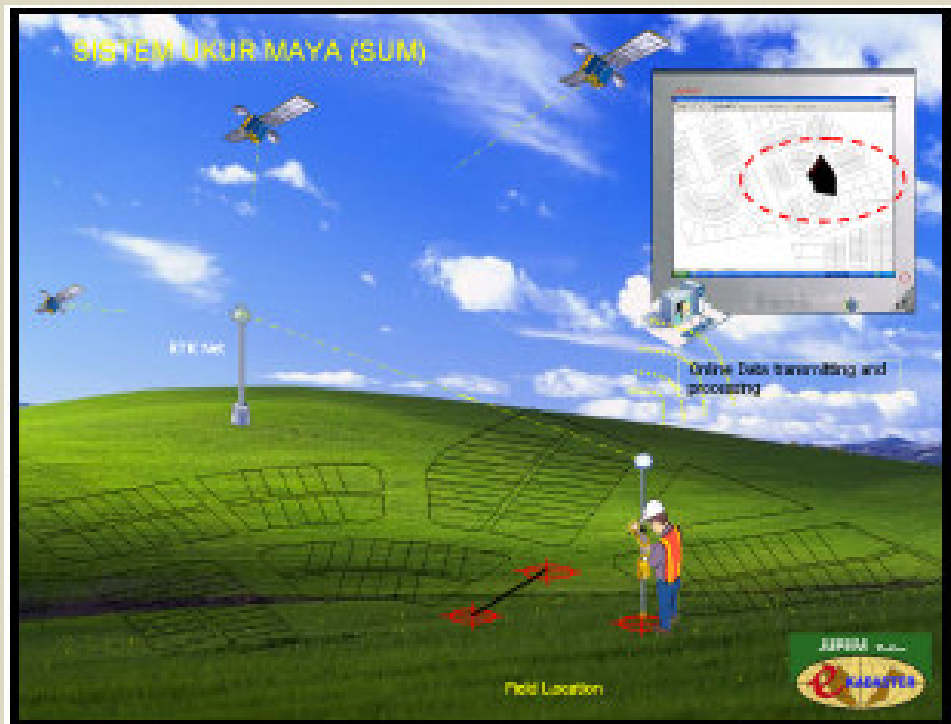


MASTER OF SCIENCES THESIS

Preparation of Coordinate Based Cadastral Map in Rural Ethiopia: Case Study Bite- Ejersa Lafo KA, Oromia Region

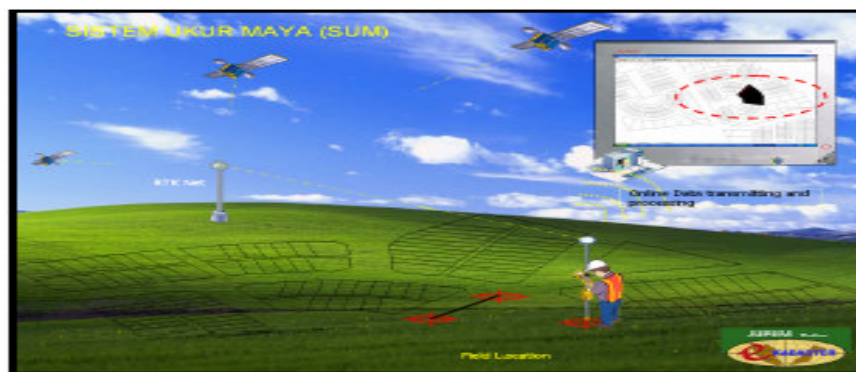


Addis Ababa
University
(Since 1950)



School of Graduate studies Master Thesis

Preparation of Coordinate Based Cadastral Map in Rural Ethiopia: Case Study Bite- Ejersa Lafo KA, Oromia Region



By: AMANUEL TEFAY

**THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY, SCIENCE FACULTY, EARTH
SCIENCE DEPARTMENT IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF SCIENCE IN REMOTE SENSING AND GIS**

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**Preparation of Coordinate Based Cadastral Map in Rural Ethiopia:
Case Study BiteEjersa Lafo KA, Oromia Region**

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Abstract

Cadastral systems have a long tradition. The Cadastre is a parcel-based system, i.e. information is geographically referenced to unique, well-defined units of land. These units are defined by the formal or informal boundaries marking the extent of lands held for exclusive use by individuals and specific groups of individuals (e.g. families, corporations, and communal groups). Besides, Cadastral Systems have been acknowledged to be a core component of *land administration systems*, yet they have been facing a number of challenges ranging from technological pressure to user requirement changes. This due to the different stages of development, different countries have different capacities for the development of cadastral systems. In particular, human, technological and financial resources will determine the most appropriate form of cadastral system to meet the needs of individual countries. Nevertheless, a full-fledged cadastral system in developing countries like Ethiopia is in its' inception stage. Hence, this has been hamper the efficient utilization of natural resources i.e., the land use and land administration of the country as a whole and the rural Ethiopia in particular. This is due to the infancy of the cadastral surveying in the country.

The cadastral surveying techniques in Ethiopia are using traditional measuring devices (e.g., chains, rods, tape, or strings). Hence, the plots are described according to their positional relationship to those features and as to their position relative to neighboring plots (e.g., whose property is on the north, south, east, and west sides of the plot being registered). For this reason in the three certification period in Ethiopia none of the regions prepared a (cadastral) map, not even a sketch and/or they simply measurement based cadastral surveying techniques. Thus, the integration of GPS and High resolution satellite images with GIS in producing coordinate based cadastral map could accelerate the cadastral map coverage in Ethiopia. This is also tested its' procedure in the study area *Bite- Ejersa Lefo Kebele Administration*.

Moreover, the research also tries to review the countries experiences on the current development and administrative framework of cadastral system which is already reported by the cadastral institutions under united nation. Likewise, an attempt has undertaken to see the Ethiopian existing capacity towards cadastral surveying techniques, and the current circumstances of cadastral map coverage in the country.

Finally, cadastral map also trying to see from the angle of NSDI (National Spatial Data Infrastructure). That is cadastral map as an input to spatial data infrastructure.

Keywords: Cadastral system, coordinate based cadastral map, GPS, High resolution satellite images, GIS, NSDI

Acronyms

CEFB	Cadastral Electronic Field Book
CSA	Central Statistical Agency
CSI	Coordinated Cadastral System
COGO	Coordinated Geometry
DGPS	Differential Global Positioning System
DNR	Department of Natural Resource
EMA	Ethiopian Mapping Authority
FIG	International Federation of Surveyors
GIS	Geography Information System
GPS	Global Positioning System
IT	Information Technology
KA	Kebele Administration
KPAs	Kebele Peasant Associations
LIS	Land Information System
NGDI	National Geospatial Data Infrastructure
NSDI	National Spatial Data Infrastructure
PDA	Personnel Digital Assistant
SIDA	Swedish International Development Agency
USAID	United State Agency for International Development
UTM	Universal Travers Mercator
WGS	World Geodetic System

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CHAPTER ONE

INTRODUCTION

1.1 General overview

Cadastral systems have a long tradition. Egypt has had such an institution since about 3000 BC. The Romans, particularly under Emperor Diocletianus in the 3rd century AD, introduced land inventories in occupied territories. Also in China a taxation system was developed for land. Spain introduced its first cadastre for taxation purposes in 1714. The colonialists in the late 19th and early 20th century introduced systematic inventories on land in the colonies to enforce their power. The purpose of the cadastrals has changed over time. Initially, taxation was the main purpose, later on juridical cadastral systems for land use control were established; and after private land ownership became more common, the systems were providing security and reliability and became a basis for land markets (De Soto, 2000).

The Cadastre is a parcel-based system, i.e. information is geographically referenced to unique, well-defined units of land. These units are defined by the formal or informal boundaries marking the extent of lands held for exclusive use by individuals and specific groups of individuals (e.g. families, corporations, and communal groups). Each parcel is given a unique code or parcel identifier. Examples of these codes include addresses, co-ordinates, or lot numbers shown on a survey plan or map. (Williamson et al, 2001).

The term *coordinate based cadastral map* refers exclusively to the cadastre being based on boundary coordinates. The crucial issue here is that the geographical extent of every registered parcel is described or defined numerically by national coordinates stored in a data base and visualized on a digital cadastral map.

Likewise, graphical indices of these parcels, known as cadastral maps, show the relative location of all parcels in a given region. Cadastral maps commonly range from scales of 1:10,000 to 1:500. Large scale diagrams or maps showing more precise parcel dimensions and features (e.g. buildings, irrigation units, etc.) can be compiled for each parcel based on ground surveys or remote sensing and aerial photography. Information in the textual or attribute files of the Cadastre, such as land value, ownership, or use, can be accessed by the unique parcel codes shown on the cadastral map, thus creating a complete Cadastre.

Cadastral Maps are the backbone of LIS which have to be updated by undertaking regular surveying operations to capture the ground realities with regards to fragmentation of parcels or consolidation of boundaries. The word Cadastre is from the Latin language which refers to the registry of lands. Cadastral Surveying is a discipline which deals with large scale surveying of parcels of land and preparation of Cadastres, to serve as public register of the lands for fiscal purposes in addition to establishing the ownership rights. Implementation of LIS therefore is not a simple matter as it involves legal, political and technical issues. Therefore, the needs to resolve these three most important issues are significant (Enemark et al, 2005).

Moreover, Cadastral systems are the foundation and an integral component of parcel-based land information systems (LIS) that contain a record of interests in land. These systems are a central component of the *land administration* and *land management systems* in a state or jurisdiction” (Williamson, 1986). Yet land information systems are a relatively recent application of cadastral systems. Cadastral systems date back a long way and have evolved over thousands of years.

Hence, Cadastral systems should be seen as a core component of more comprehensive land administration systems or infrastructures concerned with the processes of determining, recording and disseminating information about tenure value and use of land when implementing land policies. *Appropriate land administration systems then provide the basis for sound land management towards economic, social and environmental sustainability.*

1.2 Prior research, knowledge gaps, and study justification

It is estimated that while 60 percent of the Earth is mapped at a scale of at least 1:50,000, a far smaller percentage is available in 1:2,500 – 1:10,000 scale that is suitable for land ownership. In some areas, however digital parcel data are not readily available or offer poor accuracy of cadastral map (Corlazzoli et al, 2004). Among those regions *Ethiopia* is one of the different countries in the world which lacks adequate map coverage.

Preparation of coordinated cadastral map has been under way in many parts of the world in recent years. This is solely based on various types and models of GPS (DGPS & RTK) in most developed countries, but in developing countries typically based on traditional methods of cadastral surveying. But, the integration of GPS with other Geo-technologies like remote sensing and GIS can produce a resourceful cadastral map for any country and business groups. These all in most cases not the situations of cadastral surveying methodologies for decades. However, by integrating GPS and satellite imagery with GIS especially in developing countries like Ethiopia can accelerate the preparation and production of cadastral map of the whole country.

In view of this reality, in Ethiopia under the existing circumstances modern cadastral surveying methods are rarely utilized in relation with other part of the developing world like Kenya, Uganda, and Tanzania etc. Even though some efforts have been made by Governmental, and Non-Governmental organizations (USAID and SIDA) in some Regions of the Ethiopia such as Oromia, Amhara, and SNNP & Tigray in the preparation of cadastral map. These have been merely dependent on traditional surveying methodologies with poor or almost non integration with GIS and Remote sensing that is tiresome and time consuming.

Hence, in none of the regions a (cadastral) map is being prepared, not even a sketch. But, some plots are demarcated in the terrain, although not always with very durable materials. With traditional methods the size of the plot is determined (either *using ropes* or relying on knowledge of the number of ‘timads’ of a plot). In addition the plot is described by naming the neighbors on the N, E, S and W. some pilots with cadastral mapping have been undertaken mainly in the

regions, including a donor (SIDA) and USAID assisted project with use of GPS and GIS-supported mapping functionalities.

Nevertheless, according to (*Mwenda, 2001*) Kenya enjoys the advantage of HHGPS technology like any other countries in the world such as El Salvador, Indonesia, Morocco, Botswana, Namibia, Jordan and in a number of countries in Eastern Europe for cadastral surveying. Likewise, tests for use of GPS in Real Time Kinematic Systems (RTK) surveys in Belize and Albania have demonstrated that the use of GPS in cadastral surveys has considerable cost savings.

Hence, there is no doubt about the potential application of handheld GPS technology but by integrating with GIS and high-resolution satellite imagery in cadastral surveying in rural Ethiopia specifically in “Bite-Ejersalafo” Kebele Administration (KA) could prepare a resourceful cadastral map .

As a final point, the study will address the problems which can have an obstacle in the field of cadastral surveying on this particular area in relation to the approaches used, and with its socio-economic aspect of land administration. For the realization of this, field data collection using the specified methods has undertaken. The first method is to collect data from study area using hand held GPS , while second also to extract sample parcel data from high resolution satellite images(i.e. Quickbird) and Google Earth . Lastly, the research will also try to make a recommendation, and demonstrate the merits & demerits of the techniques in the project area.

1.3 Aim and Objectives of the Research

The principal aim of the research is to demonstrate the integration of GPS and Satellite imagery in preparing rural cadastral mapping and to assess some countries Experiences.

The objectives of the Research are

- To demonstrate the procedures of coordinate based cadastral map by integrating GPS and Satellite imagery with GIS in the study area.
- To assess the current cadastral surveying methodologies in Ethiopia in comparison with other countries experiences.

1.4 Scope of the research

This research deals with two main subjects ; the experiences of countries on cadastral surveying system focusing on the technical and Administrative frame work and the integration of GIS, GPS and Remote sensing in the preparation of coordinate based cadastral map. The research activities to show the current level of cadastral map coverage in Ethiopia. Besides, to reveal the preparation of cadastral map using the three techniques at case study level. This thesis work is not intended to result in a fully functional cadastral mapping, but to assess the stage of cadastral surveying development at present and to recommend accordingly.

1.5 Relevance of the Research

The research will essentially examine the methods in an effect to prepare resourceful Cadastral map for the study area. This is based on handheld GPS, Quickbird satellite image and Google Earth. On the other hand, investigating the experiences of other countries concerning cadastral surveying techniques. Hence, the research will provide information which is useful as a baseline data and guide for managing and administrating the available land resource to the decision makers. As well this could be an input for the establishment of (NSDI) National Spatial Data Infrastructure for the whole country. As a result, the research will also serve as an input to the forthcoming researchers, government bodies, NGOs and other concerned groups who have interest to pursue in related aspects of the research.

1.6 Structure of the Thesis

This thesis has eight broad Chapters. The first part includes detailed discussion of the background and the general over view of land administration system and cadastral system in the eye of the cadastral concept and its historical trends. In addition some important parts are included in this chapter such as, prior research, knowledge gap and study justification; Aims and objectives of the research; scope of the research, relevance of the research; limitation of the research are put with in this subdivision. To this end, Chapter 2 has incorporated the conceptual frame work of land administration system and cadastral system that discusses the dynamic nature of the humankind–land relationship and indicates some of the key current drivers of change that lead to the development of more complex rights, restrictions and responsibilities. Besides, issues of cadastral system i.e. cadastre and land registration, and land information management system. Consequently, in this chapter also included the potential of high resolution satellite imagery and Global positioning system in the cadastral mapping. Chapter 3 deals with the general description of the study area specifically includes geology, topography and drainage; climate and vegetation; population and settlement; economic activities of the area. Chapter 4 discusses with the data collection, materials and research methodology that emphasis and clarifies the following chapters. Chapter 5 deals with generally the countries experiences on cadastral surveying that accompanied particularly with some case studies. Besides, over all view of African cadastral experiences and current condition of cadastral surveying in Ethiopia. The purpose of these chapters is to overview relevant literature on these topics. Thus a range of secondary and where available, some primary sources are used. The interdisciplinary nature of this work has required research into a range of literature. Finally, present the summarization of countries experiences on cadastral surveying and mapping. Chapter 6 further focuses on the integration of GPS and satellite imagery with GIS in preparing cadastral map, and parts incorporated here are testing the parcel coordinates of GPS and satellite imagery; Combination of (x, y) point coordinates of Handheld GPS and Quickbird ; Testing the area of parcels:-GPS and Quickbird Imagery; The boundary of the Parcels Vs Cadastral surveying methods. Chapter 7 concludes the thesis and coming with beneficial recommendation.

CHAPTER TWO

2. CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Land Administration System

According to the UN Guidelines (1996) Land Administration concerns the processes of recording and disseminating information about the ownership, value and use of land and its associated resources. There are three important elements to manage land, the first is to count with information about land; second to have clear policies on how land should be managed; and third is to motivate the participation of everyone with an interest on stake in the land to provide with source information.

Ting and Williamson (1999) relate Land Administration with current global drivers, such as **sustainable development, globalization, economic reform** and **information technology revolution**. Lately, Williamson (2000) has related another driver that is **urbanisation**, which represents actions to solve the fast change of the formal and informal tenure in cities.

Sustainable development means development that effectively incorporates economic, social, political, conservation and resource management factors in decision-making for development. The challenge of balancing these competing factors in sophisticated decision making requires access to accurate and relevant information in a readily interactive form.

In delivering this objective, information technology, spatial data infrastructures, and land information business systems will play an important role. In this sense Cadastres may also be used in a multi-purpose role to provide a wide range of land related information.

Sustainable development is also linked to globalization. Globalisation means the process of societies to become more interconnected from a social, economic and political perspective. This process includes events in one part of the world that have more potential to impact on peoples and societies in other parts of the world. This trend widens the perspectives from the local to the global level.

The globalisation of markets has in turn influenced micro-economic reform. This represents the initiatives of change from the institutional and governmental side. This includes initiatives such as privatisation, decentralisation, downsizing, cost recovery, quality assurance, public/private partnership, and other policies to ensure service delivery and cost effectiveness. According to Kaufmann (1998) these initiatives have changed the focus from the pure technological issues to include also managerial components of building and maintaining national spatial data infrastructures.

The information technology revolution with the technological development such as digital cadastral databases and the WWW are vital tools for land administration and planning both now and into the future. In Ting and Williamson (1999), it is mentioned that the advances on technology had influenced the management of land through the large spatial database management, GPS technologies and high-resolution satellite imagery, GIS technologies, and communication technologies such as the WWW.

The global drivers described above influence the form of land administration infrastructures which support and facilitate the way societies interact with land. These drivers influence the development of the different land administration policies and models adopted by state and national governments, which in turn influence and provide the systems on which local government and city administrations rely. These models and concepts can only be developed with a clear understanding of current land administration issues and trends. By its very nature land administration focuses on land tenure and cadastral (land parcel related) issues. The land administration perspective includes understanding the changing humankind to land relationship, cadastral issues such as national cadastral systems in countries which are a federation of states, and land tenure issues such as native title.

At the same time local government or city administrations must fully recognise these land administration trends and the impact they have on their own spatial information strategies.

Besides, Land administration systems all over the world are reviewing their functional structures and undergoing major legislative and administrative changes. They are doing this in response to different internal and external drivers. In the developed countries, the major drivers for reform are advances in geo-information technology (GIT) and the associated demands from customers for improved service delivery. Reforms include electronic land administration e.g. electronic lodgment and processing of cadastral and registration documents, digital management of records and electronic distribution of products and services through the internet. In the developing countries, the main drivers for reform are the need for regularization of non-formal land rights. Reforms here mainly include innovative legislative and administrative adjustments to accommodate and accelerate the registration of individual and group rights in customary land and informal settlements.

2.1.1 Land Information Management System

A Land Information system is a combination of human and technical resources together with a set of organizing procedures that produces information in support of some managerial requirement (Dale & McLaughlin, 1999). A land information system gives support to land management by providing information about the land, the resources upon it and the improvements made to it for the purpose of land administration while implementing land management.

A Land Information Management System [LIMS] in the context of Land Administration Systems consists of a number of broad dimensions, firstly an institutional element, which includes a corporate structure in terms of policies, legal framework etc. Secondly, it consists of a set of organizing procedures, which structure the relationship among the functional components and thirdly, a technological dimension that includes hardware and software. Fourthly, it includes a platform or a resource-base, on which data are stored and from which meaningful land information can be produced, analyzed and disseminated. Finally, it includes an explicit, or implicit, policy towards users, transparency, information dissemination etc.

Generally, the process of land administration needs complete, accurate and reliable information about the ownership, use and value of existing land and its resources. Cadastres play the ‘book-keeping’ role for this information within the wider land administration and land management systems. The cadastre is considered to be the core of a land administration system (Steudler, 2004; Wiliamson, 2001a).

2.2 Cadastral system

2.2.1 Cadastre and Land Registration

The cadastral systems comprise a land registration system and a cadastral survey and/or mapping system as key components. The cadastral survey comprises processes such as the control of geodetic data, parcel demarcation and surveying, cadastral mapping, cadastral mutation and map updating. As Zevenbergen and Bogaerts (2001) mentioned, Land registration is the process by which the documentation affecting interests in land are recorded in a public register. This is the official legal registration of properties and legal rights.

The International Federation of Surveyors (FIG, 1995) defines a cadastre as a “parcel based and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, ownership or control of those interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (valuation and taxation), legal purposes (conveyancing), to assist in the management of land and land-use control (planning and administration), and enables sustainable development and environmental improvement”.

However, the concept of Cadastre is difficult to identify. It may be designed in many different ways, depending on the origin, history and cultural development of the region or country. Basically, a cadastre as such is just a record that identifies the individual land parcels/properties. The purpose of this identification may be taxation (as was the reason for establishing the

European cadastres) or it may be security of land rights (as was the case when establishing the Torrens systems in the new world such as Australia). Today, most cadastral registers around the world are linked to both the land value/taxation area and the area of securing legal rights in land.

Therefore, it makes sense to talk about Cadastral Systems or Cadastral Infrastructures rather than just Cadastre. These systems or infrastructures include the interaction between the identification of land parcels, the registration of land rights, the valuation and taxation of land and property, and the control of present and possible future use of land (Enemark et al, 2005).

According to Tuladhar (1998) the term Cadastre includes different types of purposes such as Juridical: a register of ownership of the proprietary land parcel; Fiscal: a register of properties recording their value to support taxation; Land use: a register of land use; and when a cadastre serves as a supplier of up-to-date and reliable land information at an affordable cost, it is then termed as Multipurpose Cadastre. The objective of the multipurpose cadastre is to provide a service through which the dynamics of the land parcel may be studied and also meet the demands of the evolution of LAS which means the needs of the users.

2.2.2 Classification of Cadastral System

They can be grouped under three general heads.

1. Tax Cadastre
2. Real Cadastre
3. Legal Cadastre

I. The Tax Cadastre:

It is a system of survey where information is collected for land taxation. The tax may be assessed based on area of land, type of land, value of land and produce of the land. The physical survey may be represented by sketch. Usually, accuracy of the survey is low since main objective is tax collection. The determination of rightful ownership is not done since main objective is tax

collection. As long as someone agrees to pay taxes, it does not matter to the government who the rightful owners are.

II. Real Cadastre:

In contrast, the real property Cadastre is executed mainly for the physical mapping of land holding boundaries and locating real other properties for land inventory. Real property includes not only land, but also buildings, trees etc., which are permanently fixed to it. Minerals below the surface are also integral part.

However, in the legal courts of many countries, private ownership of mineral deposits does not necessarily follow from the ownership of the land.

III. Legal Cadastre:

Survey which furnishes information for the Registration of the land. Determination of legal ownership and Registration of legal transactions is called as legal cadastre. The requirements of physical survey of land boundaries preceding registration may not be necessary since registration can be based on old documents. Thus, in general, the legal cadastre is a complement to both property cadastre and tax cadastre.

Hence, the most efficient approach is to take all three objectives together and integrate the three types of cadastres in one system. This, in essence is Land Information System or LIS.

2.2.3 Measuring the Success of Cadastral Systems

According to Dr Jim Riddell, FAO. The success of the cadastre can be measured by:

1. Clarity
2. Security
3. Timeliness
4. Fairness
5. Cost - initial, updating and access

2.2.4 Issues in Cadastral Systems

Efficient systems to officially record rights in land comprise two basic sets of information:

- ❖ registers comprised largely of textual or alphanumeric data that record

rights in land; and

- ❖ maps or a spatial framework that define the boundaries and extent of land parcels over which these rights apply.

