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Designing a Technical Solution for Managing Land Tenure Data in a Customary Setting

Egbulefu, Irene Folashade

UNIVERSITY OF CALGARY

Designing a Technical Solution for Managing Land Tenure Data in a Customary Setting

by

Irene Folashade Egbulefu

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Abstract

This study addresses the question: "In an evolving customary land tenure setting, how can a web-based land tenure information system that is equipped with a flexible database structure be designed to record customary land tenure information that complements existing tenure evidence so that land tenure security is improved for the local people?" This was done by investigating the changing current land tenure practices in the Akabor customary setting in southern Nigeria, predicting future scenarios for land tenure practices based on the socio-economic and political changes that are occurring in the community which are leading to a high rate of land disputes, and identifying suggestions for improvement. To achieve this goal, an existing TalkingTitler land tenure information system (TTLTIS) was adapted to suit the needs of the Akabor community.

In customary settings, land ownership and transactions relating to land are governed by customary tenure rules based on the traditions and norms of the local people. Also associated with customary settings are complex social relationships that exist among people and between people and their lands. However, in most customary settings, there are usually no manual paper records or digital documents of the existing oral testimonies of land tenure (such as deeds, title, survey information, and written agreements) for proving interests in land. In the case of the Akabor customary setting, land tenure evidence is currently based on the oral testimony of land owners and their witnesses alone. Furthermore, land tenure practices in Akabor are constantly changing due to both external and internal factors. In turn, these changes have resulted in a high rate of disputes over land ownership, which are difficult to resolve because of the lack of adequate or easily-accessible concrete evidence.

While conventional Land Information Systems (LIS) are used to manage formal land tenure in cities, they are not able to effectively manage or capture land tenure information in

customary settings. This is because conventional LIS are not designed to model the complex social relationships that exist between people and their lands in a customary tenure setting, nor are they able to handle the rapid socio-economic changes that frequently occur in these settings. As a result, various open source land tenure information system applications are being developed to improve land tenure security in these areas.

To achieve the objectives of this study, the researcher conducted a field study in a rural customary community called Akabor town, in the southern region of Nigeria, West Africa. Based on the user needs analysis developed from the field work, a web-based TalkingTitler Land Tenure Information software (TTLTIS) was designed and developed with two interfaces (backend and front user interface) by building on the existing TTLTIS software model, which had been developed in the Land Tenure and Cadastral Systems research group at the University of Calgary, Canada. To adapt the existing system, the backend object relational database was upgraded from PostgreSQL 8.4 to PostgreSQL 9.2 with PostGIS spatial extension; new database tables were created to supplement the existing ones; new front-end interface forms were designed and created to capture the Akabor community customary land tenure data; and finally, a map interface was integrated into the revised system to enable a spatial visualization of land parcels and features on the land, as well as to capture the geometric coordinates. Moreover, the new web-based TTLIS that was designed and developed in this project retained and leveraged the functionality developed in the previous version whereby the system is able to capture and store various forms of data such as structured (i.e., textual data) and unstructured data types (i.e., video, audio, photographs and scanned images). This retained functionality allows complex social relationships in the Akabor customary setting to be captured and manipulated within the system, thus reducing conflicts over land.

This study contributes to land tenure information system design theory in a customary land tenure administration setting by confirming that using a flexible database structure for the TalkingTitler system is appropriate for managing complex customary land tenure data. The new web-based TalkingTitler system with a flexible database structure will help improve land tenure security and mitigate conflicts and other challenges to land tenure that vulnerable and poor members of customary communities increasingly face in securing their land (especially inherited lands) due to the lack of formal procedures or cadastral technology in these rural areas. This was achieved by identifying the information systems needs of the Akabor customary community in Nigeria and designing a flexible database structure to suit their identified needs. The system is also able to capture and represent the complex social relationships that exist between the people of Akabor community and the land. Thus, legitimate landowners can use the documentation and other information the system generates to augment their traditional evidence of interest or rights in land. If this web-based TalkingTitler application is implemented in any generic customary land tenure setting, it will provide a system that can store and generate documented tenure evidence for landowners in these settings to support their interests in lands. Moreover, it will provide a computerized tool that can help reduce the problem of land tenure insecurity in the Akabor community.

Acknowledgements

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Dedication

This thesis is dedicated to my Father - Chief, Barrister C.A Egbulefu, who has continuously stood beside and encouraged me throughout my entire academic and career pursuits. His words continue to inspire and guide me in challenging outmoded ideas about women's roles, and to shine a light in the darkness towards accomplishing my goals: "Remember the old saying that 'The woman is meant for the kitchen' is a fallacy that holds no roots."

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Chapter One: **Introduction**

1.1 Introduction

The success of land development planning activities at a micro-level depends to a great extent on the quality and quantity of data that can be obtained from natural and socio-economic resources. Specifically, a rigorous database should serve as an efficient tool in the handling, storage, and retrieval of data that creates the possibility of analyzing different types of land tenure scenarios such as land title information, land management data, and other natural resource management information. Based on a previous model for recording land tenure information – the TalkingTitler - this study presents the adaption of the TalkingTitler land tenure software to design a web-based land tenure information system that can be used to enhance land tenure security and, in particular, that can help mitigate the frequent land disputes being experienced in an evolving customary tenure[1] setting such in the Akabor community in the state of Imo in southern Nigeria.

For this study, existing methods of land acquisition and various forms of boundary identification used in a typical lineage setting in the town of Akabor, whose residents are from the Igbo–speaking tribe[2], were analyzed. All field research was conducted in this specific community. The study also explored the procedures for resolving land disputes in Akabor as well as the existing processes of collecting, documenting, and managing land tenure evidence at the traditional level, state level, and

[1] Customary Land Tenure refers to land ownership at local rural levels that takes into consideration the norms and traditions of the local culture, tribes, and ethnic groups in Nigeria.

national level. Subsequently, building on these reviews and drawing on an existing version of the TalkingTitler model, a software package that could potentially be used to collect, store, manage, and present tenure and land adjudication evidence and official resolutions in an Igbo customary setting was designed, developed and tested in-house for this study.

The first phase of the study consisted of in-person interviews with residents of Akabor community to determine the specific characteristics of the existing customary land tenure arrangements in the area. The interviews were then transcribed and documented. Next, based on the research findings, the land tenure information system needs for the Akabor customary setting were defined and a software package was designed and developed to specifically suit these identified needs. As per the University of Calgary Research Ethics approval #REB13-0900 (see Appendix W), to mitigate risks and any discomfort for participants, the research questions were tailored to avoid sensitive issues that could cause uneasiness or disrupt participants' lives[3]. The identities of the participants were also protected through the use of pseudonyms in all of the collected data as well as in the data used for testing the developed software application.

The study site of Akabor was chosen for two reasons: first, the application that is being used was adapted from an earlier version of the TalkingTitler (LTIS), which is a land tenure information system model for the improvement of tenure security in post-conflict and customary settings. The laws governing land holding in the selected

[3] For example, some participants may have been reluctant to provide information about the natural resources on their land because of the risk of the government removing them from the land and taking their land because of the mineral resources.

community consist of customary laws[4] , as opposed to a statutory[5] land tenure system. As part of the software development criteria in this project, the customary land tenure system practiced in Akabor made it a suitable site for the research.

Second, the researcher is a native of Akabor; as such, she is conversant with the local customs and traditions of the community; also, due to her past experience in some of the land settlement issues in the community, she is quite familiar with the applicable land tenure administration, norms, and processes. Furthermore, the researcher has the approval of the appropriate community leaders to carry out empirical research in the community, which effectively eliminates the problem of accessibility often encountered by researchers.

In the past few generations, community land disputes in Nigeria were settled through negotiation, physical confrontations, and sometimes communal conflicts which lead to loss of innocent lives in the community. However, since the 1980's, with the inception of rural development and land reform, communal disputes in some African communities are gradually being settled through bilateral negotiations, mediation, and adjudication, especially in cases of boundary disputes (Dickerman et al., 1989).

Currently, land disputes in certain communities are traditionally settled through the mediation of elders and titled men in the community, or through judicial procedures such as law courts. In both situations there is a need to present tangible evidence to show

[4] In customary tenure system, land is occupied by native tribes or indigenous communities and administered in accordance with their customs

[5] A statutory land tenure system is a formal land tenure system that was introduced during the colonial periods; presently the statutory right of occupancy of land or property is issued by the state governor of the particular state and it covers mostly land and properties within the urban areas.

the land boundaries and proof of ownership of the contested land. However, in these situations, those who tend to lose their lands are usually more vulnerable individuals such as poor local people or individuals and groups who lack power and political influence, or proof of land tenure. As Zevenbergen et al., (2013) have reported, similar cases to those taking place in the rural areas of southern Nigeria are also occurring in Ethiopia, Kenya, and Uganda. On the other hand, a common tactic, usually referred to as 'Land Grabbing,' involves community elites taking over lands belonging to the less privileged members of the community who lack the funds required to formally register their ancestral or inherited lands.

Thus, the increasing incidence of land disputes in the rural parts of Nigeria from the occurrences noted above has driven the need for government and academic institutions or agencies to explore more effective ways of identifying and recording land tenure evidence and boundary identifications. Such initiatives aim to improve tenure security for the citizens and land owners in these areas (Nlerum, 2011). This thesis thus begins with an examination of land conflict starting at the regional level of sub-Saharan Africa, followed by a detailed look at significant factors occurring at the community level.

1.2 Context of Study

1.2.1 Sub-Saharan Africa

Since human settlement and the birth of civilization, land has been the most valuable asset for a nation or society (Nyadimo, 2006). As the value of land increased

throughout the progress of human civilization, so did conflicts over land. With increasing population growth and consequent demand and exploitation of high-value natural resources, including oil, gas, minerals and timber (Grzybowski, 2012), conflicts over land have become problematic in most parts of the world, especially in less-developed countries where land is still central to production and economic growth (Dike, 1983; Nlerum, 2011).

Some African nations, such as Nigeria, have experienced a number of severe conflicts over land. A major contributing factor to these conflicts is the increasing scarcity of land caused by population growth and changing climate conditions. Other factors include environmental degradation and cases of tenure insecurity resulting from poor governance and lack of respect for human rights and the poor (Knight, 2010). These problems have led to frequent disputes over land and various forms of unrest including economic instability in the affected African nations such as Nigeria. The disputes have been further inflated in recent times due to drastic disruptions in access to land in the wake of changes in the social structure ranging from lineage to individual identity and status within the community (Berry, 1993).

1.2.2 Nigeria

Nigeria is a federal constitutional republic composed of 36 states with a population of more than 150 million people of diverse ethnic origins and occupying a land mass of 924,768 square km in sub-Saharan Africa. In Nigeria, land is considered to be a very important resource input, especially in the aspect of agricultural and residential

properties; as a result, policies that affect land also have a high impact on all members of the community.

The concept of land tenure has been described as an arrangement of rules which outlines the privileges, obligations, and the rights and duties of persons in relation to each other and with reference to land (Famoriyo, 1979). The current pattern of tenure systems, observable in the three main regions of Nigeria, are the result of the integration of the distinct customary tenure systems of each of these groups with the various land tenure systems introduced during the colonial period (Oshio, 1990). However, the customary tenure system has continued to experience changes in response to external factors such as societal changes that involve the transition from extended family systems to nuclear family units; as a result, this is driving the customary land tenure from lineage (group) ownership to individual ownership.

During the colonial era, a period during which Nigeria was under the administrative control of the British government, land relations in Nigeria operated according to four different land tenure systems: tenure under the received English law, tenure under the State Land Laws, tenure under the Federal Land Tenure Law, and tenure under the various indigenous tenure systems under customary law (Nlerum, 2011; Oshio, 1990). State land laws are the laws governing lands that are held by the states; these include the lands that were acquired prior to the Nigerian independence and lands acquired by a State through public land acquisition (Oshio, 1990). Such parcels can be acquired by lease to individuals or organizations from a State government. The variation in the tenure systems is the result of the different traditional approaches to land practiced

in the three main cultural regions which are made up of the three main ethnic groups[6] in the country.

Customary land law prevails in the southern part of Nigeria due to their traditional conception of land tenure (Azeez et al., 2013; Mabogunye, 2010; Oshio, 1990). The southern region of the country comprises mainly the Igbo and the Yoruba ethnic groups.

1.3 Background of Case Study State and Town – Imo State

Imo state is one of the southern states in Nigeria populated by the Igbo tribe, who are one of the major ethnic groups in Nigeria. In Igbo society, land is believed to be a sacred entity that is entrusted freely by the Supreme God onto the smaller god of the earth called 'ala' (Dike, 1983). In this part of the country, the family ties and relationships are patrilineal. It is an agnatic society and so this concept arises from the fact that the kinship group descended from one common male ancestor (Dike, 1983). On the death of a father, all the properties acquired and owned by the father are bequeathed to the male children (Interview #1, 2013; Interview #3, 2013; Interview #12, 2013). See Figure 1.1 for a map showing the location of Imo State in Nigeria.

[6] Nigeria is a country that has about 250 different ethnic groups. The three largest and most popular ethnic groups in the country are the Hausa-Fulani (29%), Yoruba (21%) and Igbo, or Ibo (18%).

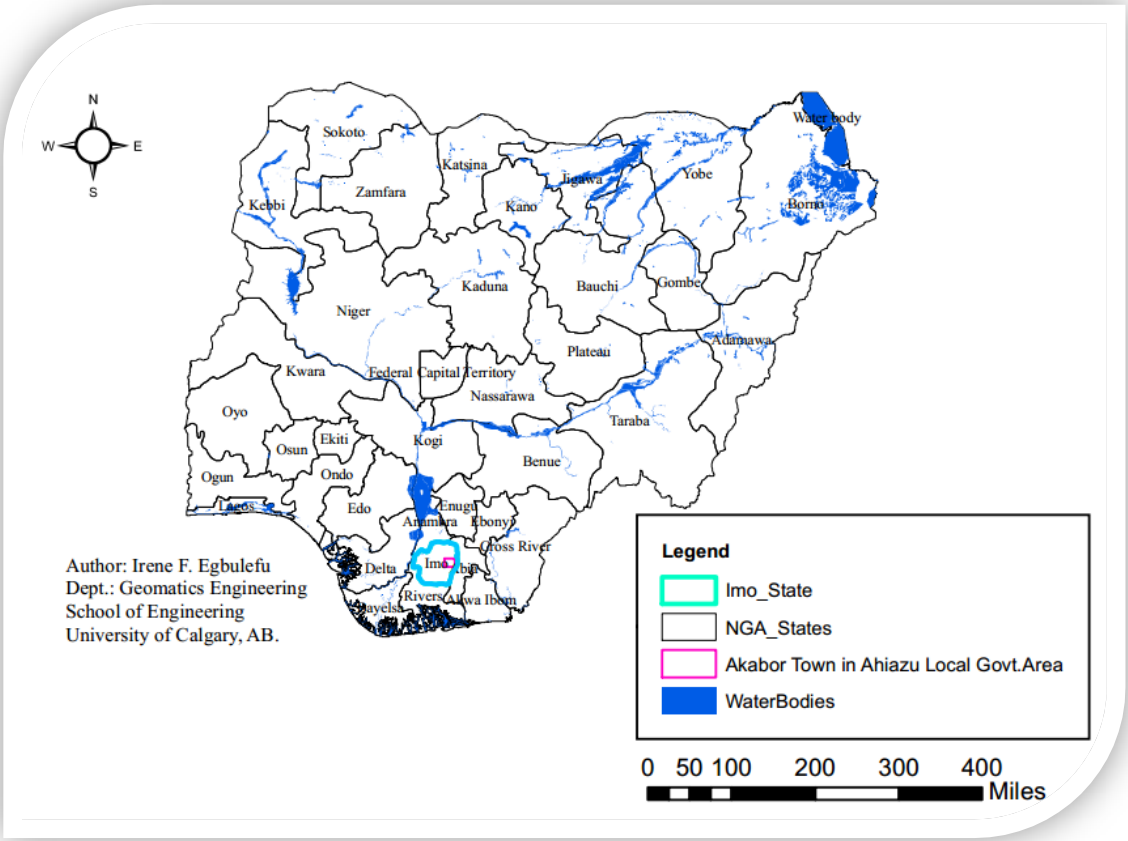

Figure 1.1 Map of Nigeria showing Imo State in the southern region
Map layer data source: Global Administrative Areas (GADM database – www.gadm.org)
(Spatial reference – WGS84)

1.3.1 Case study site – Akabor town

The case study selected for this research is a rural community in southern Nigeria known as the Akabor community in Ahiazu Mbaise local government area (LGA), Imo State, the home state of the researcher. Mbaise is one of the largest cities in Imo State and it comprises five main clans: Ahiara, Ekwereazu, Ezinihitte, Nguru/ Enyioguwu, and Oke-Uvuru. Each of the five clans covers an area that includes many towns. The Ahiara Mbaise Clan is made up of four towns or autonomous communities: Akabor, Ogwuama,

Obodoahiara and Obodoujichi. Each community is ruled by a community head called 'Eze' and each community has a separate market square where members of the community gather together on the given market day to sell their crops. The market days are rotational. The four communities also have a joint market called 'Orikpa', which is central to all of them and different from the individual community market. Members from the four communities gather together on the Orikpa market day to display and sell their wares and produces (Interview #1, 2013). A map of Imo State Showing Ahiazu Mbaise Local Government is given in Figure 1.2.

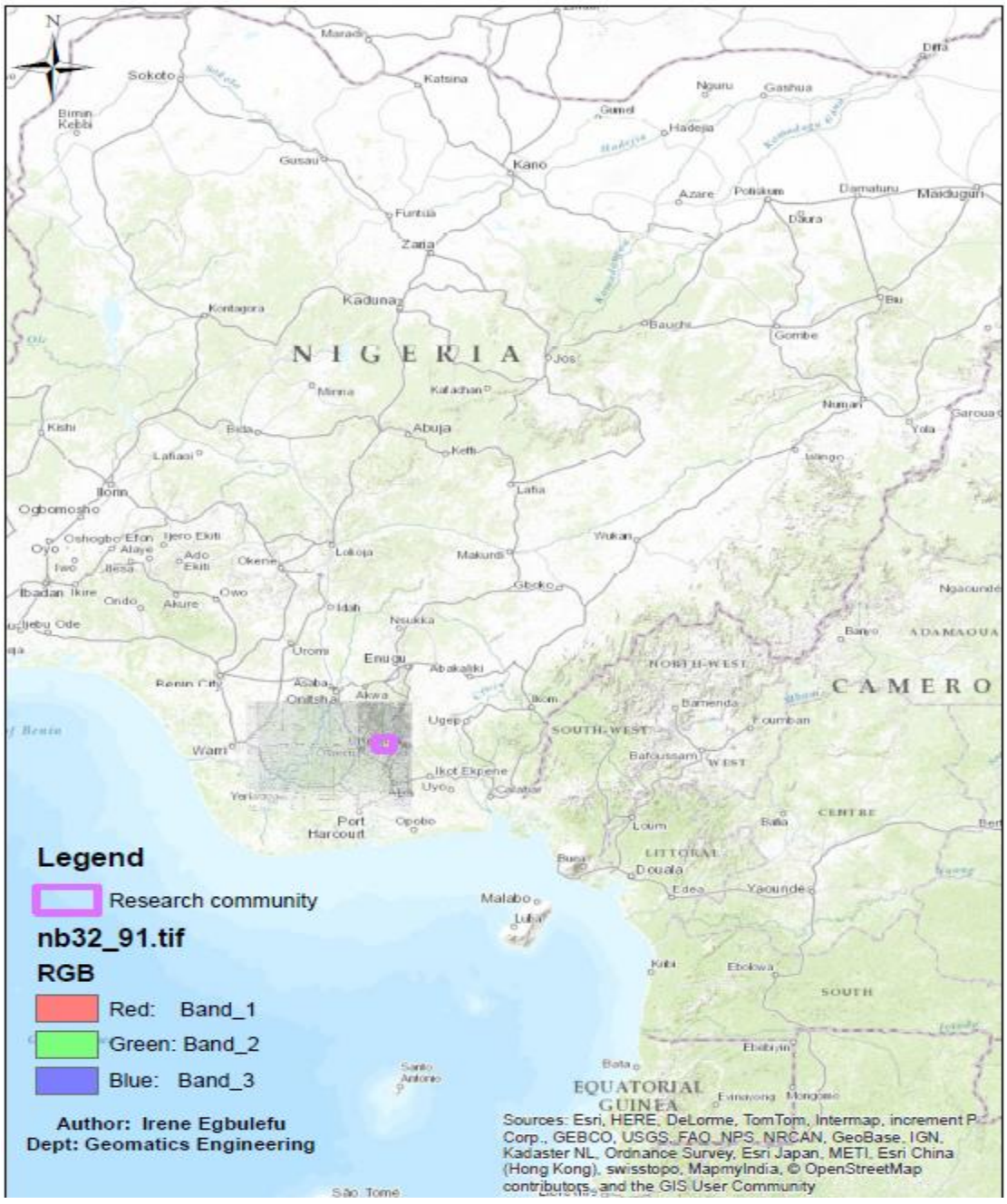

Figure 1.2 Map of Imo state Showing Study Site local government Area - Ahiazu Mbaise. ***(Spatial reference – WGS84)***

Akabor is located close to a big river called Oramurukwa River that connects to other major towns and empties into the most popular river called Imo River from which

the name of the state (Imo State) was coined. There are also other small river-lets and streams in the area, such as ‘Oniyi Ukwu, Oniyi Nta, Nwamberegwu, Iyi Ocha, and Iyi Ohia. These streams are used by all members of the community who are free to go to any of the streams for their water and fishing needs. It is only recently that people from outside the community (strangers) have been allowed to fetch water from the streams, because in the older years, the streams were restricted to only the members of the Akabor community. The river and streams are the major source of water and livelihood to the research study community and the surrounding communities (Interview #1, 2013; Interview #3, 2013; Interview #5, 2013).

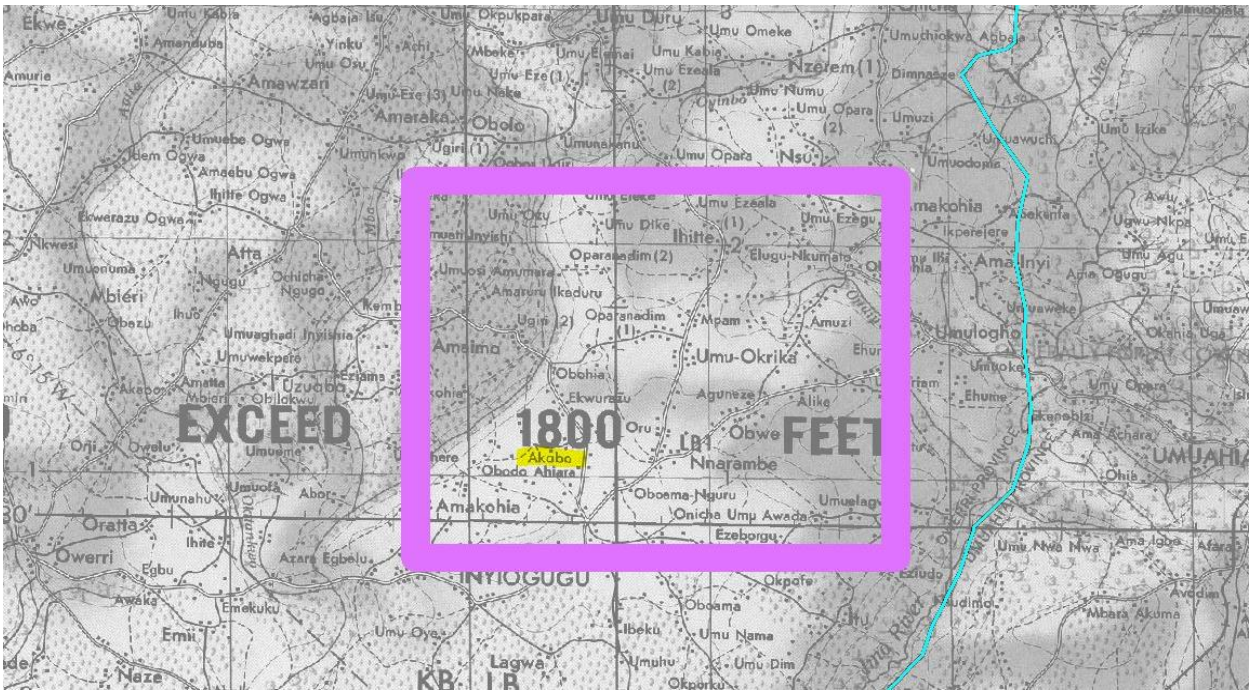

Figure 1.3 Map showing the Research study site Akabor town in (Ahiazu LGA) Source: Defense Mapping Agency Topography Centre, Washington DC (DMAAC), 1975. *(Spatial reference – WGS84)*

The town was popularly known as ‘Land Army’ during the Nigerian civil war in 1969, because of the large acres of fertile land and the bountiful food crops that were produced from the area (Interview #1, 2013). Up till the present time, the community is still recognized for its vast production of rich food crops like yam, cassava, and maize as well as vegetables of various kinds as farming is their second major source of livelihood besides fishing. The community is also very rich in natural resources such as thick forest reserves, wetlands, and a variety of economic trees like Iroko, Mahogany, Rubber, Palm, and Raffia (Interview #1, 2013; Interview #3, 2013).

The strategic location of this community coupled with its rich natural resources and ease of connection to other major towns have brought about an influx and migration of people from the neighbouring cities and other parts of the country into the area. This has caused a tremendous growth in the population of the community as well as scarcity of land and other natural resources in the area (Interview #1, 2013). The land scarcity has in turn led to continuous land disputes and conflicts amongst the residents of the community and between the community and its neighbors. Land encroachment is a major cause of dispute in the area (Interview #1, 2013; Interview #2, 2013; Interview #7, 2013).

1.4 Statement of the Problem

Conventional Land Information Management Systems (LIS) appear non-transparent because of their ambiguous procedures and the inability of the poor local people to access them due to high costs (Wehrmann and Antonio, 2011). In general, a number of constraints have been hindering the ability of these systems to optimally and

effectively manage tenure security and tenure evidence at an informal and customary level. One particular major constraint is the inability of LIS to manipulate and represent the various forms of social relationships involving persons and land in a customary setting. Furthermore, the act of registering land to secure land rights is ill-suited for certain situations and areas, such as post-conflict situations, customary land tenure settings, and in informal\unplanned settlements such as when squatters create inadequate dwellings in urban or peri-urban areas without official approval. Because of these shortcomings, a need exists for a more adaptable land tenure information system that has more flexibility than a typical registration system can handle (Barry et al., 2013). For instance, the system needs to be able to incorporate more complex relationships, rather than merely individual land ownership. Complex land ownership relationships can be described as multiple land owner relationships, such as when many family members jointly own a piece of land, lineage land tenure that involves joint ownership of land by a lineage group, and community land tenure that involves joint ownership of lands by a community (Famoriyo, 1979; Knight, 2010)

To address these issues, this research investigates the integration of a new type of software application for capturing and recording tenure information in an evolving customary setting. Our focus is on the design and testing of a new software capable of capturing and storing tenure information in multimedia formats (video, audio, picture and text) and modeling the complex customary relationships with little or no conflict.

1.5 Research Objectives

The primary objective of this research is to contribute to a land tenure information system design theory for a customary setting that is experiencing rapid socio-economic changes, based on the TalkingTitler design.

Sub-objective

To remain focused on the above primary objective, the researcher built on the existing TalkingTitler land tenure information system that had initially been designed by previous graduate students in the Department of Geomatics Engineering, University of Calgary. From this initial design, the researcher developed a web-based application package that will help to record land tenure information to improve the tenure security and adjudication processes in a southern Nigerian customary society.

The sub-objective of this research study is to:

- To design a web-based land tenure information system by adapting a database management system of an existing land tenure information system to suit the needs of the Akabor community and provide tenure evidence in the event of disputes over interests in land, especially in the adjudication process.

To accomplish the stated sub-objective, the researcher engaged in the following activities

- Investigation of the lineage system and land tenure in a typical customary setting and how land is secured in the area.

- Studied the existing land tenure information systems and assess their ability to manage and record land tenure in informal and customary environment.

1.6 Research Questions

The following research questions were adopted to guide the researcher in her investigations towards achieving the stated research objectives. The following questions address the primary research objective in Section 1.5.

1. What are the existing theories in land tenure information systems for a customary tenure setting?
2. How can an information system with a flexible database structure be designed to record customary land tenure information as a complement to existing tenure evidence and to improve tenure security for the local people?
3. How can a web-based land tenure information system be designed to benefit local people in securing their land in an evolving customary land tenure setting?

The second lines of questions are used to address the sub-objectives of this research. Answers to these questions will help the researcher to understand the complexity in the tenure system practiced in the community and identify improved means of helping the local people in the area to secure their land. These findings will also be integrated into the developed software.

4. How do people acquire land in Akabor Community?
5. How is land secured in local customary settings?
6. How is land ownership defended in the community?

7. What are the major causes of changes that are experienced in customary land tenure environment?
8. What can be done to reduce the problem of people losing their lands at customary level?
9. How can boundary encroachment disputes and illegal sale of land parcels that abound in rural communities be reduced?

1.7 Research Framework

This research utilized two philosophical world views which include Social constructivism and Interpretivism worldviews both of which rely heavily on naturalistic inquiry methods (Interview, analysis and observation of existing events). As a constructivist world view is based on the social environment and historical-cultural context, this framework was adopted in order to analyze the views and participants on issues of land disputes between members of the community. The interpretivism world view is an unscientific assumption used to interpret factual observations that enabled the researcher to gain greater understanding of the lineage land use system in the community In addition, the adoption of these two worldviews also helped in the analysis of disputes between different communities, which have increased due to the changes in traditional land ownership, from a lineage tenure system to an individualized tenure system (Creswell, 2009). They enabled the researcher to interact with the multiple participants through an interview process in order to collaboratively construct a meaningful reality of their existing land tenure systems as well as the major causes of land disputes. The

opinions obtained from the participants were used in developing the software, tool to record tenure information in the community with the aim of reducing the frequency of disputes over land in the area. The data collected from the research site were inductively analyzed to generate themes which were interpreted by the researcher. These data include video, audio, image and text.

1.8 Research Methodology

To answer the research questions above, the research methodology was split into two subsections: a) the user needs analysis, and b) the design and testing subsections. The strategies adopted in identifying the user needs include a field data collection using semi-structured and open-ended interview processes that involved video recordings and photographs of some of the land use and boundary demarcations, voluntary voice recording of land acquisition procedures from participants who are either land owners, buyers or borrowers, natives or strangers in the research community. Prior to the research data collection trip, an ethics approval to carry out a data collection from the selected community was sought from the Conjoint Faculties Research Ethics Board at the University of Calgary, since the research involves interactions with human beings and there is a need to ensure their protection, privacy and confidentiality rights (REB13-0900).

The interviews provided useful information about the community history, inheritance system, and other forms of land acquisitions, tenure evidence, documentation

and various forms of land transaction processes as well as information about land dispute in the area. During this process the researcher was able to:

- Examine the lineage system in the community;
- Examine the inheritance system and existing boundary identification types in the area;
- Examine the acceptable forms of evidence to support claims to interest in land;
- Examine the existing evidence for land ownership and how land ownership is defended;
- Identify the most frequent causes of land dispute in the area and procedures of resolving land disputes in the community; and
- Identify the information systems requirements for designing and developing a land tenure information system application that would be suitable for the customary land tenure system that is practiced in the community.

At the end of the data collection phase, the researcher engaged in software development to design and develop a web-based application on a flexible spatial database platform to record and process the data obtained during the data collection phase. The application development process involved three different stages that include the database design, scripting, test and evaluation of the developed application using data collected from the field. The software development was built on the existing TalkingTitler application designed by a previous research students specifically Asiedu (2014) in the Land tenure and Cadastral group within the department of Geomatics Engineering,

University of Calgary. The user needs analysis and software design are described in detail in Chapter Four.

To achieve the primary objective of this project, a database with spatial extension was created using an open source enterprise-level relational database application – PostgreSQL\PostGIS, which has the ability to record, store and process very large data in all formats (audio, video, text, pictures etc.). The application is designed to serve as an alternative for a title registration system as it can incorporate more complex relationships and land tenure details compared to a typical title registration system. Importantly, in most cases, simple registration forms, whether computerized or not, are not adequate to represent the complex land owner relationships associated with customary land tenure; this results in the need to integrate multimedia and spatial capability with maps into any customary land tenure information system design.

1.9 Scope and Limitation

The research area is interdisciplinary. The primary focus of this study is the development of a design based on a case study using interviews in the field to inform the design. Less weight was assigned to assessing data quality and authenticity in the qualitative interviews than would be applied in a sociology or social anthropological study of land tenure. The focus was on collection, documentation, and management of land tenure information that could be used as supporting proof of ownership, which in turn informs design.

It is accepted that the sample size was small and therefore biased by what the people interviewed chose to relate to the researcher. It is biased, but also informed by the researcher having grown up in this community and having her family still there. In addition, the researcher has a disciplinary bias, having a background in information technology and geospatial information systems.

Furthermore, the researcher did not explore land policies and adjudication procedures that are obtained in the research community in depth but rather the research process was confined to collecting and examining data\information within the context of adjudication process and tenure evidence. An assumption is that the case studied is not unique and that the design may be tested and further developed in other similar situations. The major limitation is in the area of the software development. A current and clear aerial photo or satellite image of the research community was required but could not be obtained; therefore a Google map was used to compensate although there was still a great limitation in the resolution of the map when zoomed to a certain extent. For instance, the resolution of the research area was too small and could not be displayed on Google map when zoomed into the area. With the advancement of technology and the launch of new satellites there will hopefully be higher resolution images acquired in these areas. It is also hoped that these images would be available freely over the internet.

1.10 Significance of Study/Contribution of Knowledge

This study is a design theory project that has both theoretical and practical significance; it adopts an evolutionary approach in its design. Theoretically, the study

examines the effectiveness of a generalized land tenure information system in capturing and collecting adjudication evidence in a customary setting for future use in a local community in Nigeria. The produced software attempts to translate real world situations into a computational model that is simple and easy to implement; this is achieved by integrating real world complex situations associated with customary land tenure system into a computational model. It thus fulfils the need for a flexible and evolutional LTIS where the conventional land registration systems are not suited to the local circumstances. The conventional LIS are known to have rigid rules and procedures, as are not affordable to the local people. The theoretical and academic contribution of this research stem from the fact that a well-designed database structure that supports continuous recording and storing of tenure evidences in various data formats (video, audio, image, text and map) will help to enhance land tenure security and grossly reduce issues of land disputes and land grabbing in rural areas.

The practical relevance of this study cannot be overemphasized, this includes the following:

- The Software designed and developed in this study will provide will facilitate incremental collection and effective storage of land tenure evidence over a period of time and for future use.
- Provides a tool that can generate digitized land tenure evidence to complement the existing oral evidence used in Akabor community thus reducing land tenure insecurity. The information collected and stored can be used to augment the conventional title or deed documents that are usually presented as evidence of

claims during dispute resolution, land formalization, and regularization. It can also be used to expose wrongful land allocation as well as facilitate restitution claims and, therefore, enhancing tenure security.

It is believed that the use of the application will empower the local land owners over their lands since they have visual and archived evidence to prove their rights of ownership of the land.

1.11 Outline of Thesis

This thesis is divided into six chapters. Chapter One is an introductory section of the project that provides brief discussions of the context for which this research is undertaken starting with a broader view some of the land conflict issues in Sub-Saharan African narrowing down to Nigeria as the country of interest and finally to the community on a micro-level. The research statement of problem, objectives, and questions were discussed. Finally the chapter gave a summary of the research framework and the significance of the research/contribution of knowledge.

Chapter Two provides a review of literature that aims at identifying gaps in the existing works on land information software applications developed to manage land tenure information and how they would be filled by the current work. The chapter also reviewed the current land tenure practices and administration in the research community and in Nigeria to enable the researcher obtain a proper insight of the existing system.

Chapter Three describes the research methodology including the approach and justification for the field work conducted in this research. Also discussed in this chapter

are the data collection, analysis, and design procedures with a summary of the strategies used for validating the data for reliability. Finally the chapter provides detailed descriptions of the research findings that include the existing traditional ways used by members of the research community to acquire and secure their lands and the various procedures used in the community in resolving land disputes between members.

Chapter Four provides a description of the conceptual and physical design of the land tenure information system application developed in this project. The Chapter enumerates the identified land tenure information system needs of the research community which were taken into considerations in designing a suitable land tenure information system application to accomplish their needs. It also gives a brief description of the existing TalkingTitler land tenure application that was used as a base for the development of the web-based TalkingTitler land tenure software built in this project as well as justification for the choice of the database platform used in the software development.

Chapter Five provides details of the testing of the developed web-based land tenure information system software using data collected from the field. The output result generated from the application were described and analyzed with screen shot illustrations.

Chapter six consists of the research conclusion with the limitations and constraints encountered during the implementation and recommendations for future work in the area of land tenure information software development.

1.12 Chapter Summary

This chapter has introduced the research by briefly discussing the context within which this research was conducted and background of the case study site. The research problem statement, objectives and frameworks were discussed as well as the research questions that were formulated as steps to guide the researcher towards the achievement of the research goals. Finally, this chapter briefly stated the observed boundaries for the research implementation in the scope and limitations section. The significance of this study and its contribution to knowledge were also provided.

Chapter Two: **Review of the Literature on Land Tenure Information Systems and Land Tenure Practices in Nigeria**

2.1 Introduction

As discussed in Section 1.1, this thesis involves the design and development of a software tool to improve land tenure security in a customary setting, where past traditional lineage ownership is moving towards individual ownership. This Chapter provides an overview of land tenure rights and administration in the study area and discussion of issues of land conflicts that occurred in the area.

Land tenure is a complex concept that describes the rules that govern the allocation of property rights to land within societies (FAO, 2002). In this study a web-based application was developed for tracking land tenure in a communal setting by using a flexible spatial database structure. The application can be used to collect land tenure evidence, while also integrating the norms and traditions of the community. Additionally, the chapter reviews relevant literature on the topic of land information systems and identifies gaps in existing systems, as they cannot represent or respond to the complexity of customary land tenure practices. The researcher identified and studied related research in this topic area with an aim to determining research gaps to which this project responds.

In spite of the growing interest in land administration and management world-wide, there is little research that addresses tenure security in rural communities, which often are regulated by customary land tenure laws. Most researchers look at formal tenure systems, which are common in western societies and typically in urban areas. In these areas, land tenure is already individualized and less complex. In rural developing

countries, land tenure is typically collectively owned by families and communities, which are not reflected in current land tenure management systems (FAO, 2002).

