

**WEB – BASED CUSTOMARY LANDS INFORMATION SYSTEM FOR
CUSTOMARY LANDS IN GHANA:**

A CASE STUDY OF ASOKORE MAMPONG

BY

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DECLARATION

I hereby declare that this submission is my own work towards the award of Master of Science and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the university, except where due acknowledgement has been made in the text.

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ABSTRACT

Land is one of man's most important assets and its value cannot be over emphasized. Majority of land in Ghana are under the customary land classification and as such governed by the customary land law. Ready access to customary land information by its stake, plays an important role in the customary land delivery system

In Ghana, most land related litigations and problems are as result of multiple sales of a particular piece of land or buying a piece of land from a false owner, haphazard development, persecution of tenant-farmers, fraud and lack of accountability. These problems bring to bear the need for Customary Land Information System, which will inform Ghanaians in their customary land related decision making.

The main objective of this study is to develop a web based customary land information system for the study areas.

To achieve the objective of this research, a conceptual model of a web based customary land information system was developed after reviewing customary land related literature.

A prototype model of this conceptual model is developed with ArcGIS and MapGuide as the main software. The prototype is a model that makes customary land related information accessible through the World Wide Web on the internet.

With the web based application developed, the aim of the customary land secretariat to publicize customary land information is further achieved even to a wider audience as the customary land information is hosted over the World Wide Web.

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God Bless!

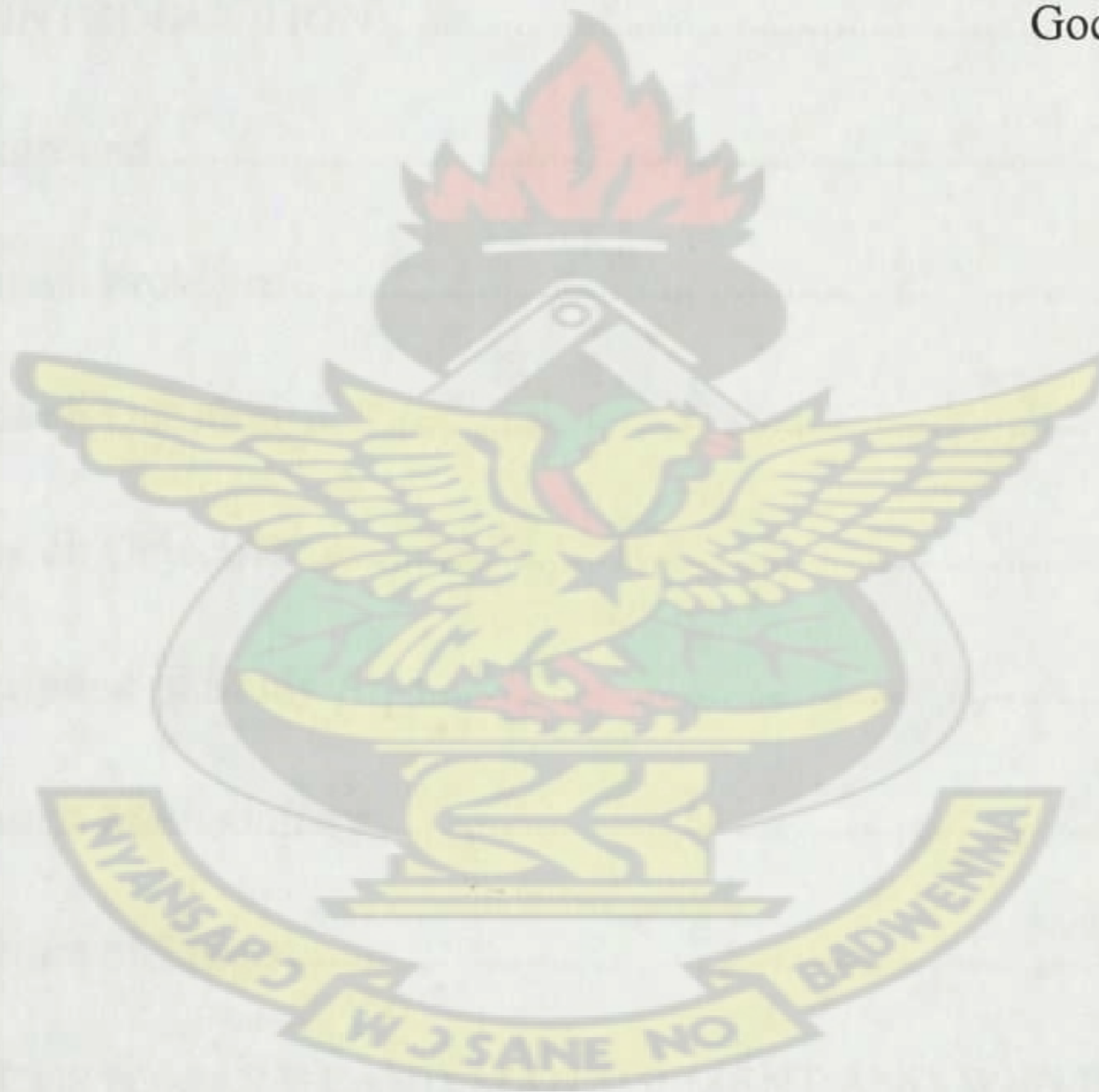


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ACRONYMS

ArcIMS	–	Arc Internet Map Server
ASP	–	Active Server Pages
CGI	–	Common Gateway Interface
CL	–	Customary Land
CLA	–	Customary Land Administration
CLIS	–	Customary Land Information System
CLI	–	Customary Land Information
CLS	–	Customary Land Secretariat
DFID	–	British Department for International Development
DGN	–	Design
DWG	–	Drawing
FTP	–	File Transfer Protocol
GIS	–	Geographic Information System
HTML	–	Hypertext Mark-up Language
IIS	–	Internet Information services
IMS	–	Internet Map Server
IMS	–	Internet Map Server
IP	–	Internet Protocol

IT	–	Information Technology
KNUST	–	Kwame Nkrumah University System
LAN	–	Local Area Network
LAP	–	Land Information System
LIS	–	Land Information System
NET	–	Network Enabled Technologies
PGIS	–	Participatory Geographic Information System
PHP	–	Hypertext Preprocessor
PNDC	–	Provisional National Defence Council
RAM	–	Random Access Memory
SDF	–	Standard Data Files
SHP	–	Shapefile
TCPD	–	Town and Country Planning Department
W3C	–	World Wide Web Consortium
WAN	–	Wide Area Network

CHAPTER 1: INTRODUCTION

1.1 Background

Land is one of man's most important assets and its value cannot be over emphasized. In Ghana land ownership can be classified into two main classes; public lands and private lands. Public lands are lands which are vested in the president for public use. Private lands are those owned by customary communities and those owned by private individuals. Customary lands are owned by Stools, Skins, Families or Clans and the heads of the respective groups hold the land in trust for the benefit of members of that group. Private individual ownership of land can be acquired by way of a grant, sale, gift or marriage. Majority of land in Ghana are governed by the customary land law as about 80% of the land falls under the customary lands classification (Alhassan, 2006). This makes the customary land system and its accompanying information very important in Ghana (Arko-Adjei, 2006).

Ready access to customary land information by all stake holders in customary lands, especially the general populace is imperative to the success of customary land administration in Ghana. In Ghana, most land related litigations are as result of multiple sales of a particular piece of land or buying a piece of land from a false owner. A common phenomenon is the presence of land litigation due to the ignorance of some traditional landholders to keep records of lands that has been allocated (Arko-Adjei, 2006).

Past governments have made a number of interventions to statutorily regulate the customary land tenure system in Ghana but it has not been successful (Mends & Meijer, 2006).

Land related conflicts and litigations, multiple grants of a particular parcel of land to different tenants, haphazard development, maltreatment of tenant-farmers, fraud and lack of accountability among others have over the years characterized customary land administration (Tagoe & Mantey, 2011). These problems bring to bear the need for customary land information system, as most lands in Ghana falls under the category of customary lands in Ghana.

1.2 Research Problem

Various researches have been conducted on developing access mechanism to improve land information.

Tagoe and Mante (2011) developed a web – based land information system for land property acquisition and registration information for land administration and management. The objective was to present a faster way of acquiring land as a property in Ghana, and also to provide a quick, secure and transparent access to land records and land registration via the internet.

Rakai and Williamson, (1995) considers the implications of incorporating customary land tenure data into a Land Information System (LIS). The emphasis was on the implications caused by the differences in individual land ownership and customary land ownership.

Lamptey (2009) used Participatory Geographic Information System (PGIS) to secure land tenure information on customary areas of Ghana.

So far, little work has been done on developing and presenting customary land information on the web.

This research seeks to develop a web based Customary Land Information System. This aims at making customary land information accessible to the public through the internet, thereby improving access to land and administration of land in Ghana in general.

1.3 Research Question

The main question that this research seeks to answer is how the customary land information of Ghana can be made accessible to all by using the internet through the World Wide Web.

Specific questions;

- What are the components of the customary land delivery system and the information system involved?
- What are the ideas involved in developing a web based customary land information system from the components of the customary land delivery system?
- How can a web based customary land information system be developed?

1.4 Research Objective

The main objective of this study is to develop a web based land information system for the customary areas of Ghana.

Specific objectives

- To analyze customary land delivery process and the components involved in the land information system
- To develop a conceptual model of a web based customary land information system

- To develop a prototype web based land information system for customary areas of Ghana

1.5 Description of Study Area

Asokore Mampong, which is the capital of the newly created Asokore Mampong District located in the Asanti Region of Ghana was chosen as a study area. Asokore Mampong was selected as the case study area due to the fact that, it falls within the customary land category and the chief of this place is cooperative when it comes to land development related issues. Asokore Mampong is one of the places with a good customary records keeping system in Ashanti Region and this will help prevent the inclusion of other problems such as lack of information to the research. Although this can be said about Asokore Mampong, there are still difficulties in land related transactions pertaining to information flow.

The town is bordered by Ayigya and Boadi which are along the Accra – Kumasi road. It is estimated to be along longitude $1^{\circ}34'$ and latitude $1^{\circ}42'$ within the central part of the region (Fig 1.1). The land is part of the Ashanti stool lands, thus a customary land and used mainly for residential purposes.

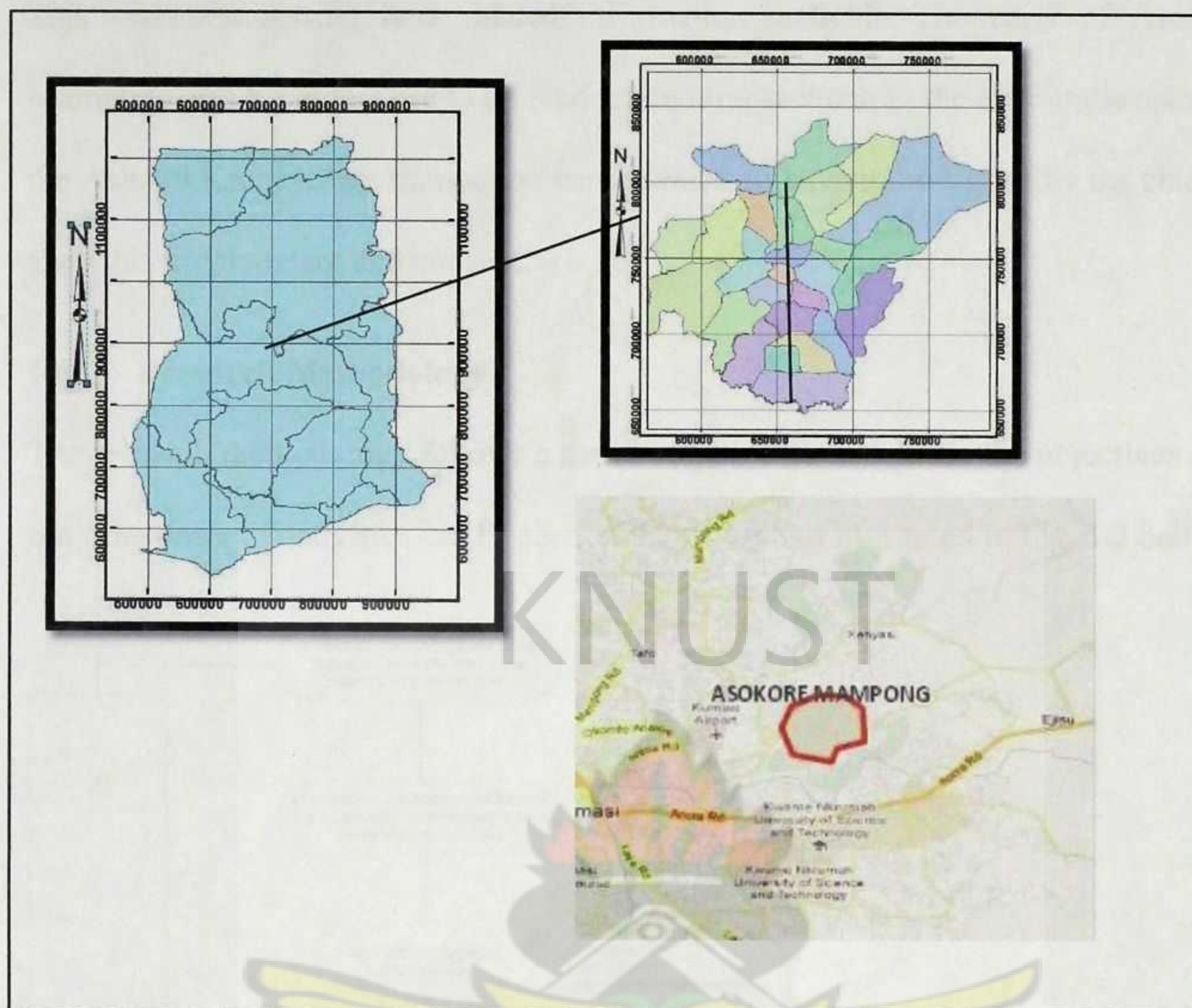


Fig.1.1: Study Area.

