *	OWNER_NAME	OWNER_ID	POSTAL_ADDRESS	PHONE_CONTACT	TENURE	TENURE_START	TENURE_TERM
1	1	MNGANDE Z. ABDALLAH	0	195 TAVETA	254721000001	LEASEHOL	5/18/2009	99
2	2	LUMAZO ZUHURA &	9714	3 TAVETA	254721000001	LEASEHOL	5/18/2009	99
3	3	LALDSERI ZUHURA &	12646	440 TAVETA	254721000002	LEASEHOL	5/18/2009	99
4	4	DAVID ZUBERUUMANNE &	12646	303 TAVETA	254721000003	LEASEHOL	5/18/2009	99
5	5	MUTHYA ZMIRI &	13238	402 TAVETA	254721000004	LEASEHOL	5/18/2009	99
6	6	HARRISON ZILILI A	13238	233 TAVETA	254721000005	LEASEHOL	5/18/2009	99
7	7	WISDOM ZILA A.	15390	195 TAVETA	254721000006	LEASEHOL	5/18/2009	99
8	8	SIMON ZIGHE A.	18461	245 TAVETA	254721000007	LEASEHOL	5/18/2009	99
9	9	SUNDE ZIGHE A. SURUMO	22653	195 TAVETA	254721000008	LEASEHOL	5/18/2009	99
10	10	ANNAH ZENGE A.	26516	40 TAVETA	254721000009	LEASEHOL	5/18/2009	99

Table 3.2 shows the attributes of the table TAVETA_OWNERSHIP in the relational database. The attributes of the table TAVETA_OWNERSHIP include; Plot No, Owner name, owner ID, postal address, phone contact, tenure, tenure start date and tenure term.

Table 3.3 Plot taxation attribute table

Table

TAVETA_TAXATION

OBJECTID *	PLOT_NO_*	STAND_PREM	ANNUAL_RENT_2009	ANNUAL_RENT_2010	ANNUAL_RENT_2011	ANNUAL_RENT_2012	ANNUAL_RENT_2013	ANNUAL_RENT_2014	ANNUAL_RENT_2015	T
1	1	50000	10000	4000	4000	4000	4000	4000	4000	
2	2	50000	4000	4000	4000	4000	4000	4000	4000	
3	3	50000	4000	4000	4000	4000	4000	4000	4000	
4	4	50000	4000	4000	4000	4000	4000	4000	4000	
5	5	50000	4000	4000	4000	4000	4000	4000	4000	
6	6	50000	4000	4000	4000	4000	4000	4000	4000	
7	7	50000	4000	4000	4000	4000	4000	4000	4000	
8	8	50000	4000	4000	4000	4000	4000	4000	4000	
9	9	32000	2560	2560	2560	2560	2560	2560	2560	
10	10	32000	2560	2560	2560	2560	2560	2560	2560	

Table 3.3 shows the attributes of the table TAVETA_TAXATION in the relational database. The attributes of the table TAVETA_TAXATION include; Plot no., stand premium, annual rent 2010-2023, total annual rent, balance stand premium and total balance.

Table 3.4 Plot transfers attribute table

Table

TAVETA_TRANSFERS

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

1 (0 out of 109 Selected)

TAVETA_TRANSFERS

Table 3.4 shows the attributes of the table TAVETA_TRANSFERS in the relational database. The attributes of the table TAVETA_TRANSFERS include; plot no, transfer from, transfer to, date of transfer and the amount.

