Development of a Property Tax Information Management System for County Governments: A Case Study of Kapsabet Sub-county

Faith Jeruto Birir and Moses Murimi Ngigi

Abstract— Complete and reliable information is important for planning and decision making. Various challenges face Kapsabet sub-county revenue sector in regard to property tax rates and single business permit fee collection and management. The main challenges include lack of full information on the property owners, poor record keeping and the outdated spatial data. There is no link between the location of a property and its corresponding data, rendering all forms of spatial analysis impossible. The main objective of the study was to address this problem by developing a web-based property tax information management system that provides an effective tax collection and management. Open source GIS software was employed to develop the system. The system developed is composed of three sub-components: a database management system, a web-based mapping display and a short message service system. The database is centralized and contains tools for data updating and visualization while the web-based hosts the map visualization. The short message service (SMS) provides information on taxes arrears. Information on land parcels, buildings, building units, land rates and single business permit fees was incorporated in the resulting system. The system has provided an interactive link between real property and office records. The database results are various maps and list of coordinates for the tax defaulters. Maps depicts land use, unregistered properties, taxed and nontaxed properties. List of coordinates enable tracing of tax defaulters through handheld GPS. The SMS has provided a convenient way of reminding the property owners on the payment of taxes through their mobile phones. This system may be used by property owners in the diaspora to access information on their property through the web.

Keywords— GIS database, Property tax, Short Message Service, Visualization.

I. INTRODUCTION

Valuation principles became routine in countries colonized by the English. The same needs for valuation such as Taxation of Land and compulsory acquisition became imminent in the colonies. In East Africa, for instance, the English set up a system of local government in each country and the local authorities had to rely on land taxation as a major source of revenue. In Kenya, Local Government Rating Ordinance was passed in 1928, giving municipal councils power to

F. J. Birir, Department of Geomatic Engineering and Geospatial Information Science, Institute of Geomatics, GIS and Remote Sensing, Dedan Kimathi University of Technology (phone: +2540722462989; e-mail: birir.faith@gmail.com).

M. M. Ngigi, Department of Geomatic Engineering and Geospatial Information Science, Institute of Geomatics, GIS and Remote Sensing, Dedan Kimathi University of Technology (e-mail: murimi99@gmail.com).

tax land. A valuation organization was subsequently set up in the land Department in 1950 to help the local authorities to prepare the valuation rolls, [1].

Property tax was introduced in Kenya as early as 1900, where it was first applied to Mombasa on annual rental value basis [2], [3]. It was introduced in Nairobi, the following year. In 1923, taxation on the basis of annual values was found wanting as too few properties had developed. The site value tax was introduced throughout Kenya in 1928.

Taxation was introduced to the whole nation but the property taxes were bestowed to the local government authority. With the implementation of the new constitution, the county government are charged with the responsibility of making sure the county runs smoothly through the funds raised from different sources. One of the most important sources are the land rates and the single business permit fees from land owners and business community.

Developing countries everywhere are undertaking fiscal decentralization and local government reforms to improve economic efficiency and accountability. These reforms involve rationalizing expenditure and revenue responsibilities along with establishing intergovernmental transfer programs to enable governments to better fulfil their stabilization, distribution, and allocation functions [4] and [5].

One critical prerequisite for sustainable local government reform is adequate financial resources. Thus, in addition to supplementing local resources through establishing central local revenue transfers, governments are searching for ways to mobilize and improve existing local own-source revenue sources. Virtually all countries seem to be focusing on strengthening the property tax, the most common revenue source for local governments throughout the world [6].

Property taxation plays a major role in financing local governments throughout the world. Property taxes account for 40-80 percent of local government finance, 2-4 percent of total government taxes and about 0.5-3.0 percent of Gross Domestic Product (GDP) [7]. In contrast to developed countries, developing countries tend to generate significantly less property taxes revenue, with property taxes typically generating a maximum of 40percent of local government revenue, 2 percent of total government revenue, and about 0.5 percent of GDP [8].

Kenya is a clear example of a developing country underutilizing its property tax capacity. Property taxes (known in Kenya as rates) provide an average of 22 percent of total recurrent revenues for local authorities and represent 1.3 percent of total government tax revenue and 0.3 percent of GDP [9]. The property rates in 1994-95 provided K£ 60.2 Million and K£ 5.1 Million to the municipal councils and to town, urban and county councils, respectively [10]. In another study, it was found that property tax is the single most important source of revenue for local authorities in Kenya [11]. This source of revenue has been said to be the most lucrative and promising [11]. Property tax in Kenya, according to [10] is the least tapped source of tax

revenue to support urban governments in Africa. These local governments are the most affected by rapid urban growth, unplanned in many countries. The extent to which local government has control and has an understanding of these taxes is an important determinant of its commitment to ensure proper administration in collection and enforcement is ensured.

Property taxes are the major source of revenue that allow County and Sub-county governments to provide community services such as firefighting services, lights along the street, cleanliness of town, sewerage, supply of clean water, recreational facilities, health facilities, schools and infrastructure services. This revenue is not tapped efficiently due to the current situation of poor record keeping and corruption. In Kapsabet Sub-County government, the record books are frayed and some information is missing. The records also do not have enough data like the telephone numbers of the land owners or email and therefore tracing them is a problem.