Asokore Mampong is a residential area for workers of various companies in Kumasi. It also has hostels that are available to serve the students from the Kwame Nkrumah University of Science and Technology, (KNUST). Land in this area has high market demand as the area is well planned.

When any one wishes to have interest in a land within the area, he is expected to:

- See the chief in person for the most reliable information to make an informed decision on the land.
- Deal with the chief directly in transactions if the interest in the land has not been transferred from the chief's name or,
- Deal with any other party who may have the highest interest in the land.

This makes accessing land related information difficult. The chief of Asokore Mampong and his elders see to all land related transactions in the area in the name of the Ashanti King. Every transaction carried out will have to be signed by the chief to show his involvement and consent.

1.6 Research Methodology

The research methodology follows a series of activities to achieve the objectives set out. The order of activities can be seen in the flow chart presented in Fig. 1.2 bellow.

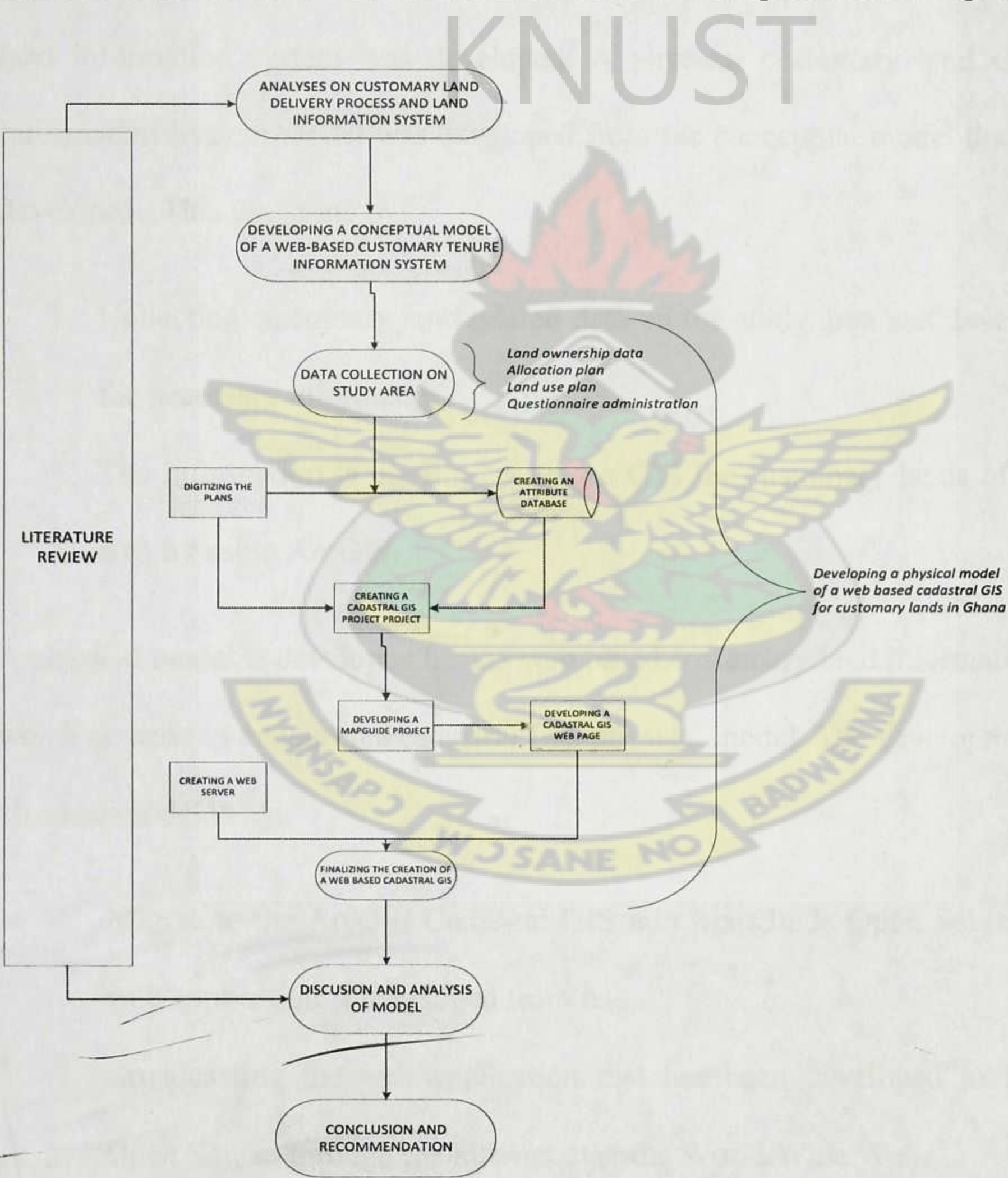


Fig. 1.2: Research methodology.

The research methodology begins with a review of various literatures on customary lands delivery and land information system in Ghana. The literature presents the state of customary information system, and it leads to defining the research problem. The literature is further analysed for ideas on how these defined research problems could be solved. Literature on web based information system is then reviewed as the research resorted to using a web based information system to solve the problems.

To help solve the research problems, a conceptual model of a web based customary land information system was developed. A physical customary land Geographic Information System model was developed from the conceptual model that had been developed. This was done by;

1. Collecting customary land related data on the study area and developed into the necessary information.
2. The information is used in creating a GIS for customary lands of the study area by using ArcGIS.

A physical model is developed for the web based customary land information system which is made to contain the cadastral GIS physical model. The development of this physical model is by;

1. Migrating the ArcGIS Cadastral GIS into MapGuide Open Source where a web application is developed from it.
2. Broadcasting the web application that has been developed in MapGuide Open Source through the internet over the World Wide Web.

The physical model is then discussed relative to the literature review and the research problem. Conclusions and recommendations are made to finalize the research.

1.7 Structure of Thesis

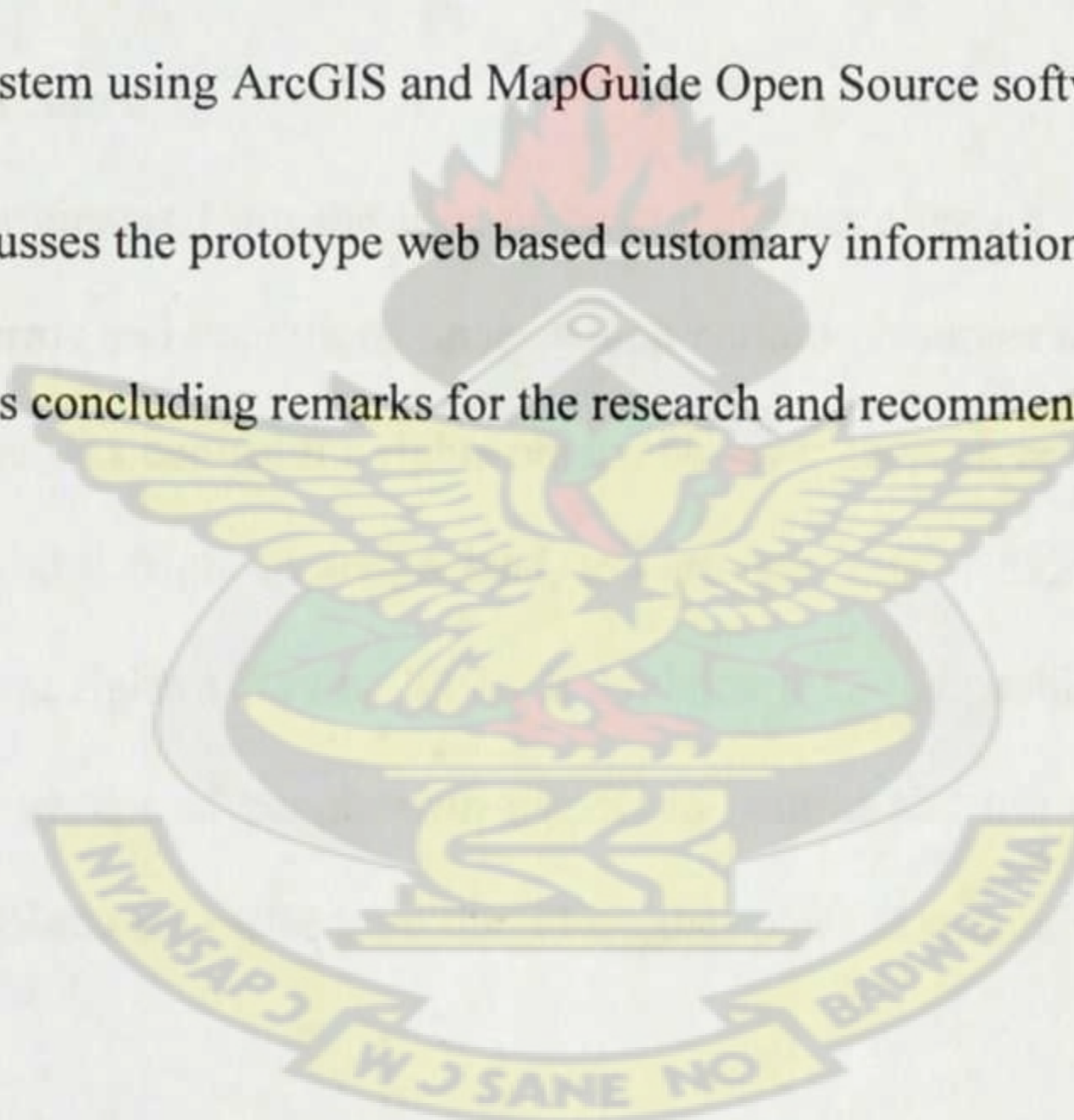
Chapter one gives an introduction.

Chapter two presents a review of literature on customary land tenure and management as well as literature on web – based Geographic Information System.

Chapter three discusses the procedures for developing a web – based customary information system using ArcGIS and MapGuide Open Source software.

Chapter 4 discusses the prototype web based customary information system.

Chapter 5 gives concluding remarks for the research and recommendations.



CHAPTER 2: CUSTOMARY LAND MANAGEMENT AND WEB BASED INFORMATION SYSTEM

2.1 Introduction

This chapter reviews literatures that are of much significance to the research. The literatures include materials on land tenure and management in Ghana with great emphasis on customary lands. The chapter also reviews literature on web based information system with interest in where the information involved is geo – information.