These two basic sets of information constitute the concept of the cadastre, which is illustrated in the figure below. Under the cadastral concept there is a close, explicit linkage between the textual and spatial data. With this link in place, various search/access mechanisms can be developed to search information on rights in land. These searches can be from keys in the alphanumeric data or from queries in the spatial framework and reports can be produced in either or both domains. The spatial framework can also be a useful tool in validating the textual data, identifying, for example, parcels where numerical data is not available. An essential prerequisite for an efficient cadastral system is therefore ensuring that the two datasets are maintained and up-to-date. No set of rights should exist without a spatial parcel to assign them to, and all spatial parcels should be linked to a set of rights. This is a simple concept, but can be very difficult to implement in practice. In many countries there is a weak or non-existent spatial framework and this is a major cause of uncertainty in rights in land.

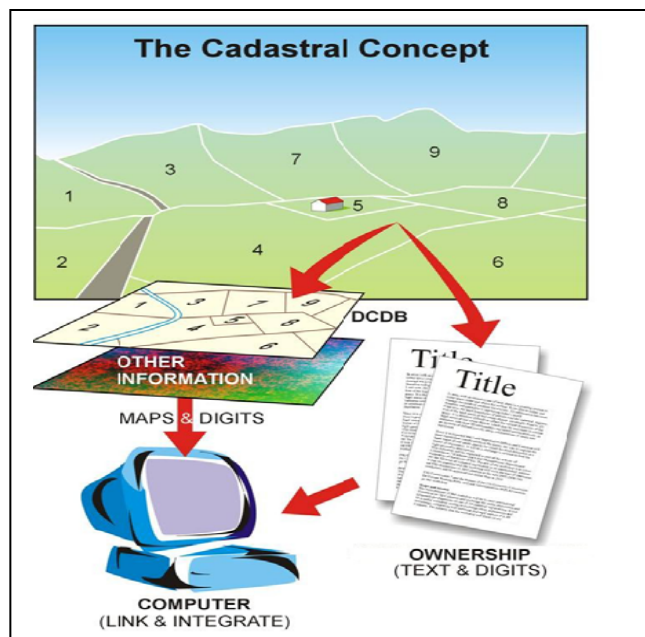


Figure2.1: Cadastral Concept (adopted from Williamson, 2002)

Hence, it is important to consider the social context of land boundaries in assessing the technical requirements for surveying and mapping. Where there is a simple, community-accepted system

of defining parcel boundaries or where there is a low social cost in getting agreement on boundaries there is reduced justification for accurate but costly surveys and comprehensive mapping systems. This is the situation in many countries for instance; Thailand where the prime emphasis in re-establishing boundaries is agreement by the parties rather than re-instatement from information recorded in the land records. Most surveys in Thailand are undertaken to lower accuracy, but lower cost, graphical standards. In other countries, such as Tunisia, there is a higher social cost in reaching agreement on boundaries. When agreement is reached on boundaries in Tunisia, accurate and costly surveys are undertaken and the coordinates determined from these surveys are used to re-instate boundaries. In England a general boundary system operates with strong community acceptance. The general boundaries are charted on large-scale topographic maps produced by a national authority. Registry maps and file plans are produced from these maps. Land owners have the option of requesting accurate surveys to fix their boundaries, but few such requests are made.

According to Ting and Williamson 2000, the cadastral map record is a prime layer in supporting the development of national Spatial Data Infrastructure. In many countries cadastral maps compiled to graphical standards that support the index aspect as stated above provide the foundation for SDI. Many users in various countries express a need for higher accuracy. These users include utility authorities that want to chart their assets on the cadastral spatial framework and typically express the need for 'spade width' accuracy, something that approaches survey-accuracy in the cadastral framework. Few if any developed countries have been able to implement such a system, even with significant recent improvements in technology and a range of innovative approaches to phase the introduction of improved accuracy.

- ❖ Generally, there are two broad aspects to the spatial framework that might support a land-registration system. The first is a topological or indexing the identification of land parcels recorded in the register, including support for the sub-division or consolidation of land parcels;

- ❖ identification of parties with an interest in a particular land parcel for a range of purposes including the identification of adjoining owners for service of notice;
- ❖ the validation and verification of registered land, including the identification of duplicate or missing records and the identification of possible problems with overlapping parcels; and
- ❖ A spatial framework for data queries and access to the data in the register.

The second is a metric or calculation aspect that supports a second set of applications, including:

- the accurate re-instatement of parcel boundaries;
- strong evidence to support the resolution of disputes over boundaries;
- the calculation of accurate parcel areas, offsets, etc; and
- The accurate determination of updated parcel dimensions where land parcels are sub-divided or consolidated.

Many systems restrict the spatial framework to the first aspect. This is the case in England. In other countries there are accurate individual survey plans that record the information that supports the second aspect, and this information is used to compile a series of cadastral index maps that support the topography and indexing of the first aspect. There is a significant increase in the cost of implementing and maintaining a system that calculates parcel boundaries. This is the situation in Australia and Thailand. In other countries, the registry maps precisely define parcel boundaries and go some way to addressing the second aspect (although most still record more accurate survey information for at least some properties on the register). This is the situation in much of continental Europe.

Lastly, cadastral survey is a land measurement activity whose purpose is to describe new or changed boundaries of land parcels and includes recovery and restoration of lost boundaries. The description may be textual, numerical, graphical or a combination of these. The surveys provide basic information about geometric description (including spatial location, size and shape) of land parcels. Such information is prerequisite to successful land registration in any country. And, land

parcel is the basic unit in the cadastral system. Each parcel is given a unique parcel number and address, which together with parcel dimensions are shown on a cadastral map.

According to what is being discussed above, the cadastre is a part of a land information system and joint with other land management systems as taxation, land use and environmental are held in a Land Information Management System [LIMS]. In Figure 2.4 is shown how these systems are related to each other and together with the creation of open and transparent institutions, organizations, resource management, technology and adequate platforms are held in a country land administration system.

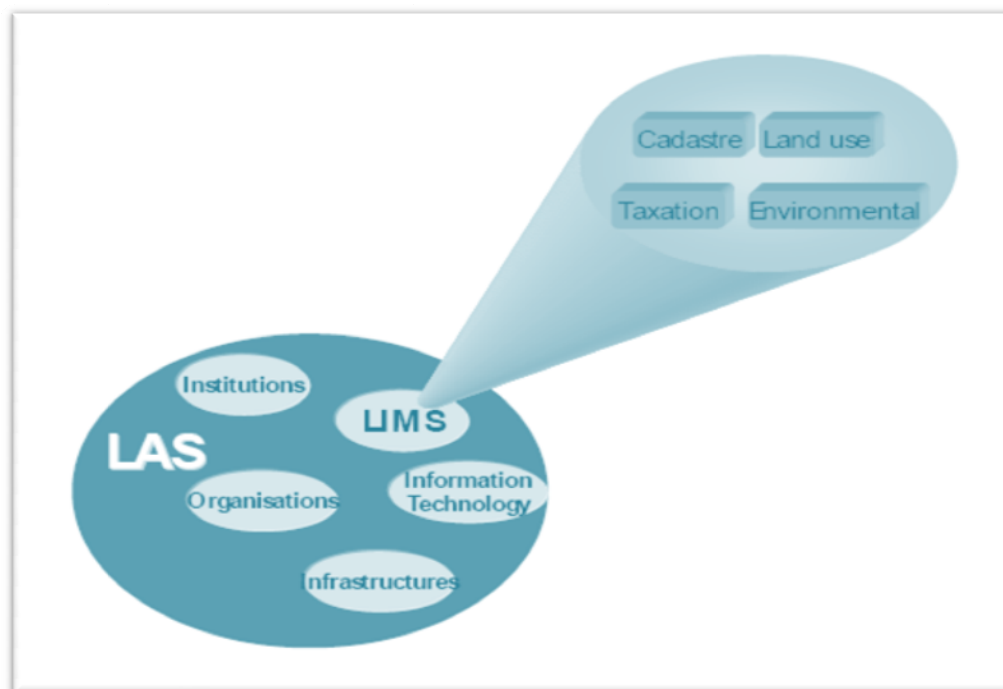


Figure 2.2 Cadastre as a LIS Supporting a land Administration system;

Source: Adopted from Cadastre 2014 Report

In this context, land administration institutions are *“the rules of the game”* in a society. These include the laws and regulations necessary for creating property rights, and the associated

restrictions and requirements imposed by the state or the community (Williamson, 2000). The organizations are at operational level, the bodies involved with the information transactions. Like van der Molen mentioned (2000) "...It is not worth it to have an organization if there are not clear, transparent and simple institutions".

The land administration infrastructures may be described as the organizations, standards, processes, information and dissemination systems and technologies required to support the allocation, transfer, dealing and use of land. Information technology will play an increasingly important role both in constructing the necessary infrastructure and in providing effective citizen access to information.

In many developing countries, the land and the cadastral registration are separated processes, even though the cadastre is still under the phase of establishment. In an ideal situation, the main task of the cadastre is the setting down on the basis of the existing or expected legal situation of parcels, which are represented on a large-scale map with a parcel identifier. This identifier is used in the land property register to indicate the legal object and relationship with the owner (subject).

2.2.5 Cadastral processes

Cadastral processes constitute the activities necessary for access to land and land delivery. Access to land refers to the opportunities that are available for one to acquire any form of land rights. Land delivery refers to the channels that are used to supply land for various uses and the technical and legal procedures that are necessary to support the process.

The processes involved in cadastre may vary in nature and/or procedure between land administration systems. However, four common cadastral procedures are recognisable in many parts of the world:

- ☞ **Adjudication** – This is the authoritative ascertainment of existing rights in land. Adjudication is usually the first component of the land delivery process before first registration. Adjudication does not alter existing rights nor create new rights. It can be carried out either as a systematic (compulsory, area by area) or a sporadic (voluntary, on demand) process.

- ☞ **Demarcation** – This is the marking of boundary limits of each unit on the ground. Physical objects (monuments) may be placed on the ground to clearly indicate the boundaries. Boundary definitions should meet the requirement of providing evidence of the location of recognized land units. The nature of boundaries that is adopted determines method of demarcation. Boundaries are categorised into two: fixed/precise boundaries (accurately surveyed boundaries that can be reliably re-established from previous survey records in cases of dispute) and general/approximate boundaries (boundaries that are determined by relaxed survey methods or no survey at all and that depend on ground evidence in cases *of dispute*).

- ☞ **Surveying** – This is the actual ground measurement of cadastral land units. Cadastral surveying is normally conducted under statutory regulations. The regulations stipulate the methods and standards of accuracy for different kinds of survey. The requirements for demarcation determine the conduct and accuracy of survey.

- ☞ **Mapping** – This is the geometric description of cadastral land units. The basic requirement of cadastral mapping is to provide a sufficient specification of the location of a land unit (or object). An index (i.e. a spatial framework) that is based on the earth's surface is necessary for this purpose. Aerial photographs provide suitable indices for cadastral mapping in many countries because land units can be identified by reference to terrestrial features using simple photo interpretation methods. Land object definitions without any reference to the earth's surface can use other means to meet the demands of providing evidence of the location of land objects. Any sort of geo-reference that is recognized by a community will meet the demands of specifying a land object.

2.2.6 Future cadastres

According to the definition of Cadastre 2014, Cadastre is a methodically arranged public inventory of data concerning legal land objects within a certain country or district, based on a survey of their boundaries. The outlines or boundaries of the property and the parcel identifier are normally shown on large-scale maps, which, together with registers, may show for each separate property, the nature, size, value and legal rights associated with the parcel.

The FIG is facilitating further developments of the cadastral concept. Two developments that stand out are:

1. Cadastre 2014
2. Core cadastral domain data model

Cadastre 2014 is a conceptual vision for cadastral systems of the future. It is the result of a study that was undertaken by a working group of FIG Commission -7 between 1994 and 1998 (Kaufmann and Steudler, 1998). The objective of the study was to develop a conceptual framework of cadastral systems in 20 years time from 1994. Cadastre 2014 consists of six statements that embody this conceptual framework based on current trends in cadastre:

1. Cadastre 2014 will show the complete legal situation of land, including public rights and restrictions
2. Cadastre 2014 will abolish the separation between maps and registers – technically (perhaps institutionally as well)
3. In Cadastre 2014, cadastral mapping will be dead; long live modeling – modern technology provides vast opportunities
4. In Cadastre 2014, “paper and pencil” cadastre will have gone - digital technology will be necessary for improved performance and service delivery
5. Cadastre 2014 will be highly privatized; public and private sectors will work closely together - the private sector will help to improve efficiency, flexibility and innovative solutions while the public sector can concentrate on supervision and control
6. Cadastre 2014 will be cost recovering – the considerable investments in cadastre need to be justified

The statements of Cadastre 2014 have drawn critical comments from various sources. Some of the comments that have questioned the validity of the statements include:

Cadastre 2014 focuses too much attention on technical issues at the expense of institutional and administrative aspects (Williamson and Ting, 2001). Secondly, the wide differences between the cadastral systems of developed and developing countries will expectedly lead to equally

different perceptions of Cadastre 2014 (Molen, 2003b)

A modern cadastre by definition is a parcel based land information system containing records of interests in land and is closely aligned with the operation of land markets (FIG, 1999). The modern cadastre is an integral component in establishing the fiscal and legal management of land and land use for the purpose of sustainable development. In contrast with the past, cadastral reform has concentrated on certainty and security of land tenure (Williamson, 1997).

Accordingly, as Kaufman and Steudler (1998) defined a Multi-Purpose Cadastre as "methodically arranged public inventory of data concerning all legal land objects in a certain country or district, based on a survey of their boundaries". The Multi- Purpose Cadastre is an extension of the modern cadastre to include other land information registers. These registers might include databases with planning, valuation and other information. By including these registers, a Multi-Purpose Cadastre is expected to serve more than its original purpose of primarily serving the land market.

In recent times, the cadastre has gone through improvements such as digitisation, automation, database integration and many more technological changes in order to better serve the public. One of the more significant improvements in the last few years was the adaptation of the WWW as the medium of integration and presentation of the cadastre.

2.3 Satellite Imagery and Cadastral Surveying

The data acquisition via satellites apparently depends on the resolution of the satellite as compared to the desired scale range. Landsat TM data with 15 m panchromatic and 30 m multispectral resolution are at best suitable for the 1:200 000 global scale range, while Spot 5 with 2.5 m panchromatic and 5 m multispectral resolution is suitable for the national 1:50 000 scale. Ikonos 2 (1 m panchromatic and 4 m multispectral resolution) and Quickbird (0.6 m panchromatic resolution and 2 m multispectral resolution) images are suitable for the local and Cadastral mapping 1:10 000 scale.

2.3.1 Main Characteristics of Quickbird Satellite Imagery

The Quickbird satellite is currently the world's highest resolution commercial satellite, supplying panchromatic and multispectral imagery with 61-72cm and 2.44-2.88m resolutions respectively. The Quickbird satellite was launched on 18 October 2001 and has quickly become a popular choice for large-scale mapping. The Quickbird sensor has an across track coverage of 16.5-19km per swathe and has a high revisit rate of between 2-3.5 days however will only capture one swathe per overpass, unlike the IKONOS satellite.

In most aspects, the Quickbird satellite and imagery captured is similar to the IKONOS satellite. The satellite usually only captures imagery when tasked over a particular area and thus is not switched on all the time. Once captured, all imagery is placed in the Quickbird archive which is publicly accessible on the Internet, and discounts usually apply to archive imagery. The Quickbird satellite captures multispectral imagery in the same four bands as the IKONOS satellite and the purchaser can nominate a multisided polygon around their particular AOI and only pay for the imagery that they require. The same polygon restrictions as IKONOS apply. However, the minimum size of an AOI when purchasing Quickbird imagery is 25 sqkm and for new captures, 64 sqkm.

The Quickbird satellite also captures 11bit imagery, with 2048 shades of colour and the system corrected imagery supplied projected into a standard geographic datum and projection with similar spatial accuracies. Similar processing as that performed on IKONOS imagery, can be performed on Quickbird imagery to increase the spatial accuracy of the final product and supply the imagery reformatted to meet clients specifications (Quickbird Product Guide, 2005).

I. Geometric (spatial) resolution

Because of the large scale of the map an image, obtained by Quickbird is selected, which for the time being is with highest resolution – **61 cm in nadir for panchromatic image.**

II. Radiometric resolution

Data obtained by Quickbird, have 11-bit dynamic range, which improves visualisation and makes them appropriate for use in urban territories, and rural cadastre.

III. Spectral range

According to the spectral range, the delivered images are grouped as follows:

- **Panchromatic** – with range of 450-900 nm.
- **Multispectral** – four channels with different spectral range:
 - Blue (450-520 nm).
 - Green (520-600 nm).
 - Red (630-690 nm).
 - Near-Infrared (760-900 nm).

Main products of QuickBird

QuickBird offers satellite images in three basic products depending on the level of processing of the rough image: Basic, Standard and Orthorectified.

I .Basic Imagery:- appears to be the product with least additional processing. Just corrections for elimination of the radiometric and sensor distortion are made, and no other geometric corrections. It is delivered with additional files with information for efemerides, sensor position, etc. These data are needed for setting up of a rigorous sensor model. Basic Imagery is considered as most appropriate for further photogrammetric processing. Minimum order is a full scene 270-300 km².

II. Standard Imagery: - is an image, which is corrected with respect to the radiometric, sensor, and platform-induced distortions and the topographic distortion, using the GTOPO30 digital elevation model. The image is georeferenced and is made in a pre-set cartographic projection. It is possible to order parts of the scene (minimum area of 25 km²). A variety of this product is Ortho Ready Standard Imagery. It is appropriate for orthorectifying when using a ready digital elevation model.

III. Orthorectified Imagery: - is a product, corrected for radiometric, sensor and topographic distortion. Usually for its orthorectification, digital elevation model and geodetic points are used,

provided by the user. It is georeferenced and transformed into pre-defined cartographic projection.

Currently, diverse needs of land information and technological advancements have necessitated changes in land administration systems, which is placing great pressure on the way the organization do their business. The digital analysis of remotely sensed data has become an important component of a wide range of land studies. In addition, the compatibility of this for digital image processing and analysis offer many advantages. However, due to the low resolution of the former generation of satellite imagery, the use of satellite data in the surveying field has been limited. This has gradually changed with the introduction of high-resolution satellite imagery amongst other geo-information technologies.

In addition, the push for multi-purpose cadastres has been made possible by the availability of technologies to capture spatial data. The advancement in technologies such as the Global Positioning System (GPS), satellite imaging and total stations have all made the capture of digital spatial data a relatively quick and easy process. So there is now a vast amount of spatial data in digital form, stored by several organisations at various locations across the globe [Phillips et al., 1998].

As Ondulo J.D. et al, 2006 stated in his report, high resolution imagery is proving useful for cadastral surveys. Consequently, traditional cadastre and land registration systems have undergoing major changes worldwide. Investigative work and production projects have shown that a spatial resolution of 2m or better would be required to support most cadastral application. This threshold of spatial resolution has now been realized with the launch of systems offering the potential of up to < 4m multi-spectral spatial resolutions, and panchromatic quickbird sat-image with < 1m.

In recent years we can observe rapidly increasing interest in the practical application of very high-resolution satellite imaging. This technology provides a rich source of up-to-date, large

scale, geospatial Earth-observation data. Such images have already confirmed their usability in many mapping oriented application areas. The parameters (image resolution, repeat cycle, etc.) of VHR sensors combined with metric image properties have strong potential for Control with Remote Sensing. Such images can be used for determination of the area and land use of declared agricultural parcels. To be applicable for this purpose the images have to meet first certain requirements defined in relevant guidelines for example by European Commission in 2004. One of the important criteria is the orthoimage geometric accuracy at least 2.5m as RMSE (Root Mean Square Error) measured on a set of independent check points.

Moreover, these new technologies have certainly dictated changes in the development of spatial information management systems. For data capture some examples of the new technologies include satellite positioning systems such as the Global Positioning System (GPS), and remote sensing technologies and especially the new high resolution satellite imagery. The data base technologies that affect the storage of very large data sets have had a major impact on the spatial information revolution and especially on managing large spatial databases and data warehousing. This in turn enhances the advantage of producing a complete large scale cadastral map and land information system.

2.4 Global Positioning System

2.4.1 Use of GPS in Surveying

GPS (Global Positioning System) is a worldwide, all weather, 24-hours navigation and timing system. The position derived from the constellation of 24 operational satellites is of very high accuracy on a reference frame called WGS-84. The accuracy of the derived positions varies with the type of instrument used for collecting data, method used in the surveying, post-processing done and the method of post-processing. The accuracy varies from few mm to several meters. With the removal of S/A (Selective Availability), available prior to May 2000, the accuracy of GPS receivers has increased greatly, in autonomous mode. This has prompted the users and GPS receiver manufacturers to come up with low cost solutions for GPS surveying. The users have started using GPS for low cost mapping and manufacturers have started innovating and coming

up with miniature GPSs. With the availability of coast guard beacons, all over the coast, the differential corrections are available to the users, all over the world, for free. This has eliminated the need of another GPS receiver for better accuracy. Also real time differential corrections are available, at a nominal price, world over, through satellites. These factors have increased the uses of GPS in almost all walks of life.

This space-based technique is widely being used these days in association with other mapping technologies. These are devices, which tries to overcome the disadvantages, GPS and other surveying techniques have. GPS may not work in highly dense area or with more than 20-30% canopy. However, there are GPS available, which works even in more than 30% canopy. The advantages with the laser range finders and data loggers are that they are hardware and operating system independent. Any hand-held computers can be used for collecting and storing data from these devices. However, at present, they have not made their presence felt due to cost factor, but with time, they will be available at a fraction of cost to its present cost, and it will probably be widely used for mapping for GIS projects.

Another innovation is the integration of GPSs with mobile devices, like PDAs (Personal Digital Assistants), Cell phones etc. More and more people have started using GPS for locating themselves in real time and transmitting their location for LBS (location based services). There have also been advancements in the field of integration of GPS with other surveying devices, like TS (Total Station), LRF (Laser Range Finder) and Camera. The developments in the field of data collecting devices and miniaturization of GPS receivers has led to the use of GPS and data loggers for common mapping practices for collection of spatial and attribute data for GIS.

2.4.2 Types of GPS Surveying

The GPS, from its inception, has been a surveying and locating instrument. It has found application in different fields, and even in surveying, for different kind of surveying. A few of the applications of GPS in the field of surveying are described in the forthcoming paragraphs.

Geodetic surveying: Dual frequency GPS receivers, in differential mode, have been in use for quite a long time towards geodetic surveying for construction, highway surveying, mine

surveying, crustal deformation studies, to name a few. This type of surveying requires sub-cm level accuracy, and in some cases, even of the order of mm level accuracies.

GIS Mapping: Single frequency code measurement GPSs and availability of carrier phase measurement facility on these single frequency GPS receivers has led to the entry of GPS for spatial data collection for the GIS projects. These have eliminated the use of costly GPS receivers and data processing software.

Mobile Mapping: The miniaturization of GPS receivers and computing devices has evolved the technique of mobile mapping. In this technique, any mobile computing device, like palm-top, PDAs and laptops, running a mobile GIS software, is connected to a mobile GPS like Pretec card GPS with or without external antenna.

2.4.3 Positioning Property Corners with GPS

The property corners of many surveyed and platted parcels are usually marked with iron pipes or nails. If coordinates of these markers are somehow obtained and input into GIS software, it would only be necessary to connect the dots in order to get a very accurate parcel map. The resulting accuracy could surpass even that of COGO. Today, with the rapid development of the Global Positioning System (GPS), it has become relatively easy to get coordinates for the property corners. In order to obtain coordinates, two different strategies could be used: static positioning or kinematic positioning.

Hence, the choice of the strategy depends on the needs and available resources. Static method provides better accuracy (down to one centimeter) but it is more time consuming, as it requires longer standing time at each point in order to get an accurate reading. The kinematic method is less accurate (accuracy ± 1 to 10 feet) but, on the other hand, it is less time consuming. Satellite readings are obtained almost immediately as you walk from one pipe to another (Corlazzoli et al, 2004).

CHAPTER THREE

3. GENERAL DESCRIPTION OF THE STUDY AREA

3. 1 Physical and Socio-Economic setting of the Area

3.1. 1Geographic Scope of the Study Area

The study area, Bite-Ejersalefo KA, is found in Dendi Wereda, west Shoa zone of the Oromiya Region. It lies on the Addis Ababa -Ambo road about 70kms around the ihudgebeya rural town to the west of Addis Ababa. Prior 1975, the Wolonkomi area was made up of five local geographic units named as Dega Egu, Rare, Debisa, Kitchu and Ketema Akababi (Mesfine et al, 1971).