Types of Property Rates

Land Rate: This is the tax levied on land based on the market value of land. Value of land increases as it is serviced with good roads, water, sewage system, street lights and other security systems. Once serviced the land is considered usable as zoned for settlements, industrial or agriculture.

Real Estate Rate (Land plus Immovable Object on the land): When a building that is immovable is added to a piece of land, this property is referred to as real estate. The property value increases based on the addition made. A property tax is thus assessed based on Land and Building combined as one.

Personal Property: These are movable objects. This mainly applies to privately held vehicles (Cars, Lorries, Trucks and others) and mobile machinery that are owned by residents of a County.

Sources of revenue

Single business permit- for registered business and operation license fee. This fee is paid to the sub county annually for respective businesses to run.

Property rates- these are land rates and land rent charged on land only. Within the former municipal boundaries of the Kapsabet sub county, land rates are charged while land rents are charged mostly outside the former municipality. Land rents are charged on land where the sub county has leased to the residents.

Housing and stall rents- these are revenue from rented houses and stalls from the former municipal council.

Accountable documents management- Receipt books for parking fee and market fee as well as the motorcycle fees.

Customer services and billing- bills arising from other activities and charges like vehicle obstruction, violation of laws, etc.

Other sources of revenue are: administrative services fees for advertisement of various documents such as part development plan, auctioneering, etc., Building fees for architectural approval fee, special approval fee, special development application fee and structural plans and cesses- animal cess, timber cess, skin and hides cess and tea cess. Public health facilities, educational related revenues such as registration of public and private schools, technical services fee such as blue prints, banners, building inspection and certificate of compliance, sewerage administration, and slaughterhouse administration fee, sale of sub county assets and social premise use charges such as hiring of social hall, etc are also sources of revenue. The study area is the Kapsabet Sub County (former Kapsabet municipality).

II. METHODOLOGY

The approach taken to achieve the set objectives involved several steps: data collection, data processing, database design, loading database to the web, development of SMS service and system implementation. The first step was to collect relevant data from Survey of Kenya, field observation; and Kapsabet sub county office, provided information such as land rates, dates of payment, etc,. Ground observation was done to verify the office records. The data was then converted to the desired formats. The spatial data was linked to respective non spatial data. To process the data, Quantum GIS software was used. Database design was done in Dia software using entity relation diagram (ERD) and was implemented in Quantum GIS and PostgreSQL. The database was published to the web using an Open Source server called GeoServer. The SMS service was developed through java code and an internet modem as the gateway as in Fig1.

Several Open Source tools and technologies were used to develop the system. Quantum GIS was for data processing and digital map creation. GeoServer was used to publish the geospatial data to the web through Open Layers. Java scripts were used to connect to the database and an internet modem as the gateway for the SMS service to reach the intended destiny.

Two types of data were collected namely the attribute and spatial data. The spatial data were the Registry Index Maps (RIMs) of fixed boundaries which was obtained from Survey of Kenya and the Quick Bird satellite image obtained from Survey of Kenya of February 2014. The attribute data was obtained from Kapsabet Sub County revenue office. These data was not adequate as the sub county staff could not release the actual data for individual tax payment for this study. Dummy data was used for ownership, land rate, single business permit fee, dates of payment and actual payments. Ground observations was done on land use, building use, number of floors of the building and unit use. The ground observation information formed the attribute data.
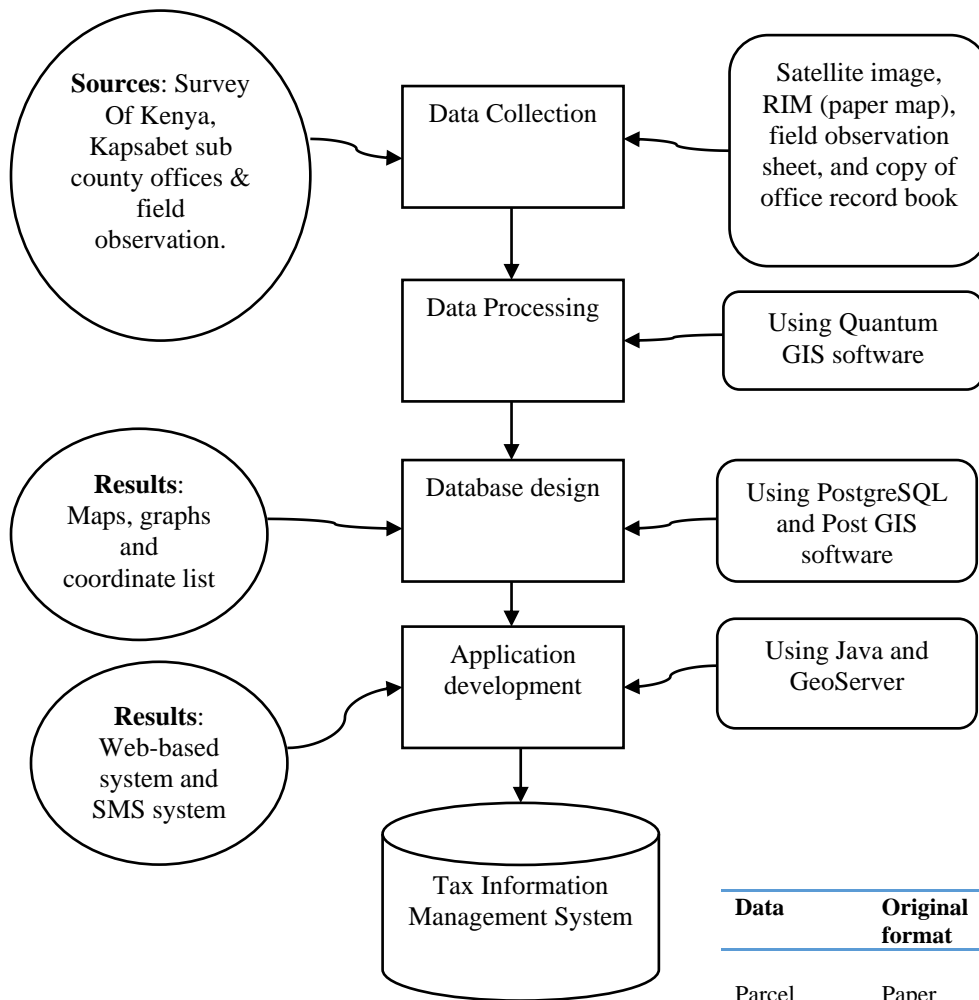
Fig 1: Flowchart for the system implementation.