2.2 Land Tenure

Land tenure originates from the idea of natural resource tenure, which in essence refers to the terms and conditions under which natural resources are held and used. Land tenure systems control the rights obtainable over each piece of land, including “operational” rights (right to access land, to cultivate it, to withdraw produce, etc.) and management rights (Cotula, 2007). It explains the relationships that exist both intra and inter groups of people with respect to control and use of land. The land tenure of one place may differ from that of another place (Economic Commission for Africa, 2004).

Two common land tenure systems in Africa are the freehold and leasehold systems. Freehold land tenure is considered to provide absolute ownership rights, implying the right to own, control, manage, use and dispose of property (Larbi, 2008).

Freehold rights may be expropriated by the state through the laws of the land for public interest such as road construction. ‘Leasehold’ land tenure is established on the concept of rentals—for long periods during which the lessee may exercise rights that are equal to that of the freeholder over the said land for the lease period.

Land belonging to one entity is by contractual agreement leased to another entity. Such leases can have varying durations. In practice, a ninety nine (99) year lease is often the longest duration of lease given and also considered to be as safe as the freehold. The lease agreement is then registered against the title of that land to create real land rights that are enforceable by law (Economic Commission for Africa, 2004); and Ghana is no exception, relative to these practices.

In Africa, freehold and leasehold land rights are usually associated with large-scale farming and elite land ownership administrations. Considering the amount of acknowledgment given by most African state to the freehold tenure system through customary laws, it is usually seen as the most secured land tenure (Economic Commission for Africa, 2004). The customary laws define the nature of customary tenure in Ghana.

2.2.1 Customary Tenure

In customary tenure, the families enjoy spatial and temporal right of use and or access over land as defined by the freehold land tenure system. These rights are passed on from generation to generation depending on the prevailing rules of succession (Ubink, 2008). The transfers of these rights are by gift or inheritance with all members of the inheriting party sharing a part of the rights.

Usually, tenure under customary lands does not allow any individual to have exclusive rights in land, thus no single person can claim total ownership of land as the whole land belongs to the community. Land is considered to be heritage for the whole community. Customary lands in Africa are mostly established with the idea of it being an ancestral trust. The lands are deemed to belong to a big family with many of its members dead, a few living and a vast majority unborn (Mudenda, 2006). The

living is entrusted with the land to safeguard it for the benefit of the unborn generation and this task is spearheaded by the customary leaders.

2.2.2 Characteristics of Customary Tenure

Customary tenure over a piece of land is held by a community, in a situation where a customary right is held by an individual, he does so for the benefit of a community. If the individual exercising the customary rights over the land abandons the right, the right is reverted to the community in whose name the individual held the right. Although each member of that community has a part in the right to the land; there are often different levels of rights reserved for different individuals in the customary community. There may also be different types of right enjoyed by different individuals on a piece of land at a particular point in time. There is the introduction of restrictions when these rights are being transferred to outsiders; an example of this is when the land is leased (AusAID, 2008).

Customary land tenure is subject to changes caused by evolution. Poor features of the tenure are eliminated and the beneficent ones are upheld (Kalabamu, 2000), this practice helps with the development and proper management of customary lands.

2.2.3 Customary Land Management

The management of customary lands is a responsibility of the customary leadership institution or authorities. The leadership groups are of members whose validity emanates from 'both anteriority of presence (the founders, or those who define themselves as such) and acknowledgment of the "magico – religious alliance" that they have created with the natives on the one hand and with governmental forces on the other' (Cotula, 2007). These institutions may comprise of the heads of a Stools, Skins, families or priest. They are consequently placed in charge of the land within

their areas and are task with responsibilities relative to the land which makes them accountable for land to their subjects and other stakeholders.

The customary institutions reserve the right to deny or grant access and or use of the land and resource. They implement rules that will protect the resource as well as develop them for the benefit of the subjects (Cotula, 2007). It is also a part of their responsibility to avail information to the general public to help reduce land litigation.

2.3 Land Administration in Ghana

As per Ghana's constitution, Ghana acknowledges two land tenure systems, being the public and customary land tenure systems (Water Aid, 2009). Most of Ghana's lands fall under the customary authorities' control. This is because majority of the lands falls under the customary tenure system. It is generally accepted that, all the lands in the name of the state are lands that have been acquired through lawful proclamation, ordinances, statutory procedures or international treaties from customary communities (Kuntu-Mensah, 2006). This is an example of transfer of interest in land, as it has been transferred from the ownership of customary societies to that of the public.

The laws of Ghana make provision for the registration of interest in land under the land title registration law 1986 (PNDC Law 152). Different types of interest in land may be registered with the following interest inclusive: freehold, leasehold, abunu and abusa. Practically, the usefulness of the law is not experienced properly throughout the country as the law is often poorly implemented in the rural areas since its establishment (Kakraba-Ampeh, 2008).

As often practiced in Ghana, the leadership by the customary authorities are much prevalent in the rural areas. In the rural areas, boundaries are mostly delineated with trees, hills and other features whose longevity may not be reliable.

The customary land administration in Ghana has various problems including poor delineation of boundaries, multiple grants of the same parcel of land to different tenants, persecution of tenant-farmers, haphazard development, fraud and lack of accountability among others. Poor records keeping on rights and interest is one of the customary land administration's biggest problems (Arko-Adjei, 2006). Currently the government of Ghana has the Land Administration Project (LAP) running, which involves measures to improve the administration of customary lands in Ghana.

2.3.1 Land Administration Project

Ghana's (LAP) is a project that has the main aim of building a better land administration and management systems that will enable a simple, efficient and transparent land related service delivery in Ghana. The services include land and property registration, land use controls and land taxation and litigation resolution, environmental management, human settlements planning, transportation and communication infrastructure planning, land market, health, education, governance, social welfare and tourism development among others (LAP, 2012).

LAP is built on four main components, namely:

1. Harmonizing land policy and regulatory framework for sustainable land administration
2. Institutional reform and development
3. Improving land titling registration, valuation and information system and
4. Project management, monitoring and evaluation

To attain the second component being Institutional reform and development, it is divided into five sub-components, with “Strengthening Customary Land Administration (CLA) through Customary Land Secretariats (CLS)” as one of them (Antwi, 2006).

It is the aim of the LAP to build a reliable, pleasant and transparent customary land administration system. This goal if achieved will be the basis for a better land administration system in Ghana relative to LAP’s main aim, as majority of Ghana’s lands are within the customary land category (Ubink, 2008).

The Sub-component of strengthening the (CLA) through the (CLS) is funded by the British Department for International Development (DFID). The major results that DFID seeks to achieve as per its project manual stated from Antwi, (2006) are:

1. CLS established and/or strengthened in pilot areas, in partnership with government land sector agencies;
2. Improved quality of records and accessibility of information at CLS level on land use and holdings, land transactions and availability, and associated financial and cadastral records;
3. Improved CLS accountability, in line with the Constitutional provisions, in a way that protects the rights of all land holders within their communities, recognizes the community interest in land management, and provides an effective interface with democratic local and national government.
4. Policy development better informed. The implementation of the Land Policy by way of the LAP will involve further policy development in order to realize its key goals. The information that this component generates, in relation to

CLSs, will be actively managed in order to ensure that the process can be developed in the light of the best possible knowledge.

2.3.2 Customary Land Secretariat

CLSs are decentralized land administration units established and owned by land owning communities who are recognized by the constitution as managers of their own lands in accordance with customary practices and usage under LAP (LAP, 2012). The functions of Customary Land Secretariats include:

1. Provision of customary land information to the public – ownership, rights, use, etc.
2. Keeping and maintaining accurate and up to date land records including fees and charges associated with land grants.
3. Serving as the link between the land owning community and the public sector land agencies, District/Municipal/Metropolitan Assemblies, Environmental Protection Agency, plot allocation and town development committees, applicants, the Land Management Committee, etc.
4. Preparing periodic reports on all activities of the Secretariat.

The CLS at certain places perform additional duties such as collection of ground rent, sensitization of local communities on land issues in their areas of jurisdiction and the provision of social services and infrastructure such as lorry park, market stalls etc. (LAP, 2012).

After completing the first five years of the LAP, the project can boast of a total of ten (10) CLS. Three out of the ten existed before the LAP but has been reinforced to achieve its goals, these three are the: Asantehene's Land Secretariat in Kumasi, Okyehene's Land Secretariat at Kyebi and Gbawe Kwartei Family Land Secretariat

at Gbawe, in Accra. The seven new CLS are distributed such that each region can have one. The CLS is mainly responsible for information coalition, management and its dissemination (LAP, 2012).

2.4 Web Based Information System

An information system may refer to the combination of people, processes, data and technology that support operations, management and decision making. The activities of an information system are mainly capturing, transmitting, storing, retrieving, manipulating and displaying information (Beynon-Davies, 2009)

An Information System (IS) according to O'Brein and Marakas (2010) consists of five basic resources, namely:

1. People, which consists of Information Technology (IT) specialists (such as a Database Administrator or Network Engineer) and end-users (such as Data Capture Clerks).
2. Hardware, which consists of all the physical aspects of an information system, ranging from peripherals to computer parts and servers.
3. Software, which consists of System Software, Application Software and Utility Software.
4. Data, which consists of all the knowledge and databases in the IS.
5. Networks, which consists of communication media and network support.

Web based information system is an information system that employs the internet to extend information and services to its users. It is purported to publish and maintain data by using hypertext-based principles.

A web based information system usually consists of one or more web applications, specific functionality-oriented components, together with information components and other non-web components. A web browser in a web based information system usually works as the front-end with a database as the back-end (Ian & Norman, 2004).

2.4.1 Web Based GIS

When the information involved in the web based system is a geographically referenced information, then the system may be referred to as a web based Geographic Information System (GIS).

Spatially referenced data over a long period of time have been presented in the form of maps, both digital and paper. In presenting spatial data (eg. maps) through the web, it is necessary to use an internet map server.

Internet Map Server (IMS) applications allow GIS database custodians to make their spatial data accessible through a web browser interface to end-users. High-speed corporate intranets make an ideal network for distributing data in this manner, given the fact that bandwidth requirements can be high. Making data available to the entire world is certainly feasible and any organization that has a public website can certainly add an IMS without opening up too many additional security holes (Yoon-Seop & Hyeong-Dong, 2004).

There are different ways to publish land related information such as map data on the web. The maps could be static, dynamic or interactive. In terms of Web GIS, the most challenging map is the interactive. The maps and other related information that are published on the web may be useful in various ways due to the different characteristics of web GIS such as the software used (Paynter & Pearson, 1998).

Users of a web GIS may be able to perform various activities such as; data display, query and analyse geographic data based on the qualities of the software used.

Web GIS is now extensively used by both the public and the private organization because of several benefits that they derive from it, including:

1. Its relative lower cost incurred by the user,
2. Its accessibility as it is used over the World Wide Web or intranet.
3. The opportunity of using most of the basic GIS functionalities remotely
4. The fact that a greater audience is reached through the web
5. Users typically do not need extensive training

Although users of a web GIS enjoy these benefits, the web GIS has its own demerits. The demerits of the web GIS may be the cost incurred through the far-reaching response time caused by factors such as connection capacity, data volume, network traffic, and processor power.

The above mentioned characteristics of the web GIS are mainly because of the components that come together to form the web GIS. The nature of the components defines how useful the web GIS system may be to the user.

The components of a typical web GIS includes data, software, hardware, human beings, set of procedures and methods, and network.

Human beings

- Developers – this includes the IT specialist whose job is to create and manage the system

- Users – the people who are at the receiving end making use of the web GIS

Data

- Spatial data – this is the type of data that has a positional element and has been stored in web file format (eg. SHP, DWG, SDF, DGN) or stored in a spatial database (e.g. Access, Oracle Spatial, Oracle Locator, SDE)
- Attribute data – It refers to the properties of map features that have been stored as textual or tabular data and usually in a relational database

Hardware

- Central server computer
- Client computers
- Connection through the Internet or intranet sites, through a Local Area Network (LAN) or Wide Area Network (WAN)

Software

- Web GIS server application – eg. MapGuide server
- Server middleware – to interpret requests from clients, interact with the web GIS application and package the data for transfer via the web
- Web server – e.g. Apache, Internet Information Server
- Client web browser – e.g. Internet Explorer, Mozilla, Opera
- Client-side applet or plug-in – requirement depends on the technology
- Web-database application software – e.g. PHP, ASP.NET,

A proper creation of a web GIS through the use of these components will ensure achieving the aims of the web GIS. A major aim of a web GIS is to make the information it publishes accessible to its users.