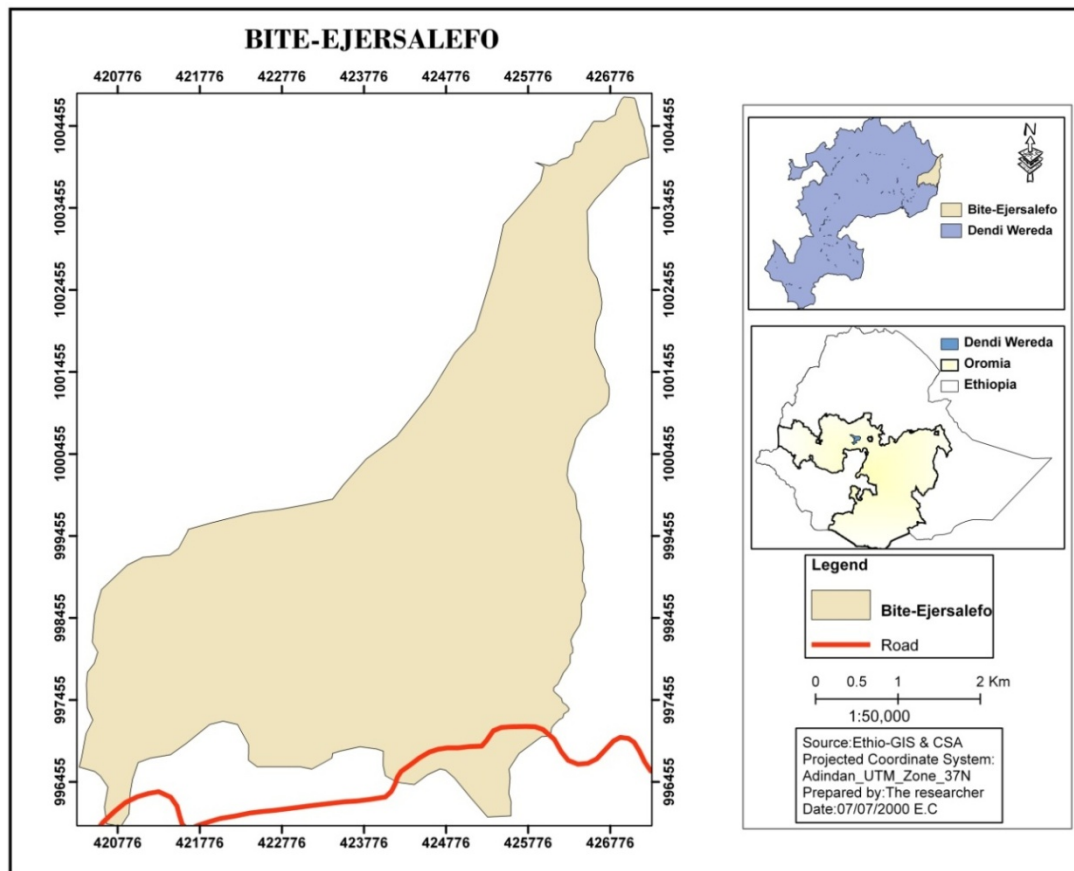


Figure 3.1 Bite-Ejersalefo KA Boundary Map

After 1975, it was restructured in to seven kebele administrative units named as Dega Egu, Gare Kora, Cheleleka Bobe, Kelana Imburto, Serwana Debisa, Koriso Odu Guba, and Bite Ejersa Lefo(Binyam,2005).

According to Dendi Wereda Agriculture and Rural Development office, it is currently restructured under two rural town centers for the purpose of service provision. Thus, Kebele Peasant Administrations(KPAs) named as Cheleleka Bobe, Kelana Imburto, Jemjem Legabatu, Fincha Gudeti, Gare Kora and Dega Egu organized within the Wolonkomi center , while Bite Ejersa Lefo, Serwana Debisa and Koriso Odu Guba under Ihud Gebeya. The whole wolonkomi locality covers an area of slightly greater than 156km², and most of its part falls within the Awash River basin.

Besides, the study area bounded by ten Kebele Administrations such as; chalalaka Bo,Gare Kora, Kalla Imbort, Kimoye, Korrisa Odda, LanKisa, Liti Guliti, Liti Mado and Sarrawa Debi.

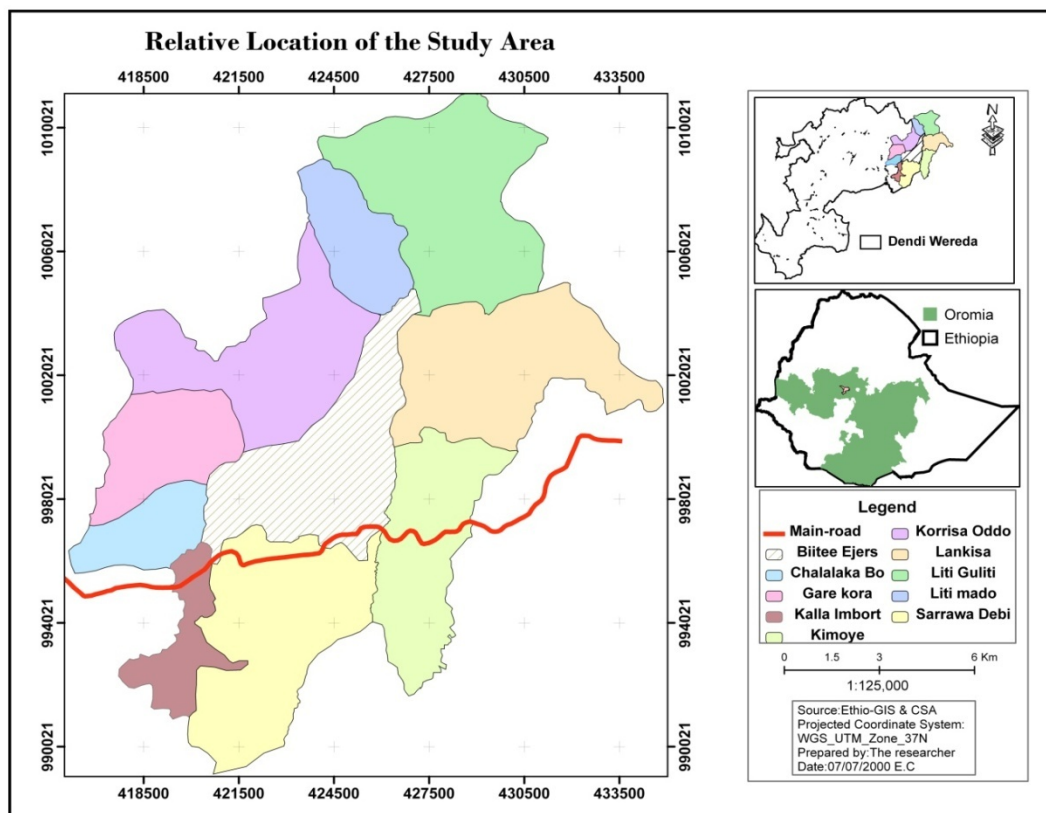


Figure 3.2 Relative Location of Bite-Ejersalefo KA with its' surrounding Kebeles

3.2. Geology, Topography and Drainage

The Wolonkomi area (i.e. Bite-Ejersa Lefo KA) is part of the central highlands of Ethiopia and it is similar to these regions in its physical and geological background. Its general landform is the result of the trappean lava series and it is closer to the unstable part of the country (Mesfine, et al, 1971).

The general elevation of the area ranges from 2080m above sea level at the course of River Awash, at the southern tip of Cheleka bob(Field survey Oct. 2006), to about 3000m above sea level at the Dega Egu mountains (Samuel, 2004). The northern part of the region is made up of the Dega Egu Mountains where a number of small streams emerge and drain to different directions. The central part of the region is an undulating landform and make up the upper plateau of Wolonkomi. The southernmost part of the area has no prominent heights or depressions and forms the lower plateau of the region (Mesfine et al, 1971).

The highest part of Wolonkomi forms a water divide between Awash and Abbay rivers and drained by three smaller streams that flow from the northwest to the southeast direction. Likewise, Bite Ejersa Lefo KA boundary almost shaped from two small local rivers i.e. huluko & shone river in the east and west respectively.

Besides the Bite Ejersa Lefo KA boundary almost shaped from two small local rivers i.e. huluko & shone river in the east and west respectively.

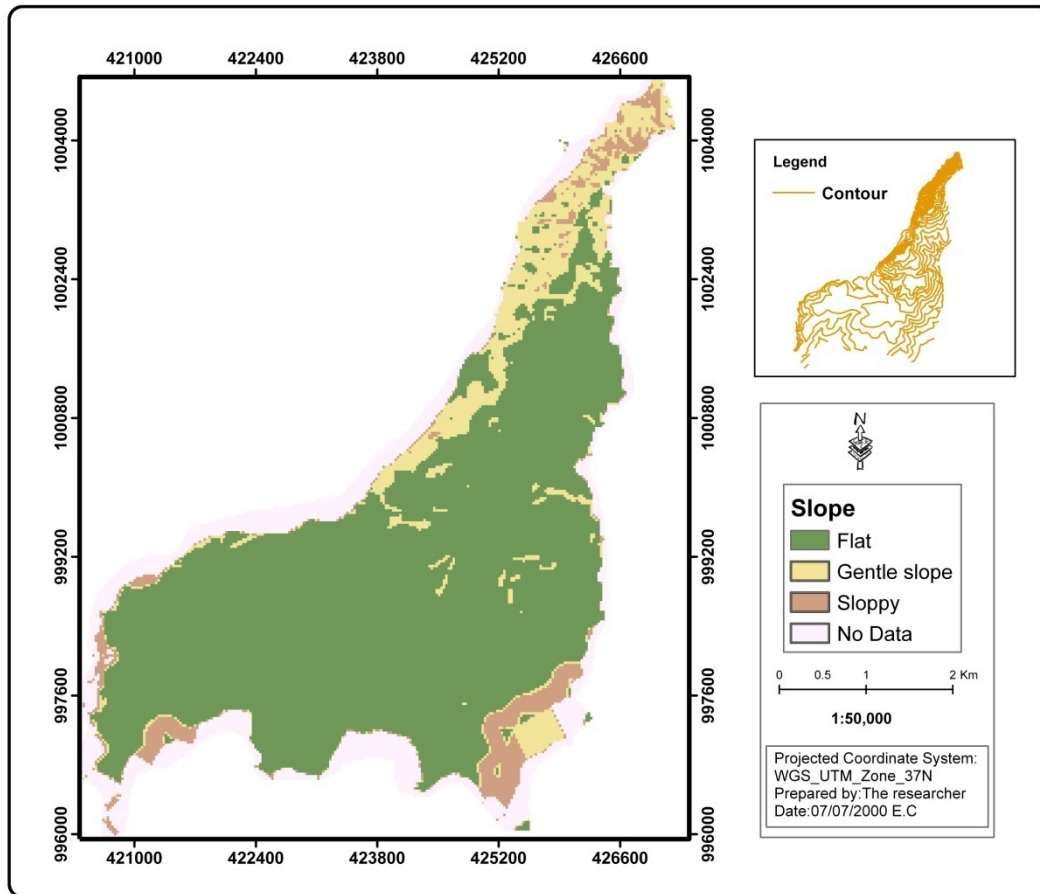


Figure 3.3. Slope and contour map of the study area

Source :Digitized from 1:25,000 topographic map

3.3. Climate and Vegetation

Temperature in Wolonkomi area varies from north to south following the altitudinal sequence of the region. The northern mountains of Dega-Egu experience a relatively colder temperature as compared to the lower plateau areas. Based on climatic data at Addis- Alem 9⁰03' N, 38⁰24'E, at an elevation of 2340 meter above sea level temperature ranges from 15.5⁰c in November to 19.9⁰c in May and the mean annual temperature is 16.5⁰c. The average total annual rainfall equals 1100mm with summer maximum. The area generally lies within the Dega and weina Dega traditional climatic zones and included in the wet summer rainfall region ((Binyam, 2005; Samuel, 2004; Mesfine et al, 1971).

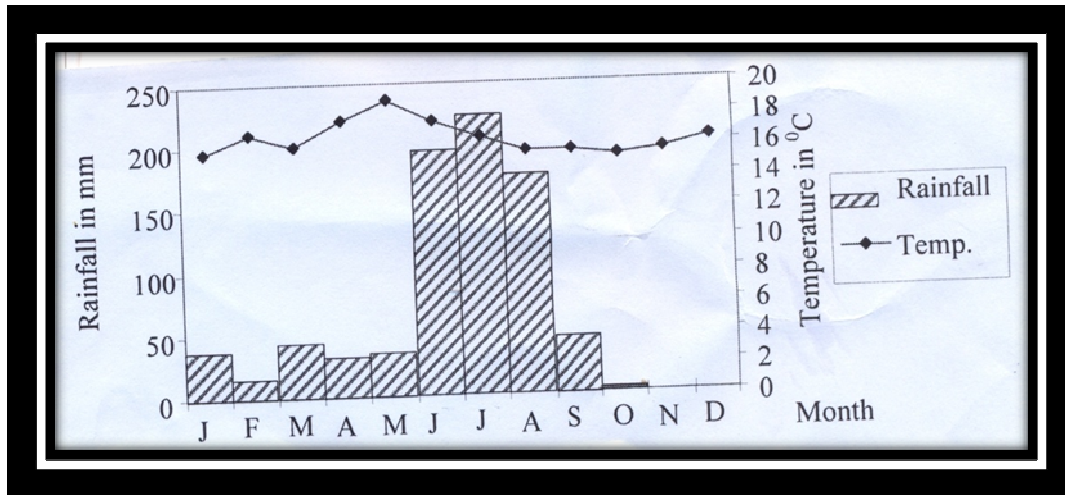


Figure 3.4. Climatic graph showing rainfall and temperature values.

Source: National Meteorological Service Agency (cited in Samuel, 2004)

According to the discussion with the local elders before fifty years the upper slopes of the study area were covered with indigenous forests and the lower plateau was covered with woody grassland vegetation (Mehrete Belay, 2007). Nowadays, the original forests are removed and converted to cultivated land and in some areas replaced by shrubs/bushes and by Eucalyptus plantation. During the field work, in May, 2008, the researcher has observed the remnant bushes of Weira (*Olea africans*), Tid (*Juniperous procera*), Zigba (*Podocurpus gracilliar*) and thorny bushes such as Kega (*Rosa abyssinica*), and Agam (*Carrisa edulies*) on the slopes of the Kora ridge, as well as acacia bushes and trees on the lower plateau areas along the banks of Ejere river.

3.4. Population and Settlement

Before 35 years, the total population of Ejersalefoa was about 1761. But as shown on (table 3.1) below, the population for the two newly structured KPAs under Bite-Ejersalefo was 2860 in 1984, 4010 in 2005, and 4500 in 2006. The number for 1971 seem lower than the 1984 and so on. This is because natural population increase that was happened in most part of rural. Besides these two KPAs are now organized under service center of Ihud Gebeya.

Table 3.1 Population size of the study area by KPA based on Sex.

KPA	1971	1984		2005			2006			
		male	female	total	male	female	total	male	female	total
Bite-Ejersalefo	1761	1410	1450	2860	1383	1231	2614	2278	2110	4388

Source: Central Statistical Authority (CSA,2007)

In the study area, the settlement pattern is made up of clustered villages scattered all over the area. Most of the houses are grass covered with some corrugated iron sheet roofs. Besides this, two linguistic groups, Oromos and Amharas, and the majority religious groups Christians live in the area with the dominant being orthodox.

3.5. Economic Activities

Although no detailed data is found for all economic activities, agriculture is the main occupation of the people in the study area. As observed from discussions with the elders and KPA officials, mixed farming (animal rearing and crop cultivation) is widely practiced in Bite-Ejersalefo. The main crops cultivated in the area include cereals, pulses, spices and oil seeds. Among cereals, teff (*Eragrostis abyssinica*) is the most important crop widely grown in the area for both market and household uses. It is the leading crop grown in the area in terms of area coverage and volume of production. In 2006/2007 crop year, teff covered 61.54% of the total cropland and 50.08% of the total crop yield in the study area. The area covered by teff crop has increased from 56.27% in year 2003/2004 to 61.54% in 2006/2007 crop year. The second most important crop in area coverage and in volume of production next to teff is wheat. It covered 15.38% of the crop

field and accounts for more than 22% of the total volume of yield produced in year 2006/2007(see table 3.2 below).

Table 3.2 Agricultural products and plot size they cover in Bite-Ejersalefo (2003/2004, 2006/2007)

Crop type	2003/2004		2006/2007		yield		fertilizer	
	area		area		Kuntal		kuntal	
	ha	%	ha	%		%		%
Teff	700	56.27	800	61.54	8000	50.08	1000	79.97
Wheat	200	16.08	200	15.38	3600	22.53	200	15.99
Lentils	100	8.04	10	0.77	60	0.38	10	0.80
Maize	30	2.41	20	1.54	300	1.88	25	2.00
Guaya	65	5.23	100	7.69	1600	10.02		
Spices	10	.80	20	1.54	250	1.56	10	0.80
Others	139	11.17	150	11.54	2170	13.58	5.5	0.44
Total	1244	100	1300	100	15980	100	1250.5	100

Source: Adopted from Mehrete Belay,2007)

3.5.1 Plot size and fragmentation in Bite-Ejersalefo

The size of the farm plot is one of the most important physical attributes that can determine the amount of crop yield received per household to support the livelihood of the family. It is the question of whether the size of the farm plot is adequate or not to produce sufficient food for the family. Thus, the size of the plot and the mode of access to it can decide the livelihood and wealth level of the family. This is because land is the basic source of all kinds of wealth.

According to Mehrete the sample survey study indicates that the farm size in the study area ranges from less than 0.5 ha. to over 4.5 ha. 10% of the households (in which all belong to the poor farm group) own < 1.0 ha. of land and the plot size of 31.67% of the households ranges from 1.1 to 2.0 ha., while 23.33% of the other households plot ranges from 4.1 to 5.0 ha. Generally, 41. 67% of the surveyed households own a plot size of < 2.1 ha. 46.07% of the surveyed female households also own less than 2.1 ha. of farm land. The survey statistics also shows that the entire medium farm group owns a plot size of greater than 1.0 ha. and that of the

rich group own a plot size of greater than 2.0 ha. This implies that land size varies with wealth category of farmers (see fig. below). This may also indicate that the well to do farm households have the potential to produce more crop yield than the poor farm households.

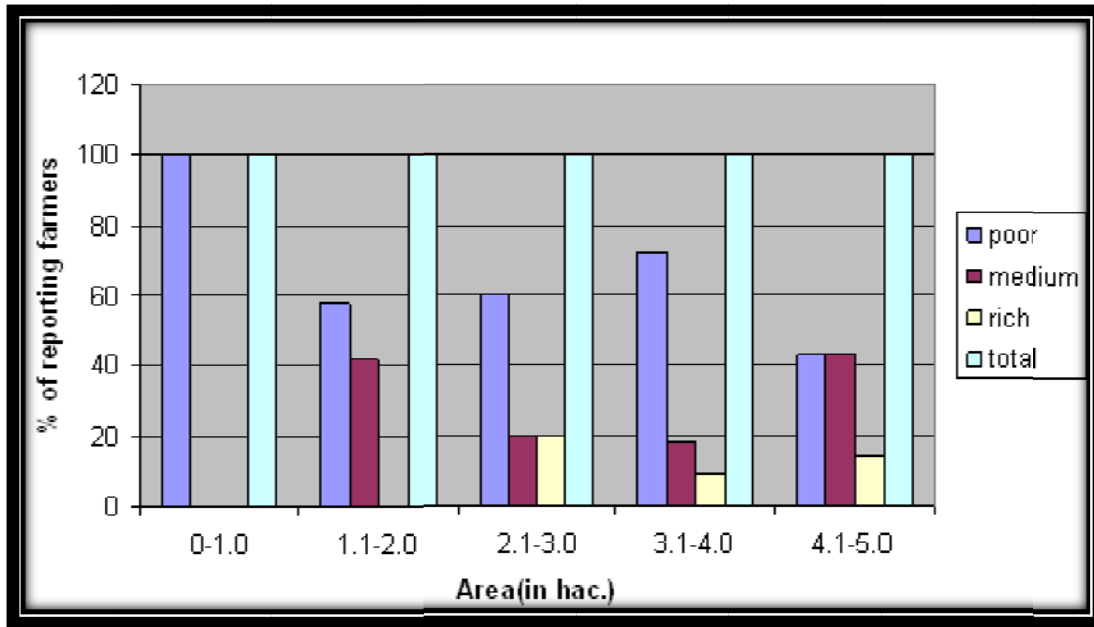


Figure 3.3 plot size by wealth category; Source: Adopted from Mehrete Belay,2007)

CHAPTER FOUR

4. DATA COLLECTION, MATERIALS AND METHODOLOGY

4.1 Data Collection

The information presented herein has been collected through the use of both primary and secondary data sources. Secondary information was obtained and analyzed from different data sources such as; books, journals, Internets and data from the Bite Ejersa-Lefo kebele Administration etc.

Besides, on the basis of these the researcher coming with:-

- Establish the existing knowledge base with respect to the research issue at hand , i.e. countries experiences on cadastral surveying and mapping.
- Socioeconomic and physical data of the KA and
- Detailed and broad literature review

Whereas, the primary data collected during the field work was using handheld GPS as well as parcel data extracting from Quickbird satellite image and Google Earth.

As already stated above the primary data collection were undertook using two procedures:-

- ★ From HHGPS point coordinates collected from the sample parcel data.
- ★ Extracting point coordinates from the sample parcels of panchromatic Quickbird satellite image and Google Earth.

4.1.1 Physical Observation

Direct observation constituted a major data collection tool both at the reconnaissance stage and during actual survey. To facilitate rapid interpretation of observed features, observations and data collection were aided by printed satellite images and topographic map of the study area at the scale 1:25000. (See in the figure 4.1)

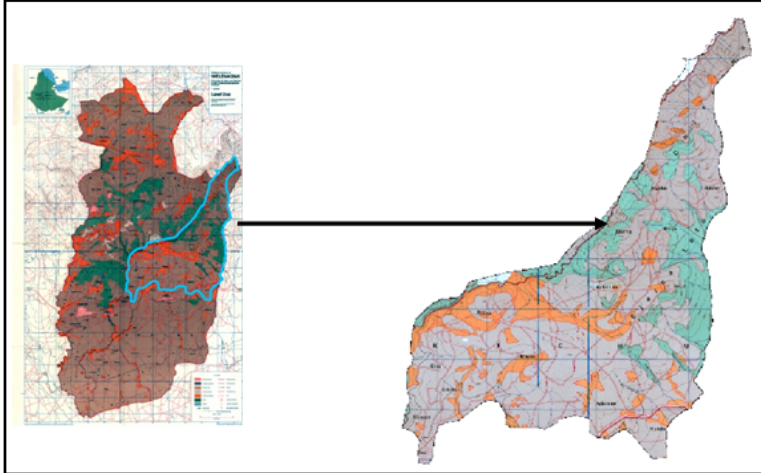


Figure 4.1 Top sheets (1:25000) of Welenkomi Area with the Bite Ejersa Lafo on the right

4.2 Materials and Data sources

4.2.1 Data sources

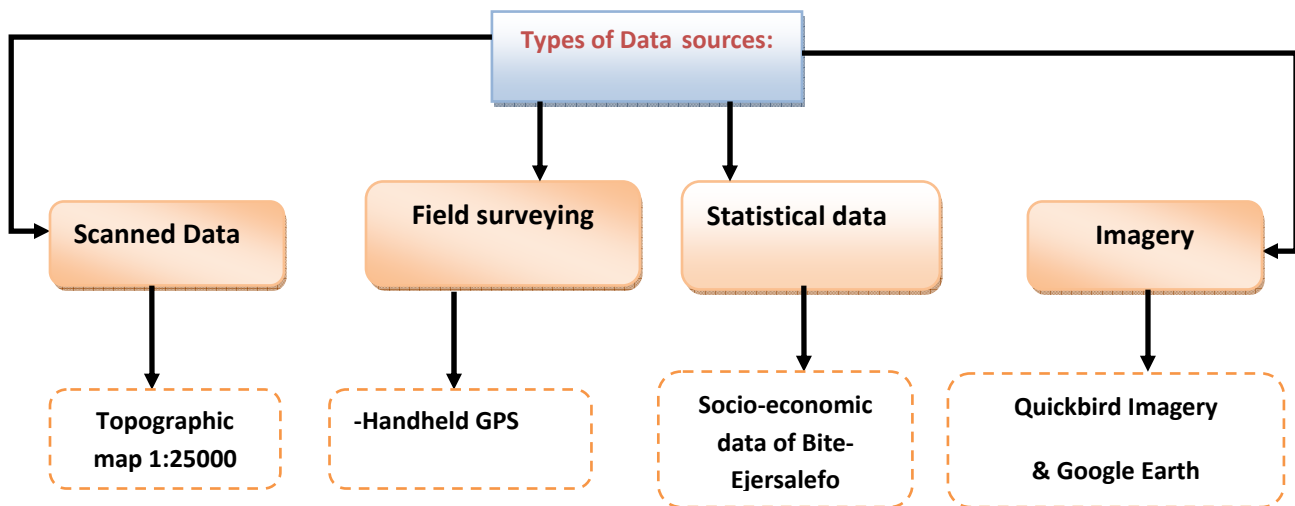


Figure 4.2: Graphical representation of Data sources used in this research; source: the researcher

Besides, the coordinate system used throughout this thesis UTM WGS 84. Hence, all the produced maps were based on the mentioned coordinate system.

