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Development of an informal Cadastre using social tenure domain model (STDM): A case study in Kwarasi informal settlement scheme Mombasa

Bartholomew, C. Mwanyungu[1*], David, N. Kuria[1], Moses, K. Gachari[1], Godfrey, O. Makokha[1] and Malachi Odongo[2]

[1]Institute of Geomatics, Geographic Information System (GIS) and Remote Sensing, Dedan Kimathi University of Technology, P. O. Box 657-10100, Nyeri, Kenya.
[2]Voyants Solutions Private Limited (VSPL), Gurugram, Haryana 122001, India.

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The Kenya government together with development partners has embarked on the development of informal settlements. Mombasa County has more than 70 informal settlements; information about the settlements and their relationship to the existing cadastral spatial layer covering the entire Mombasa County needs to be determined in order to support decision making for sustainable development. This study evaluates the Social Tenure Domain Model (STDM) land tool in the development of an informal Cadastre by capturing, storing, and manipulating social and spatial information in Kwarasi informal settlement in Mombasa. This case study is an example that can be replicated to the rest of the informal settlements in Mombasa forming a single informal cadastral database for the entire county. Participatory enumerations and the STDM tool were used in this research to present the situation of Kwarasi informal settlement. The housing structures were adopted as the spatial unit for the informal Cadastre over which the rights of the inhabitants were adjudicated, customized and uploaded into the STDM where social tenure relationships were created to form the Cadastre in the STDM system. The spatial component of Kwarasi informal Cadastre was overlaid on the Mombasa cadastral layer and their relationship determined. It has been demonstrated that the relationship would be useful for decision making to support sustainable development intervention, and ease land administration by maintaining a detail record of the informal settlements.

Key words: Cadastre, global land tool network (GLTN), informal settlements, land administration domain model (LADM), social tenure domain model (STDM).

INTRODUCTION

Millennium Development Goal number 7 that seeks to ensure environmental sustainability, target 11 to have achieved a significant improvement in the lives of at least 100 million slum dwellers by 2020, the Kenya Government has initiated programmes in order to improve the living conditions in the informal settlements

*Corresponding author. E-mail: mwanyungu@yahoo.com.

on its own and with the help of other development partners such as the Un-Habitat, World Bank and United Kingdoms' Department for International Development (DFID).

The initiatives are Kenya Informal Settlement Improvement Project (KISIP), Kenya Slum Upgrading Program (KENSUP), and Mombasa Slum Upgrading Project (MSUP) with the aim of improving the livelihoods of people living and working in slums and informal settlements in the urban areas of Kenya through the provision of security of tenure and physical and social infrastructure (Muraguri, 2011).

However, more information is required about individual informal settlements before any reasonable development intervention can be sustainable. An informal settlement inventory report prepared by the Mombasa County Government in collaboration with Pamoja Trust shows that 65% of the population in Mombasa county live in informal settlements that count to 70 in number and of various sizes (Mombasa County Report, 2013). The spread of informal settlements in Mombasa county is as shown in Figure 1, providing an overview of the situation of informal settlement in Mombasa county.

The Cadastre is a methodically arranged public inventory of data concerning properties within a certain country or district, based on a survey of their boundaries. The outlines of the property and the parcel identifier normally are shown on large-scale maps which, together with registers, may show for each separate property nature, size, value and legal rights associated with the parcel. It gives an answer to the question where and how much (Henssen, 1995).

There is a growing recognition in many countries, international organisations and with land administration practitioners that land administration, and particularly the core cadastral system, has an equally important role in supporting sustainable development objectives, rather than the traditionally narrow focus on land markets (Wiebe and Meinzen-Dick, 1998).

In UN-HABITAT (2008), the various types of land rights are viewed as existing along a continuum, with some settlements being more consistent in law than others. This view makes it possible to include the people with the weakest tenures pursuant to the idea of sufficient legal access (Figure 2).

The Social Tenure Domain Model (STDM) is a pro-poor land tool developed to serve primarily, the needs of the poor (Lemmen, 2010). STDM is a land information system that has been developed using the standards of Land administration Domain Model (LADM) which is International Organization for Standardization (ISO) certified and hence data integration is made possible (Lemmen, 2010; Enemark, 2009). Developed by the the Global Land Tool Network (GLTN), facilitated by UN-HABITAT together with coalition of international partners (Un-Habitat, IIR, GLTN, 2012).