2.4.2 Access to Web Information

Access to full or partial information presented by the web GIS can be influenced by certain factors. These factors may include the web browser used by the user, design of the web site, client plug – in software, cartographic aids, map tips and reference maps.

2.4.2.1 Web Browser

Hypertext Mark-up Language (HTML) is the standard for creating a website. The code tells a web browser where to find and how to display information. Using standard HTML as defined by the World Wide Web Consortium (W3C) will ensure that the content can be accessed by all browsers used by visitors to the site. Tags, features, and plug-ins that are available to only one brand or version of a browser should be avoided as much as possible. This is to ensure that all users irrespective of the browser being used can access the information over the internet.

There are also other languages for creating a web site that may not be accessible by all web browsers. It is therefore advisable for users to use internet explorer as it is widely known to render most languages for creating a web site.

2.4.2.2 Consistency

A consistent design and appearance makes the web site user friendly and the user is able to locate the specific information relatively easier. A clear, consistent presentation will especially assist people with visual impairments or learning disabilities who have difficulty using disorganized navigation schemes. For example,

a feature presented on every page, such as a standard navigation menu or button for the site, should always appear in the same place. It is better to keep backgrounds simple and ensure there is enough contrast.

2.4.2.3 Client Plug-In

Closely tied to the data model used for data delivery, is the requirement for additional software to enhance the functionality of the client web browser. Although whether or not a viewer plug-in is required may seem like a trivial detail, it is actually a key consideration in the implementation of Web GIS. Whether or not a plug-in will be a benefit or detriment depends mostly on the nature of the intended audience.

Specialized audience (such as municipal staff) – a plug-in provides the benefits of moving more of the processing to the client machine and reducing work load on the central server since some operations can be handled on the client side (e.g. zoom in and selection of features). The amount of effort for the actual installation of the plug-in can also be minimized in a networked environment. Once loaded, greater functionality will be available and will be handled more quickly with a plug-in, although slightly more time may be required for the initial load when accessing the web GIS site.

General audiences (such as the public) – the requirement for a plug-in is a nuisance and will often deter casual users from using the site since their dependence on the GIS is limited. The initial load is typically faster without a plug-in, but subsequent operations are usually slower.

Many web GIS applications offer both thick and thin client options. Some applications can make use of a mixed model, with some data transferred as rendered

imagery (e.g. background map) and some data (e.g. vehicles in a linear network) transferred as vector data (Bonnici, 2005).

2.4.2.4 Cartographic Aids

The limited view area and resolution of most computer monitors, especially in relation to large format paper maps, reduce the effectiveness of the communication. A couple of simple GIS features that help to alleviate this limitation are the map tips and the reference map (MapGuide, 2001).

2.4.2.5 Map Tips

The quality (and therefore the readability) of annotation suffers primarily because of the limited resolution available for map display on a computer monitor. Map tips, which function like tool tips to provide additional information when the screen pointer hovers over an object, can be used to display attributes of map features dynamically, thus minimizing the amount of required text and aiding readability (MapGuide, 2001).

2.4.2.6 Reference Map

GIS users must typically strike a compromise between detail and coverage, i.e. a “zoom-in” view showing lots of detail with limited coverage or a “zoom-out” view showing greater coverage and limited detail. A reference map can be used to help overcome this limitation by displaying current view extents in relation to the overall coverage, and in some cases, allowing the user to control the view extents by manipulating their representation on the reference map (ArcIMS, 2001).

Customary Land (CL) information can be made accessible to the general public and other stakeholders through a web GIS.

2.5 Web Based Customary Land Information System

The spatial data involved may delineate boundaries of plots as well as roads and other natural features within the customary area. The attribute data may describe the features whose spatial locations have been defined by the spatial data (eg, land use, land owner, ownership type and lease).

Development of the Web based CLIS provides two key capabilities that can greatly help the stakeholders of customary lands in Ghana. First, the Web allows visual interaction with data. The information is hosted on a web server and this will enable clients produce maps. Secondly, publishing customary information by the web GIS will enable the information reach a much greater audience, because of the near ubiquitous nature of the Internet, the geospatial data can also be widely accessible. Clients can work on it from almost any location. These features will improve access to customary land information in Ghana. The combination of ease of access to data and visual presentation of it addresses some of the primary difficulties in performing geosciences evaluations (Gillavry, 2000), as well as the land administrators performing some administrative functions.

CHAPTER 3: DESIGNING AND MODELING OF A WEB – BASED CUSTOMARY LAND INFORMATION SYSTEM

3.1 Introduction

This chapter discusses how a web – based CLIS was developed. The designing and modeling are based on information on the management and administration of customary land information system in Ghana. The first four sections discuss the conceptual model of the web based CLIS while the last section discusses the physical model of the web based CLIS.

3.2 User Requirements

Different kinds of data were needed to successfully develop the web based CLIS.

The following Materials and data were used:

- Allocation plan of the study area (Asokore Mampong)
- Information on land ownership in the said area.
- Land use map of the steady area.
- Apache Web Server
- Map Guide software
- ArcGIS (GIS software)
- Web Browser
- Computer with the minimum specifications of
 - 1GB Ram
 - Internet Information services (IIS)
 - Web browser (any one)
 - Internet explorer (recommended)

- Safari
- Opera mini
- Fire Fox
- Internet connection

To ensure that the information to be publicised on the web is the type that users of the CLIS need for decision making relative to customary lands, a survey was carried out in the study area. Respondents to the questionnaire were occupants of the land parcel digitized and the chief of Asokore Mampong. The feedback from respondents through the questionnaire showed the kind of information to be put online to help users of the CLIS in customary land related decision making. The information of interest were converted into formats that were useful in development the system.

3.3 Information Flow

Web based CLIS is purported to serve a wide range of stakeholders of customary lands in Ghana. Some of the stakeholders provide information to the system while others access information from the system. The stakeholders include the Customary Land Secretariat, Lands Commission, Survey and Mapping Division of Land Commission, Town and Country Planning, Traditional Council and the general populace. The application is to be hosted by the CLSs, as they have the duty to avail information on the customary land of Ghana to the public.

There are some of the stakeholders who may have to make inputs to the CLIS other than the CLS. Although different stakeholders of the CLIS provide information for the CLIS, only the CLS is expected to update the CLI directly with the other stakeholders doing so indirectly through the CLS. This is to be done to ensure the security and reliability of the information presented.

The proposed information flow may be the:

- Lands Commission provides the CLIS with information on state lands and any land parcel expropriate for the interest of the state as well as the information on registration of land as a property. The information from the lands commission is added to the CLIS through the CLS.
- Survey and Mapping Division of Land Commission provides the CLIS with positional data such as boundaries as well as length and location of feature within the customary area in the form of layout plans, base maps, and cadastral plans through the CLS. The Survey and Mapping Division of Land Commission receives information like feedback and inputs directly from the general public.
- Town and Country Planning Department is to provide the CLIS with town planning and or land use planning information of the customary areas through the CLS. The town planning information is sent to the CLS for it to update the CLIS. Feedback from the general public may be given to the town and country planning department directly.
- The Traditional Council is to provide information on customary land ownership in rural areas.
- The general public may obtain information about customary lands from the CLIS and give feedback information to the respective stakeholder, describing how the CLIS may be improved. All stakeholders at a point may use the CLIS as part of the general public.

- The CLS ensures the effective running of the CLIS. The CLS receives information from all the stakeholders in the form of feedback or corrections and updates. The CLS is to regularly update the CLIS to give a true picture of the customary lands in the customary area. Fig 3.1 shows the interactions among the various stakeholders.

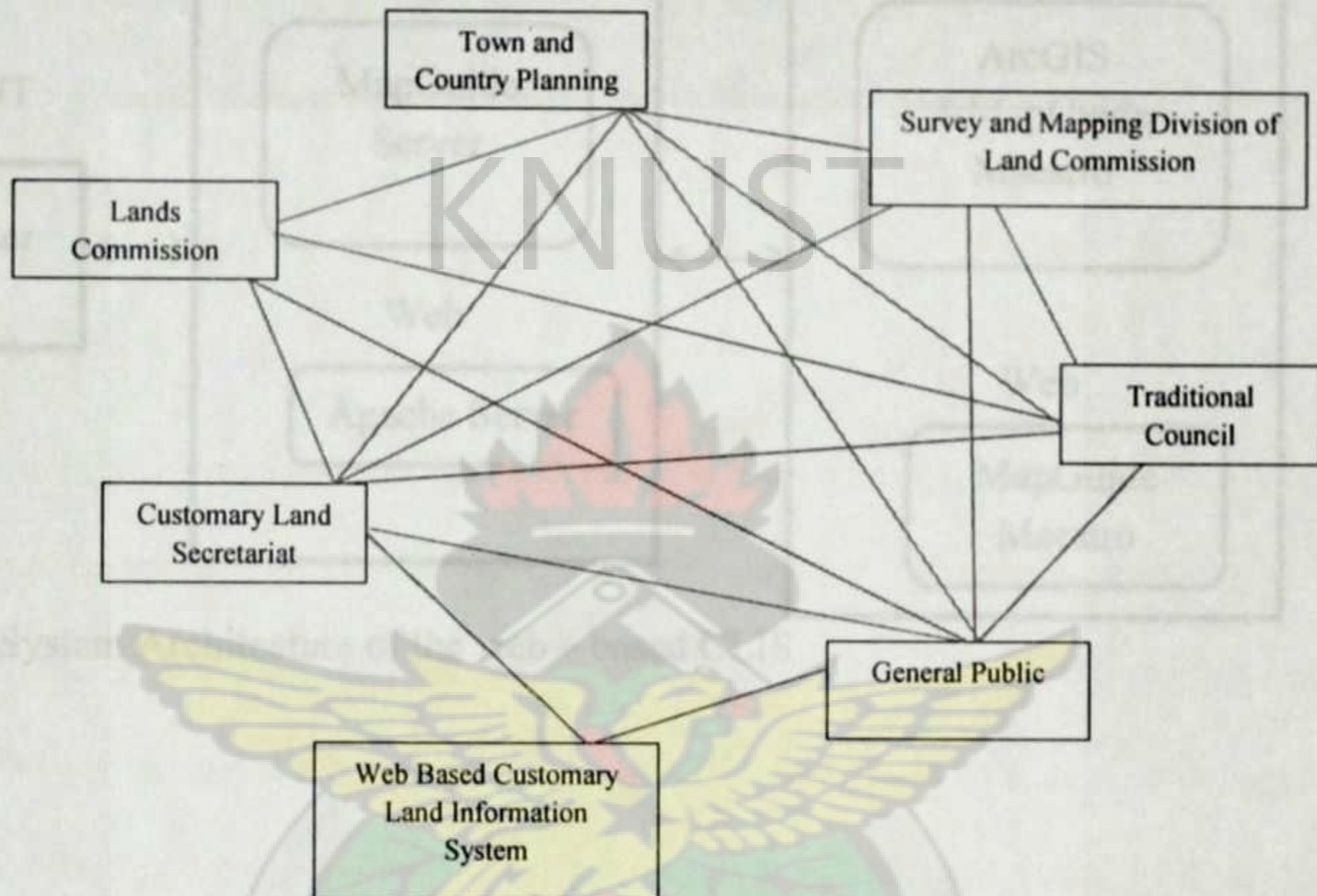


Fig. 3.1: Interaction among stakeholders and the web based CLIS

3.4 System Architecture

The system architecture comprise of three main components; client, services and data processing. Fig 3.2 shows the system architecture of a web – based CIS.