I. Metadata

Quickbird characteristic

Main requirements to be satisfied in order to use QuickBird data as a source of information for parcel identification applications can be identified as follows:

- High geometrical resolution (for large scale projects)
- Multispectral capabilities
- Radiometric sensitivity
- Good positioning accuracy
- Revisit capabilities
- Large image size

Imaging data	Quickbird
Date of acquisition	4 may 2005
Time of acquisition	9:35
Off nadir angle [°]	5°
Type of data	PAN
Type of product	standard Imagery
Radiometric resolution	16 bit
Field resolution [m]	0.61 m
Scene size [km]	16 x 16 km
Cloud cover	2 %
Dimension	6876 x 8568 x 4 [BSQ]
Size	[Unsigned Int] 536,463,360 bytes.
File Type	PCI

Table 4.1: Metadata of the Quickbird satellite image; Source: the researcher

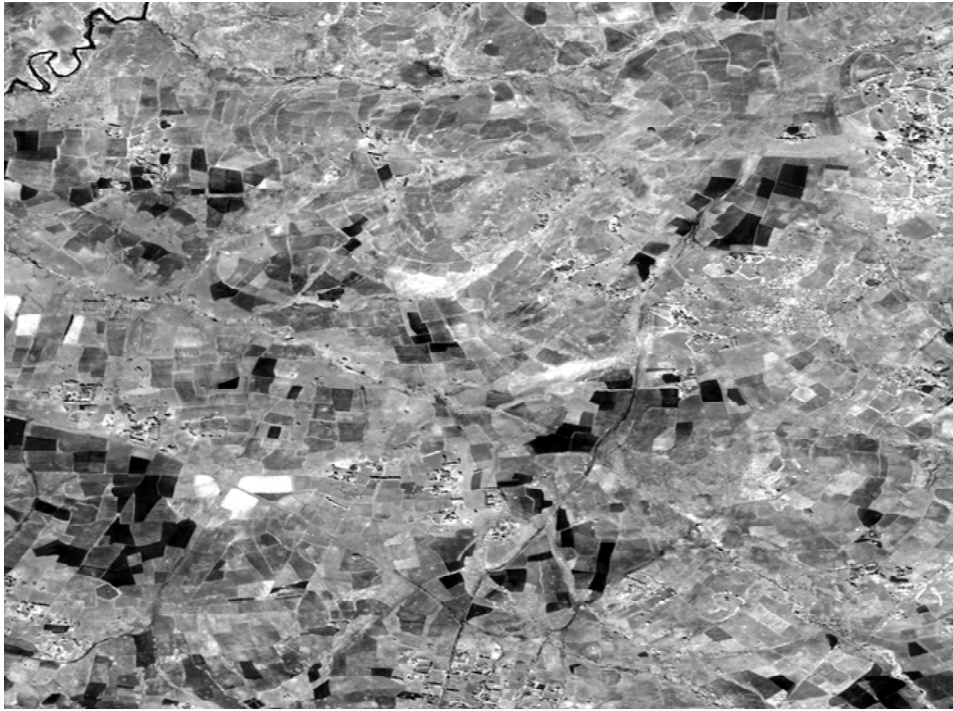


Figure 4.3 Portion of the Quickbird of the study Area (i.e raw data)



Figure 4.4 Portion of the Google Earth of the study Area (i.e raw data)

4.2.2 Materials and soft wares

The soft ware's used in this research in order to analysis the given data were:

I. Soft wares

✚ ARCGIS 9.2

✚ ERDAS IMAGINE 9.1

✚ ENVI 4.3:- this soft ware was used in order to read the uncommon file format(i.ePCI) which was difficult to open in both ARCGIS 9.1 and ERDAS IMAGINE 8.6.Besides,for visualization and identification various features from the available satellite image.

✚ Various GPS soft ware's (example, MN DNR Garmin 5.4)

II. Materials

❖ Handheld GPS(i.e eTrex Garmin and GPSMAP76CS)

❖ Digital camera etc

4.3 Research Methodology

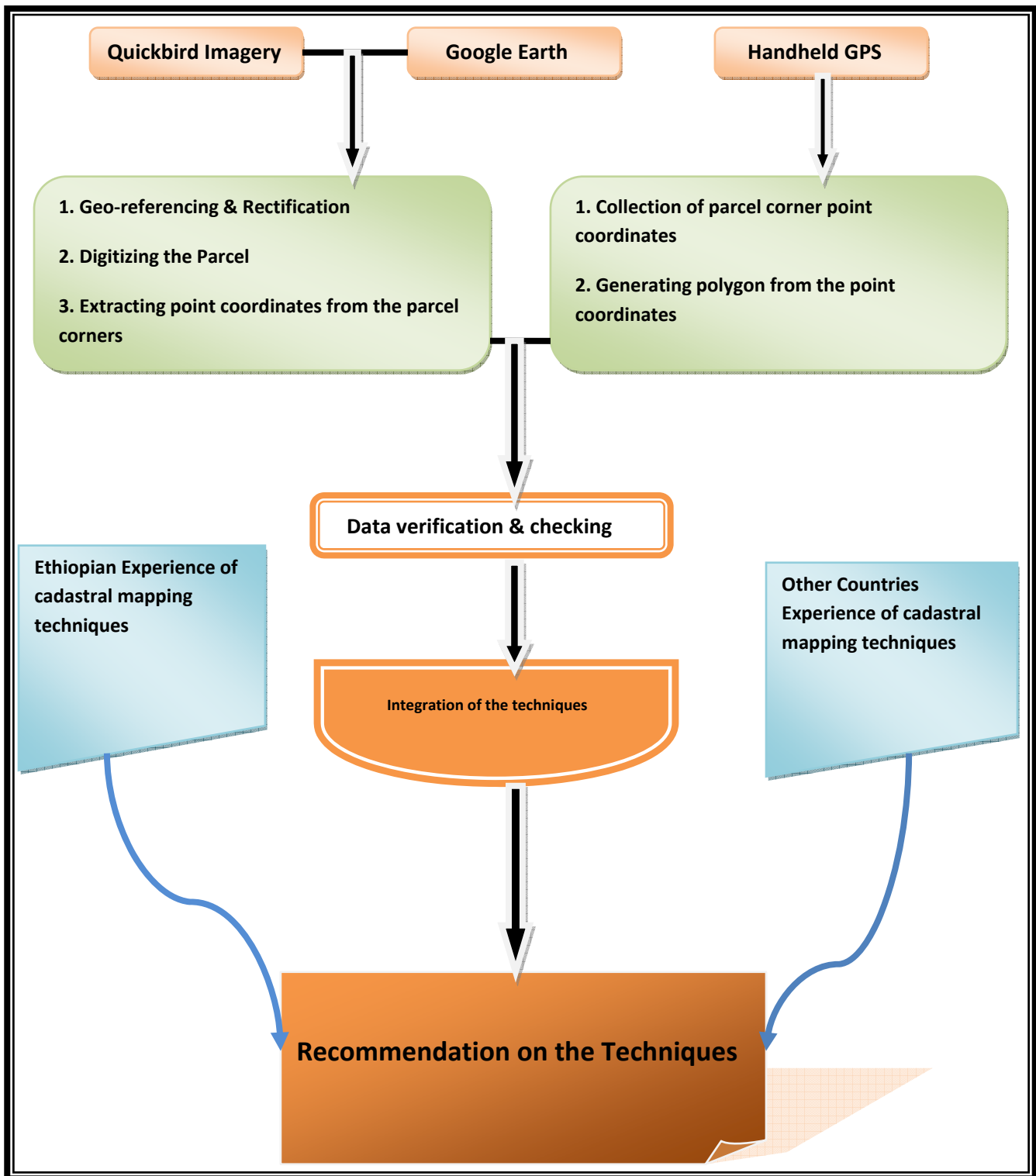


Figure 4.5 Research Methodology

CHAPTER FIVE

5. Countries Experience on cadastral surveying system

5. 1 Experience of cadastral system and surveying

The objective of this chapter is to assess the general situation of land Administration and cadastral system of the world based on the experiences of some selected case studies that are already stated and provided by various organizational reports. Many of these initiatives have previously been carried out by the International Federation of Surveyors (FIG), the UN Economic Commission for Europe (UN-ECE), cadastral template project etc.

In view of that, it is impossible to assess the whole world cadastral surveying system within this thesis work, but it is possible to come with the experiences of some selected countries. The selection method is based on the countries experiences in relation to Ethiopian background focus of interest for instance; topography, institutional and organizational framework.

According to Bogaerts (1999), the most critical success factors for cadastral systems are legislation, organization, financing, data and its quality, technologies used and human resources. Among these, organisation and management are most critical in the context of the Phase Countries. Along these lines, there are two documents available as guidelines for land administration. First, the UN-ECE (1996) provides a series of guidelines covering the broad understanding of land issues and the role of land administration, while the UNCHS (2001) elaborates guidelines for the improvement of land registration and land information systems in developing countries (with special reference to countries in Eastern, Central and Southern Africa). The study shows that these guidelines do not focus in detail on the system development process issues (users' needs, data and process models, system architecture, etc.). The implications of evolving Geo-ICT in the implementing organizations are too many. Hardware and software are changing quickly, and are costly to purchase and maintain. Communication networks and human resources are both limited. But requirements are changing owing to changes in governmental policies.

Therefore, the organizations in the developing countries are unable to cope with the changing requirements of users and the evolving nature of Geo-ICT technologies in data collecting, processing, maintaining, storing and disseminating land information. The organizations are unable to absorb these new technologies into their functions or business processes owing to a lack of financial and organizational capacity. Secondly, there are no mechanisms embedded in the organizations to understand and monitor the changing requirements of users and stakeholders regarding cadastral surveying system.

5.1.1 Organizational framework

Currently the World Bank is supporting at least 13 implemented cadastral land titling and registration projects with a total loan value of about US\$550 million. This represents about 1% of total World Bank lending on an annual basis, which is significant. This compares with the decade of the 1980s and the 1990s when about US\$150 million was lent for just three projects. The current projects are in Algeria, Argentina, Bolivia, El Salvador, Indonesia, Lao PDR, Lebanon, Nicaragua, Papua New Guinea, Paraguay, Russia, Venezuela, and Thailand. Furthermore, at least ten more projects are under preparation including those in Armenia, Georgia, Guatemala, Honduras, Kazakhstan, Moldova, Peru, Romania, Ukraine, and Viet Nam.

This World Bank experience is presented as representative of some of the current world wide activity in land titling and registration, in a search for lessons and best practice. Also it is considered somewhat representative of similar support by other multi-laterals and certain bi-laterals agencies. The Asian Development Bank is currently supporting studies or projects in Viet Nam, Bangladesh, and in one province in China. The European Union is supplying technical assistance in at least Romania, Ukraine, Bulgaria, Poland, and Russia. The Inter-American Development Bank is active in many Central and South American countries, while bi-laterals such as USAID are providing technical assistance including to Russia, Ukraine, Albania, Armenia, and Kazakhstan. Also AusAID is currently supporting projects including in Thailand, Indonesia, Laos PDR, Viet Nam, and Huinan, China.

Similarly in Ethiopia the organizational setup of land Administration in general and cadastral surveying specifically is undertaken in both Governmental and Non-Governmental sectors like any other countries of the world. To mention Ministry of Rural and Agricultural Development in collaboration with USAID coming up with ELATP (i.e. Ethiopian Land Administration and Land Tenure), and SIDA the Swedish organization.

However, the organizational framework regarding cadastral surveying system in Ethiopia is not established yet. This to mean as far as the knowledge of the researcher until now there is no a sole structured sub-organizational sector of cadastral surveying office. Even though, according to the Ethiopian constitution Land related matters is the affair of Ministry of Rural and Agricultural Development; compare to other countries institutional system of cadastral surveying it is found to be at its infant stage.

From such projects come diverse worldwide experience and lessons, several of which this research tries to assess the general circumstances of some countries experiences in comparison with the Ethiopian institutional and technical issues of land administration and cadastral system, the information technology dimension .

Hence, the design of land administration systems is very critical to its performance and sustainability. Land administration systems should be flexible enough to meet the evolutionary developments in society. The design should allow for gradual migration from simple to more complex systems instead of immediately focusing on the highest achievable cadastral accuracy and individualization of title (Molen, 2002a; Molen and Lemmen, 2004).

Table 5.1 Comparison of land administration systems

Continents	Legal framework	Administrative framework	Organizational and Infrastructural framework
Western Europe, North America, Australia, New Zealand	Policy review on information laws e.g. access to information, costing and pricing of services/products Problems with registration of public and native land rights	Centralised system architectures Functional restructuring and reviews Service improvements e.g. customer focus Cost recovery 100% cadastral coverage	Efficiency in service delivery e.g. electronic access to products and services Trends towards integrated land information infrastructures
Central and Eastern Europe	Problems with management of minority tenure rights	Improved land information systems	Incomplete land registers and cadastral coverage
Latin America	Neo-liberal land policy	Ineffective decentralisation of land administration Varying cadastral coverage (e.g. 5% in rural Guatemala; 50% in Ecuador)	Struggling with implementation of land redistribution reforms
Africa	Legal pluralism Widespread communal and informal tenure systems Conflicting and overlapping land laws Innovative land reforms	<i>Lack of financial, human, technical resources/capacity</i> <i>Inefficient land administration systems</i> <i>Minimal cadastral coverage (1% average)</i>	Inefficient (lengthy and costly) service delivery with manual systems Poor land information infrastructures
Asia and Middle East	Islamic land law in Arab countries Varying legal frameworks e.g. nationalisation in China; dual tenure system in Thailand; no land registration in Vietnam	Ineffective decentralisation of land administration (with the exception of Thailand) Varying cadastral coverage (e.g. 10% in Cambodia, 64% in rural Turkey)	Problems with land classification (private/public land) and establishment of boundaries in forest and national park areas

Source: Tabulated from www.worldwidecadastral.org

The table shows especially in the continent Africa the cadastral map coverage averagely almost less than 1 %. This indicates that the limitation of large scale map in Africa has been a great challenge for the development of spatial data infrastructure.

Likewise, the decision to embark on a certain type of land administration system and the level of complexity and accuracy should be determined by the purpose the system has to serve. Land administration systems may be designed to focus on one or more objectives e.g. it may focus on maximization of revenue through land taxation or on stimulation of land market operations. The minimum requirements to be met by the system should be clear. The system should also reflect the needs and aspirations of the people for whom it is designed. Burns, Grant et al (2003) and Molen (2003b) provide comparative analyses of different types of land administration systems around the world. Their analyses are summarized in Table 5.1 above.

Geospatial Data

Topographic and Thematic Mapping had its early roots in exploration and in military strategic and tactical planning. It has been recognized in the last century that they are an indispensable part of national and global planning strategies forming the base data for a spatial data infrastructure. The United Nations Secretariat has monitored the progress in mapping throughout the UN Regional Cartographic Conferences. The last summary published in 1993 reflects the situation for the different scale ranges for the continents of the globe, shown in Table 5.2 below:

Table 5.2: Status of Topographic Mapping worldwide

Continent \ Scale range	Africa	Asia	Australia & Oceania	Europe	former USSR	North America	South America	World
1:200 000	89.1 %	100 %	100 %	90.9 %	100 %	99.2 %	84.4 %	90.2 %
1:100 000	21.7 %	66.4 %	54.4 %	87.5 %	100 %	37.3 %	57.9 %	58.9 %
1: 50 000	41.1 %	84 %	24.3 %	96.2 %	100 %	77.7 %	33 %	56.1 %
1:25 000	2.9 %	15.2 %	18.3 %	86.9 %	100 %	45.1 %	7 %	33.3 %

Source: Tabulated from (Molen and Lemmen, 2004)

5.1.2 Cadastral Template or Model

The cadastral template is a standardised generic proforma that enables the discovery of information, including matters concerned with member countries' land policy, laws and regulations, land tenure, land administration and cadastre, institutional arrangements, SDIs, technology as well as human resources and capacity.

As a result, in terms of the registration and cadastral surveying of land, the nations faring the worst are Cambodia, Indonesia, Japan and Namibia (see fig.5.1 below). Only 10% of rural and 18% of urban parcels are legally registered and surveyed in Cambodia, which is largely due to a rebuilding phase (post Khmer Rouge) that the country is currently undertaking. Japan is another country with low levels of registration (18% urban, 46% rural) and the reason for this is unclear. Japan has the highest total number of land surveyors out of all the nations in the study, but data pertaining to the percentage of time they spend on cadastral matters was not given.

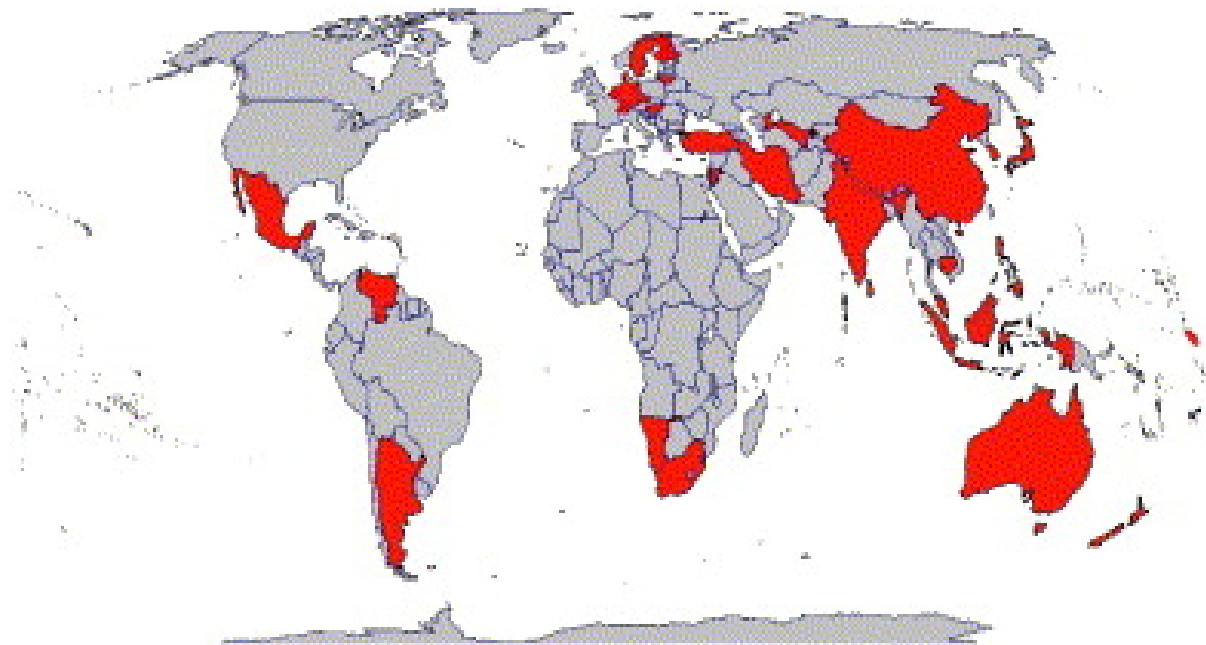


Figure 5.1 Map of cadastral template participating nations.

Source: www.cadastraltemplate.com

The large number of surveyors may indicate an attempt to rectify the lack of legally registered and surveyed parcels; this theory is supported by the systematic approach they are taking to the establishment of cadastral records. Indonesia has a total of 20% of rural and 40% of urban parcels registered and surveyed. The reason for the low percentage of rural parcels surveyed and registered is predominantly due to the occupation of land by illegal settlers and lack of cadastral infrastructural matters.

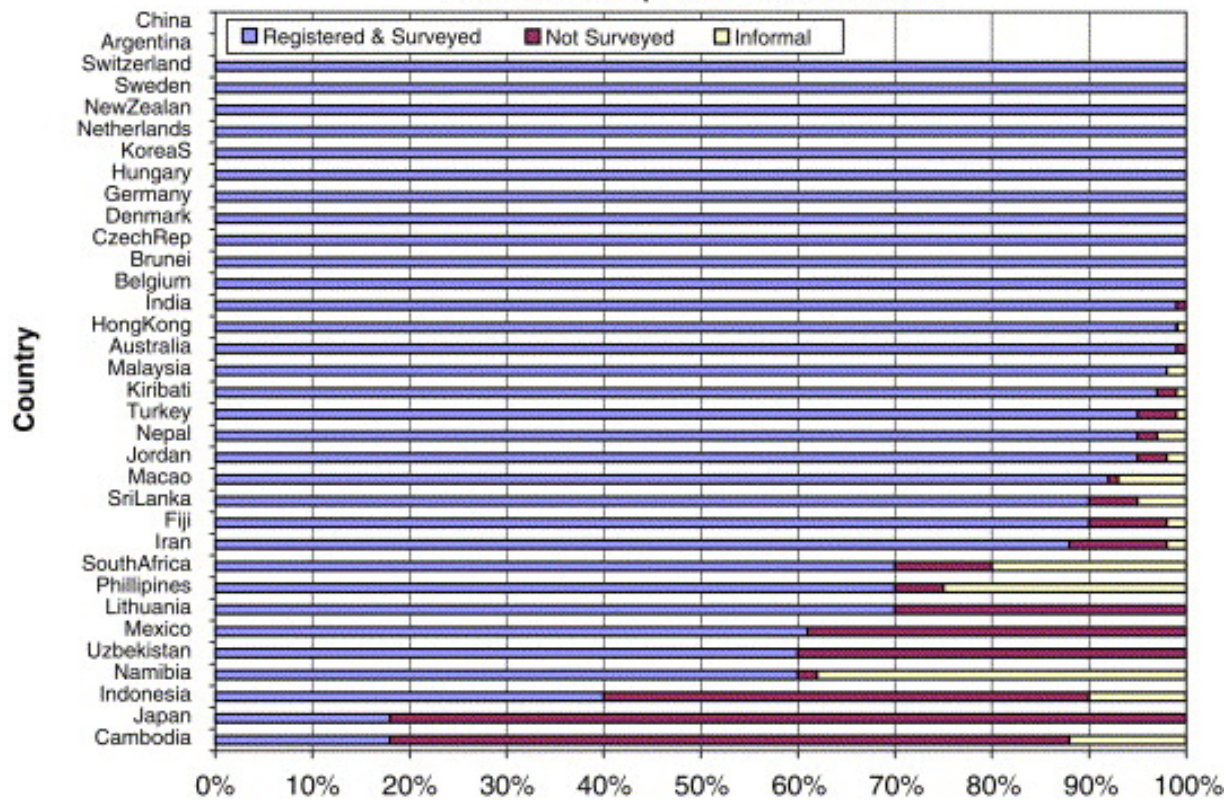


Figure 5.2 registered and surveyed some countries of the world

Source: cadastral template report 2007, www.cadastraltemplate.com

The nations with total coverage of their cadastral records (100% legally registered and surveyed) include Belgium, Brunei, Czech Republic, Denmark, Germany, Hungary, South Korea, the Netherlands, Sweden, and Switzerland.