2.2 General Classification of Land Tenure

In land management systems, land ownership is categorized into one of the follow types: private, communal, open access and state. According to the FAO standards, private tenure includes rights on land by individuals, families, or group of people. Open access tenure describes a situation where people have free access to resources, such land or forest or high seas (Marine tenure). These lands are open to everyone regardless of where they reside (FAO, 2002). The Communal tenure category describes a situation where members of a community share a common right to a portion of land. Access to the land is open to all community members, but closed to those outside the community. The State tenure category comprises of land or property rights that are restricted by some authority in the public sector, such as state owned lands or federal owned land (FAO, 2002).

2.3 Land Tenure Right Recognized in Nigeria

Nigeria recognizes four major types of tenure:

- State Tenure,
- Individual tenure,
- Communal tenure,
- Public tenure, and
- Customary tenure.

In the southern region of Nigeria, land tenure can be customary, communal, individual, and public. While customary and indigenous land tenure systems acknowledge both communal and individual (private) tenure, it is not recorded in the state government's land tenure management system. This system only identifies land as public or privately owned. The communal tenure category describes a situation where members of a community share a common right on a portion of land. Individuals can sometimes be entitled to part or all of family land either by "virtue of birth into the family or membership of a clan" (Okorji and Arua 1997).

From a legal standpoint, customary tenure rights are considered a form of communal tenure, which included rights to pastures (FAO, 2002). In Nigeria, customary tenure rights are used to regulate access to land in the rural areas and are formally recognized by the government, but not included in the formal land tenure system. The country also recognizes multiple rights to the same land, where several different persons or groups hold different rights to the same portion of land. Similarly, this land right is not recorded in the land information system.

2.3.1 Current system of land tenure administration in Nigeria.

In contrast to the individualized Western system of land rights, the customary and informal tenure system covers a wider complexity of rights, which provides Nigerians with flexibility over both the land and the resources on the land. For instance, a parcel of land can be owned by an individual or family while the resources on the land, such as trees, are owned by a different individual. Thus there can be various rights of use on a

parcel of land and its environment. By allowing one individual to have a secondary right over someone else's land, communities are able to continue their traditional economic transactions and relations (Deininger, et al. 2008). Although Deininger here refers to customary and informal land tenure systems in an east African country such as Ethiopia, the same customary and informal land tenure systems apply to Nigeria.

After the colonial era, the Land Use Act of 1978 was introduced under General Olusegun. Obasanjo's military regime uses the act to provide uniform rights of occupancy throughout the nation (Nlerum, 2011; Olusola, 2010). It placed all lands under the control of State governors who held the lands in trust for citizens (Olusola, 2010; Oluwamotemi, 2010; Oshio, 1990). Another key objective of the Act was "to enable the Nigerian government to bring under control the use to which land can be put in all parts of the country and thus facilitating planning and zoning programmes for particular uses" (Oshio, 1990). The 1978 Land-use act was effective in the northern region of the country where land belongs to the government, while individuals have only possessory rights. Because the northern region of Nigeria was the focus on colonialization, a majority of the states in this region follow western practices of land tenure; thus the customary tenure practice is not very obvious in the region. However, the southern regions still practices a customary land tenure system, which was put in place before the colonial era. Despite the land use act, the southern regions organized their land tenure according to a lineage system (Azeez et al., 2013; Mabogunye, 2010). In other words, the people in the southern region adhered to the customary system and ignored the statutory system. The federal

government of Nigeria was unable to enforce the new land tenure system in the southern rural areas, and was thus, forced to recognize the existing customary system.

In the southern region, it is a common practice for off-spring to inherit land and land resources from their parents under the customary land system. In this customary tenure system, the beneficiary has authority to decide on what to do with his land in terms of land use, such as agricultural purpose, residential, or industrial. He can also decide to lease or sell the land to someone else (Dike, 1983). Lineage land tenure is the traditional form of land holding that is based on the lineage group[7]. The lineage land was acquired by the lineage group who first arrived at the uninhabited locations and cleared as much virgin lands as they could for themselves and their future generation. These lands include both compound and farm lands (Dike, 1983). Land parcels under customary laws can be formally registered or not registered at all. For example, inherited lands and lineage lands are generally not required to be formally registered with the government, according to the Nigerian constitution.

However, land registration can be achieved in the rural areas by applying to the local government authority, which has the power to issue a customary right of occupancy (C of O) to the land owners, either as a community or as an individual (Oshio, 1990). The need for the C of O document usually arises when the land owner (either an individual or community members) wishes to use the property either as collateral for loan or to enhance the value of the land in case of land development or sale. The C of O document also helps to prevent land grabbing, by other individuals or government appropriation.

[7] Lineage Group: People who claim to have descended from a common male or female ancestor.

In the last few decades, individuals who have customary tenure rights are more likely to lose access to the land due to its illegal sale by some unscrupulous elites who engage in land grabbing of customary lands from the poor owners who do not have formal documentation and sell the land off through the formal system (Famoriyo, 1979; Nlerum, 2011).

2.3.2 Land tenure system recognized in Igbo community (the research community).

Akabor is a town within the Igbo territory and is governed by the traditions and norms of Igbo tribes; traditionally all Igbo communities are governed by the same customs and norms. In the community of Akabor, some areas are communally-owned while others are designated to the gods of the land, such as the thick forest areas that are believed to be sacred lands. The communally-owned land is usually located on the outskirts of the residential areas and includes distant farmlands and some forest lands. In this case, non-members of the community are not allowed to access or use the designated common lands, such as selling goods or agricultural products from these lands for individual benefit. The communally-owned lands may also include village market squares that are owned by the local community and situated within the town limits of Akabor.

Within the Igbo communities, land is treated as the primary form of capital and the most durable asset that one can possess. In these communities, land is also believed to have some religious significance and plays a vital role in the social relations between the people, their society and their gods (Dike, 1983; Gasiokwu, 2005). In a traditional

Igbo setting where this research is situated, land is either owned by the community, specifically, clans or sub-clans, a group of family members, or by individual members of the community. Under normal circumstances, no single individual is allowed to either use or sell communal or family land, nor can an individual lose their ownership stake in family or communal land (Dike, 1983; Gasiokwu, 2005). The only way that family land can be sold is if all members of the family group (including women and children) agree to sell the land; similarly, the only way that communal land can be sold is if all members of the community gather together and agree that the land can be sold. In this case, the proceeds from the sale of communal land must always be used for the community development such as for building clinics, schools, public toilets, market stalls, and more (Dike, 1983; Nlerum, 2011).

Increasingly, individuals in Igbo communities are seeking individual ownership of former lineage lands as a response to growing population needs and western influence (Dike, 1983). Additionally, because of the western impact, individuals are also beginning to live in nuclear, rather than extended families, and individual land ownership is thus increasingly popular. Consequently, the community rights gradually cease to exist as communal ownership of land gets transformed into individual ownership (Dike, 1983). This is causing a lot of upheaval in the society as the once peaceful members of the Igbo communities living together, and jointly cultivating the same parcels of land as descendants of one man fight over the land to defend their rights of ownership.

To ensure a continued and uninterrupted use of their land, communities need to secure formal title to land. Since the land has been traditional and communal, these

groups lack the documentation needed to secure the land title in the government land tenure management system. Without an effective means of securing rights or evidence to rights, it becomes easy for people to lose their lands, especially in the rural areas where currently there is no cadastre technology to identify land parcels and ownerships.

This project presents a land tenure management system for Akabor, in Imo state of Nigeria. The next section reviews the existing literature on the land tenure practices of the area to demonstrate the complexity that the web application needs to reflect.

2.4 Needs for a of Land Management System to Recognize Communal Rights

Zevenbergen et al., (2013) noted that the tenure complexity in customary and informal land rights is most often subject to the environmental and cultural circumstance that exists in the area. The complexity associated with tenure at the customary level makes it difficult to translate these customary tenure information into a computer understandable format, Thus, most of the time, codification would tend to reduce the flexibility in community's land tenure set-up and may subsequently eliminate secondary rights when attempting to simplify the system; this would have a negative impact on livelihood of the people (Zevenbergen et al., 2013). This complexity, a result of the community's relationship with the land, makes it necessary to provide a system that will integrate the various forms of evidence of land rights that are used in the area.

While documented/recorded tenure management may limit land use, it would provide new forms of legal evidence and could allow periodic modification of the evidence types linked to the land records. These benefits allow the system to evolve with

changes to the community's land tenure organization. Tenure management systems for communal land tenure should be evolutionary and flexible enough to fit into all local tenure situations.

The formal Land Information system in Nigeria is not meeting the current needs of changing land tenure especially in the aspect of customary and informal land tenure. (Bohannan, 1963) argued that a gap exists in the current land management system, which is based on a western individualised form of land ownership without taking into account the local traditional land management customs. Bohannan astutely observed that "there exists no good analysis of the concepts habitually used in land-tenure studies and certainly no detailed critique of their applicability to cross-cultural study".

According to Dale (1998), one major feature of land tenure is that it reflects a social relationship between people and land. The various forms of social relationships that exist between the people and land need to be taken into consideration when designing land tenure information and administration systems. In areas like villages, the current Nigerian land tenure information does not reflect the residents' relationship with the land because it is not able to track traditional and multiple land rights.

2.5 Nigerian Land Disputes

As it appears, land conflicts and disputes have been on the increase in recent times. This may be attributed to the increase in commercialization of land (both residential and farm lands) and other natural resources due to the growing urbanization of rural areas, coupled with population growth. The implication of all this is that land has

become a scarce and valuable commodity both in the rural and urban areas. This scarcity has created a rise in tension and conflict over land acquisition at individual and community levels.

Conflicts over land and natural resources occur where there are overlapping resource interests among individuals, groups, communities, or states. For instance, where mineral resources are discovered on a piece of land that lies at the boundary of two communities, there is usually a conflict due to the increase in the value of the land. Also, in the rural areas when a piece of land, found to be very fertile, lies within two or more communities boundaries, a conflict may rise between the communities, especially during farming season. The year 1996/1997 recorded a number of communal clashes between various communities in Akwa Ibom and also between a community in Akwa Ibom and a neighboring community in Abia State (Mendie et al., 2010).

In this research a number of land-related disputes that took place in northern and southern parts of Nigeria were identified and reviewed. These findings are relevant to this project because the research study site has been experiencing various forms of land disputes since 1959. This research is focused on finding a way to reduce land disputes in a typical Nigerian community that is governed by customary land laws.

Similar to other African nations, Nigerian land disputes constantly occur both in urban and rural settings. Land disputes occur frequently in rural areas where there is no durable means of identifying land demarcations and ownership apart from the local methods used by the people to define their land boundaries, which usually does not last for a long period of time. This is due to extreme weather events such as floods, heavy

rains and heavy winds that wash away local boundaries such as mud fences, ridges and live trees, leading to confusion and disputes about where the boundary line is (Azeez et al., 2013; Mabogunye, 2010; Nlerum, 2011). To discuss individual and communal land boundaries, it is important to understand how these lands are acquired and secured within the community. This can vary from community to community depending on the communal laws that govern the place (Obeng-Odoom, 2012).

As land disputes and community clashes increase, lives are lost along with valuable properties. One of the early communal conflict over land dates back to1959. The worst of all clashes and disputes over land popularly known as Tiv-Jukun clash took place in 2009 (Ekpei, 2011; Ezenwoko and Osagie, 2014). Both clashes occurred in the southern part of Nigeria. The 2009 dispute resulted in the death of 200 people; most of these were women and children. Many properties were destroyed by fire, including important crops and food sources.

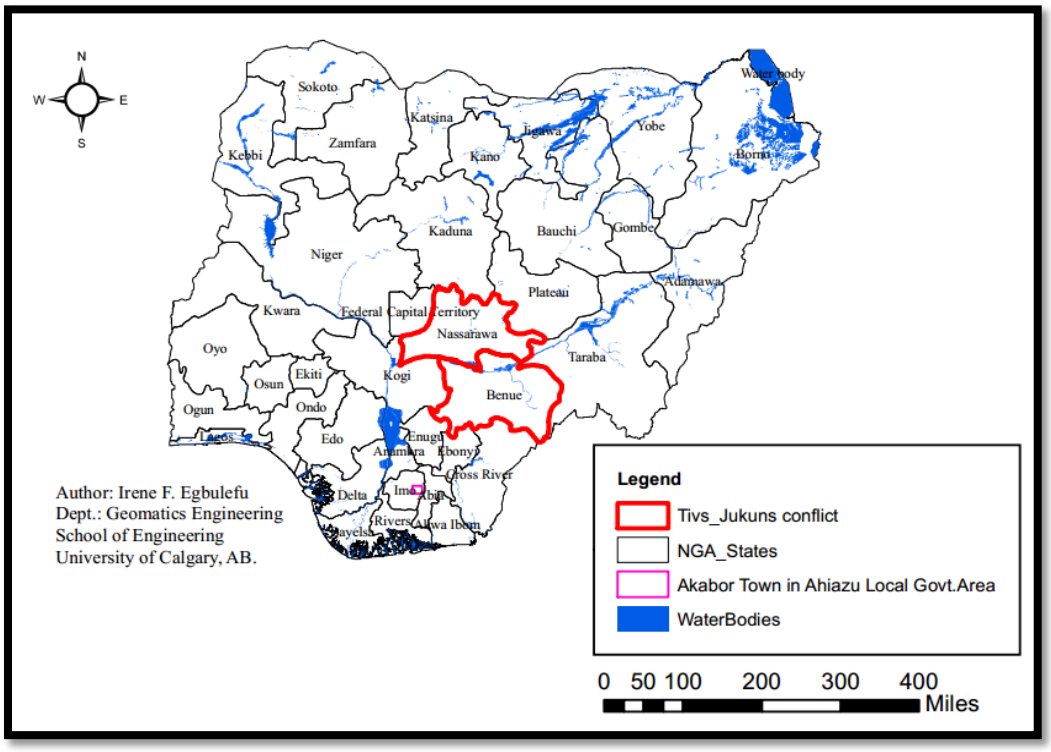

Figure 2.1 Map showing Inter-Tribal/Boundary conflict between two States (The Tivs from Benue State and the Jukuns from Nassarawa State)
Map layer data source: Global Administrative Areas (GADM database – www.gadm.org)
(Spatial reference – WGS84)

In December 2011, there was an escalation of border clashes between Jukuns (Fulani) herdsmen and Tiv farmers along the Benue-Nassarawa boundary. The clash resulted in the death of at least eight people and forced thousands to flee their homes (Ekpei, 2011). Another clash caused by land claims was between Fulani herdsmen and farmers from another ethnic group which resulted in the loss of over 100 villagers in Kaduna Sate. These conflicts involving the Fulani are typical examples of border clashes across Nigeria, including parts of the Igbo land. The Fulani group is an ethnic group that is predominant in the Northern region of Nigeria. They are mostly pastoralists and traditionally semi-nomads, moving from one part of the country to another and frequently

claiming rights of use and passage on the routes and grazing lands. This usually results in clashes between the herdsmen and the original land owners in the areas where they settle. They are always moving eastward in search of green grazing lands for their cattle as their lives revolve around and usually dedicated to their herds. They are the major migrating people in West Africa and operate in every part of Nigeria, especially in the remote areas where there is enough green savannah or vegetation for their cattle to feed on (Anther, 2011; Iwuchukwu & Igbokwe, 2012). In January 2013, a group known as "Miyette Allah Cattle Rearers Association" an umbrella body of Fulani herdsmen, presented a suggestion to the Federal Government of Nigeria to create grazing routes for herdsmen across the country (Duru, 2013). This would help to mitigate the trespassing by the herdsmen and their herds into other people's lands thus reducing frequent conflicts in the areas. These grazing routes if implemented by the Federal Government, can be digitally captured and recorded in a land tenure information system application for future references and in dispute situations

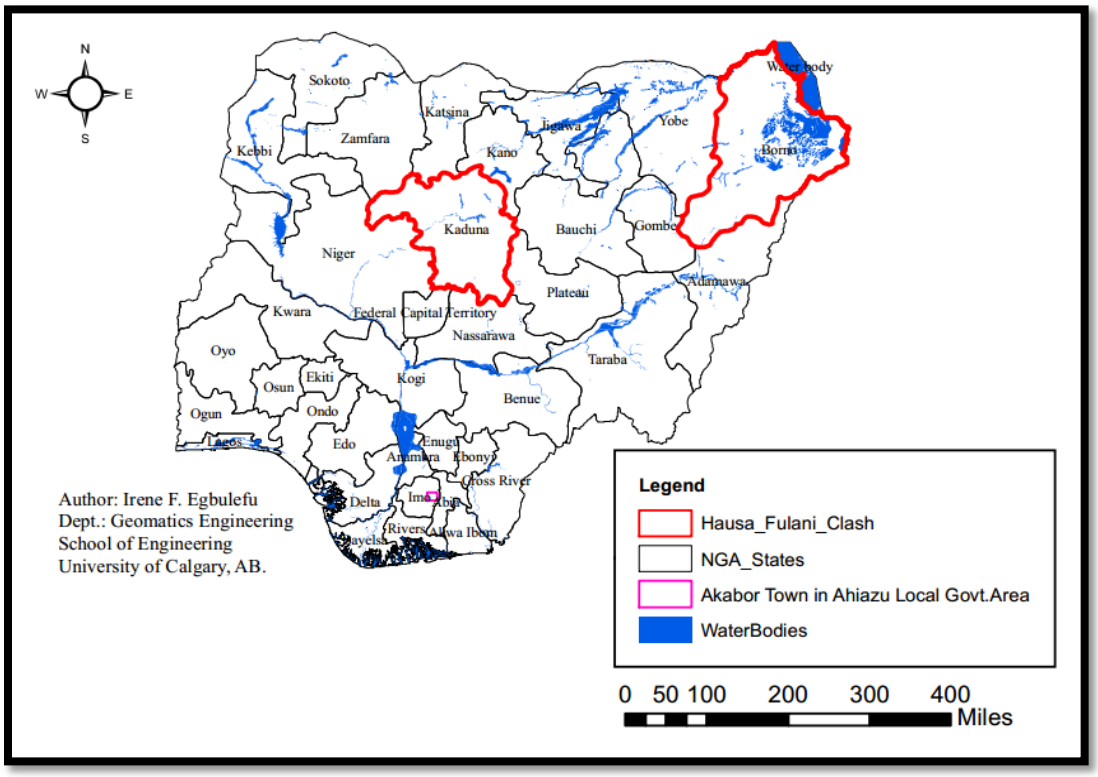

Figure 2.2 The Fulani –Hausa clashes over land is more prevalent in the two states (Kaduna and Borno State). Both states are in the northern part of Nigeria.
Map layer data source: Global Administrative Areas (GADM database – www.gadm.org)
(Spatial reference – WGS84)

Like the Fulani, the Ezillo clan frequently clashes with Ezza settlers, as nomadic people claim lands which are now individually owned by settlers. One clash that happened in 2008 claimed the lives of 600 people and damaged properties worth more than N1 billion, an equivalent of CAN $6.7 million (Eze, 2010). Extreme clashes are becoming more frequent in the southern part of the country and one of the major cause of these clashes is the rising population, which inadvertently leads to increase in the value of lands.

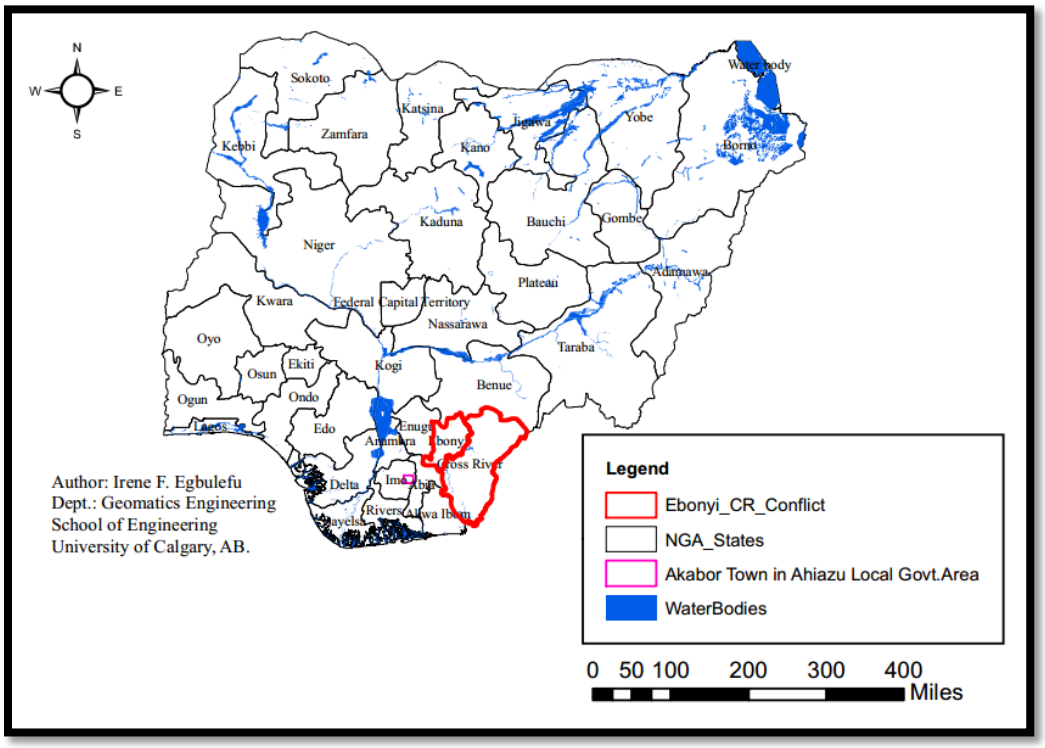

Figure 2.3 Map showing Ebonyi State and Cross River State in boundary conflicts
Map layer data source: Global Administrative Areas (GADM database – www.gadm.org)
(Spatial reference – WGS84)

Clashes over land ownership are on-going as land claims are not resolved because the current land management system does not collect oral evidence. For example, (Ujumadu, 2013) of the Nigerian Vanguard Newspaper reported a renewed clash between the Anambra East local government area of Anambra State and their Echonwa and Odeke neighbors in Ibaji local government area (L.G.A) of Kogi State. According to the report, the two communities have been fighting over a piece of land that separates them since 1987. Neither community had the land title nor did the current system collect alternative evidence, like local history.

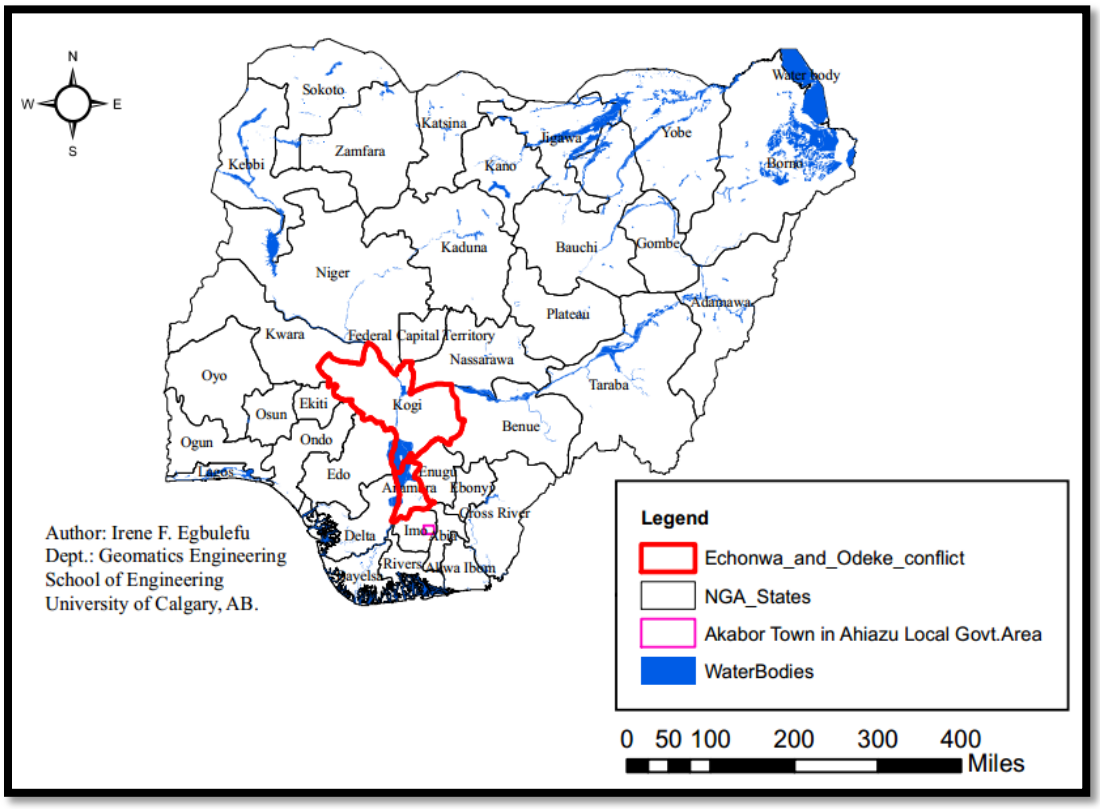

Figure 2.4 Inter-State Conflict between Echonwa L.G.A in Anambra State and Odeke in Kogi State
Map layer data source: Global Administrative Areas (GADM database – www.gadm.org)
(Spatial reference – WGS84)

It is possible that some of these disputes could have been averted if there was a proper land recordation and documentation system in place, which would spatially identify the boundary between the communities. For example, recognition of communal land right for nomadic people would ensure that other land ownership cannot restrict their ability to use these areas for grazing. This project's web-application is a part of an ongoing move to design and implement a tenure information system that can address the local, social, political, and economic situation of a community by using a range of data types, such as multimedia data and oral history.

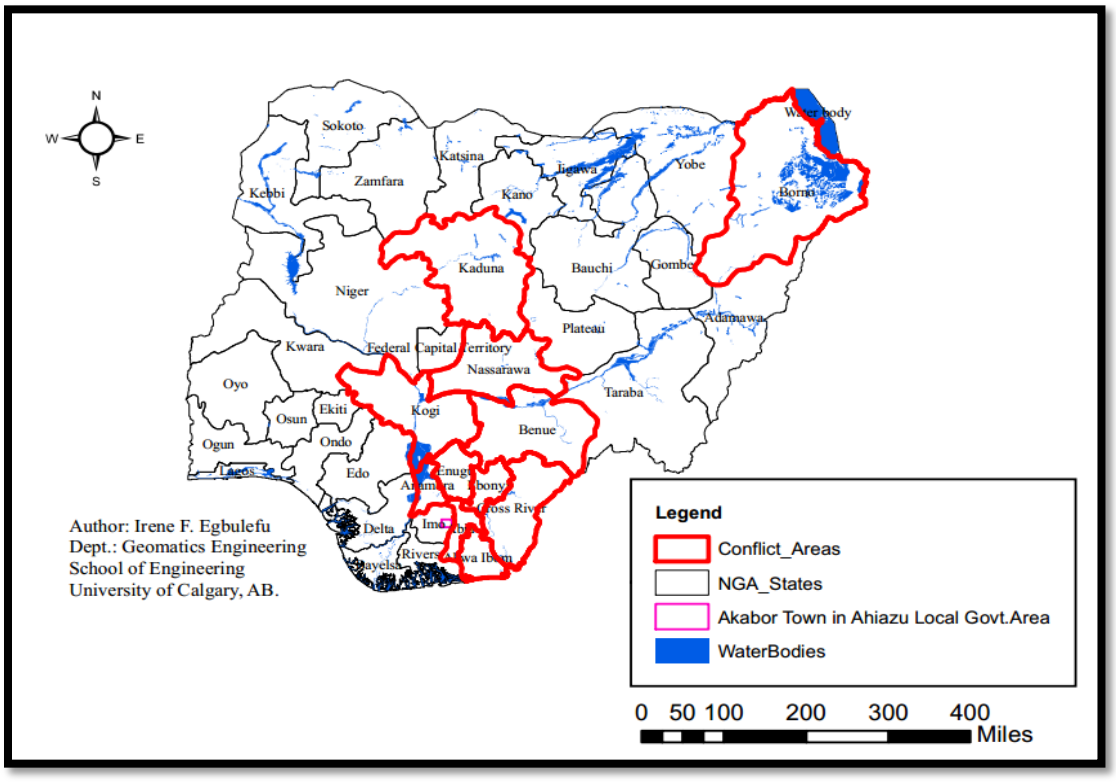

Figure 2.5 Map of Nigeria showing areas of the country that are experiencing escalated conflicts over land
Map layer data source: Global Administrative Areas (GADM database – www.gadm.org) *(Spatial reference – WGS84)*

In the rural parts of Imo state, there are issues of inadequate documentations of tenure information and legal foundation thereby contributing to increased disputes over land between members of the same community and/or neighboring communities and between neighboring communities as well. In some cases, these disputes are caused by lack of clear boundary identification between overlapping lands and natural resources. One of the ways to sometimes resolve the issues is to ask the disputing individuals or parties to provide tenure evidence (Deddy, 2006). This evidence in most cases is non-recorded and non-surveyed since they do not have to pass through the legal process of

deed or title registrations to guarantee a proof of ownership. As time goes on, the inability of the local people to present documented or recorded evidence of ownership of their land properties may hinder them from effectively defending their lands in dispute situations or during adjudication process. The security of land tenure depends on the ability of the claimants to present evidence, either documents, text, or oral and video to prove their interest in the land whenever it is required.

In their efforts to reduce the land conflicts at rural level, the Nigerian government set in place some local customary courts to address land disputes at the rural level. However, this arrangement has yet to achieve the objectives laid down by the government as some of the less privileged members of the community still lose their lands due to lack of concrete evidence or proof of ownership (Oluyede, 1978). In the event of land dispute between individuals, some of the individuals are financially handicapped in a way that they are not able to seek redress in the customary courts.

Most of the disputes at the community level are usually due to disagreement in the position of the land boundary; people tend to encroach into their neighboring farmlands especially during the farming season. This causes a lot of dispute between the neighboring farm owners. The increasing number of land disputes and encroachment issues and their consequences in some communities especially in southern Nigeria needs to be addressed. This research is focused on identifying some of the major causes of the conflicts and ways to mitigate them.

2.6 Information Technology and Land Tenure Administration

Every information management requires data processing, so the land tenure information and management systems also require intensive data processing in order to provide the required solution. To facilitate a proper tenure management information system, there is the need to process certain types of data that are uniquely associated to land; such data types include land parcel map that comprise of ownership, administrative and geopolitical boundaries, land ownership and governance, land cover/land use, ecosystem zones and regions, socio-economic data, utilities and infrastructure assets (UNEC, 2008).

The ICT division of United Nations Economic Commission for Africa pointed out two approaches for managing land information: systematic and non-systematic information management approaches. The systematic approach of land information management integrates the use of computer technology into land management and administration while the non-systematic approach does not make use of computer system; this is the system that is currently obtained in most third world countries that do not have enough funds and technical expertise to implement system information management. The systematic approach to land information management is aimed at developing diverse application systems that will help to improve administrative land management dealings. These diverse applications systems can either be in the form of a proprietary software or free open source software. The proprietary software requires the users to purchase the license that can give them access to the use of the software while the open source land

information software do not necessarily require the users to perchance a license to enable them make use of the application (UNEC, 2008).

The administration of every public service and every branch of national activity connected with land is greatly assisted in the execution of its work by the existence of an up-to-date and faultless map and record of landed property throughout the country (Kain & Baigent, 1993). The drivers of economic growth in most countries include the various forms of land-based economic activities such as agriculture, livestock production, housing, tourism and the extraction of mineral ores and oil. These are some of the basic factors that lead to appreciation of land values and cost in the various communities.

The strategic importance of a proper land information system cannot be over-emphasized as it provides necessary support for the variety of land tenure systems that exist over the world today as well as good land management information and data storage. This is very crucial in communities that are governed by customary land law. Bohannan (1973) described land tenure system as a relationship that exists between individuals, people or social group and a parcel of land. He identified three important factors that are required to understand a typical land tenure relationships in a cross-culture; these include: the concept of land, correlation of man with his physical environment, and a social system with a spatial dimension.

Generally, evidence for land adjudication process in Africa are collected and managed in a conventional way (i.e. without using high tech tools and/or methods). The conventional method involves bringing together claimants, adjudicators, witnesses from related communities, government official, and land surveyors and registers, and other

stakeholders in an informal hearing setting in order to ascertain rights of claimant(s) over an unregistered parcel of land (Nyadimo, 2006).

The adjudication officer in a customary setting relies on the evidence (either oral or written) presented by the contending parties to pass his judgement in the case. These can include formal documents such as survey plans and maps (to show land parcels and their boundaries), receipt of land transaction, or deed documents that are registered and certified by government; other acceptable evidence include oral testimonies from local witnesses, sketched diagrams for illustrations and so on (Njenga, 2004; Toulmin, 2009). In conflict situations, most of the time, an adjudication process is concluded based on the number and authenticity of the presented evidence by the plaintiffs to the adjudication committee that is usually presided over by an adjudicator (Nyadimo, 2006).

The conventional way of land adjudication has been experiencing significant delays and shortcomings; while some of these delays can be due to poor administration and lack of resources, others are caused by ineffective methods of collecting, documenting, and presenting the evidence required for the adjudication.

Since the conventional way of adjudication proceedings in a customary setting requires that all the stakeholders gather together in one place and at the same time to present their proofs to the committee, the adjudication verdict can be delayed or compromised by issues of punctuality or absence of witnesses and/or involved parties. Local politics may also force certain parties to be excluded from the process. Furthermore, the lack of effective and incremental documentation of evidence prior to and during the process of adjudication in the conventional method can impose further

challenges on the resolution as well as the final verdict that would be taken (Azeez et al., 2013; Nyadimo, 2006). For instance, it is possible for a key witness to change or alter his/her statement or die before the completion of the adjudication process. In these cases, the evidence is no longer reliable or available for consideration, which may result in disagreements or unfairness in the given verdict (Barry and Khan, 2005). Other issues that are hindering customary land adjudication include record keeping system. This system is currently a manual system that is accessible only at a single location (Toulmin, 2009).

Some of these issues can be mitigated or improved by integrating new methods and tools for collecting, recording, and managing the evidence. In his paper, Njenga (2004) proposed digitizing of maps and adjudication records as well as the use of GPS and GIS (as obtainable in modern surveys) during land adjudication process in Kenya. The importance of integrating modern technologies in land adjudication process and evidence collection and management has also been discussed by other researchers. Toulmin (2009) explained the roles of new technologies and method, such as Global Positioning Systems (GPSs), computerization of records and Geographic Information Systems (GIS) in improving securing rights of land. Additionally, she discussed the need for a computerized record system that will facilitate multiple accesses to adjudication process in order to reduce the time required for checking claims and testimonies. In addition to speeding up the adjudication process, these computerized systems and high tech tools will enhance transparency and accessibility to adjudication evidence by local people and the general public as well as will reduce dependence on cost associated with

obtaining government gazette, for the benefits of poor and non-educated members of a community (Barry and Khan, 2005; Toulmin, 2009).

Recently tools like Social Tenure Domain Model (STDM) have been proposed for recording and managing adjudication evidence. STDM was developed with the support of Global Land Tool Network (GLTN) partners, UN HABITAT, FIG, the World Bank, and ITC in order to improve security of tenure and increase conflict management amongst other benefits (Augustinus, 2010). The STDM initiative is designed to cater for situations where land titling is inappropriate (Barry et al., 2011).

Zevenbergen et al. (2013) stated some key reasons for land recordation process that include:

- **"**Evidence or proof of land rights including of the transaction, of the parties involved, of the land involved, and of the acceptance by the community.
- Notice to the world, including the state.
- The creation of ranks or priorities between different recorded documents.
- An index linked to the names of the parties, which will facilitate ease of access to information.
- A geometrical index, which facilitates linking the land documents to the ground.
- Easier operations for (local) government for services and to organize other land management activities.
- An increased level of status in the eyes of the state.

- An increased level of status in the eyes of the community, depending on the acceptance by the community of the system, its presence on the ground, the land documents and other services".

The authors explained that the recording system can only be beneficial to landholders if it is systematically designed and executed using a fit-for-context approach.

Technical gaps that are inherent in the conventional land administrations systems that made them deficient in handling a range of tenure types such as customary areas and slums could be filled by the application of STDM (Augustinus, 2010). As a result, application of STDM in land management, as Augustinus (2010) argues, will improve the sustainability of the planet and food production as well as reduce poverty and its negative impact of human settlement. STDM application, which is a land information management model, aims at integrating formal, informal, and customary land systems as well as administrative and spatial components (Augustinus, 2010). Despite the objectives and goals set for STDM, the software is still in developmental stage though it has been tested in some pilot areas such as Uganda and Kenya.

Another approach of integrating technology in land tenure security is the use of audio-visual evidence in land records with the participation of community members in order to improve the existing land record information which is currently limited to written text and survey plans or sketch plans (Barry and Khan, 2005). This is supported by Barry and Khan's (2005) hypothesis that individual's beliefs and attitude towards land tenure system can be captured through multimedia applications. For this purpose, the researchers presented the concept of "TalkingTitler" software that can integrate video

clips, photographs, and sound files into the conventional land records. The objective of the software is to improve the completeness and quality of evidence relating to claims to rights and interests in land (Barry and Khan, 2005). Furthermore, Barry et al. (2012) presented a theory to explain and predict why and how land holders register or fail to register transaction at grassroots levels. Their study was used to establish how people secure and use registration within the context of local and regional politics, social change and social inequalities.

Barry et al., (2012) gave an overview of popular information system development approaches namely the top-down and the evolutionary system design approach. They noted that while the top-down approach is suitable in stable situations where the problem context are simple and well understood such as in the design of an information system that will support land registration, the evolutionary system design approach allows the frequent evolvement or modification of the information system with time. It is thus suitable for use in chaotic or democratic organizational cultures that encourages creative thinking, risk taking and innovation.

They provided some explanations on the benefits of adopting an evolutionary system design approach in developing land tenure information system (LTIS) as in the case of the TalkingTitler development approach. The adoption of this approach stems from the need for an application that is flexible enough to handle frequent changes that arises from time to time in system requirements, unconventional data forms and structures, and unforeseen user requirements. The system development in this case may evolve in a number of different ways with various outcomes of scenarios. The

TalkingTitler software development adopted some form of agile development strategies such as delivering small, incremental releases and iterating. The iteration in this case implies that the development cycle involves three steps that are always reoccurring and they are Analysis, Development, and Testing of each feature that is being developed. The TalkingTitler software used in this project is presently using PostgreSQL object relational database management system (Asiedu, 2014), although, without a PostGIS spatial extension. The PostGIS spatial extension was introduced in this project to manage the spatial information integrated into the software.