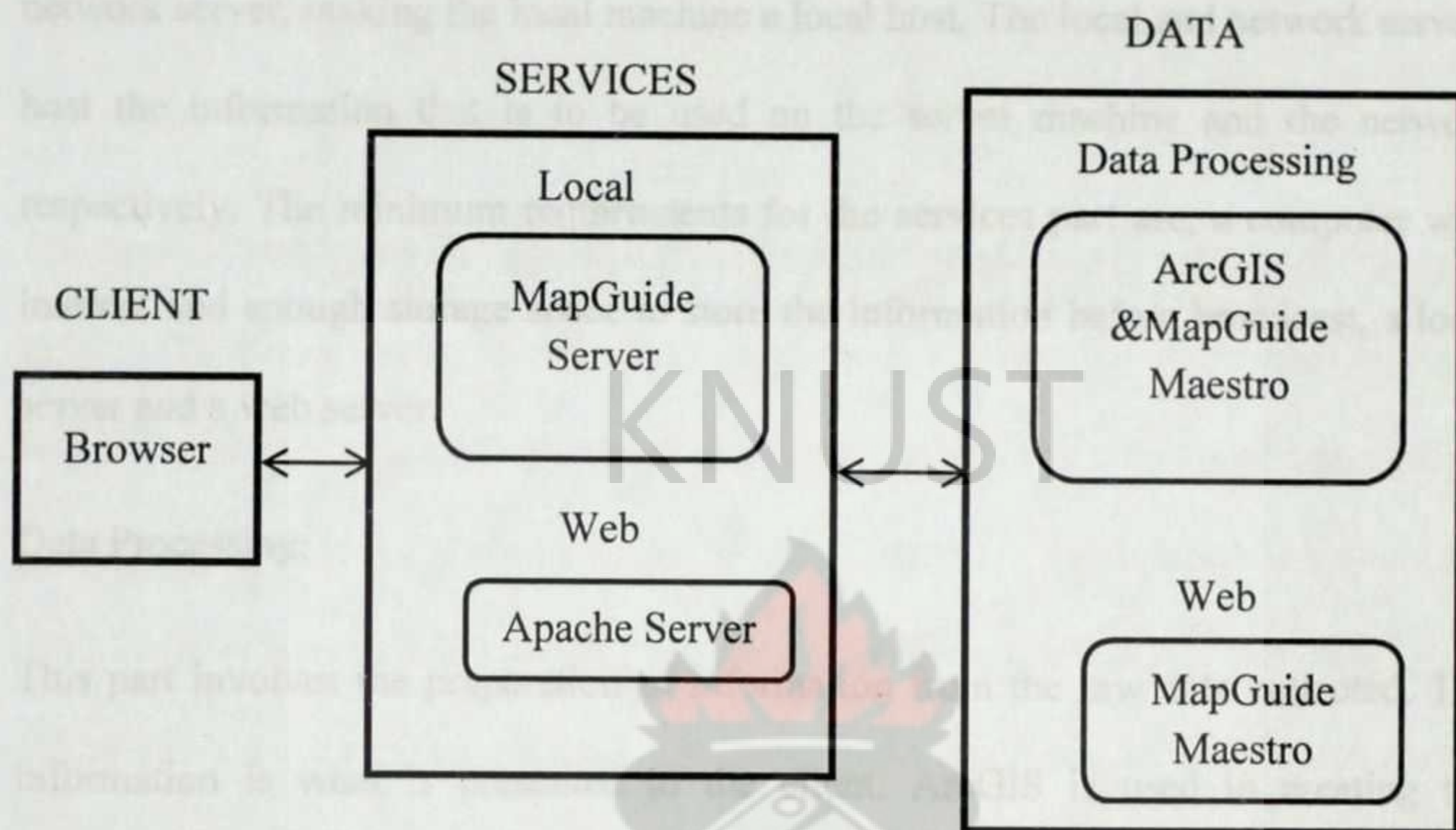


Fig. 3.2: System Architecture of the web – based CLIS

Client:

This refers to the end user's part and it is the output point of the system. This is the point where information that is being publicized can be seen. The major requirement is a web browser; which is very common as Microsoft provides internet explore for all Microsoft user for free. There are other web browsers such as opera, mozilla and google chrome. The minimum requirement for the client is a computer that can surf the internet with any of the mentioned web browsers. There is information flow between the client and the services. The browser receives information from the servers and presents it to the user while sending request commands from the user to the server.

Services:

This part provides services for the system to run, both locally and over a network. MapGuide server works as the local server whilst Apache server works as the network server, making the local machine a local host. The local and network servers host the information that is to be used on the server machine and the network respectively. The minimum requirements for the services part are; a computer with internet and enough storage space to store the information before broadcast, a local server and a web server.

Data Processing:

This part involves the preparation of information from the raw data collected. The information is what is presented to the client. ArcGIS is used in creating the shapefiles along with the spatial data and the attribute data in developing an information system for customary lands. MapGuide maestro is first used to enhance the visual effects of the customary land information and secondly used to develop the web layout and the web application for the broadcasting of the customary information. The minimum requirement for the data processing part are ArcGIS, MapGuide Maestro and a computer with; internet, enough storage space, high processing capacity and high random access memory.

3.5 Developing A Web Based GIS

3.5.1 Preparation of Maps

The data pertaining to plots in the form of a paper map and their respective attribute data were obtained from the chief of Asokore Mampong. Shapefiles for the various

features and themes to be shown in ArcGIS were created in ArcCatalog 10. The shapefiles were for; Plots, Roads, Cultural Points, Land Use and Boundaries.

The layout plan used for plot allocation was georeferenced and digitised in the ArcGIS environment. The object of interest whose shapefiles had been added were digitized from the georeferenced image.

The attribute tables of the shapefiles were updated in ArcCatalog by defining more fields. The tables were populated to give more information about the digitized features. The information were those that would satisfy the interest of users of the CLIS as proposed by the questionnaire administered. The information from the questionnaire was collated and the features with much occurrences were used. The information include; plot number, plot size, block, purpose of land, land owner, market status of land, location of land, district and region

3.5.2 MapGuide Services

A server usually refers to a physical computer devoted to host one or more services. It may sometimes refer to a computer programme that serve other programmes or a programme that operates as a socket listener in terms of Internet Protocol (IP) networking. Servers often provide essential services across a network, either to private users inside a large organization or to public users through the internet (Vangie, 2012).

A local server plays a pivotal role for most web developers. It allows development and testing on a local machine without the concerns of losing internet connection, accidentally creating temporary security holes, or constantly uploading files via FTP. Depending on the options chosen, setting up of the local server may vary in difficulty, but it is a necessary foundation for a web based developing environment.

In this research, MapGuide server was used as the local server and it is mainly because it is an open source programme. The computer that was used had its administrative settings changed to accept MapGuide as the local server. The administrative settings that were changed included:

- Admin connection port to 2810
- Site connection port to 2811
- Web connection port to 2812
- Stating the developing environment as PHP
- Giving the MapGuide server site server IP address as 127.0.0.1

3.5.3 Mapguide Maestro Project Creation

MapGuide Maestro was used to deploy the GIS project created in ArcGIS unto the web. MapGuide Open Source is a web – based platform that enables users to develop and deploy web mapping applications and geospatial web services. MapGuide has an interactive viewer that includes support for feature selection, property inspection, map tips, and operations such as buffer, select within, and measure (MapGuide, 2001).

Upon running MapGuide Maestro programme, a new working folder (ASOKORE MAMPONG) was created with sub folders: “DATA, LAYERS, SYMBOLS, MAPS and LAYOUTS”. As the names of these folders implies, they contain data, layers, symbols, maps and layout respectively that were presented on the web.

3.5.4 Mapguide Maestro Project Preparation

The ArcGIS project created was migrated into MapGuide maestro. The shapefiles created were added as resources to the “DATA” folder in MapGuide maestro and the coordinate system of the added resources were specified as Ghana_Meter_Grid in MapGuide maestro. The procedure for loading the shapefiles was saved and the “Load Resources” button was clicked to get the shapefiles unto the local server. Properties of the features that are to be presented in the web viewer for each layer were checked to be shown in the web viewer. These properties were modified as in colour and line weight to improve the graphical presentation (Fig 3.3).

There was the need to combine all the features into one map. A new map was defined into the “MAP” folder as a new resource and all the features were added to that map. The layers of these features were arranged in an order such that all the features can be seen at the same time if necessary, but the raster layer showing pictorial view of the area is made invisible to improve performance and the user is allowed to turn it on if desired.

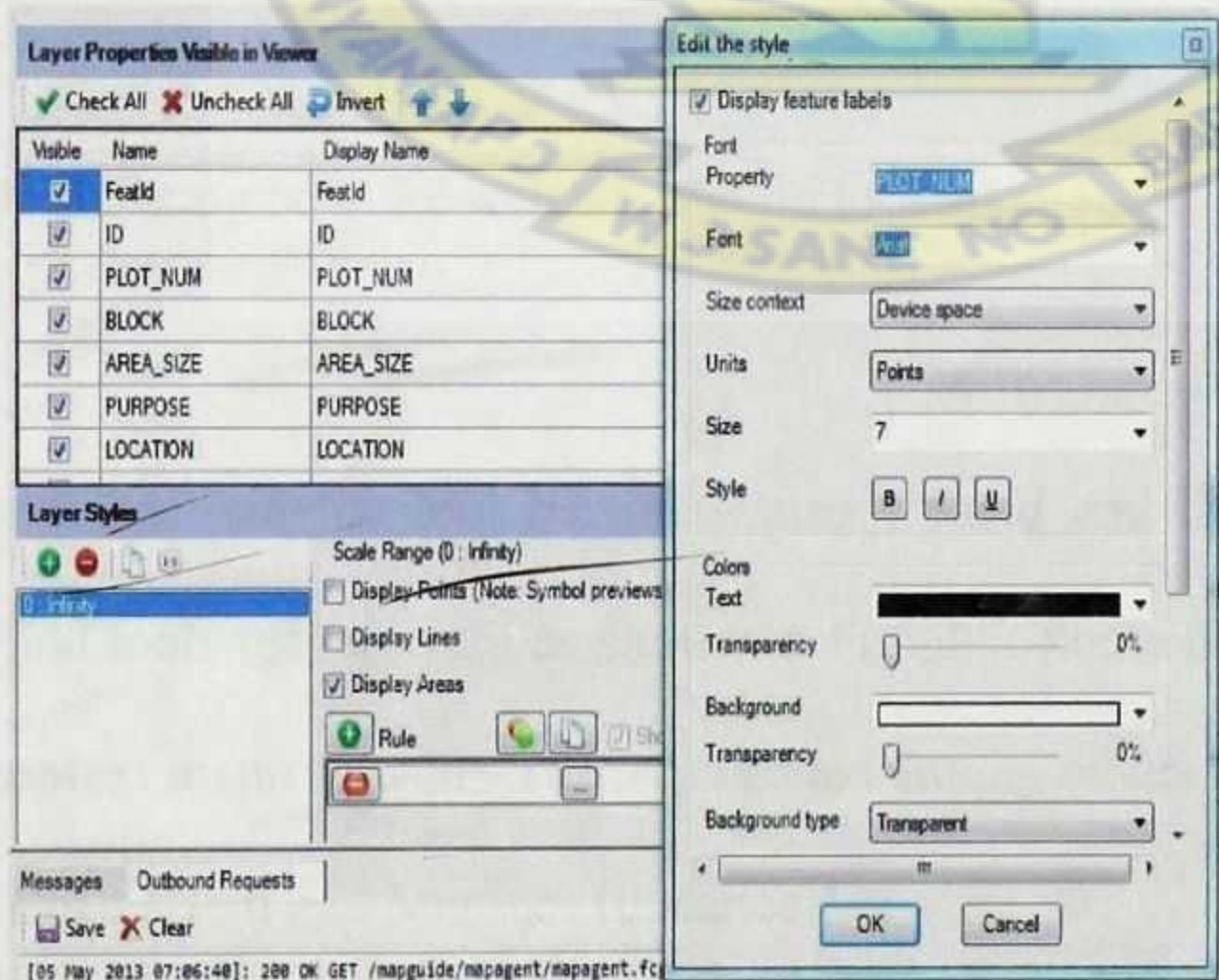


Fig. 3.3: Specifying the properties of a layer to be shown.

3.5.5 Web Layout Design

The web layout was defined into the “LAYOUT” folder. The layout presents how the users of the web site will see the information that is being presented. Features were added onto the site to make it more user friendly. The features added included: Information pane, Map pane and Task pane. Fig. 3.4 shows how feature that are to be shown within the web layout are defined. Other items were added to the layout and these items were the bars.



Fig. 3.4: Defining how the web site should look like.

The menu bar and the tool bar were also created and they were populated with menus and tools respectively as shown in Fig. 3.5. Some of these tools were placed in the context menu as well. The tools added among others were: Print, Zoom, Select, Buffer, Pan and Measure (distance).