5.1.3 Countries Experience on Cadastral surveying Methodologies

Few cadastral projects have used satellite imagery to delimit parcel boundaries. Argentina and Nicaragua have experimented SPOT 4 on fiscal and physical cadastral plans but could not achieve accurate boundary maps because of the poor resolution of the image, (Axes, 2004). The launch of SPOT 5 improved the geometric performance of its previous models and has brought a significant support to cartography.

In Guatemala, SPOT 5 imagery has been evaluated with data from total stations – GPS measurements and orthoimage identification for different types of parcels. Good results were obtained for large and medium extensions; although it presented its limits for identify accurately small parcels, peri-urban and urban estates. The accuracy of identification depended directly to the size and shape of the property, the topography of the area, the type of fences and vegetation coverage present on the study area as well as the scale of the orthoimage used in the identification process (Corlazzoli, 2004). The Guatemalan research recommended the use of SPOT 5 orthoimage as an input that can be considered in countries regarding cadastre with less strict precision.

Mamoru et al (2002) considered the possibility of IKONOS imagery for making topo cadastral maps. The results suggested that IKONOS imagery has advantageous characteristics of interpretation for making and updating middle scale topographical maps such as 1:25000, compared with analogue aerial photo. The horizontal accuracy of IKONOS ortho-imagery varies between 1.0-1.2m in flat areas and is worse in mountain areas. QuickBird satellite imagery has the highest resolution, among the satellite imaging systems that are commercially available. This will definitely be the possible immediate option in resolving Kenya's PID problem.

QuickBird has panchromatic and multispectral sensors with resolutions of 61- 72cm and 2.44- 2.88m, respectively, depending upon the off-nadir viewing angle (0- 25 degrees), the geometrical resolution can be easily compared with the one resulting from an average scale aerial flight (Cay et al., 2003). The sensor covers 16.5-19km in the across-track direction. In addition, the along-track and across-track capabilities provide stereo geometry and a revisit frequency of 1-3½ days. The data is available in different formats, including the raw data format (Basic Imagery), which preserves the satellite geometry and is preferred by the photogrammetry and mapping community to achieve high accuracy geometric correction and geospatial products, (DigitalGlobe, 2002)

Cay et al., (2003) has enlisted the following to be some of the major strengths of QuickBird image as a source of information for cadastral survey: High geometrical resolution (for large scale projects), Multispectral capabilities, radiometric sensitivity, Good positional accuracy, Revisit capabilities and large image size.

5.2 The Experience of African countries in cadastral System

5.2.1 Demands on Cadastre

African countries in general have large areas of land, which are sparsely populated. The economic output from these lands is generally very low. Only specific types of land use can generate income that can motivate the investment in a cadastral system. One aim of a cadastre is to provide security of tenure. The customary tenure system in African countries, which usually comprises most land, provides adequate security of tenure for the members of the community. Transfer of land between members of the community can usually also be handled with enough security within the traditional systems. There is therefore no need and consequently no demand from land users of systematic establishment of cadastral systems in these large areas. Any attempt in that direction will consequently fail.

The traditional system is however unable to provide appropriate security of tenure in areas where it no longer exists, or are being misused or for other reasons are falling apart. One such misuse

occurs when traditional leaders start to look upon themselves as owners (instead of custodians on behalf of the community) of the land and see opportunities to own money on land transactions and speculations. Other disturbances of the customary tenure occur with migration of people, mixing of people of different origin, diseases and calamities, investment by foreigners, and the urbanization. In all these situations, which are more and more frequent, there is a demand for some kind of more elaborated cadastral system in order to provide the security of tenure that the customary tenure fail to provide. But the system must be appropriate, which means that they must be designed in such a way that they are affordable and accessible for the users. African countries need economic development and thus need investments. One of the most important sectors for investments in African countries is agriculture and other types of efficient land use. Capital needs to be brought in from abroad. This will not happen without a cadastral system, which can provide security of tenure for these investments. The investor needs security for his investment. He also needs to finance his investments through financial institutes, which in turn will demand security for the credit provided.

Also indigenous people who likes to develop; entrepreneurs need access to security of tenure and for mortgages in order to be able to attract capital. Obviously, there is an urgent need for development of cadastral systems in African countries to promote economic development.

Demands on social justice will also create demands on the establishment of cadastral systems. Women's rights to land and property are usually protected by modern legislation and constitutions in African countries, while practice in case of divorce or decease of the husband usually is governed by traditional law. Traditional law does usually not protect women's rights in the same way as modern legislation. Cadastral systems will improve the possibilities for women to protect their rights according to the modern legislation. Cadastral systems will allow the establishment of procedures for fair land allocation prevent land speculation, protect ethnic minority interests etc. One consequence of aids is a demand to provide for proper registration of property to protect children's access to heritage after their parents.

From government point of view, land information is needed for taxation of land and property, and for better decision-making for sustainable development of land resources, through for instance land use planning, improvements of land management practices and for environmental

protection. Land markets are usually regarded as more efficient on allocating land resources to most economic use than traditional land tenure systems. In order to function well, with low risks and low transaction costs, land markets need cadastral systems to provide reliable information to the actors on the market. However, cadastral systems will not create land markets. When economic development in an area is reaching such levels, when demands on a more efficient land market occur, the time will be ripe to introduce cadastral systems. Economic development, investments etc can create conflicts between investors and traditional land users, Modern governmental administration can come into conflict with traditional leader's authority and also into conflicts with local communities. Often much money is involved and temptations for corruption occur. Cadastral systems can be demanded in order to establish more transparent procedures and to allow for solving interest conflicts of this kind to the benefit for all parties.

Generally, the cadastral system in most African countries is in its' inception stage that is with less than 1% cadastral map coverage. And most of the countries are used a measurement based cadastral surveying which traditional method of surveying. For instance, the Egyptian Survey Authority (ESA) started developing cadastre since 1988, using the total station technique. About 1.2 million parcels (feddans) of total nine million parcels were covered by cadastral maps. The shortcoming digital maps with no attribute data have been produced which is incomplete cadastral map.

However, in relation with other African countries Egypt, Kenya, Uganda and South Africa have relatively well organized cadastral surveying and mapping administrative as well as technical framework. For example, the cadastral surveying of Egypt was established during the period 1897-1907. This because, the increase in the total area of cultivated land and the rapid escalating need for planning of national projects, highways, canals as well as updating land information require non-traditional solution of such large-scale maps.

Kenya is perhaps the best examples of a country, which has tried to establish European like cadastral systems for land registration through adjudication of existing traditional rights in very systematic and comprehensive way, through different more and more simple methods in order to keep the costs for the registration as low and affordable as possible. Several millions of parcels have been registered in these adjudication processes. Yet, there is no clear evidence that this enormous investment by the government is contributing to economic development in a way that should motivate the investments made. On the contrary, the cadastral system thus established seems in many cases to fall apart through lack of proper maintenance. The poor maintenance can depend on many different causes, from lack of interest and understanding among the landowners to lack of appropriate services from the responsible authority. Both can be translated into a lack of demand of cadastral services (Wachter, D. et al,1992).

Sometimes the conclusion of these problems has been that cadastre and land registration is not appropriate for African conditions. Africans need to develop new approaches to land information, for instance Geo- information system to support decision-making regarding land use and management that are based on the principles of cadastre.

Therefore, modern Surveying must be designed in such a way that the costs for the establishment and maintenance of the system are affordable compared to the economic value of the existing land Administration. This can be achieved through a combination of modern technology and a flexible/ non-traditional approach to the information content of the information system and the technical and legal demands on accuracy etc. Cadastral procedures should be designed to allow for an efficient decision-making based on law and free from political influence in developing countries like Africa. The process should be participatory and transparent. The cadastral officer should be responsible to investigate all aspects of cases and to protect all private and public interests on an equal basis in the process (Wachter, D. et al,1992).

However, many African countries have recently changed their land legislation or institutional setup with the goal of being able to recognize land rights and provide security of tenure to

occupants in new and innovative ways. One key objective of doing so has been to establish systems of land administration that can provide country-wide coverage at an affordable cost, and that can be upgraded in a flexible way as and when the need to do so arises. While a systematic assessment of the performance of such systems would be of great importance to inform the policy debate, it is made difficult by a huge and widening gap between legal initiatives and actual implementation. The case of Ethiopia, where –within a rather short time frame- about 6 Million land use certificates were distributed, even though during the “first phase” no map or spatial reference is included, is thus of potentially large interest for policy makers (Wachter, D. et al,1992).

5. 4 Ethiopia Land Policy and Administration Assessment

Recent land tenure regimes in Ethiopia fall into three broad time periods. Before 1975, land tenure was based on a feudal system where land was concentrated in the hands of absentee landlords and the church, tenure rights were highly insecure, and arbitrary evictions took place. Following the overthrow of the imperial regime in 1974, the Marxist-oriented government (the Derg) transferred ownership of all rural land to the state for the distribution of use rights to cultivators through local peasant associations. The further transfer of land rights was highly restricted, because transfer through sales, lease, exchange, or mortgage was prohibited, and inheritance was severely restricted. Tenure security was further weakened by the peasant associations’ and other authorities’ ability to redistribute land. The government that took power in 1991 following the fall of the Derg—while committed to a free market philosophy— has made little substantive change to farmers’ land rights, which are still considered inadequate.

The 1994 Ethiopian Constitution draws a broad framework for land policy in the country and enshrines the concept of public land ownership and the inalienability of landholdings. The Ethiopian Constitution asserts state ownership of land; there are no private property rights in land. Article 40(3) states:

The right to own rural and urban land as well as natural resources belongs only to the state and the people. Land is an inalienable common property of the nations, nationalities and peoples of Ethiopia and shall not be subject to sale or to other means of transfer.

5.4.1 Existing Surveying Capacity in Ethiopia

Ethiopian Mapping Authority (EMA)

The EMA is the Ethiopian Government's institution responsible for spatial data at the national level. It is an organization of approximately 360 professionals and technicians with the responsibility for all national geodetic surveys, datum definitions, and cartographic programs. EMA has capacity in use of satellite data, planning and management of air photo acquisitions, production of orthophotos, and basic GIS development. It carries out training at the national and regional levels, though the way this is carried out could be vastly improved.

Enhancement of the EMA capacity could provide significant assistance to regional land administrations in terms of access to spatial data as well as training programs and staff development. Modalities would need to be worked out to determine to what extent mapping activities should be devolved to regional administration and what activities should remain centralized. The EMA could be taking a more active role in assisting the regional governments in this area. This would ensure that efforts undertaken by the regional governments are compatible with national standards.

Other Ethiopian Government Agencies

Significant interests on the part of a variety of Ethiopian Government institutions are working with spatial data, the most notable after EMA being the Ministry of Agriculture (MOA), Ministry of Water Resources (MOWR), Disaster Preparedness and Prevention Commission (DPPC), and Central Statistics Authority (CSA). In the MOA, the Woody Biomass project has become one of the national leaders in use of remotely sensed imagery. The MOWR is classifying land cover at 1:250,000 in the watersheds in the key the four main regions and developing orthophoto products

for its irrigation schemes (photo acquisition by the Israeli firm OFEK as a result of international tender and orthophoto production through EMA).

In an effort to share and standardize information among these agencies, EMA has taken the lead on the development of a National Spatial Data Infrastructure (NSDI). Numerous Ethiopian Government agencies are participating.

Nongovernment Institutions and the Private Sector

Some capacity exists outside of the government structures. At present there is only limited capacity within the university community. There is some indication of private sector activities developing as companies are awarded contracts for digitizing maps.

International Community

The international community is also quite active in the collection and use of spatial data, though the primary use is in the development of GIS and thematic maps for specific project activities. Image processing of remotely sensed data (satellite data and air photos) is only being carried out by a few donors, including USAID/Famine Early Warning System (FEWS) and soon the World Food Program (WFP). Numerous projects (such as GTZ's Land Use Planning and Resource Management Project in the Oromiya region) have made extensive use of remotely sensed images and GIS.

The international community's involved in mapping and use of other forms of spatial data, led by WFP, have organized a Mapping Task Force to address issues common to all of the participants. These include issues of sharing data, common and standardized coding, projection, and datum standardization. The technical leaders in this appear to be WFP VAM Unit, USAID/FEWS, and the United Nations Children's Fund (UNICEF). To their credit, there is good national representation in the Task Force in the representation so far (two meetings) of EMA, MOA, and MOWR.

5.4.2 The situation of cadastral surveying techniques in Ethiopia

As far as the Knowledge of the researcher the cadastral surveying and mapping in Ethiopia at this time has not any clear administrative and technical framework. Even the Ethiopian Mapping Authority (EMA) currently has not a clear and well organized strategy towards the development of cadastral surveying and mapping. This is to say that cadastral mapping in Ethiopia just like most African countries has not a full-fledged and clear direction.

However, some pilot projects which are started yet in the three regional states such as, Oromia, Amhara, SNNP and Tigray have been utilized traditional surveying. These are plot perimeters and distances from permanent features are measured using traditional measuring devices (e.g., chains, rods, tape, or strings). Besides, the plots are described according to their positional relationship to those features and as to their position relative to neighboring plots (e.g., whose property is on the north, south, east, and west sides of the plot being registered). Areas are stated in local measurements (e.g., “timads” in parts of Ethiopia).



Figure5.3: The colored area represents the four regions Project area of cadastral map in Ethiopia.

Source: www.ardinc.com

Under the Ethiopian Mapping Agency (EMA) was commissioned to field test five levels of cadastral surveying technologies with respect to factors such as cost, efficiency, accuracy and appropriateness of technology regarding skill requirements, availability of equipment, costs per hectare and cost per parcel. While some of the factors raise questions of subjectivity, the findings presented a clear picture of the different options (See Table 5.3).

Table 5.3 Comparison of cost of rural cadastral surveying technologies

No.	Method	Cost in Birr/ha	Application
1.	Rope only	13.00	Most rural areas
2.	Rope & HH GPS centroid reading	15.70	Most rural areas
3.	Hand-Held (HH) GPS corners reading	80.40	Most rural areas
4.	Compass/Tape	291.80	Inappropriate for all areas
5.	Total Station	117.41	High potential areas: - peri-urban, irrigation - resettlement, compensation; - commercial farming - investment purposes, etc.
6.	IKONOS high resolution satellite data	229.90	Applicable for all areas if cost contained
7.	DGPS (not in EMA study)	-----	High potential areas as in Total Station

Source: ELTAP 2006 (under preparation). Data compiled from the Ethiopian Mapping Agency testing of various survey technologies.

The costs shown in table above are the one-shot direct costs of land titling. They do not include the cost of the certificate and the annual maintenance cost once the cadastre is established. As can be seen, the direct cost of land titling escalates quickly as one move up the technology scale.

The cost of using handheld GPS with corners reading that produces parcel area is six times that of the traditional rope-only method. Using total station costs nine times more.

The conclusion drawn was that the high-end technologies which are also expensive are not appropriate to low-valued rural lands with little potential of development. Such technologies should be reserved for high-valued land in peri-urban, commercial agriculture, irrigation development and resettlement areas. No single methodology would be appropriate for all of Ethiopia, or for all circumstances in a given region or wereda. Decisions will have to be made on a case by case basis bearing in mind that areas surveyed by low cost technology could be upgraded to a higher level of sophistication and accuracy as capacity, resources and needs require. In subsequent discussions, regional land administration agencies preferred to use handheld GPS for their cadastral surveying. A manual was prepared for this purpose and 13 federal and regional trainers of trainees (ToTs) were given practical training on using handheld GPS for measuring parcels and producing index maps. They in turn are going to train district staff and private contractors in this methodology in the four regions.

Nevertheless, the current status of the Ethiopian horizontal and vertical geodetic reference frame is that they are in very poor condition and completely unsuited to supporting modern positioning (e.g., GPS) and remote-sensing technologies and applications.

Their systems will not adequately support the application of modern cadastral surveying operations that could be used to enhance the rapid collection of positional data relative to land parcel boundaries.

Thus, EMA should be committed to enhancing the National Spatial Data Infrastructure to be consistent with the recommendations of the International Association of Surveyors (FIG) Commission X, African Reference System (AFREF) working group as outlined in the “Windhoek Declaration” adopted at a meeting of African National Mapping Organizations in December 2002. Besides, EMA should be modern enough at all circumstances regarding spatial data collection system especially cadastral surveying. And, in order to be consistent with principle and statement of cadastre 2014.

5.5 Summary

The issue of Cadastral surveying and mapping has been an international trend, starting with the United Nations Summit on Social Development in 1995, the United Nations City Summit in 1996, the Bogor Declaration on Cadastral Reform in 1996, and the multi-million dollar cadastral projects in Thailand, Indonesia, Malaysia, the Philippines, South Korea, China, Australia, New Zealand, South Africa, most countries of Western Europe as well as Argentina and Brazil in recent years. These prove that great majority of the developed countries and many developing countries have entered cadastral reform program.

In developed countries, survey and mapping organization undergo various degrees of privatizing and budget cut. Most of them have their cadastral maps digitized. Few leading countries are now converting their cadastral map from map accuracy to survey-accuracy and developing internet data communication facilities.

The South Korea, Netherlands, Canada, Sweden and Singapore are the forerunners in these areas. The reforms are for better economics and efficiency. There are also cadastral system reforms. The force, which drives a cadastral system reform, always comes from political changes. Eastern European countries and South Africa are examples of this group.

Commission 7 of FIG had set up a working group in 1994 to develop a vision for a modern cadastre 20 years into the future. The resulting research named 'Cadastre 2014' is an important document, which will impact on cadastral reform world-wide for many years. The cadastral vision developed fully recognizes the changing role of governments in society, the changing relationship of humankind to land, the dramatic influence of technology on cadastral reform, the changing role of surveyors in society and the growing role of the private sector in the operation of the cadastre. Based on studies of existing cadastral systems all around the world, the working group agreed to six statements on the development of cadastre in the next twenty years (see in the Appendix).

Moreover, the cadastral reform is inevitable in this new millennium to handle and manage the constant proliferation throughout the world. This is to some extent due to technological advancement in computerization, information acquisition and communication. Cadastral reform may relate to various aspects of cadastral system such as office automation, field measurement, and cadastral database development. These will lead to the concept and realization of the Coordinate based Cadastral System in some countries today.

Cadastral reform is concerned with improving the operation, efficiency, effectiveness and performance of the cadastral system in a state or jurisdiction. Cadastral reform is being undertaken in many and diverse parts of the world. Different countries have different needs for a cadastre at different stages of development.

Due to their different stages of development, different countries have different capacities for the development of cadastral systems. In particular, human, technological and financial resources will determine the most appropriate form of cadastral system to meet the needs of individual countries. Thus, a simple low cost manual cadastre recording only private ownership rights may be appropriate for one country, while a sophisticated and relatively expensive fully computerized cadastre recording a wide range of ownership and land use rights may be appropriate for another country.

In order to improve a cadastral system the importance of focusing on the cadastral processes to identify bottlenecks, inefficiencies and duplication was recognized. Once the processes have been fully documented and understood it is possible to re-engineer them to improve efficiency and effectiveness in the delivery of cadastral services to the user. Such re-engineering often requires changes to legislation, modified institutional and administrative arrangements, and the use of different technologies (Williamson, 1998).

However, the nations with total coverage of their cadastral records (100% legally registered and surveyed) include Belgium, Brunei, Czech Republic, Denmark, Germany, Hungary, South Korea, the Netherlands, Sweden, and Switzerland.

In contrast, in many African countries the development of cadastral surveying and mapping is in its' infant stage which is almost below 1% cadastral map coverage. The same is true for the countries like Ethiopia that is the cadastral surveying is still based on traditional rope system (i.e. measurement based cadastre).Even with this method in Ethiopia there is no a full-fledged cadastral map.

Therefore, in order to accelerate cadastral map coverage for the whole country in the near future the modern coordinate based cadastral surveying is a must. As a result, the integration of GPS and high resolution satellite image with GIS could be the appropriate techniques for the acceleration of cadastral map coverage.

Chapter Six

6. Integration of GPS, Satellite imagery with GIS in preparing coordinate based cadastral map in the study area

This chapter entirely focuses on the integration of GPS, satellite imagery and GIS in preparing coordinate based cadastral map in the study area.

Since cadastral data are defined as the geographic extent of the past, current, and future rights and interests in real property, including the spatial information necessary to describe that geographic extent.

Preparation of low cost rural coordinated cadastral map using GPS and satellite imagery integrating with GIS is apparently the a splendid idea for countries like Ethiopia which has at least no or little cadastral map coverage as discussed in the earlier chapter. This is in the sense that the maps in general and cadastral maps in particular could be an input to NSDI (National spatial data infrastructure).

Hence, this section tries to demonstrate the integration of the three methods based on the data collected from the field using handheld GPS and the satellite imagery (i.e. panchromatic Quickbird), and as supplementary Google Earth. This is based on extracting the absolute coordinate points rather than the traditional surveying methods which give us a cadastral map that has relative location (i.e. NE, SE, NW and SW) only.

The study area has about 5000 parcels of land with varied topographical setting i.e. hilly and some undulating land scape as it has already discussed in chapter 3. However, producing cadastral map is not the scope of this research work and apparently is not an easy task. Hence, this section will try to test coordinate of some selected parcels of the data collected from handheld GPS and Satellite imagery as well as Google Earth.

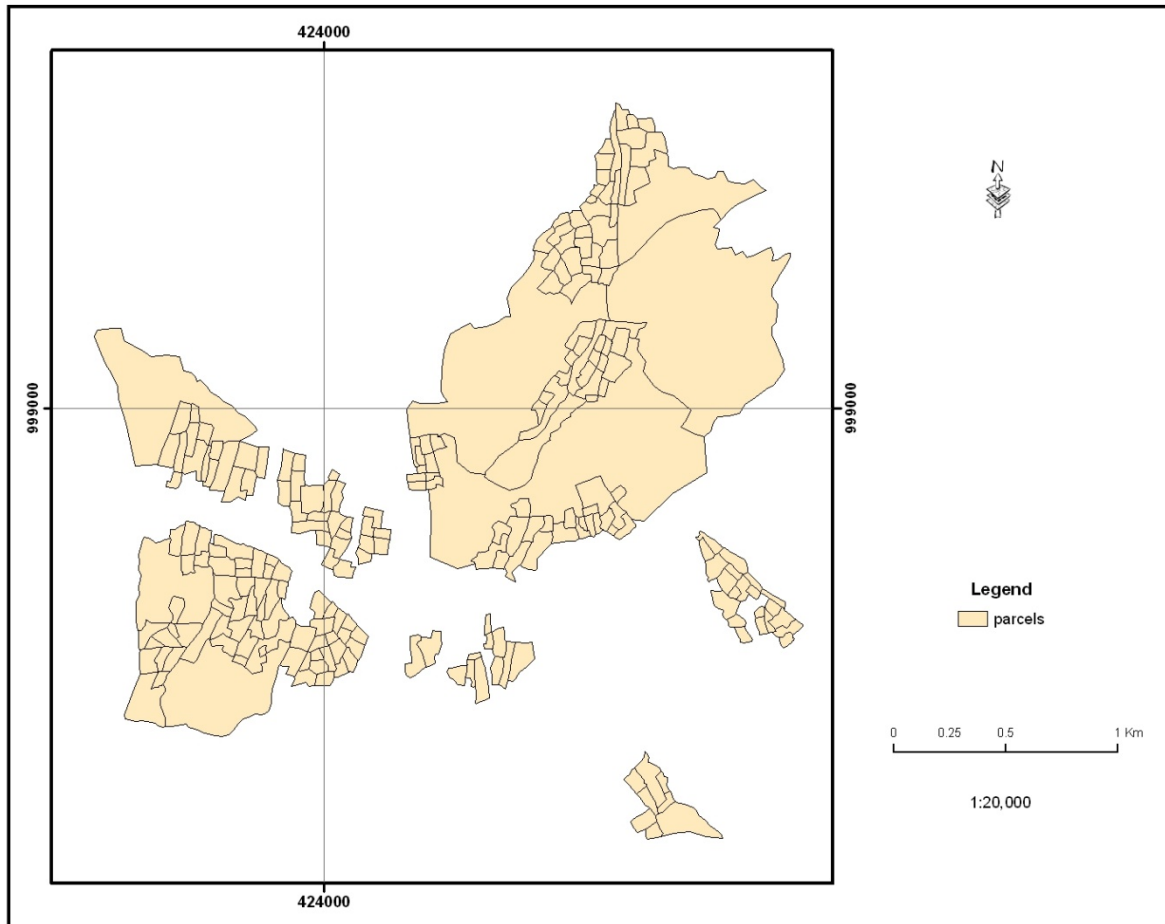


Figure 6.1 : selected parcels of the study area(source; Author)

This test was conducted in welenkomi area part of Ihud Gebeya town Bite Ejersa Lafo Kebele Administration by comparing the Selected point coordinate and areas of the parcels data collected from the field using Hand held GPS, satellite image and Google Earth . The test area is more or less have an average elevation 2443 with undulating type of topography and majority of the area have a slope ranges from 0-10 degree (see in cahpter 3).