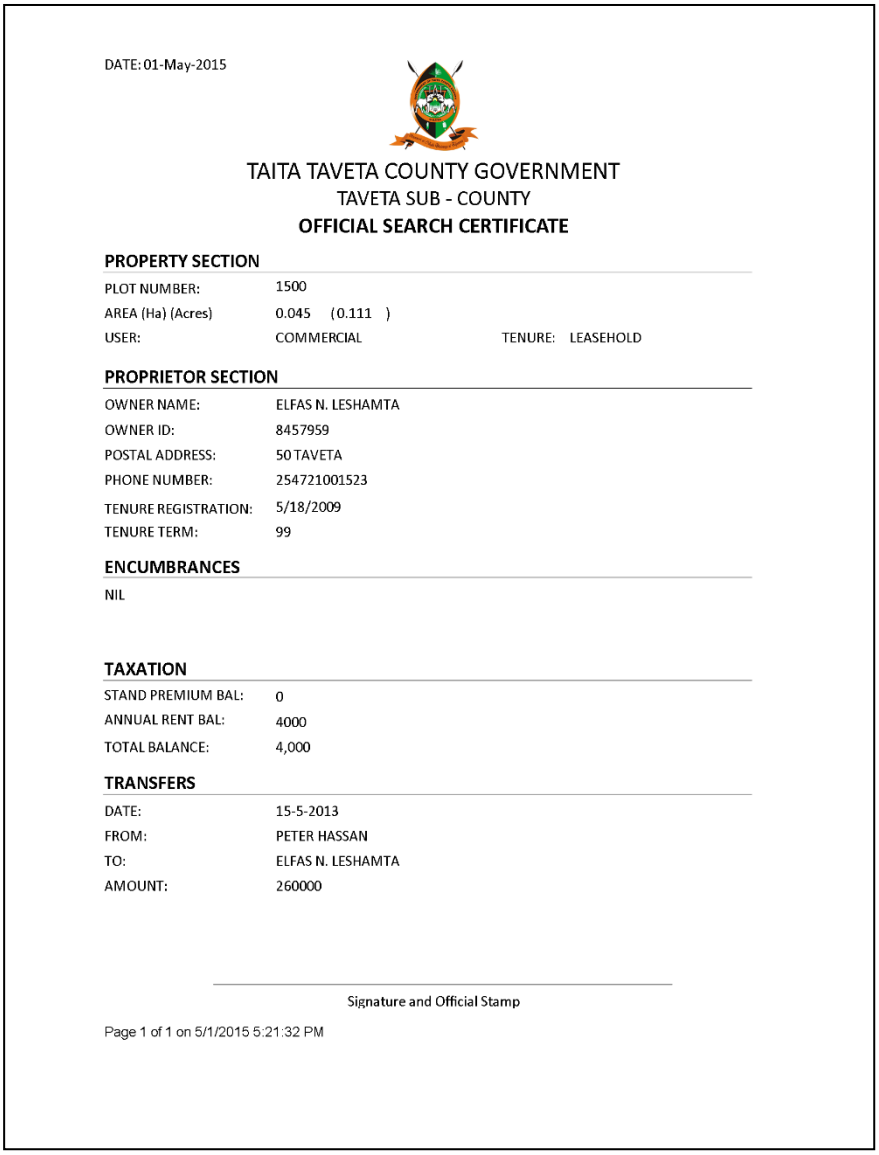
3.3 Discussion of the designed relational database

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

3.4 Search results

In carrying out a search on a parcel of land in the New Taveta Town Land Information System, one has to provide copies of the title deed/certificate of lease of the parcel, photocopy of ID and Kenya Revenue Authority PIN no. of the person doing the search and fill in the requisite forms.

3.4.1 Search results plot no. 1500



DATE: 01-May-2015

TAITA TAVETA COUNTY GOVERNMENT
TAVETA SUB - COUNTY
OFFICIAL SEARCH CERTIFICATE

PROPERTY SECTION

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

PROPRIETOR SECTION

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

ENCUMBRANCES

NIL

TAXATION

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

TRANSFERS

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

Signature and Official Stamp

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Figure 3.2 shows the search report on plot no. 1500.

3.5 Discussion of search results

The search reports generated on plot number 1500 has five sections. The five sections are; property section, proprietor section, encumbrance section, taxation section, and transfers section. The property section gives information on the plot number, the area of the plot in hectares and acres, the official user of the plot and the land tenure system. The proprietor section gives information on the name of the owner, the ID No. of the owner, postal address, phone number, date of tenure registration and the tenure term. The encumbrances section gives information on any encumbrances such as charge or caution on the property. The taxation

section gives information on the stand premium outstanding for the plot, the annual rent balance and the total balance due. The County Government use the taxation information to generate demand notices to plot owners having balances. The transfers section gives information on the date a plot transfer has taken place, the transfer from person A to person B and the amount registered as the purchase price. This gives information on stamp duty to be paid. At the bottom part of the search report there is a section for signature and official county government stamp, to show that the search is generated by the county government and also the date and time the search was generated from the database. The generated search report was compared with the classical search and it was found that the generated report gives more comprehensive information as compared to the classical search, which will be more beneficial to the users.