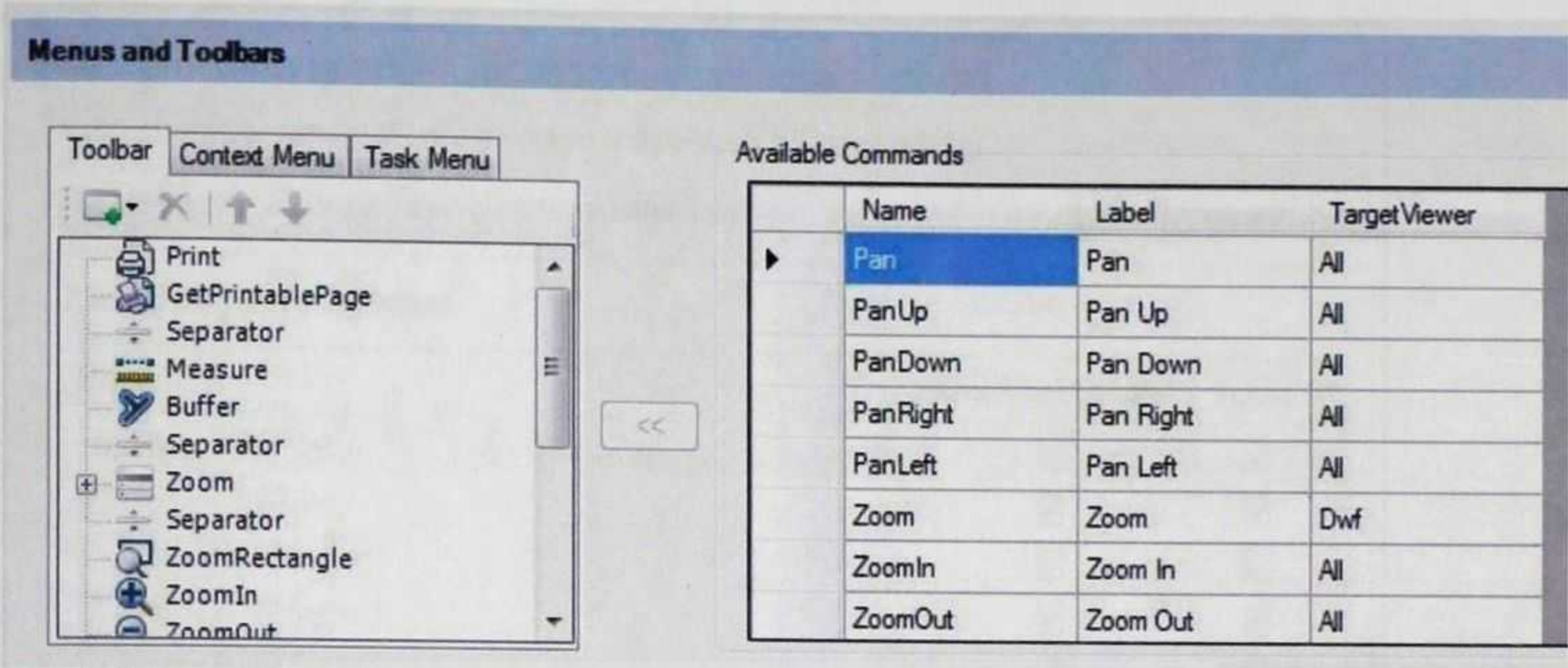


Fig. 3.5: Populating the tool bar and menu bar.

3.5.6 Web Server Creation and Hosting

After the information had been hosted locally, the next thing was to host it over the web. Apache web server software was used to host the information over the web. Map guide server installation package comes with the installation of apache web server.

To ensure that the information from the local server could be accessed by other computers over the web, the (IP) address of the local computer was port forwarded through port 80.

Port forwarding was done by the file with file name *httpd.conf* from the apache installation folder. The file was edited and the IP address and port to be listened to were changed to the local computer's IP address and port 80 respectively.

Apache server was added to the local computer's trusted services under the fire wall to allow incoming and outgoing data as shown in Fig. 3.6. The information to be presented on the web was then placed in the "htdocs" folder under the apache installation folder and the apache server was then started.

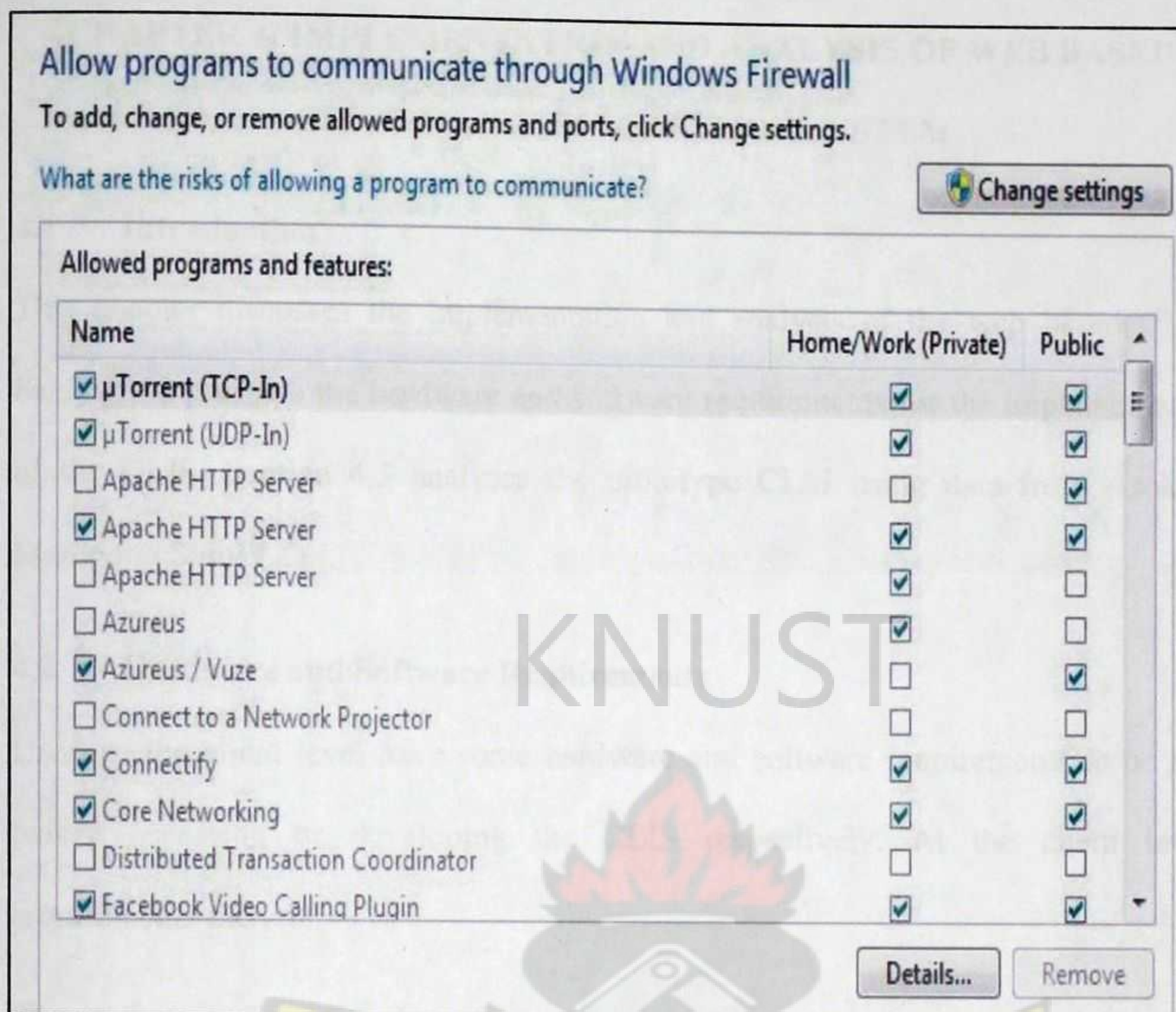


Fig. 3.6: Adding apache server to the computer's trusted services

CHAPTER 4: IMPLEMENTATION AND ANALYSIS OF WEB BASED CUSTOMARY INFORMATION SYSTEM

4.1 Introduction

This chapter discusses the implementation and analysis of the web based CLIS. Section 4.2 presents the hardware and software requirements for the implementation of the CLIS. Section 4.3 analyses the prototype CLIS using data from Asokore Mampong Stool Land.

4.2 Hardware and Software Requirements

Users at the client level have some hardware and software requirements to be met before accessing or developing the CLIS respectively. At the client level, requirements include:

Computer with the minimum specifications of;

- 500MB Ram
- Internet Information services (IIS)
- Web browser (any one)
 - Internet explorer (recommended)
 - Safari
 - Opera mini
 - Fire Fox
- Internet connection

In getting an Internet Map Server (IMS) to work successfully, the software involved requires certain components to function. The components needed include a geospatial data processing engine that runs on the server side as a service, a servlet

or Common Gateway Interface (CGI) application, that processes the raw spatial data into a map and a standard web server that manages the incoming requests and replies with the proper map data back to the client side browser or application window. The end product is either a raster or vector image, which is transmitted back to the client browser or a stream of data that is interpreted by a plug-in to the client

4.3 Prototype CLIS

The welcome page to the prototype web – based CLIS is shown in Fig 4.1. After selecting the Ashanti region tab, Asokore Mampong, being the district of the study area can be selected from the drop down menu. Selecting Asokore Mampong will lead to the map page shown in Fig. 4.2.



Fig. 4.1: An introductory page to the web based CLIS

The figure below; Fig. 4.2, shows the layout of the map page presented to the end user by the web based CLIS. As labelled, there are eight main features of the map page. These are; map area, tool bar, legend pane, property pane, task pane, overview map, scale and coordinates.



Fig. 4.2: User interface of the web based CLIS

Map Area–It contains the map data and displays the map

Tool Bar– It gives a shortcut to the list of tool to carry out the various task in the task pane

Legend Pane– It displays a legend of all the layers presented on the web and allows the user to turn a layer on or off.

Property Pane – It contains the properties of an object when the object is selected in the map area.

Task Pane – It contains a list of the tasks that can be carried out on the information available in the map area.

Overview Map – It gives an over view of all the map data to assist in navigation on the map area

Scale – It gives the scale of the information presented on the map area

Coordinates – It gives the coordinates of the pointer position at every point in time

A user can get information about any parcel of land within the study area. When any parcel within the “MAP” area of the user interface is selected, the non – spatial information of the parcel are presented in the property pane as shown in Fig 4.3. The user may also inquire of the coordinates of any point; the coordinates of any point is shown at the lower left corner of the user interface when the pointer is placed at that point.

