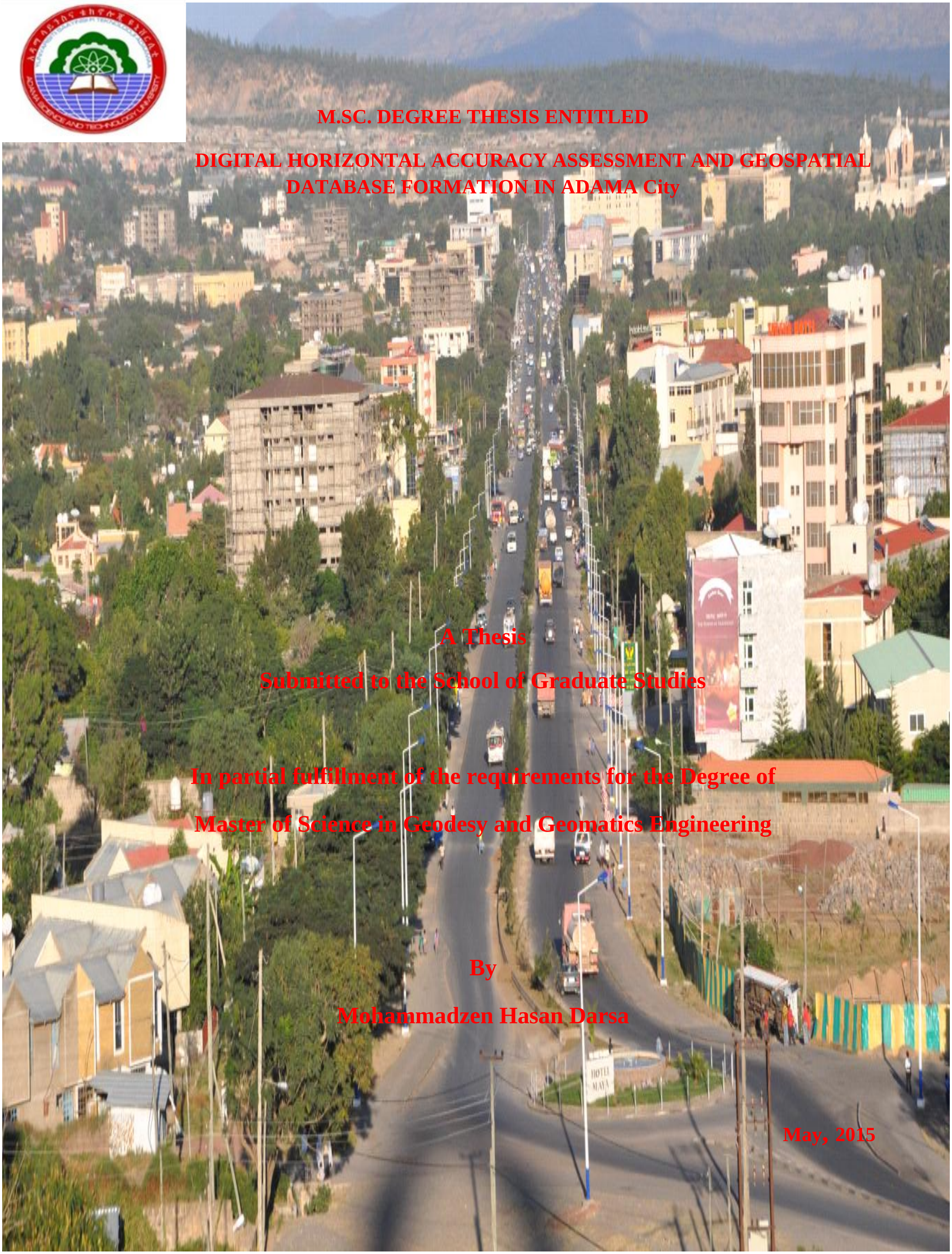

M.SC. DEGREE THESIS ENTITLED

DIGITAL HORIZONTAL ACCURACY ASSESSMENT AND GEOSPATIAL DATABASE FORMATION IN ADAMA City

A Thesis

Submitted to the School of Graduate Studies

In partial fulfillment of the requirements for the Degree of

Master of Science in Geodesy and Geomatics Engineering

By

Mohammadzen Hasan Darsa

May, 2015

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Thesis Advisor

Dr. Hassan Raja

Co-advisor

Seid Yhdego (Msc)

May, 2015

ASTU

CANDIDATE'S DECLARATION

I hereby declare that the work which is being presented in the thesis entitled "**Digital Horizontal Accuracy Assessment and Geospatial Database Formation in Adama City"** Submitted to School of Engineering in partial fulfillments of the requirements for the award of the degree of master of science in Geodesy and Geometics Engineering authentic record of my own work carried out from October to May, 2015 under supervision of Dr. Hassan Raja (main advisor) and Seid Yhdego, (co-advisor).

The matter embodied in this thesis has not submitted by me for the award of any other degree or diploma. All relevant sources of information used in this thesis have been duly acknowledged.

Mohammadzen Hasan ________________ __________________

Name Signature Date

This is to certify that the above statement made by the candidate is correct the best of our knowledge and believe. And this has been submitted for the examination with our approval.

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Main advisor Signature Date

________________ __________________ __________________

Co-advisor Signature Date

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF GEOMATICS ENGINEERING

MASTER'S DEGREE PROGRAM

This is to certify that the thesis prepared by Mohammadzen Hasan Darsa, entitled: **Digital Horizontal Accuracy Assessment and Geospatial Database Formation in Adama City**, and submitted in the partial fulfillment of the requirement for the Degree of Master of Science complies with the regulations of the University and meets the acceptance standard with respect to originality and quality.

APPROVED BY EXAMINING BOARD:

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Chairman, Department Graduate Committee Signature Date

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Advisor Signature Date

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ABSTRACT

In the well-developed applications of remote sensing and GIS, the importance of geospatial data source is valuable worldwide. Ethiopia has countered with these problems about the scarcity of geospatial and digital data sources. However, there is abundant of high resolution Google Earth imagery of different area temporal data that is used as an alternative of geospatial data source, which requires to examine its horizontal positional accuracy assessment, for further use as a geospatial data sources. In this research Google Earth and IKONOS Satellite image of horizontal positional accuracy were tested. The geodatabase has been generated to know the current status of the Adama city. In the, the check points, lines and polygon samples are used. The samples are taken from Google Earth image, IKONOS 2004 satellite image and Orthophoto and the computed point Root Mean Square Error (RMSE) in X_coordinate between Orthophoto and Google Earth was 2.66ft/ 0.813m and Orthophoto and IKONOS satellite image was 11.263ft/ 3.433m. The Y_coordinate of Orthophoto and Google Earth was 1.296 ft/0.395m and the Orthophoto and IKONOS satellite image was 3.806ft/1.160m. The horizontal line shift between Google Earth and Orthophoto is 3.541ft/ 1.079m, IKONOS to Orthophoto was 4.097m/ 13.442ft and the area difference between the Orthophoto and Google Earth was 4.219sqft/ 0.392sqm, and the Orthophoto and IKONOS satellite image was 13.347sqft/1.24sqm. The current geospatial database structures in Adama city shows that around 173km is coble stone road network and 77km is Asphalt Road, the rest is earth/ foot path. The electric power distribution is around 274km through electric lines and 319 pole mounted transformers are exists currently.

Key Words: Horizontal positional accuracy, Geospatial data, Google Earth, IKONOS Satellite Image, Orthophoto, RMSE

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ACRONYMS AND ABBREVIATION

Amsl:	Above mean sea Level
ASPRS	American Society of Photogrammetry and Remote Sensing
AVHRR:	Advanced Very High Resolution Radiometer
EEPCo:	Ethiopian Electric Power Corporation
FGDC:	Federal Geographic Data Committee
NSSDA:	National Standard for Spatial Data Accuracy
NMAS:	National Map Accuracy Standard
GIS:	Geographic Information System
GPS:	Global Positioning System
ha:	Hectare
I N T O S A I:	International Standards of Supreme Audit Institutions
Km2:	Square Kilometer
LULC:	Land Use land Cover
UN:	United Nations
CSA:	Central Statistical Authority
USGS:	United State Geological Survey
UTM:	Universal Transverse Mercator
MER:	Main Ethiopian Rift
NE:	North East
GCP:	Ground Control Point
GE:	Google Earth
RMSE:	Root Mean Square Error
RS:	Remote Sensing
TVET:	Technical and Vocational Education and Training

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Numerous electro optical low and medium spatial resolution satellite sensors such as the Landsat image series and the advanced very high resolution radiometer (AVHRR), like quick bird, IKONOS, aerial photo and Google Earth (GE) imagery are the main sources of the geospatial database now days. These and other data sources have been successfully used to generate geospatial database used for rural and urban land use/cover mapping (Jaywalk and Luis, 2013). The geospatial data sources are different in nature but possibly one can create geospatial database information applicable for different purposes.

The spatial data sources of a GIS project depends on the accuracy or correctness & modern of the derived geospatial data (Mutluoglu and Ceylan, 2009) for large scale application with spatial information requires accuracy & less costs.

Geospatial at its simplest refers to using maps to record and analyze geographic, or spatial, patterns. Traditionally, the tools employed were printed maps map overlays on transparent paper or plastic, today the tools of the geospatial analyst focus on computer-based geographic information systems (GIS), and related tools such as GPS and remote sensing (Stephen L., 2011). Technological advances over the past 30 years have enabled surveyor to combine these methods, using GPS to identify locations, remote sensing (satellite images and air photos) to identify objects visible from overhead and geographic information systems for electronic mapping and analysis. Together, these geospatial technologies provide a powerful means for conducting pattern and process research.

Information for geospatial urban management requires high-resolution satellite data for different infrastructures and urban spatial land use land cover change. Bengt (2009) is defining Satellite remote sensing is increasingly being used for timely and cost-effective development of spatial information in a wide number of applications. At the same time, computer-based geographic information systems (GIS) are being used more and more by urban agencies to improve the spatial management and use of spatial information which is currently a strong trend toward more closely integrating these two.

Geospatial information is information about a specific location on earth, to be able to visualize this information on a map or analyses this information in a Geographical Information System, information (coordinate) is needed on the specific location of a municipality on the Earth's surface or to get information about where can it be found Egbert, 2011) and to define a specific location on the Earth's surface, coordinate (X, Y and Z value) systems have been introduced. When information is available about a certain location, the spatial information can be linked to that location by using the coordinates systems.

All geographic features on the earth's surface can be characterized and defined by points, lines and polygon (area) feature. A point features represents a geographic feature or event characterized by location and attributes. Its location can be represented by a single x, y coordinate pair, while attributes can be many. For example, a populated place or a mine site can be represented by a point symbol in maps, a line features represents a geographic feature characterized by linear dimension, but not area. A census division, a lake, or a province (any geographically defined surface) is examples of area features. Therefore, every geographic phenomenon can in principle be represented by either a point, line, and/or an area.

Timely and accurate data base formation on the urban area is extremely important for precise location and timely constructed urban infrastructures (Jaywalk and Luis, 2013) of the urban area. The spatial information related to the earth which is the most precious resource now a day; it requires the analysis and interprets in very accurate manner. Then especially in urban area the spatial data used is need to be accurate and less costs as much as possible.

Urban spatial Land use is influenced by economic, cultural, political, population density and historical and land tenure factors at multiple scales. It is referred to as man's activities and the various uses which are carried on urban spatial land use and infrastructures (Rouge and Mary 2010).

The high-resolution satellite remote sensing data and aerial photography are important for detecting short-term and long-term changes that occur at a specific location. Although high-resolution remote sensing data can never replace aerial photographs, which provide images at a resolution of 0.2 to 0.3m, which is suitable for detailed land cover mapping applications (Sridhar and Alvarinho) and for this study finding aerial photography used is with 0.15m which is very high resolution with the scale of 1:2000 and Satellite image of IKONOS 2004 with 1m resolution and freely available of Google Earth imagery.

Taylor and Francis in 2012 define Google Earth enables scientists around the world to communicate their data and research findings in an intuitive three-dimensional (3D) global perspective. Different from traditional GIS, Google earth digital globes are low cost and easy to use in data collection, exploration, visualization and for other application. Since 2005 the Google earth beginning, a considerable number of papers have been published in peer-reviewed journals and proceedings from a variety of disciplines that shows Google earth more popular.

1.2 Statement of the Problem

The detailed information of the urban area is valuable to protect the spatial resources precisely. Depending on the level of detail of a map a municipality can be represented by a single point (or one specific combination of coordinates) or an area with its boundaries being defined by a number of points or a combination of coordinates. A river would then be represented as a combination of points forming a line on a less detailed map and as an area with a distinct boundary on a more detailed map.

It is obvious that geospatial or digital data is focus on information for specific area/ position, this positional accuracy is also very important for accurate design and construction of urban infrastructures like road networks, sewerage network, house distributions, for navigation purpose, for analyzing and carried out planning for engineering work. The geospatial data base can be generated and the different engineering works can be carried out separately from GPS and remote sensing data sources: like satellite images, aerial photographs and Google Earth images, however, the amount of the costs they expense (invest) for purchase or getting the raw data may be different in these data sources for selection of less costs and more accurate (Egbert, 2011).

The less costs and accurate position geospatial data sources are very crucial in developing and developed countries for generating different geospatial database and other purpose like supervising of constructed infrastructure, sewerage design, distribution of telecommunications, urban land use land cover change detection and etc.

The expansion of urban land use is continued throughout because urbanization is an unavoidable process due to economic development and rapid population growth. Urban spatial expansion, particularly the movement of residential and commercial land use to rural areas at the periphery of metropolitan areas, then for land use land cover detection analysis remote sensing and satellite data is required, (Jatit 2011), however, the commercial high resolution satellite images are much cost to purchase for urban land use land covers change detection and geospatial database generation for developing countries like Ethiopia exclusively, which has not its own satellite image data sources.

From these geospatial data sources Google earth is cost free high resolution Orthophoto available everywhere especially in the urban area, when it compared to the other geospatial data sources like commercials high resolution satellite images (Quick bird and IKONOS) and aerial photograph and Google earth also has the advantage of existing images in specific location with periodical times.

The problem of the commercial high resolution satellite image is not only their costs their presence is also another headaches which are very less incidence and very costly. Change detection analysis necessitate minimum of three to five remote sensing data with different times (satellite images or aerial photographs) that requires much costs to purchase and carry out their study findings for researcher. When it was compared the availability and the costs the Google earth is more preferable than this high resolution commercial satellite image and Aerial photography, but the horizontal positional accuracy of each this data may be different which can affect the accuracy of the geospatial database formation.

This horizontal positional accuracy of Google Earth and high commercial satellite image of IKONOS image is need to assessed with the ground base available of Orthophoto of Adama city based on the different accuracy standards by using Root Mean Square Errors in this research for assessing this accuracy.

The update information of geospatial database for urban area is very important over different times. It is obvious that towns in developing countries are changing from time to times to get better life, educational institute, well-structured road and electric networks, well building structures & etc. and also urban geospatial expansions of the current status is required. That this research is need to generate the current status of some geospatial database structure (road network, electric power distributions and some utility) and including the field or primary data of Adama city kebele boundaries.

1.3 Objectives

1.3.1 General

Assessment of Horizontal Positional Accuracy of Google Earth and IKONOS 2004 satellite image of Adama city for Possible Scientific Applications

1.3.2 Specific

- Comparative Positional Accuracy (point, line and polygon sample level) assessment of Google earth's high-resolution Adama City Imagery Archive,
- Comparative Geospatial Database cost benefits analysis,
- Creation of current status of road network, electric coverage & some utility map.

1.4 Significance of the Paper

The end results of this research paper will have great advantages to city administrations by getting the present state of road network (asphalt, coble stone and earth road), electric power line and transformers, some utility maps. This research also has an advantage for any related body that requires information with the expansion of coble stone roads in this study area after a decade.

And the researcher, municipal office or related body can get the current status of Adama kebele boundaries (including GPS track data), some utility areas like hospitals (private and government), factory (some private and government, like garment, flour, soap and etc.), electric power lines distribution network (including GPS positions of transformer distribution in Adama city), road network distribution and types (asphalt, coble stone, earth), and etc. are clearly get in formations.

CHAPTER TWO: DESCRIPTION OF THE STUDY AREA

2.1 Geographical

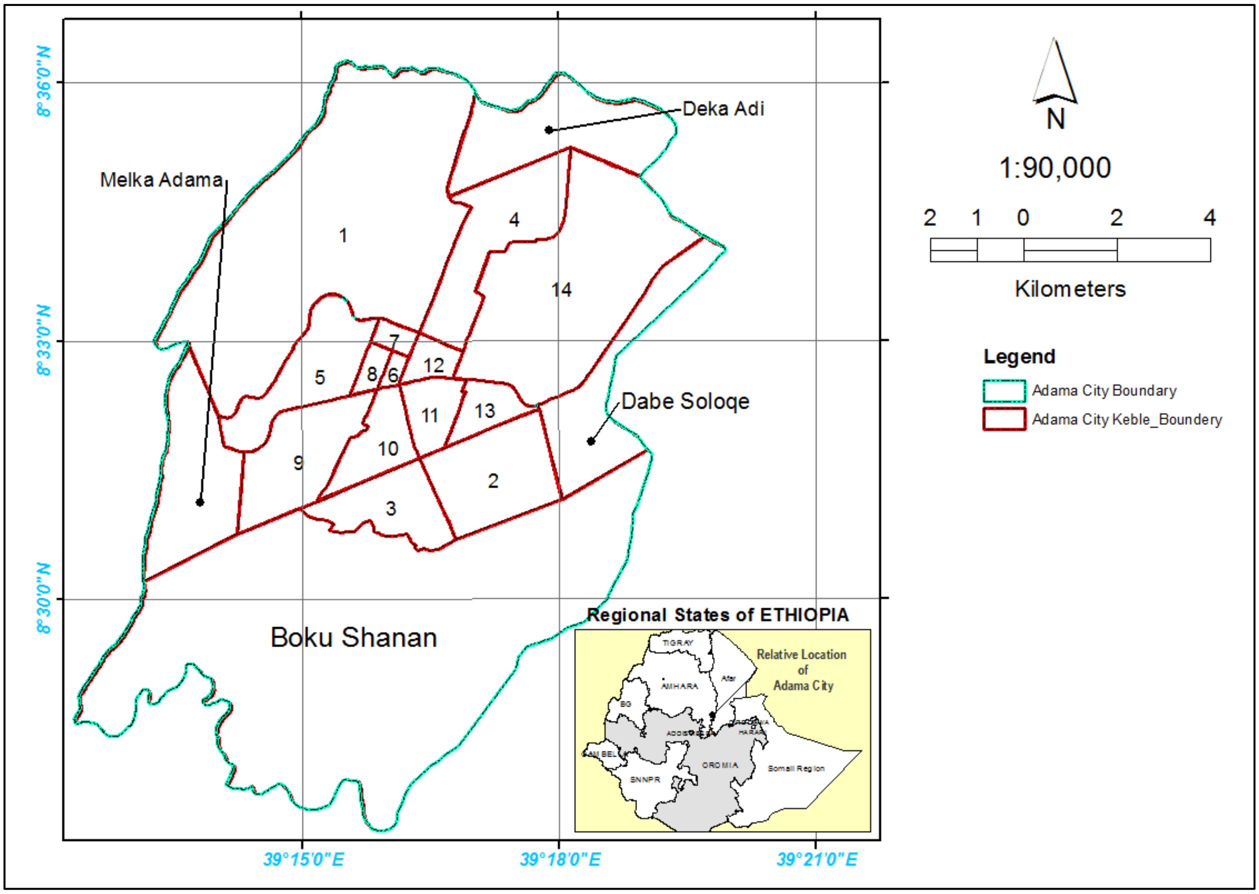

Figure: 2.1 Location Map of The Study Area (Adama City)

Source: Adapted From Adama City Municipality

The study area is Adama City which is located about 100km. South East of Addis Ababa along the main road to Harar, enclosing between around $8^0 27'$ 00" to $8^0 37'00"$ north latitude and 39^0 12' 00" to "39^0 20' 00" East longitude at an average altitude of 1700m above mean sea level. East shewa zone, in which Adama is located, form a part of the mid central plateau physiographic unit.