Unfortunately, in this area and other part of the country as a whole there is no any kind of the existing cadastral maps, and only with poor filing system of ownership information to be collected from the responsible weredas or any surveying office. Hence , the parcels were digitizing from Quickbird and Google Earth and the corner points of coordinate were collected by handheld GPS .Besides, the digitised parcel data of each areas were automatically computed.

Accordingly, the slope map and sample parcels of the study area tries to test the parcel which is found in the slope 0-10 degree and as well as which was not affected in shape relatively for long years compare with other parcels of the area. Hence, this selected to show the differences among the coordinate collected in the field and the data extracted from the satellite imagery.

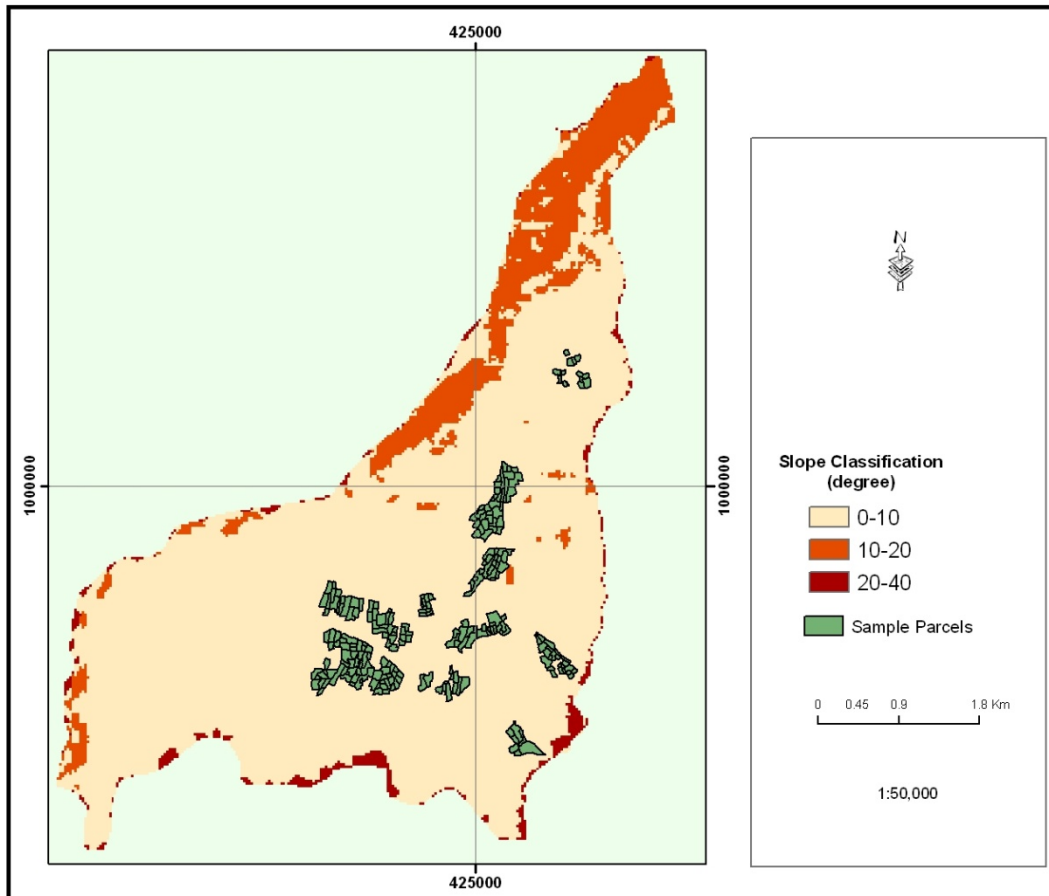


Figure 6.2: Overlaying Sample parcels with Slope map of the study area

(Source; digitized from Quickbird imagery)

Generally, in the study area different types of parcel shape and size exist in relation with the topographical setting of the physical landscape of the area. Likewise, the figure below show as the average parcel size of the digitized and collected field parcels in the area ranges from 0.2-2.6 ha maximum and minimum respectively. But the average parcel size in the area is 0.5 hectare and indicated in red color as illustrated in the Graph.

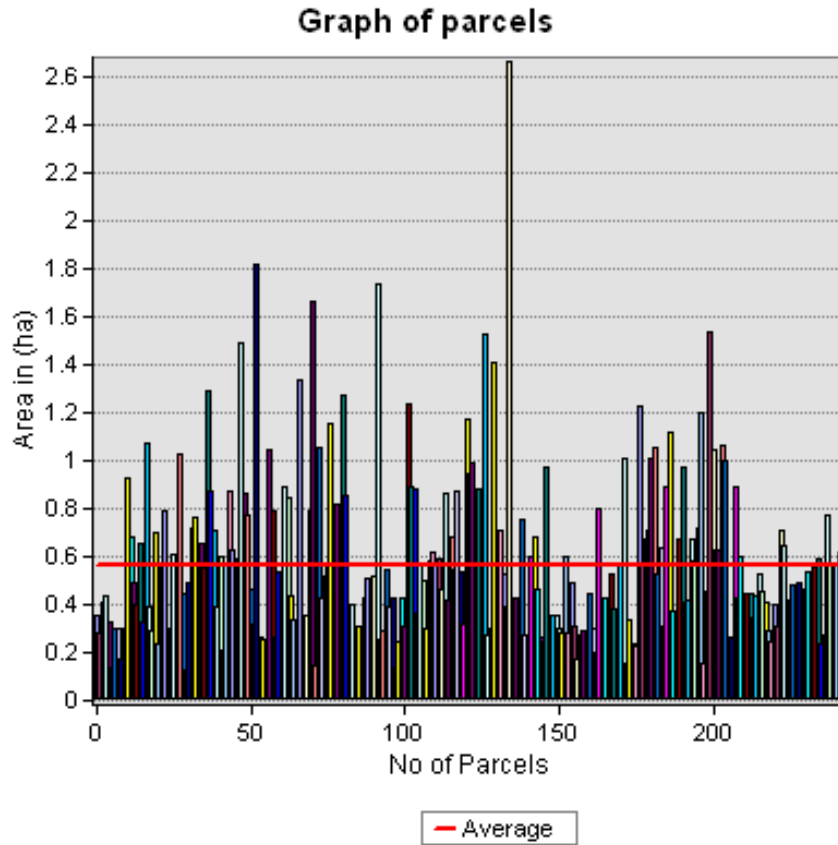


Figure 6.3: parcels with their respective area in hectare (Source: plotted from the field data)

The detailed and further analysis of the parcels point coordinate as well as the size of the parcels will be organized in the coming subsection.

6.1 Testing the parcel coordinates of GPS and Quickbird imagery

In this section tries to analyze the association of coordinates and area of some selected parcels which are extracted from the methods i.e., Quickbird and Hand held GPS respectively.

6.1.1 Quickbird Imagery Data

The parcel in fig 6.3 is one of 243 polygons digitized from the panchromatic Quickbird. This is selected because of its relatively static nature of the parcel form year to year. The parcel has seven corner point coordinates, and these are also different from the points extracted and generated from both hand held GPS and Google Earth (and Appedix-2 respectively). Besides, the parcel generated from the hand held GPS based survey has different in shape and to some extent its orientation.

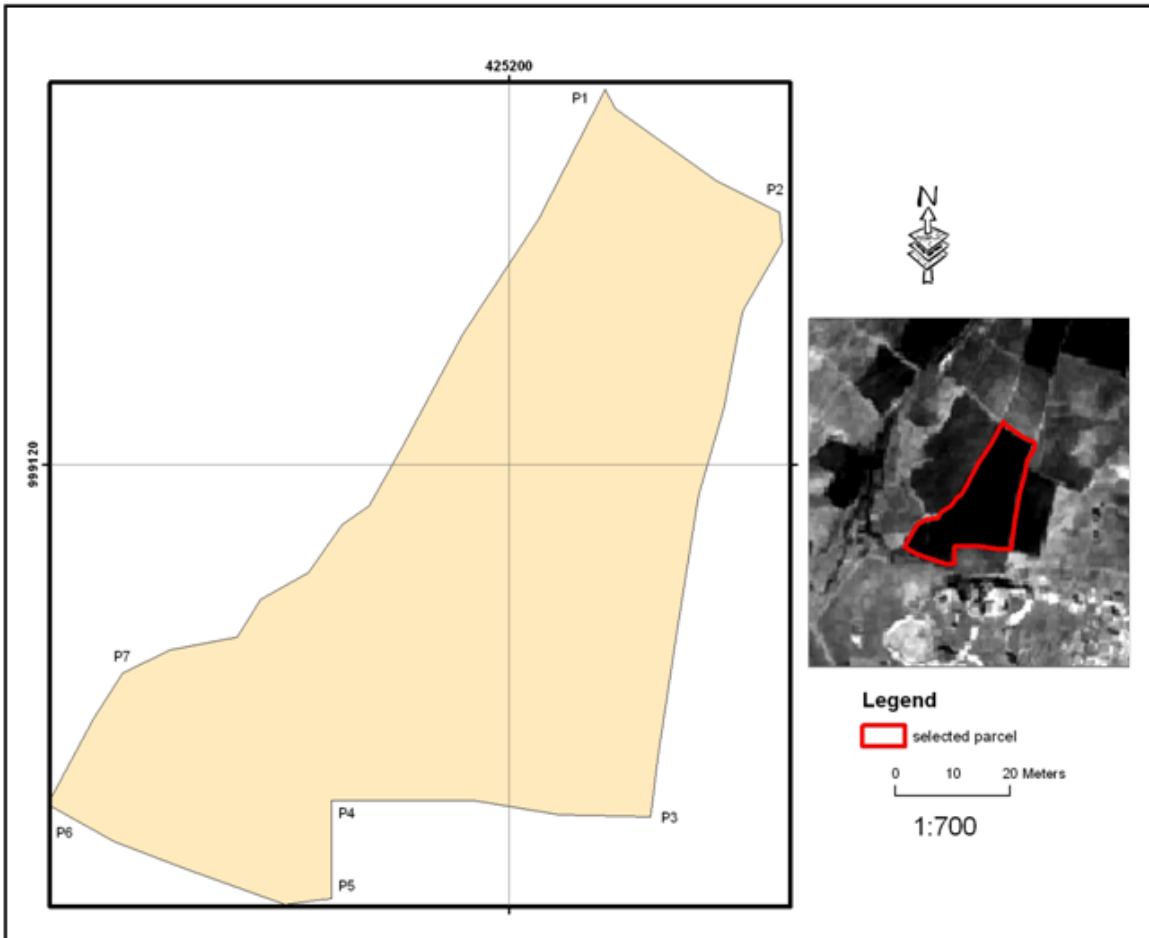


Figure 6.4: Map of the selected parcel digitized from Quickbird Imagery (source: Author)

The digitized line features; Line (arc) and area (polygon) features consist of a series of linked single point positions; therefore, single point tests can be used to estimate the accuracy of line and area features.

Table 6.1 Coordinate of seven point corners

Parcel No	Coordinates(in meter)		Elevation (in meter)	Remark
	Easting	Northing		
P1	42 5216.67	999185.46	2351	
P2	425247.09	999159.76	2350	
P3	425224.60	999058.55	2346	
P4	425168.89	999061.47	2346	
P5	425168.13	999044.34	2347	
P6	425119.81	999060.47	2345	
P7	425132.45	999083.66	2347	

source: Tabulated from the Map 6.3 Parcel

6.1.2 Handheld GPS Data

After the field data collection of corner points of the parcel using hand held GPS (i.e **GPS Map76 CS**) in the study area the process of data transfer was undertaken. Hence, the GPS connected with the Hp Laptop by the cable USP serials and the points transferred by using latest soft ware MN DNR Garmin 5.4(Minnesota Department of Natural Resources soft ware).consequently, the transferd points save in ArcMAP as a shapefiles which is compatible format type to the available ArcGIS software's.(see Appendix 4)

Finally, as depicted in the figure below the corner coordinate points displayed in ArcMAP and ready for further analysis.

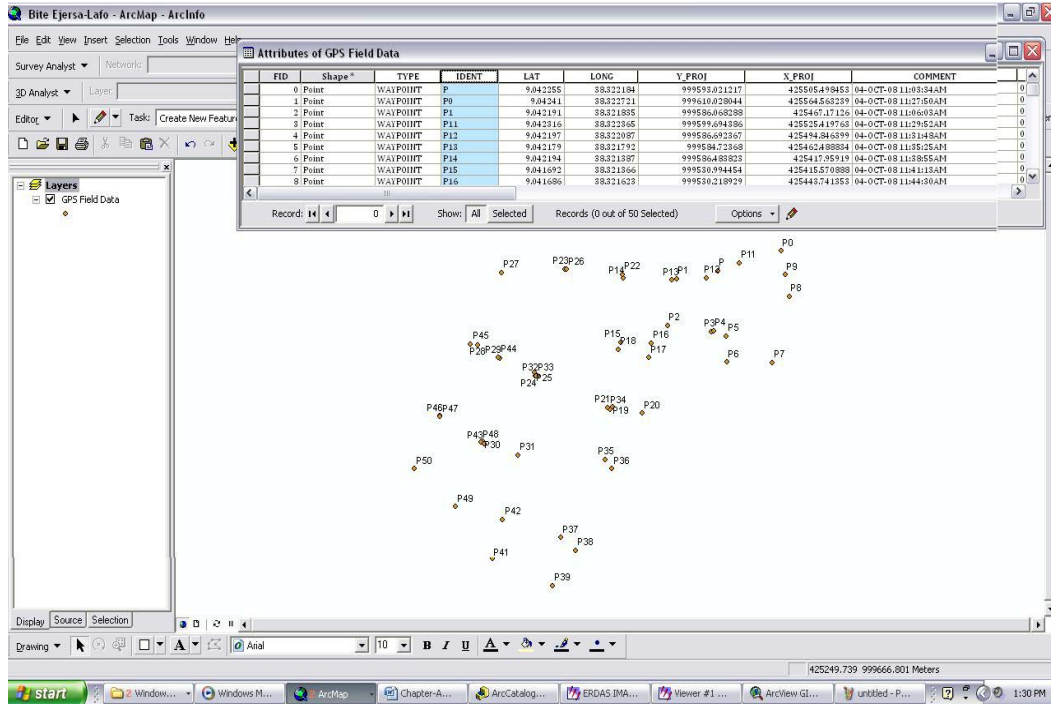


Figure 6.5 the distribution of collected GPS points

Subsequently, some of the collected points are converted or generated to be a polygon, and with further editing the attributes and the spatial data of the parcels in Arc MAP are provided for comparison and analysis.

Hence, the corresponding parcel with the already digitized and extracted from the panchromatic Quickbird earlier (see fig 6.4) and the parcel generated from hand held GPS below (see fig 6.6) have relative similarity in shape but different in the number of corner parcel point coordinates.

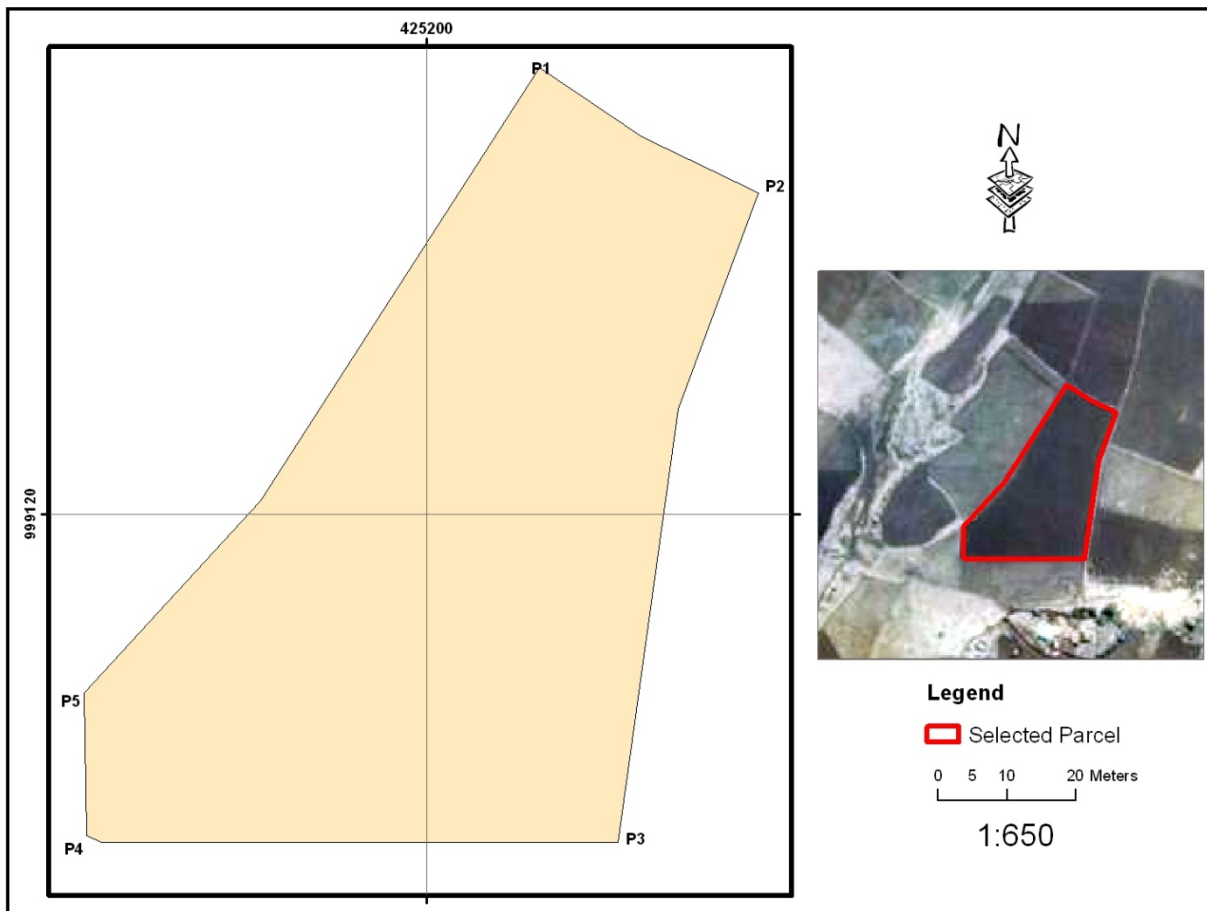


Figure 6.6: Map of the selected parcel (source: Generated the parcel from Collected Field

GPS Data, 2008)

Table 6.2 coordinates of five point corners

No	Coordinates(in meter)		Elevation (in meter)	Remark
	Easting	Northing		
P1	42 5272.10	999380.38	2351	
P2	425304.38	999363.11	2350	
P3	425280.88	999285.00	2346	
P4	425197.50	999260.09	2346	
P5	425199.13	999280.22	2347	

Source: Tabulated from the Map 6.4 Parcel

Generally, both fig 6.4 and 6.6 above indicated that the same parcel but with more or less varied coordinate setting and different in shape of the given polygon. Those coordinate points which are extracted from Quickbird have seven points where as from hand held GPS have five for the identical parcel in the study area.

The reason for this variation can be essentially the social and technical context of the study under consideration. First, this is apparently due to the dynamic nature of the agricultural farm area in Ethiopia as whole and in the “Bite Ejersalafo” in particular. The logic behind this is mainly because of land parcel fragmentation and crop rotation. Secondly, the satellite imagery year of data acquisition should be as recent as possible in order to have current interface of the area under study .But, the satellite image used for this date of data capturing was November, 2005.Hence, the

6.2.3 Combination of (x, y) point coordinates of Handheld GPS and Quickbird

As shows in table 6.3 below ten selected points of the collected from the field using GPS and extracted from Quickbird are taken for comparison purpose. As a result the analysis indicated in the difference chart is the variation in both x and y coordinates reaches up to 20 -30 meters respectively.

Table 6.3: coordinates of 10 selected points of three methods

No	Coordinates from Quickbird		Coordinates from Google Earth		Coordinates from Handheld GPS		*Diff	
	Yq	Xq	Ygo	Xgo	Ygp	Xgp	Dxq-Dxgp	Dyq-Dygp
P1	999586.06	425467.17	999586.00	425467.16	999585.06	425468.17	-1.00	1.00
P2	999545.64	425458.71	999545.14	425458.21	999543.64	425459.71	-1.00	2.00
P3	999540.22	425499.17	999539.22	425499.17	999541.22	425500.17	-1.00	1.00
P4	999540.77	425501.67	999540.42	425501.45	999539.77	425502.67	1.00	1.00
P5	999536.41	425513.48	999536.40	425512.47	999538.41	425515.48	-2.00	2.00
P6	999513.81	425514.05	999513.70	425513.05	999516.81	425524.05	-10.00	-3.00
P7	999513.40	425556.34	999513.57	425555.67	999523.40	425546.34	10.00	-10.00
P8	999570.69	425572.14	999571.65	425573.10	999560.69	425582.14	-10.00	10.00
P9	999589.30	425567.91	999590.30	425563.81	999579.30	425547.91	20.00	10.00
P10	999610.02	425564.56	999611.02	425565.56	999640.02	425554.56	10.00	-30.00

Sources: The Author

But the point coordinates extracted from of Google Earth in comparison with both hand held GPS and Quickbird image as shows in the table 6.3 above almost insignificant discrepancies with the later one but significant variations with the former. However, in terms of absolute point coordinate positioning the (x, y) points of both images have similarity compare with handheld GPS.

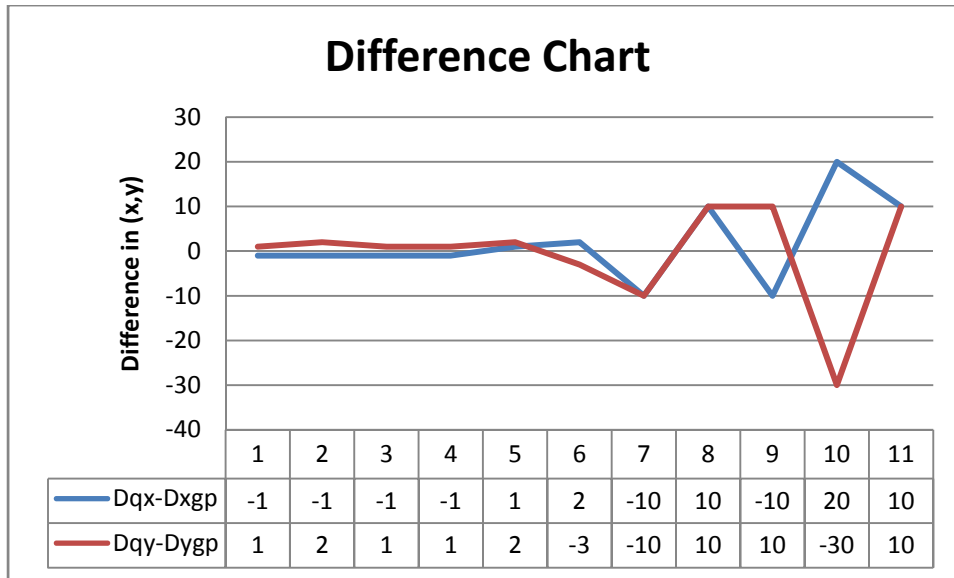


Figure 6.7 Difference Chart

The lines both the blue and the red colored which are intermingled indicated that corner point coordinates of handheld GPS and Quickbird satellite image of the study area almost small variation regarding absolute point positioning. While, in generating a polygon features from the collected coordinate points of both methods have their own limitation. The reason behind this is not clear. However this could be due to the trend or the period of the high resolution satellite image and the nature of the handheld GPS own error.