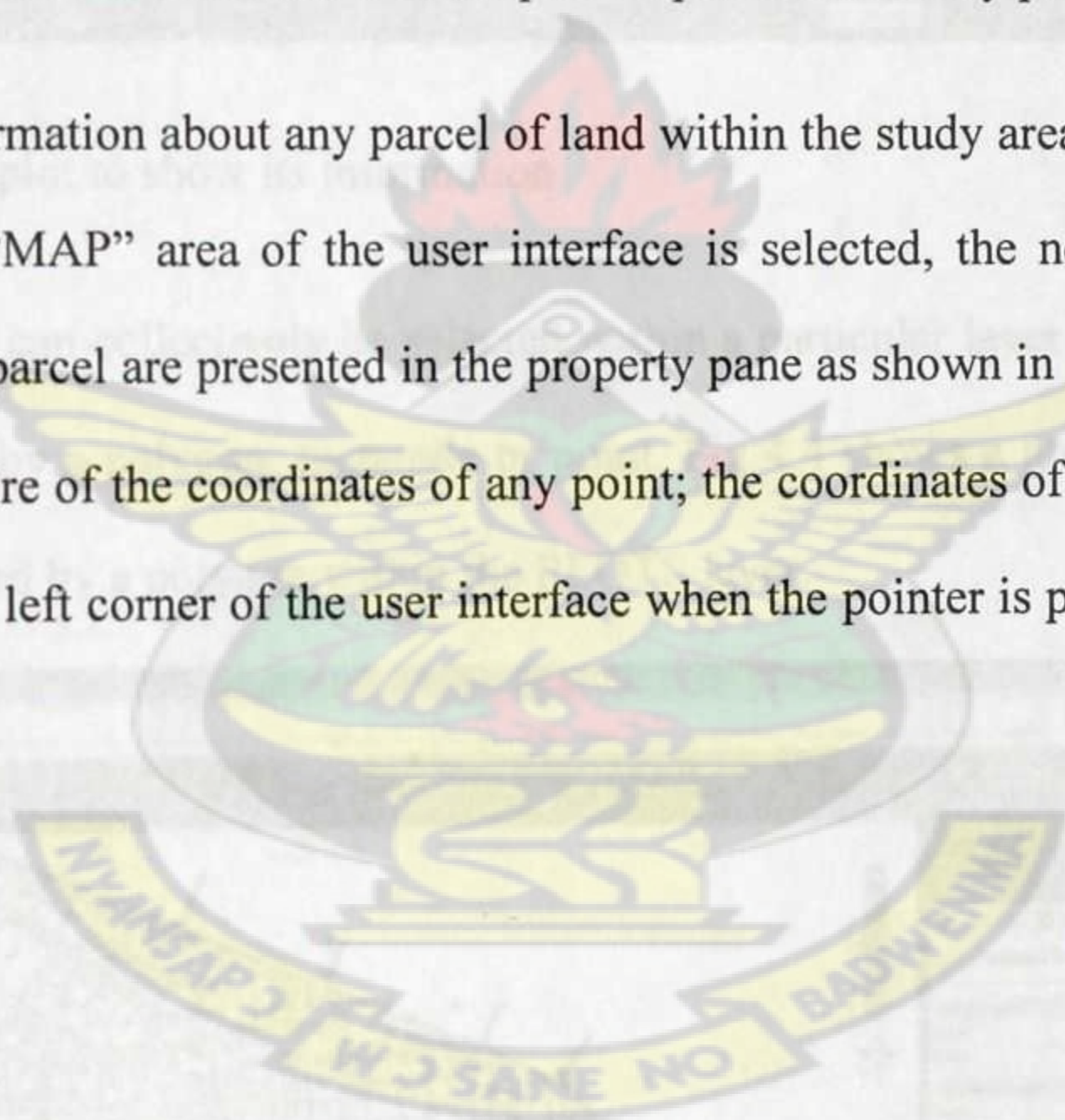




Fig. 4.3: A selected plot to show its information

A group of features can collectively be selected within a particular layer. The extent of select is defined by a polygon, rectangle or point. Fig 4.4 shows a group of plots that has been selected by a polygon within the PLOTS layer.



Fig. 4.4: A group of plots selected together.

The application allows the user to print or plot the content of the map area by using print or plot button respectively from the menu bar. Fig 4.5 shows sample plot output. As indicated on the sample printout, the printout is not for the purpose of legal document but for informational purposes. It also shows the scale of plot and the date of plot, though the information plotted will be relative to how frequently the information is updated.

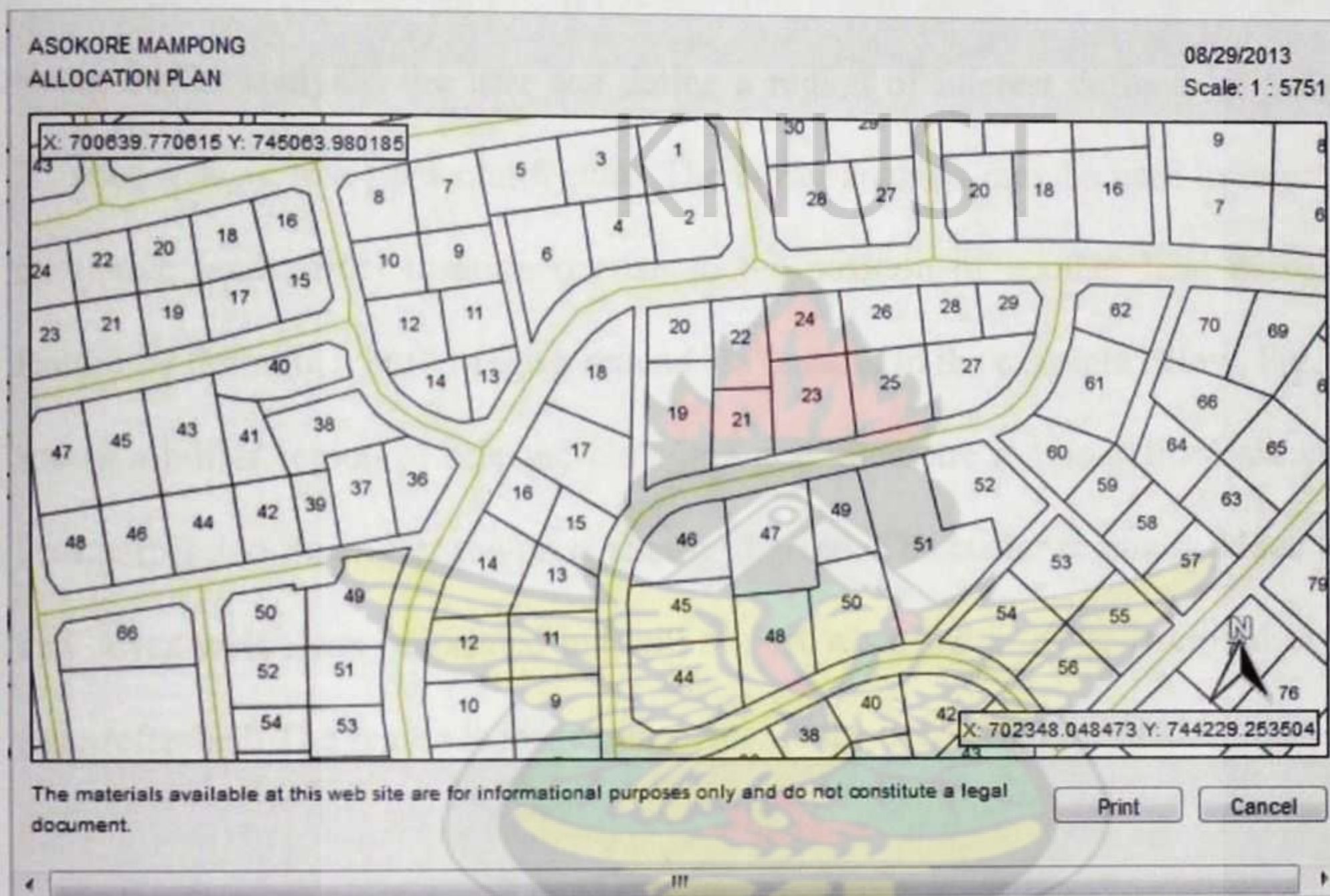


Fig. 4.5: A sample plot output from the CLIS

It also allows the user to create additional layers whose content is part of the already created layers to the user's own preference, but these newly created layers are only stored on the client computer's Random Access Memory (RAM) at the time of browsing. The newly created layers are deleted after each browsing session.

4.3.1 Selection of Parcel

The user can perform spatial and non-spatial queries and inquire for more information other than what is presented in the property pane. Most of the common GIS analysis can be done with this application, thereby informing users on their

decisions relating to customary land within the study area. Some of the analyses that can be performed are:

- Buffer analysis
- Measurements
- Non – spatial selection
- Spatial selection

Using buffer analysis, the user can define a region of interest defined by a fixed distance relative to a particular feature. The buffer analysis may be used in selecting a suitable land parcel location relative to the position of another land parcel or feature by defining a buffer region around the feature. In the example below, Fig. 4.6 shows a buffer region of selected plots in a one kilometre radius defined around a land parcel and the buffer region is shown in green. The buffer region is added as a new layer which can be printed but will be lost when the browser is closed or the page refreshed. The region is made transparent to the user's specification.

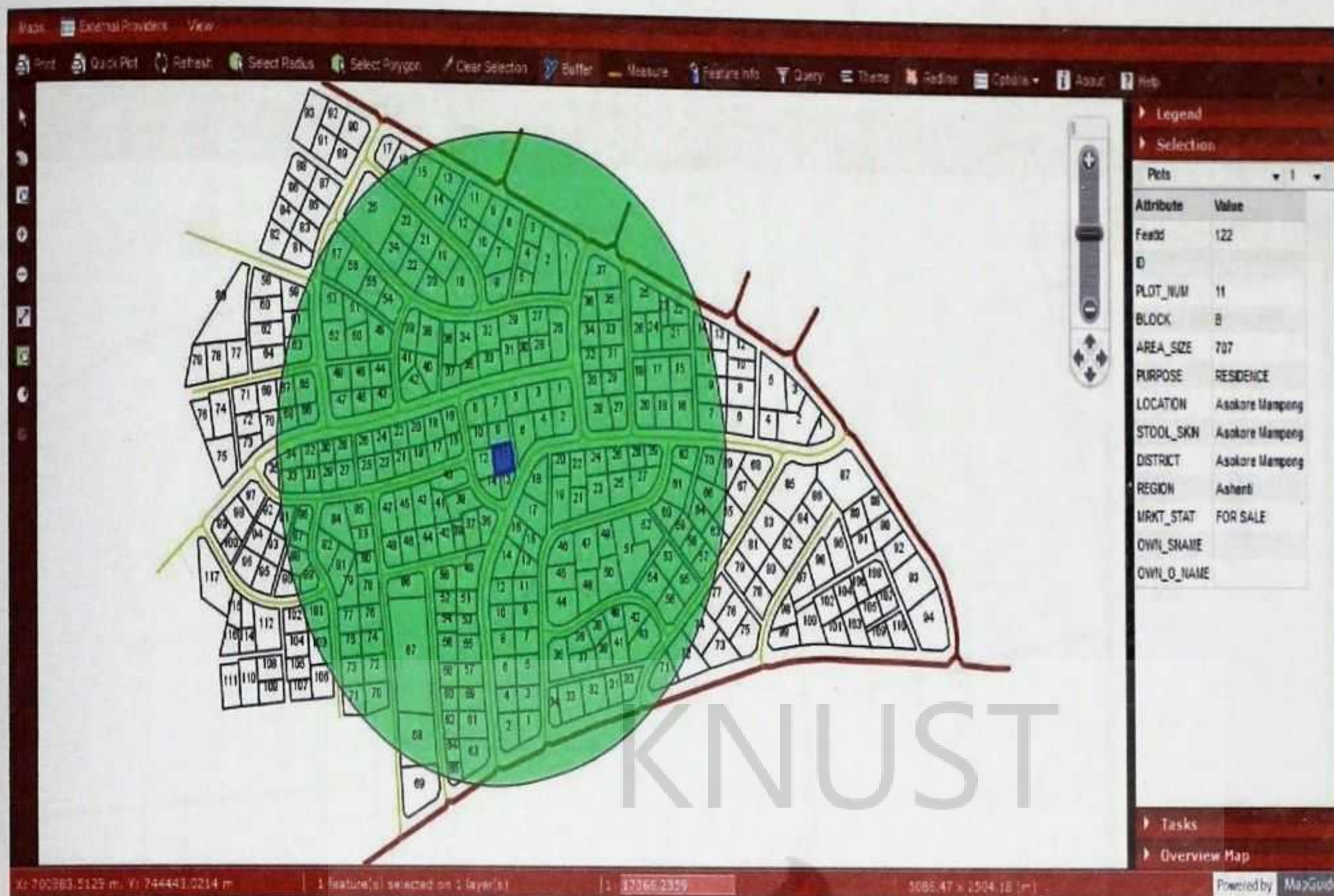


Fig. 4.6: A buffer region shown in green around a local land parcel.

Measurement of distances and areas can also be done by using the measure tool. The system gives the distance estimation between two points after clicking on the points of interest when the measure tool is selected. The system automatically estimates an area for the user if the network of points forms a polygon. Fig. 4.7, a series of measurements that has been done with the area of the polygon formed estimated.