Adama City is found on a nodal location along main national and regional transport lines from the capital Addis Ababa to other important towns. It is also situated close to natural recreational sites such as 'Sodore', "Boku' and others.

2.2 Landslide and Flooding

Rockslides are common features observed around the city of Adama especially along the ridges exploited by quarrying activity. Small-scale rock fall at fault escarpment and continuous slump at valleys and stream channels are common. In the city of Adama landslide prone areas are those located along ridges where quarrying activity is taking place (Alula, 1992).

The city and its environs are characterized by deep gullies called inverse gullies that are deep up stream and shallow downstream that cut through loose tuff deposits. Since the nature of gully is deep around the city, there is serious risk of sliding along the gullies that cause gully widening. Such activity consumes farmland by increasing soil erosion. The areas affected by gullies erosion are located around Boku, north of Adama (around cemeteries), and behind Migira ridge on the way to Wolenchiti (Teshome, 1999).

Adama is bounded by Kechema ridge in the west, Kurfagutu peaks on the north, Dibibisa and Migira ridge in the west and Boku ridge in the south. The city can be seen clearly from the surrounding ridges that provide fascinating panoramic view. It is located within the structural depression bounded by parallel scarps running in NE-SW direction (Getahun, 1987).

CHAPTER THREE: REVIEW OF LITERATURE

3.1. General Review

Access to imagery with ground sample distances (GSD) has increased significantly in recent years with the launch of several airborne and satellite sensors. This expansion in the availability of high spatial resolution image data provides new possibilities for deriving image related products but also places new demands on processing capabilities. The improvements in spatial resolution provide the potential for automatically defining linear features that were previously unattainable however, to be most useful imagery must be processed quickly, and features must be located positional accurate and classified correctly.

There are different organizations that set thresholds (other not) for map accuracy standards for the positional accuracy. These organizations are like American Society of Photogrametry Remote Sensing, National Standard for Spatial Data Accuracy, National Map Accuracy Standard, United State of Geological Survey, and etc. Because of major changes in technologies since ASPRS published its Accuracy Standards for Large-Scale Maps in 1990, ASPRS has recently published new standards specifically intended for digital Orthoimagery, digital planimetric data and digital elevation data (all independent of map scale), as well as scaled maps.

The new ASPRS Positional Accuracy Standards for Digital Geospatial Data include for digital geospatial data, whereas the National Standard for Spatial Data Accuracy (NSSDA), published in 1998, did not provide accuracy thresholds. The ASPRS 1990 standard provided accuracy thresholds for hardcopy maps only, as did the National Map Accuracy Standard (NMAS) of 1947; for these reasons, the new ASPRS standards have long been in demand to establish accuracy thresholds for digital geospatial data new horizontal accuracy classes based on Root Mean Square Errors of horizontal X_coordinates (RMSEx), and Root Mean Square Errors of horizontal Y_coordinates (RMSEy) (ASPRS, 2014).

Based on this principle the horizontal accuracy of freely available Google Earth and high resolution of satellite image IKONOS 2004 of Adama city is treated against the government prepared of Orthophoto of 2013 Adama city.

Google Earth is a virtual globe, map and geographical information program that are controlled by Google Corporation. It maps the Earth by the superimposition of images obtained from satellite imagery & aerial photography. With millions of users all around the globe, Google Earth has become the ultimate source of spatial data and information for private and public decision-support systems besides many types and forms of social interactions. Many users mostly in developing countries are also using it for surveying applications.

3.1 Horizontal Positional Accuracy of Google Earth's High-Resolution Imagery Archive

David (2009) defines the consideration of aerial photography for particular geospatial mapping applications depends on the scale of photography. Traditionally, the positional and elevation accuracies achievable using photogrammetric methods and the scale of the final map were determined based on mapping requirements and practice. The accuracy and photo map scale relationships mainly depend on the scale and resolution of aerial photography, the flying height, the base height ratio and the accuracy of the stereo plotting. The choice of the photographic scales based on the mapping scale and contour interval.

Sheppard and Cizek in 2008 are define as Google Earth a 3D interface to the Planet was publicly released in June 2005 and has attracted widespread public use and attention due to its ability to view landscapes in fairly realistic three dimensions, using a combination of digital elevation models & satellite imagery. Google Earth grew to over 100 million users on the internet within one year of its release (Google Corporation). In the United Kingdom, it is reported that Google Earth became the eighth most popular search term during the month of January 2006 this indicate that Google Earth is very popular including developed country.

Other programmers are becoming available with some similar capabilities, including World Wind and ESRI's Arc GIS Explorer (Environmental Systems Research Institute, 2006). Breakthroughs in tiling, data transfer, and caching technology have allowed seamless viewing and real-time exploration of spatial data, including medium to high resolution satellite imagery anywhere in the word. The appeal of these techniques is evident, not only for private users but also for scientists, practitioners, policymakers, and stakeholders on environmental and planning issues (Butler, 2006) can use this spatial data source.

Google Earth is becoming a popular browser for online geospatial-related data and information, it is facilitating people to discover, add, and share information about any subject that has a geospatial element via its virtual template of the world (Potere, 2008). Although, the original purpose of Google Earth is to use the Earth itself as an organizing metaphor for digital information, now, Google Earth virtual globe is changing the way in which scientists and general public interact with the geospatial data in a virtual environment. It is high resolution archive represents a significant, rapidly expanding, cost-free and largely unexploited resource for scientific inquiry.

As Google acquires more updated, better-resolution and clearer satellite images it is hoped that the Google Earth application will correspondingly connect and display images accurately to offer viewers a truly seamless viewing experience and some applications with limited area in developing countries where there is inadequate of satellite images.

Google Earth has positioned itself at the forefront of this geospatial information wave by providing free access to high-resolution imagery through a simple, user-friendly interface, and also Google Earth imagery has been widely exploited across the earth sciences for geospatial visualization, education, and place-based searches; few studies have utilized the high resolution imagery to yield measurement at the earth's surface or geospatial information.

The ubiquitously Google Earth service is arguably the most well-known and frequently used internet service that provides free-of-charge access to the global collection of georeferenced satellite imagery. Its popularity is thanks not only to its accessibility, but also the availability of tools that allow users to add their own content to the imagery, such as photographs (Marrakech, 2011), point data, line data, polygon features, area calculations, linear measurements, coordinate determinations for points, notes (text) and etc. with GE which its positional accuracy is required for further understanding its accuracy level.

Many users mostly in developing countries are also using Google Earth for surveying applications (Farah and Algarni, 2014) that classified under Class III accuracy level with the scale of 1:2400 like cadastral survey & some engineering application in developing countries according to ASPRS accuracy standards.

There are international commercial satellite imagery companies that provide high resolution imagery that can be found in software tools like Google Earth. Examples of these commercial companies and their employed satellites are:

US based Digital Globe is currently operating three satellites: Quick Bird, Worldview -1 and WorldView-2 (Digital Globe, 2014), US based Geo Eye is currently operating three satellites: GeoEye-1, IKONOS and OrbView-2 (Geo Eye, 2014), French based Spot Image is currently operating two satellites: SPOT 4 and SPOT 5 (SPOT, 2014), German based Rapid Eye is currently operating five satellites: Rapid Eye 1-5 (Rapid Eye, 2014), Netherlands based Image Sat is currently operating two satellites: EROS A and EROS B (Image Sat, 2014).

However, it must be noted that Google Earth provides this service with a disclaimer that warns users about the quality of the data. Despite this warning, many individuals still refer to Google Earth as a reliable and accurate data source beyond its accuracy level while others are still refer Google Earth as a useless.

But its horizontal positional accuracy level should be assessed and determine to understand its limitation and benefits based on its level of accuracy. While inaccuracies in the Google Earth data are not expected to cause harm or damage in many cases, it can potentially cause problems if it is used for navigation purposes, or in technical tasks requiring high accuracy surveying and mapping applications (Farah and Algarni, 2014), according to some accuracy standard there is an area that Google Earth imagery is used and not as well that different researchers are tested it accuracy level scientifically. Based on this the study finding is try to test the Google Earth and IKONOS 2004 Satellite image of Adama city accuracy level.

(Potere, 2008) tested the Google Earth horizontal positional accuracy of 436 control points located in 109 cities worldwide. The study concluded that those control points had a positional accuracy of 39.7 meters RMSE (error magnitudes range from 0.4 to 171.6 meters).

(Farah and Algarni, 2014) tested the Google Earth positional accuracy of nine (9)control points in Riyadh, capital of Kingdom of Saudi Arabia (KSA), According to a small-scale assessment study of this positional accuracy of Google Earth Imagery the results show that the RMSE of the Google Earth imagery for the horizontal position is 2.18 m.

(Becker et al., 2011) tested the Google Earth positional accuracy of more than 1900 control points located in five continents worldwide. The study concluded that the error could reach 1.5 km in some cases. (Naji et al., 2013) tested the Google Earth positional accuracy of 16 control points located in Khartoum state, Sudan. This was carried out by comparing Google earth measured coordinates of control points with Global Positional System (GPS) and the study concluded that the Root Mean Square Errors (RMSE) for horizontal positional accuracy was found to be 1.59 m.

In all this above studied there is no consideration for line shift & polygon features which is only based on the point features of geospatial information classifications it may happen in horizontal shift & area difference in these spatial data sources; and also the terrain or slope characters of the geospatial information or land form is ignored in all the above studied, but the terrain character is very important to consider because the elevated sample value is may be different from the lowest values of land slope in digital data due to radial displacement and no consideration of the scale of the test of the GE or digital image, this scale of testing is very important according to different organization that set for Accuracy Standard of horizontal positional accuracy of digital data.

As the scale change the accuracy level of geospatial data is also change according to these standards. This research carried out an assessment to determine of the horizontal positional accuracy level of Google Earth and IKONOS 2004 satellite image of Adama city with concern of points, lines & polygon features separately with different classes of slope characters in Adama city based on the Orthophoto in consideration of the scale to determine their accuracy level.

The total 213 samples are selected which are 21 samples points, 41 sample lines and 9 samples of polygon features from each data sources (Google Earth imagery, IKONOS 2004 Satellite image and Orthophoto of 2013) are tested with different slope categories distributed in Adama city.

3.2 Remote Sensing Data Accuracy and Its Applications

The combined powers of data collection through remote sensing techniques and geospatial analysis tools by means of the internet and other (Tsou, 2004) can significantly reduce the high cost and labor associated with traditional field monitoring.

The majority of remote sensing work has been focused on natural environments over the past decades; applying remote sensing technology to urban areas is relatively new. With the advent of high resolution imagery and more capable techniques, urban remote sensing is rapidly gaining interest in the remote sensing community (Gabriel et al, 2007; Weng and Quattrochi, 2006) driven by technology advances and societal needs, remote sensing of urban areas has increasing become a new arena of geospatial data.

In terms of analyzing urban growth, (Batty and Howes, 2001) believe that remote sensing technology, especially considering the recent improvements of spatial resolution, can provide a unique perspective on growth and urban land-use change processes. Data sets obtained through remote sensing are consistent over great areas and over time, and can provide information at a great variety of geographic scales. The geospatial information derived from remote sensing can help to describe the urban environment (Banister et al. 1997; Longley and Mesev 2000; Longley et al. 2001); leading to an improved understanding that benefits applied urban planning and geospatial database management.

In the recent years, remote sensing data and geographic information system (GIS) techniques are widely being used for mapping (to understand the urban pattern), monitoring (to understand the urban process) and measuring (to analyze) the urban growth, land-use land-cover change, and sprawl (Axtell and Epstein 1994; Parker et al. 2003). The physical expressions and patterns of urban growth and sprawl on landscapes can be detected, mapped, and analyzed by using remote sensing data and GIS techniques and also the decision support systems within the GIS can evaluate remote sensing and other geospatial datasets.

Uncorrected images do not allow for accurate measurement of distance between two points. Aerial imagery does not include Orthorectification (from either photographic or digital) unless that service is requested; either type of imagery can be geo-referenced for use in GIS applications (Kansas, 1999).Good accurate geospatial database maps can be derived from Orthophotography because the image has been corrected to ensure that horizontal scale is constant. Streets and roads, curbs, manholes, water edge, tree inventories, and numerous other features can be accurately mapped from the Orthophoto.

Many features like street centerlines, edge of pavement and buildings can be extracted from remote sensing data in many different map scales.

3.3 Cost of GIS Data Collection, Management and Retrieval

A GIS has many tools for making and using geographic or spatial information. There are many formal definitions of GIS; for example the National Centre of Geographic Information and Analysis (NCGIA) states that: A GIS is a system of hardware, software and procedures to facilitate the management, manipulation, analysis modeling, representation and display of georeferenced data to solve complex problems regarding planning and management of resources. For practical purposes, (Burrough and Frank, 1995, states of Kansas 2007) GIS is defined as a computer based system to aid in the collection, maintenance, storage, analysis, output and distribution of spatial data and information.

One of the main components of a Geographic Information System (GIS) is the formation of the database. More than 70% of the time and cost is spent on developing this database. The success of a GIS project depends on the accuracy of the obtained geospatial data required for development of the GIS project (Mutluoglu and Ceylan, 2009). According to international resources, total cost of data collecting and processing are 65% of total cost. This show important is spatial data (Kokturk, 2003; Durduran et al, 2007), that take attention to compare the horizontal accuracy of spatial data sources of GE and IKONOS Satellite image based on the different accuracy standards to determine the accuracy level of them.

GIS has emerged as promising tool for prioritizing and analyzing geospatial environmental issues for sustainable development. Because geospatial database management and land use conflicts are resolved by this GIS, (Mohan, 2002) any rigorous analysis of spatial and land use database management alternations must include consideration of the spatial interactions between people and their environment.

Many technological approaches have been developed by many different disciplines to use various data sources for collecting spatial data in GISs. Since the data acquisition process in GISs is carried out by using more than one data source (states of Kansas 2007), the accuracy level & cost comparisons of these data sources also has required attention.

3.4 Geospatial Data Accuracy Standards According to Different Organization

The selection of a required map scale and accuracy is typically determined by the intended use of the map and the positional accuracy requirements. The term small scale map indicates a large area of the earth is shown in a map, typically requiring significant generalization of detail for map features (for example cities might be represented as point symbols). A map of the entire a country at a scale of 1:12,000,000 (where one inch equals 190 miles) is an example of a small scale map. Conversely a large scale map indicates a map that covers less geographic area and provides much greater map detail geospatial information such as manholes, flag poles, etc.

Today many maps are created in a computer environment that can be plot the maps at virtually any scale we choose. Scale remains an important factor in the accuracy of a map. Many digital maps are derived from aerial photography or digitized from existing paper maps. The accuracy of these digital maps is a function of the scale of the aerial photography or map.

The horizontal accuracy assessments of this geospatial data sources may be performed both in absolute and relative conditions. Absolute requires the use of ground control points from high accurate Orthophoto for testing purposes. These points, found in the image and coordinates from the Orthorectified image, are compared to the published coordinates. Relative horizontal accuracy assessment involves the visual inspection of adjacent Orthophoto for edge matching, and etc. The relative displacement would be quantified by using the computations of standard deviations. Accuracy standards vary in complexity and usability.

The most commonly used data standard for county and municipal mapping applications are the American Society of Photogrammetry and Remote Sensing/ASPRS, USGS/United State of Geological Survey (states of Kansas, 2007), the National Map Accuracy Standard/NMAS, the Federal Geographic Data Committee/FGDC, the National Standard for Spatial Data Accuracy/NSSDA and etc.

The ASPRS Accuracy Standards for large scale maps (1:12,000, 1:2,400, 1:1,200, etc.) measure accuracy as Root Mean Squared Error (RMSE). RMSE is a calculation of the average difference between the actual location of something and the location shown on your photograph or image.

The ASPRS Accuracy Standard varies depending on the scale of the map, and the class of accuracy.

Table: 3.1 ASPRS Accuracy Standard per Class

ASPRS Accuracy Standard				
Map Scale	1:600	1:1,200	1:2,400	1:4,800
Acceptable RMSE Class I	6 inch	1 foot	2 feet	4 feet
Acceptable RMSE Class II	1 foot	2 feet	4 feet	8 feet
Acceptable RMSE Class III	1.5 feet	3 feet	6 feet	12 feet

Source: ASPRS Accuracy Standard (Kansas, 1999)

Tables: 3.2 Detail ASPRS horizontal accuracy requirements.

Planimetric Feature Coordinate Accuracy Requirement (Ground X or Y in feet) Points				
Target Map Scale		Limiting RMSE in X or Y, ft ASPRS		
1 in=x Ft	Ratio ft/ft	Cass I	Class II	Class III
5	1:60	0.05	0.10	0.15
10	1:120	0.10	0.20	0.30
20	1:240	0.20	0.40	0.60
30	1:360	0.30	0.60	0.90
40	1:480	0.40	0.80	1.20
50	1:600	0.50	1.00	1.50
60	1:720	0.60	1.20	1.80
100	1:1200	1.00	2.00	3.00
200	1:2400	2.00	4.00	6.00
400	1:4800	4.00	8.00	12.00
500	1:6000	5.00	10.00	15.00
800	1:9600	8.00	16.00	24.00
1000	1:12000	10.00	20.00	30.00
1667	1:20000	16.70	33.30	50.00

Source: Army Corps of Engineers Topographic Accuracy Standards

In the U.S. Geological Survey Accuracy Standards: Map scale is defined by the U. S. Geological Survey (USGS) in its USGS Fact Sheet 038-00, April 2000, as to be most useful a map must show locations and distances accurately on a sheet of paper of convenient size. This means that all things included in the map ground area, rivers, lakes, roads, distances between features, and so on must be shown proportionately smaller than they really are and its accuracy level is as follow. It is similar to the Class III of ASPRS accuracy standards.