2.7 Land Information System Currently used in Nigeria

Land administration and management in Nigeria is presently at a rudimentary stage due to lack of transparency in the work processes, poor record management, manual procedures, high rate of perceived corruption amongst the land management personnel, mistrust on the part of the customary land owners in land administration by the government personnel, and lack of technical expertise to operate new technologies that are in place. There is also the problem of trust amongst the land agencies.

In Nigeria, land operations at the Federal Level in Nigeria are coordinated by two federal ministries: the Federal Ministry of Housing and Urban Development, which is responsible for the managing all land that are under the jurisdiction of the Federal Government of Nigeria in all the States of the Federation and the Ministry of the Federal Capital Territory (MFCT) who is responsible for all land belonging to the Federal Government of Nigeria in the Federal Capital Territory only (Anther, 2011).

One of the popular applications currently used for land management and administration in the Federal Capital Territory is the Abuja Geographic Information Systems (AGIS). Abuja is the capital city of Nigeria. The focus of AGIS is to reduce poverty and enhance economic and social growth by improving security of tenure. This system will also help to simplify the process of land acquisition by the public, and enhance the efficiency of the existing system of land management and administration in the Federal Capital Territory. The computerize land information at the federal level and at the federal capital territory level were identified with the acronyms "FELIS" which stands for 'Federal Land Information Systems' and MFCT which stands for 'Ministry of the Federal Capital Territory'. The MFCT was later evolved into the present AGIS comprising of two components: Geographic Information Systems (GIS) and Land Information Systems (LIS) (Adeoye, 2006).

These software applications were developed based on western form of land tenure, and are basically used to manage, individual, and public land ownership rights, they are not able to handle the multiple and overlapping land rights that exist in the rural areas where customary land tenure rights are practiced. They are only suitable in the urban areas.

2.8 Observed Gaps in Formal Land Information Systems and Significance of the Research

A Land Information System (LIS) is described as a tool for managing and administering land and its resources. LIS was primarily developed to serve the needs of

countries that use a 'western' style land market, where individual land rights are the norm (Rakai and Williamson, 1995). However, for countries such as Nigeria which have a good portion of their lands held under customary land tenures that are predominantly feature communal land rights, there is a need to incorporate customary land tenure data and relationships into the LIS.

The literature review above revealed some fundamental gaps in conventional land information system software packages; such gaps include issues such as the affordability and accessibility of these applications to the local people at the grassroots level (Zevenbergen et al., 2013), although there is no actual proof or measures to attest to this stated fact.

The conventional land information systems lack the functionalities to integrate the complexities and social relations that are inherent in customary land rights. These conventional software applications do not have the capacity to handle or represent the web-like nature of relationships that exist between a portion of land and the different persons in a customary setting. For instance in a typical customary setting a portion of land can have different persons having various forms of rights and interest on it; these interests and relationships between the portion of land and the various persons need to be effectively recorded and appropriately represented in the computer application.

Furthermore, the conventional land information system applications were developed without putting into considerations the need for tenure evidence recordation in various formats (audio, image, video, text etc.) for future use; such recordation is very useful and handy during land adjudication processes. The limitations of these

conventional land information system applications have made them difficult to be practically and effectively used in land tenure management and administration in rural areas of some of the African nations that practice customary land tenure legislations.

2.9 Existing TalkingTitler Software Design Approach

A critical part of software development is in specification, design and conceptual construct (Beynon-Davis and Tudhope, 1999). The existing TalkingTitler software was designed using a prototyping and evolutionary approach which was also adopted in this project. The focus of the TalkingTitler application was to provide optimum flexibility in the creation of social relationships between people and between people and their interests in land by integrating various forms of data structure and data types to provide tenure evidence such as videos, photographs, documents, maps, digital graphics and sound recordings (Barry et al., 2013). The flexibility integrated into the software facilitates effective management of the frequent changes in system requirements, unconventional data forms and structures as well as unforeseen user requirements associated with most unstable situations. The concept and design approach adopted in the development of the existing TalkingTitler software aims at promoting equity and fairness at the local level and at the same time incorporate the claims of powerless groups within the highly complex, changing and local political state of affairs (Barry et al., 2011).

Roux and Barry (2001) provided some highlights on how the incorporation of video evidencing in a land information system can help to address issues that relate to uncertain situations in informal settlements or local settings. In their statement they

remarked that the valuable video evidence can be used to augment existing land tenure information being used in any of the settings. They further stated that an incorporation of a spatial system to capture both spatial and non-spatial attributes of land rights would help to reduce the uncertainty that prevails in formalizing land rights in informal settlements and in certain rural land restitution cases thereby reducing these uncertainties.

The initial development of the TalkingTitler application started off as a simple structure of cadastral information model with an ability to handle multimedia data; it was built on a Microsoft Access database platform and later upgraded into PostgreSQL 8.4 database system. The system was modeled as four inter-related class comprising of (1) Person to represent right holders, (2) Reference Instrument such as title or deeds, (3) Land Object (parcel, trees, house) and (4) Media Item (a range of multimedia files) (Muhsen and Barry, 2008). Over time, the Talking Tilter software has evolved and became more robust. It has been tested in South Africa where it was used to identify some solutions to the growing cases of `off-register sales of land` (Barry and Roux, 2013). The application was designed as a prototype evolutionary software that is simple but flexible enough to manage a combination of different land-related issues in areas that are experiencing some level of uncertainties and insecurity in land tenure (Muhsen and Barry, 2008).

Software prototyping is described as a ‘working model of an information system that emphasizes specific aspect of that system’ (Vonk, 1990). It is a procedure in software development that requires input from various sources which in effect makes it an approach for developing prototype applications by providing enhancement on the existing

application. The TalkingTitler application is an incremental\ evolutionary (vertical user-interface) prototype as each of the feature in the software is started and completely implemented at a time.

Prototyping can be used when users' expectations and requirements are not clear (Carey and Currey, 1989) and for systems that are dynamic and used in transaction processing \ user dialogues (Klinger, 1988). The software developed in this project is focused on managing the complexities associated with tenure information in customary situation that is experiencing changes.

2.10 Analysis and Design

Today, the prime objective of a land administration and information system is to facilitate flexibility in land information data processing, storage and data representation including spatial and non-spatial data in an effort to capture the physical relationships and complexities that exists in land transactions and the person-land relationship. Some of these data processing include the representation of land tenure, title, deeds and various land transactions between persons. Other forms of land information processing and representations include land surveying and mapping. The processed land information can be communicated or stored for decision-making or record purposes.

Presently, there is a growing number of land information software in use (proprietary and non-proprietary). However, none of them can be described as holistic; thus the determination of a good and functional system can vary between stakeholders,

perspectives, and system purposes, as well as functionalities and ease-of-use (Ashby, 2004).

In every standard practice, information management requires data processing; this also applies to land information management, which in most cases requires intensive data processing in order to provide the required solution. An effective land information management system involves the processing of certain types of data to provide an optimal and adequate management of the activities and transactions that take place on the land. Such data types include administrative and geopolitical boundaries, land ownership and governance, land cover/land use, ecosystem zones and regions, socio-economic data, utilities and infrastructure assets as obtained in land parcel mapping (UNEC, 2008).

A number of open source software applications are being developed to improve land tenure security. These include the UN-Habitat supported Social Tenure Domain Model (STDM), and the Open Title application, which is a commercial package that is based on the STDM design (Edmead, 2011). Also included here is the software targeted at low cost land registration Solutions for Open Land Administration (SOLA) funded by FAO and the Government of Finland. SOLA uses the Land Administration Domain Model (LADM) as a point of departure and aims at making land registration and computerised cadastre affordable for developing countries (Pullar et al., 2012). These land information system applications are briefly described below.

2.10.1 Social Tenure Domain Model (STDM)

The Social Tenure Domain Model (STDM) is a land administration data modeling application developed as a specialization of the International Federation of Surveyors also known as Fédération Internationale des Géomètres (FIG) Core Cadastral Domain Model (CCDM) putting into considerations the requirements and short comings of the CCMD. Its aim is to model the person-land relationship regardless of their formal or legal status (Lemmen et al., 2007). The conceptual model of the STDM is based on three core classes of Land Administration Domain Model (LADM) which include the Social Tenure Relation class, Spatial Unit class and Person class (Molero et al. 2010). This is a recast of the LADM core classes of Person and Register Object (e.g. a title or deed), into a social tenure. The LADM core classes which are related through a third class RRR (Rights, Restrictions, and Responsibilities) was developed to model different situations such as tenancy and ownership arrangements (Lemmen et al., 2007).

The STDM software strives to support various forms of land rights, social tenure relations and possible overlapping claims to land. It is not totally based on the level of 'formalization or legality' of the relations but it can be used as a basis for the development of land administration system that can support all forms of land rights such as obtained in post conflict areas. The model is aimed to be used in undeveloped countries, countries with very little cadastral coverage in urban and/or rural areas, post-conflict areas, and countries with large scale informal settlement and/or large scale customary areas. The STDM software application provides the ability to put rights into a system, rights which are not registered or register-able as well as claims that need to be

adjudicated both in terms of the 'who', the 'where' and the 'what type'. The application is focused on recorded rights (or social tenure relationships) and not on registered rights (Lemmen et al., 2007).

The data modeling in STDM software is dynamic and can be implemented either as decentralized or a distributed set of (geo-) information systems that can support the maintenance of activities and the information supplied from a given dataset. The software was developed as a modular structure and each module is configured to perform unique functions or to achieve particular objectives. For instance, the software has the ability to capture and display the different stages of a parcel land as well as the rights on the parcel using a geo-code functionality that will reflect the dynamic nature of the application. To make the software simpler and friendlier, the tenure types in STDM software are identified by specific keywords that make it easier to capture different information on land tenure relations in the various situations. Some of the keywords assigned to tenure types in STDM include: Structure owner, Part owner, Tenant, Sub Tenant, Relative of Structure owner, Friend of Structure owner, Relative of Part owner, friend of Part owner, Relative of Tenant, Friend of Tenant, Relative of Sub Tenant, Friend of Sub Tenant, Joint ownership (married), and Child of the owner.

The robustness in the STDM design is a positive point, the problem in this case is that this design is unable to capture the complexity of some of the situations obtained in a customary tenure system. The software is highly technical and cannot be operated by people with minimal computer knowledge. The installation process is somewhat complex as it requires a lot of initial configurations and setup of various plugins required to run the

application. For instance the STDM software requires a QGIS plugin for its mapping. QGIS is a simple emulation of the ESRI ArcMap and thus requires a skilled GIS resource person to understand and operate the software. The STDM does not provide users with the flexibility to customize the software to suit their needs. There is no front-end query interface; the system can only be queried through the back-end which is the database. It would require a lot of training for users to be able to operate and use the application.

2.10.2 Software Solution for Open Land Administration (SOLA)

This is free open source software developed with the full support of the Food and Agriculture Organization (FAO). The aim of the software is to computerize cadastre and land registration systems in order to make them more affordable and efficient. The Land Administration Domain Model (LADM) was adapted in the development of SOLA software. The SOLA software was developed for the purpose of making land registration more accessible and affordable (Pullar et al., 2012). It does not appear to be targeted for customary or post-conflict situations that are not suited for land registrations.

The SOLA database is not available to users as a web application. Thus users can neither query the database content nor relate uploaded data to a desired entity in the database. The application is not easy to manipulate and does not have a spatial data interface although this can be optionally provided through a process of customization which would also require the skills of a computer programmer. It comprises of data input forms for entering land registration information. It is important to note that simple forms may not be suitable enough to represent the complex situations that are associated with

customary land tenure. This therefore calls for the need to integrate multimedia and spatial capability with maps in order to provide software that is robust enough to handle the complex nature of customary tenure information. The SOLA software application lacks most of these functionalities, which makes it unsuitable for use in a customary tenure environment.

2.10.3 The TalkingTitler Model (TTM)

The TalkingTitler system model aims at addressing uncertain situations where titling is inappropriate at a given time. It is based on four core classes: Media, Person, Land Object and Reference Item (Figure 2.6) (Barry et al., 2013). In this case, the Person and Land Object classes are similar to the core classes of STDM and LADM.

The third and fourth class of the TalkingTitler is the Land object and Reference Instrument classes which helps to improve the integrity of the stored information. For instance, local people usually base their record system on some form of reference documents such as a title, a file number, and some form of map with unique identifiers to model land parcels etc. The Media comprises unstructured data items, such as video clips, photographs, sound recordings, written notes and reports, title deeds, contracts, permits, wills, marriage contracts and cadastral survey plans (Barry et al., 2013).

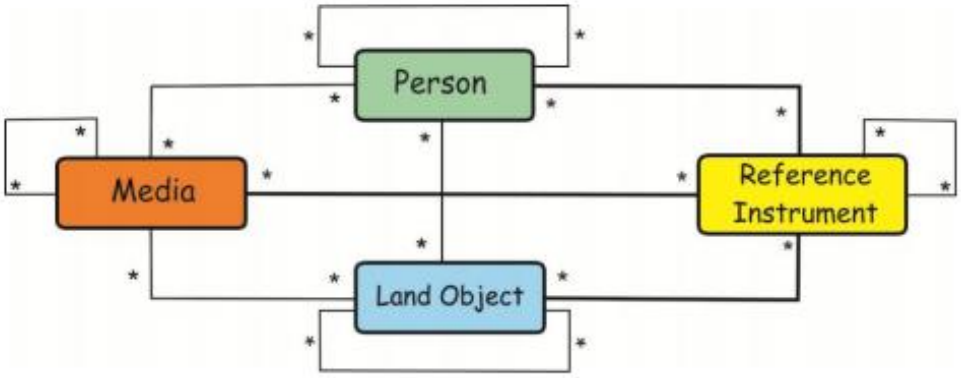

Figure 2.6 TalkingTitler Four-Class Conceptual Model (Barry et al., 2013).

Unlike the STDM and SOLA applications, the TalkingTitler model provides the flexibility to capture conflict and complex situations and also able to model the complex customary land tenure scenarios such as the person to person relationships and the person to land relationships. In this model, two or more person objects can have joint interest in one parcel of land. An example is in the case of family lands, pledged land, borrowed land. Furthermore, the TalkingTitler Models was designed as a self-adaptive land tenure Information system. This implies that the model allows for an evolution of a basic land administration model into a specialized LTIS that can be adapted for specific land administration situation (Barry et.al, 2010). These are some of the features that made it the choice model for the software developed in this study.

2.11 Chapter Summary and Relevance to Research Objectives and Questions

This chapter has briefly reviewed the various types of land tenure rights recognized in the research study area as well as the current system of land tenure

administration at the national level and community levels. In addition, the Chapter discussed some of the prevailing issues of land disputes that are experienced in the research area at macro-level, which involves reviewing the general issues in Sub-Saharan Africa and Nigeria as a nation.

A review of some of the existing research articles and land information systems for land tenure administration was carried out to identify gaps that can be filled by this study. The chapter explained briefly the existing TalkingTitler model and the features that made it a suitable information system for customary land tenure administration.

This chapter has partially addressed the research objectives stated in section 1.5 by highlighting the need for an appropriate Land Tenure information system that can integrate the traditions and norms of the citizens while protecting their interest especially for the regions of the country whose tenure system is predominantly customary. The research objective would be further addressed in chapter 4 and 5 of this documentation.
The chapter analyzed some of the existing studies and software applications that were developed to manage land tenure information as well as land registration information thus providing solutions to Research Question 1 in Section 1.6.

The chapter also identified the short-falls in the various software analyzed, specifically, in the aspect of their inability to handle the complexity associated with the customary land tenure system. For instance, the STDM software was targeted for informal and customary environment but the software did not take into consideration the complexity associated with these environments and thus lacks the functionalities that can capture and represents the complex social relationships that exist physically in the

customary tenure environment. The STDM software, though targeted for under-developed and developing nations where there are still problems of informal settlements and customary land tenure practices, was also developed with lots of complex interfaces and plugins which made it difficult for people with minimal computer knowledge to understand and to operate. The SOLA software that was developed as a simple data input form for recording land tenure registration information is not able to handle some of the unstructured and spatial data necessary to represent the complex customary tenure information.

Finally the TalkingTitler tenure application which is being developed as evolutionary system software provides a flexible data model and data structure that can facilitate the representation of the complexity and evolving nature of the customary land tenure environment. The users of this application are provided with flexible data structure and relationships to represent complex real world scenarios in a computer understandable form. In the next chapter, the field research approach adopted in this project implementation as well as the research findings relating to the customary land tenure practice in the Akabor community will be presented

The next chapter will focus on the approach adopted in carrying out the field study conducted in Akabor town, which includes the data collection, analysis and processing. Also discussed in this chapter are the research findings and insights made based on the field study.

Chapter Three: **Research Methodology and Findings**

3.1 Introduction

This chapter describes the research methodology and findings from the field work conducted in this research. An in-depth description of the data collection, analysis and design procedures along with a summary of the strategies used for verifying the reliability of the data are provided. Additionally, the Chapter provides details of how the members of Akabor community acquire and defend their lands. It also provides some insights into the common causes of conflicts over land in the area and the traditional ways in which these conflicts are addressed and resolved.

To investigate the lineage system and land tenure in a typical customary community, field interviews were carried out at the designated research site in the state of Imo, Nigeria. The researcher adopted some strategies suggested for a case-study research approach to explain the complex social phenomenon associated with land tenure in a customary setting. Using a single design, qualitative and exploratory study approach that involves multiple sources of evidence, the researcher designed and developed a prototype web-based land tenure information system software. Also, based on the findings from the empirical field work, some theories were developed to describe the land tenure system practiced in the community, and the major contributing factors to land disputes that are frequently encountered in the area.

3.2 Data Collection

In addition to the literature review carried out to understand the background problems, and the existing procedures for acquiring and securing land in a typical customary Igbo community, the researcher took further steps to gather data at the research study site. During the pre-research visit, the researcher travelled to the research community to inform the community head of her research intention and sought their approval. The community head of Akabor, gave his approval and referred her to some members of his cabinet who would assist her further in the research process.

The data collection approach involved one-on-one semi-structured interviews with qualified participants. First, the criteria for the selection of participants were identified (see Section 3.5.2 for complete inclusion criteria). The criteria for qualification to participate in the interview were based on the fact that in the Igbo society, women are traditionally not recognized as land owners since it is believed that their share of inheritance lies with the husband (Dike, 1983).

Some of the respected elders of the community who were used as gate keepers volunteered to help in contacting members of the community that met the interview requirements; these gatekeepers also helped to inform the participants about the scheduled days of the interview ahead of time to ensure their attendance and participation. Potential participants who met the criteria were selected and were sent interview request letters through the gatekeepers. The participants were also asked to sign a consent form to show their voluntary participation in the interview to provide

information about their land properties to the researcher. A sample consent form signed by the participants is shown in Appendix B.

For the interviews, the researcher developed an interview guide consisting of both open- and closed- ended questions and captured the interviews using both audio and video recordings. The interview guide is shown in Appendix U. As well, as part of the interview process and with the permission of the participants, photographs were taken of some of their various forms of land use and the traditional means by which they mark and identify the extent of their land portions or boundaries.

Thirteen participants were interviewed; these were all men who were over the age of 18 and owned at least a portion of land in the community. In this research female participants were omitted as the culture of the research community does not recognize female land ownership; thus women do not own land in the Akabor community. The interview was focused on land ownership, acquisition system and how the people identify and secure their land properties. A number of interviews were conducted at the residences of various participants, in the presence of some other members of the village who showed interest in the research. A few other interviews were conducted at the village town hall. The information recorded during the interview includes voice recordings of the participants, some photographs and videos showing their land properties, as well as textual data that were noted by the researcher during the interview. The interviews were carried out in the presence of three or more member of the community who are also knowledgeable in the land histories and ownerships in the community. At the end of each data collection exercise, the collected data were reviewed with some respectable and key

members of the community who were also the members of the gatekeepers in this research. They helped to certify that the information given by the participants was accurate.

3.2.1 Units of Analysis and Research Participants

The units of analysis in this study include the land portions identified by the boundaries and the research participants. Some of the research participants were able to communicate in both English and the local language, which is 'Igbo,' while a smaller number of the participants (mostly the older ones) were not able to communicate in English. The research interview was conducted in the preferred language of the participants, as the researcher is able to communicate fluently in both the Igbo and English. This ensured that all participants participated in the language they feel most able to communicate and express themselves.

The inclusion criteria used for the research interview participants are as follows:

- Community members who are males and own at least one parcel of land, and are over 18 years of age.
- Community members who have lived in the community long enough to understand the traditional norms and procedures for acquiring land in the community, such as the chiefs and elders and other titled men in the community.
- Non-natives of the community who own or lease land in the community
- Tree growers who have rights to the trees they plant or purchased but not rights to the land.

- External sources that are knowledgeable about land matters in the area such as government land officials.

The exclusion criteria were as follows:

- Children and youths under 18 years of age, whose capacity for judgment and self-direction is still maturing, and therefore may not have good knowledge of land matters in the community.
- Adults whose capacity is diminished or fluctuating due to illness or injury
- Adults whose capacity remains only partially developed (e.g. congenital conditions)
- People who may be adversely affected by the study (though this is unlikely).

3.2.2 Data Analysis, Processing, and Design

Although the data collection and analysis took about three months from December 2013 to February 2014 to complete, the qualitative approach adopted provides detailed description from multiple sources during the examination of the group in a natural environment. This research considered three different data types: structured data, unstructured data, and spatial data. Structured data refers to information with a high degree of organization which makes it easy and readily searchable when entered into a relational database. Some examples of the structured data collected in the study include text such as the demographic information of the participants (age, gender, sex, family size, marital status, and history of land use).

Unstructured data is essentially the opposite of structured data. It does not have any identifiable internal structure and is highly unorganized though it can be visualized. The unstructured data include video \ audio recordings and photographs. The spatial data type is information that identifies the geographic location of the parcel boundaries and features or resources on the land such as the location of the economic trees, boundary markers (live trees), or other constructed features like ridges, fences and dwarf walls. Spatial data are usually stored as coordinates and topology. The spatial information is used to map or locate the parcel information on a map.

The purpose of data processing is to extract information that would be used as sample input data for the Talking Tilter land tenure information system. The recorded interviews and field notes were transcribed and documented with Microsoft Word. The information collected was used to test the performance and functionalities of the developed software, especially its ability to effectively store and represent the complex data structure associated with an evolving customary land tenure system. The procedures for land acquisition and tenure transactions as well as transactions involving other land resources such as economic trees were extracted from the interviews. At the end of the data collection process, the responses of the participants were analyzed and processed. A tabulation of popular land acquisition method and tenure evidence used in the community was extracted from the interview with the participants (Table 1).

In the absence of complete ethnographic detail from the study area, a review of the literature in comparable areas of the world, as well as the responses obtained from the participants during the interviews, were used to generate relevant questions that members

of Akabor community would be interested in asking about their land and features on the lands. From these questions, the database and requirements were determined, and were also used to construct a user-friendly interactive query interface that is relevant to land tenure information management in the Akabor community. The sample questions were formulated based on the interview responses. As a result, the questions\information that members of the research community would like to obtain from the database system are as follows:

a. How many portions of land does Mr. A own or have interest in (i.e., land sharing arrangements, family land interests) within the community? How many portions of land were inherited? How many of them were purchased?
b. What is the history (i.e., previous type of land acquisition, previous owners, previous disputes, and previous land use) of a particular parcel of land?
c. Who are the owners of the lands that bound Mr. A's land (Neighboring lands that share boundary with Mr. A).
d. What are the transaction histories behind the portion of land I want to buy (i.e., previous leases or holds on the land)?
e. What is the span of my land parcel?
f. How close is my land to the nearest road?
g. How close is my land to the nearest river or stream?

h. What boundary identification features are on my land boundaries? How old are these features (i.e., how old are the boundary marking trees in case they need to be replaced)?

i. What is the most popular land use in the area where my land is located (i.e., what are the most popular types of crops grown in my land area)?

j. What types of crops are currently planted on my parcel?

k. Who is the current lessee on my land (for leased land) and who are the past lessees on this land?

l. What types of economic trees exist on my land (i.e., Trees such as palm trees, Iroko trees, mahogany trees, oil palm trees, coconut trees, orange trees, mango trees, pear trees and more that are leased or sold on the land)? How many of each are there and when were they planted?

m. Who owns the trees on my land parcel?

n. Which of my lands are due for fallowing?

o. How many lineage lands do we have in this community? What are they used for? Where are they located?

Interview Number	Participant Name Pseudonyms)	Title	Age	Land Owner	Method of Acquisition	Proof of Ownership
001	Chief Ugwmba	Lawyer	75	Yes	Inheritance	Oral Testimonies from Kinsmen and Neighbouring Land Owners
002	Agwu Maxwell	Chief Priest	84	Yes	Inheritance	Oral Testimonies from neighbouring land Owners
003	Dim Nwoga	Lawyer & Adjudicator	61	Yes	Inheritance & Purchase	Oral testimonies from Kinsmen and agreement documents signed by him and the owner of his purchased lands
004	Ignatius Amadi	School Teacher	58	Yes	Inheritance	Oral Testimonies from Neighbours and Kinsmen
005	Uzo Uzodinma	Farmer	86	Yes	Inheritance	Oral Testimonies from Neighbours and Kinsmen
006	William Okoye	Musician	43	Yes	Inheritance & Purchase	Oral testimonies from Kinsmen, paper documents (Receipts of sales transactions and agreement document)
007	Paul Onyeaso	Bus Driver/para-surveyor	63	Yes	Inheritance	Oral Testimonies From Kinsmen and neighboring land owners
008	Kingsley Madu	Commercial tricycle driver	53	Yes	Purchase	Agreement document and oral testimony from kinsmen
009	Christopher Akuwudike	Accountant	36	Yes	Family & Purchase	Agreement document, Oral testimony from kinsmen
010	Basil Oleaku	Businessman\ Nze Title	54	Yes	Individual land and Purchased	Oral testimony of Kinsmen and neighbouring land owners
011	Emeka Ojo	Farmer	26	Yes	Family	Oral testimony from

						uncles and kinsmen
012	Mathew Omenuko	Photographer/ land recording officer	49	Yes	Inheritance & Purchase	Oral Testimony from kinsmen and brothers
13	Jorom Ozumba	Farmer	67	Yes	Inheritance	Oral Testimonies from Kinsmen and neighbouring land owners

Table 1 Sample Interview participants' information

3.3 Research Findings - Genealogy of the Land Tenure System

The research interview process yielded some valuable insights into the history and genealogy of the research study site. Specifically, Akabor is a town named after the man who founded it; Akabor had eight sons who founded the eight villages in Akabor town - each named after one of the eight sons. The land of Akabor was inherited and shared amongst the eight sons thus each village had joint ownership of the land apportioned to them. As the families of the various villages grew and expanded, the descendants of each of the sons of Akabor in the villages began to segregate from the large lineage groups into smaller units known as 'kindred'. The lineage lands and their resources were shared according to the number of kindred groups in each village, so members of each kindred group became joint owners of their inherited land and natural resources. As time went by, the kindred unit expanded and then segregated into smaller families. As a result, they began sharing their inherited lands and resources according to the number of families that made up each kindred group. Accordingly, as the number of families increases in each kindred group, the land tenure continues to be divided up amongst the ever-increasing family units. In each family unit, the inherited land and natural resources are placed in the trust of the eldest males in the family. These elderly men usually deliberate and make

decisions on how the land is used although all male members of the family have equal rights to use the land and resources allocated to the family (Interview #1, 2013; Interview #2, 2013; Interview #4, 2013). There has been a continuous and gradual transition of land ownership from lineage tenure into individual tenure. Most of the jointly owned family lands are now shared out to the individual male children in the family (Interview #1, 2013; Interview #3, 2013).

Generally, in typical Igbo communities, prior to the practice of individual land and property acquisitions, the tradition in Igbo community was such that Land does not include the things growing on or attached to the soil thus economic trees, forest resources and even structures on a land can be owned separately or jointly; these can also be managed as a communal or lineage property or individual (Dike, 1983; Nlerum, 2011; Obioha, 2008). Over the years, as the population of the lineage families grew and expanded, they began to share their lineage or communal lands according to kindred[8], and according to families, entrusting each family's portion of land to the male head of the family (usually the eldest male). With the advancement of years, and the number of male children in the family expanding to form their own nuclear families, land ownership became individualized in the sense that the family lands now get shared out to the individual male children in the family, apportioning the largest share of the land and assets to the first son ('Opara Nna'). In families where there is only one male child, the male child inherits all the lands and properties of his father, but where there is no male

[8] This is sub-lineage group in Igbo society that recognizes themselves as people who share a collective vision and primordial interest in the community

child born to the family the brothers the late father share his land and assets amongst themselves (Gasiokwu, 2005; Interview #12, 2013).

In Akabor town, the age and stage of family cycle are factors that determine land rights and duties. The communities that constitute the town also have strong patrilineal principles in land allocation. The rights of women to land are determined by marriage and in-law ties (Interview #1, 2013; Interview #6, 2013). The women are allocated use-rights to land by their husbands, and this right ceases to be valid once the husband dies or if she gets divorced. The right can only be upheld if she has male children by the late husband. Tradition prohibits women from partaking in the inheritance of their father's properties. The reason for this is that the female children will soon get married and become part of a different family, and are expected to get a share of the land from their husbands, just as the women married into the Akabor community automatically get the right to share in their husbands' portions of land and other inheritance.

The land rights system in the Akabor community transitioned from a lineage-rights system to individual rights. Currently, the community practices a mixture of lineage land rights and individual land rights, as there are still many portions of the land that are jointly owned and used by all members of the community, and other lands owned jointly by members of different kindred.

For instance, the village town halls are built on lineage lands, while market squares (e.g. Eke-Akabor), the community school, and church and aladinma arena are situated on lands that are jointly owned by the entire community. There are also agricultural palm plantations jointly owned by the community planted on the community

land; the funds raised from these plantations are usually saved in the community bank (which is also in the village) and subsequently used for community development projects such as water projects and road works. Part of the fund is also used for the upkeep of the Eze and members of the Eze's cabinet, such as the chiefs and titled men. The Eze also gets some funding allocation from the state government for his upkeep and his cabinet. A flowchart of the evolving changes of land tenure in Akabor town is shown in Figure 3.1.

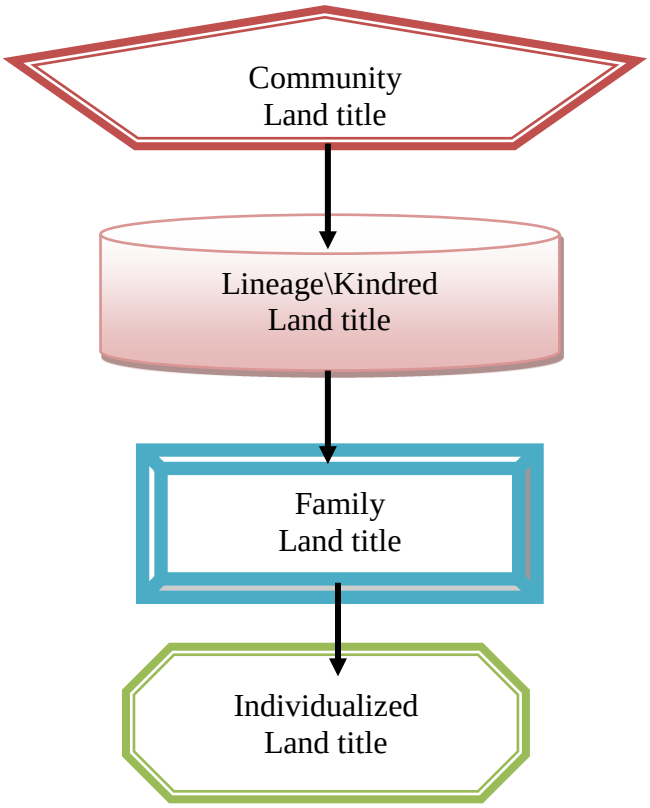

Figure 3.1 Diagram illustrating the evolving changes in the land tenure system experienced in Akabor community

The apical ancestor of Akabor town had eight sons named Chokondiobu, Chokonnamagu, Ofor, Ebizi, Ekwennye, Akamugha, Ayaka and Oji. The eight sons

formed the eight villages named as follows: Umu-chokondiobu, Umu-chokonnamagu, Umu-ofor, Umu-ebizi, Umu-ekwennye, Umu-akamugha, Umuayaka, Umu-Oji; the prefix 'Umu' is used in all the village names to show that they are children of the same father, as 'Umu' in the Igbo language means 'Children'. The eight villages are further divided into kindred; for instance, the Umu-ebizi village is made up of three kindred groups – Umuopara, Umueze and Umuezeala (Interview #1, 2013; Interview #2, 2013; Interview #5, 2013). The flowchart in Figure 3.2 represents the genealogy of the Akabor community.

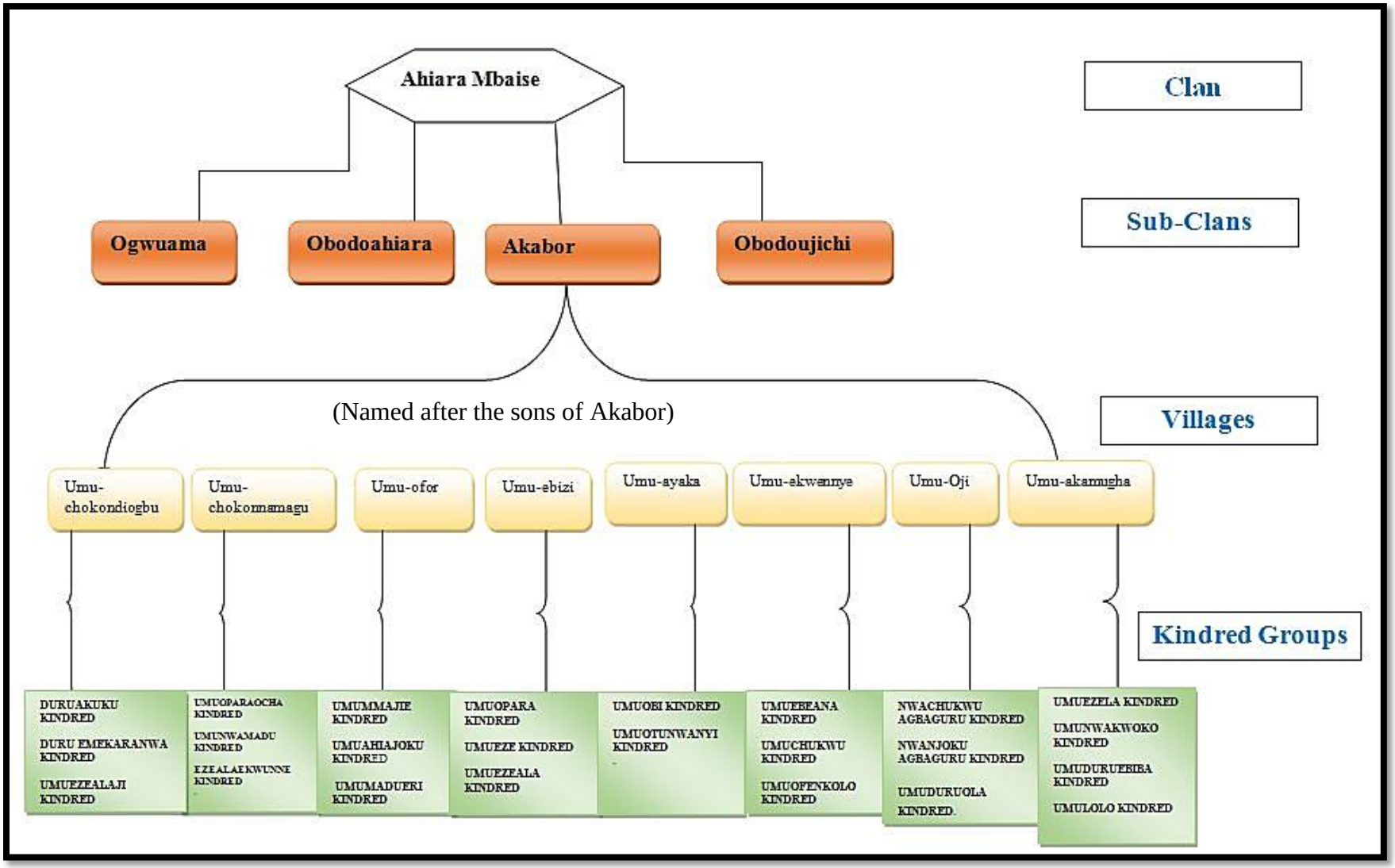

Figure 3.2 Representation of the genealogy of the Akabor Town

3.4 Boundary Identification in Akabor

Boundary identification in the community is comprised of a mixture of dynamic and static boundary identification. In order to identify the extent or span of their land properties, the land owners use various types of features to identify their land boundaries; such features include pathways, rivers, dwarf mud-walls of about 3ft to 4ft in height, 'life-sticks' which are trees or shrubs that exist for long periods of time such as 'nturukpa', 'aboshi', 'ukpo', 'oha', and 'ogirishi' trees. In some cases, the land owners create ridges known as 'ovuru', in addition to the 'life sticks' to demarcate their lands from the neighboring lands (Interview #1, 2013; Interview #2, 2013; Interview #4, 2013; Interview #7, 2013). The 'life trees' get their name from the fact that they are plants which thrive for many years, but this does not mean that they do not eventually die; the ridges (Ovuru) used in marking the boundary sometimes also get washed off by flooding, especially in areas that experiences erosion.

The changing nature of these boundaries make them ineffective in situations of dispute; this emphasizes the need for effective documentation of the boundaries, either spatially or otherwise, in order to mitigate the encroachment issues that are the major cause of land disputes between members of the community, and most frequent during the farming season.

Figure 3.3 Picture showing life trees planted in line to indicate boundary line between two neighbouring land portions. (Tree Line is indicated by the red colored arrow)

3.5 Land Acquisition in Akabor Community

Akabor is an Igbo community where land is believed to be a sacred entity that is entrusted freely by Supreme God onto the smaller god of the earth called 'ala' (Dike, 1983). There are several various ways of acquiring land in this community and they include:

- Land acquisition by inheritance
- Land acquisition by outright purchase
- Land acquisition by lease hold
- Land acquisition through pledging
- Land acquisition through marriage – this is mostly for use-right allocation to women by virtue of their marriage, and
- Land acquisition through sharecropping.