III.   DATA PROCESSING AND ANALYSIS

The data used in the study was in different formats depending on source and type. All the data used to develop the system is summarized in Table 1.

Data	Original format	Process	Final format	Source
Parcel	Paper Map (RIM)	Scanned, georefenced, digitized	shape file	Survey of Kenya
Roads and Buildings	Image/ raster (Quick Bird)	Digitize roads and Buildings	Shape file	Survey of Kenya
Building units	Image/raster (Quick Bird)	Digitize	Shape file	Survey of Kenya
Parcel, building and building unit information	Paper	Digitize	Parcel, building and building unit information	Field observation and sub county

Table 1: Data, process and source

Scanning is the process of converting analogue data to digital raster model. RIM sheet 1 of Kapsabet Township was scanned at a resolution of 400dpi and colour. The scanned RIM was georeferenced that is aligning geographic data to a known coordinate system so it can be viewed, queried, and analysed with other geographic data. It may involve shifting, rotating, scaling, skewing, and in some cases warping, rubber sheeting, or orthorectifying the data. Four control points were used to georeference the scanned RIM in QGIS software environment. The four control points were obtained from field observation of the actual location of beacons. The coordinates system used the Universal Transverse Mercator projection (UTM) and the datum was Arc 1960.

Satellite image was in soft copy and geo-referenced in UTM coordinates with Arc 1960 as the datum. Layer of parcels was created as shape file and the above projections information were input. Buildings, units and road layers were created too on QGIS environment.

The process of converting the geographic features on a satellite image and RIM onto vector format in the computer was done in QGIS environment. This process is called on screen digitization. It converted raster data model into vector data model.

The layers created and digitized were parcels, buildings, roads and building units. Parcels and buildings were digitized as polygons. Roads were digitized as polylines while building units were digitized as points. The attribute fields' of the layers implemented results of the entity relation diagram. One of the attribute field for parcel layer was parcel identification number. Parcel identification number was composed of two parts. Part one is the township number, while the second part is parcel number.

Building layer had attribute field for parcel identification number and for the building number. Building units' purpose was verified through field observation. Its attribute field contained the building unit number and building number.

A. Topology building and editing.

This is where checks were carried out to ensure that relevant information required was free from errors. Topology checker is the operation done to display the relationships between connecting and adjacent features in a certain layer such as parcels. These are arcs, polygons and points. It is used for spatial modelling operations that do not require coordinate information. Topology checker in vector main menu is used. Building topology accomplishes the following; merge coordinates within the tolerance of each other, create a list of arcs that define each polygon boundary, numbers the nodes, deletes dangling arcs that are shorter than the specified dangle length. It also builds a polygon attribute table depending on the option used.