GLTN partners support a continuum of land rights (Figure 2), which include rights that are documented as well as undocumented, including slums which are legal as well as illegal and informal (Un-Habitat, IIR, GLTN, 2012). STDM is a conceptual model that is descriptive and not prescriptive and records the status quo leaving people-land relationships intact (Charisse et al., 2013).

The main objective of this project was to evaluate the STDM land tool in the development of an informal Cadastre in order to support decision making for sustainable development intervention in the informal settlements in Mombasa County. This is by bringing out into view and put into record the informal settlement details of Kwarasi informal settlement in Mombasa county as a model to be used for replication to all the other informal settlements in the county and the rest of the country. This was achieved by:

(1) Adjudication of the informal rights within Kwarasi informal settlement, relating the rights with the spatial unit and create the social tenure relationships for the settlement in the STDM system.
(2) Using the spatial and attribute cadastral data in the STDM database to generate reports and produce certificates of residence directly from the system and lastly.
(3) Overlaying of the informal Cadastre on the formal Cadastre to bring out the relationship between the formal and the informal cadastral information in Kwarasi in order to aid in decision making for sustainable development.

Obtaining legal regime in Mombasa county

The Land Titles Act (LTA) cap 282 laws of Kenya (repealed), formerly the Land Titles Ordinance (LTO) is the only law that came close in recognising and institutionalising informal land rights in Kenya. It is a deeds registration act that was enacted in 1908 and operated in the ten nautical miles strip inland of the Kenyan coast including Mombasa town where the project area is situated (Government of Kenya, 1908).

The act recognised rights that may be termed as informal including traditional customary or any describable right and hence phenomena of informal land rights are not new to the persons of the project area. However, the system is manual and therefore for ease, management would required computerisation so that the interests therein could easily be retrieved. The act was designed as both a land adjudication and registration act at the same time. It was institutionalized by the establishment of a court presided by a recorder of title which is only subordinate to the high court of Kenya and a chief surveyor for mapping the adjudicated claims. The principle land registrar administered the registration part.

Most land registration systems adhere to the Latin maxim "Quicquid Plantatur Solo, Solo Cedit" which means "whatever is affixed to the ground belongs to the