3.5.1 Inheritance

Inheritance is a general form of wealth and asset transfer between people; it is most often known to occur between parents and their children (Interview #3, 2013; Interview #5, 2013; Interview #8, 2013). The Akabor community practices a tradition that allows male children to inherit or acquire their father's assets, including his land assets, upon his death; only the male children are eligible to share the properties of their late father amongst themselves. The females are not included (Interview #1, 2013; Interview #2, 2013; Interview #3, 2013; Interview #7, 2013).

In families where there is only one male child, the male child inherits all the lands and properties of his father. Where there is no male child born to the family, the brothers of the late father share his land and assets amongst themselves (Interview #1, 2013; Interview #3, 2013;

Interview #8, 2013). Women can gain access to land through marriage, and do not necessarily own the land, as they are only allocated use rights to it by their husbands. A woman also loses her right to the land once her husband dies or if she gets divorced.

3.5.2 Purchase

People from within and outside the community acquire land through outright purchase from the owners. This usually involves some traditional procedures in which the potential buyer brings with him witnesses to physically meet with the seller, who also brings along his witnesses to observe the transaction. The buyer is expected to present to the seller some other items besides the money for payment of the land; the seller dictates what he wants and his demands must fall within the items that are traditionally allowed. Some of the requirements that are expected from the buyer include traditional kola nuts, a male-goat, bag of salt, spirit drinks (Interview #2, 2013; Interview #3, 2013; Interview #5, 2013; Interview #7, 2013). The buyer and seller in land transactions can sign a written agreement to support the sale (Interview #3, 2013; Interview #9, 2013; Interview #11, 2013).

Selling of land in the research community is usually not very common; land is only sold in an extreme situation of need for cash. Sometimes the land owner can pledge out his possessive rights to the land in exchange for money for a limited number of years, after which the land will be returned to him.

3.5.3 Lease Hold

This is a customary land transaction that allows the use of land for commercial purpose. In this type of transaction, the lessee has exclusive rights over the land for an agreed period of time and under specified conditions. A lease hold transaction generates funds for the original

owner of the land for the lease period without affecting his possessive right to the land (Paterson, 2001).

Lease hold land transactions are frequent practices in Akabor community. Individual members of the community who are too old or sick to cultivate their own lands, and do not have children at home to cultivate it for them, often put some of their lands on lease hold to generate money to take care of themselves (Interview #7, 2013; Interview #9, 2013).

3.5.4 Share Cropping

This is a situation whereby a land owner decides to give out his land to another person to cultivate and farm on it. When the crop is grown and harvested, the land owner gets a share of the produce from his land even though he did not partake in the planting and cultivation of the land. This practice is usually common between the indigenous peoples and strangers (Interview #2, 2013; Interview #7, 2013; Interview #11, 2013).

3.5.5 Pledging

This is a form of land transaction where a land owner (pledger) surrenders the possessive and use-rights to his land in return for cash to a pledge creditor (Famoriyo, 1979; Nlerum, 2011). In this transaction, the pledgee uses the land until the pledger pays back in full the money that was borrowed. There is usually an agreed period of time within which the pledger is expected to pay back the money and collect back his rights over the land from the pledge. In most case, the pledgee cultivates only annual crops and does not make any major investment or put up any structures on the land (Famoriyo, 1979). If at the expiration of the agreed number of years the pledger is unable to pay back the cash borrowed, the 'pledgee' can become the de facto owner of the land, thus the pledger would permanently loose his possessive and use-rights over the land.

Land pledging is a form of indigenous mortgaging. This type of transaction is very common in the research community and mostly takes place between the richer and more influential members of the community and the poor ones who do not have enough in-flowing cash, but have lands that were inherited from their ancestors.

3.5.6 Borrowing

In Akabor community, the act of borrowing land is to help the borrower raise annual crops for subsistence. This form of transaction usually occurs between members of a family or between friends. For instance, the family head can decide to give some portions of lands on loan to any of his daughters who is married outside the community if the husband is not able to care for the woman and her children. The family of a woman can mark out some portions of land for the woman to cultivate to help her provide food for her family, since the woman does not have any inheritance rights from her father's land. The woman may be allowed to cultivate the land for a good number of years but cannot sell or own the land completely (Interview #2, 2013; Interview #3, 2013; Interview #5, 2013).

3.6 Popular Land Use in the Study Area (Akabor Community)

Popular Land use in Akabor town is located closed to one of the large rivers in Imo State known as the Oramurukwa river (as stated earlier in section 1.3.1 of Chapter 1). The major occupations of the people ware farming and fishing (Interview #2, 2013; Interview #3, 2013; Interview #5, 2013). During the interview the various uses of land discussed by the participants for their lands were recorded. These were later used to design and populate the database tables that can be used for managing land tenure in this community.

"Agriculture"	"Palm Plantation"
"Grazing"	"Yam Farms"
"Residential"	"Coconut Plantation"
"Cocoa Farm"	"Rubber Plantation"
"Family Compound"	"Community Forest Land"
"Market Square"	"Aladinma Arena"
"Cash crops with Livestock"	"Community Playground"
"Livestock only (for raising animals' e.g. goats and sheep)	"Vegetable farms"
"Plantain\Banana Plantation"	"Rice Farms"

Table 2: Popular land use in the research community

3.7 Common Causes of Conflicts over Land in Akabor Community

The impact of land conflicts reflects mostly on the economic, social, spatial and ecological development of a society. In recent times, issues of land conflicts are most common in developing countries where land market institutions are still not very strong, and there are frequent occurrences of illegal land sales and tenure insecurity for the poor members of society (Wehrmann & Antonio, 2011). The root causes of land conflict are usually greediness among a certain set of people, scarcity of land, and appreciation of land value (Wehrmann & Antonio, 2011). Some of the key causes of conflicts over land in the research community are

Boundary conflicts usually occur:

- between individuals (over private land),
- between clans (over common property) due to unascertained and unrecorded oral testimonies and fuzzy land boundaries,
- between administrative units (villages, communes, municipalities, districts),
- between private individuals and the state (over private or state land).

Ownership conflicts are associated with inherited properties. Examples include:

- Inheritance conflicts within a family
- Inheritance conflicts within a clan
- Ownership conflicts due to legal pluralism
- Overlapping/contradictory rights due to legal pluralism (customary/indigenous rights vs. statutory law)
- Ownership conflicts due to lack of land registration
- Conflicts can result when people lay claims on the same property, either due to lack of proper documentation, proper land registration or loss of documents (Wehrmann, 2008).

Amongst the key factors listed above, a few of them were identified as experienced in the research community, including the following:

- Disputes over boundary position;
- Disputes involving the sale of family land without the approval and agreement of all members of the family; and
- Land grabbing.

Dispute over boundary position is the most frequently occurring land dispute in the community. It usually arises where parties disagrees over the boundary line between their adjoining lands. It is experienced most often during the farm season when people are busy

cultivating the land and arises when the markers that were used for boundary identifications get destroyed either by natural forces like erosion, heavy rain or wind, or by human forces when unscrupulous people cut down trees used to mark boundaries in order to encroach on their neighbours' land (Interview #1, 2013; Interview #12, 2013) . Sometimes the older persons who were witnesses to the boundary locations may be dead leaving (Interview #1, 2013; Interview #2, 2013; Interview #6, 2013) younger ones who may not know the exact boundary position or even change the boundary with a different object. Thus when land transaction takes place in this state of boundary uncertainty, the intending purchaser may not have a valid means of verifying conclusively the truth of the traditional story upon which the vendor's title is founded.

Land grabbing is not very common in this area, although there have been some incidences of people from outside towns infringing on some of the uncultivated land that are located close to the highways. According to testimonies of the interviewees, these strangers are usually very rich, and use money to bribe certain elites within the community, who then go to customary court to testify against the original owner of the land in contest. Some of the members of the community are said to have lost their lands to strangers through land grabbing because they do not have enough money to contest the case in the court or to buy over the elites to testify on their behalf (Interview #1, 2013; Interview #2, 2013; Interview #6, 2013).

3.8 Strategies for Resolution of Land Conflicts in Akabor Community

Following Wehrmann (2008) general descriptions for the different types of conflict resolution, amongst which are Facilitation, Moderation, Consultation Conciliation, Mediation, Arbitration and Decision by a powerful authority (adjudication).The approaches used in dispute

resolution in Akabor community are described in this section. The Moderation, Mediation and Consultation approach are recognized as consensual approaches. These are strategies that attempt to identify a middle ground that is acceptable to all parties involved in the conflict. The aim is to re-establish peace and cordial relationship between the parties (Adeyinka, 2014).

- **Facilitation**

Facilitation is a process in which a neutral person comes in to assist individuals or group of persons to communicate and work collaboratively with each towards a common goal either as members of family or community (Brad, 2003). In Akabor community, facilitation involves a neutral person who usually is an elder in the family, community or a respected elite in the community, inviting together the disputing parties to help them solve the problem amongst themselves. The neutral person who is referred to as a facilitator would be a person that is acceptable to the disputing parties. This resolution approach is beneficial at the early stage of the dispute and helps to prevent further escalation of the issue (Interview #1, 2013; Interview #3, 2013; Interview #4, 2013).

- **Moderation**

This is achieved when a moderator intervenes to bring together the disputing parties and help them discuss the issue to resolve it amicably. This approach is also very useful at the early stage of the conflict to avoid escalation (Wehrmann, 2008). In Akabor, the disputing parties are invited together before the Umunna or immediate family members (when the two parties belong to the same family). In this case the moderator would be a member of the immediate family or extended family who is very well respected by members of the family. The moderator listens to the grievances of each person from the disputing parties and then appeals to both parties to allow

peace to reign. Once the matter is amicably resolved, the families would prepare and serve food and drinks (usually palm-wine) to all the attendees to mark a return of peace in their families. Sometimes if the disputing parties are from different kindred, the moderator will be a neutral person from a completely different kindred. The procedure followed in this case is the same as the one described above. The only difference is that the attendees will be people from the two kindred groups that are in dispute. The moderator can be a member of the immediate family or extended family who is highly esteemed and respected by the family (Interview #1, 2013; Interview #2, 2013; Interview #6, 2013).

- **Consultation**

In Akabor, this approach is popularly used to resolve disputes between the women especially in polygamous homes, where a man is married to two or more wives and his brothers also marry more than one wife. In this case the women could be harbouring some hostile attitudes toward themselves over access to the jointly owned family lands. This approach is useful for long-standing disputes that have resulted in hostility and prejudices among the disputing parties. The consultant who is usually the oldest member of the family (male or female) addresses the perceptions, attitudes, intentions and behaviours of the parties with the aim of calming them. This approach helps to avoid full-blow clashes between the parties. In some cases, the disputing parties may be required to stand before the village oracle to swear to an oath over the land (Interview #1, 2013; Interview #2, 2013; Interview #6, 2013).

- **Conciliation**

This approach is a combination of consultation and mediation using a conciliator who brings the disputing parties together to negotiate on how to resolve the issue by addressing

perceptions, attitudes, intentions and behaviours of the parties (Wehrmann, 2008). In the research community, the consultant is usually a person in a highly placed position, such as community Chief or respected elite in the community. This conflict resolution approach is also common in situations where the disputing parties are members of the same family and the conciliator is usually the family head, who is the eldest member of the family (Adeyinka, 2014; Wehrmann, 2008). For instance, if a son in a family is not happy with the sharing of the family inheritance which in most cases can result in a very wide family discord, a conciliator can intervene to reconcile the issue within the family by inviting all the members of the family together including the father-figure (if he is still alive) in the family and the unhappy son to amicable resolve the issue; sometimes, this might involve a re-sharing of the family assets. This type of scenario usually arises when the father figure in the family dies without sharing out his assets while he is alive or without writing a will on how his assets are to be shared amongst his family (Interview #1, 2013; Interview #2, 2013; Interview #6, 2013).

The adoption of any of above three conflict resolution approaches depends on the people that are involved in the conflict, i.e. if they are from the same family, kindred or strangers in the community or if the conflict is between a member of the community and a stranger in the community. The neutral person that stands in to reconcile the two parties will also depend of the reconciliation approach to be used. The length of time the conflict has been going on as well as the bone of contention in the matter would also determine the approach to adopt in resolving the dispute.

- **Mediation**

In this approach the disputing parties should be willing to come together to reach a resolution. Each party is given an opportunity to present his evidence and give testimony to support his claims. At the end, the mediator and the parties will identify an agreeable concession that will be acceptable to all parties involved in the dispute. This approach sometimes requires the disputing parties to sign some written agreement or contract to seal the agreement (Adeyinka, 2014; Wehrmann, 2008). The mediation approach is carried out in situations where the disputing parties are from the same kindred or sub-clan; in this case, the elders of the sub-clan (usually referred to as 'Umunna') will serve as the mediator between the disputing parties. Each sub-clan in the community has a town hall where they gather to preside over issues that affects the members of the clan such as land dispute matters, family matters and community issues (Interview #1, 2013; Interview #2, 2013; Interview #6, 2013).

- **Arbitration**

This approach involves the position of an influential and powerful person who serves as an arbitrator. The arbitrator provides guidance about how the conflict can be settled and has decision-making power. The approach can be used for conflicts that have escalated to the highest level (Adeyinka, 2014; Wehrmann, 2008).

The arbitration approach is used when the disputing parties are from different sub-clans. In this case, the disputing parties will present their case before the traditional authority known as 'Aladinma' which is a forum comprising of the Community leader, his chiefs and titled men, and the elders of the entire community. The forum is headed by the community leader who also

makes the final decision that will be offered to the disputing parties after hearing their testimonies on the land issue. Each party in the dispute is expected to appear with his witnesses during the Aladinma proceeding, and the proceeding usually takes place at the village square. During the proceedings other members of the community are allowed to be present and listen to the proceedings. This approach of dispute settlement is not frequent in Akabor community as sometimes, cases that are brought up to the Aladinma level can be referred back to the lower levels for settlement such as the mediation level where the Umunna is considered fit enough to take care of the matter between themselves. At this level also, the complainant is expected to bring certain things such as Palm wine, Kola-nut, African Salad (Oil-bean fruit salad) to present his case before the arbitrators. He would require some money to buy these things (Interview #1, 2013; Interview #2, 2013; Interview #5, 2013; Interview #7, 2013).

- **Adjudication**

The adjudication approach is adopted where any of the disputing parties is not satisfied or disagrees with the decision issued at the Aladinma proceeding. This disagreeing party can escalate the case to the customary court, a government institution that oversees certain matters including land cases in rural areas. The land matter can be presided over by an adjudicator or by a magistrate who listens to the testimonies of the disputing parties and issues his or her verdict on the case. The verdict given in this court must be adhered to by the parties involved in the dispute (Interview #1, 2013; Interview #3, 2013; Interview #4, 2013). This is usually the last resort in land conflict resolution. It requires that the disputing parties should appear before the family heads or palace courts and sometimes before a court of justice (usually customary court or

high court) for a dialogue and hearing of their testimonies, adjudication, and finally resolution of their issues before an adjudicator or a court magistrate.

Some of the approaches explained above are being adopted in the research community to resolve land disputes between various parties in the community. The most commonly used strategies are the consultation, mediation, arbitration and adjudication approaches.

3.9 How do People Defend Their Lands in Akabor?

Most of the landowners in the research site inherited the land from their ancestors and do not have documentation or any proof of ownership. They rely on the testimonies of their kinsmen and testimonies of neighbouring land owners that share boundaries with them. The responses of the interviewees attest to this fact.

Q: If someone comes up to claim ownership of your land, what would you do? How do you prove that the land is yours?

Chief Priest and Farmer: I will report the person to our village heads and they will bring the case to the village square court (Ama-ala or Aladinma) before all the people. I will bring my witnesses while he will bring his own witnesses. The Aladinma will judge the case. Sometimes if the person refuses to give up the land after the kinsmen (Ama-ala) have pass their judgement, he will be asked to swear an oath, so if he survives the oath then he will take the land but if he dies, I will take back my land. The result of the oath swearing usually comes out in seven days. (Interview #2-131203 M84, Agwu Maxwell; Chief Priest and Farmer).

3.10 Traditional Procedure for Land Dispute Resolution in Akabor

To provide suggestions on how to successfully resolve land conflicts in customary setting, it is vital to critically analyze the various forms of land conflicts, the parties involved and the dimension of the conflict. For example, it is important to know the actors involved in the conflict, the land that is under dispute, whether it is privately owned, family owned or community owned land. The complexity of the causes of the conflict is one other issue that needs to be looked into. These are some of the crucial items for consideration in any conflict resolution strategy.

In the Akabor community, land disputes between members are settled at various levels of authority within the village, depending on the level at which the dispute occurred. The levels of land dispute resolution are diagrammatically illustrated in Figure 3.5. The lowest authority is the 'Umunna' level which involves a gathering of the kinsmen in the kindred; this gathering usually takes place in the community town hall (Figure 3.6).

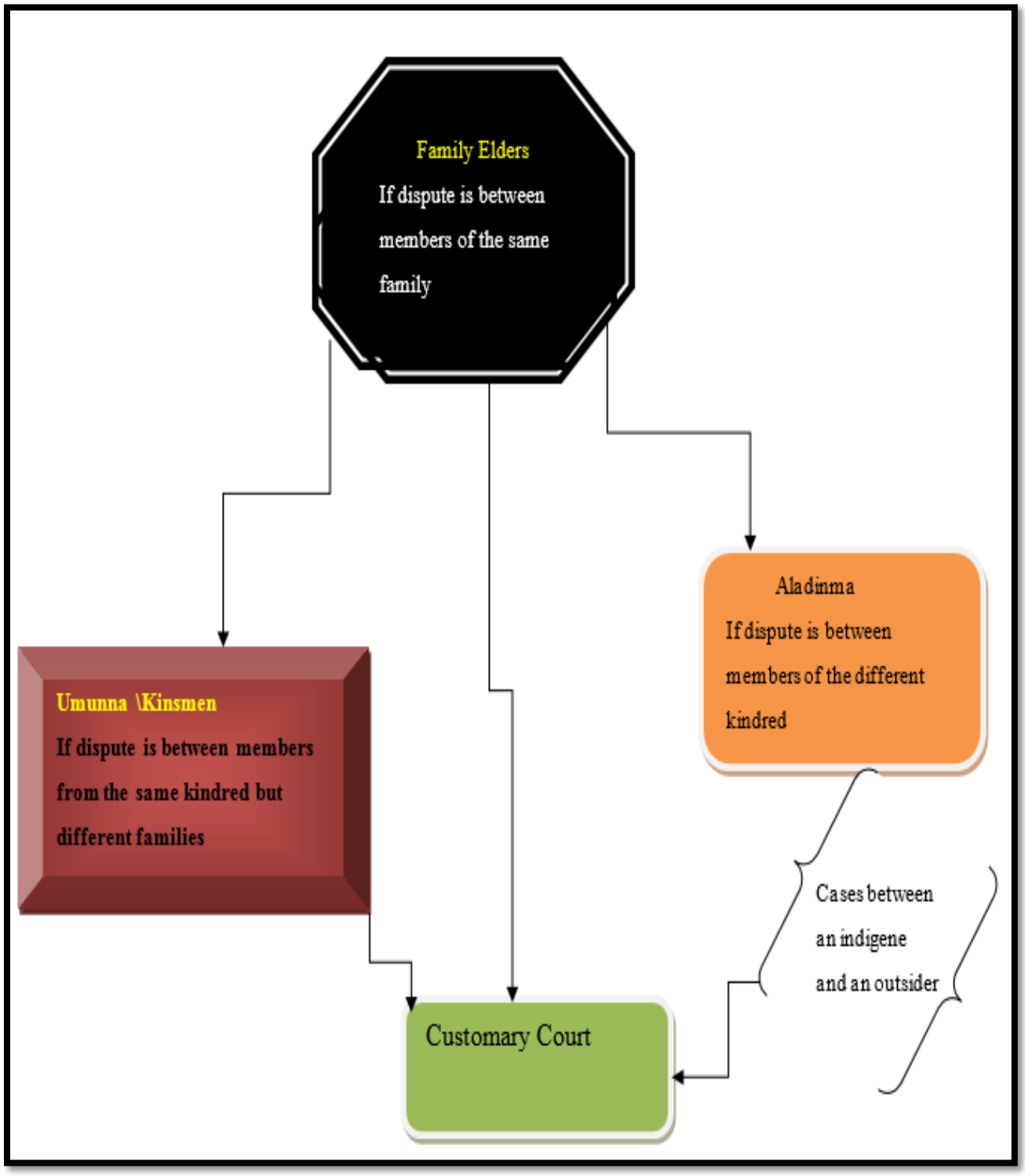

Figure 3.4 Illustration of the different levels of land dispute resolution in Akabor community

Figure 3.5 Umu-choko Nnamagu village town hall where members of the same kindred meet to resolve land dispute between their members. (Photograph obtained with permission of the community leader).

The highest level of authority that is traditionally recognized by the village is the 'Aladinma' level which involves the gathering of elders from various clans that makes up the entire village. The Aladinma meeting is usually headed by the Eze of the community who also is the highest traditional authority in the sub-clans. The appointment of the chiefs and titled men in the community falls under the authority of the Eze. Figure 3.7 shows a picture of the Palace of the Community leader i.e. the 'Eze'. Each of the four sub-clans in Figure 3.2 has its own 'Aladinma' headed by the Eze of that sub-clan.

Figure 3.6 Picture showing the Palace of the Community leader of Akabor (Research community). (Photograph obtained with permission of the community leader)

There is an open land that is designated specifically for the Aladinma gathering known as the village square (Figure 3.8), this village square is sometimes used for recreational and social activities such as the hosting of community development meetings and other traditional festivals (such as the 'New yam festival' which is an annual festival used to mark the onset of harvest of yam crops, usually between August and October), as well as settlement of escalated family disputes (Interview #1, 2013; Interview #3, 2013; Interview #4, 2013). There are some huts erected around the village square where the people assemble for any Aladinma meeting, and there are also tree canopies grown all-round the square where people take shelter from the sun during the meeting.

The land settlement disputes usually involve the appearance of the disputing parties before the Aladinma gathering in the presence of community heads - 'Eze', Chiefs, titled members of the community, elders, as well as interested women and youths of the community, for the traditional adjudication of the land matter. In situations where the Aladinma authority is unable to resolve the issues between the parties involved, the matter can be taken up to the customary court of justice which is situated at the local government headquarters – Afor Oru by either of the disputing parties.

Figure 3.7 Village Arena where the Aladinma gathering takes place to resolve land dispute between two sub-clans or villages. (Photograph obtained with permission of the community leader)

This section has provided details of how land is acquired and secured in Akabor town. It also explained the processes used by the people to defend their interest in land and the traditional methods of resolving land conflict in the area. It is obvious from the ongoing that the research

community has an existing traditional system for identifying their land, defending their land and also procedures for peaceful resolution of conflicts over land that arise within their community. The questions now become: Can these systems and resolution approaches remain valid or withstand the rapid social, economic and political changes that are occurring in the customary setting of this community? What can be done to help this seemly peaceful environment retain its values and customs while mitigating crisis over land due to the fast and inevitable changes that are happening? The insights gleaned from the field research about the challenges confronting the community as a result of these changes are discussed in the next section and these in turn justifies the need for a land tenure information system that can be tailored to suit the needs of the members of the Akabor community while preserving their customs and traditions. This is the TalkingTitler land tenure information software, which design and development steps were discussed in details in Chapters 4 and 5.

3.11 Insights

The negative effects of land conflicts cannot be over-emphasized. The impact is felt on the economic, social spatial and ecological development of community (Wehrmann, 2008). This impact is usually obvious in developing countries when viewed from macro perceptive; it can also be felt in customary settings that are experiencing changes, where there are no proper and strong rules in place to guide the land market. An obvious negative impact of these changes in the customary settings is that they create opportunities for economic gains by illegal land transactions which in turn results in the disadvantaged group in the society losing access to their lands (Obioha, 2008). Generally, customary rules are usually not static; they are continually

evolving as a result of diverse factors such as cultural interactions, population pressures, socio-economic change, and political processes (Famoriyo, 1979; Nlerum, 2011; Osita, 2014).

The customary land tenure system differs from the formal land tenure system in that it regulates a wide range of issues such as family relations, lineage\community assets as well as individual land assets. While customary law regulates a wide range of issues including the way land and natural resources are held, managed, used and transacted (e.g. lineage land resources, family lands and individual land resources) (Nlerum, 2011; Osita, 2014). The customary law also regulates the numerous rights that exist over each parcel of land as well as the operational rights such as right to access land, right to cultivate it, and right to harvest the produce from the land, right to allocate or transfer the land or the resources on the land (Osita, 2014).

In Akabor community, access to land is controlled by clans or families on the basis of various mixtures of group rights to individual rights. Access is also based on group membership (e.g. family membership, or kindred membership) and social status (Chief, Eze, elder, Sons) (Interview #1, 2013; Interview #3, 2013; Interview #5, 2013); thus the resource tenure system in Akabor community varies considerably depending on the context.

3.12 Observed Factors Driving Change in the Customary Land Tenure in Akabor Community

During the field research process in this study, the researcher identified some of the possible factors that are responsible for the changes in the customary land tenure system of Akabor community. These factors are not exhaustive as the field research period was not long

enough for the researcher to gather further information in details. The observed factors are enumerated below.

- **Demographic change**

Over the past decades, the Akabor town has experienced strong demographic growth. The population growth rate in this community is in line with the population growth rate of the state of Imo which is annually estimated at between 2.5 and 3% and projected based on the 1991 population census. As a result of the demographic growth, the population density of the community has increased substantially. The rapid growth in the demography of the community has obvious implications on the land tenure activities such as increased competition on the existing natural land resources. There is an observed increase in the value of land and a progressive transition from communal\lineage land rights toward individualization of land rights (Interview #2, 2013; Interview #5, 2013; Interview #8, 2013).

- **Extension of urbanization into the rural areas**

Nigeria is a highly populated and developing third world country that is experiencing a rapid growth of urban population. The urbanization in the country coupled with high population growth has led to an extension of the urbanization into the rural areas (peri-urban or 'ruban' areas) leading to significant implications for land use and tenure in these areas. Generally, these urbanization processes are usually unregulated; thus; there are random conversion of land from farming and agricultural to residential and micro industrial use (Interview #1, 2013; Interview #2, 2013; Interview #3, 2013; Interview #6, 2013).

Furthermore, urbanization has the implication of high demand for food products in order to satisfy the population mass. This in effect increases the need for intensive agricultural processes and commercialization in these peri-urban communities like the Akabor community where the existing subsistence food crops are now being replaced by production of food intended for sale in neighboring cities; this can be attested from the interview given by Mr. Paul Onyeaso who converted his inherited land to a coconut plantation which he harvests and ships to the cities for sale to earn more income (See screenshot on Figure 5.27 of Chapter 5 (Interview #1, 2013; Interview #2, 2013; Interview #5, 2013; Interview #6, 2013; Interview #9, 2013).

- **Influences from politicians and elites within and outside the community**

Another observed causes of changes in the customary land tenure of this community is the influence of the urban elites such as politicians, businessmen as well as public officials seeking to buy land in the local community for personal or business purpose; some of the land bought by these classes of people are used to build their micro projects such as water production, soap industry as well a commercial agriculture and cash crop production. The attraction of high value in their land has become a tempting idea for some of the local formers prompting them to sell their land at high cost (Interview #1, 2013; Interview #2, 2013; Interview #6, 2013; Interview #9, 2013).

- **Culture shock among the youths**

Observation in the Akabor town revealed that a majority of the youths in the community migrates to bigger cities to take up formal or informal employment. These youths become

exposed to different cultural models which consequently make them to challenge the existing customary rules and institutions in their homeland. Example of some of the cultural models adopted from the urban areas includes nuclear family as against the extended family system. Thus they would want the family land to be shared out and cultivated individually instead of the existing joint ownership and cultivation that has been in place. This also brings about a fragmentation of the extended family and in return a significant effect on the customary land tenure system (Interview #1, 2013; Interview #2, 2013; Interview #6, 2013).

- **Monetization of the economy**

One other observed significant driving factor that is causing a change in the customary tenure system in Akabor community is the transiting socio-economic and local livelihood of the members of the community. An example is the monetization of the economy that can be attributed to the income earned through diversified livelihoods. For instance, in the past, the main source of livelihood in Akabor was farming and fishing; presently, these have diversified into other forms. Some members of the community now earn their livelihood from land transactions with strangers and also from non-farm business activities such as professional teaching, cab \ bus driving and other professional portfolios.

- **Migration of youths to the cities and outside world**

In addition to the monetization of the economy stated above, the impact of the migration of the youthful and able young men and women from the community to urban areas and abroad, has resulted in shortage of human resources to help cultivating and managing the land and its

resources in the community. The implication of this act is that the older generation left behind in the community who has become too weak to cultivate the land, sells off the land to strangers, although this type of land sale transactions are not formally recognized as there are no title or deeds to cover the transaction, the buy in the transaction can eventually apply for a certificate of occupancy (C of O) from the local government authority who has the constitutional power to issue such certificate thereby formalizing the tenure. Also, some unreliable elites within the community and outside the community grab and sell the fallow lands indiscriminately including the jointly owned family and lineage lands. Since, there are no documented records of who owns what land in the community, some members of the community become vulnerable and unable to defend or secure their land as these lands are not formally registered or surveyed. They do not have adequate documentation for their land properties, but only depend on the traditional evidence of title used in the community which usually consists of oral traditional history handed down from generation to generation or of acts of ownership with living memory. From the point of security of title, these types of evidence are unsatisfactory because two or more families with equal honesty may claim ownership of the same piece of land.

The outcomes of these rapid changes cumulate to frequent dispute and conflicts over interest in land in the community, and unscrupulous people including strangers who put up false claims on lands as a result of the indiscriminate and unrecorded land transactions (Interview #1, 2013; Interview #2, 2013; Interview #4, 2013; Interview #9, 2013).

3.13 Chapter Summary and relevance to research objectives

In this chapter, the approach adopted in conducting this research was described. These include the procedures used in data collection, processing and analysis. The chapter also described the procedures used in recruiting the research interview participants, and went on to enumerate the research findings such as how land is acquired in the area, and how the local people identify their land boundaries. Finally, the common causes of conflict over land, and how the people defend their interest in the land were discussed. The different strategies and procedures used by the people to resolve land conflicts were also described in detail.

The Chapter has provided the solutions to Research Questions 4-7 in Section 1.6. Also, the research findings in this chapter enabled the researcher to identify the information system needs of the research community which was integrated into the design of the land tenure information software developed in this project; thus contributing to the achievement of research sub-objective in section 1.5.

The next chapter will describe the software design with descriptions of key requirements identified during the field study to develop software that will suit the Akabor customary tenure environment. The chapter will also present some theoretical database concepts that were considered in the software design and development.

Chapter Four: **Software Design**

4.1 Introduction

This chapter describes the design strategies adopted in the development of a web-based land-tenure information system for a customary land tenure setting that is experiencing dynamic socio-economic changes.

Based on the interviews and subsequent research findings discussed in Sections 3.2 - 3.12, it was determined that the Akabor community needs a system that will assist them to complement their existing land tenure evidence while preserving their customs and traditions. During the field data collection phase of this research, the interviewed participants greatly welcomed the idea of developing a land tenure information system with multimedia interface that can complement their existing tenure evidence while improving their land rights security (Interview #1, 2013; Interview #3, 2013; Interview #5, 2013; Interview #6, 2013).

To meet the information system needs of the research community, a web-based adaptation of the TalkingTitler land tenure information system with flexible database structure was designed. Also a GIS spatial interface with mapping tools was integrated into the web-based TalkingTitler land tenure application to fill the gaps in basic geographic and land resources information that are absent in the existing TalkingTitler LTIS. The proposed software was achieved by adapting the existing TalkingTitler land tenure information system originally designed by previous research students. This is described in more detail in Section 4.4. The developed software was built with a graphical interface (GUI) for ease of operation by the users who may or may not be members of the Akabor community.

Also, based on the user requirements articulated in Section 4.1, the suitable database platform that can store and manage the customary land tenure data was identified to be a relational database system. This database would be able to store both the spatial and non-spatial attribute data with restricted access control and an identity management framework. Building on Asiedu (2014), the object-relational PostgreSQL database system was selected for this purpose because of the various capabilities and the robustness built into it. Other important database system qualities required to meet the user needs described above for a customary land tenure information system include ease of integration and deployment with maximum uptime, data security, and standard compliance. These additional system qualities were integrated into both the front-end and backend (database) design.

The design procedures adopted in this research are illustrated in the flowchart diagram shown in Figure. 4.1.

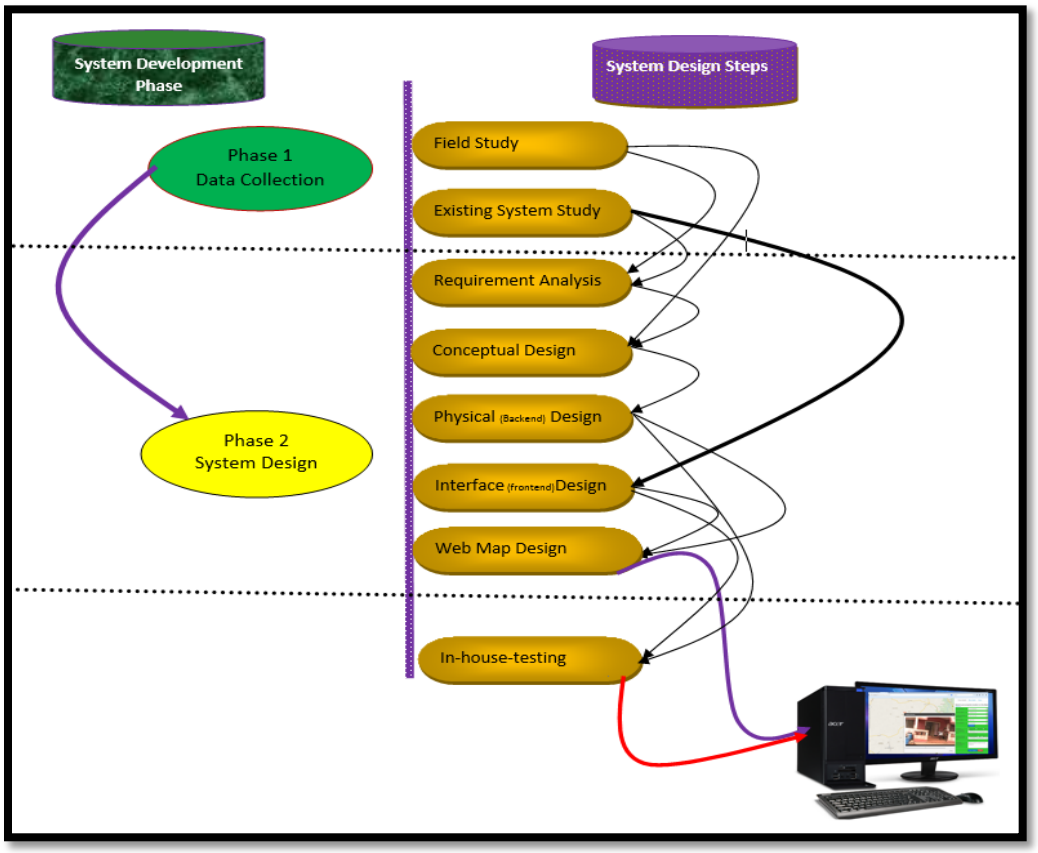

Figure 4.1 Design Procedure of the web-based TT tenure system

The first two system design steps, Field Study and Existing System Study (which investigated the present land tenure management system in the community) were discussed in Chapter Three, Sections 3.2– 3.12. The requirement analysis which includes the identified information system development requirements that would suit the customary tenure in Akabor is enumerated in Sections 4.2 and 4.3.

Detailed explanations of how the existing TalkingTitler (LTIS) was adapted and used for the customary land tenure setting and justification for the choice of the database platform are provided in Sections 4.4 - 4.9. These include the Conceptual design, the Physical design, and the

Interface\web-map design procedures. The last step - Testing of the developed software is discussed in Chapter Five.

4.2 Information Systems Design Requirements for the Akabor Customary Tenure Setting

The Akabor customary land tenure is a complicated one and thus requires a software design approach that can capture the complexities in their existing social relationship. Based on participants' answers to semi-structured and unstructured interview questions, reported in Sections 3.9 - 3.10, as well as the author's observations during the field study and during the time she lived in the community, the following were identified as critical land tenure information system requirements for the Akabor customary community:

1) Design and develop a land tenure information system tool that can capture and represent the hierarchy of complex rights and interests associated with land ownership in Akabor town (See Section 3.5).
2) Design and develop an information system tool that can capture the changing rules in family lands and transition from communal\lineage\family interest in land to individual interest in land (See Sections 3.3and 3.12).
3) Design and develop a flexible database system that can store and manipulate the multiple and overlapping interests co-existing on the same piece of land such as communal interest in land, the lineage and family interests as well as individual interests on a piece of land (See section 3.5).
4) Design and develop a spatial database structure with a front-end and backend interfaces that can store and generate documented tenure evidence for landowners in the

community, such as lease documents, rent cards, media items such as scanned contracts and agreements, wills, survey plans, photographs, and multimedia items (i.e., audio and video testimonies of the people).

5) Design and develop a query interface that can retrieve information from the database based on selected criteria (See Appendix J and K).
6) Design and develop a web-based system with an OpenLayers (GIS) map for visualization of the land parcels and features on it. This will provide support for future participatory community mapping of the land and its resources by transforming community members' local knowledge into digital map formats. Although the use of mapping alone will not be able to resolve the representation of complicated land rights issues such as inheritance and power over resource use rights, integrating map objects to the web-based system will enable text files to be linked to map objects such as land parcels which have resource rights linked to them in text format and are stored in a database.
7) Design and develop a more effective method of identifying land boundaries and features on the land such as trees and other structures, rather than merely using trees and mud walls to identify the land boundaries. This could be achieved by mapping the positions of the boundaries and digitally documenting their spatial coordinates to complement the existing physical boundary features used by the people to identify their boundaries. The documented spatial coordinates will provide evidence of the boundary locations in the event the physical features are destroyed.

- **Potential users of the web-based TalkingTitler land tenure information system.**

  The potential users of the land tenure software developed in this project are:

  - ❖ Individuals or committee members of the Akabor community
  - ❖ The Ahiazu Local Government Office (Akabor is a town under the jurisdiction of this local government)
  - ❖ Non-Governmental Organizations (NGOs) such as the UNDP, UN HABITAT, NGOs that are involved in rural development
  - ❖ Adjudication and Customary Court tribunals
  - ❖ Imo State ministry of Lands, Survey and Urban Planning
  - ❖ Imo Geographic Information Agency (IGIA).