Nevertheless, the integration of these two methods could minimize the error which can obtain in the field and might accelerate the cadastral map coverage of a certain locality.

6.3 Testing the area of parcels:-GPS and Quickbird Imagery

In Ethiopia, like many other countries, there is no complete cadastral map or land register that includes information about holding areas. Experience from previous surveys and a census also reveals that most of the holders in rural Ethiopia are not able to accurately determine the size of their land in useable quantitative units. As a consequence, all information about size of land has to be collected by measuring.

Hence, the handheld GPS based calculation of areas was done by two ways. One by downloading some track log polygons to GIS software using MN DNR Garmin and by converting the collected coordinates in to polygon in ArcMap for storage, mapping and area calculations on a lap-top. Likewise, the parcels extracted from the image also done in order to compute the area of each parcels.

Thus, as illustrated in the Graph below the average area of the parcel of the collected by GPS and extracted from satellite imageries is 5000 sq.meter and depicted in a red color in the graph below. Besides, the total ranges between 2,000-26,000 sq.meter with minimum and maximum respectively.

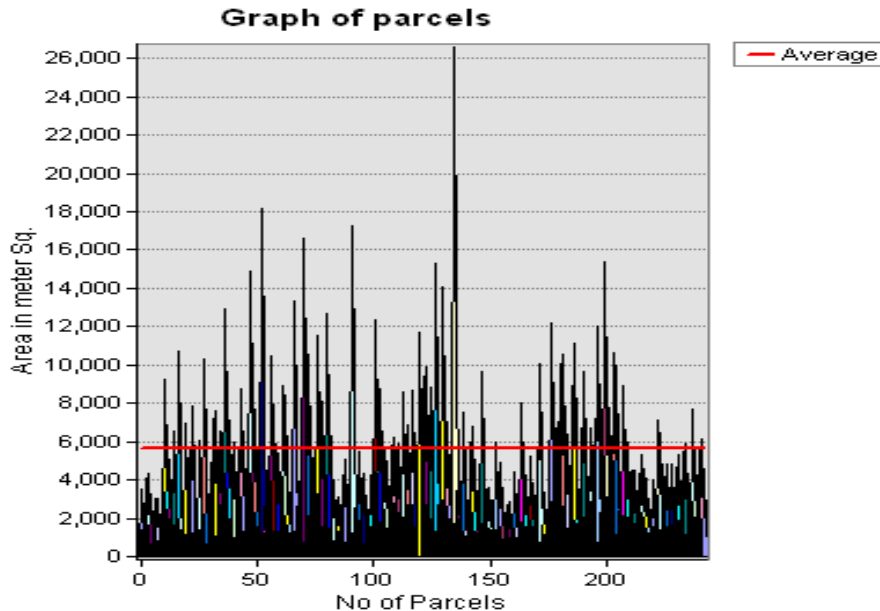


Figure 6.8: The Graph of some selected size of parcels in meter sq. of the study area

(Source: plotted from the field data)

Hence, the graph generally shows us in the study area the size and shapes of the parcels are varied. That is the size of the parcels classified as from very small from below 2000 sq.meter to larger than 26000 sq.meter in size .Besides, the shape of the parcels are classified as irregular

and regular i.e. the shape of parcels varying in relation with the topographical setting of the area(see fig 6.1).

Table 6. 4: Area of some selected parcels (in sq.meter)

Parcel-Id	Owner Name	Area1	Area2	(Area1-Area2)
1		1398	1400	-2
2		1696	1689	7
3		2816	2810	6
4		2969	2969	0
5		3014	3000	14
6		3031	3021	10
7		3241	3240	1
8		3246	3240	6
9		3557	3550	7
10		3893	3890	7
11		4000	4010	-10
12		4065	4067	-2
13		4325	4320	5
14		4874	4870	4
15		6507	6500	7
16		6773	6776	-3
17		7910	7903	7
18		9289	9280	9
19		10749	10751	-2
20		26598	26588	10

Area1	Extracted from Quickbird
Area2	Generated from Handheld GPs
(Area1-Area2)	Differences in Area

Source: (Author)

The table demonstrates the area of parcels computed from both GPS and satellite image. The differences of the size of the parcels range from 0-14 sq.meter. This shows the variation between these methods is not as such large. But, the table generally indicated the size of the parcels computed from the image is larger than the parcels extracted from hand held GPS.

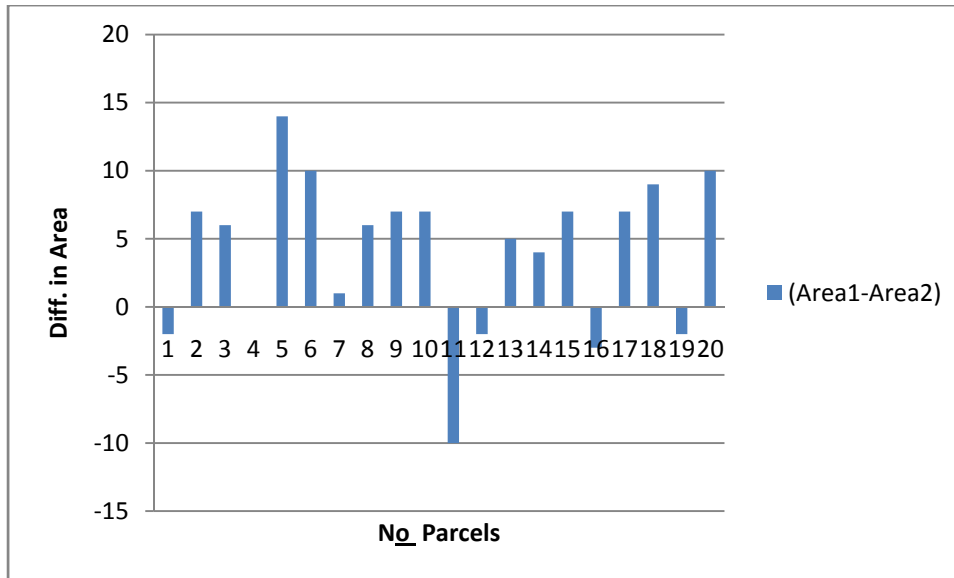


Figure 6.9: Differences in Area of parcels extracted from GPS and Quickbird

The results from the above figure indicates that Quickbird of the plots that are more than 0.5 hectares or 5000 sq,meter , gives a slightly larger area per plot compared to the same plot area measured by hand held GPS equipment. This tendency seems to be the same when plots with area size less than 0.5 hectares are measured. i.e. those plot areas that were less than 0.1 hectares or 1000 sq,meter .This indicated that small parcels are relatively stable or unchanged.

In addition, the graph display only 5 of the parcels out of 20 have a negative value .This indicated that the value of Area1 is larger than Area2.This in turn shows us size of the parcels in the study area which have extracted from the Quickbird are larger than the size of the parcels generated from the hand held GPS as discussed above.

Hence, from the analysis in the study area the variation of the size for identical parcels comes from the two main factors i.e. as discussed before the inconsistency in shape and the size of the parcels due to apparent land fragmentation and crop rotation. This is especially in the study area crop rotation have its own impact in the shape and size of the parcel deformation. As a result the effect of these could have their own impact on the mismatch or inequality between two different techniques during the application of cadastral surveying. For instance, in this research the methods used are satellite imagery and hand held GPS but, the image was captured before two to three years where as the GPS data collected currently. Therefore, time differences should be

taken in to account during the preparation to select the techniques of cadastral surveying mainly satellite imagery integrating with other methods.

This map indicated the combination two selected identical parcels taken for the purpose of comparison .These parcels originally extracted from Quickbird and hand held GPS but as depicted in the figure below they are not equal in shape as well as in size. As already discussed before the size of the parcels computed from the image is larger than the hand held GPS. Likewise, in figure also the area of parcel [1] is larger than parcel [2] i.e. 7910 and 7903 Sq.meter respectively (see table 6.4). And they are not overlap even though they are similar.

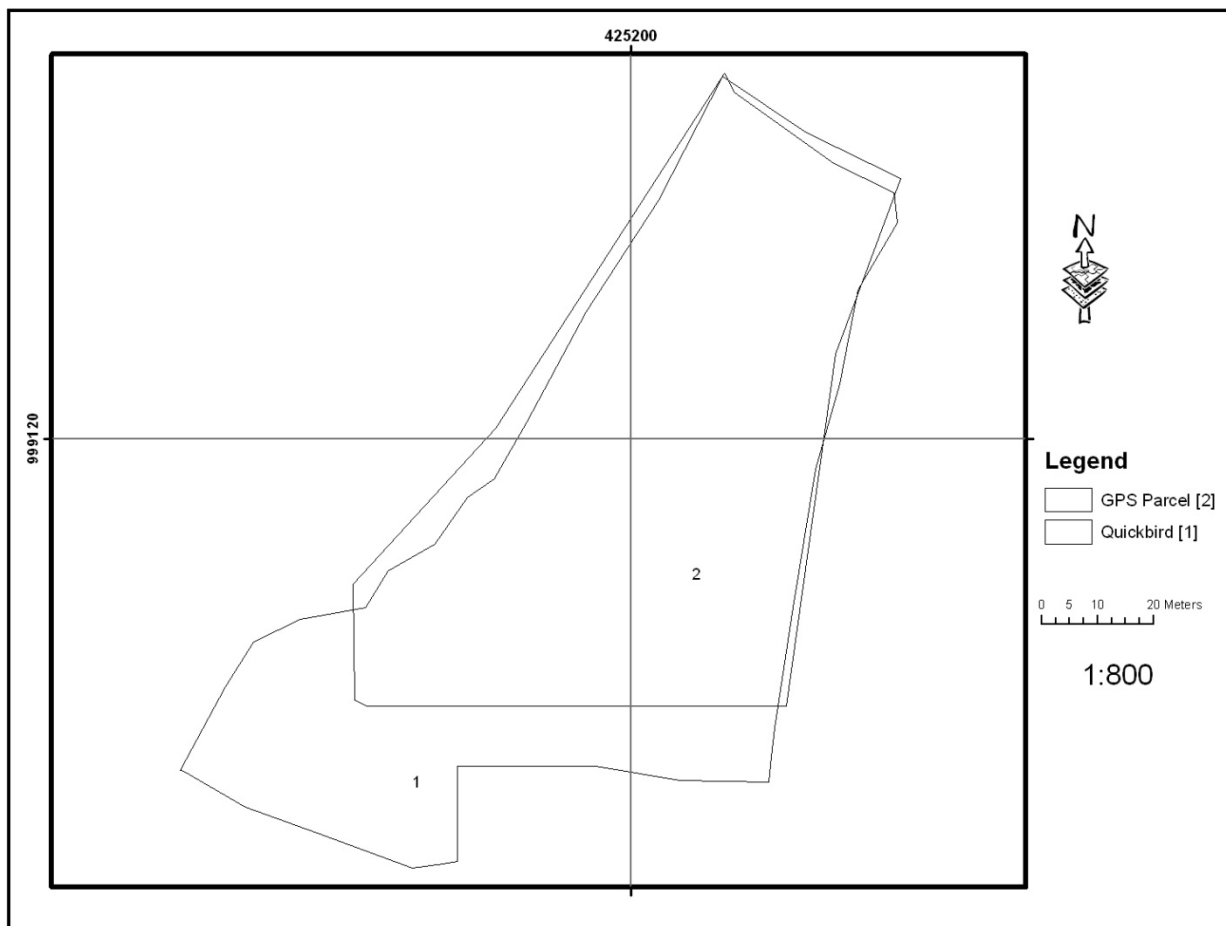


Figure 6.10: Map of selected Quickbird and GPS parcels overlaid

Thus, the rural parcels have apparently changed with time due to the factors already discussed and other unforeseeable factors in this study. To conclude the integration of different techniques

in cadastral surveying and mapping have their own diverse limitations. However, by considering these limits and moving to take an action also can have a benefit of accelerating the preparation of cadastral map for the country that do not have even a single organized cadastral map.

Generally, the results of the area measurements by the GPS and the satellite image are very close – for parcel areas there were no statistically significant difference between the results of the two methods. Considering the human errors in account that the parcels extracted from both GPS and Quickbird imagery is much faster than that of traditional methods. This in turn indicates that the potential applicability of both techniques for agricultural area measurements.

6.4 The boundary of the Parcels Vs Cadastral surveying methods

The boundaries of the actual agricultural land used of course do not necessarily follow the plot boundaries of the cadastre. Indeed, agricultural parcel boundaries, which are defined as units of land used by a single farmer and covered by a single crop, most commonly do not correspond to the plot boundaries, but are a part of one/several plots, or even several agricultural parcels may lie within one plot. Moreover, most agricultural parcel boundaries may vary from year to year. Examples of parcel/plot relationships and the difference between the cadastral geometries and the geometries resulting from delineating the actual land use parcels of a specific year are illustrated in Fig.6.11 below. This figure also illustrates that the plot/parcel relationship can best be depicted on the basis of recent high resolution raster data, such as aerial photographs.

However, empirical studies related to rural land disputes are very scanty. In some parts of the Ethiopian highland, as a custom, uncultivated grass strips or soil bunds are used to define boundaries to separate property rights. Often the width of the strip or the soil bund stretches from less than a meter to up to two meters (see figure 6.11 below).

Usually the boundary between two or many parcels is unclear and different in shape as well as in type in developing countries like rural Ethiopia specifically the study area (Bite Ejersa Lafo).As a result this may happened with the community boundary conflict .Besides ,it is difficult the preparation of cadastral map only by one method of cadastral surveying for instance using Remote sensing (i.e. satellite imagery).This because it is not easy to identify the boundary of

each parcels on the ground from the satellite imagery due to the Quality and Resolution as well as the ability of the interpreter is considered.



Figure 6.11 Various parcels boundary of the study area (Photographed by the Author, 2008)

Moreover, the GPS and other surveying technologies have also their own limitation during rural cadastral mapping that is for instance absolute coordinate errors of the parcels corner. This due to the total GPS errors and lack of skilled manpower.

Any adjoining owners or holders some times in the study area sparks boundary disputes this usually due to the unclear parcel boundary. Thus, the cases are often brought to customary institutions or Social Justice of the Kebele Administration, depending on the local custom and the magnitude of the dispute. The provisions on boundary demarcation and its legal basis in both Federal and regional land administration and use laws are much generalized. Monumentation of parcel corners with peg as boundary demarcation can be easily obliterated and buried in the ground given the widespread animal-based crop cultivation and free livestock grazing practices in most parts of the Ethiopian highlands.

Moreover, with the vagueness of the law on the issue, causes related to boundary-related disputes may not be settled with clear-cut procedures and approaches. On the contrary, they may aggravate the disputes.

Hence, to settle such a dispute it is better to use the integration of different methods in the preparation of rural cadastral mapping such as remote sensing, GPS and other surveying mechanism in combination with GIS and related surveying soft ware's. Accordingly, every farmer could have a printed out certificate of his own property of land.

Generally, when a parcel splits or the ownership of a parcel changes. It is a legal process that reflects overall trends of parcel development over time. Although this legal change of parcels could take place pre- or post-development, it is often the case that parcel use change occurs after a parcel is purchased or divided among the member of the family(*i.e. fragmentation of the land*), especially when a agricultural activities are involved. Tenure change therefore sets up a framework for other land-use change induced by humans. There are generally five aspects of parcel-based change in which we are particularly interested: (1) overall trends of temporal changes that reveal factors that affect the change during a specific period; (2) parcel physical parameters such as number and size; (3) spatial patterns and their spatial relationships to tourism and recreation resources; and (4) ownership of large parcels that indicate who or which agents have been involved in the parcel based land-use change.

Likewise, some of the factors are the reason for physical parcel change in the study area as mentioned earlier the dynamics of parcel change are mainly the fragmentation of parcels of land and crop rotation specifically in the area.

Chapter Seven

7. Conclusions and Recommendations

7.1 Conclusions

Ethiopia is like most developing countries of the world the cadastral surveying technique is still supported by traditional methodologies. Hence, the output comes from this kind of methodology is apparently the measurement based identification of the parcels .For instance, cadastral survey was undertaken in the four regional state (Oromia, Amahara, SNNP & Tigray) with traditional methods in the first ,second and third level of certification. But, the size of the plot was determined either using ropes or relying on knowledge of the number of ‘timads’ of a plot. In addition the plot is described by naming the neighbors on the N, E, S and W. Thus, in none of the regions still produced a full-fledged cadastral map and not even a valuable sketch that could distributed as a certificate to the owner of the parcels of the land.

Coordinate based cadastral map refers exclusively to the cadastre being based on boundary coordinates. The crucial issue here is that the geographical extent of every registered parcel is described or defined numerically by national coordinates stored in a data base and visualized on a digital cadastral map. Thus, this kind of cadastral Surveying will enhance the cadastral map coverage of the country and

Hence, the preparation of coordinate based cadastral map using the integration of GPS and high resolution satellite imagery in rural areas of Ethiopia have the advantage to accelerate the cadastral map coverage for the whole country in the upcoming decades. As a result, the integration of these techniques conducted in the study area ‘Bite Ejersa-Lefo’, to see the possibility and procedures of methodologies.

Likewise, the area and corner point coordinates of the parcels are taken in order to testify the parcels that are extracted and generated from the Quickbird and handheld of GPS. Accordingly, out of 243 digitized parcel polygons from the image some selected parcels were taken in to account along side with the parcels generated from the hand held GPS. Thus, the results of the area measurements by the GPS and the image are very close for parcel areas have no statistically significant difference between the results of the two methods. Considering the human errors in account that the parcels extracted from both GPS and Quickbird imagery is much faster than that of traditional methods. This in turn indicates that the potential applicability of both techniques for rural cadastral mapping. Even though, the scope of this thesis work is confined to demonstrate the integration of the methods in preparation coordinate based cadastral map one should also take in to account the accuracy, cost and time for preparation of cadastral map.

Generally, the integration of other modern surveying with GIS is the prime alternative for evolving strategies for better governance. However, the present widely used traditional method needs to be further refined for better acceleration and accuracy in the maps.

Due to their different stages of development, different countries have different capacities for the development of cadastral systems. In particular, human, technological and financial resources will determine the most appropriate form of cadastral system to meet the needs of individual countries. Thus, a simple low cost manual cadastre recording only private ownership rights may be appropriate for one country, while a sophisticated and relatively expensive fully computerized cadastre recording a wide range of ownership and land use rights may be appropriate for another country.

Finally, improving land administration and the cadastral system in particular has the potential to significantly increase investments in agriculture by all producers, improve rural livelihoods, reduce conflicts over land, reduce land degradation, and improve resource use. Along with other interventions, improved tenure security is vital to creating an environment in which the rural population is able to survive and prosper and at the same time to adapt to environmental and other shocks.

7.2 Recommendations

Preparation of low cost rural coordinated cadastral map using GPS and high resolution satellite images integrating with GIS is apparently the a splendid idea for countries like Ethiopia which has at least no or little ful-fledged cadastral map coverage. This is in the sense that the maps in general and cadastral maps in particular could be an input to NSDI (National spatial data infrastructure).

It is difficult to built a complete and resourceful cadastral map using traditional surveying techniques in short period of time. Hence, it is better to use an up to date surveying technologies, such as the integratin of GPS and satellite images with GIS, in order to enhance and accelerate the level of cadastral map the country.

Generaly, in order to practice healthy land admnistrstion and management, and to fullfill all issues related to the sound sustainable use of land.

List of Recommendations

- Federal institution should be responsible for land administration to support and coordinate regional efforts in order to improve land administration system at kebele level.
- Rural cadastres should be principally maintained at' kebele 'levels where these would provide for convenient access to the records, considerable costs will be incurred in the establishment, staffing, and maintenance of offices at this level.
- Enhancing the capacity for the dissemination of information to the public about the various land administration reform programs, their impacts, objectives, and ways that they will impact local resource use.
- The land administration programs should be technological center regarding data collection for land registration purpose.

- The decision makers should aware enough about the integration of surveying methodologies such as GPS and high resolution satellite images with GIS effectiveness in cadastral surveying projects.
- Cadastral surveying project should mainly perform in collaboration with academic institutes like Addis Ababa University.

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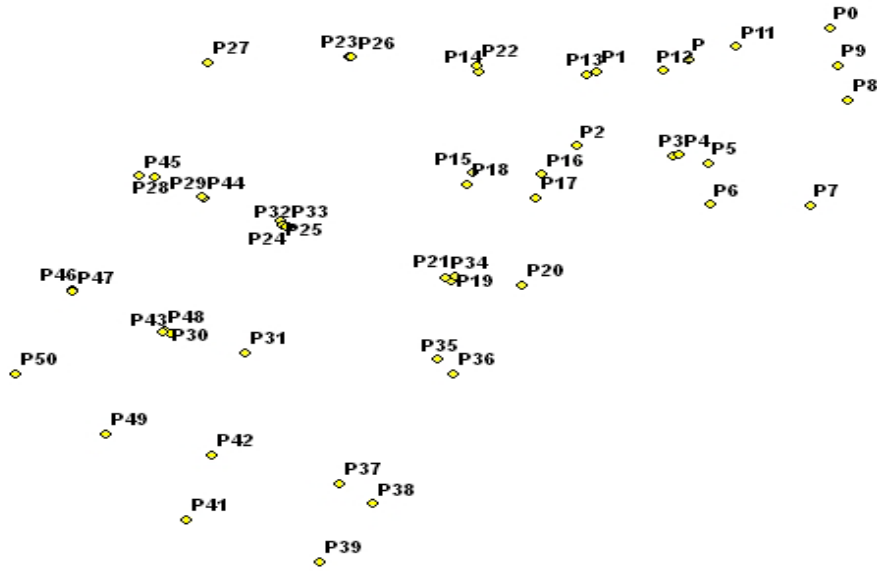
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List of Appendices

Appendix 1: Field Data GPS Points

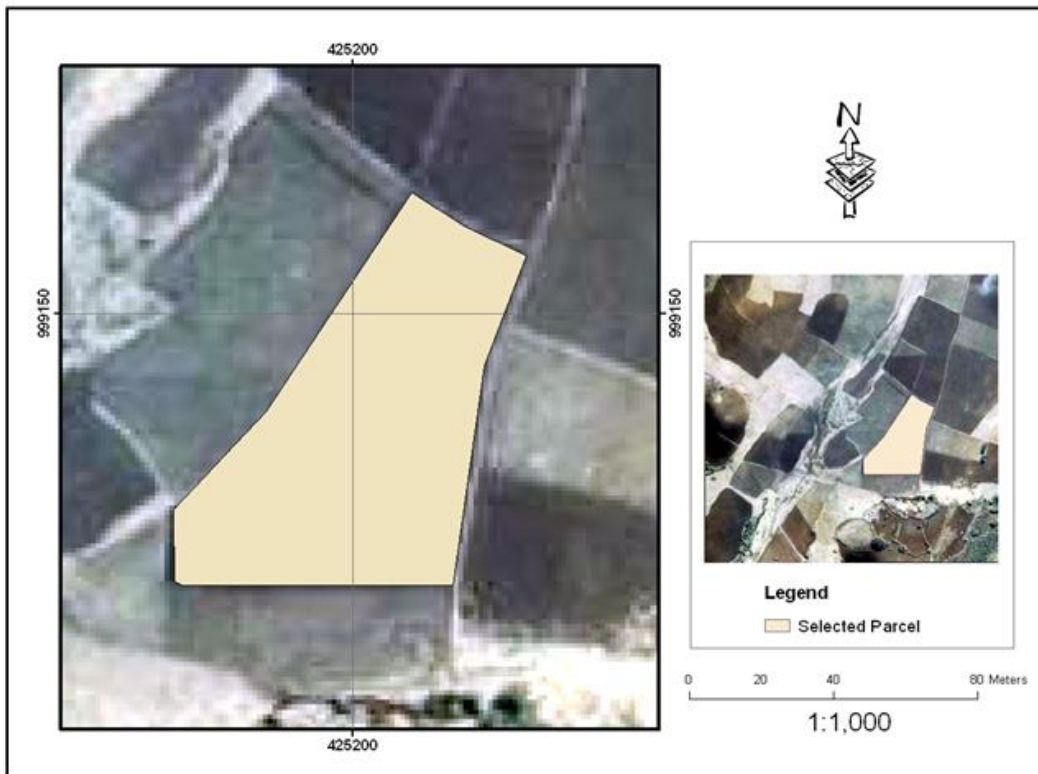
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P10	999610.028	425564.563	2468
P1	999586.068	425467.171	2458
P11	999599.694	425525.419	2463
P13	999584.723	425462.488	2466
P14	999586.483	425417.959	2464
P15	999530.994	425415.570	2467
P16	999530.218	425443.741	2463
P17	999517.647	425441.323	2468
P18	999524.753	425412.979	2468
P19	999472.581	425405.843	2467
P2	999545.649	425458.712	2466
P20	999469.643	425435.337	2463
P21	999474.764	425407.561	2468
P22	999589.785	425416.813	2468
P23	999594.490	425363.620	2468
P24	999501.715	425338.085	2465
P25	999505.047	425334.996	2467
P26	999594.034	425364.688	2468
P27	999591.347	425304.830	2468
P28	999528.916	425282.354	2470
P29	999517.469	425303.172	2469
P3	999540.227	425499.172	2467
P30	999445.240	425286.887	2459
P31		425319.744	2458
P32	999433.113	425335.783	2466
P33	999502.155	425336.979	2464