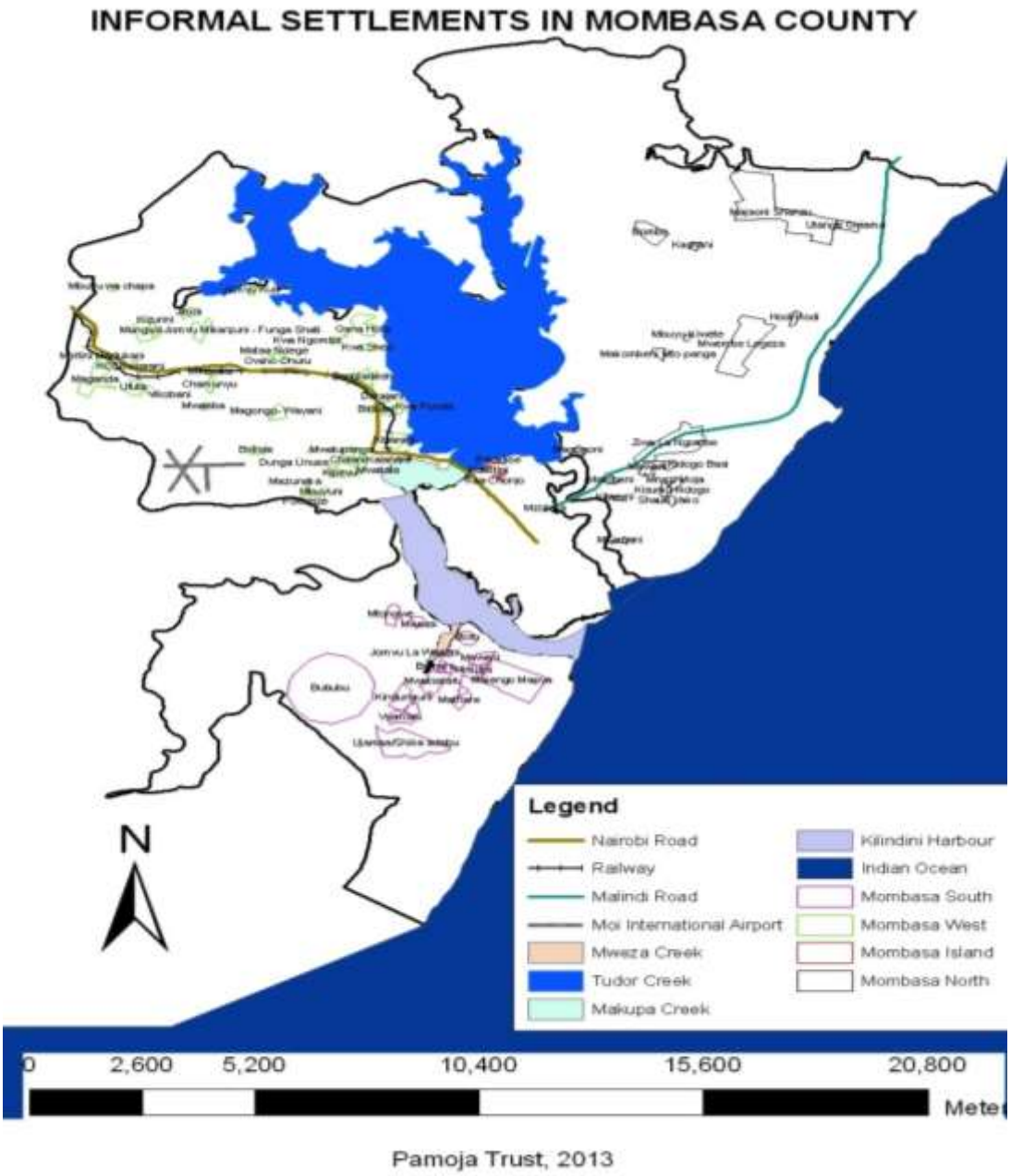

Figure 1. Spread of informal settlements in Mombasa County (Mombasa county report, 2013).

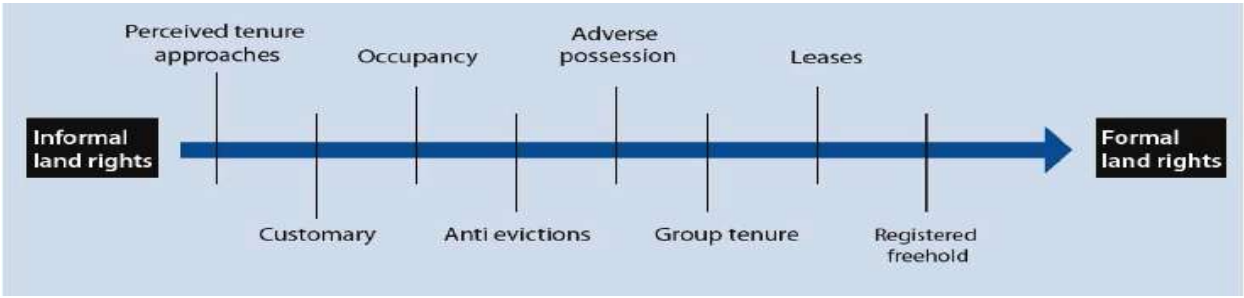

Figure 2. Continuum of land rights (UN-HABITAT, 2008).

ground." Hence, the owner of the title owns all that is permanently attached to the land such as buildings trees crops, etc.

Under this law, fixtures are recognized and can be registered independently and owned by a different person from the title owner. As an illustration, the interest registered over the parcel of land under the LTO was a fixture that would be considered as part of the land in other statutes.

Makuti houses in the documents are usually owned by a different person from the owner of the title. The *makuti* house may have been constructed with the consent of the owner of the title of land without necessarily subdividing the land or selling it to the owner of the structures. This is evidence that such a situation is a recordable possibility in this registration system and may include water wells, permanent plants such as coconut and mango trees.

This has been possible due to the fact that the registration model was designed to accommodate such occurrence and designed in consideration of the culture lifestyles and traditions of the local people. Such a state is not feasible in other acts of registration but was possible in the LTA and can be used to enhance STDM. It is very clear that for any process of upgrading informal settlements to succeed, detailed knowledge and information will be required on the prevailing systems of land administration; together all the vested interest by the tenants, extralegal powers and absentee slum lords (Omwoma, 2013).

METHODOLOGY

Study area

The study area is Kwarasi informal settlement situated in Mombasa county. Mombasa county located along the Kenyan Coastline (Latitudes 3° 80' and 4° 10' S and Longitudes 39° 60' and 39° 80' E) and has a population of about one million people (Figure 3).

Mombasa is the second largest city and oldest municipality town in Kenya which is a port city that also doubles up as a county managed by a county government. Kwarasi informal settlement is in Mombasa mainland west, Changamwe constituency. The settlement is composed of tenants and landlords with a total population of about 200 people within an area of about 4 acres.