3.6 Results Queries on the database

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

3.6.1 County Government Query, Taxation on the database

The county government may want to find all plots that have a balance of more than or equal to Ksh. 200,000 so that they can send demand notices to the plot owners. The SQL statement to retrieve the information from the database will be:
Select: Plot numbers
From: Parcels
Where: Taveta Taxation Total Balance is greater than or equal to Ksh. 200,000.

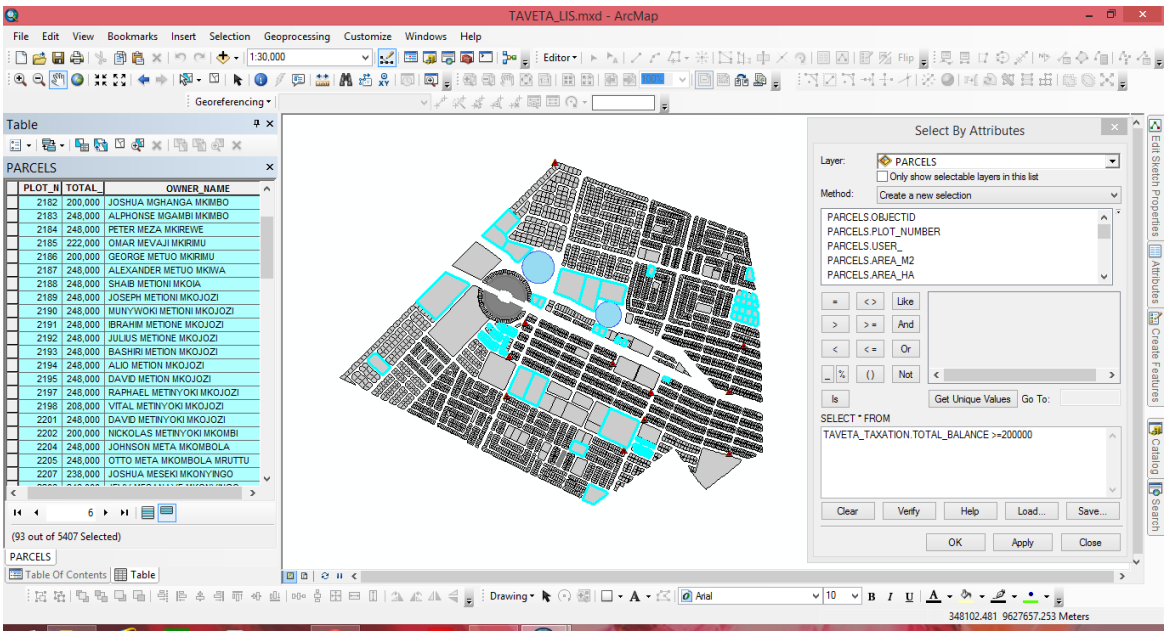

Fig 3.3 Query result taxation balance equal or greater than 200,000

Fig. 3.3 shows results of a query by the county government to find all plots that have a total balance of greater than or equal to Ksh.200, 000. A total of 93 plots have balances of Ksh.200, 000 or more, the results are displayed on the map and the details of the ownership are shown in the attribute table.