Table: 3.3 USGS Horizontal control points Accuracy Standard

USGS Map Accuracy Standard			
SCALE	1inch= x Feet	Horizontal Accuracy (ft.)	Vertical Accuracy (ft.)
1:1200	100	3.33	(Contour Interval)*0.5
1:2400	200	6.67	(Contour Interval)*0.5
1:4800	400	13.33	(Contour Interval)*0.5
1:12000	1000	33.33	(Contour Interval)*0.5
1:24000	2000	40.0	(Contour Interval)*0.5
1:100000	8333	166.67	(Contour Interval)*0.5

Source: USGS map accuracy standard (PaMagic, 2002)

While another National Map Accuracy Standard (NMAS), developed in 1947 is also similar with ASPRS accuracy standard in III class accuracy level, was designed to review data on map sheets (Kansas, 1999) and it establishes thresholds as the following table 3.4.

Table: 3.4 NMAS Horizontal control points Accuracy Standard

NMAS				
Map Scale	1:600	1: 1200	1: 2400	1:4800
Acceptable RMSE Class III	1.66 feet	3.33 feet	6.33 feet	13.33 feet

Source: NMAS Accuracy Standard (Kansas, 1999)

The newest standard developed by the Federal Geographic Data Committee (FGDC) to update the NMAS is the Geospatial Positioning Accuracy Standards, National Standard for Spatial Data Accuracy (NSSDA). The NSSDA uses RMSE to estimate positional accuracy. Unlike the NMAS and ASPRS standards, NSSDA does not define threshold values. These values are defined by the customer that means the customer may require high or less accuracy for the project run; ultimately, the accuracy you define for your project will depend on how you plan to use the imagery.

From these Accuracy Standard from different organization ranks or classifies the accuracy of geospatial data based on their accuracy level and the scale of geospatial data sources.

The geospatial data source used for test in this study finding is Orthophoto of scale 1:2000 with 0.15m resolution which is prepared by two Ethiopian government organizations (Ethiopian National Security Agency/ENSA and Ethiopian Mapping Authority/EMA). The flight (aerial photograph) part is by Ethiopian National Security Agency. The photogrammetry or base map preparation (georeferencing/ Orthophoto) part is by Ethiopian Mapping Authority

This data is currently available in Adama municipal in Land Administration department, and this office is donated to this study finding without of any charging. In this research the Orthophoto is used as a ground control or as coordinates from the Orthorectified image (ASPRS, 1999) to evaluate and ranking the Google Earth imagery and IKONOS Satellite image based on the different accuracy standards.

CHAPTER FOUR: DATA SOURCES, MATERIAL USED AND METHODOLOGY

4.1. Introduction

The study involved primary data collection and secondary data collection. The collections are especially used for Adama road network generations and verifications of Adama kebele boundaries. In Road Network handheld GPS was used for tacks the coble stone roads in some area. These tracks are not cover all area, the rest is carried out by digitizing the Asphalt, Coble and Earth roads from Orthophoto followed by field observation for ground confirmation. The Orthophoto (2013) from Adama Land Administration and High resolution IKONOS satellite image of 2004 of Adama City is obtained from Highway engineering consultancy, free cost Google Earth image of Adama City of different year is downloaded from http://www.Google Earth.com website.

This study finding is carried out the horizontal accuracy assessments and some geospatial data base is generated. The sample features used are points, lines and polygon with different terrain character. At the beginning the Satellite image is processed and classify with four classes of land use type. Like Vegetations, Grassland, Bare Soil and Built up area in selected sample area (kebele 03) this area selected because of the limitation coverage of the existing IKONOS image which not cover all area.

The following software plays a great role in this study finding

EREDAS software:-In this study the EREDAS 2013 Software is used for image processing, classification, subset, output maps etc. The output maps are used for urban land use land cover horizontal positional shift analysis.

Arc GIS10:- Is used for Random point selection, Extraction, data conversion or project data, in horizontal accuracy assessment used for coordinate computation for points, distance measurement for lines samples & area calculation for polygon samples, select point, polygon and area feature for root mean square error computations.

GPS: Is used to collect field data like: track of coble stone roads, for verifications of kebele political boundaries, positional check for utility map of Adama city.

Microsoft Word & Excel: For typing and calculations of Root Mean Square Error (RMSE), the difference calculation in point, line and polygon and the standard deviation.

4.2. Data Sources and Materials used

Table: - 4.1 Primary and Secondary data sources.

Description	**Sources**
Handheld GPS Garmin 32 Instrument	From my Advisor.
IKONOS Satellite image of 2004.	Highway Engineering Consultancy.
Adama DEM with 30.6 x 30.6 pixel size	From my Advisor.
Administrative boundaries.	Adapted from Adama municipality.
Adama city Othophoto image (2013) at the scale of 1:2000.	Adama Land Administration office.
Google Earth Image at years (2009 and 2014).	http://www.Google Earth.com website.
Utility Attribute data	Adama municipality.
Electric data	Ethiopian Electric power corporation SE region
Software used:- ERDAS Imagine 2013,Arc GIS 10, Micro Soft Excel, Google Earth, Garmin etc.	

4.3 Methodology

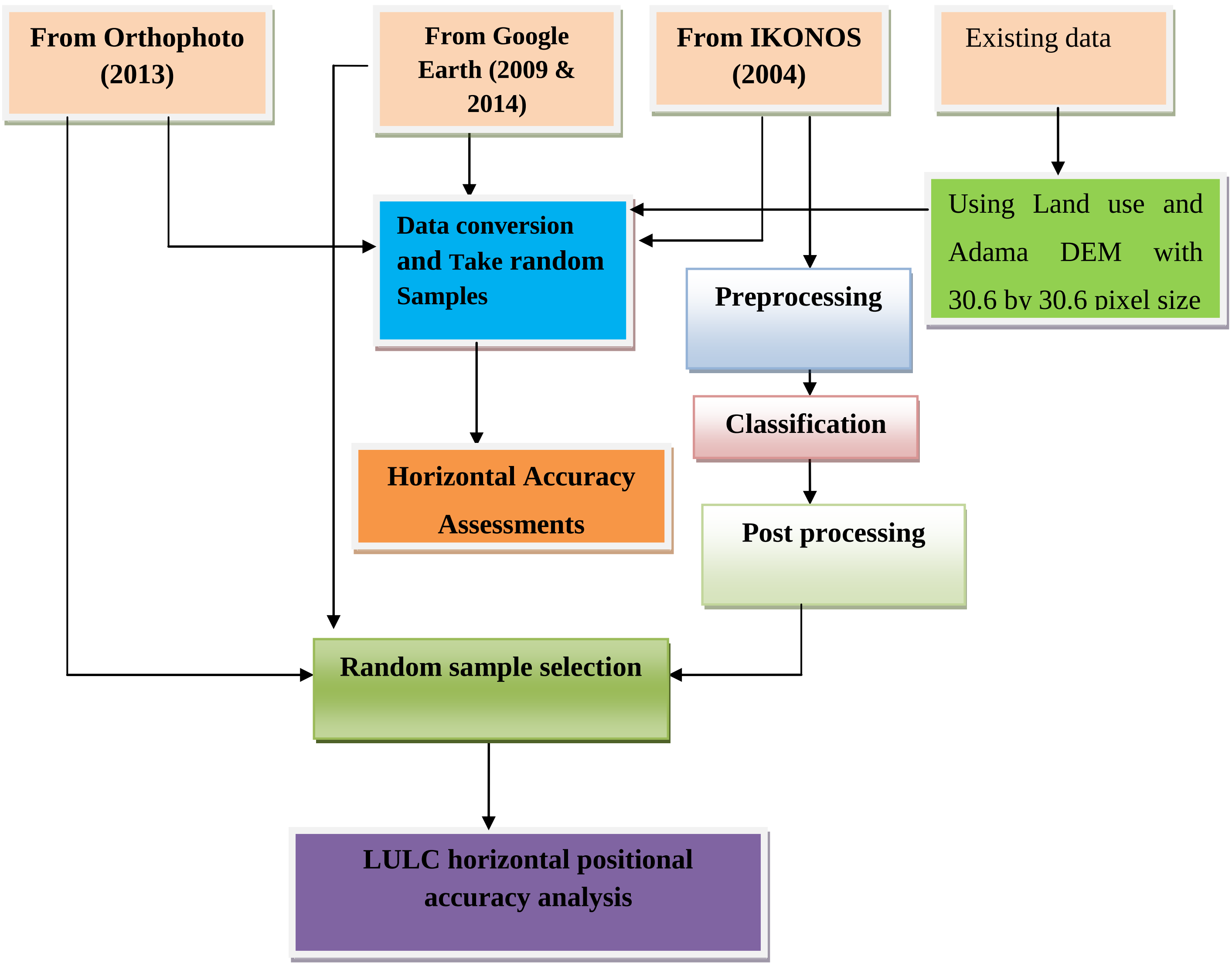

Figure: 4.1 General Schematic Diagram of Research method

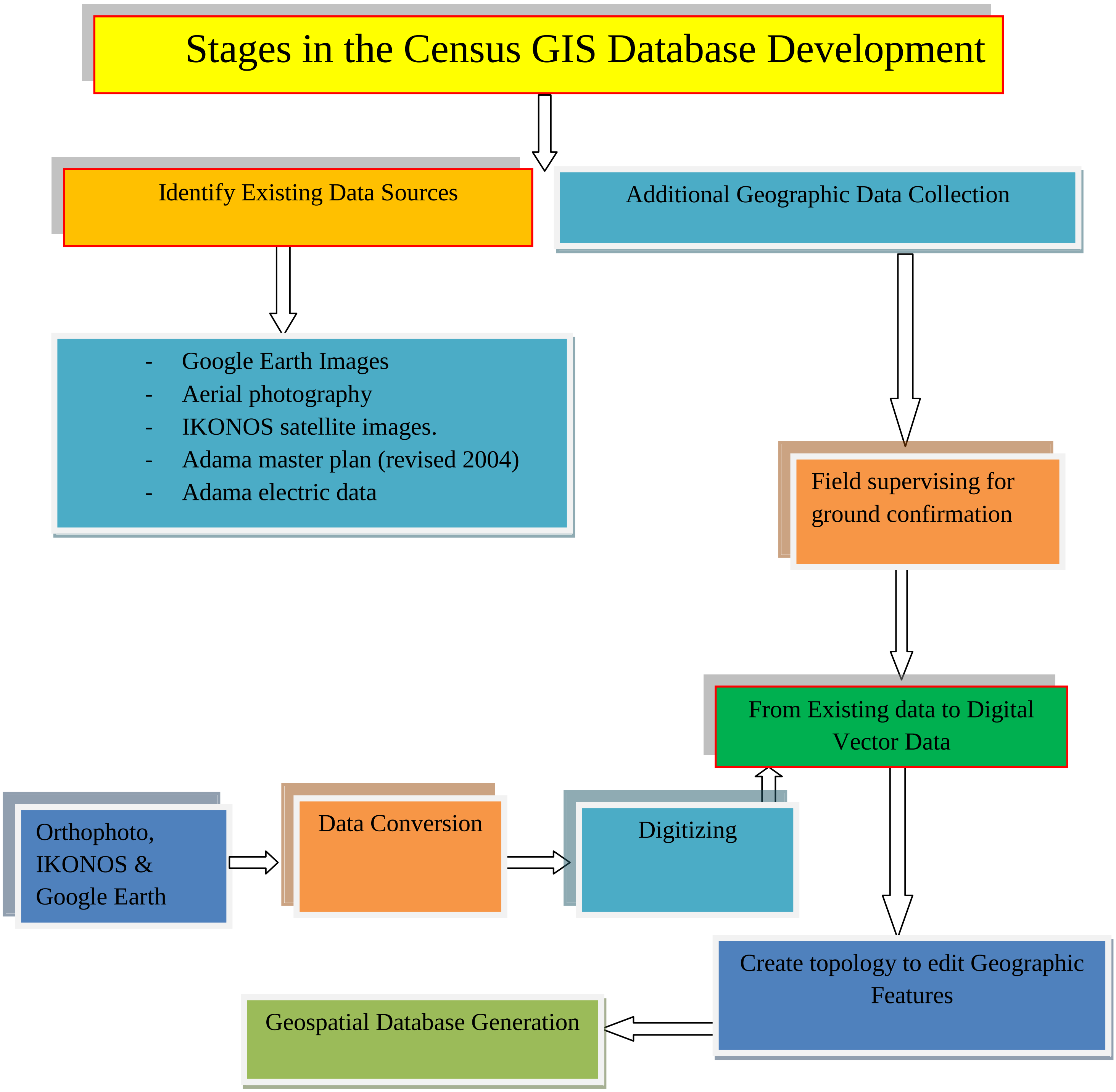

Figure: 4.2 Geospatial database generation methods

CHAPTER FIVE: GOOGLE EARTH'S HIGH-RESOLUTION IMAGERY ARCHIVE DATA POSITIONAL ACCURACY ASSESSMENTS AND RANKING

5.1 Introduction

Google Earth now hosts high-resolution imagery that spans the large part of the Earth's landmass. This contemporary high-resolution archive represents a significant; rapidly expanding, cost-free and largely unexploited resource for scientific inquiry (Potere, 2008).

In the face of the errors, the question arises: how trustworthy is the horizontal positional information in this archive? Large errors in geospatial registration would limit the scientific utility of the Google Earth archive. In this analysis, we address this important question of horizontal positional accuracy. Requirements for the accuracy of geometric correction of satellite imagery vary depending on the application. In this research the horizontal accuracy of Google Earth image and IKONOS satellite image with ground base of Orthophoto in the light of different accuracy standards.

This horizontal accuracy assessment was carried out after all the data sources have been converted into same coordinate. That is WGS 1984 coordinate system. The WGS 1984 coordinate and datum system was considered because all the spatial data that are collected from Google Earth Image are in WGS 84 coordinate and Datum system then to make similar these other data sources are converted to this coordinate system.

Since the study is mainly focused in urban area, position, length and area measured must satisfy the accuracy level set by different standards for further engineering applications. Due to these facts, point, line and area feature were used to assess its accuracy standards; the results were analyzed and compared with the United State Geological Survey, American Society of Photogrammetry and Remote Sensing, National Standards of Spatial Data Accuracy, National Accuracy Map Standard and etc horizontal positional accuracy standards.

In photogrammetry relief displacement is the main factors that affect the positional accuracy, during this study sampling stage terrain features with spatial resolution of 30.6 by 30.6 pixel size were used to considered the elevation difference, that means samples were collected at different slope categorized in to five class based on the natural breaks measured in meters. These classes range are1473-1582, 1582-1653, 1653-1738, 1738-1842, and 1842-1966 meters elevations. The Adama city has a slope variation with a minimum elevation of 1473 and a maximum of 1966 meters. The Root Mean Square Errors are computed for each data sources considering this slope variation to identify their horizontal accuracy level.

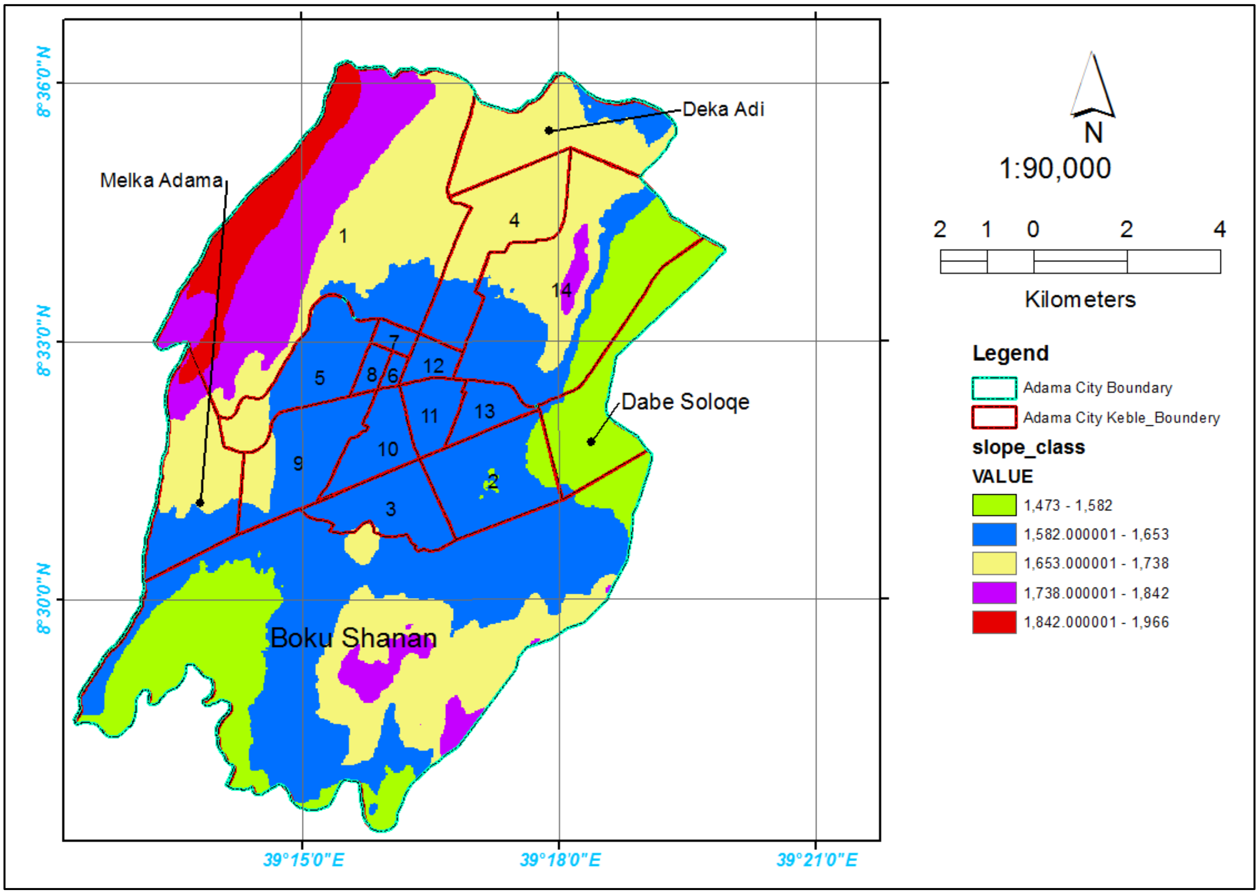

Figure: 5.1 Adama terrain class

5.2 Google Earth Imagery Data Positional Accuracy Assessment at selected Point Data

The selected points are concentrated to the center because the selected position concider the visibility in all sources to reduce the errors from selected different position. Then the selected positions are like cross center line of the roads, squares, and etc which is visible only on at the center. The points sample has been taken for positional accuracy analysis. The following tables

5.1 and 5.2 shows the sample points selected from different slope ranges and from data sources of GE, IKONOS and Orthophoto data sources. Twenty one sample points were taken and for each point geographic positions were computed by Arc GIS 10 software in the attribute tables. The point coordinate value differences, standard deviations (Relative Accuracy) and Root Mean Square Errors (Absolute Accuracy) are computed or calculated by using Microsoft Office Excel 2007 and the results are mentioned in table 5.1, 5.2 and 5.3.