The constitution of Kenya 2010 categorizes land as public, community and private land (Government of Kenya, 2010). The National Land Policy (NLP) states that squatters are found on public, community and private land (Government of Kenya, 2009). Prior to this categorization of land, informal settlements already existed in Mombasa county. On examining the informal settlement inventory for Mombasa county, the following types of land situations are host to informal settlements:

(a) Informal settlements on public land: These are settlements that are situated on public land that is not alienated or land reserved for a public facility such as a school, social hall or any other public amenity.
(b) Informal settlements on private land: Informal settlements that are on registered land held by any person under any freehold or leasehold tenure and any other land declared private land under an Act of Parliament.
(c) Informal settlements on land owned by absentee landlords: These legally fall in the category of private land whose owners appear on the lands registry record but cannot be traced. They are mainly people who were registered in the early 20th century as owners on free hold interest or long duration leases who then relocated to other countries mostly Portuguese, Arabs, Asians and Britons.
(d) Squatting on riparian reserve: Informal settlements on riparian reserves in Mombasa are mainly areas that abut the high water mark of the Indian Ocean, mostly grown with mangrove trees, this land falls under the category of public land.
(e) Tenants at will: Tenants at will in Mombasa is where landlords allow tenants to construct houses on their land at a deposited amount of money and subsequently a monthly rent under a lease agreement that is private, perpetual and for as long as the house is in existence. The developments are temporary, not planned and are not part of the city main stream plan. The land lord who holds the free hold title indicates the site of construction in disregard of planning regulations.

All the aforementioned settlements constitute structure owners and tenants on residential and small businesses within the informal settlements.

Method

Figure 4 shows the general flow of research activities undertaken. Attribute cadastral data modelling was done using Unified Modelling Language (UML) tools in Dia software. Through the situation analysis that was observed from the Mombasa informal settlement inventory and county government records it was noted that the persons that represent the party in the STDM were mainly structure owners and tenants. Structures were adopted as the spatial units for the STDM since there were no land parcels as in the formal cadastral systems in the case of Kwarasi.

Datasets and materials

Spatial data

The Mombasa County Government has completed the preparation of the Integrated Spatial Urban Development Plan (ISUDP) for Mombasa city for up to the year 2035. Part of the data used for the project in the custody of the county government is the Mombasa county aerial photo image in digital format that has been geo-referenced and sheets combined into one continuous mosaic for the whole county. The co-ordinate system of the photo-mosaic is UTM Zone 37 arc 1960 projection. This image acquired in the year 2014 was used in this project to identify and map the structures, the spatial unit of the STDM informal cadastral spatial data. The entire Mombasa county digital cadastral layer was another product of the preparation of ISUD and is also in UTM Zone 37 arc 1960 projection that was used as part of the project data. Others were the site and service scheme plans of World Bank Housing Project II, and site location plans from the county government of Mombasa. The informal settlements including Kwarasi lie on the un-serviced areas of Chaani site and service scheme and spill beyond into other properties.

Attribute data

The Mombasa county assisted by the National Government through KISIP has embarked on an exercise of regularization of informal settlements. For that purpose attribute data was collected from