3.6.2 Surveyor's Query,corner beacons on the database

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

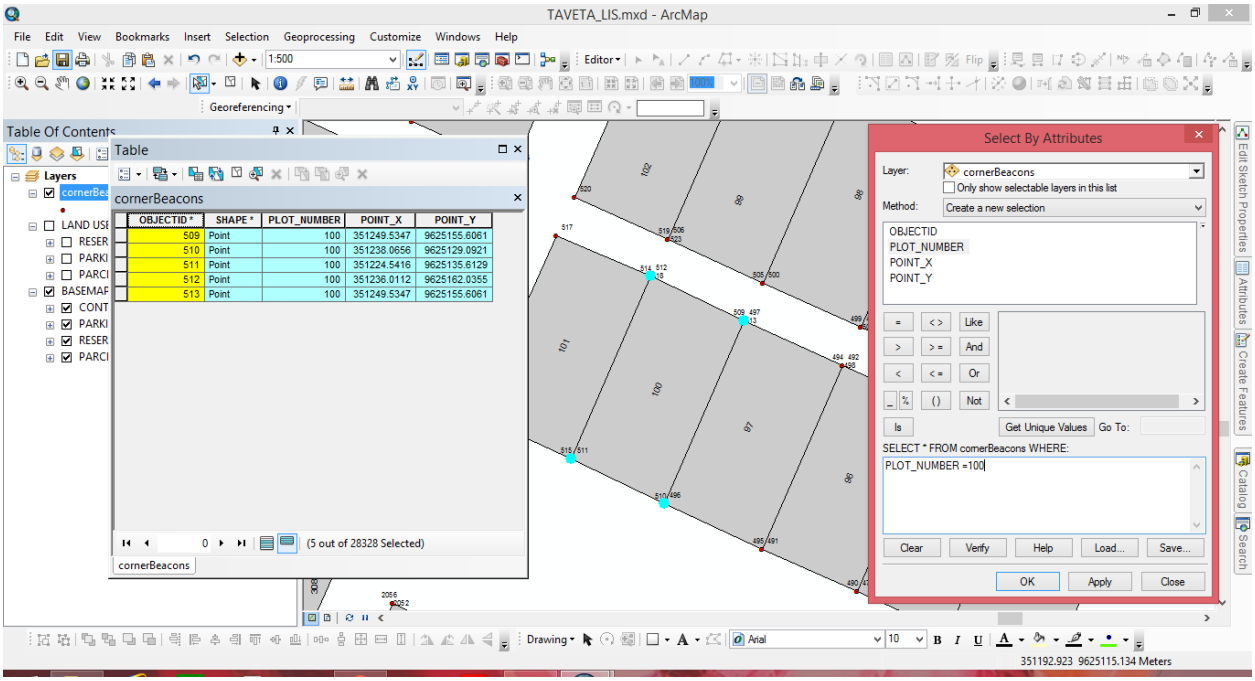

Fig 3.4 Query result corner beacons of plot no. 100

Fig 3.4 shows query results for a surveyor who wants to find out the corner beacons coordinates of plot no. 100. Plot No. 100 is highlighted on the map and the corner beacons coordinates are displayed in the attribute table. The coordinates are in UTM Datum WGS 84, the coordinates assist the surveyor in carrying out a survey on the property.