4.3 Spatial Data Interface Design Requirement

One of the critical information system needs of the Akabor community is a web-based GIS mapping tool to map and visualize the land parcels, the features of the land as well as the boundaries; this information will be digitally stored into the database and used as evidence in the event of land or boundary disputes. To date, a mapping system has not been developed as part of the TalkingTitler system. Therefore, a mapping interface was developed for this project using the OpenLayers code to generate an editable Google map interface that was integrated into the existing TalkingTitler application to enable a simple representation of the land parcel, and the various features on it for visualization. This provides recognizable and understandable relationships between the different geographic features such as the land parcel, economic trees and other structures that are located on the land parcel, by representing and visualizing them on a

map. The choice of using the OpenLayers Mapping application was made because it is Open Source software that is available free online and it provides flexibility in that a user is not tied to any particular map provider or technology such as Google Maps, Google Hybrid Maps, or Open Street Maps. In the author's opinion, it also has better vector support to efficiently accommodate points, polylines, and polygons. Moreover, a user has the ability to add any new features needed such as line features, multiline features, and more. These features are invaluable in being able to represent land parcels, boundaries and elements on the land such as trees and other special plants.

The spatial relationship between the geographic features was designed with topology[9] rules which are generally used to control the appearance of spatial features represented on maps. The topology rules adopted in this system design were coded into the script used to generate the OpenLayers map. For instance if a user tries to draw a parcel on an existing parcel of the same dimension, the system will prompt an error message to indicate that the action cannot be allowed (see Figure 5.6). Some key spatial descriptions were used in describing land parcels and features on the map including the map projection, the coordinate system for x-, y-, units, the spheroid, and the datum, vertical coordinate system z-which represents the surface elevation and m- used for measuring line features such as distance along a road. Furthermore, identifying the parcel boundaries by their spatial coordinates to compliment the traditional identification methods may contribute to a more effective solution to the boundary encroachment issues, which is one of the key dispute factors over land in the community.

[9] Topology is the spatial relationship between geographic features, which helps to ensure data quality and data compilation.

4.4 Conceptual Data Model for the Web-based TalkingTitler LITS

To design a flexible database structure that would suit the needs of the Akabor community, Asiedu's (2014) conceptual design of the database relationship was adapted. In the new conceptual design for this project, the many-to-many entity relationships were redefined using composite[10] entities. The composite entity acts as a bridge between entities that engage in many-to-many interactions. Thus, they serve both as an 'entity' on their own and as a 'relationship' between the entities connected to them. This will avert the usual problems that arise when two entities engage in a direct many-to-many association without an intermediate entity. An example of such a problem is a decrease in the speed of the database operations which can result when the ERD is translated into a relational model or when the database gets larger and more complicated. The conceptual model created in this project comprises of six normal entity items and two composite entities. The normal entity items include the 'property', 'person', 'media', 'reference', 'land-use', and 'ownership_type' entities while the composite entities include the 'person-ownership_type' and the 'Tenure-relationships', these will translate to intermediate tables in the physical database design, as they would be used to achieve the many to many relationship between the tables that are linked through them. The 'Person and Media entities are recursive. For instance one person can be related to different persons in the same person table (e.g. extended family situation), while one media item can be linked to one or more media items. A land owner can provide three different media items (photograph, video and audio

[10] Composite entity: These are entities that exist to represent the relationship between two other entities. It is also known as a "bridge" entity because it is used to handle the many-to-many relationships that the traditional database entity could not handle.

data) as evidence to support a parcel of land, thus these 3 media items can be linked to each other in the Media table. The composite entities are used to capture overlapping interests in land that exists in the community; for instance different individuals and groups of persons can have different land rights on a parcel of land and different land parcels can belong to different individuals and vice versa.

In the existing TalkingTitler physical model (Appendix B) which will be discussed in more details in the subsequent sections, the composite entities were translated into "intermediate tables" and used to capture the complex relationships that exist in the land tenure situations. A screenshot of the existing TalkingTitler entity relationship diagram created by Asiedu (2014) is shown in Appendix A while the modified entity relationship diagram created in this project is shown in Figure 4.2.

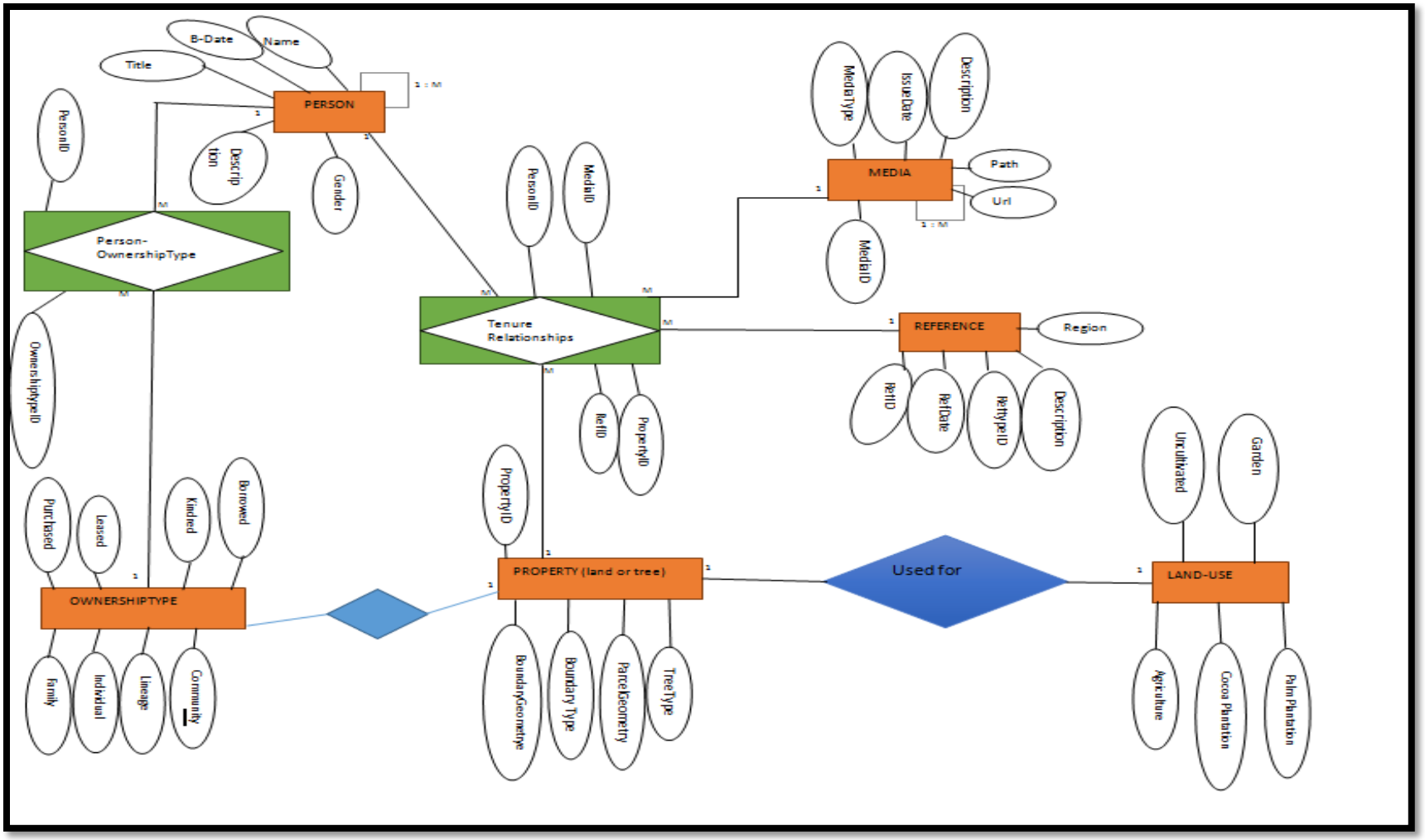

Figure 4.2 Modified Entity relationship diagram illustrating the data connection between the various tables in the New TalkingTitler land tenure database

4.5 Design of the Web-based TalkingTitler system

As mentioned previously, TalkingTitler is a land tenure software with database tables and input forms that were developed, built upon, and evolved from the work of a number of graduate students with Dr. Mike Barry, at the University of Calgary, Canada, and previously at the University of Cape Town, South Africa. Some of the data input forms\objects used in this project were adapted from the work of previous students in the Land Tenure and Cadastral Systems group in the Department Geomatics Engineering at the University of Calgary. Specifically, Asiedu (2014) developed a model for data mining and analysis to support a visualization of complex relationships between objects. He migrated the existing TalkingTitler application from the MS-Access database platform developed by Muhsen (2009) into the PostgreSQL8.4 for data storage.

In his study, Asiedu (2014) used data mining to identify hidden relationships that can emerge as society changes; specifically, he used data from a field study in Ghana done by Danso (2013) and some simulated data to model complex relationships that exist between people and land in peri-urban customary situations. In this project, the existing TalkingTitler application developed by Asiedu's (2014) was utilized as the foundation upon which this web-based TalkingTitler was built to suit the Akabor customary land tenure setting. The software was designed with two interfaces including the front-end interface and the backend or database interface to achieve the user needs. The front-end is the interface available to users with or without administrative rights to the database, while the back-end is only accessible to the users who have administrative rights on the database such as the database administrator. Both interfaces were designed differently, although there is a feedback relationship between the two.

- **Justification for using a relational database system**

While a database is a collection of related data, a database management system is the software used to access and manage the database, using the functions such as searching, sorting, filtering, and retrieving data, or parts of it, from the database. There are different types of database management systems; these are determined by the database model[11] based on how the data is stored, organized, and manipulated.

The new web-based TalkingTitler Tenure information system was built on a relational database management system (RDBM) platform. Presently RDBM is one of the most widely used database management system platform (Oracle database online documentation, 2014). Other reasons for choosing the relational database system include:

- Relational database management systems are known for their characteristic feature of normalizing data stored within rows and columns in tables. The data can be linked to other data in the same table or in other tables within the database system. Thus, the system provides users with the ability to connect one or more tables to facilitate easy and effective data management.
- A relational database is easy to implement and provides room for data modification; for instance, new tables and rows or columns can be added with ease.

[11] Database model: A database model is a description of how data are stored, managed and administered within a database system.

- The relational join mechanism that is built into the system, coupled with the query language, provides flexibility in retrieving data from the database as needed, even in ad-hoc situations.

- **Justification for the Choice of PostgreSQL Database Management System**

A proper database setup provides a good foundation for effective handling, storage and retrieval of information when needed, as well as creates the ability to analyze different scenarios of events. The existing TalkingTitler application started out on the MS Access database platform with many-to-many[12] relationships between the tables design to provide flexibility in the data structure. The MS Access database tables were migrated into a higher level database management system which is the PostgreSQL 8.4; this database system was later upgraded to PostgreSQL 9.2 which is an enterprise-level version. The existing database tables in the version 8.4 were further migrated over to the new PostgreSQL 9.2 DBMS to leverage the spatial extension (PostGIS) enterprise–level benefits such as hot backup, high availability, robustness as well as the ability to handle unstructured datasets (multimedia data).

Traditional database systems are able to store data in a limited number of forms such as numeric values (integers, floating point, and fixed point) and text strings, these data types are often limited in size. In today's world, data can be generated in various formats, e.g., structured and unstructured data formats. The complexity and availability of

[12] Many-to-many- This is obtained when a single record in one table (Ai) can relate to many records in another table (B), and a single record in the second table (Bi) can also relate to many records in the first table (A).

unstructured data types are growing significantly. For instance, unstructured data generated in video, audio and photo formats including web pages while readily available cannot be easily categorized as a result of their complex nature. However, to overcome the drawback posed by the complex unstructured data types, the developers of PostgreSQL provided various ways of handling these arbitrary unstructured data formats, these include a) use of links into a file system or the web, b) use of encoded long text strings, and c) use of Binary large object (BLOB). Option (a) and are the most commonly used approaches.

The TalkingTitler application version on PostgreSQL 8.4 that was adapted in this design made use of the option (a) above to store the media files by placing all the multimedia files in a normal filing system creating text links to the files within the database table. This approach has a number of benefits such as minimizing the database size thereby making the TalkingTitler application more portable, enabling a fast retrieval of the media data, as the data is read directly from the file system. The limitation arises from the fact that the use of links does not enforce referential integrity in the database, thus changes made to the media files that are stored elsewhere are not automatically updated in the database. The PostgreSQL 9.2 provides support for binary large object that is suitable for storing large data items such as multimedia data directly through its ‘oid’ column type. The ‘oid’ column type is an object identifier for referencing arbitrary data.in the database. They are used to manage the BLOBs and can be used to transfer the contents of any file into the database, and to extract an object from the database into a file. Other benefits provided by BLOB include improved security against traditional virus infection which affects physical files, fast data retrieval, database security which protects

the multimedia files from being accessed by non-database users. In this project, the multimedia files were handled using option (a) as there was a constraint in the computer workstation memory, when the option (c) was used. Additionally, the BLOB functionality is optimized for very large data environment.

Finally PostgreSQL 9.2 has two unique functionalities that can be used to emulate a schema-less database to overcome some of the limitations of a relational database as obtained in the NoSQL databases. These unique functionalities include the Key-value Store (HStore) which has the ability to store key/value pairs within a single column, and providing the flexibility for users to create a schema-less key-value store that is ACID[13] compliant. Also integrated in the PostgreSQL 9.2 is JSON[14], a data type that facilitates the document database capabilities and enable effective management and storage of unstructured data within the PostgreSQL 9.2 database (EDB-Whitepaper, 2014). These added functionalities in PostgreSQL 9.2 provided the combined benefits of relational and non-relational database such as ability to access all data type via SQL including – structured, unstructured, and semi-structured, query raw data (without having to transform it into relational form) and high-performance SQL queries over key-value data.

[13] ACID (Atomicity, Consistency, Isolation, Durability) is a set of properties that ensures transactions in the database are processed reliably

[14] JSON - JavaScript Object Notation: Is syntax for storing and exchanging data.

4.6 Physical Design of the Web-based TalkingTitler (LTIS) (Back-end Interface)

The PostgreSQL 9.2 database which is the main backend feature of this application is managed through a program administration interface called the pgAdmin. The pgAdmin is a database administration interface through which the database instances and tables were created and managed. After the installation and setup of the PostgreSQL 9.2 database system application, a 'TalkingTitler' database instance was created within the database to manage and store land tenure information.

There is a total of 29 tables in the TalkingTitler database within the PostgreSQL 9.2 database system including the database tables that were migrated over from the existing PostgreSQL database 8.4 created by Asiedu; four of the migrated tables were modified and used in this project to store data related to the Akabor customary land tenure. Some of the modifications include changes in the data type and the character length features of the table. These tables include the 'Media table' used to store the media data; the 'Person table' used to store the biographic data of landowners; the 'Title lookup table' used to store the titles of the landowners, and the 'Person-to-Person relation table' used to capture the complex social relationships that exist amongst the members of the Akabor community including the co-interests such as family and lineage interests. These tables were populated with data entered through the user input forms described in Section 4.8. A screenshot of the pgAdmin showing a list of the tables within the TalkingTitler database instance in PostgreSQL 9.2 database system is shown in Appendix L. More details of the tables are shown in Appendix C.

4.6.1 New additional database tables created in this project

The following new tables were created to address the specific needs of the research community that were not catered for in the version of the TalkingTitler software that was adapted in this project. These tables were created to receive and process land tenure information within the PostgreSQL 9.2 database and they include the Property table, Boundary Identification table, Land Tenure (Ownership) Type table, Land Tenure (Ownership) Type table and Land-Use table. A detailed description of these tables is given in Appendices D1-D4. The physical layout is shown in Figure 4.4.

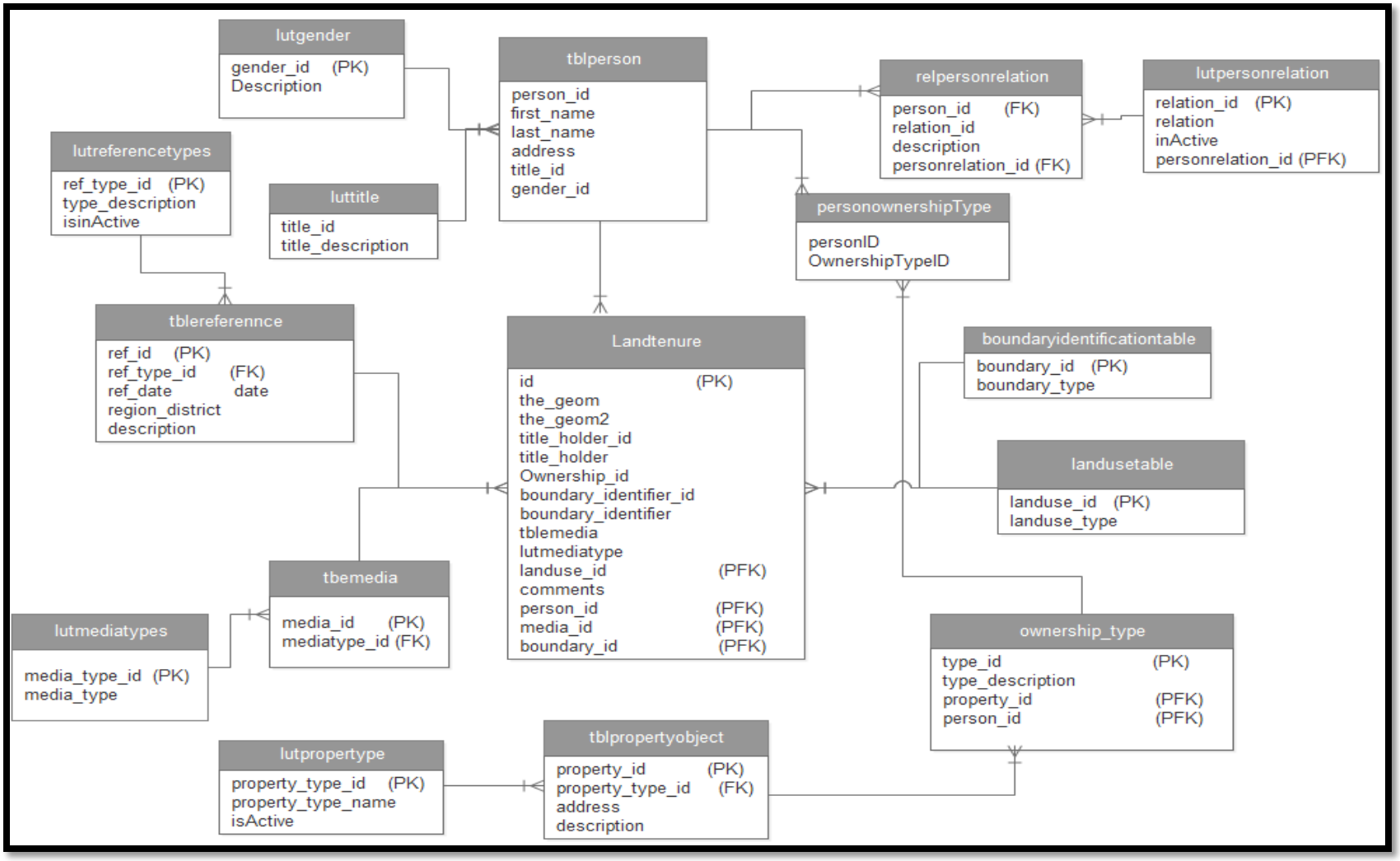

Figure 4.3 Physical design of the web-based TalkingTitler LTIS

4.7 Designing the Front-end Interface (Data input forms)

The front-interface input forms were created to capture land tenure-related information into the database tables described in Appendices C and D. The input forms adapted from Asiedu (2014) include the following: the "Add person" input form that was used to input biographic information such as name, birth-date, and address into the person table in Appendix C. See sample screenshot of this form in Appendix F1; the "Add media input form" provides an interface to users for uploading the media data into the media table also described in Appendix C. Sample picture, video, audio and text data that were collected during the field research, which are information that can be used by landowners to defend their land or prove of their interest in land, were loaded into the database through this input form. A piece of land can have more than one supporting evidence e.g. video, audio and picture and text files. A sample screenshot of this form is shown in Appendix F2.

The "Relate person" input form was modified and used to capture the complex relationship scenarios that exist amongst the local people and between the local people and their lands. Individual persons in the database can be linked to one or more other individuals as a relationship and the description of the type of relationship is entered into the description field provided on the form. The form was used to represent the extended family relationships as well as some of the complex land transactions that exist in the Akabor community. For instance, consider the scenario of family interest in land which relates to existence of many interests in a piece of land - when a portion of land is owned by more than one person, such as land inherited by three brothers in a family. The three brothers would be entered into the database as separate

individuals using the ‘Add person’ form. The ‘Relate person’ form will be used to create a relationship between the three of them to show that they are members of the same family.

4.7.1 Additional Data Input Interface Forms

New forms were created for inputting data into the database tables described in Appendices D1 – D4 and they are the “Land Tenure Data” input Form, the More Detail form and the query form. The land tenure data input form was designed to collect information about land parcels and other resources such as trees located on land parcels in Akabor community. The lands include farm\agricultural lands, residential\compound lands, fallow lands, and grazing lands and so on. The lands can also include parcels of land that are currently under dispute; in this case, the disputed lands were linked to all the parties involved in the dispute using the Relate form described in Section 4.7. The information captured on this land tenure data input form are stored in the “property” table in Appendix D1. More detailed features of this form are described in the Chapter Five, Section 5.4 using illustrations from the output results.

Other new input forms include the “More details form” which was created to enable users to input addition information when necessary. The additional information includes further descriptions of the land parcel that might be of interest, for instance if the parcel of land is currently used for animal grazing, poultry, pig farming, forest reserves (like sacred land), shifting cultivation, plantation, subsistence cultivation or commercial cultivation.

4.8 Query Form

Queries are generally used to extract relevant information from a database. In the TalkingTitler land tenure application some predefined criteria were built into this form to enable users search and extract information that relates to parcel of land or other land resources drawn on the map and stored into the database The query data can be generated and used for analysis or report purposes. The results of the query can be viewed on the screen, printed out, or copied to the clipboard. More details on the operations of the Query function is provided in the result section in Chapter 5, with screenshot illustrations from processed data.

4.8.1 Map interface

The map interface of this project was generated from the OpenLayers JavaScript code developed in this project. The code was used to produce a mapping application with customized map-layers, built-in functionalities and controls such as zooming, panning, layer switcher, overview map, and permalink map controls. The customized map layers include two different map layouts - OpenLayers Google satellite and Google Street map. These maps are interactive maps embedded in a web page and viewed over a web browser. In designing the map interface, the following data representations were implemented. Geographic features such as land parcels, trees and boundary demarcations were represented as polygons, points and lines respectively. The projection used for data displayed on the map is a standard WGS 1984[15] projection which is compatible with the

[15] WGS 1984 – World Geodetic System. It is geodetic datum that was first defined in 1984 and is suitable for use in any part of the world for reference data located on the earth surface.

OpenLayers map projection. The spatial properties of the data sets, as well as the scale used for representing the features on the map, were defined based on the OpenLayers map standard.

The default information to be used by the produced world map (for instance, the coordinates where the map will be centered when the page is loaded) was centered at Imo State of Nigeria which is the state where the research study site is located. The data entry forms and the query forms which were also embedded within the map interface were coded with a combination of JavaScript, JQuery, PHP and HTML scripting languages to facilitate communication between the browser and the PostgreSQL\PostGIS database. A summary description of the software applications is shown in Appendices E1-E6.

4.9 Chapter Summary and relevance to Research Questions/Objectives

This chapter has provided a description of the conceptual, physical, and interface design strategies that were adopted in developing the web-based TalkingTitler land tenure information system to suit the land tenure information system needs of the Akabor community. The chapter described and justified the choice of the database system used to implement the project as well as the webserver platform. The chapter also provides a description of the revision of the designed concepts adapted from the works of past research students on the existing TalkingTitler application. In addition, the chapter described the land tenure information system needs of the research community identified by the researcher based on her field investigation. The previous TalkingTitler application was redesigned to address these specific needs of the Akabor community that were not catered to by the previous TalkingTitler versions. To achieve the

specific needs, a new web-based TalkingTitler concept that integrates mapping and spatial interface was developed. The entity relationship diagram of the previous TalkingTitler software version was redesigned and modified to suit the needs of the research study. The chapter goes on to describe the integration of a Query interface and a spatial interface with map functionalities that will enable a visualization of land parcels and the land resources by drawing them on the map. This will facilitate a retrieval of the spatial attributes of the land parcels such as the parcel geometry and the spatial coordinates of the boundaries that can be stored in the database. These are added features and enhancement on the existing TalkingTitler land tenure design.

The primary objective of this research which is to contribute to land tenure information system design theory was achieved in this chapter by designing a web-based land tenure information system that can satisfy the land tenure information system needs in a customary setting such as in the Akabor community in Southern Nigeria. The solution to research question 2 was also provided by designing a flexible database structure built on the PostgreSQL 9.2 database that is able to store and generate various forms of data including spatial, structured and unstructured data types such as recorded video, audio and text evidence. This information can be used by members of the Akabor customary community to complement their existing oral method of proving their interest in lands. Currently, the members of this community use oral testimonies (versus written, digital, or electronic testimonies) from witnesses and neighboring land owners (or) to prove their interests in land. The next chapter will provide details of the output results of the new TalkingTitler that was developed in this project as well as the in-house testing of the software using data collected during the field study. The results generated from the software were illustrated using screen captures of the running application.

Chapter Five: **Software Implementation, Testing and Results**

This chapter describes the implementation and testing of the web-based TalkingTitler land tenure information system (LTIS) software. The software implemented and functional achievements described in this section provides a demonstration of the primary objective of this study which is to contribute to the development of a land tenure information system design theory for an evolving customary setting. The sections in this chapter provided details of the interfaces with descriptions of the in-house testing to illustrate the functionalities of the package using live data from the Akabor community.

5.1 Development of the Web-based LTIS Front-end (User Interface)

The front-end interface was developed using a combination of programming languages which include PHP, JavaScript/Html5, and JQuery. A summary of each of these programming languages and the purpose of using them in this project is explained in Appendix B. The communication between the back-end and the front-end interfaces of the project was tested on a local host to ensure proper functioning and running of the software. In this software development, the front-end comprises of the TalkingTitler home page, shown in Appendix C, and the Data Input forms described in Chapter 4 Section 4.7.

An important criterion about a good information system is the ease-of-use of the system. The approach adapted in the development of this web-based TalkingTitler application is one that puts the user, rather than the system, at the centre of the process. This web-based TalkingTitler software is menu-driven and includes colourful graphics to facilitate ease of operation for people

with minimal computer knowledge and skills. The software operation starts with a home page which is displayed when a user enters the web address; in this case, the local host address was used –http://localhost:8080/landinfosys/index.php. The web interface is hosted on an Apache web server. The home page displays four (non-active) and ten (active) menus. The active menus are clickable tabs, as shown in Appendix F. Nine of these active tabs are basically data input tasks which were migrated from the existing TalkingTitler (LTIS) application developed by Asiedu (2014). By clicking on each of the tabs, a sub-task of data entry form will open for the user to input data. The various tabs on the home page screen include an 'Add Object' tab, which are used for entering information such as land owner data and media information (pictures, videos, audio, text, scanned documents, etc.). The 'Relate Object' menus were used to graphically link the various data entered into the 'Add Object' menu. These tabs enable users to manually link/relate data in the database as obtained in the real world, without going into the back-end.

The TalkingTitler (LTIS) main screen was modified to include a new tab "Go to Map" (highlighted in a red box on Appendix E) which when clicked, takes the user to a new web page. This web page was specifically designed for processing land tenure data; thus all the information displayed on this interface is additions made to the existing TalkingTitler software. They include an OpenLayers map interface with map controls which are tools made available to enable the users to interact with the map, land tenure data input interface, and a query interface. A screenshot illustration of the Land Tenure information processing page is shown in Figure 5.1 and in Appendix F3.

5.2 The OpenLayers map interface

The user is provided with three choices of map layouts to select from, as shown in Figure 5.1 (Google Street Map) and Appendix F3 (Google Satellite map). The maps were generated from the OpenLayers programming codes. Users can interact with the map by using the map controls provided to draw features on the map to represent parcels of land or trees and save the coordinates in the PostgreSQL database by clicking the save tab after entering all the fields on the tenure input form which are attributes used to describe the feature on the map. An illustration of how a user can interact with the map using the map controls will be shown in subsequent sections which describes the testing of the software. The next section will provide a description of the input forms displayed by the side of the map in Figure 5.1.

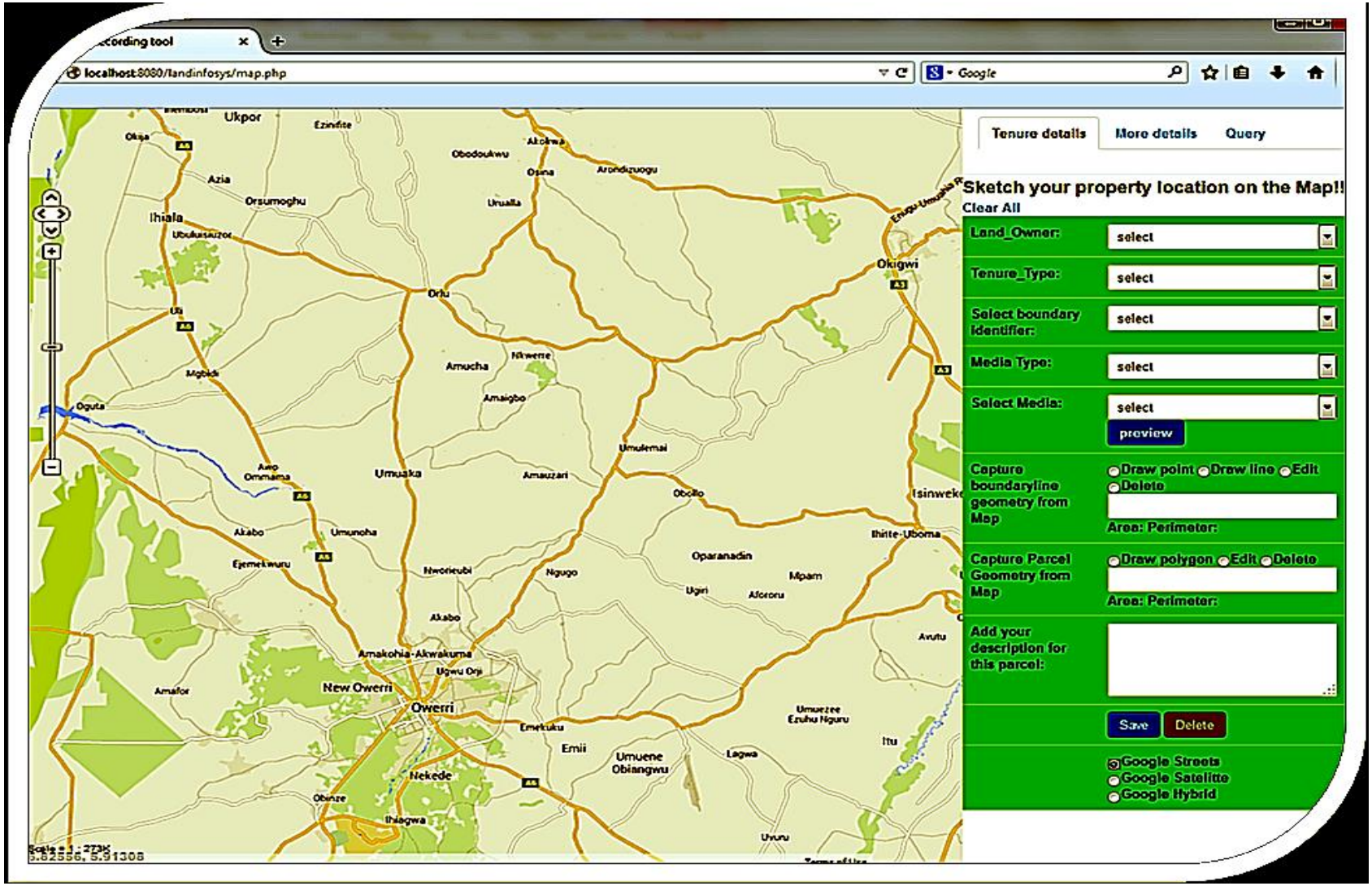

Figure 5.1 Google Streets Map and Tenure Information gathering forms

5.3 Land Tenure Input Form

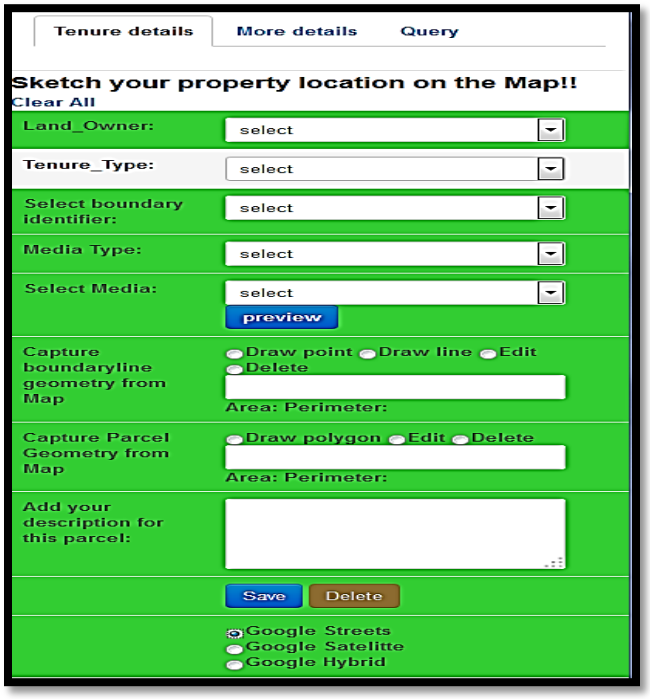

Figure 5.2 Tenure Information Gathering Form

The tenure information gathering form depicted in Figure 5.2 provides a screen for users to collect and record information that relates to the features drawn on the map (land parcel or tree feature). Each feature drawn on the map is identified by the owner; for instance, for a land parcel represented with a polygon feature, the following information would be required as attributes to the feature: landowner's name, tenure type, boundary type, media type, and geometric information. After the information is entered into the displayed fields, the user clicks on the 'Save' tab to save all entered information into the database. If the user makes an error when entering information, there is an option to clear all the information and to start over by clicking on 'Clear all'. Users can also make minor changes to the features drawn on the map, or delete them entirely, as may be

required. This is achieved by using the ‘edit’ button or the ‘delete’ button provided on the form. The various fields on the Tenure Information gathering form on Figure 5.2 are briefly described in the ensuing paragraphs.

The landowner can be the name of an individual, a family, an institution, an organization or a community. The Landowner field on the form is dynamic dropdown listing populated from the “Person Table” which was described in Appendix C. The names in this list were entered into the database through the ‘Add Person’ form designed in Section 4.7. A screenshot of the dropdown listing is shown in Figure 5.3.

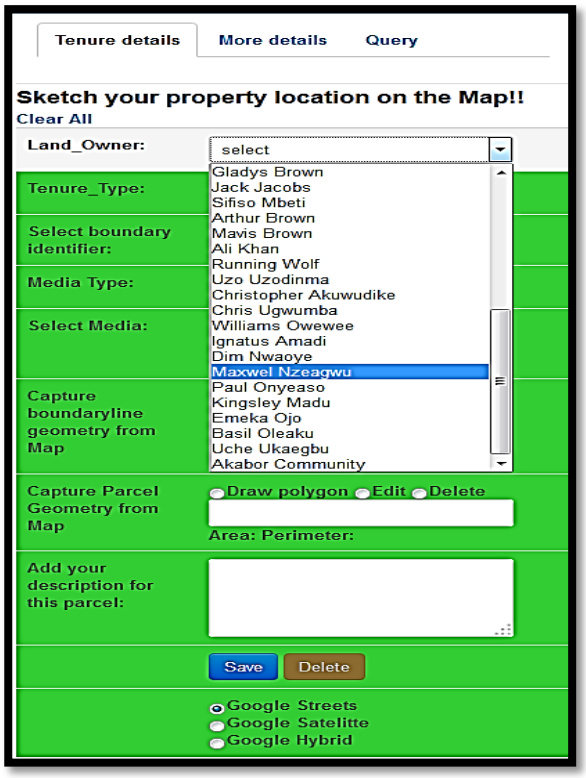

Figure 5.3 Drop down list showing the list of land holders retrieved from the back-end to the front-end for users' selection

The Tenure type describes the tenure type, which could be Inherited, Family, Lineage, or Community. It could also be borrowed land, purchased land, leased land, or land used for sharecropping between two or more persons. In other words, tenure types depend on the terms or conditions of acquisition and use of the land. The Tenure Type drop-down listing is populated from the database table designed in Section 4.7, and described in Appendix D3. A screenshot of the dropdown listing is shown in Appendix G.

As stated in the field research finding, one of the major causes of land disputes in Akabor community is encroachment into neighboring lands by some landowners\users which tends to be more recurrent during farming seasons. This is a result of fluidity and fuzziness in the existing boundary interpretation by the disputing parties in the community. Sometimes the features used to identify the extent of their lands are not durable enough and the get washed off by heavy flood\erosion, strong wind or even get cut down by unscrupulous neighbors who have the intention to encroach into their neighboring lands.

An identification of the land parcel boundaries using a combination of spatial coordinates (which is fixed and durable at all times) and the traditional physical boundary features would help to mitigate the boundary disputes in Akabor community as the recorded and stored spatial coordinates can be used if the physical features get destroyed. This web-based version of TalkingTitler land tenure information system developed in this project has the capability to record and store the spatial coordinates of the land parcel boundaries and match the coordinates with the planted or erected features for physical

identification; the spatial coordinate can be captured and stored in the database using GPS tools. The stored information will be very useful during boundary dispute resolution. The screenshot in Figure 5.5 shows how the boundary features are selected and stored for each feature drawn on the map. The dropdown list for the boundary features are populate from the boundary table in the database. The selection of the features is used to complement the geometric coordinates of the boundary.