B. Designing of database in PostgreSQL

In PostgreSQL, the database was created first by connecting to the localhost server and creating new database. The Postgres user password was entered to connect to the server. The database management system was created. A command was run through SQL to enable database with Post GIS extensions. The command was CREATE EXTENSION postgis, it was typed and executed. The attribute fields were created after the normalization process in relational database management system as in Fig 2 and Fig3.
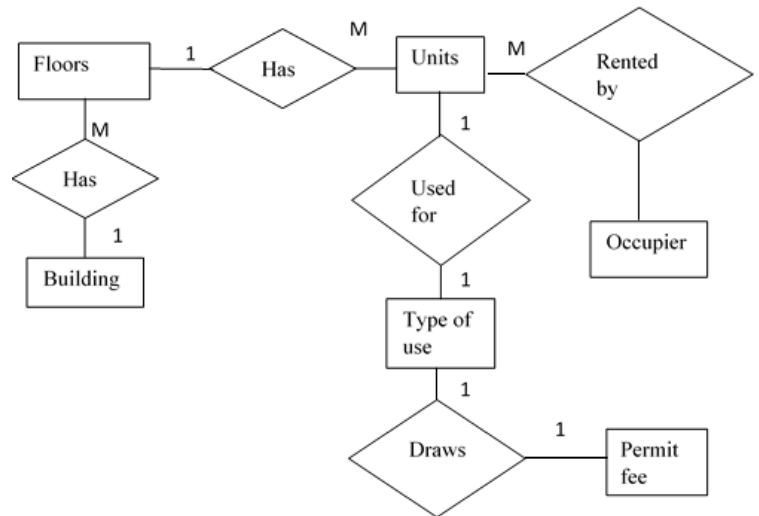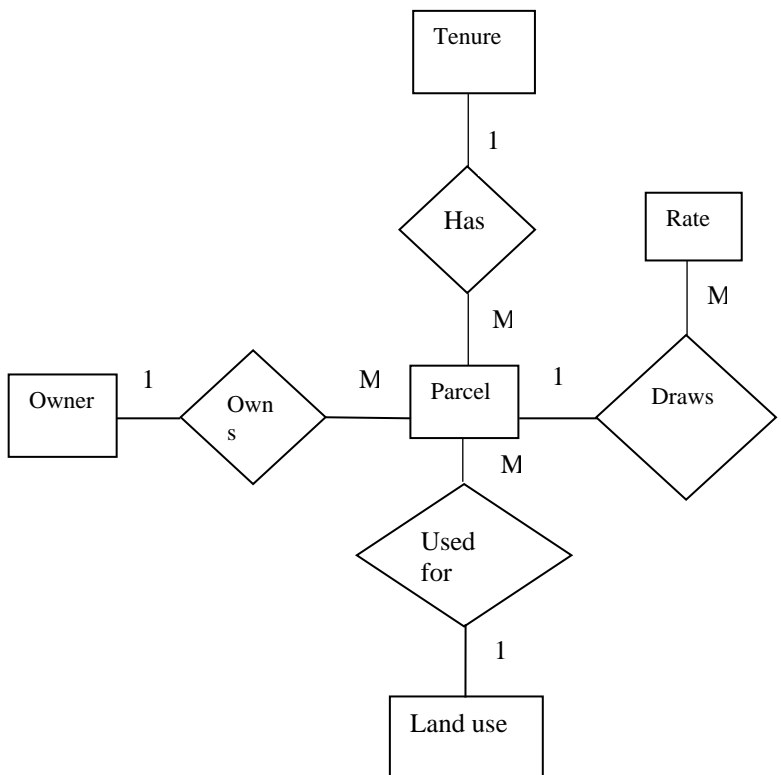

Fig 2: Entity Relational Model for building

Fig 3: Entity Relational Model for parcel

The datasets captured in QGIS software were imported to PostgreSQL to create tables using Plugins "Post GIS Shape file and DBF loader 2.1." The Post GIS shape file and DBF loader 2.1 was used to import shape files created in QGIS environment. Tables created were units, building, parcel and spatial reference system. Each table had geometry field and more fields were added and data typed.

C. Importing PostgreSQL database data into QGIS software

The data that was entered into the database, was exported onto QGIS application using Post GIS Shape file Import/Export Manager tool.

Post GIS connections was done and the shape file was added and imported to QGIS environment.

D. *Publishing map layers in the Web*

GeoServer is an open source server for sharing geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards. The GeoServer was started. Mozilla was started and the URL http://localhost:8080/geoserver/web/ was copied to Mozilla new page. The username and password were entered as " admin" and "geoserver" respectively. The workspace was created in GeoServer as the first to loading and publishing data. A workspace (sometimes referred to as a namespace) is the name for a notional container for grouping similar data together. It is designed to be a separate, isolated space relating to a certain project.This workspace was where the map layers were stored once they were imported from the QGIS geodatabase. The next step was to create store. A store is the name for a container of geographic data. A store refers to a specific data source, be it a shapefile, database, or any other data source that GeoServer supports. The layer was loaded into the store. A layer is a collection of geospatial features or a coverage. Typically a layer contains one type of data (points, lines, polygons, raster) and has a single identifiable subject (streets, houses, country boundaries, etc.). A layer corresponds to a table or view from a database, or an individual file. GeoServer stores information associated with a layer, such as projection information and bounding box that is the extend of data. Finally a layer group was created. A layer group makes it possible to request multiple layers with a single WMS request. The map layers were displayed by Open Layer flatform.

E. *Creating Short Message Service (SMS)*

The creation of SMS service was categorized into several steps. The template for GSM modem in form of files were downloaded and installed to relevant directories in the computer. Modem drivers were ran to install the modem and the modem port number checked and used in the NetBeans environment. Java codes were generated to connect the Modem, PostgreSQL database, interface and message and also to send the message.