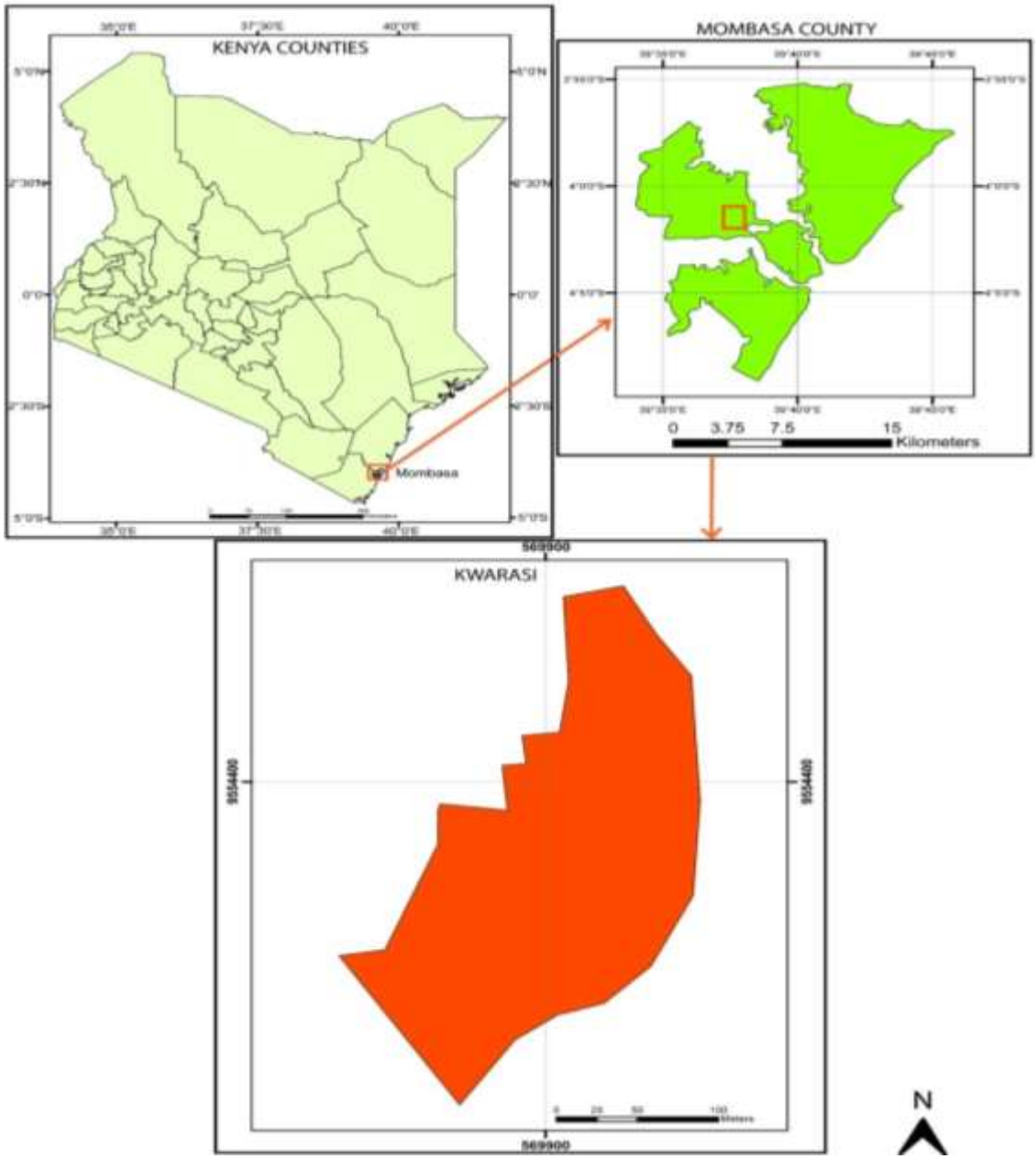

Figure 3. Location of Kwarasi informal settlement.

Kwarasi and other settlements in order to inform the regularization exercise. Kwarasi is one of the settlements where the data was collected and released to the county government. The data was used in this project to decide on the model to adopt for customization to the STDM data model (schema). The data was acquired through the process of public participation by questionnaires and focus group discussions direct from the inhabitants of Kwarasi during the regularization exercise carried out by consultants in collaboration with the county government department of land for the National Government Ministry of Land, Planning and Urban Development KISIP project.

The structures were assigned numbers that were written on the doors of the structures. The numbers referred to as structure numbers were identified with the persons who held an interest on the structures. The relationship type between the people to structures noted in existence was tenants and landlords, and the spatial units were identified and accepted to be the structures that were marked with unique number labels.

GPS coordinate readings were used to identify the position of the structures on the photo image for those that had full details enough for Cadastre data requirement. The house number which was on the door was logged into the GPS coordinate reading and which is the same number used as the structure identifier tabulated with the people relation. This way it was easy to identify and digitize the structures on the QGIS canvas. The secondary attribute data sources were from existing records at the county government of Mombasa.