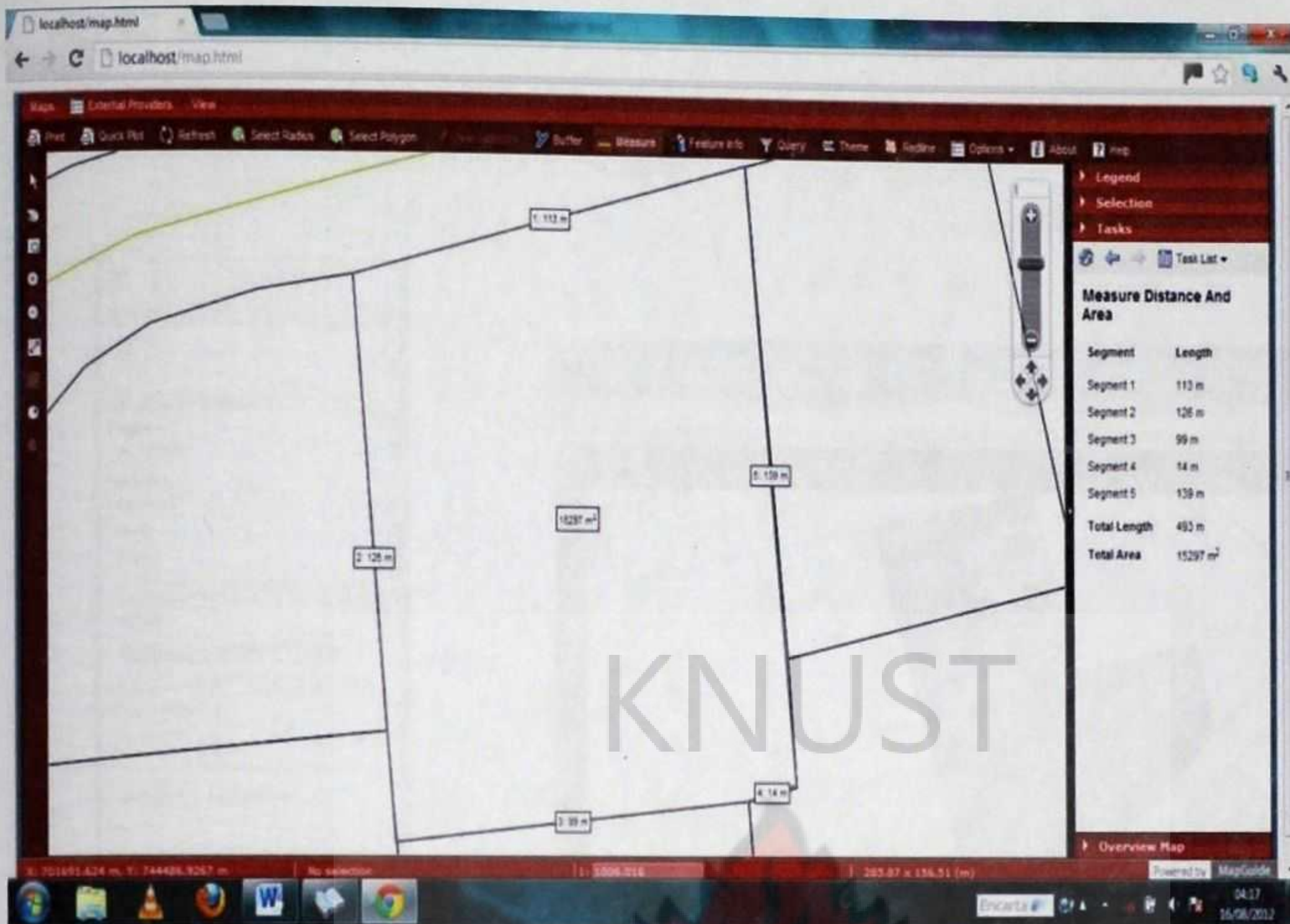


Fig. 4.7: Distance and area measurements over a plot of land.

A non-spatial selection of a feature from the attribute data of features within a specific layer may also be done by using the query tool. The query tool presents the user with the option of defining the criteria for the query in a query dialogue box. When the criteria for the query are defined, the application queries the attribute data to find the features that satisfy the criteria defined by the user.

In the example bellow, Fig. 4.8 shows a query box with a criteria for selecting an allocated land parcel purported for a market. In a situation where the user is searching for a vacant residential land, the market status should be set to “For sale” and the purpose to “Residence”

The search of a vacant residential land parcel can be improved by searching for the land parcel relative to the position of a feature of interest. A buffer around the feature of interest at a defined distance can be overlaid on the residential land selection.

Fig. 4.8 shows the query box whilst Fig. 4.9 shows a feature that has been selected upon a criteria defined.



Fig. 4.8: A query dialogue box.

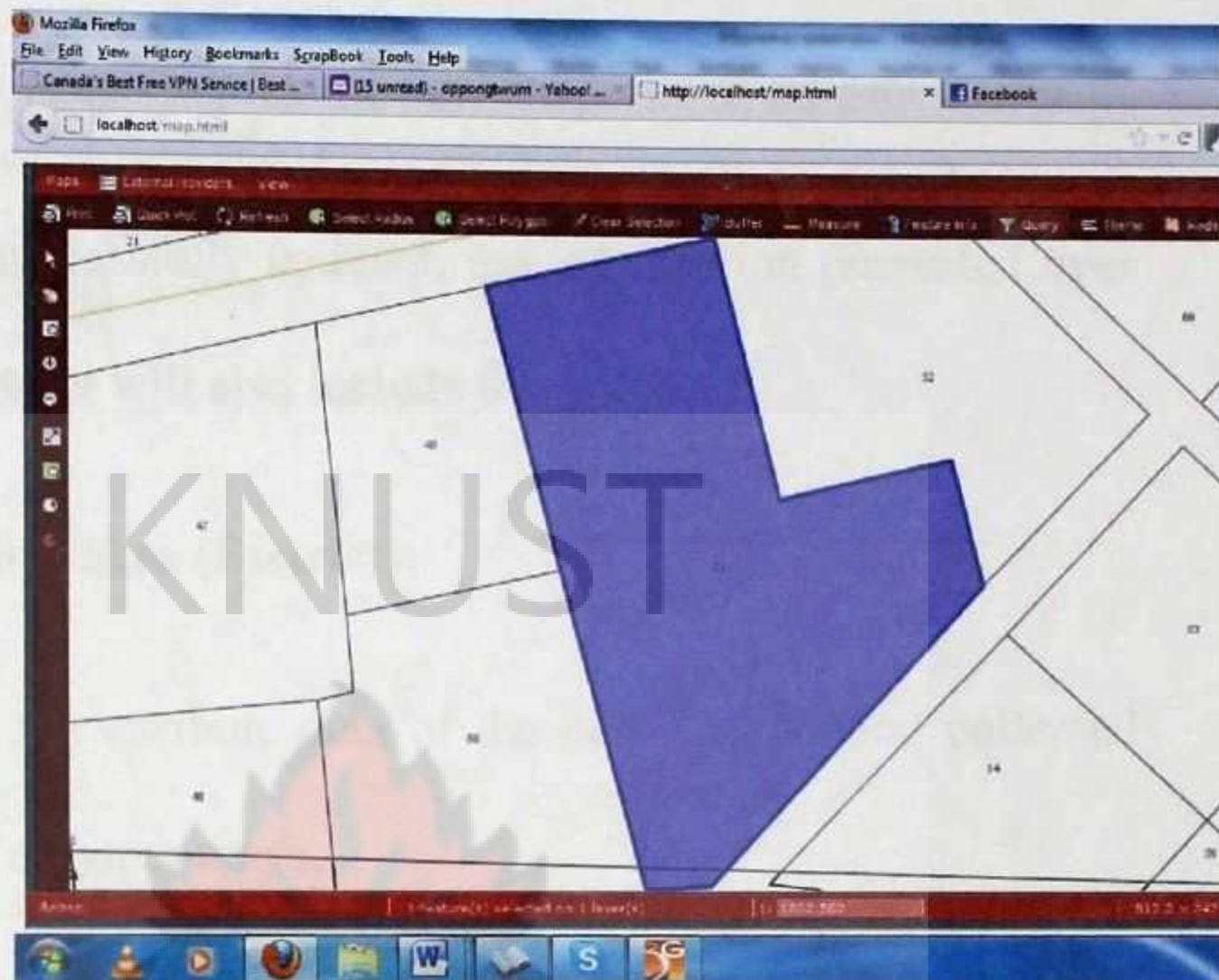


Fig. 4.9: A market selected by the query in Fig. 4.8

4.3.2 Updating The CLIS

As stated in Section 3.3, the CLS is expected to regularly update the CLIS with information received from other stakeholders. To update the information within the CLIS, the CLS would have to follow the procedure bellow.

Updating a land parcel's information:

- When one or more information about one or more parcels of lands changes, the CLS is expected to update the information in the CLIS. Such change may be the market status of a land parcel being changed to from “For Sale” to “Not For Sale”.

- The attribute data of that feature is updated in a particular shapefile in ArcGIS.
- The updated shapefile is used in the MapGuide project to replace the earlier shapefile.
- The MapGuide project is edited to pick the new shapefile as its data source.

Once the MapGuide project is successfully updated, the information presented over the internet through the web browser will also include the update.

To include a layout plan of a new area (District):

- All the spatial data and the attribute data of the new area is first collected from owners in the form of paper maps.
- The boundaries of the land parcels, roads and other features of interest within the area are digitized into their respective shapefiles in ArcGIS. It is important to specify the coordinate system.
- A new map is created in MapGuide Maestro with the newly created shapefiles as its data source.
- A new map layout is created from the map created.
- The regional tab and the district name in the introductory page of the CLIS is linked to this new map page.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

What are the components of the customary land delivery system and the information system involved?

In analyzing customary land delivery process and land information system, it can be concluded that, the components of the customary land delivery system involves the customary land owners or custodians and the customary land laws of Ghana. The customary land laws prescribe the type of interest a person may hold in a particular parcel of land. It also defines the type of information needed for customary land delivery with the main information being a person's hometown.

What are the ideas involved in developing a web based customary land information system from the components of the customary land delivery system?

In developing a conceptual model of a web based customary land information system, it can be concluded that, the ideas necessary to develop a web based customary land information system were based on the system architecture of structure: Client, Services and Data. The client refers to the end user of the CLIS receiving information through a web browser. The services involve the servers that host the information on both the local computer and over the network. Finally the data refers to the data processing part that comes with ArcGIS and MapGuide Maestro software as well as the web part that also uses MapGuide Maestro.

How to develop a web based customary land information system?

It can be concluded that a prototype Web-based CLIS application was successfully designed by using MapGuide Maestro software package, Microsoft IIS, MapGuide server software and ArcGIS software. A web based CLIS has been developed for the broadcast of customary land information. CLIS application development adopting Internet technology was necessary because of the importance of information publication in the case of customary land delivery.

Finally, it can be concluded that, the information about the customary lands of Ghana can be made accessible to all through a web – based customary land information system

5.2 Recommendation

It is recommended that a research may be done on the collection and records keeping of customary land information in rural areas. This will help the stake holders who help with the update of the CLIS to improve on the update they provide.

It is also recommended that a research be done on adding pictures to the the information presented over the internet to aid communication.

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APPENDIXES

Appendix 1: Stakeholder/Data Input

STAKEHOLDER	DATA INPUT
Survey and Mapping Division of Land Commission	Base Map (A map showing the purpose for which each parcel of land is being used). Sectional Maps (A map showing the boundaries of all land parcels including the roads within the customary area).
CLS	Ensure the updates from other stakeholders are effected
Town & Country Planning	Land Use Map – A map showing the purpose for which each parcel of land is being used. Town design – A map showing the proposed design and as built design of the customary land
Lands Commission	Customary land registration documents Information on public and vested lands that are within a customary area
General Public	Feed back to other stakeholders for their respective inputs
Traditional Council	Land ownership information in rural areas

INFORMATION ONE MAY NEED

BEFORE BUYING A LAND

- ☐ Plot Number
- ☐ Duration Of Lease
- ☐ Lessor
- ☐ Site Plan
- ☐ Current Owner
- ☐ Who To Deal With
- ☐ Previous Owner
- ☐ Plot Size (Area)
- ☐ Plot Dimensions
- ☐ Purported Land Use
- ☐ Picture Of Plot
- ☐ Current Land Use
- ☐ Other Parties With Interest
- ☐ Type Of Land Ownership
- ☐ Whether The Land Is Registered
- ☐ Prior Uses Of the Land
- ☐ Court Decision Relating To The Land

(Please write any other information you think may be necessary)