Placing files in correct directory

SMSLib files were downloaded from the http://smslib.org/download. They were placed in three different folders (lib, lib_ext, and bin). The files in these folders were copied into their respective folders in Java folder in the computer. The Java comm extension was downloaded from http://java.sun.com/products/javacomm/ and installed to the computer. The following files were part of this installation:

- File comm.jar was installed to JDKDIR/jre/lib/ext/
- File javax.comm.properties was installed to JDKDIR/jre/lib/
- Library files was installed to JDKDIR/jre/bin/

RxTx is a native library for serial and parallel communication in Java. It is found in pre-build files in the http://smslib.org/download site. It provides a portable implementation of Sun's JavaCOMM. File RXTX comm.jar was downloaded and installed to JDKDIR/jre/lib/ext/ while library file was downloaded and istalled to JDKDIR/jre/bin/ in the computer.

Connecting the database

Connecting to the database in postgreSQL was done in Java Neatbeans environment.The package was named survey_sms_project. Classes were created and used as following:

- DBsql class was created to connect to the database in PostgreSQL. Columns of the tables in the database were specified as the owner, rate, arrears and mobile phone number.The interface to display data from the database was created using Pallete Pane. From the interface, SMSlib class was linked.
- SMSlib (message) class was created to send SMS. This was possible when it was linked from the interface.

In Java Neatbeans environment, methods and classes were used. Some of the methods used were: Connect which established connection to the database, input which inserts parcel and building units details into the database, and sendmessage which links the mobile phone number and message and send the message to tax defaulter.

IV. RESULTS

Property Tax Information System

The property tax information system is the system that is able to perform GIS queries and analysis on the spatial database that was created using QGIS, PostgreSQL and Post GIS softwares. The system shows the taxed and untaxed properties as in Fig 4 and Fig 5.
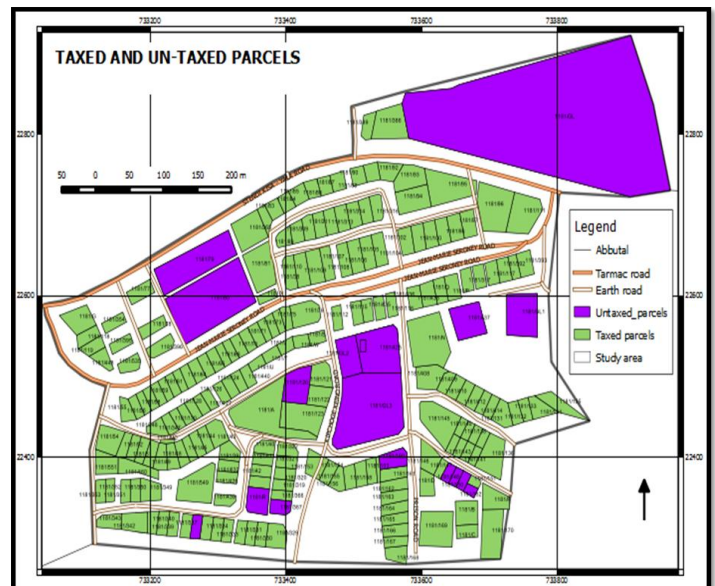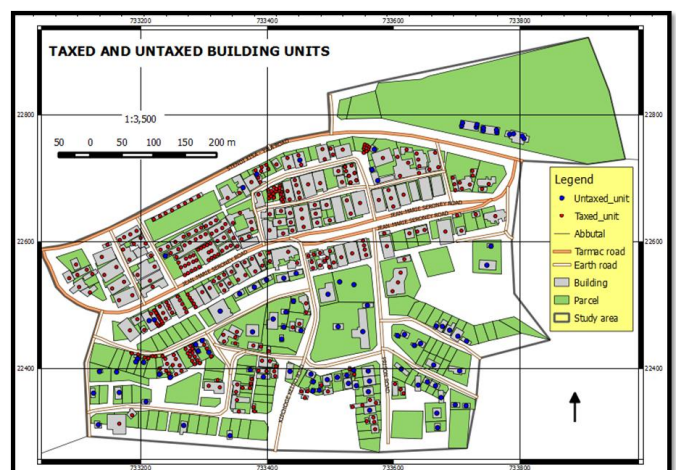

Fig 4: Taxed and untaxed parcels

Fig 5: Taxed and untaxed building units

The system facilitates display of properties that have not been registered. Properties are not appearing in the Sub County records as in Fig 6.
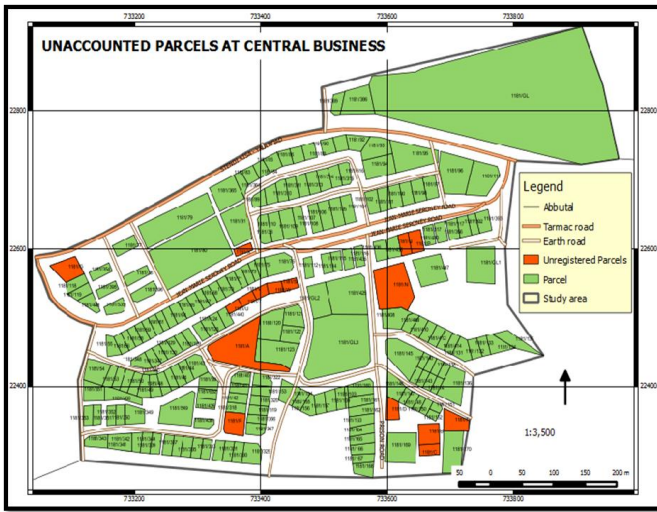
Fig 6: Unregistered parcels