P34	999501.818	425403.571	2460
P35	999474.077	425400.586	2460
P36	999429.210	425406.993	2460
P37	999421.477	425359.465	2456
P38	999361.958	425373.346	2458
P39	999350.560	425351.094	2454
P4	999318.852	425501.679	2455
P41	999540.778	425295.299	2458
P42	999341.977	425305.812	2457
P43	999377.247	425288.754	2460
P44	999443.356	425301.966	2464
P45	999517.926	425276.072	2463
P46	999529.437	425247.683	2460
P47	999467.334	425247.792	2464
P48	999466.342	425285.614	2465
P49	999444.289	425262.120	2462
P5	999388.672	425513.482	2464
P50	999536.410	425223.848	2461
P6	999421.412	425514.057	2460
P7	999513.815	425556.341	
P8	999513.402	425572.146	2469
P9	999570.692	425567.915	2469
R01	999589.309	424453.832	2474
R02	997530.490	424516.723	2361
R03	997865.419	424815.924	2371
R09	998368.638	424354.054	2393
R11	997205.871	425192.264	2356
	999429.153		2455



Source: Field data collection Using GPS Map 76cs,(2008)

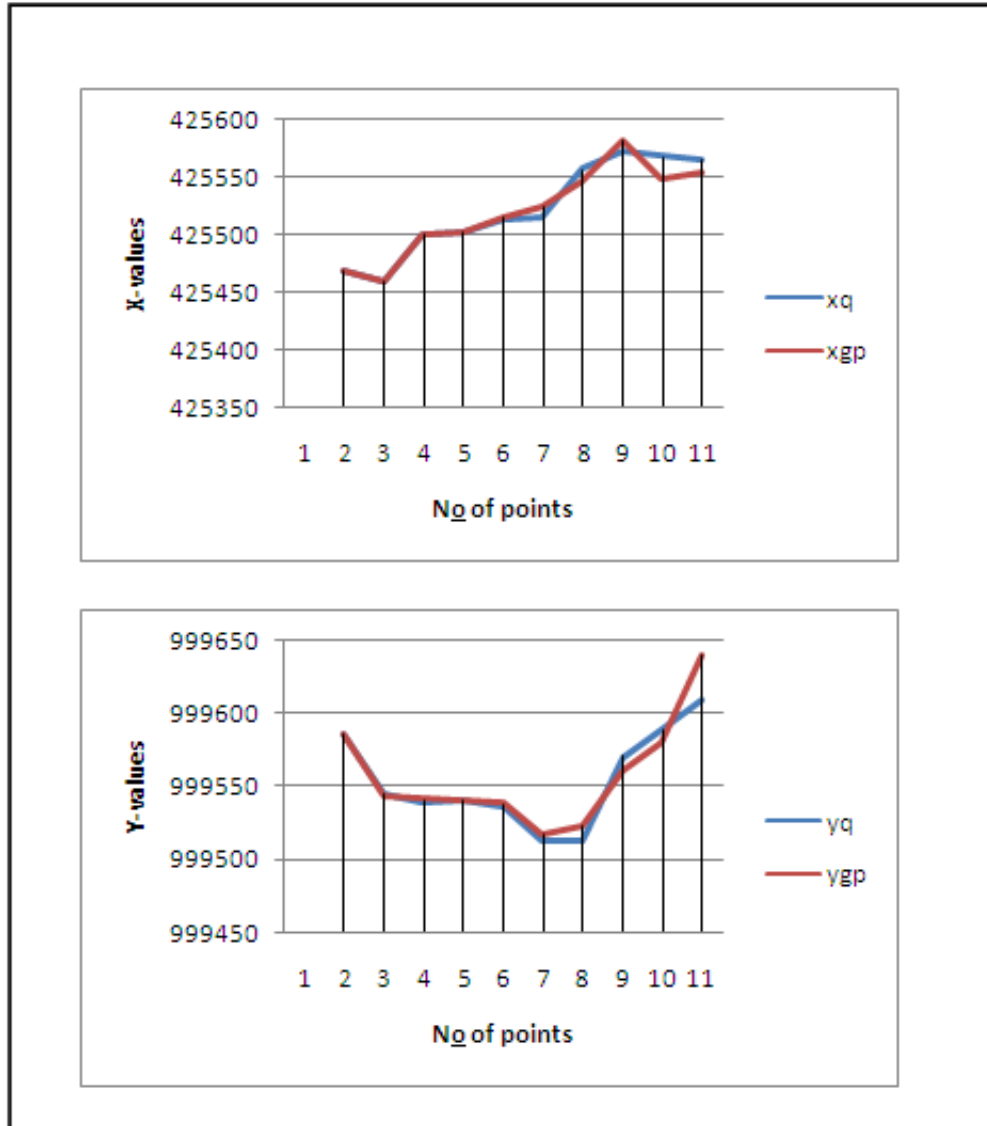
Appendix 2: Google Earth Map



(Source: Author)

Appendix 3

(X, Y) combination Graph of coordinates



Source: (Author)

Appendix 4

Short explanation: the Garmin handheld GPS Map76 CS used in this Research

It provides *8 megabyte* of internal user memory to be used for storing downloaded point of interest.

Major features:

- Designed for navigation
- Works very well with collection points
- Small and lightweight.
- By calibrating and correcting the data collected is also used for Surveying etc.

Accuracy:

- Uncorrected data without Selective Availability: 10-20 meters
- Under trees 20-50m
- During best time of hunting and Fishing , and good latency Ranges from 3-10 meters

Software:

Various software is available for downloading GPS data to ArcGIS 9.2. But, in this study the researcher was used the latest version of GPS software DNR 5.4 Garmin extension to connect with Arc Map and Google Earth. This was freely downloaded from Department of Natural Resource of Minnesota State.



(Source GARMIN, from www.garmin.com)

[Further details available from <http://www.garmin.com/products/gps76cs/> (Accessed on 12/6/2008)]

Appendix 5: The connection between MN DNR,GPS with ArcMAP

Lat
Alt

Lon
EPE

<<< Data Table >>>

Waypoint
 Track
 Route
 RTimeWpt

	type	ident	lat	long	y_proj	x_proj	commer
101	WAYPOINT	P50	9.040698049999995	38.3196239300001	999421.41229285	425223.84859384	04-(
100	WAYPOINT	P5	9.041743019999997	38.32225719	999536.41023265	425513.48250617	04-0
99	WAYPOINT	P49	9.040402580000003	38.3199727	999388.67216637	425262.12065714	04-(
98	WAYPOINT	P48	9.040906000000001	38.32018551	999444.28913490	425285.61420682	04-(
97	WAYPOINT	P47	9.04110482	38.31984102	999466.34226572	425247.79265751	04-(
96	WAYPOINT	P46	9.041113790000002	38.3198400100001	999467.33424010	425247.68349964	04-(
95	WAYPOINT	P45	9.041675960000003	38.32009725	999529.43778175	425276.07239456	04-(
94	WAYPOINT	P44	9.041572280000001	38.32033304	999517.92608963	425301.96641503	04-(
93	WAYPOINT	P43	9.040897620000001	38.3202141000001	999443.35674214	425288.75477807	04-(
92	WAYPOINT	P42	9.040299989999999	38.32037042	999377.24781098	425305.81258935	04-(
91	WAYPOINT	P41	9.039980809999998	38.32027537	999341.97717976	425295.29993428	04-(
90	WAYPOINT	P4	9.041782329999996	38.3221497300001	999540.77849608	425501.67979662	04-0
89	WAYPOINT	P39	9.039772600000002	38.3207834	999318.85241655	425351.09426949	04-(
88	WAYPOINT	P38	9.040059759999997	38.32098532	999350.56089622	425373.34628729	04-0
87	WAYPOINT	P37	9.040162610000004	38.3208588300001	999361.95838611	425359.46504556	04-0
86	WAYPOINT	P36	9.040701730000003	38.3212902500001	999421.47783519	425406.99303719	04-0
85	WAYPOINT	P35	9.040771560000002	38.32123183	999429.21053378	425400.58652354	04-0
84	WAYPOINT	P34	9.041177409999999	38.32125823	999474.07788995	425403.57165813	04-0
83	WAYPOINT	P33	9.041427190000003	38.3206518800001	999501.81891304	425336.97984668	04-0
82	WAYPOINT	P32	9.041430209999999	38.32064099	999502.15504934	425335.78356153	04-0
81	WAYPOINT	P31	9.040805500000002	38.3204962300001	999433.11370096	425319.74442619	04-0
80	WAYPOINT	P30	9.040914630000002	38.32019708	999445.24093901	425286.88763320	04-0
79	WAYPOINT	P3	9.0417773	38.32212693	999540.22701423	425499.17284400	04-0

Not Connected 0 of 111 Selected

Source: Author

Appendix 6: Field Photo



The Researcher during Field Data collection (Photo graphed by :Brahanu)

Appendix 7

The six statements of cadastre 2014

Statement 1 on Cadastre 2014

Cadastre 2014 will show the complete legal situation of land, including public rights and restrictions!

Comment The population of the world is growing. The consumption of land is increasing. The absolute control of the individual or of legal entities of land is increasingly being restricted by public interest. To provide security of the land tenure, all facts about land must be made obvious by the cadastral system of the future.

Consequences A new thematic model is necessary. Surveyors must take into consideration public law.

Statement 2 on Cadastre 2014

The separation between 'maps' and 'registers' will be abolished!

Comment: The separation was necessary because the available technology – paper and pencil – did not allow other solutions.

Consequences: The division of responsibilities between surveyor and solicitor in the domain of cadastre will be seriously changed.

Statement 3 on Cadastre 2014

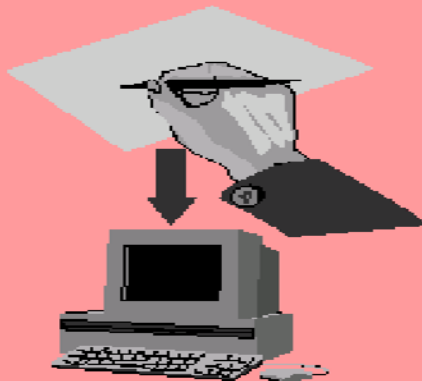


The Cadastral mapping will be dead!
Long live modelling!

Comment: Maps have always been models, but the available technology did not allow for the use of these models in a flexible manner. So in mapping flexibility had to be brought in by different scales. Different scales had to be represented by different data models. Modern technology allows the creation of maps of different scales and registers in different forms from the the same data model.

Consequences: In 2014 there will be no draftsmen and cartographers in the domain of cadastre.

Statement 4 on Cadastre 2014



'Paper and pencil - cadastre' will have gone!

Comment: Geomatics technology will be the normal tool for cadastral work. Real low-cost solutions are only possible when this technology is used in combination with lean administrative procedures. Developed, developing, and transitional countries need models of the existing situation to resolve the problems of population, environment and reasonable land use.

Consequences: The modern cadastre has to provide the basic data model. Surveyors all over the world must be able to think in models and to apply modern technology to handle such models.

Statement 5 on Cadastre 2014

Cadastre 2014 will be highly privatized! Public and private sector are working closely together!



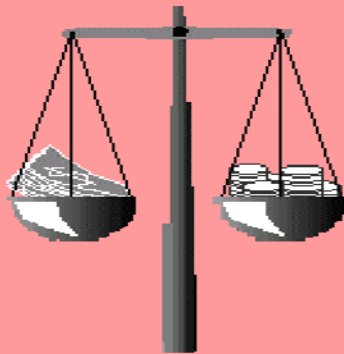
Comment : Public systems tend to be less flexible and customer oriented than those of private organizations.

Free economies demand flexibility in land markets, land planning and land utilization. Flexibility may be provided better by private institutions. For necessary security, however, public involvement is indispensable.

Consequences : The private sector will gain in importance. The public sector will concentrate on supervision and control.

Statement 6 on Cadastre 2014

Cadastre 2014 will be cost recovering!

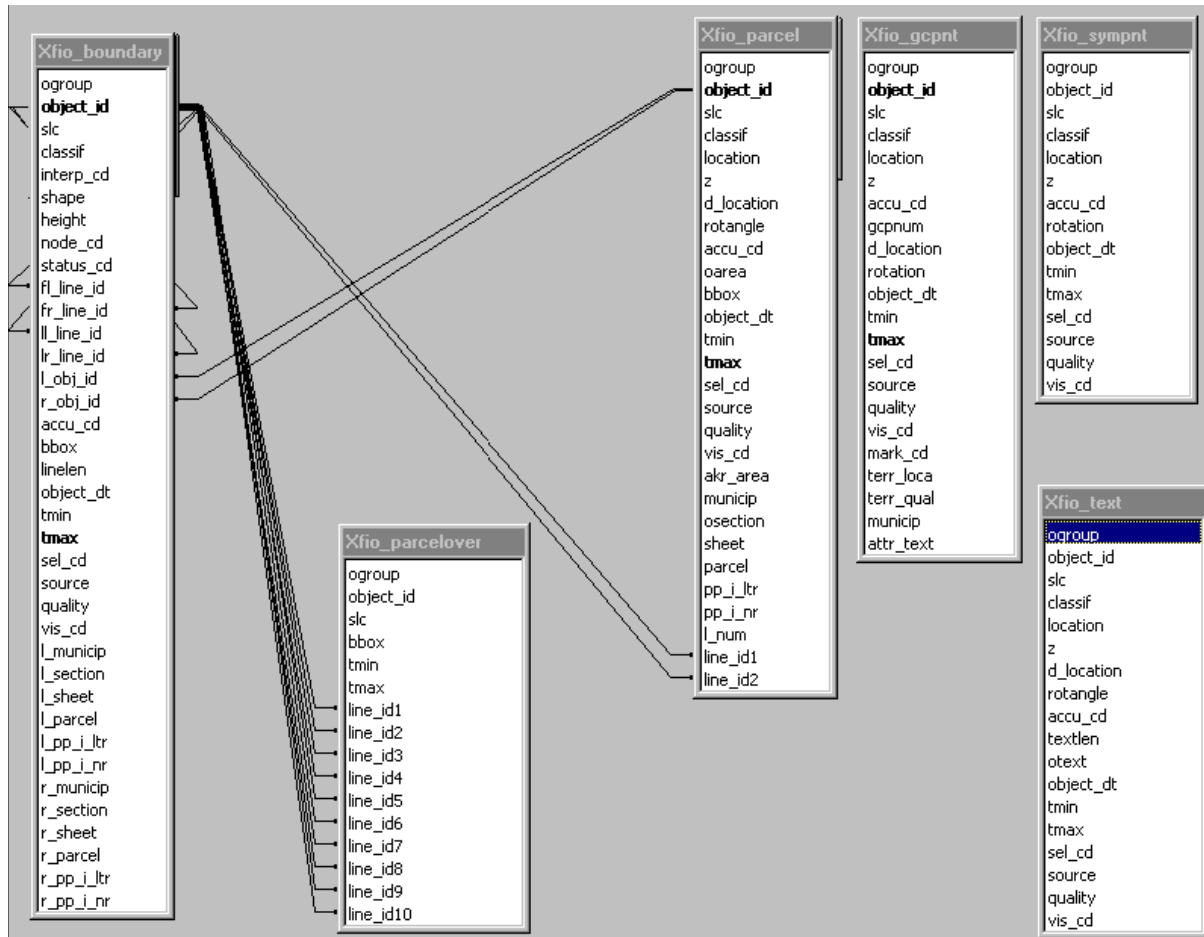


Comment : Cadastral systems need considerable investment. But the land documented and secured by the cadastre represents a multiple of the investment. The investment and operation costs have to be paid back at least partially by those who profit.

Consequences : Cost/benefit analysis will be a very important aspect of cadastre reform and implementation. Surveyors will have to deal more with economic questions in future.

Source: from the Report by Cadastre 2014(www.fig.net, Accessed on 12/6/2008)

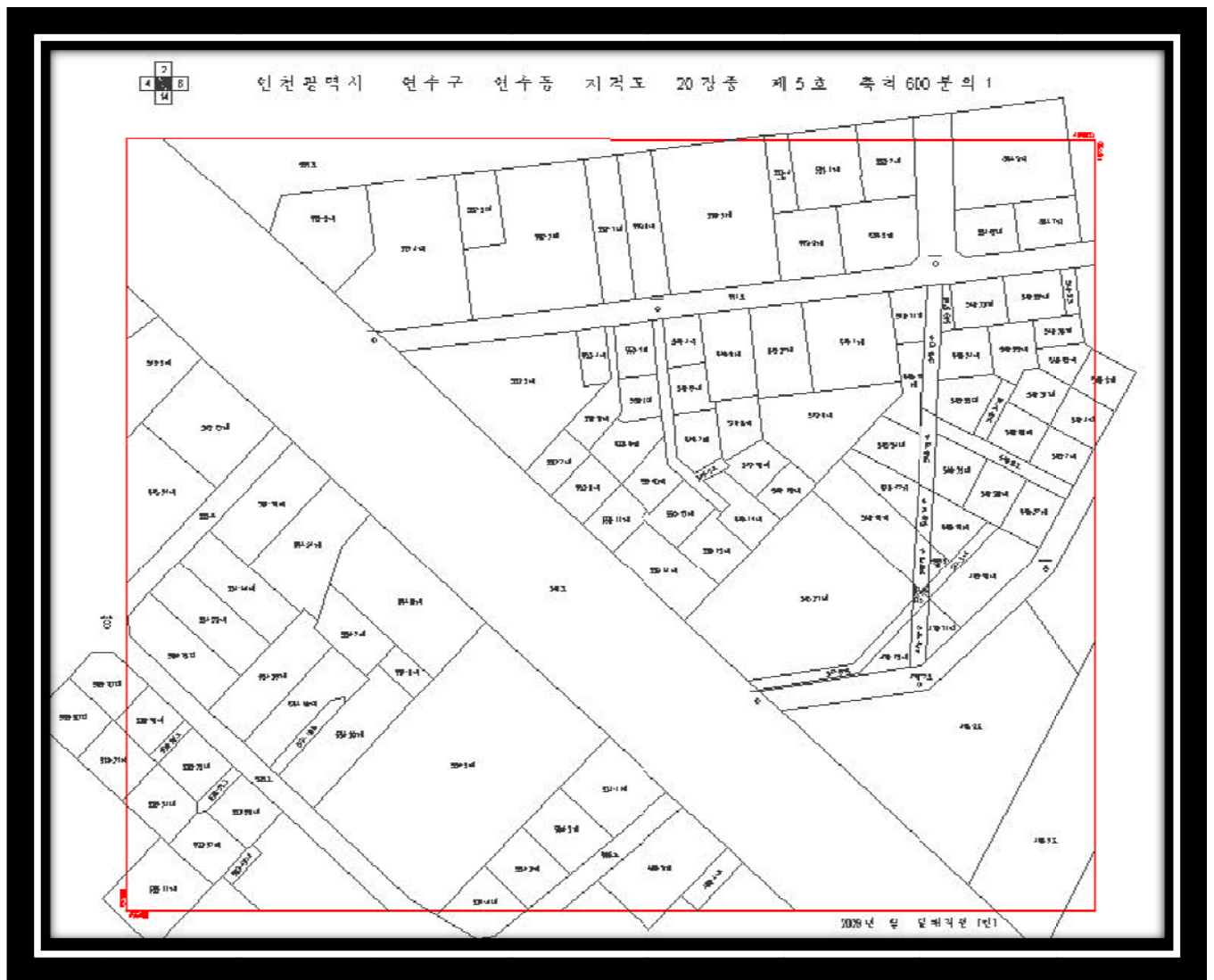
Appendix 8: Schema of the Dutch cadastral system



Source: Adopted from the Netherland cadastral Report (www.dutchcadastre.net, Accessed on 12/08/2008)

Appendix 9: Example of a Cadastral Map

Cadastral map is re-structured by seamless mapping in one single graphic database with NGIS (National Geographic Information System), which is provide a public service by LBS (Location Based Services) system in parcel address system.



Source: www.kcsc.co.kr; (Accessed on 12/6/2008)

Appendix 10

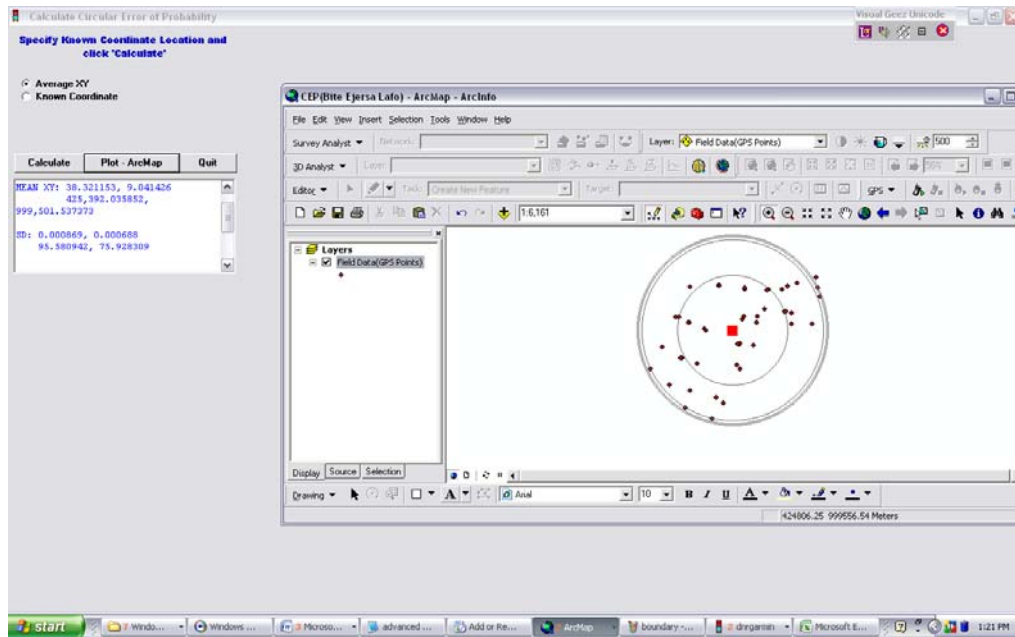


Figure: The plot is prepared by the combination of DNR Garmin 5.4 with ArcGIS 9.2

(Source: Field Data)

Table: CEP, Mean XY, SD XY of the 50 points (source: calculated from field GPS data)

Coordinate Type	Mean (X,Y)	SD (X,Y)
Geo.coordinate	(38.321, 9.041)	(0.000869, 0.000688)
UTM	(425,392.039 , 999,501.537)	(95.580, 75.928)

Circular Error of Probabilities (CEP) in Meters:

- 50% = 113.41**
- 90% = 186.36**
- 95% = 192.92**
- 98% = 196.64**

Declaration

This thesis is my original work and has not been presented for the Degree in any other University, and that all sources of material used for the thesis have been dully acknowledged.

Name: Amanuel Tesfay Gebru

Signature: -----

Date: December, 2008

Place: Addis Ababa University

This Thesis has been submitted for examination with my approval as a university advisor.

Signature: -----

Dangnachew Legesse (Dr.)

Signature: -----

Ato Esayiyas Sahalu

December, 2008

Addis Ababa, Ethiopia