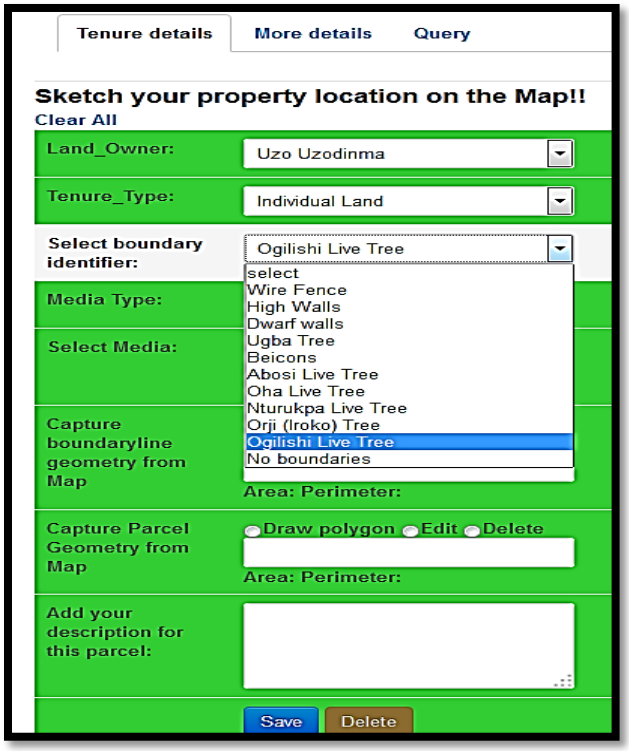

Figure 5.4 Drop-down listing of the land boundary identification types used in Akabor town

This Media type describes the supporting tenure evidence collected and recorded for parcels of land drawn on the map. The media type could be video records, audio records, pictures, scanned documents or text files. These are captured and stored in the

database as references or evidence of ownership for each land parcel or feature on the land. A screenshot of the media type dropdown list is shown in Appendix H.

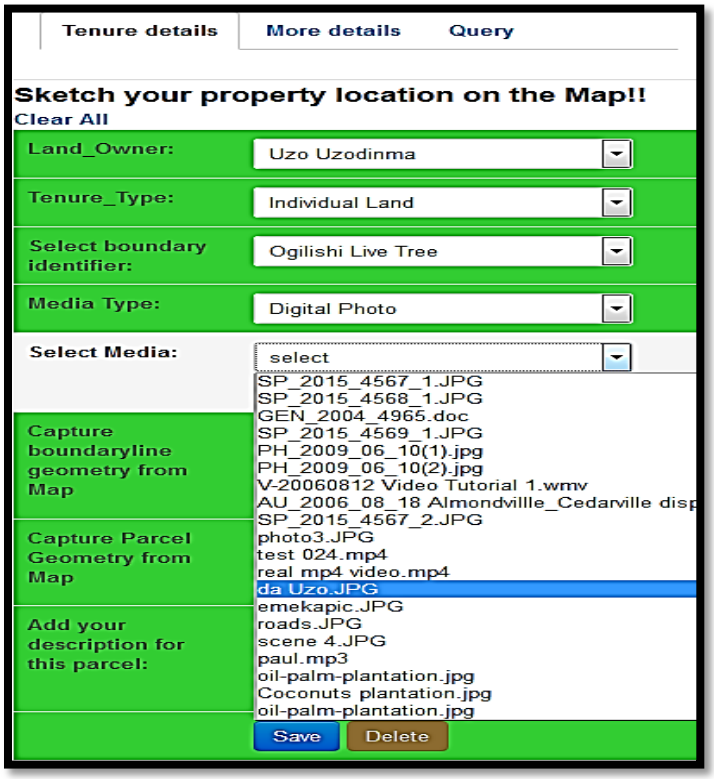

Figure 5.5 Drop-down listing of reference data for supporting land ownership

During this research field study, some of the interview participants expressed their happiness and views about the video and audio recordings. They stated that the integration of this technology would serve a good purpose in their land transactions especially in the event of land contract change or death of one of the contractors, the audio-visual evidence of the contract would be an indisputable evidence to have. The software will also help their children and grandchildren to keep track of the transactions made by their parents during their life time even before the children were born. This will generally reduce situations that will bring about conflicts or dispute in their land

transactions. The drop down list in the media field was populated from the Media table designed in Section 4.7 and described in Appendix C. The media files were uploaded through the Input-form shown in Appendix E. A preview tab is also provided on the form to enable users to preview the selected reference or supporting documents before processing and saving the Tenure Information.

5.4 Geometry Field

The geometry and spatial position of the features drawn on the map (land parcels or trees) are automatically displayed in the 'geometry' field on the form. The boundary line Geometry calculates and records the geometry of the line features drawn on the map to represent the boundary lines, while the parcel geometry calculates and records the geometry of the polygon feature used to represent parcels of land. The point geometry is used to represent other features on the land such as trees. These pieces of information are loaded into the database when the user clicks the 'Save' button at the bottom of the form. In case of any data input error, the delete tab is used to delete the data that were mistakenly entered into the form.

In real world, the geometry or spatial position of a land parcel or other land features like trees can be tracked using tools such as GPS. A GPS can be used to track and record the dimension of the land parcel and the position of all the boundary features, trees, mud-walls, ridges, and pillars. The information collected with the GPS can be manually entered into the database or exported directly as may be required. Using a GPS to track and record the location information of the features will ensure that the recorded

position of the land parcel or land feature remains the same at all-time irrespective of time, year or weather conditions. Exceptions can arise in situation of parcel fragmentation, conversion or sharing between family members. The software is designed to not allow overlapping of parcels, thus no two parcels of the same dimension can exist on the same location. An error prompt is displayed on the computer screen whenever this rule is contravened by users. A screenshot of the error message is shown in figure 5.6

Figure 5.6 Shows error prompt by the system when a user attempts to draw a feature on an existing feature

A description field is provided at the bottom of the tenure data input form to enable users to enter further information when necessary. For instance, if the land is in dispute, the information regarding the dispute, including the names of the disputing parties would be entered into the description field with all other necessary information that affects the land in dispute. If a parcel of land is owned by more than one individual,

the names of the second individual owners can also be entered into the description field as an alternative to using the 'Relate Persons' form described in Appendix C.

An additional form captioned 'More Details' is provided to enable users to add more information into the database if needed. See Screenshot in Appendix I. Information such as land use or other plantings on the land such as economic trees including palm trees, cocoa, coconut trees, iroko trees, mahogany trees, etc., or any other unique plant can be recorded into the database through the "more details' form. If name of the land resource item being entered into the system is not included in the dropdown list provided, the user can manually enter the resource item into the "Input Resource name" field provided.

As discussed in Section 4.9, the Query form is used to query or search for information stored into the database. There are different search criteria provided as shown in Appendix J and H. The database can be searched by 'Surname' in which case the user types in the surname of the landowner; the database can also be search by other criteria as shown in Appendix K.

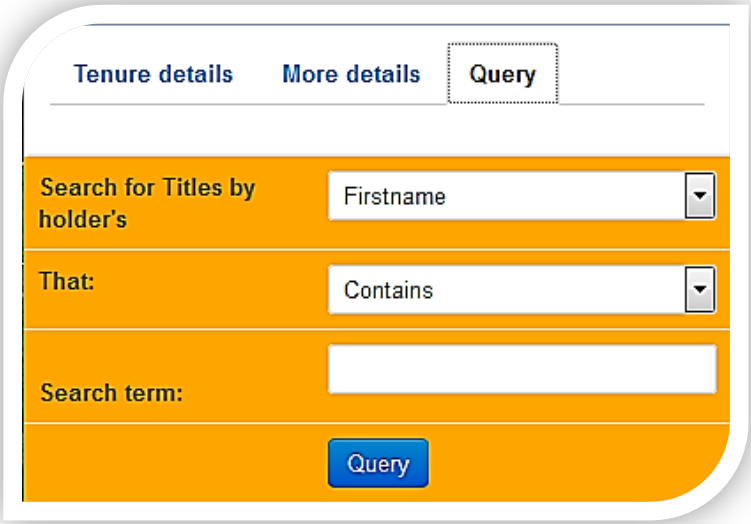

Figure 5.7 Sample Query form for searching and retrieving data from the database

To search for, and display a list of all the features drawn on the map and saved into the database, the user can simply click on the 'Query' button without selecting any criteria. In response to the button click, the system will display a summary of all the features that have been entered and saved within the database. There are hyperlinks embedded within each summary result listed and a click on the hyperlink will display more detailed information about the search item.

5.5 Testing of the Software using Live Data

The ensuing sections in this chapter are illustrations of the functional testing of the web-based TalkingTitler (LTIS) developed in this project using live data that were collected from the Akabor communtiy. The images used in these illustrations are arbitrary pictures and the names used are fictitious names. One of the benefits of this

application is the ability to store historical data that can be used for verification of title\interest in land especially for the inherited lands in case of disputes.

The first illustration in Figures 5.9 and 5.10 are records of the testimony provided by “Elder Uzo” about one of his land parcel which is also represented on the map with a polygon feature drawn using the ‘draw’ map control. According to his testimony, the land is a subsistence farm land he used to cultivate yams. Also planted on this farm land is an “Iroko” tree (indicated by an arrow pointer in Figure 5.10) which is an economic tree situated by the edge of the land close to his boundary with a neighbouring parcel of land. To provide a concrete evidence to support Elder Uzo’s testimony about his land, the position of the land parcel and his economic Iroko tree were spatially sketched on the map to extract the geometric coordinates as well as the boundary coordinates which would be used to augment the physical boundary trees. A photograph of “Elder Uzo” narrating the story of his land and a photograph of his yam farm were all attached to his land record along with the geometric coordinate information extracted from the map. All the information were then stored into the PostgreSQL database for future reference. This illustration is relevant to research Question 3 (“How can a web-based land tenure information system be designed to benefit local people in securing their land in an evolving customary land tenure setting?”), as the information recorded for Elder Uzo can be used by him or his children either in the present or future time (if he dies) to supplement their traditional evidence in securing their interest in this parcel of land. This evidence will be relevant despite the changing situations in the land tenure system.

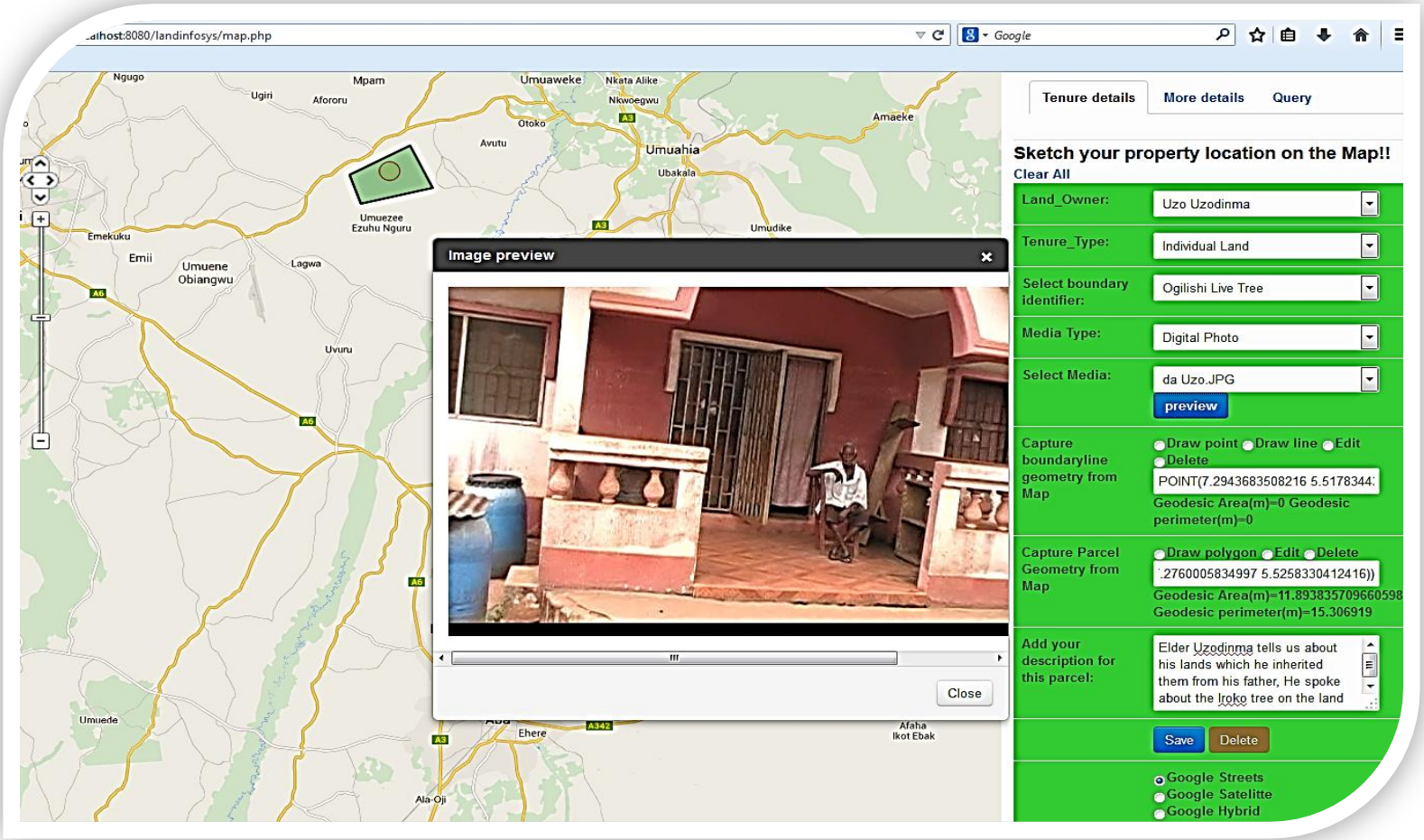

Figure 5.8 Elder Uzo sitting in front of his home narrating the history of how he acquired his land properties in Akabor community. (Google Street Map presentation)

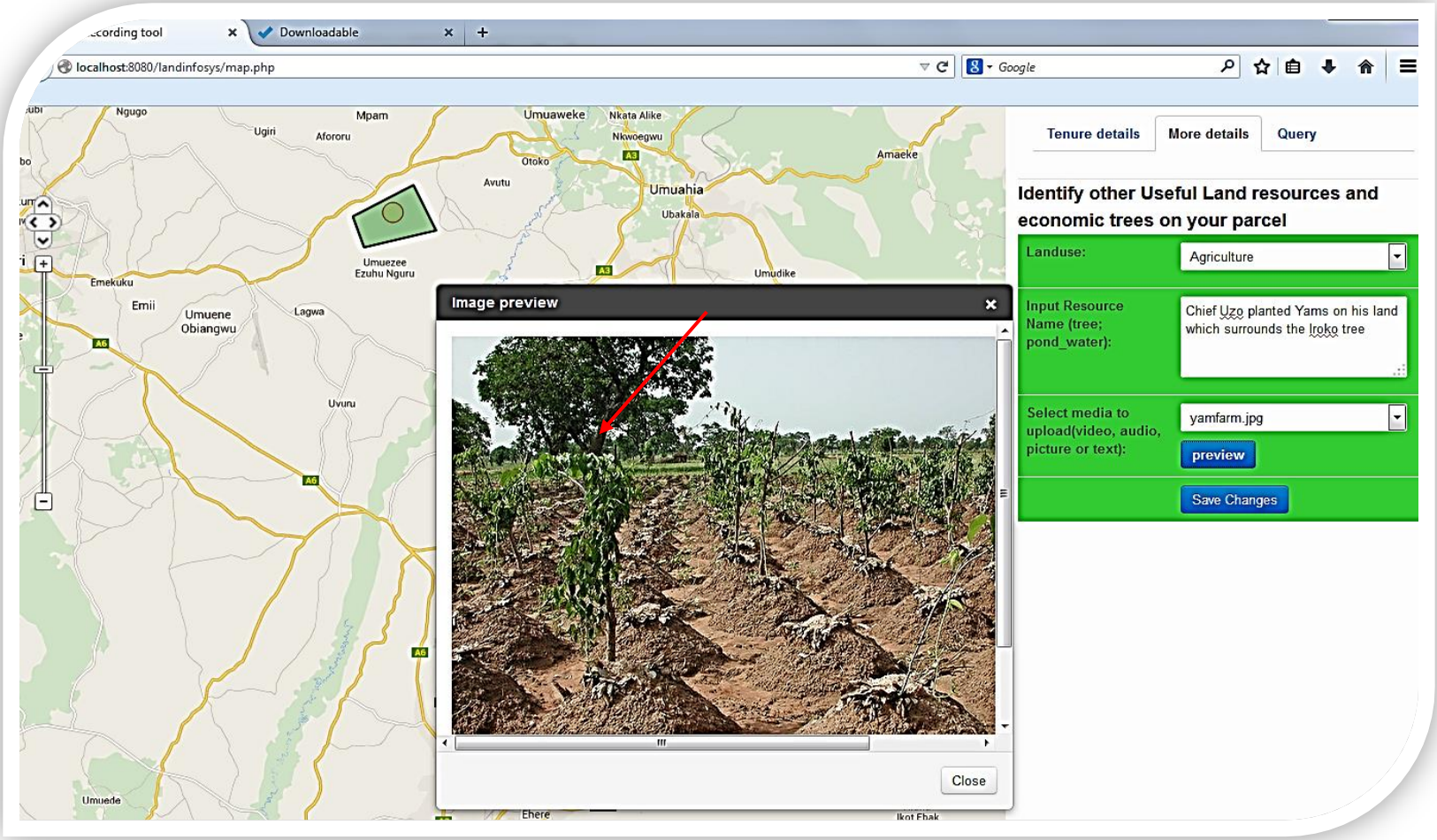

Figure 5.9 Elder Uzo's yam farm, showing one of his economic trees (Iroko tree) growing on the land

5.5.1 Testing of the audio and video information recording

(Interview Participant #12- Emeka Ojo)

The next illustration is the result generated from an interview recorded from another participant "Emeka Ojo" about his family land. The participant gave his permission for a video recording of his extended family land which was shared between his father and uncles (his father's brothers). The share of the land inherited by Emeka's father from his grandfather will later be shared between him and his younger brother as the two of them are the only male children born to his father "Nze Ojo". This land is thus jointly owned by the "Nze Ojo's" family comprising of Emeka, his younger brother and their father although it is currently cultivated by "Emeka" who lives in the village, with the permission of his father who is currently alive. Emeka's younger brother lives in the city away from Akabor town. In an audio recording, Emeka (in the presence of his father and an uncle), narrated the story of how the land was obtained by his father from his grandfather as his own share of the inheritance. "Emeka" in his story talked about the palm trees on this parcel of land (see appendix O, one of the trees is indicated by red arrow) which are still jointly owned by members of the extended family which include Emeka's father and Uncles. This implied that Emeka 's father has a sole right on the land parcel but joint rights with his brothers (Emeka's uncles) on the palm trees that are grown on the land. A screenshot of video and audio recording of the participant's interview is shown on Appendix M and Appendix N. The boundary between the Ojos' family land and their neighbouring land parcels are indicated by the planted Ogilishi life trees located at the far end of the farm (see Appendix O- Yellow arrows point to Ogilishi boundary trees).

This illustration of the TalkingTitler application to capture and represent a family land tenure situation and co-existence of different interests on the piece of land (Emeka's father having full rights on the land while sharing equal right with Emeka's uncles on the palm trees grown on the land) satisfied the user requirement 3 in section 4.2 and also answers Research Question 2. The ability of the TalkingTitler application to capture these vital information was made possible by the multimedia functionality that exists in the software as well as the flexible database structure that is able to store, retrieve and manipulate the various data types (audio, picture and video). The software also provides the functionality to link the land and tree resources to the various interest owners.

Further illustrations of the multimedia functionalities of the web-based TalkingTitler software is provided in Appendix R which showed an audio and picture recording from interview participant #7 (Mr. Paul Onyeaso) who provided a testimony about his individual land parcel which he used to cultivate coconut trees.

5.6 Query Results

This section presents sample queries and the results generated from the developed land web-based TalkingTitler (LTIS). The queries were used to extract information about the various landowners and their land that were in the PostgreSQL database. A screenshot of the query criteria are shown in Appendix J and K. In this illustration, the search criteria "First name" was used to extract information about "Elder Uzo" within the database by typing the word "Uzo" in the 'Search Item' field. A screen shot of the Query response is the query results are illustrated using the screenshots in figures Appendix S and T.

5.7 Chapter Summary

This chapter presented the in-house testing of the functional adequacy of the web-based TalkingTitler software developed in this project. The two main interfaces that made up the TalkingTitler web-based application were demonstrated with illustrations of how the software can be used to record data from a customary land tenure environment (using data collected from the empirical research site of Akabor town) to provide an improvement on the existing tenure evidences used by landowners to secure their interest in land. The in-house testing of the developed web-based TalkingTitler (LTIS) is presented with screenshot illustrations of the two interfaces which include the front-end (user interface) comprising of the data input forms, the query forms and the map, and the back-end (database interface) comprising of the program administration interface (pgAdmin) and the database tables. The interfaces were designed and created in a flexible way to accommodate unforeseen changes such as changes in system requirements as well as changes in the land tenure data that may arise in the community.

To handle these unforeseen changes, the system was built on a robust PostgreSQL database system that is able to accommodate and manage several terabytes of data including structured, unstructured data types, spatial data and non-spatial data types. In addition to these, the web-based TalkingTitler (LTIS) software is independent of the operating system on the computer. The basic requirement for operating the web-based TalkingTitler land tenure software is a browser of any choice to connect to a PostgreSQL database backend which can be installed on any operating system. The system also carried along the portable feature that motivated the use of MS Access in the initial development. Thus with the PostgreSQL database backend, the web-based TalkingTitler land information system can be fully operated on a workstation, laptop

or server environment since both the frontend and backend interfaces of the software can be installed and run on a single PC workstation, laptop or server either on a local host (in the absence of internet access) or over the internet where there is availability to internet hosting and connection.

This chapter has addressed both the primary and sub objectives of the study by providing detailed results of the test carried out on the developed land tenure information system software that was designed in Chapter four. The software implementation adapted the existing TalkingTitler model to produce a web-based TalkingTitler (LTIS) that suits the needs of Akabor customary setting In addition, the chapter provided solutions to Research Questions 2 and 3 in Section 1.6 by demonstrating the suitability of a flexible database structure in recording and managing land tenure information in a customary setting such as the Akabor community. The system integrated a lot of unstructured data types such as video, audio, image and spatial data files which helped to capture complex and unconventional data that were the majority of the Akabor customary land tenure data collected in this study; these unconventional data are data forms that cannot be fully expressed in textual format without altering their meanings. The Query interface provides a support to the fulfilment of research sub objective by demonstrating how computer technology can be used to record and retrieve land tenure information. The information generated from the database query can be used by the local people as proof of their interest in land during an adjudication process.

This project has demonstrated based on the example scenarios presented in this study, that the web-based TalkingTitler application is a good information technology tool that can be integrated into land tenure management in Akabor customary setting to complement and improve

their existing methods of proving their interests in land and land resources especially for the local and less fortunate groups. The application is able to integrate the customs and traditions of the people as well as the complexity in their social interactions with each other and with their land. It would also help to make life better for the local people by avoiding situations of escalated dispute over land and people having to spend money on legal services to go to court for adjudication.

Chapter Six: **Conclusion, Limitations and Recommendations**

This research addressed the importance of designing and developing a web-based land tenure information system application for recording and managing land tenure in an Akabor customary setting in Southern Nigeria. In the Akabor community, access to land and other natural resources are governed by customary rules which take into consideration the traditions and norms of the people. Currently, land tenure evidence in this community is based on the oral testimonies of the land owners and their witnesses, and there is no formal or computerized land tenure application or system to manage their tenure information. The research identified the need to improve the current oral testimony process of proving interests in land by designing and developing an information system that can complement these existing oral procedures of securing land and/or other land resources such as trees and tree products (for example, palm fruits, oranges, coconuts, and bananas) in the Akabor customary setting. The integration of a land tenure information system tool to improve land security in this community has become paramount due to the rapid economic, societal and political changes that are occurring and resulting in numerous land-related disputes. It is anticipated that the rapid socio-economic and political changes will most likely continue for many years to come (Rakai and Williamson, 1995). However, such dramatic socio-economic changes create challenges because they tend to benefit only a few powerful actors (the elites) in the society, while creating hardship and economic and emotional distress for the poor and disadvantaged.

From the onset, this project was designed to fit into an existing and on-going TalkingTitler land information system (LTIS) design; the web-based TalkingTitler (LTIS) software designed for this project incorporated a flexible database structure, mapping function,

query and spatial interface that could be used for recording tenure information in the Akabor community. It was designed to capture the complex social relationships that exist in Akabor land tenure and to record land ownership and ownership of other features such as economic trees and other structures on the land. Some of the complex social relationships that the system can capture include the existence of overlapping rights on the same parcel of land originating from lineage, family, individual, and community rights.

Overlapping rights could also apply to features on the land. In Akabor community, secondary rights over land such as rights to use, improve, assign and transfer natural resources are considered highly relevant as it affects the livelihood options of those relying on them. For instance, consider a situation that involves the co-existence of four different interests in one parcel of land. The actors in the scenario are Mr. A, Mr. B, Mr. C and Mr. D. Mr. A and Mr. B are brothers, but Mr. C and Mr. D are non-members of the family. In this scenario, Mr. A. has inherited and owns the land, while Mr. B has inherited and owns the trees on the land. Then, Mr. A gives the right to cultivate his land to Mr. C, while Mr. B gives the right to harvest the fruits on his trees to Mr. D. Thus, all four men have an interest in this particular parcel of land, and this primary (ownership rights) and secondary use rights on the land need to be captured and represented in the system.

A major constraint past researchers have experienced when they attempted to capture and computerize a customary tenure system is the inability to represent the complexity that is inherent in this setting, as they have not taken into consideration the customs, norms, and traditions of the local people. In effect, previous attempts to codify the customary land tenure system to fit into the current westernized conventional land information system has meant that

the customary system's characteristic flexibility and adaptability has been weakened and even lost (Zevenbergen et al. 2013; Rakai and Williamson, 1995). However, it is exactly this flexibility in customary land social relationships that is considered to be strength of the system and thus needs to be captured and retained in a computerized system (Rakai and Williamson, 1995)

In Nigeria, the customary land tenure system is affected by factors such as demographic growth, urbanization, monetization of the economy, livelihood diversification, greater integration in the global economy, and cultural change (Cotula, 2006). Some of the changes resulting from these factors include the transition from lineage and subsistence farming that has been in practice by the people for many years into an individualized and commercialized system of land ownership and land use.

Given these economic and societal challenges and changes, the web-based TalkingTitler LTIS developed in this study is a tool that can help the members of the Akabor community to manage and administer their land resources. The data generated by this information system will help to provide guidance for land management, land use planning and also improve tenure security for the local people.

As justice and fairness are two critical values that are expected to drive the improvement of a land administration system, it was thus necessary to design an information system software with a sufficient flexible data structure that can capture the rapid changes in land tenure relationships and accommodate the use of both conventional and unconventional data forms (such as videos, audio, picture and textual data), as well as unforeseen user requirements in this customary setting (Barry et al., 2010). Prior to the software design and implementation, an

overview of the study area and issues of land conflicts confronting the area were analyzed to identify the information system needs of the community which was integrated into the software developed in this project.

The primary and sub-objective of this research were accomplished as follows:

Sub-Objective: To design a web-based land tenure information system by adapting a database management system of an existing land tenure information system to suit the needs of the Akabor community and provide tenure evidence in the event of disputes over interests in land, especially in the adjudication process.

The steps taken in this research to achieve the sub-objective include an investigation of the lineage system and land tenure procedures in a typical customary setting that was conducted to study how land is secured in the area. The activities involved a review of the literature that relates to land tenure in sub-Saharan Africa, Nigeria and the case study site of Akabor Community.

Additionally, a review and analysis of existing and popular land tenure information systems were carried out to assess their effectiveness in managing customary tenure information. It was found that some of the existing land information systems applications were designed to suit the formal land tenure arrangements such as obtained in the cities and urban areas, thus, they are ill-suited for the customary setting as the traditions and norms in the customary settings were not considered in the software design.

An empirical field study of land tenure system was undertaken in Akabor community by adopting a qualitative research strategy using oral interview and observation strategy to enable the researcher to see the world from the eyes of the participants. The result of the literature

review and field study revealed that in the Akabor community, access to land and other natural resources are governed by customary laws and the land tenure relationship in the community is a complex one with a combination of lineage, family and individual tenure co-existing together. The majority of the land acquisition in the community is by inheritance and it is only in recent times that people started acquiring land through other land transactions such as outright sales, borrowing, share-cropping and leasing. The land tenure system is evolving from lineage tenure to individualized tenure system due to influences from the rapid socio-economic and political changes in the area.

Further steps were taken to identify the information system needs of the Akabor customary community to design a flexible database structure based on these needs, to capture and store the various data types that can be used by members of the Akabor community to secure and defend their interest in land. The various forms of data that were used include structured data such as textural data and unstructured data such as multimedia data (video, audio and picture or image files) and spatial data which include geometric information of the land parcels and the other resources on the land such as economic trees. Prior to the physical implementation of the software, a conceptual database model was designed and created using an entity relationship diagram which was later translated to a physical database implementation on a PostgreSQL 9.2 database platform with spatial extension that enables the database accommodate attributes used to describe the geographic objects such as the spatial coordinates and projection and mapping.

The existing TalkingTitler (LTIS) design was enhanced in this project by integrating a map interface, a query interface, and additional database entities to accommodate the customary tenure data that could not be accommodated in the old version of the TalkingTitler database

tables. The objective of integrating a map interface is to support the identification on the ground of the land that is described in the recorded document. This is because occasionally, textual information can be used to describe the same parcel of land in different ways; thus an integration of a spatial information will provide a unique identification information to support the oral testimonies of land owners and their witnesses especially in the aspect of boundary locations. New front-end interface was designed and developed to capture and store specific attribute information that were used to described land tenure situation recorded for each piece of land or other land resources stored in the database.

Primary objective: This objective is to contribute to a design and action theory in land tenure information system design for a customary setting that is experiencing rapid socio-economic changes, based on the TalkingTitler design. The achievement of the sub-objective led to the fulfilment of the primary objective. This project has contributed to land tenure information design theory by adapting the flexible database structure of the existing TalkingTitler land tenure information system to design web-based land tenure information software that was used to capture, manipulate and store land tenure data collected from the Akabor customary setting. The principles of evolutionary system design adopted in the development of the TalkingTitler application facilitates the flexible system design that is able to capture the changes that are taking place in the customary land tenure setting.

6.1 Benefits of the web-based TalkingTitler Software

The web-based TalkingTitler software is able to captures and stores data in a digital format. Having the land tenure information available on an electronic database with

accompanying audiovisual testimonies implies that the information can be digitally accessed and provided at any time, rather than requiring that a person come and testify in person to ownership, as they currently have to. The existing oral testimony process used in the community makes it harder for older people, and those who are infirm, incapacitated, working, away, to effectively defend their land in situations of dispute because they may not easily assemble their witness to appear before the adjudication meeting (some witnesses may be deceased, or sick or away, etc.) .

The ability of the TalkingTitler LTIS to store historical land tenure information will contribute to building a cohesive community where members live harmoniously. The software also has the potential to preserve the traditional values and customs of the people by recording customary land tenure data for future generations.

Furthermore, the ability to readily generate land tenure information of members of the Akabor community supported with spatial information could help to make their land claims recognized by state and federal institutions, since the existing legal framework in the State and Federal government levels in Nigeria is receptive to this type of claims. The integrated map interface would help to ascertain the accuracy of boundaries based on the spatial information which is necessary for dispute and conflict resolution. Finally, the unique functionalities and capabilities provided by the Talking Title application in this research bridge the current gap that exists in a conventional land information system that is ill suited for a customary land tenure setting.

The TalkingTitler application software is a practical, fit-for context software and effective tool for tenure information data collection and management in formal, informal and customary settings. It is anticipated that this web-based land tenure application will benefit the

Akabor community in the following ways: (1) by providing a mechanized system that can automatically record and generate the evidence needed to prove rightful owners' interest in land; (2) through establishing a digitized, easily accessible history of land parcels and resources on the land; (3) by generating a historical record of the transactions that have taken place on the land which will help speed up the adjudication process in dispute situations, and (5) by helping mitigate disputes over land tenure, especially boundary encroachments, before they escalate to an adjudication level.

If the web-based TalkingTitler land tenure application is deployed, these five main benefits will help empower community members to more effectively manage their rights and interests in their land and other land resources. This will result in a more just, fair, and equitable society in the Akabor community, especially for the less advantaged community members who otherwise have to depend on the oral testimonies of their witnesses to prove their interest in land.

A comparative table showing features of the existing TT and the web-based TT designed and developed in this project is in table… below.

Existing TalkingTitler Application	New TalkingTitler Application
The conceptual design of the existing TalkingTitler model was designed with a direct many-to-many relationships between the entities	The conceptual design was modified to suit the complex relationship in Akabor customary community by using composite entities to achieve the many to many relationship between entities
Database built on entry level PostgreSQL 8.4 DBMS	Database built on enterprise level PostgreSQL9.3 with PostGIS 2.4 spatial extension

Does not have Schemaless emulation features	Database have schemaless emulation features such as JSON-style data that enables varying set of data fields with different data types for each field, Hstore functionality that enables storage of text documents in the database columns
Does not store spatial data	Stores Spatial data such as geometric information of land parcels through the PostGIS spatial extension enabled in the PostgreSQL 9.2 DBMS
Contains existing database tables	Contains both the existing database tables and new database tables created to store and manage customary tenure data
Contains data input forms	Contains existing data input forms and new forms created to captured land tenure data
Does not have a Query interface	Contains a Query interface used for searching and retrieving data from the database
Does not have Map interface	Contains map interface for Visualization of the land parcels and other land resources such as trees that can be drawn on the map. The map interface is programmed to disallow the overlapping of two parcels or other land resources of the same size overlapping themselves which in reality would help

	to avoid the same entity being drawn and entered into the database twice

Table 3. Comparative features of the existing TT software and the web-based TT software designed in the research

6.1.1 Potential weaknesses of using the TalkingTitler (LTIS) for land tenure administration in Akabor community

Although the TalkingTitler LTIS will facilitate improvements on the efficiency of land tenure security and resolution of tenure disputes and claims by providing up-to-date information of existing situation, it is still somewhat not advisable to rely fully on the software for the management of land tenure and land use in the community. This land tenure management should be done alongside the existing traditional methods for high effectiveness. There are some anticipated problems that might be encountered should the web-based TalkingTitler land tenure software be integrated in the management of the Akabor customary land tenure.

A major problem would arise from the high cost of implementation and sustainability of the TalkingTitler LTIS in rural areas like Akabor community where most of the residents are low income earners and would not be able to afford it; although there might be some interest from the non-governmental agencies and local government to subsidize the cost of initial implementation, the subsequent cost of maintenance might not be immediately available and the system if deployed might end up terminating over a period of time. There is no assurance of posterity in the use of the software.

The TalkingTitler LTIS, just like every other information systems operated by human beings, is prone to human error. An erroneous data input into the system can result in an intensive or explosive discord which might take years to resolve. Also, information generated

from the software can be misinterpreted or manipulated by some unscrupulous groups of people such as the corrupt elites in the community thereby resulting in dissection or serious conflicts with genuine land owners.

Furthermore, if the information generated by the TalkingTitler LTIS is made public, it could expose the land owners to land grabbers or unscrupulous people and government agencies who could use the information of the owners to sell the land behind them.

Finally, the changes or on-going transitions in the customary land tenure is a typical reflection of the dynamic nature of man-to-land relationship and could become too complicated to manage with the software over time. The system design would need to be updated and expanded upon which would require the input of the initial software designers and developers who may not be there at the time.

6.2 Research Limitations

A major limitation encountered in implementing the web-based TalkingTitler LTIS was the unavailability of editable feature layers and shape files of the research area, therefore, OpenLayers Google map of the area with very poor spatial resolution was used instead in the map interface. The field data used in the project design and testing of the TalkingTitler application were obtained from the testimonies and stories given by the interviewed participants in the Akabor community. These testimonies could be biased and somewhat subjective and there are some chances that some of the stories may evolve or be manipulated to suit the interest of the participants. Although there were checking measures in place to ensure the validity of their stories by ensuring that the data were collected in the presence of other members of the

community and also confirmed by the chiefs of the village, it is still important to find alternative means of authenticating these information so as to eliminate bias in the results of the analysis which could favor participants' interest.

6.2.1 Limitation in the software

The database platform used in developing this application is a PostgreSQL which is a relational database application. One of the limitations of relational database systems is that data are stored in fixed predefined structures and are usually manipulated using structured query language (SQL). This becomes a constraint for achieving full flexibility in the representation of complex customary land tenure relationships; this also caused some restrictions in the ability of the system to capture continued rapid changes in the Akabor community customary land tenure situation. Additionally, data in relational database systems (RDBS) generally reside in multiple tables which are interlinked through a shared key value, these tables can sometimes become incoherent and complicated as the database gets larger. There is a need to impose a coherent table structure by obtaining the services of an experienced database programmer to choose the right data types to avoid unnecessary complexities in the data structure; this type of resource person may not be immediately available.

Finally, due to the time constraint experienced during the software development phase, there was not enough time to create more interactive map controls to make the map interface more flexible. Also, the web-based TalkingTitler software, though tested in-house, remains to be thoroughly tested and evaluated in the Akabor community.

6.3 Future Work and Recommendations

This section presents recommendation for future works on this research and on the web-based TalkingTitler (LTIS) developed in this project.

- The map interface in the web-based TalkingTitler application can be designed to be more interactive by integrating pop-ups and markers that can be used to label or identify the land parcels, trees and other geographic features on the map.
- An availability of editable feature layers of the research site would enhance the map interface of the software as it would make it possible to directly calculate the land parcel dimension in metric or imperial units. It will also make it possible for users to calculate the distance of the geographic features from nearest land marks such as roads, water or inhabited areas of the community; these functionalities were not provided in this design.
- The data collection process of the research study could be improved and made more valid by applying the principles of community participation action which will involve a higher number participant from the research community thus providing a wider range of contributions and opinions on their land tenure information.
- The application of the TalkingTitler information system should not override the existing traditional methods that are in use by member of the community to defend their interest in land as it might tend to favour the rich and the educated more than the poor and illiterate members of the community; rather the application should be used to complement the traditional methods as originally designed from the onset by the founder of the TalkingTitler LTIS, Dr. Michael Barry.

- To improve the flexibility of the database structure and to integrate robustness into the system used in this study, the relational database platform currently used to support the TalkingTitler application could be tried on a non-relational database system such as the Neoj4, which is a graphical database management system, to see if it could be leveraged to integrate robustness into the system as well as improve the flexibility required in the data structure for a customary land tenure information system. The security aspect of the database should be considered when making this choice as relational databases are generally known to have extensive built-in multi-user support, which is lacking in the Neoj4 and other graph databases which forces user management to be handled at the application level.
- A field testing of the developed software in the Akabor customary community is recommended to assess its effectiveness in recording land tenure data that can be used to complement existing tenure evidence used by the land owners to defend their lands in dispute situations.