The database facilitated easy identification of the spatial location of tax defaulters and non-tax defaulters as in Fig 7 and Fig 8. The tax collectors can use the spatial location to physically locate the tax defaulter. It will also enable them to easily know how much the tax defaulter owe the sub county.
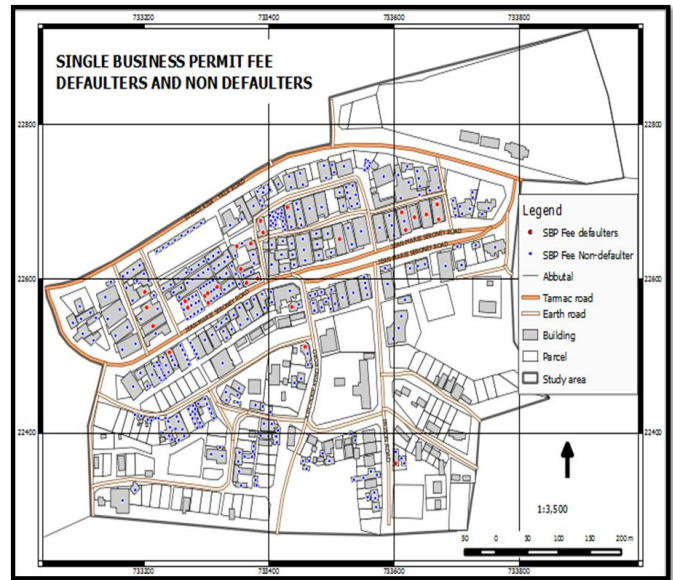

Fig 7: Land rate defaulters and non-defaulters

Fig 8: Single business permit fee defaulters and non defaulters

It was also easy for the sub county officials to generate list of owners as well as location of tax defaulters for the Single business permit fee and the land rates from the system. From the centroid of the parcels belonging to tax defaulters, the coordinate list was generated as in Fig 9.
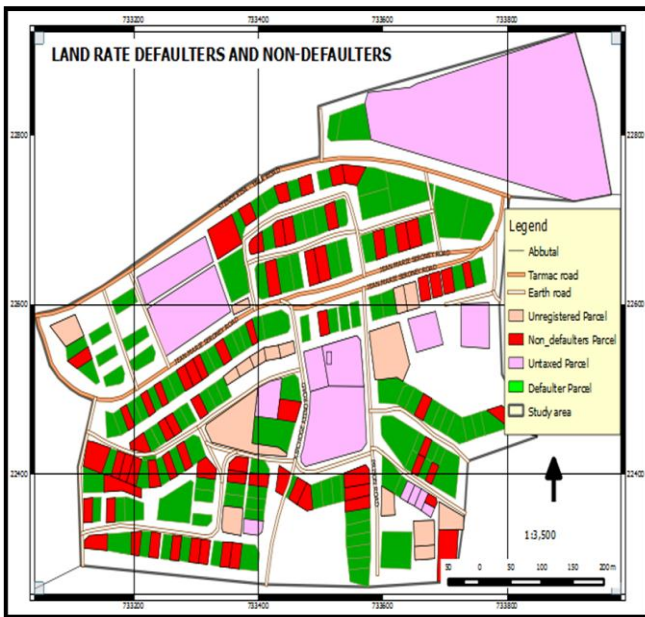
Coordinates of the single business fee defaulters

fname	lname	Phone_no	arrears	POINT_X	POINT_Y
Stephen	Koech	712545232	4000	733371.15	22644.19
Stephen	Koech	0712545232	2000	733348.00	22640.55
Peter	Maiyo	0712459877	2000	733355.56	22611.13
Rachael	Serem	0775621111	2000	733364.00	22593.19
Rachael	Serem	0775621111	2000	733381.71	22598.80
Richard	Barno	0735237489	1000	733386.00	22673.62
Richard	Barno	0735237489	3000	733390.35	22658.49
Kelvin	Terer	0721006598	2000	733429.19	22691.27
Mark	Misoi	0720852951	3000	733671.81	22675.51
Mark	Misoi	0720852951	3000	733669.00	22695.12
Benard	Chepkwony	0720714563	4000	733652.00	22681.95
Francis	Maneno	0722145263	2000	733633.00	22678.31