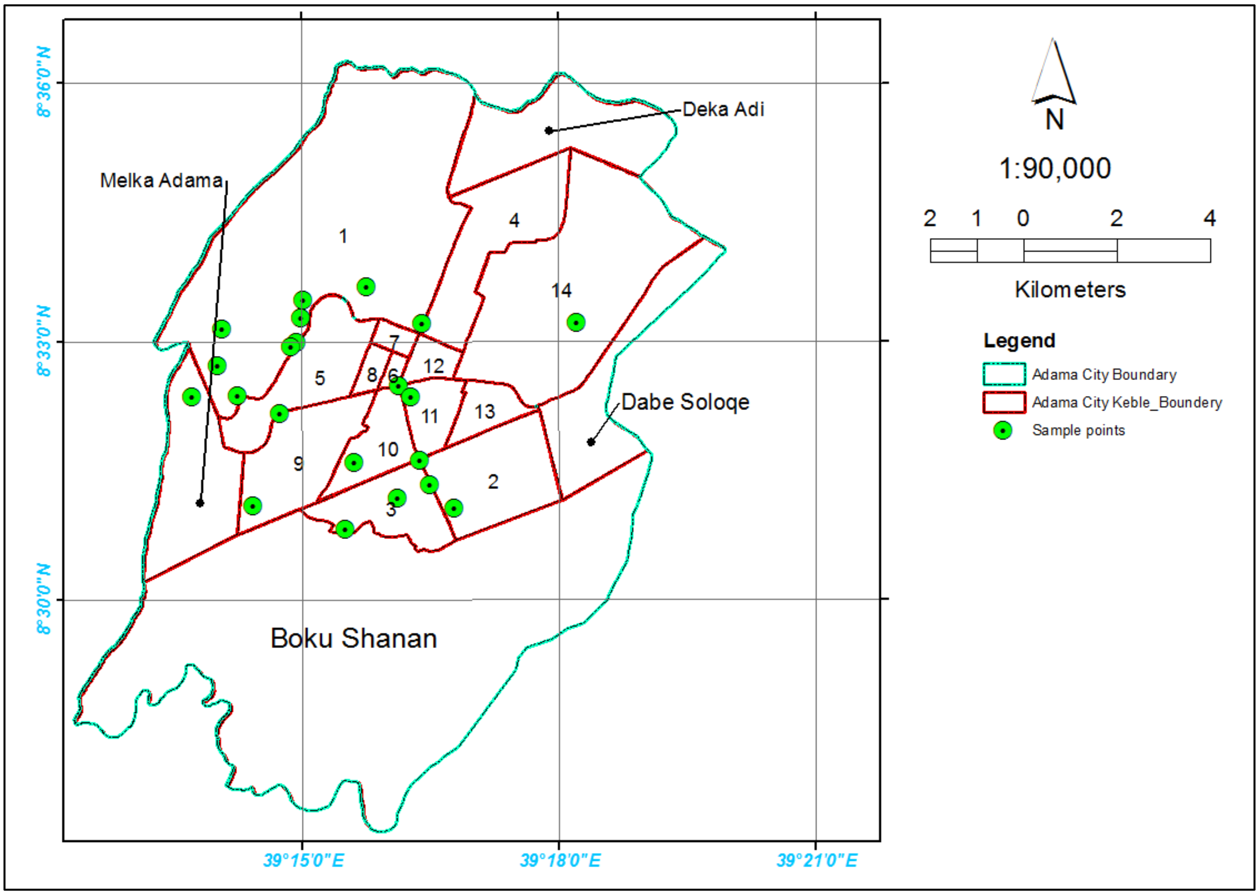

Figure: 5.2 Sample points selected

Table: 5.1 Sample Point Data Distributions at Different Slope Category

Point	From Google Image , 2014		From Orthophoto 2013 Image		From IKONOS2004 Image	
	X-Coordinate	Y- Coordinate	X- Coordinate	Y- Coordinate	X-Coordinate	Y-Coordinate
1	529596.99	944175.99	529596.73	944175.88	529596.54	944176.73
2	529857.99	943924.99	529859.16	943925.18	529857.54	943926.86
3	527053.99	943582.99	527055.95	943582.96	527053.15	943583.83
4	530103.99	945507.99	530104.13	945508.02	530102.98	945508.12
5	530787.00	941536.99	530788.45	941537.42	530786.89	941537.77
6	529001.00	945973.99	529001.92	945973.49	529000.23	945974.86
7	527411.99	945104.99	527411.45	945104.43	527399.64	945107.26
8	525811.99	945377.99	525812.59	945378.35	525811.29	945377.58
9	526145.99	943965.99	526145.38	943966.56	526137.56	943968.88
10	526474.00	941589.99	526474.40	941590.17	526473.79	941589.32
11	528469.99	941087.99	528469.08	941087.59	528469.16	941087.19
12	528652.99	942525.99	528653.14	942525.68	528652.02	942526.11
13	525169.99	943939.99	525169.31	943939.87	525166.13	943940.14
14	527495.99	945625.99	527496.31	945626.07	527495.51	945626.07
15	525725.00	944596.99	525725.78	944596.85	525724.76	944595.85
16	527287.99	945004.99	527288.23	945005.00	527287.75	945004.00
17	527545.00	945999.99	527545.87	945999.86	527544.13	945999.03
18	533403.00	945525.99	533402.79	945527.09	533402.61	945526.76
19	530281	942057.99	530281.00	942057.99	530278.28	942062.68
20	529572	941762.99	529572.81	941762.81	529571.72	941758.79
21	530051.99	942563.99	530052.95	942564.14	530051.29	942566.69

Source: Generated by the Author

Table: 5.2 Results of Sample data collected from different sources and terrain features

Points	X Difference		Y Difference		Slope class
	Google with Ortho	IKONOS with Orthophoto	Google with Orthophoto	IKONOS with Orthophoto	
1	-0.26	0.19	-0.11	-0.85	1582-1653
2	1.17	1.62	0.19	-1.68	1582-1653
3	1.96	2.8	-0.03	-0.87	1582-1653
4	0.14	1.15	0.03	-0.1	1582-1653
5	1.45	1.56	0.43	-0.35	1582-1653
6	-0.18	2.13	0.28	1.69	1582-1653
7	-0.54	11.81	-0.56	-2.83	1653-1738
8	0.6	1.3	0.36	0.77	1842-1966
9	-0.61	7.82	0.57	-2.32	1653-1738
10	0.4	0.61	0.18	0.85	1653-1738
11	-0.91	-0.08	-0.4	0.4	1582-1653
12	0.15	1.12	-0.31	-0.43	1582-1653
13	-0.68	3.18	-0.12	-0.27	1738-1842
14	0.32	0.8	0.08	0	1653-1738
15	0.78	1.02	-0.14	1	1738-1842
16	0.24	0.48	0.01	1	1653-1738
17	0.87	1.74	-0.13	0.83	1653-1738
18	-0.21	0.18	1.1	0.33	1582-1653
19	0	2.72	0	-4.69	1582-1653
20	0.81	1.09	-0.189	4.01	1582-1653
21	0.966	1.66	0.140	-2.55	1582-1653

Source: Generated by the Author

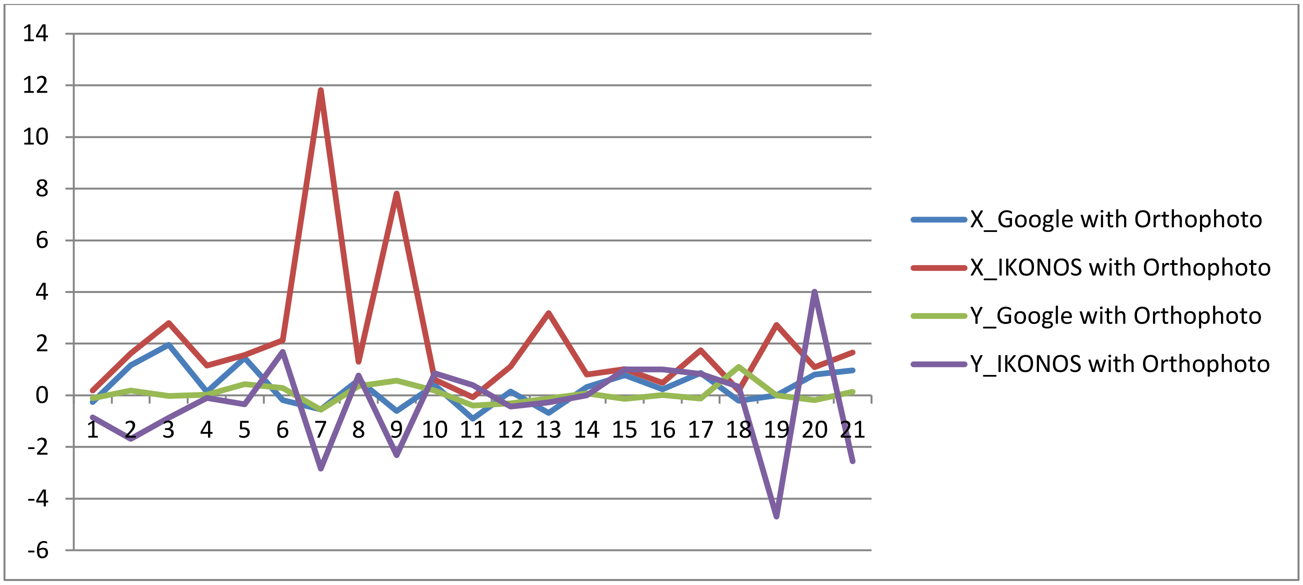

Figure: 5.3 Horizontal Coordinate Differences between different data sources

The two major type of accuracy assessment method absolute accuracy (RMSE) and relative accuracy (standard deviation), Absolute Accuracy is average deviation or distance of points in a candidate data set from their known positions on the ground used for evaluating horizontal positional (Ubukawa, 2013; ASPRS, 2014).

Calculation of Absolute Accuracy or RMSE (from ASPRS, 2014)

RMSE in X_Coordinate of Ortho and Google= $\sqrt{\frac{1}{21}\sum_{i=1}^{21}\left((X\_Go - X\_Orth)_i^2\right)}$ **=2.66ft./0.813m**

RMSE in X_Coordinate of Ortho and IKON= $\sqrt{\frac{1}{21}\sum_{i=1}^{21}((X\_Ikon - X\_Orth)_i^2)}$=11.263 ft./3.433m

RMSE in Y_Coordinate of Ortho and Google= $\sqrt{\frac{1}{21}\sum_{i=1}^{21}\left((Y\_Go - Y\_Orth)_i^2\right)}$**=1.296 ft. /0.395m**

RMSE in Y_Coordinate of Ortho and IKON $\sqrt{\frac{1}{21}\sum_{i=1}^{21}((Y\_Ikon - Y\_Orth)_i^2)}$ = 3.806 ft. /1.160m

Relative accuracy (RA) is a measure of internal accuracy. It is based on the difference between true and measured distances between all pairs of check points. It is the sum of squared errors is divided by one-half the number of pairs to arrive at a value reflecting the error at one point. It can be shown that relative accuracy is equal to the standard deviation of the errors (Bruce et al., 2014).

Calculation of Standard deviations of point data or Relative Accuracy

Table: 5.3 Sample Point Data Relative Accuracy Assessments (meter and feet).

	X – coordinates		Y- coordinates	
	Google with Ortho	IKONOS with Ortho	Google with Ortho	IKONOS with Ortho
STDEV(m)	0.747	2.769	0.377	1.802
STDEV(ft.)	2.450	9.084	1.238	5.912

Source: Generated by the Author

Both methods (Accurate and Relative accuracy assessments) resulted that the Y_coordinates are more accurate than the X_coordinates in horizontal position. That indicates the application carried out by this Google Earth image is positionally accurate in Y_coordinate than the X_coordinates.

5.3 Google Earth Image horizontal Positional Accuracy Assessment at selected Line sample Data

The spatial information is also can be represent by line features which is required to assess the positional accuracy in line features as point. Then this study takes samples line to evaluate the horizontal positional accuracy assessment. Forty one sample lines were taken from each data sources with the considerations of slope class. The geographic length (in the case of horizontal length), sample lines positions after converting to point (in the case of horizontal shift) were computed by Arc GIS 10. And each length and point coordinate values difference, standard deviations (Relative Accuracy) and Root Mean Square Errors (Absolute Accuracy) are computed by using Microsoft Office Excel 2007 and the results are obtained.

A. Horizontal shift between data sources or cross-tracks

The selected lines for the horizontal shift were under the single slope class because of selected area should the center lines of the roads that can be clearly observe in all sources and easy to check the shift. This horizontal shift assessment between different data sources was carried out by selecting lines or tracks in the center lines of the roads from Google Earth and convert to GIS shape file to evaluate this value on Arc GIS. The same position lines are selected from Orthophoto & IKONOS satellite image of Adama city. This process through all selected lines from Google Earth is converted to the layers/shape file from KML Google Earth file. The selected lines vertices are converted to points by using Arc GIS tools to get point from selected lines. This used to evaluate the shifts between these different data sources, which can be expressed by using root mean square errors from vertices point coordinates.

The following table: 5.4 shows the values difference in coordinate from different data sources sample line selected after convert vertex of line to point and calculated their coordinate value by Arc GIS 10 (see the Appendix D).

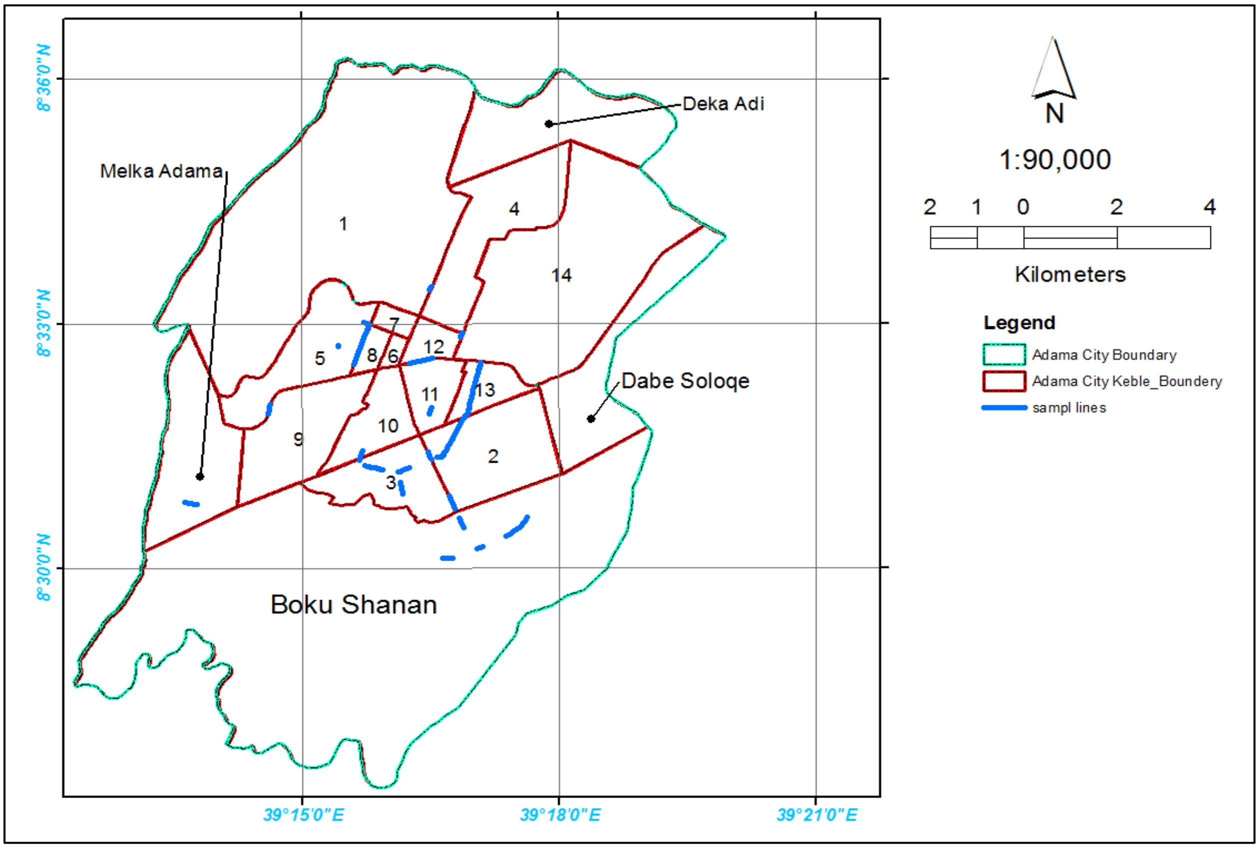

Figure: 5.4 Sample lines selected

Table: - 5.4 Sample Lines coordinate difference (meter)

Lines Numbers	X_Ortho – X_Google	Y_Ortho – Y_Google	X_Ortho – X_IKON	Y_Ortho – Y_IKON
1	0.765	-1.479	6.615	-2.315
2	-0.034	-1.534	0.997	-1.693
3	-0.932	0.272	-2.112	0.096
4	-0.124	-1.693	-3.226	0.784
5	1.006	0.185	No data	No data
6	0.361	0.386	-2.337	0.704
7	0.015	-0.969	-6.673	1.693
8	-0.393	0.502	No data	No data
9	0.349	0.228	No data	No data
10	1.31	0.096	3.307	1.587
11	-0.112	-1.411	1.27	0.424
12	0.626	-1.586	2.545	-1.467
13	0.419	0.34	5.732	0.081
14	0.106	-0.688	No data	No data
15	-0.453	-0.468	-0.218	0.624
16	0.548	-1.016	No data	No data
17	0.224	-0.243	No data	No data
18	0.753	-0.782	No data	No data
19	0.53	0.238	No data	No data
20	0.787	-0.29	4.519	1.425

Source: Generated by Author

The following table 5.5 shows the distance shift between each selected lines samples from Orthophoto to Google Earth and Orthophoto to IKONOS satellite image.

These can be calculated as distance is $=\sqrt{X_i^2 + Y_i^2}$ when X_i^2 = change in X coordinate

Y_i^2= change in Y coordinate

Table 5.5 Horizontal Line shift between data sources

Lines Number	Shift b/n Google with Orthophoto	Shift b/n IKONOS with Orthophoto
1	1.665	7.008
2	1.534	1.964
3	0.970	2.114
4	1.697	3.319
5	1.022	No data
6	0.528	2.440
7	0.969	6.884
8	0.637	No data
9	0.416	No data
10	1.313	3.668
11	1.415	1.338
12	1.705	2.937
13	0.539	5.732
14	0.696	No data
15	0.651	0.661
16	1.154	No data
17	0.330	No data
18	1.085	No data
19	0.580	No data
20	0.838	4.738

Source: Generated by Author

The root mean square errors can be calculated as follow: - Let X_i and Y_i denote the measured error at the i^{th} check point and N the number of checks points.