Existing data was verified during the GPS survey where the

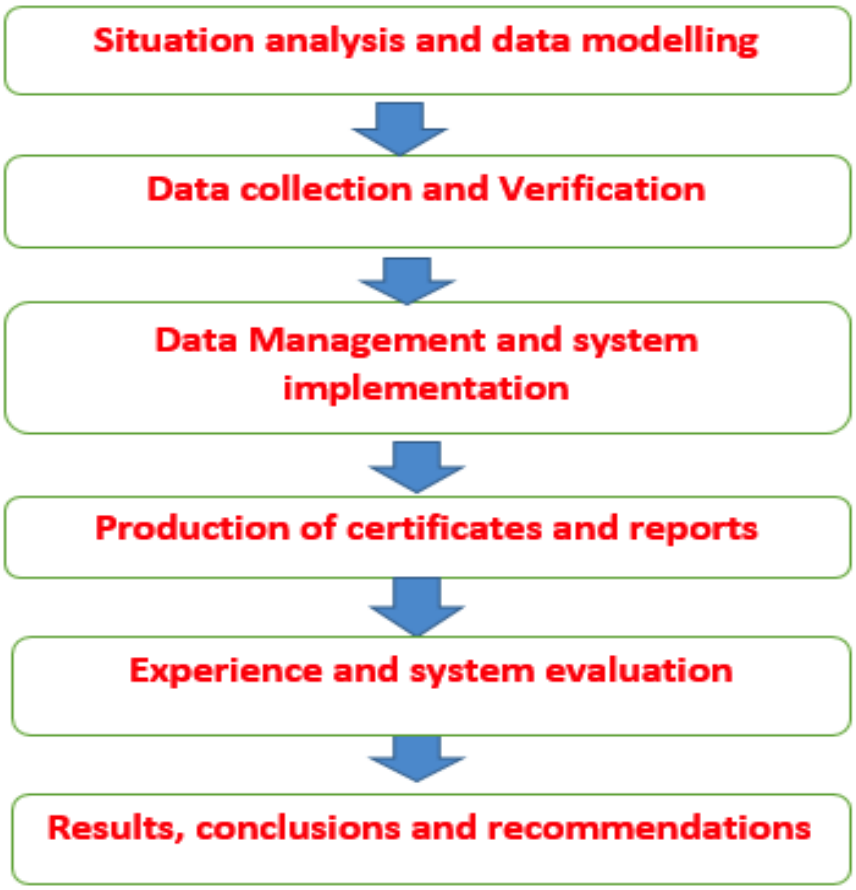

Figure 4. Work flow diagram.

owners could positively identify themselves in relation to the structures that were already numbered. Although the attribute data included other socio-economic information such as availability of amenities and development priorities only ownership, tenancy and party attribute information was considered for the informal cadastral model. Some owners and tenants were not available during the verification exercise and hence full information was not availed and to be sourced on another day.

The verification of the structure ownership and tenancy was done at the same time with GPS readings to verify and identify the structure owner with the building and the tenants. The form for party linked the social information with the mapped structures by use of GPS (that is, link socio-economic with spatial STDM).

Project implementation process

The STDM system was used to integrate all the relevant data into one, generate reports, print certificates, upload photos and any other information that was of use such as personal details. The tool was used for the digital record, data analysis and production of certificates and reports. The plans that had the required spatial data were scanned, geo-referenced and then digitized into the GIS to extract the spatial information for the Cadastre. These included the entire Chaani site and service scheme and the peripheral informal settlements including Kwarasi to show their relation to the site and service scheme. The numbered structures were identified on the QGIS canvas by use of the GPS control points that were obtained by using Garmin Handheld GPS. The GPS control points were imported into the QGIS canvas from an excel sheet which was saved in CSV comma delimited format.

The digitized structures were identified by numbers that were inscribed on the doors. The Chaani site and service scheme development plan was digitized and over-laid on the photo mosaic of Mombasa county. This enabled the serviced area to be separated from the un-serviced area by creating a boundary between the serviced parcels of land that appear on the development plan and the informal settlements. The other part extent of the settlement was determined by skirting the area that has built up structures that abut the main Changamwe storm drain by digitization. This allowed the inclusion of all the structures that were within Kwarasi Informal Settlement Scheme in the project area. Mapping the project spatial extent in order to delimit the project extent was thus completed. The perimeter of the project area was here determined and overlaid on the geo-referenced aerial photo mosaic of Mombasa county to show the structures that fall within Kwarasi informal settlement.

The developments on the project area were clearly visible on the aerial photo at the scale of 1:2,500. The digitization of existing manmade and natural features that are relevant to the project was possible and hence the structures were digitized as the spatial unit for project. These enabled the creation of the structure layer on the QGIS canvass. A layer of GPS control points was also created. Open spaces for passages were also clearly visible at that scale.

Data processing and analysis were done on the platform of the open source QGIS software then imported into the STDM system.

The STDM plug in was used for creating the social tenure relationships between the spatial and party attributes to form the cadastral database within the STDM system. The import of spatial data and attribute data into the STDM and creating the relationships was done after cleaning the spatial data and customising the attribute data to the STDM Model. Note that the STDM does not accept data that is topologically non-compliant or incorrect hence only the digitised layers of structures were imported into the STDM.