Fig 9: Coordinate list of tax defaulters

From the system, it was easy or possible to generate land have been used at Kapsabet Central Business District as in Fig 10.
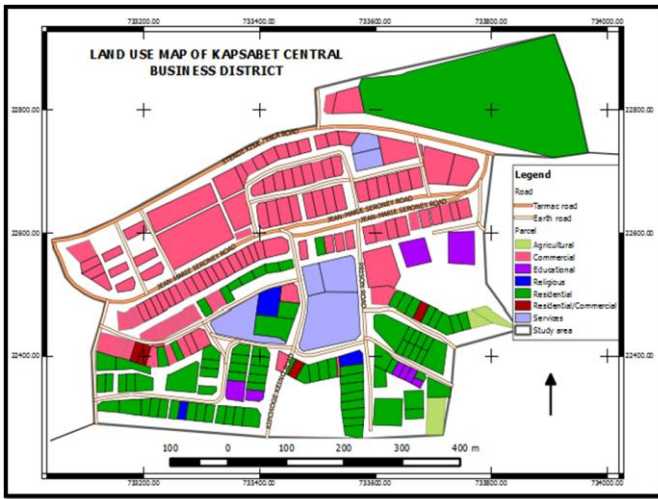
Fig 10: Land use map of Kapsabet Central Business District

At the central business district, there are mainly commercial parcels while residential parcels are away from the central business district. Single business permit fee characteristics, was easily generated from the database. These characteristics will enable the sub county officials to identify the business that generates revenue as in Fig 11.
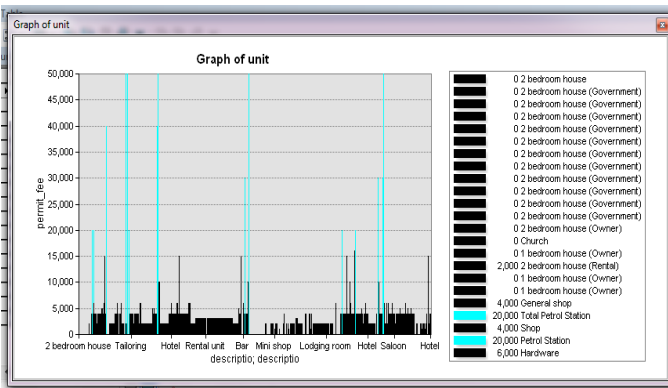

Fig11: Single business permit characteristics

Publishing map layers in the web

Map layers were loaded and published to the web through GeoServer 2.3.0. Mozilla new page was connected to the GeoServer through GeoServer URL. The map layers are loaded to a workspace created in GeoServer. The map layers are from QGIS database. The map layers could be grouped or displayed as one layer. The map layer such as parcel is displayed in the web in the layer preview. The spatial data was displayed as well as the attribute data as in Fig 12.
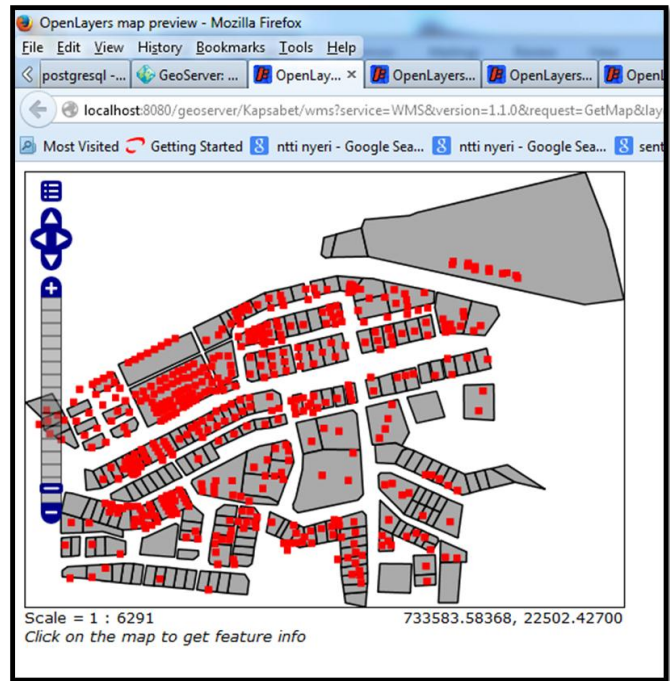

Fig 12: Parcels and building units displayed in the web

SMS service System

SMS service system was developed in Java NetBeans IDE 6.7. SMS service system is the system that enables the link of database management system and the message and send information on tax arrears through an internet modem as the gateway. Java scripts were used to connect the system with the PostgreSQL database and to create interface that links the database and message. The system can send messages to several category of tax defaulters. The system picks each individual arrears amount and the mobile phone and sends the message to each one as in Fig13. This provides an easy way of reaching many tax defaulters at once. The system can also send message to one tax defaulter by checking on the send column.
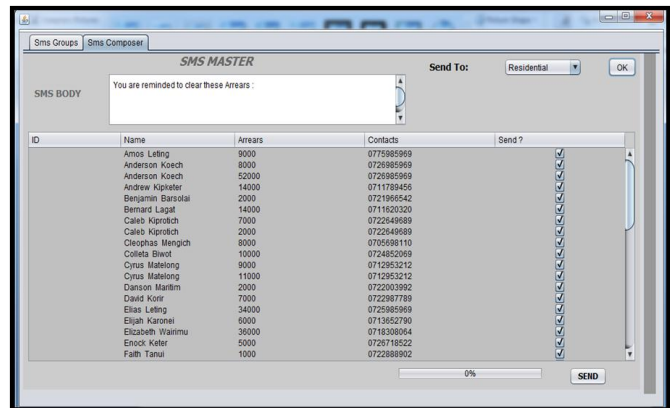