The Root Mean Square Error = $\sqrt{\frac{1}{N}\sum_{i=1}^{N}(X_i^2 + Y_i^2)}$ (ASPRS, 2014)

Orthophoto with Google Earth = $\sqrt{\frac{1}{20}\sum_{i=1}^{20}(X_i^2 + Y_i^2)}$ = 1.079 meter = 3.541 feet

Orthophoto with IKONOS satellite = $\sqrt{\frac{1}{12}\sum_{i=1}^{12}(X_i^2 + Y_i^2)}$= 4.097 meter =13.442feet

From result the Root Mean Squares Errors of horizontal positional shift accuracy between Orthophoto with Google Earth and Orthophoto with IKONOS 2004 respectively 1.079m/3.541ft, 4.097m/13.442ft.

B. Horizontal length differences between data sources

In this sample lines it was focus on the distance (length) difference between Orthophoto with Google Earth and Orthophoto with IKONOS satellite image data sources. It was carried out by selecting lines considering the slope range of the study area and measure these sample lines length by using Arc GIS 10. The line sample select from Google Earth is converting to GIS shape file through Garmin software map source or directly from KML Google Earth to shape file by using Arc GIS toolbox. Then based on the length difference of each sample lines calculate the relative accuracy or standard deviations and absolute accuracy or Root Mean Square Errors of these sample lines.

Table: 5.6 Horizontal Line Length of selected line feature

SN	Length in Google Earth (m)	Length in Ortho(m)	Length in IKONOS (m)
1	501.43	501.77	502.542
2	1574.36	1574.57	1573.48
3	336.69	336.77	331.35
4	1343.41	1342.85	1341.71
5	1371.86	1371.9	1364.49
6	1037.49	1037.08	1037.49
7	2023.76	2023.44	2030.26
8	4400.09	4400.06	4399.18
9	3764.04	3763.45	3764.37
10	248.24	248.82	247.82
11	281.99	282.1	280.91
12	518.82	518.52	517.42
13	324.85	324.52	323.83

14	262.87	262.57	262.42
15	447.48	448.31	446.83
16	862.07	862.11	861.93
17	423.49	423.49	422.99
18	643.35	643.5	642.97
19	95.03	95.31	94.75
20	124.59	125	124.62
21	107.3	107.29	106.99

Source: Generated by Author

Table: 5.7 Lines sample differences and their standard deviation (meter)

Point	Google Earth with Orthophoto	IKONOS with Orthophoto	Slope class
1	0.34	-0.77	1582-1653
2	0.21	1.09	1582-1653
3	0.08	5.42	1582-1653
4	-0.56	1.14	1582-1653
5	0.04	7.41	1582-1653
6	-0.41	-0.41	1582-1653
7	-0.32	-6.82	1582-1653
8	-0.03	0.88	1582-1653
9	-0.59	-0.92	1582-1653
10	0.58	1	1582-1653
11	0.11	1.19	1582-1653
12	-0.3	1.1	1582-1653
13	-0.33	0.69	1653-1738
14	-0.3	0.15	1653-1738
15	0.83	1.48	1653-1738
16	0.04	0.18	1738-1842
17	0	0.5	1653-1738
18	0.15	0.53	1653-1738
19	0.28	0.56	1653-1738
20	0.41	0.38	1738-1842

21	-0.01	0.3	1842-1966
STDEV	0.367116823	0.421584313	

Source: Generated by Author

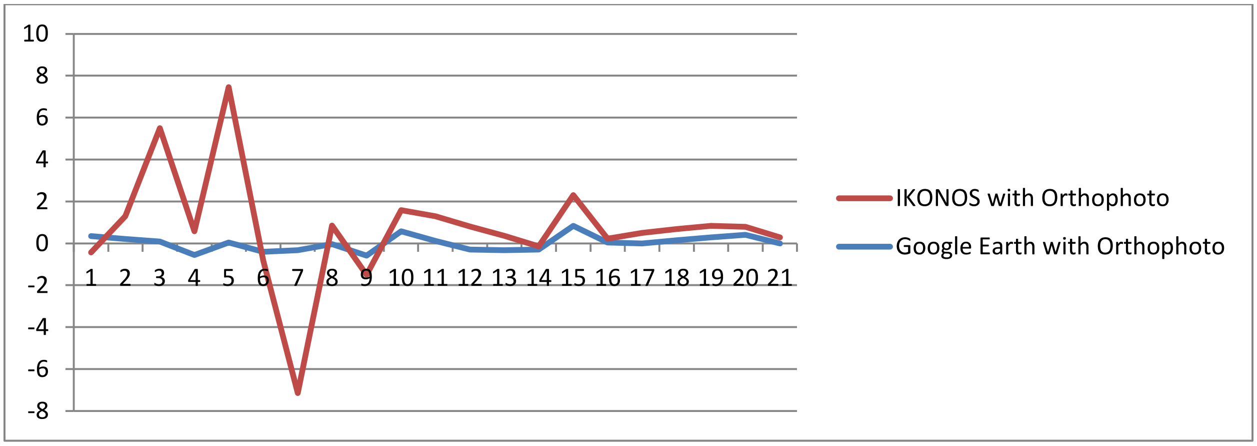

Figure: 5.5 Lines sample selected distance differences

RMSE of Ortho with Google= $\sqrt{\frac{1}{21}\sum_{i=1}^{21}\left((\mathbf{Dist\_Orth - Dist\_Go})_i^2\right)}$ = 1.176./0.358m

RMSE of Ortho with IKONOS= $\sqrt{\frac{1}{21}\sum_{i=1}^{21}((\mathrm{Dist\_Orth} - \mathrm{Dist\_Ikon})_i^2)}$= 8.562ft./2.61m

The distance shift result for horizontal positional test in this case also comparable with the previous test results that the positional change with Google earth is adequate and not for IKONOS satellite image in these accuracy standards with the scale of 1:2000.

5.4 GE Image horizontal Positional Accuracy Assessment at selected polygon (Area) sample Data

In the case of sample area it was focus on the calculated area difference between the Orthophoto with Google Earth and Orthophoto with IKONOS satellite image of 2004 Adama city data. It was carried out by selecting area/polygon features by considering the slope range of the study area and calculated area of these samples by using Arc GIS 10. Then based on the area difference of each sample polygon calculate the standard deviations and Root Mean Square Errors of these sample polygon. These recorded values of different data sources can be summarized as the following tables 5.8 and 5.9.

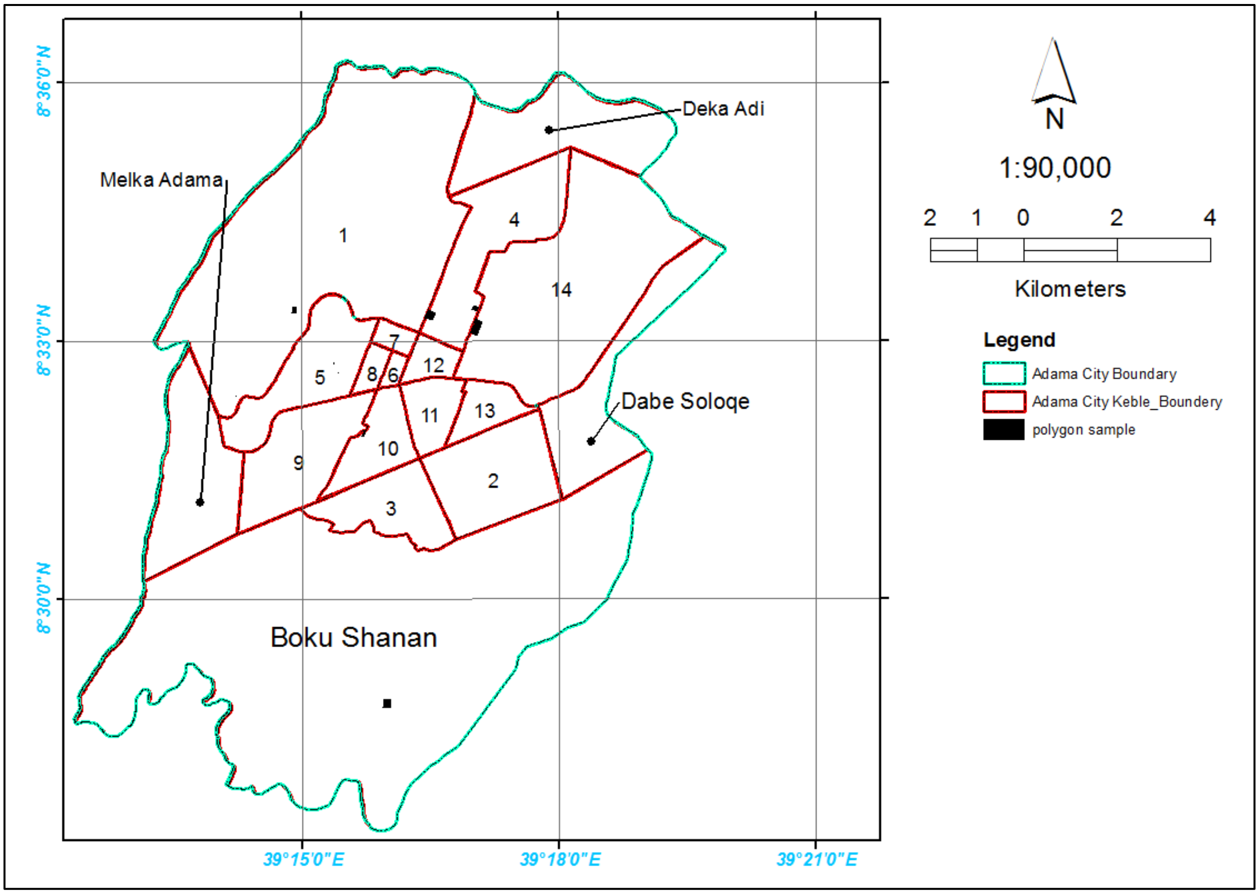

Figure: 5. 6 Sample polygon selected

Table: 5.8 polygon sample area calculated

SN	Area in Google Earth (m^2)	Area in Orthophoto (m^2)	Area in IKONOS (m^2)
1	53797.72476	53797.59254	53796.15739
2	12320.37505	12320.25012	12318.94076
3	34116.30215	34116.40135	34115.87081
4	4999.100601	5000.053214	4997.557886
5	927.31944	927.496293	926.353527
6	1474.619255	1475.112145	1474.218771
7	1464.813685	1464.914069	1465.013115
8	14085.64797	14085.49331	14085.23001
9	35585.52416	35585.52142	35586.22021

Source: Generated by Author

Table: 5.9 polygon sample area calculated differences and their standard deviation (sqm)

Point	Google Earth with Orthophoto	IKONOS with Orthophoto	Slope class
1	-0.13222	1.435146	1582-1653
2	-0.12493	1.309362	1582-1653
3	0.0992	0.530545	1582-1653
4	0.952613	2.495328	1582-1653
5	0.176853	1.142766	1582-1653
6	0.49289	0.893374	1582-1653
7	0.100384	-0.099046	1653-1738
8	-0.154655	0.263302	1738-1842
9	-0.002743	-0.698791	1653-1738
STDEV	0.360301678	0.940607349	

Source: Generated by Author

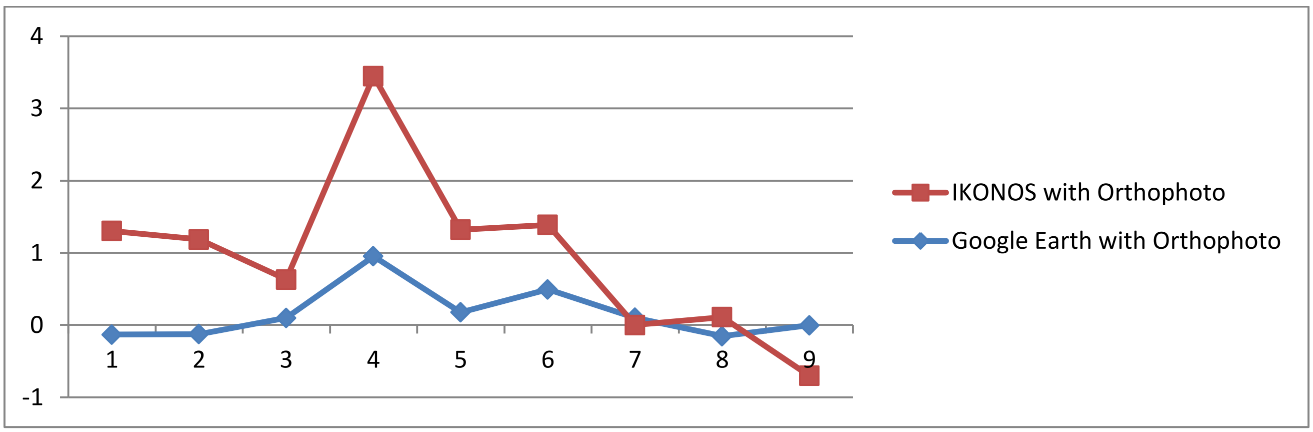

Figure: - 5.7 Sample polygon selected area difference between data sources

RMSE of Orthophoto with Google=$\sqrt{\frac{1}{9}\sum_{i=1}^{9}\left((\mathbf{Area\_Go} - \mathbf{Area\_Orth})_i^2\right)}$= 0.392sqm/4.21sq**ft**

RMSE of Orthophoto with IKONOS=$\sqrt{\frac{1}{9}\sum_{i=1}^{9}((\mathrm{Area\_Ortho} - \mathrm{Area\_Ikon})_i^2)}$=1.24sqm/13.347sqft

The Root Mean Square Error of the area difference of Orthophoto with Google Earth is 0.392sqm/4.21sq**ft** while the Orthophoto with IKONOS satellite image is 1.24sqm/13.347sqft.

According to the computed Root Mean Squares Errors of area positional accuracy between Orthophoto with Google earth of Adama city outcome indicated that two dimensional positional changes in polygon/area between Google Earth with Orthophoto data is less than six root mean square errors which can classify under Class III horizontal accuracy standards.

Ranking of the discrepancy of measured errors between different data sources in points, lines and polygon features with their slope range.

Points Sample Ranks

Table: 5.10 Google with Orthophoto X_Coordinate Rank
(Over all error magnitudes range from -0.91 to 1.96 meters see Table 5.2)

Rank	Google with Orthophoto	Slope range
1	-0.91	1582-1653
2	-0.68	1738-1842
3	-0.61	1653-1738
4	-0.54	1653-1738
5	-0.26	1582-1653

Source: Generated by Author

Table: - 5.11 IKONOS with Orthophoto X_Coordinate Rank
(Over all error magnitudes range from -0.08 to 11.81meters see Table 5.2)

Rank	IKONOS with Orthophoto	Slope range
1	-0.08	1582-1653
2	0.18	1582-1653
3	0.19	1582-1653
4	0.48	1653-1738
5	0.61	1653-1738

Source: Generated by Author

Table: - 5.12 Google with Orthophoto Y_Coordinate Rank
(Over all error magnitudes range from -0.56 to 1.1 meters see Table 5.2)

Rank	Google with Orthophoto	Slope range
1	-0.56	1653-1738
2	-0.4	1582-1653
3	-0.31	1582-1653
4	-0.19	1582-1653
5	-0.14	1738-1842

Source: Generated by Author

Table: 5.13 IKONOS with Orthophoto Y_Coordinate Rank
(Over all error magnitudes range from -4.69 to 4.01 meters see Table 5.2)

Rank	IKONOS with Orthophoto	Slope range
1	-4.69	1582-1653
2	-2.83	1653-1738
3	-2.55	1582-1653
4	-2.32	1653-1738
5	-1.68	1582-1653

Source: Generated by Author

Lines sample length rank

Table: 5.14 Rank of line length Google Earth with Orthophoto
(Over all error magnitudes range from -0.59 to 0.83 meters see Table 5.7)

Rank	Google with Orthophoto	Slope range
1	-0.59	1582-1653
2	-0.56	1582-1653
3	-0.41	1582-1653
4	-0.33	1653-1738
5	-0.32	1582-1653

Source: Generated by Author

The slope class for this line selected is concentrated to single slope because as stated in report the selection for this is on the center lines of the roads that is difficult to select lines from different slope without this center lines.

Table: - 5.15 Rank of line length IKONOS with Orthophoto
(Over all error magnitudes range from -6.82 to 7.41 meters see Table 5.7)

Rank	IKONOS with Orthophoto	Slope range
1	-6.82	1582-1653
2	-0.92	1582-1653
3	-0.77	1582-1653
4	-0.41	1582-1653
5	0.15	1653-1738

Source: Generated by Author

Area (polygon) Ranking

Table: - 5.16 Rank of Area of Google Earth with Orthophoto
(Over all error magnitudes range from -0.154655 to 0.952613 meters see Table 5.9)

Rank	Google with Orthophoto	Slope range
1	-0.154655	1738-1842
2	-0.13222	1582-1653
3	-0.12493	1582-1653
4	-0.002743	1653-1738
5	0.0992	1582-1653

Source: Generated by Author

Table: - 5.17 Rank of Area of IKONOS with Orthophoto
(Over all error magnitudes range from -0.698791 to 2.495328 meters see Table 5.9)

Rank	IKONOS with Orthophoto	Slope range
1	-0.698791	1653-1738
2	-0.099046	1653-1738
3	0.263302	1738-1842
4	0.530545	1582-1653
5	0.893374	1582-1653

Source: Generated by Author

The ranking of the geospatial data sources positional differences in points (X and Y Coordinates), lines and polygon with their respective slope class is used to show easily, whether these discrepancy is based on elevation differences or not. These ranking is show from first to fifth of increasing order of the horizontal position difference from each feature class and their respective slope range that shows these difference is not related to the elevation difference, it is only the data sources different.

5.5 Cost Benefits Analysis of the Data and Findings

The Google Earth service (Google, 2013) is the most well-known internet service that provides free of charge access to the global collection of georeferenced satellite imagery. Google Earth now hosts high-resolution (0.5 meter) imagery (Innes et al., 2011) and (Naji et al., 2013) allows human observers to readily discriminate different spatial information. It is not only a commercial product with the main intent of making money, it also is available in a free version, which is a platform for everyone to explore for different purpose. Like: - generate geospatial data, find and locate places around the world. With Google Earth you can find locations like restaurants, hotels, schools, museums, etc., and even your own location with very high resolution.

This contemporary high resolution archive represents a significant, rapidly expanding, cost-free and largely unexploited resource for scientific inquiry (Potere, 2008). To increase the scientific utility of this archive, this paper intended to comparing Google Earth with Orhtophoto & IKONOS Satellite Image cost based analysis over a limited area of Adama City.

Although high-resolution imagery has long played a role in scientific inquiry, the 1999 and 2001 launches (respectively) of the commercial imaging satellites IKONOS and Quick Bird have generated increased interest in methods that facilitate the efficient extraction of scientifically relevant information from high-resolution imagery. As we understand the IKONOS Satellite image is commercial rather than cost free like Google Earth.

The data is the basic elements of Geographical Information System. There are various methods i.e., GPS, Aerial Photographs, Satellite Images, Digitization and documentary are the principle methods of data collection and creation. Aerial photographs and data of satellite image are the most important resources to provide data of GIS in both Photogrammetric and remote sensing (Onder, 2003). According to international resources, total cost of data collecting and processing are 65% of total cost that show the importance of data (Kokturk, 2003). High resolution satellite imagery on the wide area can be achieved more repeatedly and economically compared to the aerial photos (Jeong et al., 2003; Cay et al., 2004) which require less costs than aerial photo.