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Interview #6 (2013 (Mbaise006-131204 M47 William Oke community musician and trader and para-surveyor), Oral interview on Akabor customary land tenure system. Akabor, Imo State Nigeria.

Interview #7 (2013). (Mbaise007-131209 M64 Paul Onyeaso bus driver, para-surveyor, and Farmer) oral interview on Akabor customary land tenure system. Akabor, Imo State Nigeria.

Interview #8, (2013). (Mbaise008-131207 M54 Basil Oleaku, technician, (title-holder) - Nze Ebizi 1 of Ebizi) oral interview on Akabor customary land tenure system. Akabor, Imo State Nigeria.

Interview #9, (2013). (Mbaise009-131203 Mr. Christopher Akuwudike M34 accountant and business man), oral interview, on Akabor customary land tenure. Akabor, Imo State Nigeria.

Interview #11, (2013). (Mbaise011-1312012 M56 Kingsley Madu, commercial tri-cyclist), Oral interview on Akabor customary land tenure. Akabor, Imo State Nigeria.

Interview #12, (2013). (Mbaise012-1312012 M32 Emeka Ojo, trader and Farmer), Oral interview on Akabor customary land tenure. Akabor, Imo State Nigeria.

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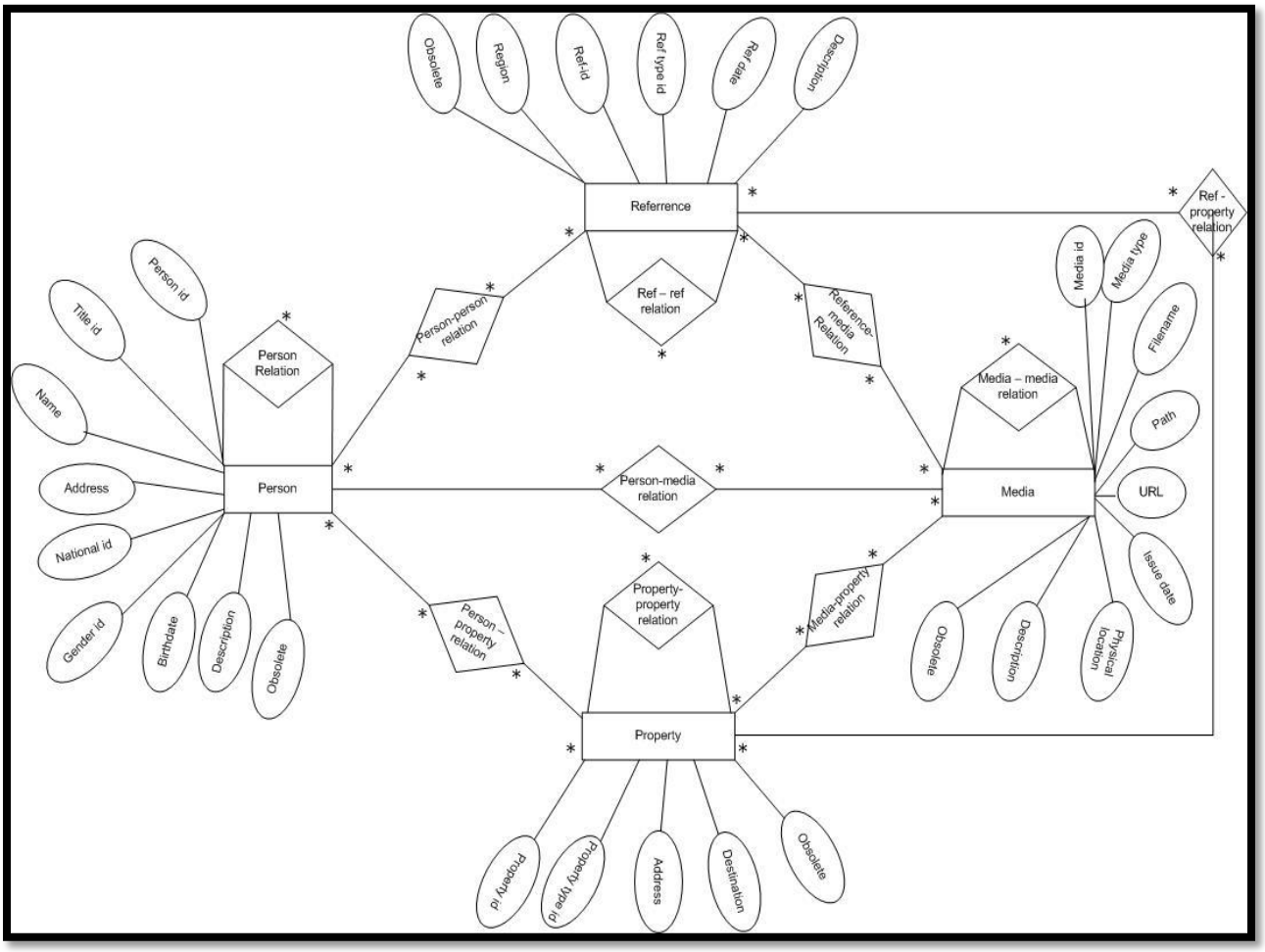
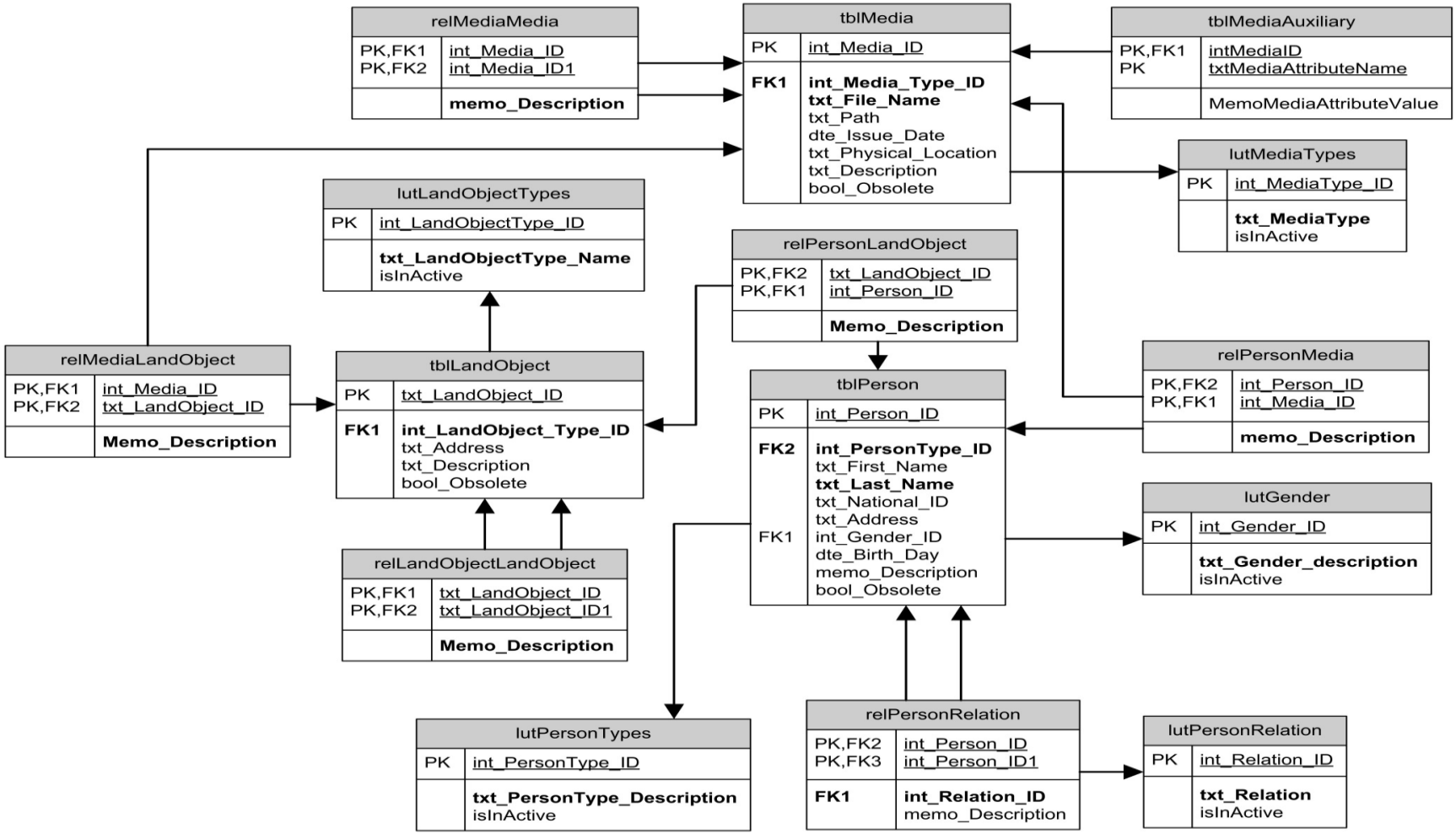
Appendix

Appendix A



Entity relationship diagram of existing TalkingTitler software
Source: Diagram provided with permission from Asiedu (2014)

Appendix B: Existing TalkingTitler Physical Model (Source: Musen, 2008)



APPENDIX C: THE EXISTING TALKINGTITLER TABLES THAT WERE USED IN THIS PROJECT.

The tables that were migrated from the old TalkingTitler PostgreSQL 8.4 database and used in this project include following:

The media table(tblmedia), which stored multimedia files (Video, Audio and picture images) in the previous version TalkingTitler system in the form of URLs[16], was migrated over to the new database and modified to store the sample video files that were recorded for this project during the field data collection.

The person table (tblpersons)' was migrated into the new database and was altered to store biographic information about land owners that participated in the interview

The Title look-up table (luttable) in the existing TalkingTitler database was migrated over to the new database system and slightly altered to include traditional titles of the members of the Akabor community. These Titles are bestowed on individuals in recognition of their achievements and contributions made to the community Examples of these titles include Eze-1-of Akabor, Ezeji, Eze-ala (Chief Priest) Chief, Lolo, Mazi, Elder, Mr. and Mrs.

The person-to-person relationship table (relpersonrelation) was used to simulate relationships between people by linking one person to another, one at a time. This composite table was migrated to the new system and used to capture land transactions, and, most importantly, the complex social relationships that exist between joint

[16] URL – Uniform Resource Locator. This is the address that points to the location where the multimedia files were physically stored.

landowners, including individual and family owners. For instance, joint landowners such as persons who have joint interest on a parcel of land by the status of their family membership are linked to each other as related with a description of the type of relationship (father, mother, brother, sister, joint land owner, land borrower and so on). These relationships are capture and store into this database table and later linked to their jointly owned land parcel.

Appendix D1-D4: New database tables created and used in this project

Appendix D1: Property Table

The Property table was designed to store information that relates to each feature item (i.e. tree or land parcel) represented on the map including the geometry information of the feature. This table is linked to some other tables in the database that contains information required to describe each land parcel or featured such as the administrative information stored in the 'Person' table, the media information stored in the 'Media table', 'title information stored in the 'Title table'. Other tables that were linked to this tenure table include the 'Ownership-type table', the 'Boundary-identification table'. The table is populated through the 'Land Tenure data input form' described in section 4.7.2.1.

Appendix D2: Boundary Identification Table

This table stores the different types of boundary identification markers used by the local people to mark out their land. The information used in populating this table was gathered during the field data collection as described in section 3.10 of chapter 3. The table comprises of the various life trees cultivated by the local people to mark the boundary

between their land and neighboring lands as well as other features besides the life trees used by the local people to identify their land boundaries. The boundary type information is linked to the geometry and spatial information of the recorded land parcel stored in the land tenure table. A sample screenshot of the boundary table and its contents will be provided in Chapter 5, Figure 5.16 as this documentation progresses.

Appendix D3: Land Tenure (Ownership) Type Table

The land tenure type table was created to store various land ownership types that are obtainable in customary and informal setting. This table is currently populated with the information that was gathered from the Akabor community during the field data collection process. The land ownership type include 'Inherited', 'Purchased', 'Leased', and 'Borrowed' Family and so on. The information contained in this table helped to describe the rights on each feature (parcel of land or tree) drawn on the map and entered into the database. A screenshot of the database table containing the various land tenure type in the Akabor community is shown in chapter 5, Figure 5.15.

Appendix D4: Land-Use Table

This table was created to store the information about how the people are using their land. In the research community, the various ways that members of the community use their lands were identified during the research interview. These data were used to populate the Land Use table. Some of the popular ways the people make use of their lands are

tabulated in Chapter 2, Table 2. Apart from their residential and compound[17] lands, other forms of land use in the community include subsistence farming such as domestic animal rearing, yam farms, cassava farms, vegetable gardens, coco farms; intensive farming such as coconut plantation, rubber plantation, 'oil palm plantation' poultry, piggery cattle grazing and so on.

Appendix E: Summary of the Software packages used in the project

Platform	**Application**	**Software Type**	**Source**
Webserver Platform	Apache HTTP Server 2.2.1	Open Source Application	Downloaded from the Internet
Web Mapping application	Open Layer	Open Source Application	Downloaded from the Internet
Scripting Languages	JavaScript, HTML, PHP, SQL, JQuery	Open Source Application	Downloaded from the Internet
Spatial extension	PostGIS	Spatial Data extension	Downloaded from the Internet
Database Platform	PostgreSQL	Open Source Application	Downloaded from the Internet
Web browser	Internet Explorer Mozilla Firefox Google Chrome	Open Source Application	Downloaded from the Internet

Appendix E1: Apache HTTP Server 2.2.1

This is an open source web server application developed by Apache Software Foundation to provide support for various scripts such as PHP, JavaScript, CGI Scripts, and python script, and it enables dynamic content to be run on the server. To provide a solution to Research Question 2, Section 1.6 , a web-based TalkingTitler application was developed

[17] Compound Lands are usually the land on which people build their homes, it's usually individually owned. Most times, the extra pieces of land around the erected structure in the compound land are used for cultivation of garden crops such as vegetables, cocoa yam, pepper, corn and so on.

and hosted on an Apache web server to help land owners and land officials access land tenure information over the internet.

Appendix E2: OpenLayers Map

OpenLayers is an open source, client-side JavaScript library used in making interactive web maps that can be viewed in any web browser. The requirement for using an OpenLayers application is to develop and produce an OpenLayers code that can smoothly execute on a web browser. OpenLayers can be executed on most browser types such as Internet Explorer, Mozilla Firefox, Google Chrome, etc. and can also be hosted on any web server (Hazard, 2008). The maps generated with the developed codes were used to visualize land parcels and other land features drawn on the map by the system users and to generate geometric information for these land parcels and the features on them.

Appendix E3: PHP Scripting Language

PHP is an acronym for Hypertext Preprocessor. It is a server-side HTML scripting language used in creating dynamic web pages. As a web-oriented application, PHP language provides various forms of Internet functionalities, such as connectivity to remote servers, and provides dynamic communication between the browser (front-end) and the database (back-end). In this project, the developed PHP scripts were used to generate dynamic high speed web pages. The scripts were also used to pull information from the database to the browser for the users to view. It accepts users' input data and

pushes them back to the database to be processed and later stored. The data input forms in this software development were created with PHP\HTML\JavaScript codes that run in the background during the software execution.

Appendix E4: JavaScript

This is a prototype based, lightweight object-oriented scripting language that can be inserted into any HTML page (Kourbatov, 2011). It can be used in server-side programming, game development and the creation of desktop and mobile applications executed easily on all types of web browsers. One of the reasons for using JavaScript in this software development is because it facilitates interactive web pages and is supported by most web browsers such as Internet Explorer, Firefox and Safari. The web-based TalkingTitler application developed in this research is a flexible and adaptable application built to run on any browser.

Appendix E5: PostgreSQL

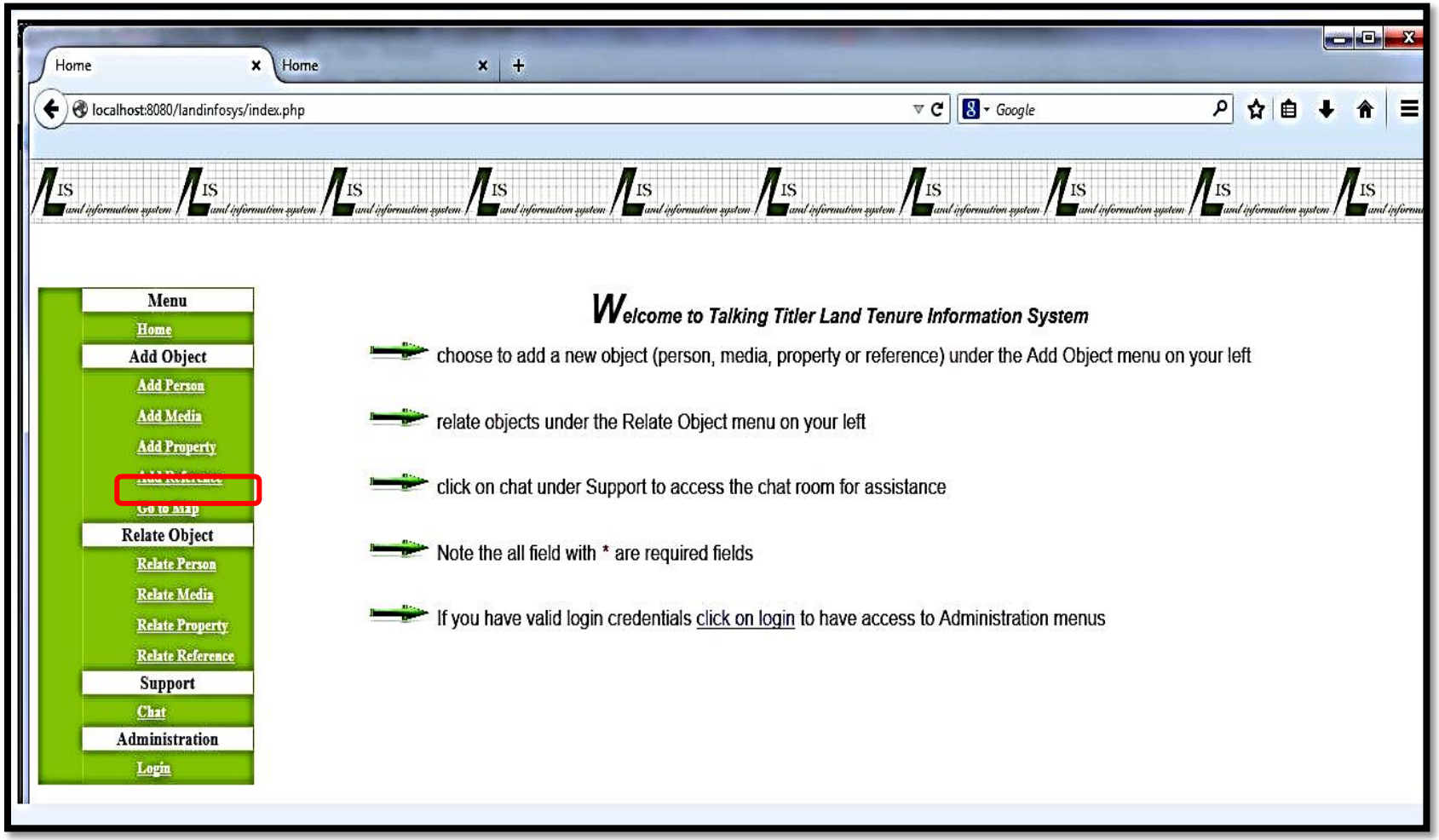
PostgreSQL is an Open Source objected-relational database management package that was originally produced as Postgres by a computer science professor at the University of California, Berkeley (PostgreSQL9.2 Documentation, 2014). It is an enterprise database that runs on most operating systems including Linux, UNIX, and Windows. As a database application package, the PostgreSQL has many data integrity features, which include primary keys that are also compound in nature, and foreign keys that have restricting and cascading updates/deletes (PostgreSQL9.2 Documentation,

2014). The PostgreSQL database has other constraint-features such as check constraints, unique constraints, and not-null constraints. It also provides support for many procedural languages as well as library interfaces that make it possible for both compiled and interpreted programming languages to interface with it. The object-relational PostgreSQL database management system is portable and can be used to develop in-house, web based or commercial application packages such as the TalkingTitler land tenure information system which was produced in this project. There are different versions of PostgreSQL and each version is an upgrade to previous versions (PostgreSQL documentation, 2009). This project was implemented on PostgreSQL version 9.2, which is a more robust and adaptable system than all the previous versions.

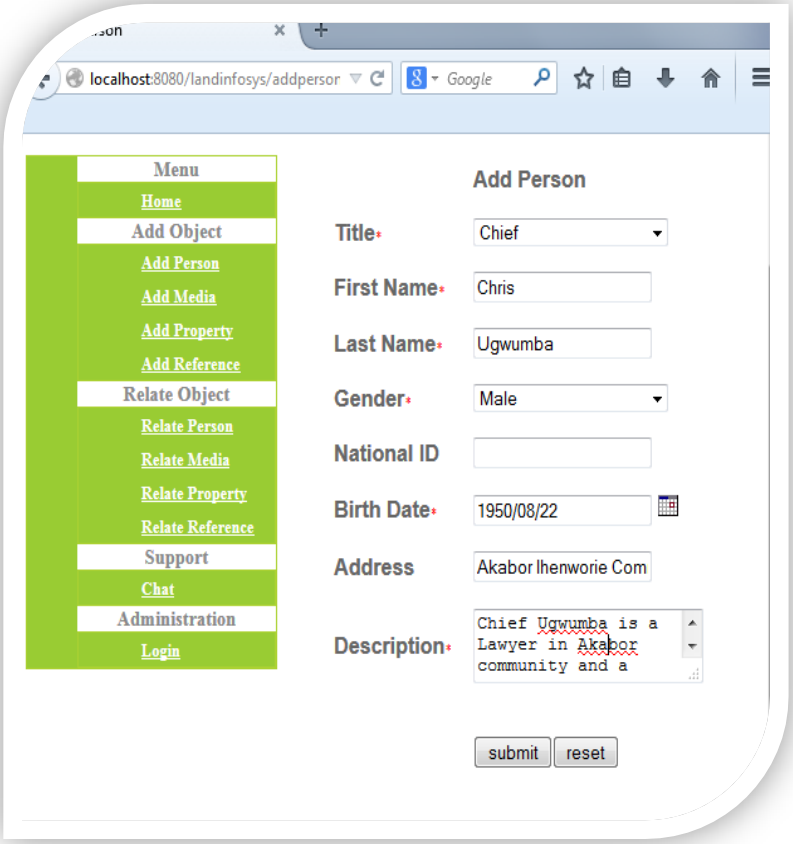
Appendix E6: PostGIS

This is described as the spatial arm of PostgreSQL; it was developed by Refractions Research Incorporation. The PostGIS interface provides PostgreSQL with the functionalities needed to store and manipulate spatial data in its database. Both PostgreSQL and PostGIS applications are open source software that can be downloaded freely from the internet. In this project, the PostGIS version 2.4 was installed as a spatial extension on the PostgreSQL database to enable the storage and manipulation of the geometric information generated from the OpenLayers maps as a user draws features on the map to represent the land parcels, boundary and other resources.

Appendix F: TalkingTitler main screen (Adapted from Asiedu (2014) showing the new Tab 'Go to Map" tab (in red box).



Appendix F1: 'Add Person' Input form

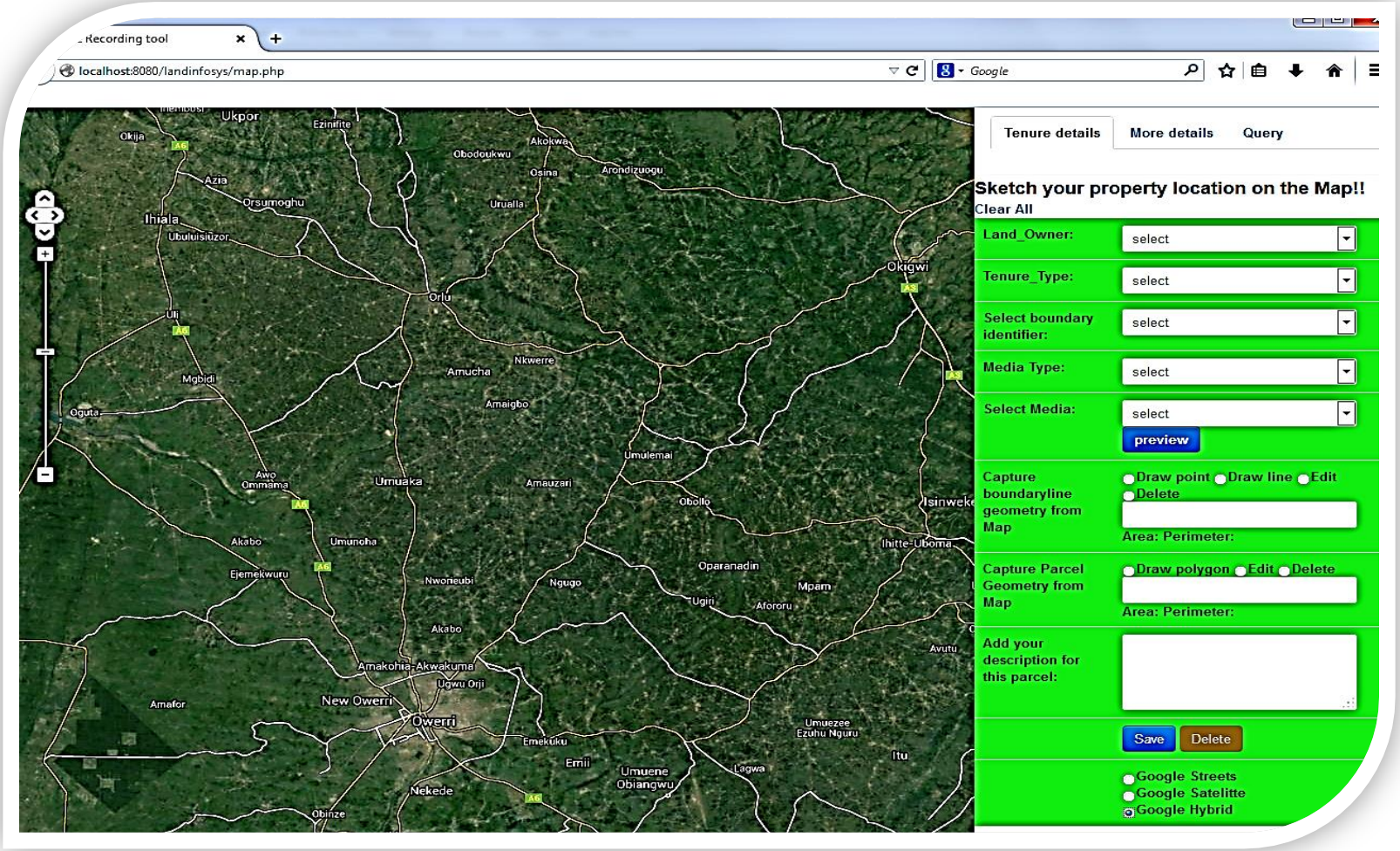


Used to enter biographic information about Landowners

Appendix F2: 'Media Input' form

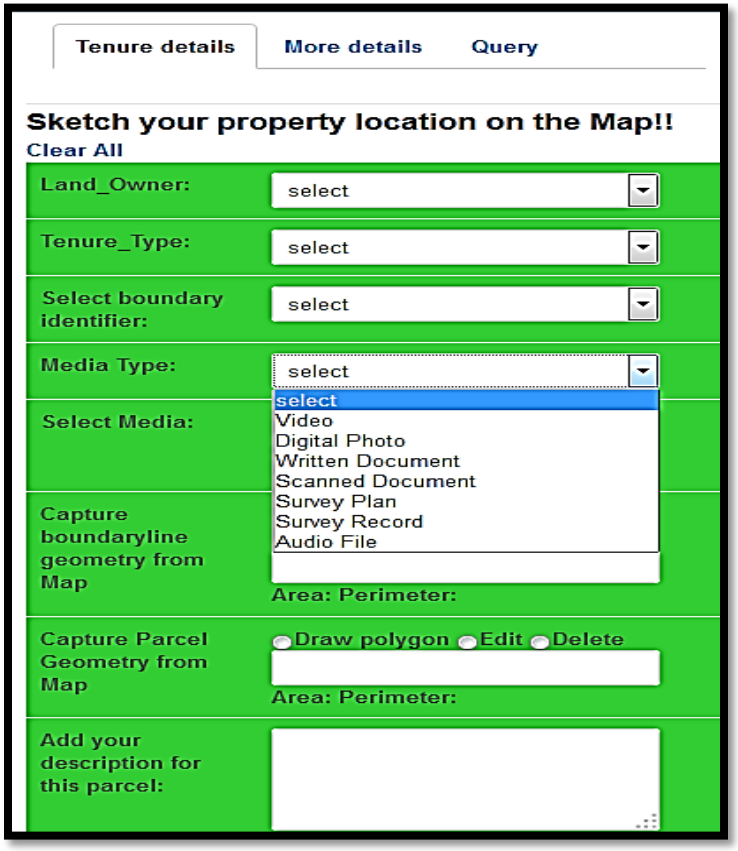
Used to upload media data into the database (Asiedu, 2014)

Appendix F3: Google Hybrid Map and Tenure information gathering forms



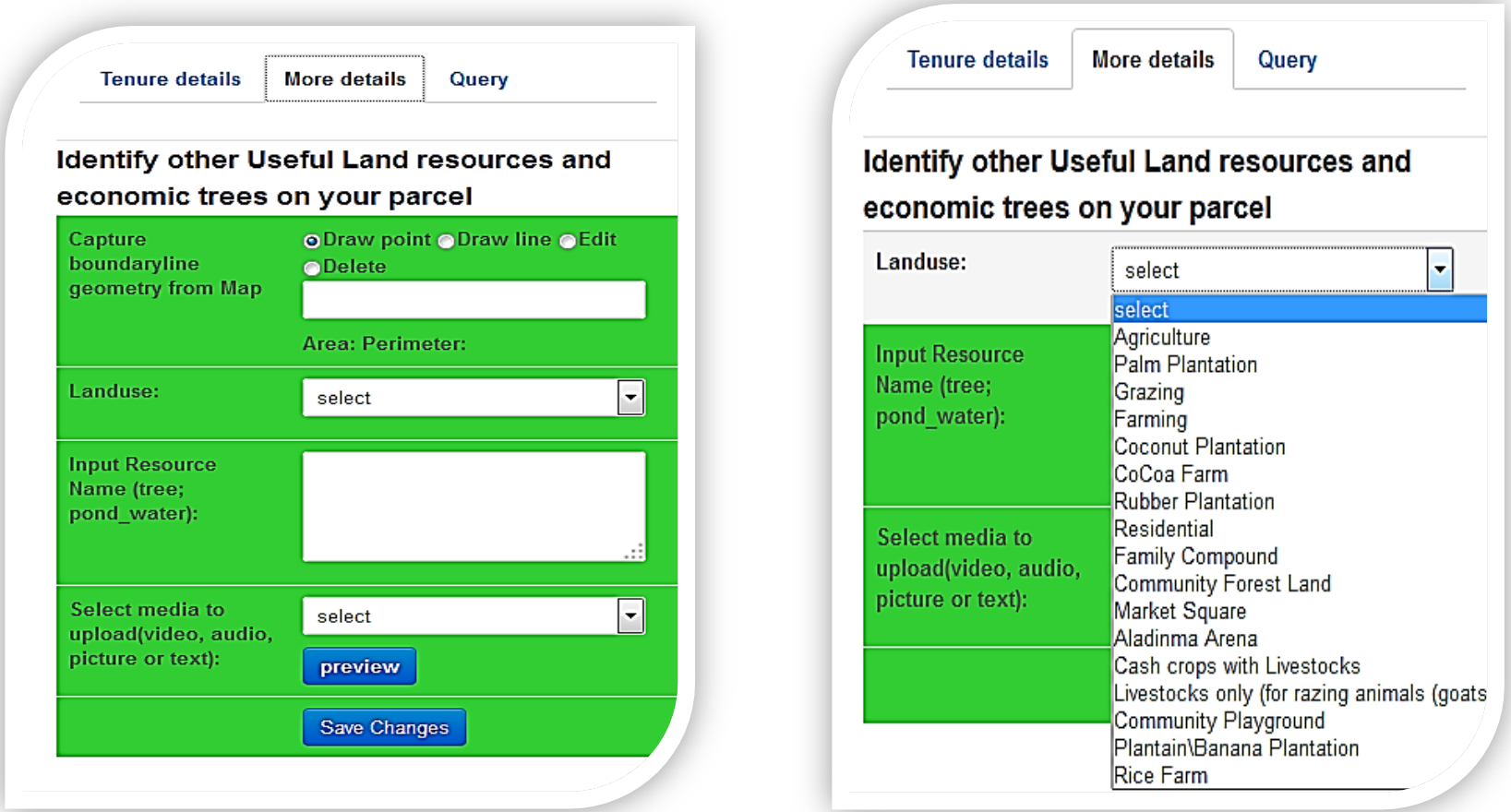
Appendix G: Tenure Types

Appendix H: Media Types



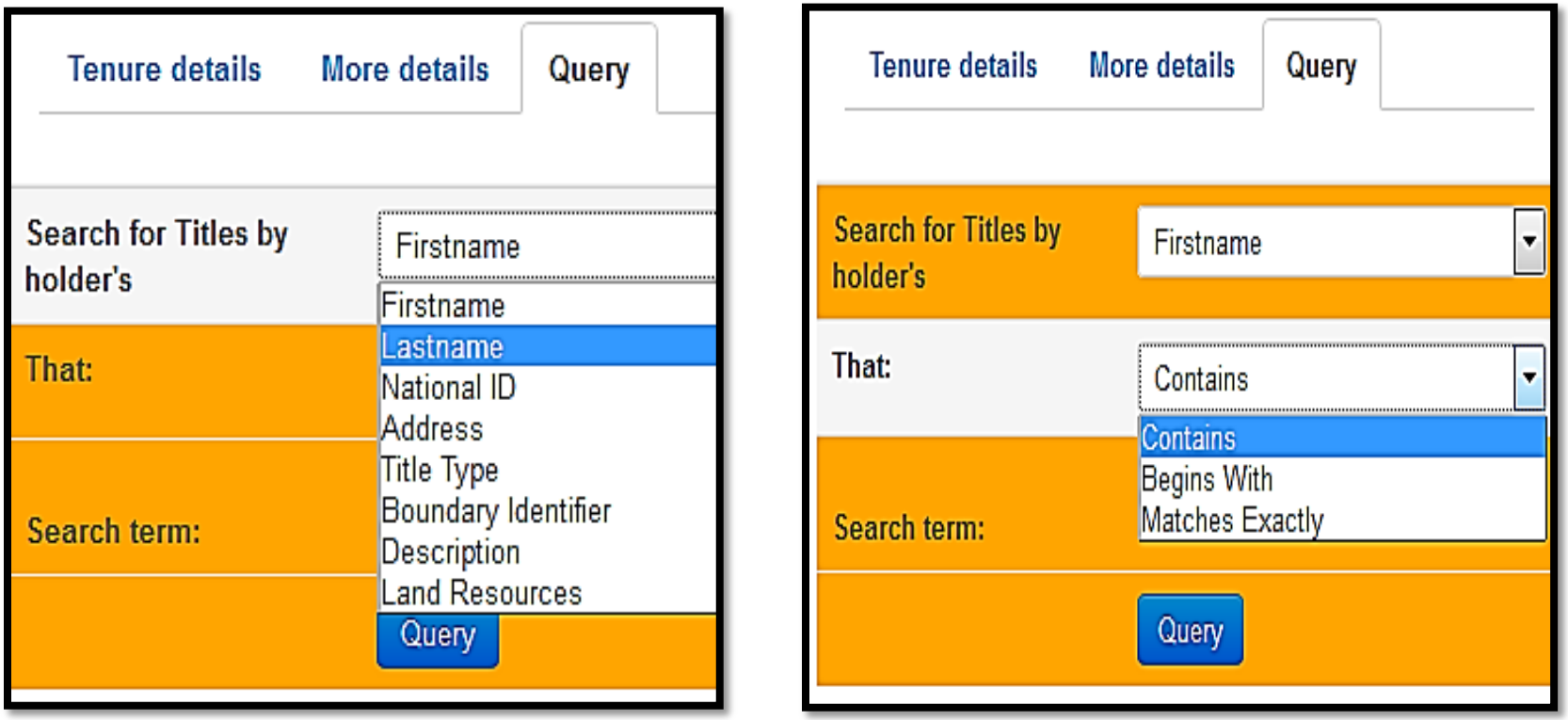
Appendix G: Screenshot showing a drop-down listing of the various land tenure types to select from.
Appendix H: Screenshot showing a drop down list of reference data types that can be recorded and stored into the database