Fig 13: SMS service system linked to database and message

V. CONCLUSION

The designed Property Tax Information System will address the needs of Kapsabet sub county revenue officials. One of the most important need for the officials was mapping of the taxed and non-taxed properties within their area of jurisdiction. This will help the Kapsabet sub county officials to quantify taxed and untaxed

properties and locate. The system will enable categorization of properties depending on the proximity according to the number of staff, hence inspection of tax properties becomes manageable. The officials will be able to identify the unaccounted/ unregistered properties and so serves as a check on updating of transacted properties due to subdivisions of land parcels and erection of buildings. The updating of property is made easy in the system. The research found out that there about are sixteen parcels which were not registered in the registry index maps as well as in the tax books in the Kapsabet Sub County. Few businesses are running without the single business permit license, implying that taxes from businesses are mostly tapped.

The developed system will also enable the sub county staff to identify land use and institute laws and regulations on development of the area. Land use enables the concern bodies to plan and implement laws and regulations to ensure that there is environmental sustainability in the area of jurisdictions.

The tax information system has provided an interactive link between real property and office records and can facilitate tracking of the property owners through use of handheld GPS. Geographical Information Systems have proven to be power tools in the collection of taxes (land rates and single business permit fee) and tracking delinquent tax payers thus assisting in raising the revenue collection. This is shown by locating the tax defaulters where they are geographically located in the system and also by being able to reach the parcel owners effectively and efficiently through the use of handheld GPS and coordinate list and also sending SMS through the SMS service system. The SMS system retrieves tax arrears information and mobile phones of the tax defaulters from the central database, composes the message and sends to the tax defaulter's mobile phone through an internet modem as a gateway. The SMS is the most convenient and quick way of reaching the tax defaulters. The SMS saves time and resources wastage in spatially locating the tax defaulter and it is not limited by distance. The message received by the tax defaulter in the memory chip is permanently there unless deleted.

Kapsabet residents in the diaspora and local will be able to check on their property tax information in the web. The properties displayed in the web have their attributes that is in the database which is convenient for the property owners. They will also receive messages in their mobile phones to remind them on the payment of property taxes.

The implementation of this system, will aid in efficiently and effectively reach the parcel owners with real time issues and information. It will also aid the Sub County workers to efficiently and effectively perform their duties. It will enable the County officials to ascertain environmental sustainability in the county by making sure land is used as required.

VI. RECOMMENDATION

The research study was limited to land rates and single business permit fee. In county and sub county governments, there are many sources of revenue which may not have been focused in the research study. There is therefore a great need for further research in the area of property taxes sources in the county and sub county government with emphasis on how emerging technologies can be used to address management of property taxes.

The Property Tax Information Management System development should be taken into considerations by the county government to enable Sub County and the whole County of Nandi collect almost all revenues. This will boost the revenue level in order for the Kapsabet Sub County government and entire County be able to meet the demands of the people by providing the social amenities required in the county.

REFERENCES

[1] P.M Syagga, "*Real Property Valuation in the Year 2000 and Beyond*". Proceedings of the Institution of Surveyors of Kenya Seminar 10th December, Mount Kenya Safari Club, Nairobi, 1999.

[2] W.H.A. Olima, Land Value Taxation in Kenya in McChuskey W.J. and R.C.D Franzsen (eds),Land Value Taxation and Applied Analysis; Ashgate Publishing ltd England. African Journal of Science and Technology. : VLIR, 2005.

[3] W.H.A Olima and P.M. Syagga, "Rating System in Kenya: Evolution, Constraints and Potentials", Real Estate Studies Unit - Journal of Property Tax Assessment and Administration. An International Journal for Research in Property Tax. Vol. 2, No. 1, 1996.

[4] J. Hopkins, the analysis of household surveys: A micro econometric approach to development policy, 1997.

[5] T.T. Minassian, Decentralizing government operations can improve economic welfare. But decentralization requires close policy coordination among all levels of governments, 1997.

[6] W. Dillinger, "*Urban Property Tax Reform: Guidelines and Recommendations*". The World Bank: Urban Management Program. Washington, DC, 1993.

[7] Youngman and Malme, Land Value Taxation and Development Activity: The Reaction of Toronto and Ottawa Developers, Planners, and Municipal Finance Officials, 1994.

[8] R. Kelly, "Designing a Property Tax Reform Strategy in Sub-Saharan Africa: An Analytical Framework applied to Kenya." HIID Discussion Paper 707. Cambridge, MA: Harvard Institute for International Development, 1999a.

[9] Government of Kenya, CBS, World Food Programme and Government of Kenya, Community Based Food Aid Targeting and Distribution in Kenya: Field Manual, 1996.

[10] R. Kelly, Property Taxation in Kenya in R.M. Bird and E. Slack (eds), *International Handbook of Land and Property Taxation*, Edward Elgar Publishing Limited, UK, pp. 177-188, 2001.

[11] C. Kariuki, N. Nzioki and J. Murigu, '*A Review of the Training Needs for Revenue enhancement for local Authorities in Kenya*', University of Nairobi Department of Real Estate and Construction Management, 2009.