One of the main components of a Geographic Information System (GIS) is the formation of the database. More than 70% of the time and cost is spent on developing this database. In this study data used and generated by host study area's country that invest much costs to develop Orthophoto of the study area which is around 1.9 to 2 million Ethiopian Birr is invested on the preparation of Orthophoto including base map for Adama City (Ethiopian National Security Agency).

To analysis the cost invest for development of this Orthophoto per square kilometer, the Adama city area is around 135.98 square kilometers (Adama municipality and field data of the study), when it calculated costs per square kilometers that is total cost to total area around 13972.643 to 14708. 045 Ethiopian Birr is required to generate one square kilometer of base map by using Aerial photography.

CHAPTER SIX: CURRENT STATE OF PHYSICAL INFRASTRUCTURES OF ADAMA CITY

6.1 Introduction

It is obvious that urban geospatial database is changed from time to time, and a number of scientific researchers are studied urban land use land cover change over times. Most of these researches are focus on geospatial changes from time to times, the directions of the sprawl, the future development directions of the city (modeling) etc.

Urban spatial data dynamic in day today activity, dynamics are widespread, accelerating, and significant processes driven by human actions (Agarwal et al., 2002) to required better life, well-structured infrastructure, telecommunication, well designed and structured of drainages, sewerage design, road networks, well distributed health care, educational institute and etc. these all are geospatial data base.

These dynamics alter the available geospatial data base previously exist in that country. This condition is highly prevailed in urban of developing countries and some conditions in developed countries, these change is not only the existing geospatial data bases but also change from rural to urban area.

Urban sprawl is the term commonly attached to rapid, low-density, automobile oriented urban spatial expansion (Chang, 2006) which is more significant in the developing countries than the developed countries because the majority of the people in developing countries migration is continued from rural to urban areas as the number of residence is increase in the urban the demand for health care, schools, telecommunication network and etc.

The Adama city kebele boundaries change & the new kebele added in this city. These kebeles are as an example: Dabe Soleqe to the Entry of Djibouti road, Deka Adi North end of 04 kebele, Melka Adama Entry of Addis Ababa, and Boku Shanan Entry of Asella roads. These kebeles are new while this study finding is carried out, it was tried to generate it GPS demarcations of these boundaries as another kebele boundaries, but for these new boundaries still there is no limited extent for each new boundaries or boundaries are not demarcate with their neighboring. Therefore this change occurs from time to time in geospatial change including political boundaries, utilities, road networks, electric power distribution, educational institute and etc. and this study is intended to focus on the development of current status of geospatial database in Adama city.

6.2 Geospatial Data Base Creation

Geospatial data is geographic data with coordinates in a two dimensional or three dimensional spaces like roads, electric network, utility maps, houses, sewerages, pipeline, buildings, rivers and etc. on maps. In such a system, the database is a collection of data objects over a particular multidimensional space (Ooi, et al., 2011).

It can provide information regarding the location of critical infrastructure, hazardous materials, evacuation routes and other information that is highly valuable for emergency planning and response, short path selection for ambulance, and etc.

In this some geospatial database is tried to generate to shows the current state of Adama physical infrastructure. These are road network, some utility maps and electric power distributions, as shown below.

6.2.1 Road Network

Roads are essential for easy movement of goods and materials, human beings and other movable things. A good road network promotes and accelerates the economic development of any country, through trade, tourism and other commercial developments. The technology of remote sensing provides a descriptive and analytical way for identifying geographic features. GIS provides the mechanism for generating road network from remote sensing data (Egunjobi, 1991 and Orisakwe, 2013) and shows the distribution of this geospatial database.

In this research field observation, Adama Orthophoto of 2013 and Google Earth were used to generate and quantify the road network of the city. The Orthophoto mosaic and clipped with city boundary; the roads were digitized followed by categorizing various road type in the city. The coble stone road network was ground surveyed or supervised on the field to identify the beginning and ending of the road that have been digitized from the Orthophoto. Similarly, the Asphalt road network was digitized using Adama Orthophoto followed by editing and topology creation.

After digitizing road network of Adama city of Asphalt, Coble and Earth roads of 2013, their lengths were calculated and the total road length of coble stone, Asphalt and the earth were calculated to be 450.723km out of which 77.594Km found as Asphalt Roads, 173.349Km were Coble stone Roads and 199.780Km were Earth Streets. The results shows that Adama City road network is dominated by Coble stone roads which is applicable in Ethiopian road systems is not more than a decade. This road is constructed with both educated and illiterates of host countries citizens, and some scholars says this coble stone is more preferable than the asphalts in the case of economy and durability of the roads.

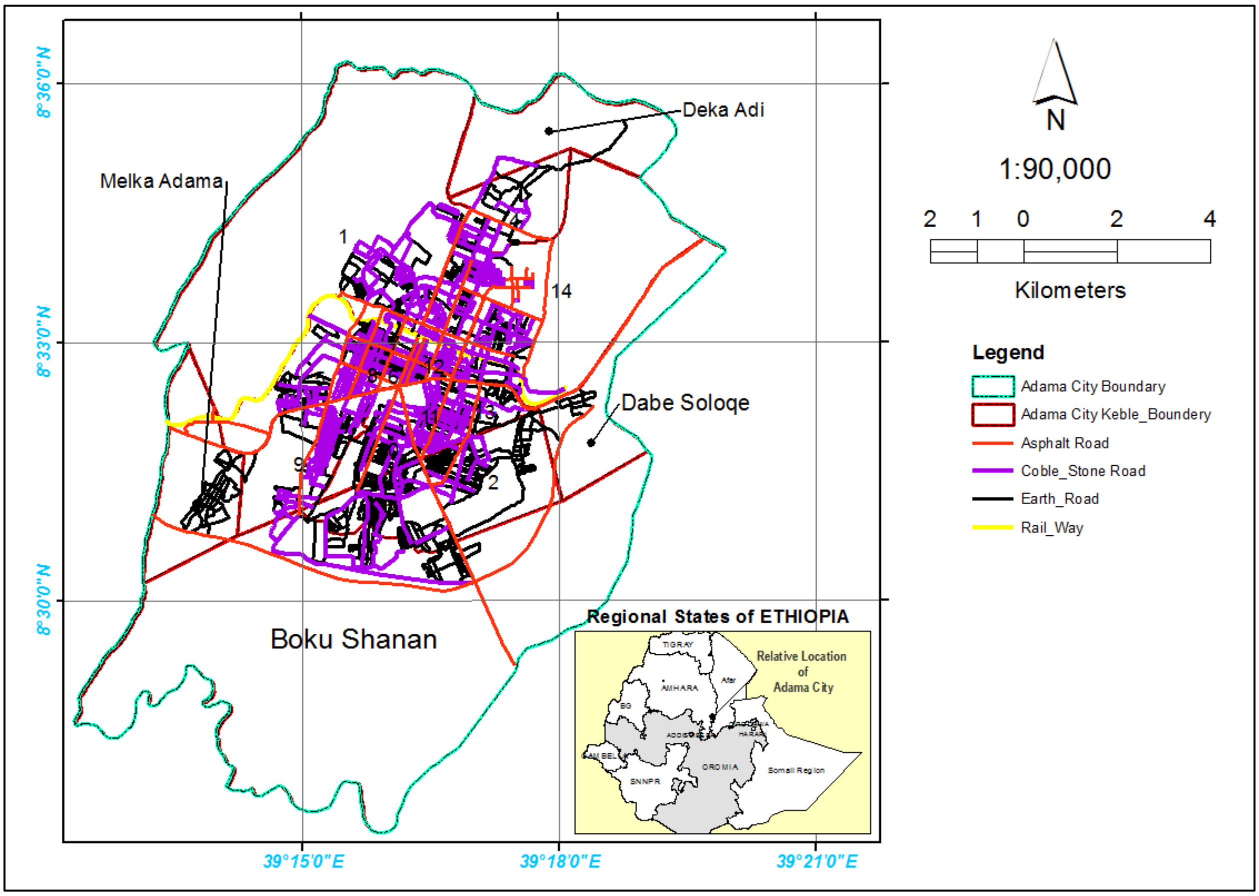

Figure: 6.1 Adama Road Network

6.2.2. Some Utility Map Generation

Geo-referenced and mosaicked aerial photograph of the year 2013 and Google Earth images of 2014 were used to generate some utilities map of Adama City. The utilities are private and government or public hospitals, educational institutes like: Universities, colleges, schools, technical educations, and private and government factories and etc. This study generates only some of them from Orthophoto and Google Earth imagery. The Orthophoto was opened in Arc GIS as a backdrop and some utility areas were digitized to shows the utility areas in the Adama city by using the Orthophoto prepared in the year 2013 and freely available Google Earth imagery.

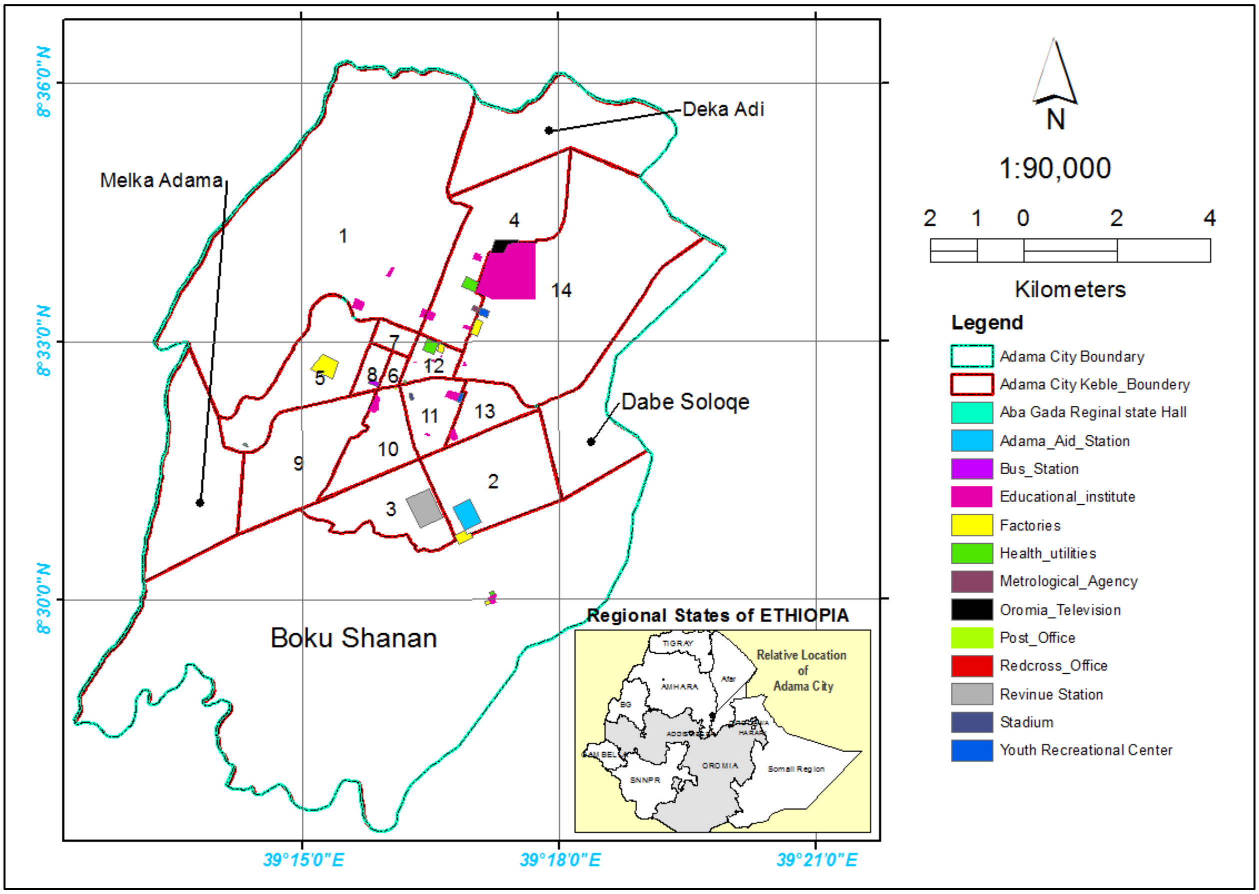

Figure: 6.2 Some utility map of Adama city

6.2.3. Power line Network

The Ethiopian Electric Power Corporation (EEPCo) was named in 1997 after serving previously in the name of the Ethiopian Electric Light and Power Authority, which was established in 1956. EEPCo is a government owned utility responsible for the generation, transmission, distribution and sales service of electric energy throughout Ethiopia. Regional interconnections with neighboring countries including Djibouti, Sudan and Kenya are under the construction and procurement phases. EEPCO increased the number of electrified towns and villages. EEPCo has

Mission to provide adequate and quality electricity generation, transmission, distribution, and sales services, through continuous improvement of utility management practices, and responsive to the socio-economic development and environmental protection needs of the public. (www.eepco.gov.et).

Adama is also part of this plan, and the electric network is distributed in the town to provide electric energy to its nation. Especially in the central part of the city almost all electric coverage is enough as compared to new areas that recently added to the Adama City which has less or no electric power distributions in the peripheral area and other utility as shown in different maps including the following map. Around 274.503 km power lines and 319 pole mounted transformers are found in Adama city currently. To develop this electric network the electric data from EEPCo South East region revised master plan is used. It was extracted from Auto Cad data from revised master plan.

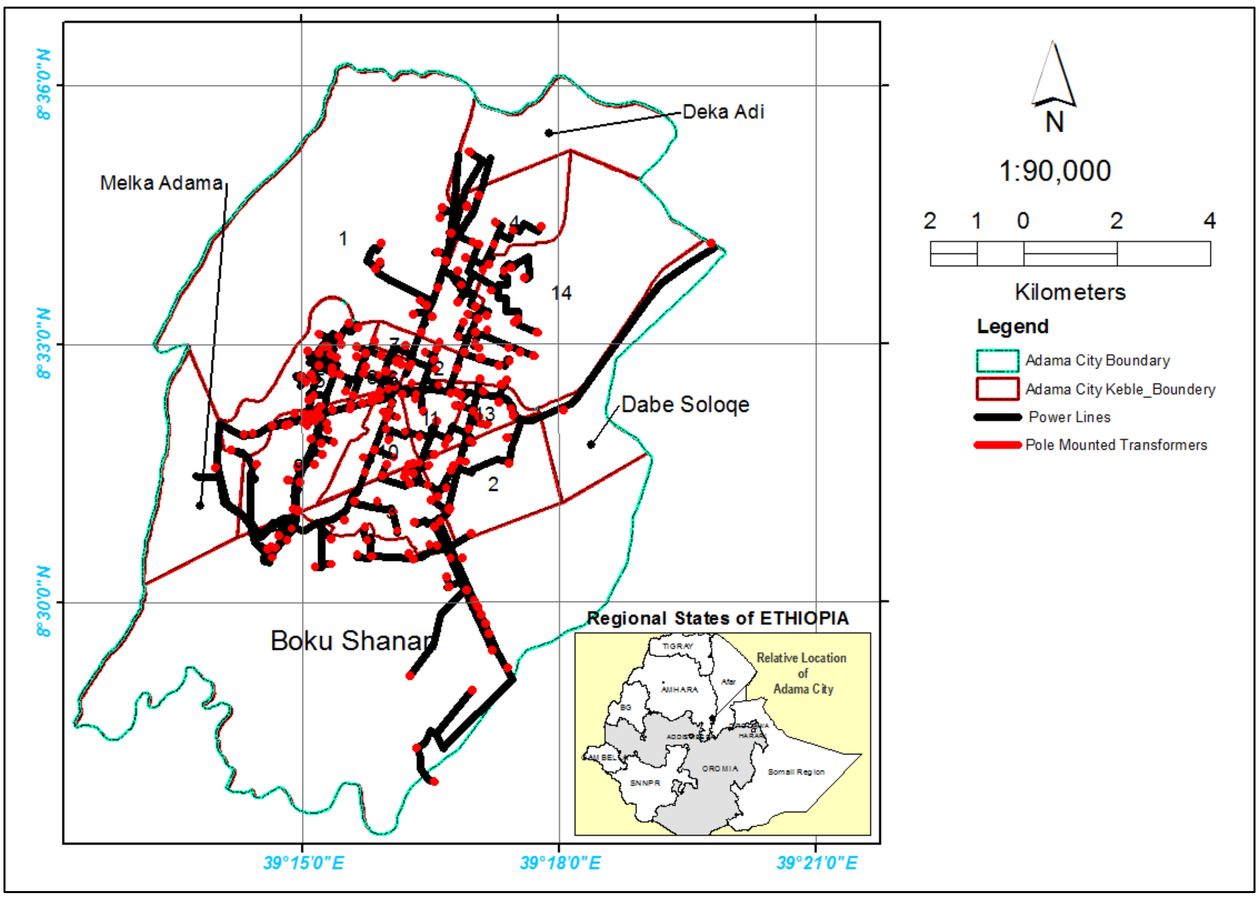

Figure: 6.3 Adama electric power distributions

CHAPTER SEVEN: URBAN LAND USE /COVER CHANGE POSITIONAL ANALYSIS AT KEBELE LEVEL

7.1 Introduction

Urban land use and land cover dynamics are widespread, accelerating, and significant processes driven by human actions but also producing changes that impact humans (Agarwal et al., 2002). These dynamics alter the environment and enforce to appear different geospatial database in urban area including road network, electric power distribution, utilities like educational institute, expanding factories, health care facilities and etc. and also biophysical resources including soil, vegetation, water, animal feed and others. Consequently, urban land use and land cover changes could lead to a decreased availability of different products and services for human, livestock, agricultural production and damage to the environment as well, however, people in the urban area to get better infrastructure, better health center, educational institute they force environment to change.

Techniques are required to deal with time series of data that are produced from different sensors, thus having different temporal and spatial resolutions. Digital image processing and classification deal with time series of satellite data in spatial dynamics studies (Masek et al., 2000; Kaufmann & Seto, 2001; Gluch, 2002; Read and Lam, 2002; Seto et al., 2002; Herold et al., 2003; Cabral et al., 2004) have been proceeds to detect urban land use land cover change.

Application of remotely sensed data made possible to study the spatial changes in urban land cover in less time, at low cost and with better accuracy (kwacha, 1985) with different geospatial data sources in association with Geographical Information System (GIS) that provide suitable platform for data analysis, update and retrieval (Star et al., 1997, Cracker et al., 1998, Chiller, 2000).

Space borne remotely sensed data may be particularly useful in developing countries where recent and reliable spatial information is lacking (Dong et al., 1997). Remote sensing technology and geographic information system (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and geospatial data base formation. By understanding the driving forces of land use development in the past, managing the current situation of geospatial information with modern GIS tools, and modeling the future. The change in any form of land use is largely related either with the external forces and the pressure built-up within the system (Bisht and Kothyari, 2001) that dynamically change in the urban of developing country related with better economy & needs better life which is day to day happen.