Appendix I: More Details form



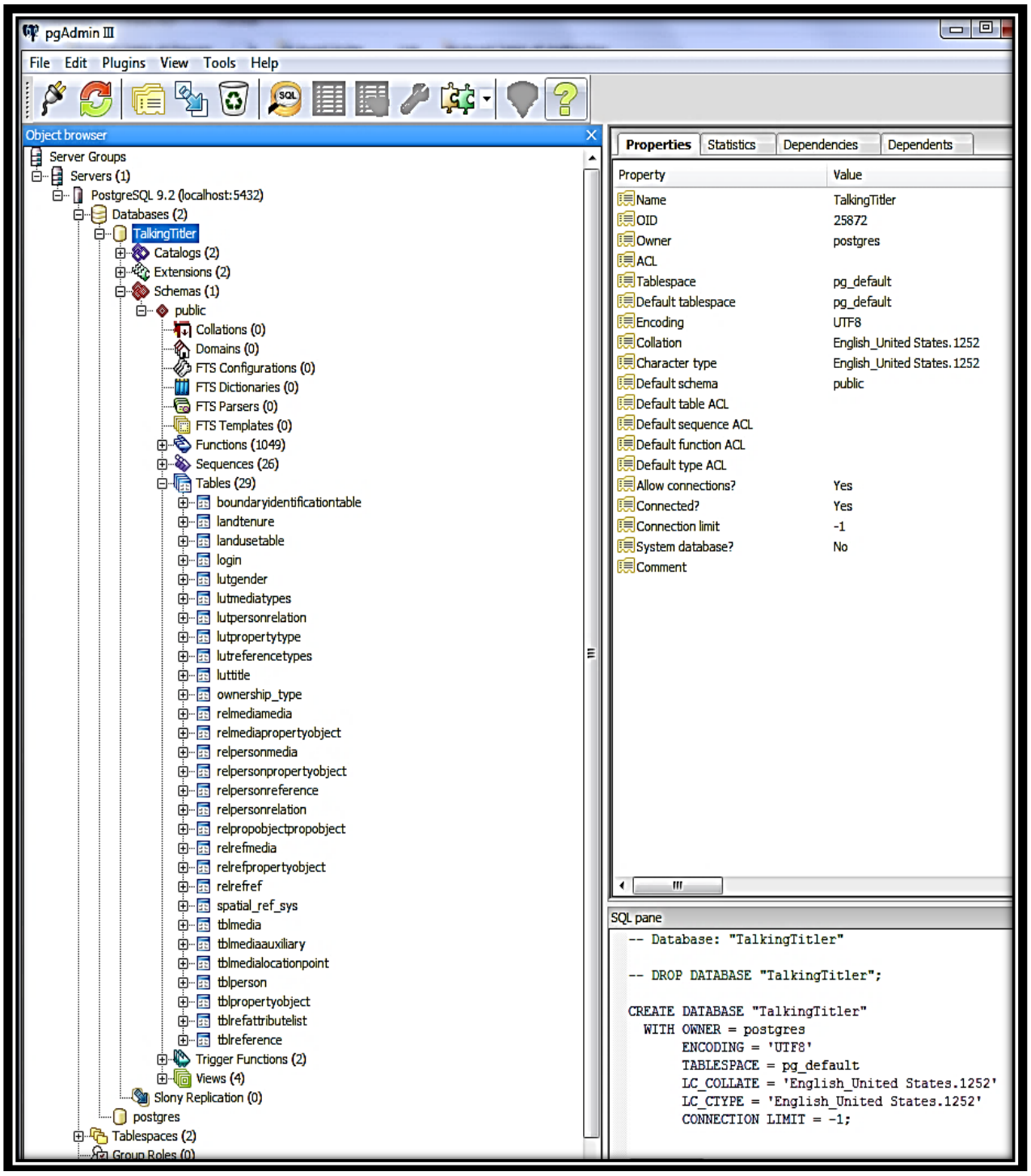
Additional data entering form for entering other useful features on the land parcel. Drop down list shows the various land use in Akabor town

Appendix (J. and K.): Query form



Appendix J & K: Search Criteria used in searching for information stored in the database

Appendix L: PostgreSQL PgAdmin showing TalkingTitler database tables



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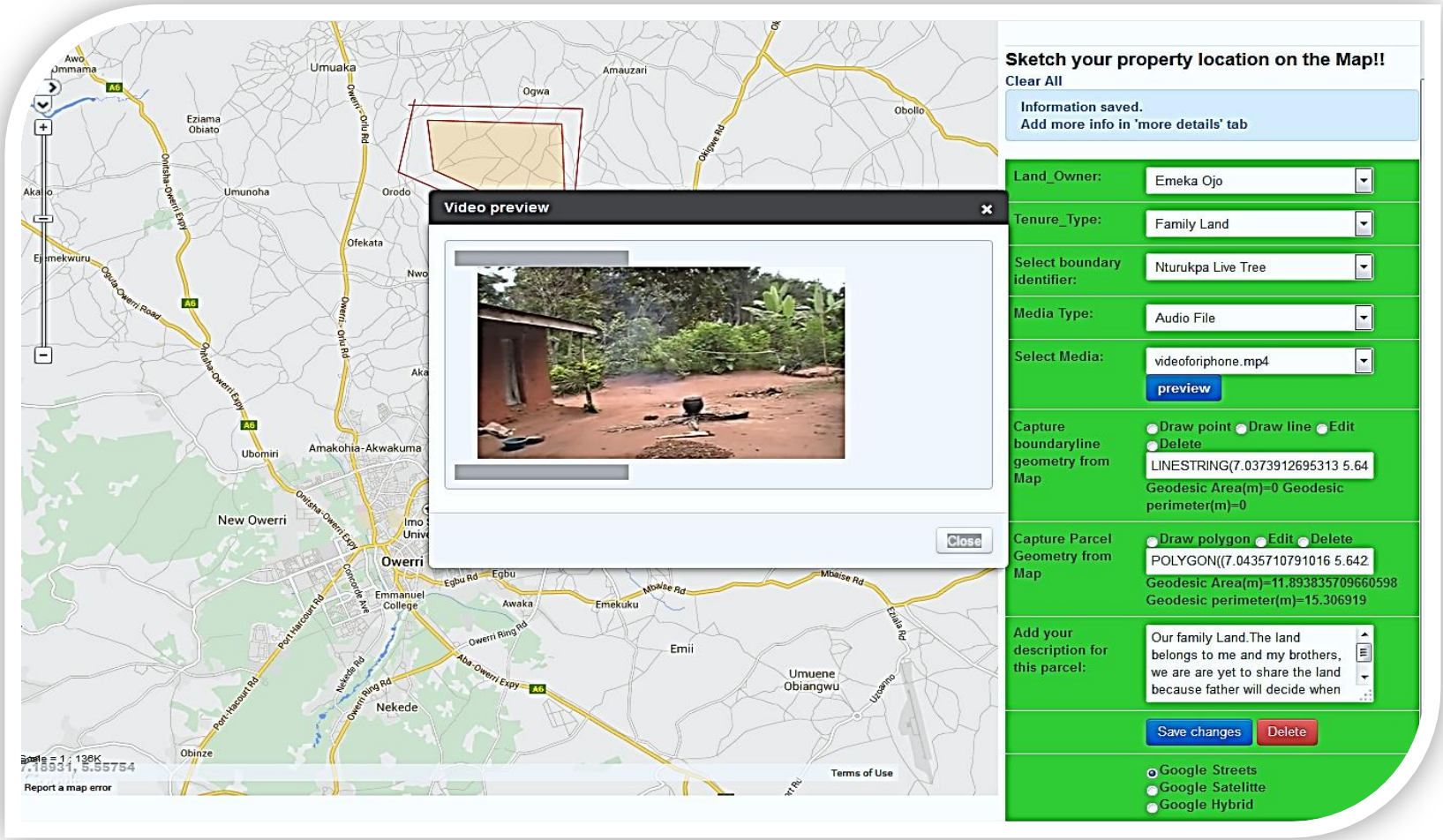
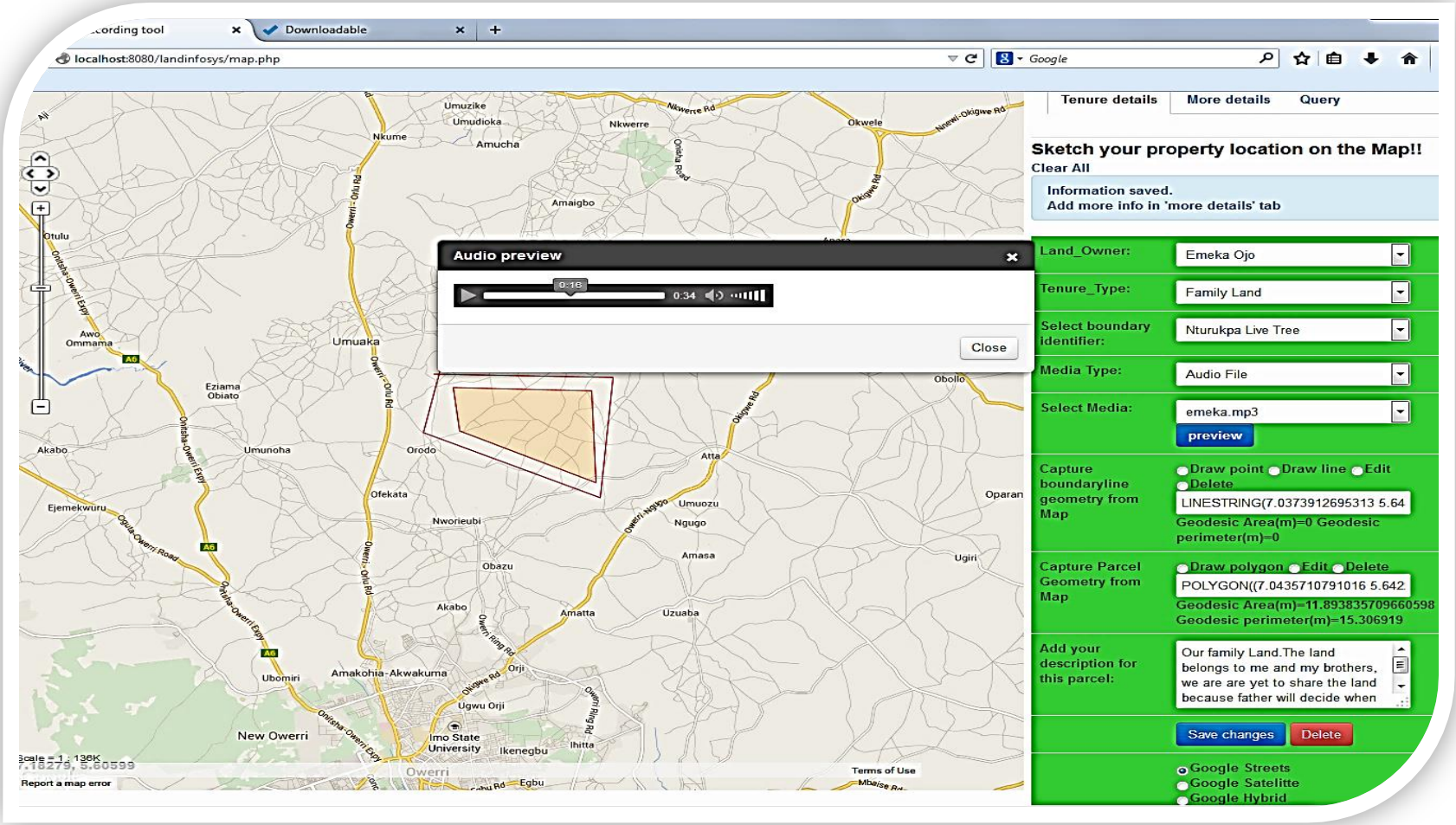
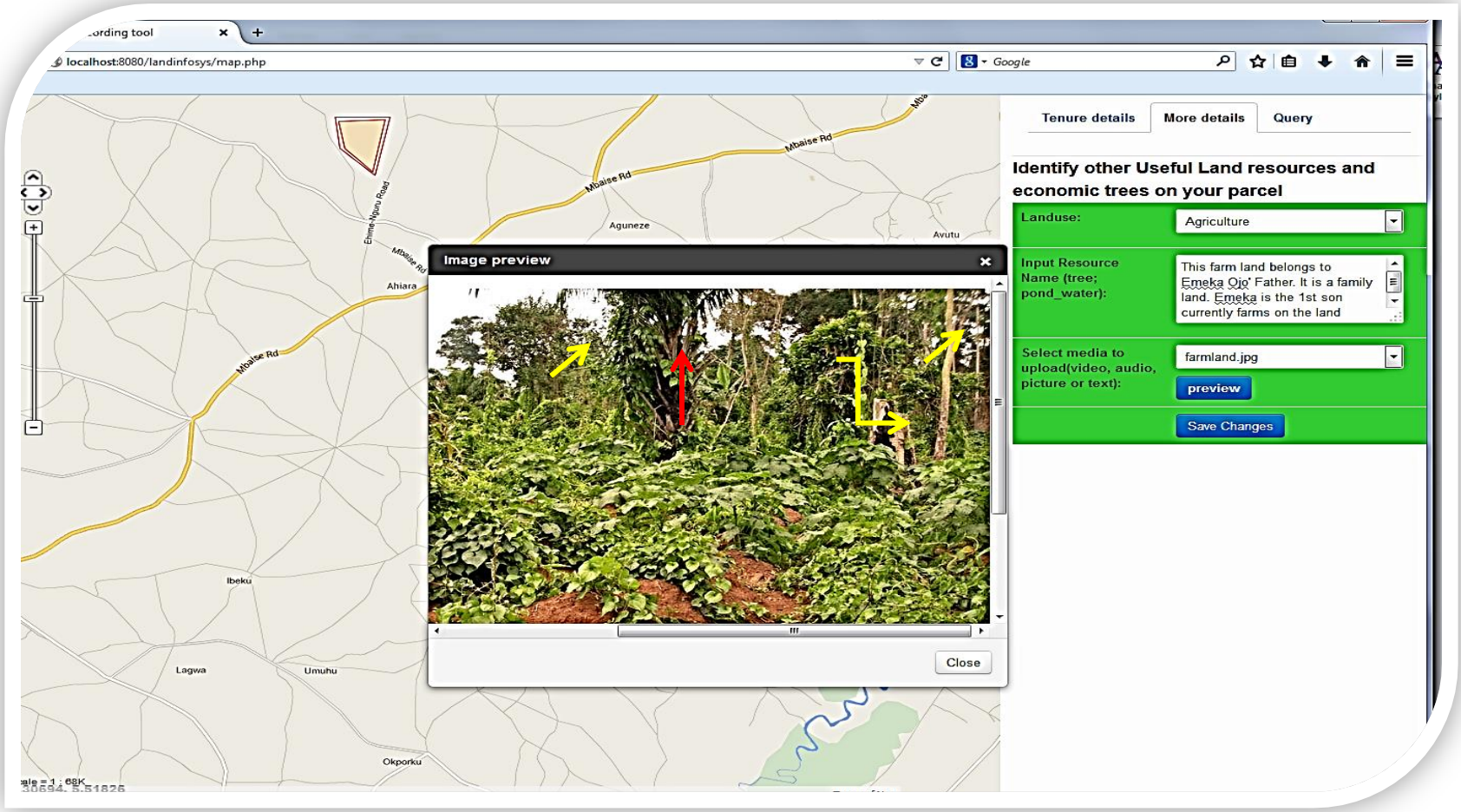
Appendix M: Video recording of Emeka's family land



Appendix N: Audio recording of Emeka's family land and palm tree resource tenure testimony



Appendix O: Picture showing the jointly owned palm trees on the Ojo's family land

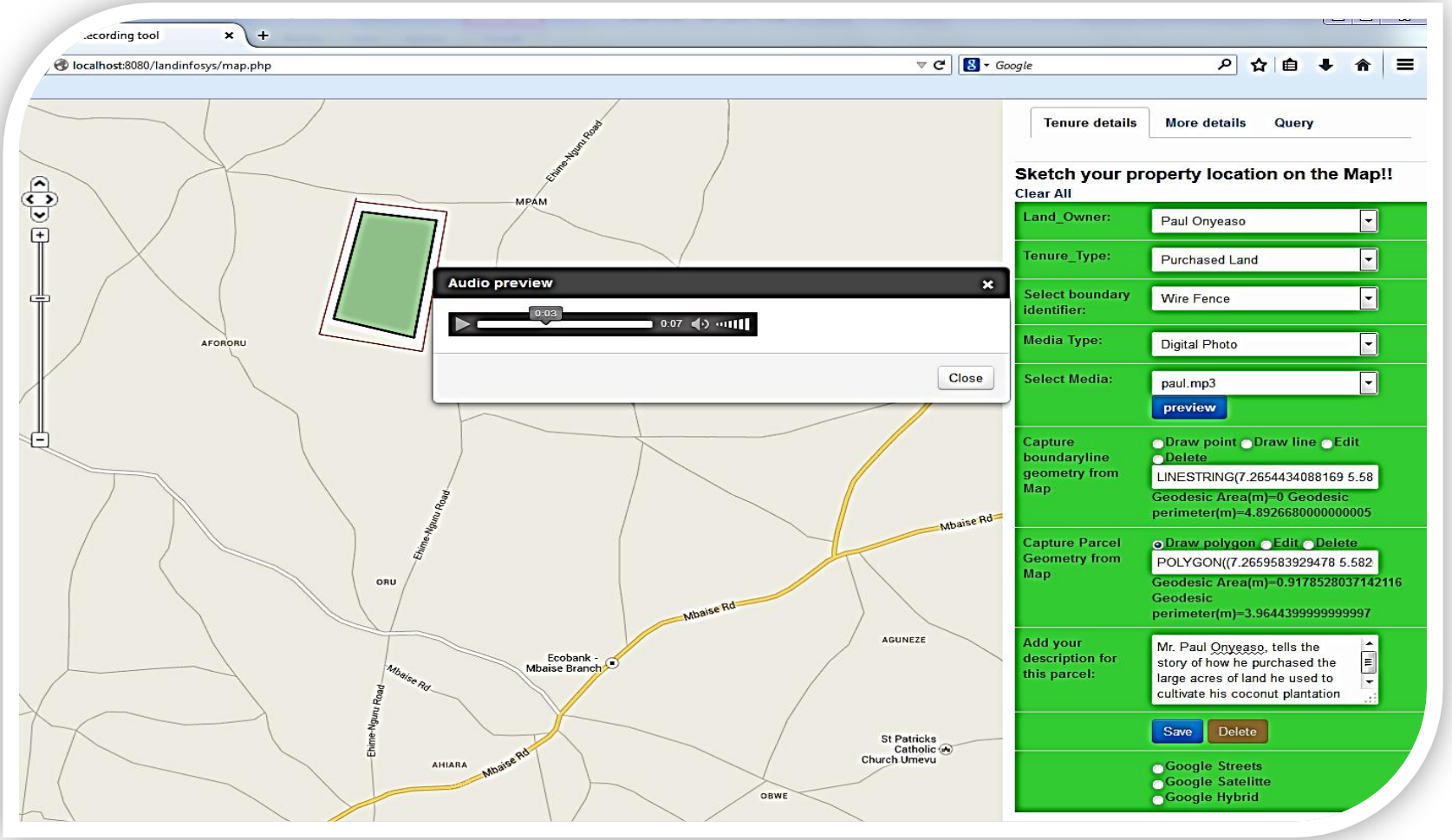


(Sample oil palm tree is marked with a red arrow while the boundary trees are marked with yellow arrows)

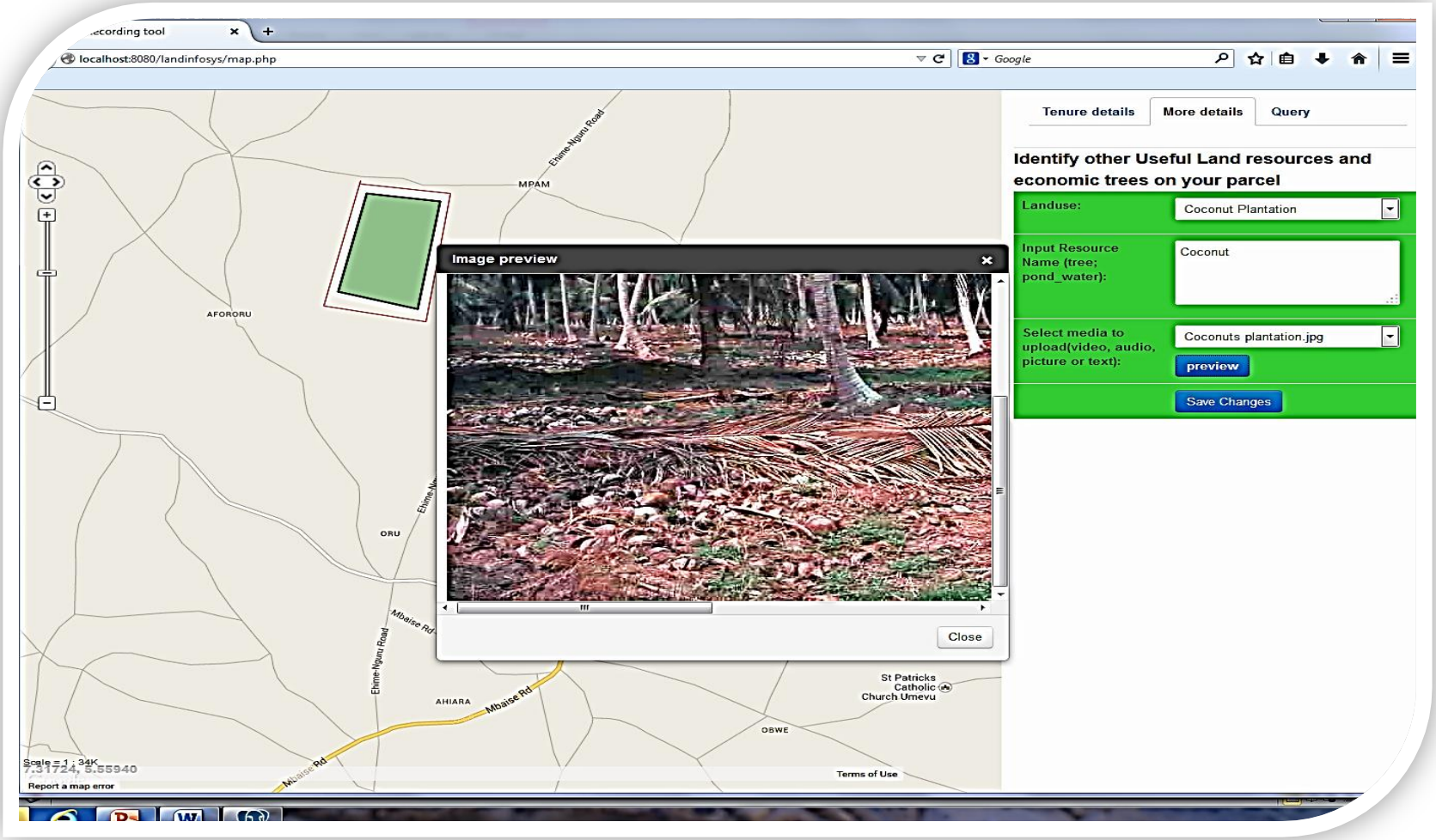
Appendix P: Audio and picture information recording of "Paul Onyeaso"

Audio recording of Mr. "Paul Onyeaso" on how he acquired the land which he used to cultivate his coconut plantations. According to his testimony, the land was banqueted to him and his brother after their father died. Mr. "Onyeaso" was jointly cultivating the land with his brother who later died without a child and so now he owns the entire land alone. He decided to use the land to cultivate coconuts. According to Mr. "Onyeaso", this particular land is not very fertile for cash crops or garden crops because of the soil type which is sandy soil with little humus so it is best used for growing the coconut trees. He ships the harvested coconuts to bigger cities such as Lagos and Abuja where he supplies them to manufacturing companies that produce coconut juice.

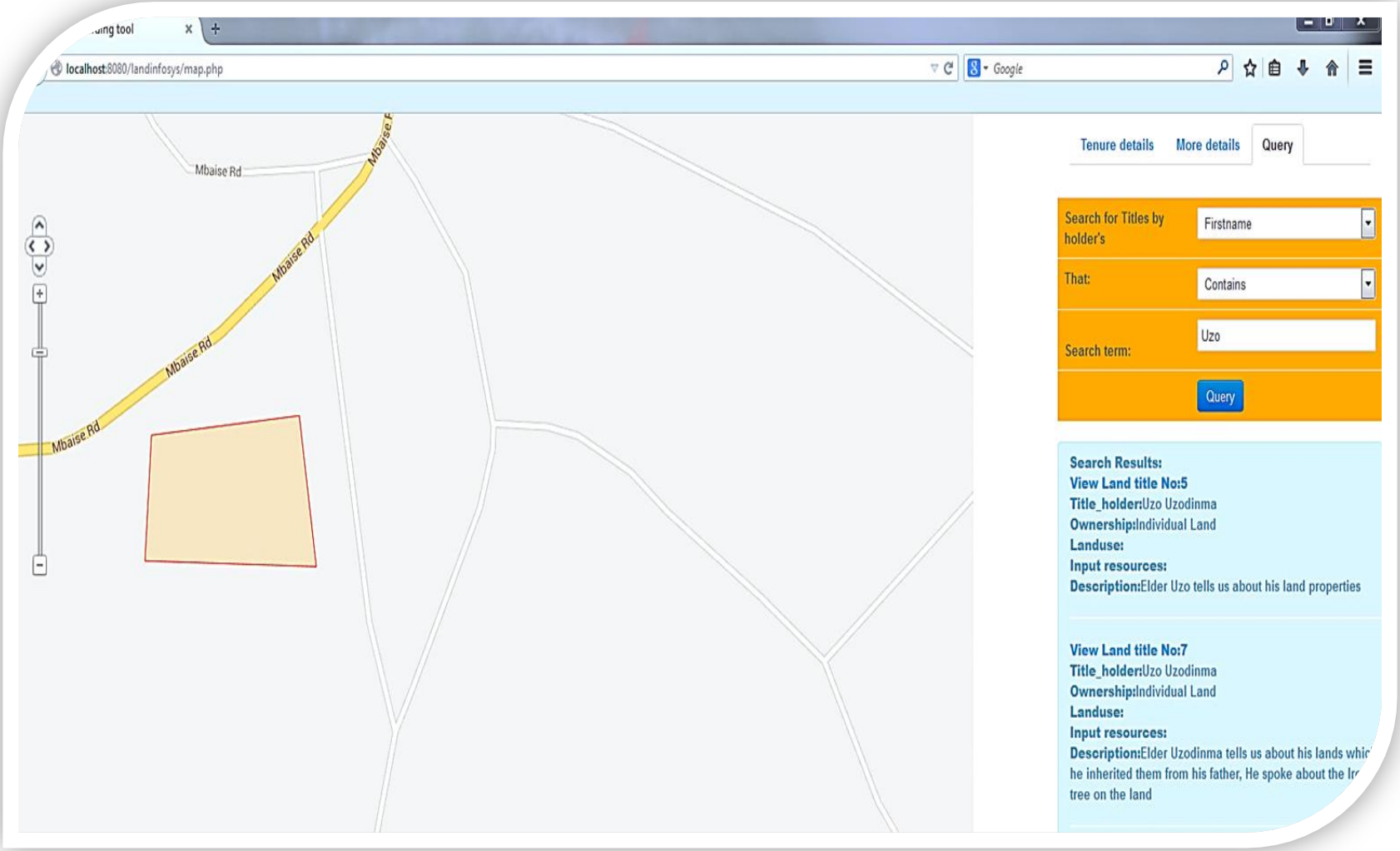
Appendix Q: Mr. Onyeaso's parcel on the map and audio recorded testimony



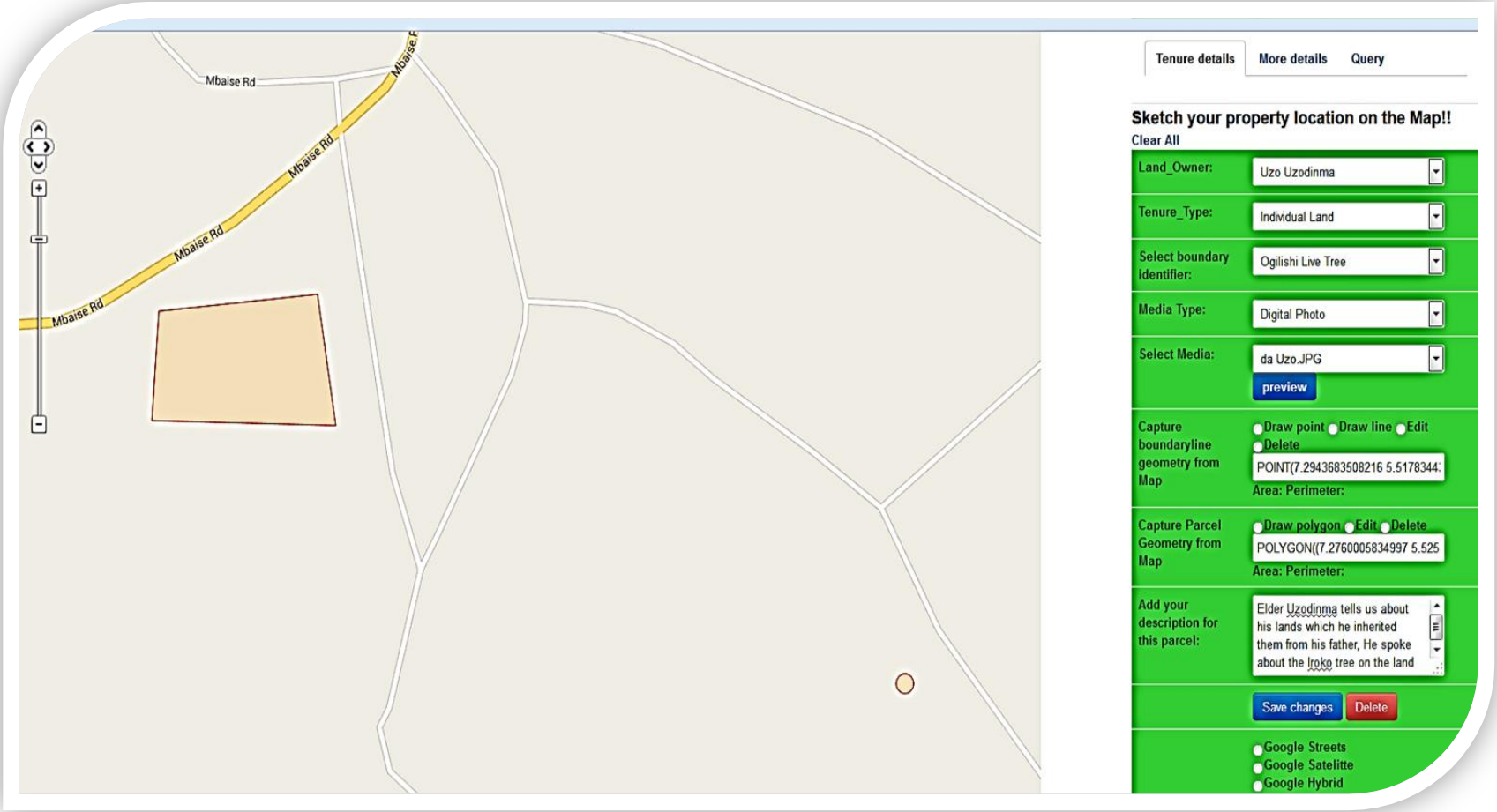
Appendix R: Screenshot of Mr. Onyeaso's parcel and the coconut plantation



Appendix S: Sample Query result showing all the parcels of land belonging to Uzo



Appendix T: A click on the hyperlink "View parcel No 5 will display details the screenshot



Appendix W: Research Ethics Certificate

Conjoint Faculties Research Ethics Board
Research Services Office
3rd Floor Mackimmie Library Tower (MLT 300)
2500 University Drive, NW
Calgary AB T2N 1N4
Telephone: (403) 220-3782
Fax: (403) 289-0693
cfreb@ucalgary.ca

UNIVERSITY OF CALGARY

CERTIFICATION OF INSTITUTIONAL ETHICS REVIEW

This is to certify that the Conjoint Faculties Research Ethics Board at the University of Calgary has examined the following research proposal and found the proposed research involving human participants to be in accordance with University of Calgary Guidelines and the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans 2010* (TCPS 2). This form and accompanying letter constitute the Certification of Institutional Ethics Review.

Ethics ID:	REB13-0900
Principal Investigator:	Michael Brendan Barry
Co-Investigator(s):	There are no items to display
Student Co-Investigator(s):	Irene Egbulefu
Study Title:	Exploring technical solutions to enhance land tenure evidence in a Customary Setting
Sponsor (if applicable):	

Effective: December 3, 2013 **Expires:** December 31, 2014

Restrictions:

This Certification is subject to the following conditions:

1. Approval is granted only for the project and purposes described in the application.
2. Any modification to the authorized study must be submitted to the Chair, Conjoint Faculties Research Ethics Board for approval.
3. An annual report must be submitted within 30 days from expiry date of this Certification, and should provide the expected completion date for the study.
4. A final report must be sent to the Board when the project is complete or terminated.

Approved By: **Date:**

Christopher R. Sears, PhD, Chair , CFREB December 3, 2013

Appendix W1: Consent form for Participants

CONSENT FORM FOR PARTICIPANTS

Name of Researcher, Faculty, Department, Telephone & Email:

Irene Egbulefu
Department of Geomatics Engineering
+ 1 403 9939111, iegblef@ucalgary.ca

Title of Project:

Designing a Technical Solution for Managing Land Tenure Data in a Customary Setting

This consent form, a copy of which has been given to you, is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

My name is Irene Egbulefu. I am conducting interviews to collect tenure right evidence in a manner that fits local situations, rules and norms for the purpose of designing a database interface for an existing tenure information system management application.
The designed database interface will be used for storing and managing adjudication evidence.

Purpose of the Study:

The purpose of the study is to understand how rights to lands are secured in this area as well as to understand adjudication evidence that are generally acceptable in situation of land disputes. Your invitation to be a participant is because of your depth of knowledge on land issues in this area/ you own a land in this area.
Your contribution is greatly appreciated.

What Will I Be Asked To Do?

This interview takes about 30 minutes, if you agree to participate.

You will be interviewed on land registration, how rights to land are obtained or lost, the processes involved and some of the occupation and use problems associated with the land.

Upon request, you will be given the option to review information contributed within a time frame of 2 weeks after a transcript has been provided. I will accept that you are satisfied with the transcript provided if I do not hear from you within this time frame and hence carry on with what has been provided.

What Type of Personal Information Will Be Collected?

Should you agree to participate, you will be asked to give your gender, age, educational level, status in community, how and when you secured rights to land, and how you make a living.

A choice exists as per the provided check boxes below:

You can choose all, some or none of them. Please put a check mark on the corresponding line(s) that grants me your permission to:

I grant permission to be audio taped:	*Yes:* ___ *No:* ___
I grant permission to be photographed:	*Yes:* ___ *No:* ___
I grant permission to have my organization's name used:	*Yes:* ___ *No:* ___
I will like to review transcript of the information I provided	*Yes:* ___ *No:* ___
I wish to remain anonymous:	*Yes:* ___ *No:* ___
I wish to remain anonymous, but you may refer to me by a pseudonym:	*Yes:* ___ *No:* ___
The pseudonym I choose for myself is: _____	
You may quote me and use my name:	*Yes:* ___ *No:* ___

Are there Risks or Benefits if I Participate?

There are no risks involved when you participate in this research interview. The researcher will try his best to ensure that you will not experience any risk more than what you experience on a day-to-day basis.
This study does not provide any direct benefit to you but will provide you the awareness of how technology can be integrated into land tenure and adjudication evidences.

What Happens to the Information I Provide?

No one except my academic research supervisor - Dr. M Barry and member of my research team will be allowed to see or hear any of the answers to the interview questions or the interview tape.

The analogue or hard copy data are kept in a locked cabinet only accessible by the researcher and his supervisor. Digital data will be stored for five years on a computer disk, at which time, it will be permanently erased. The information will be used in researchers' theses and also published in academic journal articles. However, in all these, careful measures will be put in place to ensure you are not identified in any way should you choose to remain anonymous.

Signatures (written consent)

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information throughout your participation.

Participant's Name: (please print) _____

Participant's Signature _____Date: _____

Researcher's Name: (please print) _____

Researcher's Signature: _____Date: _____

Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact:

Irene Egbulefu
Department of Geomatic Engineering
University of Calgary, Alberta Canada
Tel 011-4039939111

Dr. Michael Barry
Department of Geomatics Engineering
Telephone +11 403 220 5826, mbarry@ucalgary.ca

If you have any concerns about the way you've been treated as a participant, please contact the Senior Ethics Resource Officer, Research Services Office, University of Calgary at (403) 220-3782; email rburrows@ucalgary.ca.

A copy of this consent form has been given to you to keep for your records and reference. The investigator has kept a copy of the consent form.

Appendix W2 Interview Guide

Personal Data

1. Age: …….

2. Gender: [ ] Male [ ] Female

3. Educational Background: [ ] Tertiary Level, [ ] Secondary/Commercial [ ] Middle/JSS, [ ] Illiterate

4. Occupation- ……..

5. Inheritance System practices: [ ] Patrilineal [ ] Matrilineal [ ] Both

6. Nativity: [ ] An Indigene [ ] Non Indigene [ ] [ ] Visitor, [ ] Stranger Specify: …….....

7. How long have you lived in Akabor Community .Years, ..Months ..Weeks .. Days [ ] From Birth

9. How many children do you have? ……. Male, …..Female

10. What is your position in this community?
[ ] Chief [ ] elder [ ] youth member [ ] Other..... [ ] Does not have a specific position

11. Describe how you came to live in the house/on the land you now live in and what you know about the history of land in this community.

Land Tenure Data

12. Do you have land? Yes / No. If **No, please go to Question 31; If Yes, Continue to Question13**

13. How did you acquire the land? [ ] Inheritance [ ] Gift [ ] Purchase [ ] Leased [ ] Borrowed
[ ] Others Specify……

14. Where is the land situated/located? [ ] This Community [ ] Neighbouring Town [ ] Other Region, Specify…….

15. What is your land use for?
[ ] Agricultural [ ] Grazing [ ] Residential, [ ] Fallow [ ] Subsistence Farming
[ ] Commercial [ ] Other purposes.....

16. What evidences do you have to show that the land belongs to you?

17. What are the other acceptable tenure evidences you know about in this community?

18. How do you preserve these evidences for future presentation or use when needed?

19. What are the laws that govern landholding in this community?

20. What kind of interest/right do/did you have in the land?
[ ] Allodial [ ] Customary Freehold [ ] usufructuary right [ ] Leasehold [ ] Tenancies
[ ] Licenses [ ] Use Right [ ] Others, Specify…….....

21. How do you demarcate the boundaries of your land portion from those of your neighbouring land portions?

22. Do have you have a written documentation over your land? [ ] Yes [ ] No

If **'Yes'**, what type of documents are they? What happens if you lose your document?

If **'No'**, why do you not have any documentation over your land?

23. What happens if you want to sell your land?

24. What happens to the land if you die?

25. What considerations would you accept for sale of your land? [ ] Money, Specify Amount…....
[ ] Drinks, Specify…..... [ ] In Kind Specify……..... [ ] others……

26. How do people secure their interest/rights in land?

27. Has there been changes in the land tenure system in this community? Yes/No. IF 'Yes' what are they?

Land Tenure Security and Dispute Issues

28. Have you registered your interest in land? [ ] Yes [ ] No
If 'No', what is the reason for not registering your land?

29. Do you think you can lose your land/interest to someone else? [ ] Yes [ ] No If 'Yes', Give the reason. If 'No', Why?

30. If someone comes up to claim ownership of your land, what would you do? How do you prove that the land is yours?

31. Are you aware of land disputes in this community?

32. How frequently do community members fight themselves over land boundary issue?
33. How were the disputes over land resolved?
34. What are the common causes of land dispute you know of in this community?
35. Are you aware of any boundary dispute between the Akabor community and any neighbouring community either in the past or present?
36. Was the dispute resolved amicable? [ ] Yes [ ] No If 'Yes' How was it resolved?