The Kwarasi informal settlement structure layer was overlaid on the Mombasa spatial cadastral layer so that the position of the structures in Kwarasi informal settlement in relation to the formal cadastral could be determined to aid in decision making for sustainable development intervention.

The attribute data was linked to the numbered structures to form the social tenure relationship (STR) within the STDM domain. Reports were to be generated by the use of PostgreSql which is adopted by STDM by answering queries from the attribute data. A certificate template was designed to suit the study area and the information in the STDM database. The template was used as a tool in the STDM system for extraction of certificate details directly from the informal cadastral database.

RESULTS AND DISCUSSION

The results of the project were to assist in the evaluation of STDM as a Land Administration tool for use in decision-making in sustainable development of informal settlements in Mombasa County.

One of the expected results in this research project was an attribute and spatial database hosted in the STDM system that consist of information about the inhabitants of Kwarasi and their relationship to the structures they live in or own within the informal settlement scheme.

This overlaid on the formal cadastral spatial layer of Mombasa county in order to show the position of the informal settlement in relation to the existing formal cadastral parcels of land for decision making in sustainable development. With the spatial and attribute cadastral data in the STDM system reports and certificates of residence were to be generated.

The process of determining the extent of the project area resulted in a perimeter line that included structures that form Kwarasi informal settlement. This was helpful in restricting operations of the project within the project area. Figure 5 shows the extent of the project area overlaid on the Mombasa aerial photo mosaic.

Verification by GPS

In the case where owners and tenants were available during the verification exercise and hence full information was availed and the structures were identified by GPS readings and given a different colour (Figure 6).

Informal cadastral database

Attribute informal Cadastre information was formed within the STDM system by creating social tenure relationships between the party and attributes. For spatial units of the Cadastre, the structures were represented in the STDM database system complete with structure numbers in order to identify their relative positions for identification. The structure are linked to the party information by the structure number which is in this case the primary key of the party relation. Figure 7 shows the structures with their numbers and GPS points that were used as datum to identify the structures that had full information.

Certificate of residence

Certificates of residence were automatically generated based on the template by extracting information directly from the database. This enabled production of certificates of residence only for the persons that exist in the database and hence in the settlement scheme excluding non-residents. Figure 8 shows a certificate of residence generated automatically from the STDM system. In addition to certificates and maps, reports too can be generated from the database. The overlay of Kwarasi informal settlement spatial layer of the structures over the Mombasa county spatial cadastral layer revealed the position of the structures in relation to the formal cadastral. Figure 9 shows the structures in Kwarasi informal settlement that fall on parcel number MN/V/3849 which is the Chaani site and service scheme (public land), those that fall on parcel number MN/V/2648 which is privately owned and the others that fall on the boundary of the two parcel. This result would answer the question on what type of informal settlement is Kwarasi.

Conclusion

The main objective of this project was to evaluate the STDM land tool in the development of an informal Cadastre in order to support decision making for sustainable development intervention in the informal settlements in Mombasa county.

With the use of the STDM land tool, the project research demonstrated from the results the spatial and attributes information data can be captured and managed in the STDM system. Informal cadastral data acquisition, documentation, storage, manipulation and its integration with socio-economic, spatial and informal rights data in the informal settlements was achieved.

The party's informal rights over the structures within Kwarasi settlement scheme were adjudicated by participatory approach and the social tenure relationships documented hence creating an informal Cadastre for the settlement using the STDM to support decision making in sustainable development.

Certificates of residence were generated directly from informal cadastral database within the STDM system so that they only respond to residents of the informal settlement meaning that if you do not belong to the

Figure 5. Showing the extent of the project area overlaid on the Mombasa aerial photo mosaic.

settlement as a landlord or tenant the system will not recognise you nor respond to your details.

The spatial component of the informal Cadastre was overlaid over the formal cadastral layer of the Mombasa county and their relationship determined at the Kwarasi area. Hence, position of structures in relation to the Mombasa cadastral layer for decision-making.

This shows that STDM has the capability to host an informal cadastral system and compare it with the formal cadastral spatial layer in the same environment as initially expected in the start of the research project hence STDM has successfully been evaluated and qualified as potential land administration tool for use in the enhancement of sustainable development of informal settlements in Mombasa county.