Google Earth can show the temporal image of particular point over a period of time in its Arc View which is used for small scale land use land cover change and is used to check what specific areas of land use (built-up) previously functioned for, to prevent illegal land encroachment in municipal environment, to protect land legally delineate land for parks or urban green areas in natural environment management.

7.2 Land Use/Cover Change and position Analysis at Randomly Selected Point

The different geospatial data sources exist with different spatial resolutions which can limit and/ promote the applications of different works in different areas. There a number of geospatial data sources that originated from remote sensing data (satellite image and aerial photography) have different spatial resolutions. The high spatial resolution of remote sensing used for urban land use/cover change and other applications may have different positional accuracy, which the result of the horizontal positional accuracy assessed in chapter five of this research shows.

In that assessment the point position selected were not equally distributed in all area to compare horizontal positions of these points over the study area because of selected visible position over all data sources and accessibility of the place. For further horizontal positional analysis these research is try to evaluate or analysis horizontal positional accuracy of the Google Earth image and IKONOS Satellite image with Orthophoto and analysis the selected point status in different serious of time to detect the land use change over the times. For these achievements in this study finding the parts of Adama city (kebele 03) is used as a sample area.

This area is selected because of the limitations of the coverage area of existing IKONOS 2004 satellite image of Adama city, which is not covers all Adama city boundary. These kebele (selected sample area) is configuration of different land use categories; it contains bare soils, agricultural lands, urban built-up areas and etc.

Geo-referenced, mosaicked and Clip IKONOS satellite of the year 2004 with the sample boundary was used for this land use land cover classifications which is used for randomly selected points, the EREDAS 2013 software is used for preprocess the Satellite image & classify in to four different land use categories.

After this urban land use land cover classification is carried out with this IKONOS 2004 satellite image data sources, sample points are randomly selected from these classified land use land cover by using Arc GIS toolbox. This random sample selected method was used to cover each and every land use type based on their magnitude/ large area require large number and the small is as well based on the area coverage.

The random sample select method used in this point sample is Stratified Random Sampling of Proportional Allocation of sample size. Stratified Random Sampling is used when the population is heterogeneous with respect to the variable or characteristic under study, then the technique of stratified random sampling is used to obtain more efficient results. Stratification means division in to layers or groups. Stratified random sampling involves the following steps:

1. Stratify or group the given sample kebele in to four sub-groups or sub-populations known as strata like Grassland, Vegetation, Bare soils and Built up.

Thus in stratified sampling the given population of size N (total land use) is divided in to say, k (four class) relatively homogeneous strata of sizes N_1,N_2,N_3,…, N_K respectively such that $N = \sum_{i=1}^{k} N_i$. In this case N represent the land use type. N_1 = Grass land, N_2= Vegetation, $N_{3,}$ =Bare soils, N_4 =Built up.

2. Draw simple random samples from each of the k strata. Let size *n*, be drawn from the ith strata, (i= 1, 2, 3… k) such that $\sum_{i=1}^{k} n_i = n,$ Where n is the total sample size form a population of size N in this case total number of sample to be taken is 100 which can be determined by the researcher.

Proportional Allocation of sample size in stratified sampling are selected from each stratum in the same proportion as they exist in the population. The allocation of sample sizes is termed as proportional if the sample fraction, i.e., the ratio of the sample size to the population size, remains the same in all the strata.

Mathematically the principle of proportional allocation gives:

$$\frac{n_1}{N_1} = \frac{n_2}{N_2} = \frac{n_3}{N_3} = ... = \frac{n_k}{N_k}.$$

n_1=sample from Grassland, n_2 =sample from Vegetation, n_3 =sample from Bare soil, n_4 =sample from Built up.

By the property of ratio and proportions, each of these ratios is equal to the ratio of the sum of numerators to the sum of denominators, i.e.

$$\frac{n_1}{N_1} = \frac{n_2}{N_2} = ... = \frac{n_k}{N_k} = \frac{n_{1+}n_2 + ... + n_k}{N_1 + N_2 + ... + N_k}$$
$$= \frac{n}{N}$$
$$= c, (cons\tan t)$$

$$\frac{\text{sample from Grassland}}{\text{Grass land}} = \frac{\text{sample from Vegetation}}{\text{Vegetation}} = \frac{\text{sample from Bare soil}}{\text{Bare soil}} = \frac{\text{sample from Built up}}{\text{Built up}} = \text{constant}$$

$$\frac{17.41}{57.74} = \frac{32.36}{107.35} = \frac{43.12}{143.05} = \frac{7.11}{23.58} = 0.301$$

In this the numerator is area in hectares and the denominator is the selected sample size.

Since the total sample size n is 100 in this case, and the population size N331.72 hectares in this case are fixed.

Hence,

$$n_1 = N_1\left(\frac{n}{N}\right), n_2 = N_2\left(\frac{n}{N}\right), ..., n_k = N_k\left(\frac{n}{N}\right)$$
$$\Rightarrow \boxed{n_i = N_i\left(\frac{n}{N}\right)}, (i = 1, 2, 3, ..., k)$$

In this case total sample size n is 100, and the population size N is 331.72hectare and it is known that summations of each area give the total population, in this stratified the area of each land use type is known. Then by this principle or formula the rest sample size will be calculated according to the following (All random formula is from Introduction to Basic Statistics).

$$n_i = N_i\left(\frac{n}{N}\right)$$

$$n_{Vegetation} = 57.74\left(\frac{100}{331.72}\right) = 17.41$$

$$n_{Grassland} = 107.35\left(\frac{100}{331.72}\right) = 32.36$$

$$n_{Bare\ soil} = 143.05\left(\frac{100}{331.72}\right) = 43.12$$

$$n_{Built\text{-}up} = 23.58\left(\frac{100}{331.72}\right) = 7.11$$

Table: -7.1 Sample Size per Land Use

Land use type	Area in hectares	Sample size per land use	Percent
Vegetation	57.74	17.41	15
Grassland	107.35	32.36	37
Bare soil	143.05	43.12	41
Built-up	23.58	7.11	7
cumulative	331.72	100	100

Source: Generated by Author

This table indicates that from samples randomly selected from land use classified IKONOS 2004 satellite images around 18 samples from vegetation land use class, 32 from Grass land, 43 from bare soils and 7 samples from built-up land use categories. The attribute tables of these land use categories in Arc GIS 10 also shows this values which is confirm with this above table results.

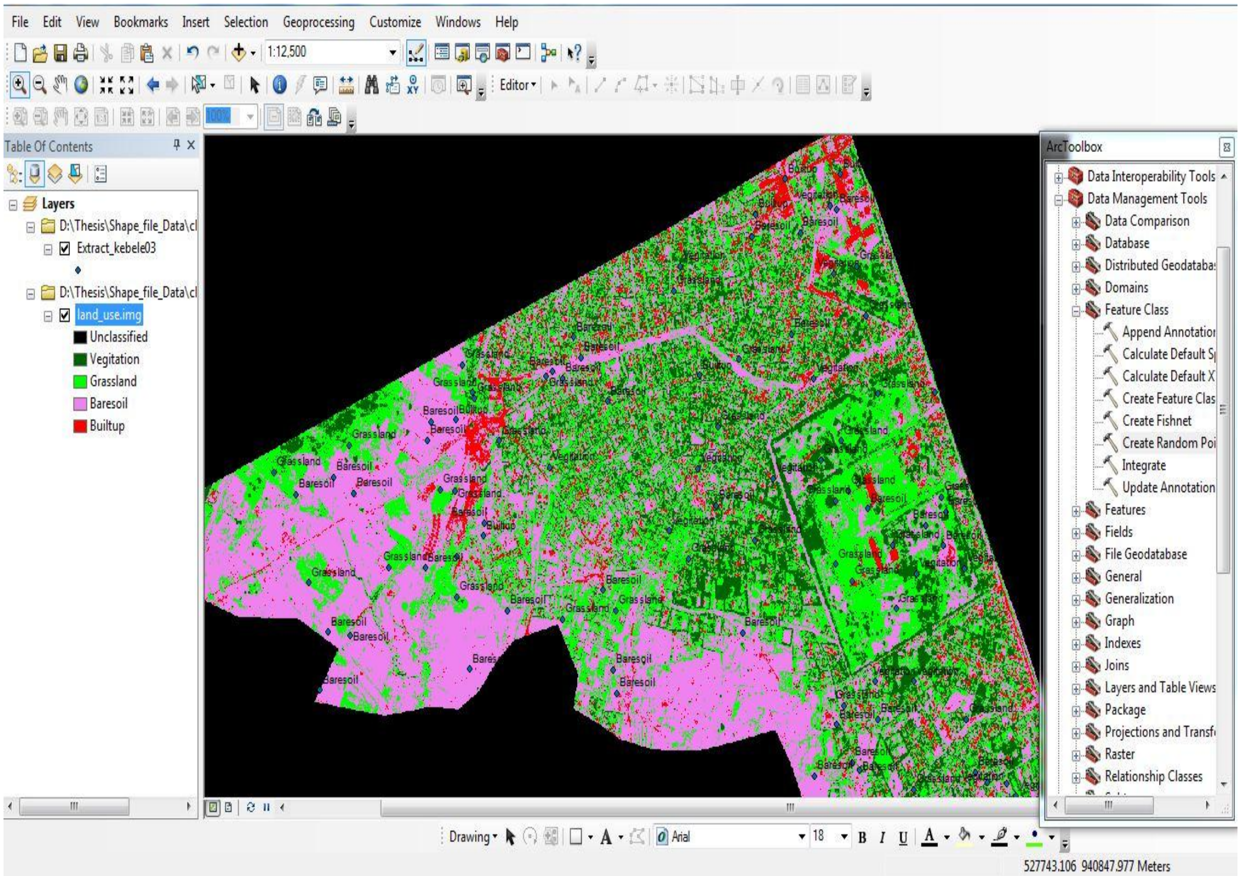

Figure: 7.1 Land use/covers map of Sample kebele 03 Based on IKONOS 2004 Satellite Image

When the random points selected from this land use /cover classifications of IKONOS 2004 satellite image were tested or superimpose over Google Earth of 2009 and Orthophoto of 2013 data sources for additional analysis of horizontal positional accuracy with spatial information classified by IKONOS 2004 satellite image in Adama city.

The following images indicate the IKONOS 2004 image, Orthophoto 2013 and Google Earth image superimposed by the random points selected from high resolution IKONOS 2004 Satellite image classified of land use land cover of sample area of Adama city.

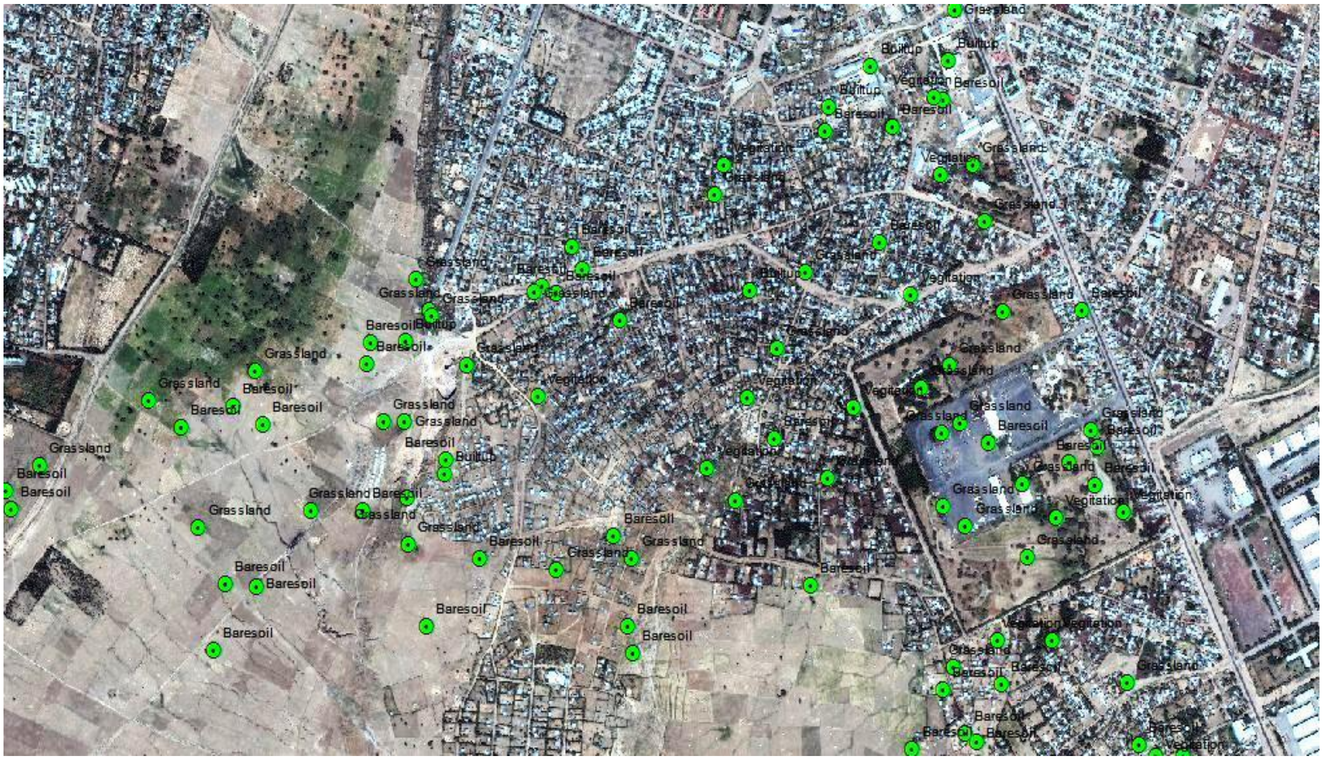

Figure: 7.2 Superimposed of randomly selected sample points on 2004 IKONOS satellite Image

Figure: 7.3 Superimposed of randomly selected sample points on 2013 Orthophoto

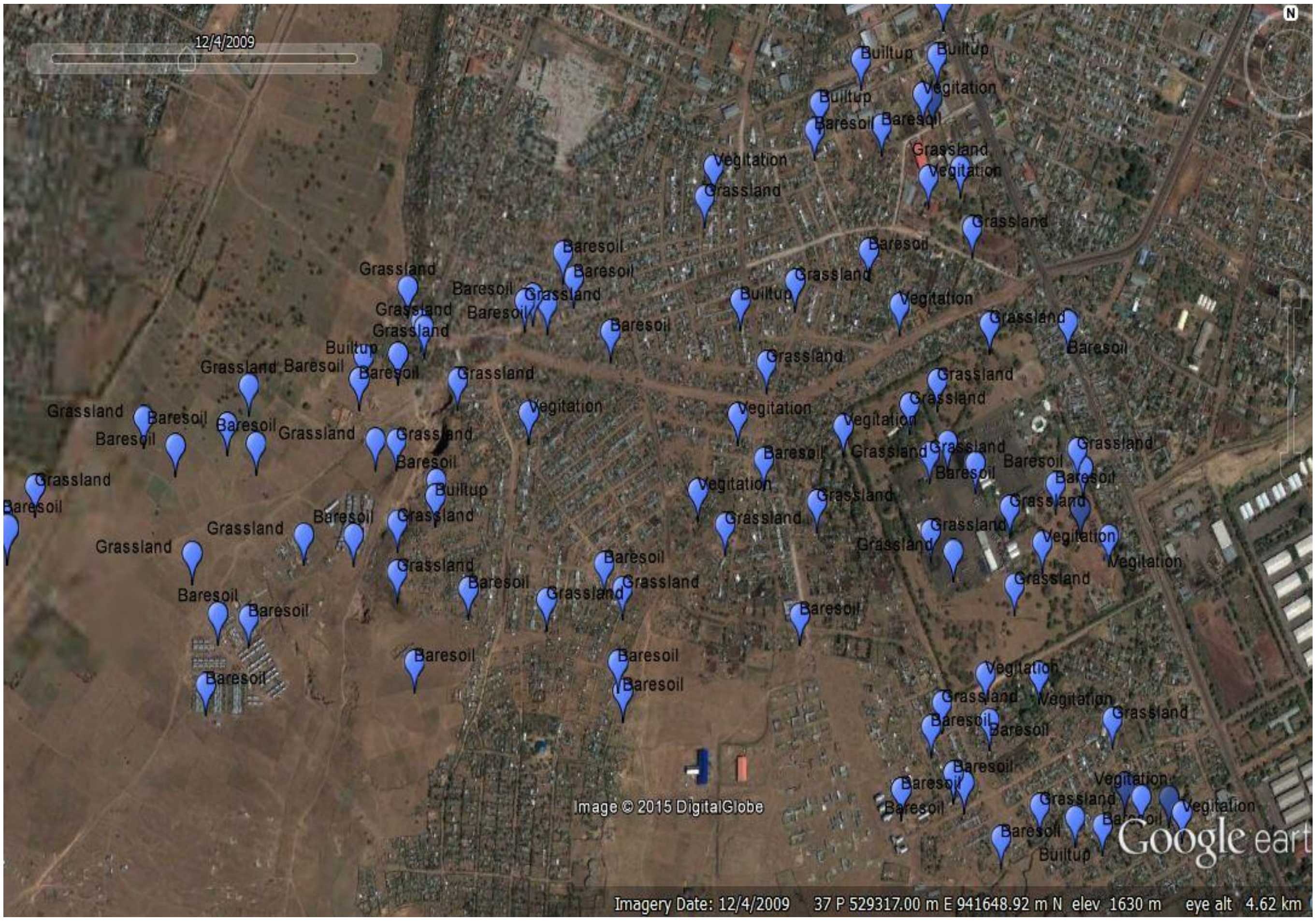

Figure: 7.4 Superimposed of randomly selected sample points against 2009 Google

Selected point number 55 On Orthophoto

selected point number 55 On IKONOS sat

Selected point number 12 On Orthophoto

Selected point number 12 On IKONOS

Selected point number 12 On Google Earth 2014

Selected point number 55 On Google Earth 2014

Figure: 7.5 Some selected samples indicate positional shift on data sources.

As the results indicate these random sample points are selected from the IKONOS 2004 Satellite image. The land use/ cover classifications horizontal positions of the selected points are clearly shows shift in horizontal position on IKONOS Satellite that almost shows similar positions on Google Earth images and Orthophoto as it clearly shows on (fig 7.5).

Because of the prevalence of horizontal positional shift of these selected points on IKONOS, this study uses Google Earth image and Orthophoto for urban land use land cover change positional analysis.

Appendix A shows that six of points are converted in to built-up from different land use categories on Google Earth 2014 from Orthophoto of 2013. The random selection of samples indicate that 6% of the total land use in this area is converted to Built up from different land use categories in this a year.

The Appendix B also shows that seventeen selected points are converted to built-up from different land use categories on Google Earth of 2014 from Google 2009 Image. The sample indicates 17% of the total land use in this area is converted to Built-up from different land use categories over five years.

These Google Earth and Orthophoto are used for land use land cover change. According to the Appendix C eighteen selected points are converted to built-up from different land use categories from Google Earth of 2009 to Orthophoto 2013 in a period of four years. The selected samples indicate that 18% of the total land use in this kebele is converted to Built-up from different land use categories in this elapse of four years. The Google earth is also important to show the images of specific area in different years. The following images show the images of Google Earth in an identical place with the years of 2009 and 2014.