3.6.3 Investors query on the database

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

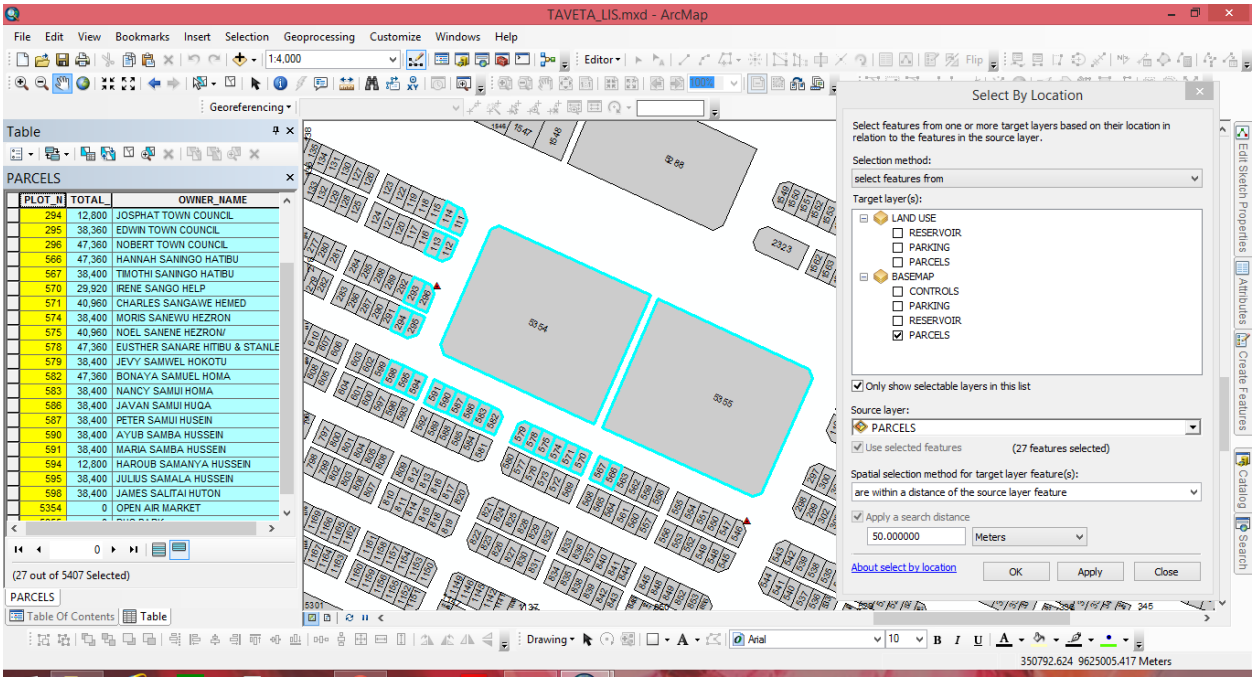

Fig 3.5 Query result plots within 50 metres of the open air market

Fig. 3.5 shows results of a query by a potential investor who wants to find all plots that are within 50 metres of the open air market. There are 27 plots that are within 50 metres of the open air market, which is highlighted in light blue colour on the map. The Ownership details of the 27 plots is also displayed in the attribute table.

3.7 Discussion Query Results

In the database design process the first step involved the external modelling also referred to as a 'user needs assessment'. The potential users of the database were determined, their information needs and the data that is required to satisfy those needs. The users of the LIS identified included the County Government of Taita-Taveta, land owners, surveyors, planners, valuers, potential investors, financial institutions, land brokers and the real estate companies. The different users of the database have different data and information needs. The information needs of a surveyor for example is information on plot numbers, plot area, coordinates and control points near the area of interest. The surveyors query on the database returns result on coordinates of the plot of interest and controls near the plot of interest. The investors query on the database returns results of plots within a distance of 50 metres from the open air market and the same result is also displayed on the map. The displayed result will enable potential investor

to identify the plots to purchase for investment. The County Government query on the database returns results of plots whose total balance is greater than or equal to Ksh. 200,000 which is also displayed on the map. The result enables the County Government to identify the plots with the stated balance and to send out demand notices.
The database can be queried for other information requirements of the users of the database by putting different constraints and query inputs.

4. CONCLUSIONS AND RECOMENDATION

4.1 Conclusion

The primary objective of this study was to develop a Land Information System for the New Taveta Town. It can therefore be concluded that in this project:

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

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

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

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

In the introduction the shortcomings of manual record keeping were highlighted as well as the growing need for a computerized LIS as put forward in the National Land Policy. The search results from the LIS was compared against the classical search from the ministry of lands, housing and urban development, the results showed that the search is sufficient in support of land transactions in the town. Input from professionals such as lawyers, planners, valuers and surveyors was obtained on information they required from a computerized LIS. Audits were carried out to determine whether the system provides the required information. From the audits it was found that the New Taveta Town Land Information provides the information required by the professionals.
The results of the study has shown the importance of acquiring a computerized LIS for the New Taveta Town.

4.2 Recommendations

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

i) Data on utilities such as power from Kenya Power, Water and Sewerage from Taveta Voi Water and Sewerage Company Ltd be included in the LIS to add more value.
ii) Design of a program to link the payment system used by the County Government-LAIFMS (Local Authority Information and Financial Management System) to the

New Taveta Town LIS so that information on taxation can be updated in real time as payments are being made.

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

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

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

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