The experience of STDM at Kwarasi should be replicated to all other informal settlements in Mombasa county to create a complete overlay of all informal settlements of Mombasa county over the existing cadastral layer. Revision of the Mombasa Cadastre layer needs to be prioritized for accuracy and up-to-date information. STDM should be used for both formal and informal cadastral as a tool to assist in decision making for implementing sustainable development, managing conversion from informal to formal land tenure and contribute as an input in land policy formulation.

STDM is recommended as a quick means of informal cadastral data capture, storage and management for the Mombasa informal settlements. Stakeholder participation is recommended for data collection in sustainable development. While the county government should maintain and manage the database for informal settlements in the entire county; individual settlements should take care of their own data through committees formed by the county government in order to manage changes.

Mombasa county needs to formulate an administrative framework to assist in the management of the informal cadastral to serve along the formal cadastral creating a continuum of rights as in Un-Habitat (2008) (Figure 2)

Figure 6. Structures with full information picked by GPS ground control points during verification.

Figure 7. Digitized structures as they appear on the STDM system, the GPS points that guided digitization and structure numbers are displayed.

Figure 8. Certificate of residency generated directly from the STDM data base.

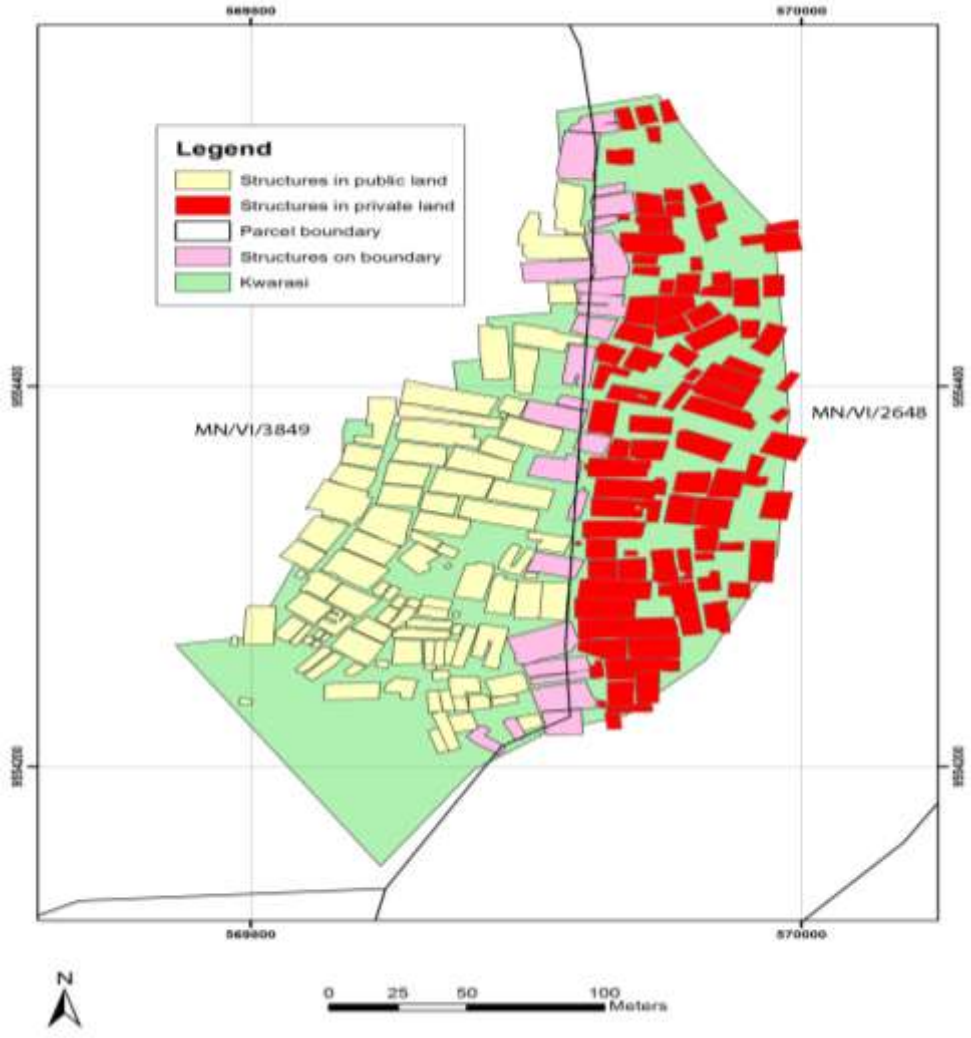

Figure 9. Structures in Kwarasi informal settlement that fall within the public, private and on the boundary between the two.

for the ease of land management in Mombasa county.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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