Google Earth Image, 2009 Google Earth Image, 2014

Figure: 7.6 Google Earth images over different years

These Google Earth images are also shows the relative horizontal position similar with Orthophoto 2013 and IKONOS 2004 Satellite image. Anyone can get the information from IKONOS or Orthophoto and from Google Earth image as well, which is planimetrically shown in the following images, these relative positions are similar in all these data sources.

Orthophoto IKONOS Image Google Earth Image

Google Earth Image Orthophoto IKONOS Image

Figure: 7.7 Two dimensional relative similarity between different geospatial data sources

CHAPTER 8: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This research is carried out in the Adama City, Ethiopia. The study has two parts and the first part belongs to horizontal position accuracy assessment of Google Earth imagery and IKONOS 2004 satellite image with compare to Orthophoto 2013. The second part is geospatial database creation of current state of Adama city. These geospatial databases include road networks, electric power line & transformers distribution, utility map generation, ground verifications of Adama kebele boundaries.

The study found is carried out horizontal positional accuracy of Google Earth with Orthophoto and IKONOS satellite image with along Orthophoto. The selected samples consider the slope class of the study area. The Google Earth imagery is in point position (X and Y coordinate), lines (length & shifts) and areal (polygon) assessments are horizontal positions are give less than six root mean square errors that tested under class III accuracy standards according to American Society of Photogrametry Remote Sensing, National Standard for Spatial Data Accuracy, National Map Accuracy Standard, United State of Geological Survey, and etc accuracy standards, however, for IKONOS it is more than six root mean square errors.

The accuracy assessment results of point positions shows that the Y_coordinates are less root mean square errors than the X_coordinates in horizontal position. As indicated in ranking table of these spatial positional errors, the difference or error value is not related to any elevation difference (tables 5.10 to 5. 17), that means the sample selected from low elevation is not different with high elevation value due to its variation.

Interestingly study found that Google earth is more preferable than other in terms of availability and cost. Horizontally according to this result when these geospatial data sources evaluated based on different map accuracy standards the result obtained is quietly satisfactory on free charge available Google Earth than the commercial IKONOS satellite images in horizontal position only but the IKONOS has a number scientific applications, which Google earth cannot use.

The study produces and gives the current status of Adama city geospatial database and updates kebele boundaries (including GPS track data), some utility areas like hospitals (private and government), factories (some private and government, like garment, flour, soap and etc.), electric network (including GPS positions of transformer distribution in Adama city), road distribution and types (asphalt, coble stone and earth) are generated.

It recommended that over the time it is obvious that the geospatial database of urban is alter due to a number of matters. As this study shows the peripheral kebele boundaries which are complicated to delineate the kebeles, which use electric power line. This problem is exists between the kebeles of 13 and 02, 03 and 10, and it will happen between the new added kebeles which are currently not delineated. In these kebele like 13 and 02, 03 and 10 the delineate barrier is the electric power line. The barrier is not prevailed on the surface contact to the earth and under this line the residence people are constructed the houses. The understanding of the boundary between the kebeles is very difficult for researchers and the others.

The utilities geospatial database generated on this study finding is not cover each and every utilities in the city. The provided time and budgets is not enough to generate each and every utility for this study.

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Appendix A

Comparative Land use/Cover Change Analysis on the bases of Google 2014image from Orthophoto 2013

Point FID	Point Sample Classifications based on Orthophoto 2013	Point Sample Classifications According to Google Earth 2014	X_coordinate	Y_coordinate	Remark
0	Bare soil	Bare soil	528533.557	941801.952	No change
1	Grassland	Grassland	530206.024	941299.882	No change
2	Bare soil	Bare soil	528619.889	941616.43	No change
3	Built-up	Built-up	528722.882	941495.417	No change
4	Bare soil	Bare soil	530075.78	940866.539	No change
5	Built-up	Built-up	528673.667	941137.627	No change
6	Bare soil	Bare soil	529861.539	942308.097	No change
7	Grassland	Built-up	529460.76	941433.313	Change
8	Built-up	Built-up	529430.886	942218.228	No change
9	Built-up	Built-up	528959.279	941677.779	No change
10	Built-up	Built-up	528241.946	941229.732	No change
11	Vegetation	Vegetation	529653.097	941234.526	No change
12	Built-up	Built-up	530004.58	942463.999	No change
13	Vegetation	Vegetation	529045.663	942027.965	No change
14	Vegetation	Vegetation	529830.096	942036.57	No change
15	Bare soil	Built-up	530604.56	940832.348	Change
16	Vegetation	Vegetation	530130.87	941104.637	No change
17	Grassland	Grassland	528625.708	941439.19	No change
18	Bare soil	Bare soil	529689.372	942297.999	No change
19	Grassland	Grassland	529640.014	941968.238	No change
20	Vegetation	Built-up	529935.819	941697.431	Change
21	Bare soil	Bare soil	529992.685	942370.739	No change

22	Vegetation	Bare soil	528162.407	941236.892	Change
23	Bare soil	Bare soil	530376.974	941468.594	No change
24	Vegetation	Vegetation	529967.75	942378.763	No change
25	Vegetation	Grassland	528681.923	941878.293	Change
26	Bare soil	Bare soil	529764.663	941649.473	No change
27	Vegetation	Vegetation	529390.939	941508.53	No change
28	Bare soil	Bare soil	529188.201	941137.028	No change
29	Bare soil	Bare soil	528048.858	941605.521	No change
30	Bare soil	Bare soil	527615.935	941411.598	No change
31	Vegetation	Built-up	530533.201	940833.387	Change
32	Bare soil	Bare soil	530278.343	941393.19	No change
33	Grassland	Bare soil	529909.544	941916.667	Change
34	Vegetation	Vegetation	530269.502	941105.089	No change
35	Grassland	Bare soil	527688.069	941515.686	Change
36	Bare soil	Bare soil	527967.267	941666.338	No change
37	Bare soil	Bare soil	528968.679	941934.763	No change
38	Grassland	Grassland	530362.073	940788.906	No change
39	Vegetation	Vegetation	529199.059	941295.686	No change
40	Bare soil	Bare soil	530313.065	941522.644	No change
41	Bare soil	Bare soil	529989.907	941418.494	No change
42	Bare soil	Built-up	529006.122	941917.531	Change
43	Grassland	Bare soil	528133.189	941082.037	Change
44	Grassland	Bare soil	530270.921	940815.684	Change
45	Bare soil	Bare soil	530432.803	940771.04	No change
46	Vegetation	Vegetation	528689.625	941864.116	No change
47	Bare soil	Bare soil	530105.604	941567.772	No change
48	Grassland	Grassland	530007.463	941749.812	No change
49	Bare soil	Bare soil	530018.617	941040.93	No Change
50	Built-up	Built-up	529983.413	942197.53	No change
51	Vegetation	Grassland	529152.379	941349.091	Change

52	Bare soil	Bare soil	529701.656	942356.432	No Change
53	Grassland	Grassland	530194.39	941471.338	No change
54	Bare soil	Bare soil	530459.598	941004.723	No change
55	Built-up	Built-up	529807.512	942451.359	No change
56	Bare soil	Bare soil	528725.113	941529.512	No change
57	Built-up	Built-up	529407.885	942151.153	No change
58	Built-up	Built-up	529007.099	941271.791	No change
59	Bare soil	Bare soil	530383.984	941558.751	No change
60	Built-up	Built-up	530140.742	941003.007	No Change
61	Bare soil	Bare soil	528257.124	941609.694	No change
62	Built-up	Built-up	530047.83	940887.308	No change
63	Built-up	Built-up	528382.235	941409.899	No change
64	Built-up	Built-up	529073.095	941973.451	No change
65	Grassland	Grassland	530170.597	940745.395	No change
66	Bare soil	Bare soil	528093.868	941368.932	No change
67	Bare soil	Bare soil	529167.355	941855.985	No change
68	Bare soil	Bare soil	528809.041	941295.42	No change
69	Bare soil	Bare soil	530097.313	942086.274	No change
70	Built-up	Built-up	529200.778	941074.495	No change
71	Grassland	Grassland	530066.203	942218.664	No change
72	Built-up	Built-up	529493.212	941674.592	No change
73	Bare soil	Bare soil	530451.005	941407.192	No change
74	Built-up	Built-up	529560.087	941576.674	No change
75	Bare soil	Bare soil	530048.418	941374.159	No change
76	Vegetation	Grassland	530638.054	940799.362	Change
77	Bare soil	Bare soil	529566.758	941788.602	No change
78	Built-up	Built-up	530490.604	940861.281	No change
79	Built-up	Built-up	529499.436	941925.105	No change
80	Built-up	Built-up	528776.96	941749.403	No change
81	Bare soil	Bare soil	528521.904	941751.577	No change

82	Grassland	Grassland	528627.044	941331.333	No change
83	Bare soil	Bare soil	528512.162	941409.577	No change
84	Built-up	Built-up	529987.365	941589.719	No change
85	Vegetation	Grassland	530142.32	941875.378	Change
86	Bare soil	Vegetation	528948.041	941922.142	Change
87	Built-up	Built-up	530020.015	942584.505	No change
88	Bare soil	Bare soil	530345.349	941879.392	No change
89	Built-up	Built-up	529696.804	941483.639	No change
90	Bare soil	Bare soil	528565.204	941618.374	No change
91	Bare soil	Bare soil	530033.508	941614.799	No change
92	Built-up	Built-up	529990.707	940989.063	No change
93	Grassland	Bare soil	528237.661	941737.538	Change
94	Bare soil	Built-up	529913.569	940851.576	Change
95	Bare soil	Bare soil	527604.911	941456.065	No change
96	Grassland	Bare soil	530369.107	941598.365	Change
97	Grassland	Grassland	528647.189	941952.996	No change
98	Grassland	Bare soil	528182.14	941652.173	Change
99	Bare soil	Bare soil	528621.982	941806.389	No change

Source: Generated by Author

Appendix-B

Comparative Land use/Cover Change Analysis on the bases of Google 2009 image and Google 2014 Image

Point FID	Point Sample Classifications based on Google 2009 Image	Point Sample Classifications based on Google 2014 Image	X_ coordinate	Y_ coordinate	Remark
0	Bare soil	Bare soil	528533.557	941801.952	No change
1	Grassland	Grassland	530206.024	941299.882	No change
2	Grassland	Bare soil	528619.889	941616.43	Change
3	Built-up	Built-up	528722.882	941495.417	No change
4	Bare soil	Bare soil	530075.78	940866.539	No change
5	Bare soil	Built-up	528673.667	941137.627	Change
6	Bare soil	Bare soil	529861.539	942308.097	No change
7	Grassland	Built-up	529460.76	941433.313	Change
8	Vegetation	Built-up	529430.886	942218.228	Change
9	Vegetation	Built-up	528959.279	941677.779	Change
10	Built-up	Built-up	528241.946	941229.732	No change
11	Built-up	Vegetation	529653.097	941234.526	Change
12	Built-up	Built-up	530004.58	942463.999	No change
13	Bare soil	Vegetation	529045.663	942027.965	Change
14	Bare soil	Vegetation	529830.096	942036.57	Change
15	Vegetation	Built-up	530604.56	940832.348	Change
16	Vegetation	Vegetation	530130.87	941104.637	No change
17	Grassland	Grassland	528625.708	941439.19	No change
18	Bare soil	Bare soil	529689.372	942297.999	No change
19	Built-up	Grassland	529640.014	941968.238	Change
20	Grassland	Built-up	529935.819	941697.431	Change

21	Built-up	Bare soil	529992.685	942370.739	Change
22	Bare soil	Bare soil	528162.407	941236.892	No change
23	Bare soil	Bare soil	530376.974	941468.594	No change
24	Vegetation	Vegetation	529967.75	942378.763	No change
25	Grassland	Grassland	528681.923	941878.293	No change
26	Vegetation	Bare soil	529764.663	941649.473	Change
27	Vegetation	Vegetation	529390.939	941508.53	No change
28	Bare soil	Bare soil	529188.201	941137.028	No change
29	Bare soil	Bare soil	528048.858	941605.521	No change
30	Bare soil	Bare soil	527615.935	941411.598	No change
31	Grassland	Built-up	530533.201	940833.387	Change
32	Vegetation	Bare soil	530278.343	941393.19	Change
33	Grassland	Bare soil	529909.544	941916.667	Change
34	Vegetation	Vegetation	530269.502	941105.089	No change
35	Bare soil	Bare soil	527688.069	941515.686	No change
36	Grassland	Bare soil	527967.267	941666.338	Change
37	Bare soil	Bare soil	528968.679	941934.763	No change
38	Built-up	Grassland	530362.073	940788.906	Change
39	Grassland	Vegetation	529199.059	941295.686	Change
40	Bare soil	Bare soil	530313.065	941522.644	No change
41	Built-up	Bare soil	529989.907	941418.494	Change
42	Bare soil	Built-up	529006.122	941917.531	Change
43	Bare soil	Bare soil	528133.189	941082.037	No change
44	Grassland	Bare soil	530270.921	940815.684	Change
45	Bare soil	Bare soil	530432.803	940771.04	No change
46	Grassland	Vegetation	528689.625	941864.116	Change
47	Bare soil	Bare soil	530105.604	941567.772	No change
48	Grassland	Grassland	530007.463	941749.812	No change
49	Bare soil	Bare soil	530018.617	941040.93	No change
50	Vegetation	Built-up	529983.413	942197.53	Change

51	Bare soil	Grassland	529152.379	941349.091	Change
52	Vegetation	Bare soil	529701.656	942356.432	Change
53	Grassland	Grassland	530194.39	941471.338	No change
54	Bare soil	Bare soil	530459.598	941004.723	No change
55	Built-up	Built-up	529807.512	942451.359	No change
56	Bare soil	Bare soil	528725.113	941529.512	No change
57	Grassland	Built-up	529407.885	942151.153	Change
58	Grassland	Built-up	529007.099	941271.791	Change
59	Bare soil	Bare soil	530383.984	941558.751	No change
60	Built-up	Built-up	530140.742	941003.007	No change
61	Bare soil	Bare soil	528257.124	941609.694	No change
62	Built-up	Built-up	530047.83	940887.308	No change
63	Built-up	Built-up	528382.235	941409.899	No change
64	Built-up	Built-up	529073.095	941973.451	No change
65	Bare soil	Grassland	530170.597	940745.395	Change
66	Grassland	Bare soil	528093.868	941368.932	Change
67	Bare soil	Bare soil	529167.355	941855.985	No change
68	Built-up	Bare soil	528809.041	941295.42	Change
69	Bare soil	Bare soil	530097.313	942086.274	No change
70	Built-up	Built-up	529200.778	941074.495	No change
71	Grassland	Grassland	530066.203	942218.664	No change
72	Built-up	Built-up	529493.212	941674.592	No change
73	Bare soil	Bare soil	530451.005	941407.192	No change
74	Vegetation	Built-up	529560.087	941576.674	Change
75	Bare soil	Bare soil	530048.418	941374.159	No change
76	Vegetation	Grassland	530638.054	940799.362	Change
77	Bare soil	Bare soil	529566.758	941788.602	No change
78	Bare soil	Built-up	530490.604	940861.281	Change
79	Built-up	Built-up	529499.436	941925.105	No change
80	Grassland	Built-up	528776.96	941749.403	Change

81	Built-up	Bare soil	528521.904	941751.577	Change
82	Grassland	Grassland	528627.044	941331.333	No change
83	Bare soil	Bare soil	528512.162	941409.577	No change
84	Grassland	Built-up	529987.365	941589.719	Change
85	Grassland	Grassland	530142.32	941875.378	No change
86	Grassland	Vegetation	528948.041	941922.142	Change
87	Grassland	Built-up	530020.015	942584.505	Change
88	Built-up	Bare soil	530345.349	941879.392	Change
89	Grassland	Built-up	529696.804	941483.639	Change
90	Grassland	Bare soil	528565.204	941618.374	Change
91	Bare soil	Bare soil	530033.508	941614.799	No change
92	Built-up	Built-up	529990.707	940989.063	No change
93	Grassland	Bare soil	528237.661	941737.538	Change
94	Built-up	Built-up	529913.569	940851.576	No change
95	Built-up	Bare soil	527604.911	941456.065	Change
96	Grassland	Bare soil	530369.107	941598.365	Change
97	Vegetation	Grassland	528647.189	941952.996	Change
98	Bare soil	Bare soil	528182.14	941652.173	No change
99	Bare soil	Bare soil	528621.982	941806.389	No change

Source: Generated by Author

Appendix-C

Comparative Land use/Cover Change Analysis on the bases of 2013 Orthophoto and 2009 Google Earth Image

Point FID	Point Sample Classifications According to Google 2009 Image	Point Sample Classifications based on Orthophoto 2013	X_ coordinate	Y_ coordinate	Remark
0	Bare soil	Bare soil	528533.557	941801.952	No change
1	Grassland	Grassland	530206.024	941299.882	No change
2	Grassland	Bare soil	528619.889	941616.43	Change
3	Built-up	Built-up	528722.882	941495.417	No change
4	Bare soil	Bare soil	530075.78	940866.539	No change
5	Bare soil	Built-up	528673.667	941137.627	Change
6	Bare soil	Bare soil	529861.539	942308.097	No change
7	Grassland	Grassland	529460.76	941433.313	No change
8	Vegetation	Built-up	529430.886	942218.228	Change
9	Vegetation	Built-up	528959.279	941677.779	Change
10	Built-up	Built-up	528241.946	941229.732	No change
11	Built-up	Vegetation	529653.097	941234.526	Change
12	Built-up	Built-up	530004.58	942463.999	No change
13	Bare soil	Vegetation	529045.663	942027.965	Change
14	Bare soil	Vegetation	529830.096	942036.57	Change
15	Vegetation	Bare soil	530604.56	940832.348	Change
16	Vegetation	Vegetation	530130.87	941104.637	No change
17	Grassland	Grassland	528625.708	941439.19	No change
18	Bare soil	Built-up	529689.372	942297.999	Change
19	Built-up	Grassland	529640.014	941968.238	Change
20	Grassland	Vegetation	529935.819	941697.431	Change

21	Built-up	Built-up	529992.685	942370.739	No change
22	Bare soil	Vegetation	528162.407	941236.892	Change
23	Bare soil	Bare soil	530376.974	941468.594	No change
24	Vegetation	Vegetation	529967.75	942378.763	No change
25	Grassland	Vegetation	528681.923	941878.293	Change
26	Vegetation	Bare soil	529764.663	941649.473	Change
27	Vegetation	Vegetation	529390.939	941508.53	No change
28	Bare soil	Built-up	529188.201	941137.028	Change
29	Bare soil	Bare soil	528048.858	941605.521	No change
30	Bare soil	Bare soil	527615.935	941411.598	No change
31	Grassland	Vegetation	530533.201	940833.387	Change
32	Vegetation	Bare soil	530278.343	941393.19	Change
33	Grassland	Grassland	529909.544	941916.667	No change
34	Vegetation	Vegetation	530269.502	941105.089	No change
35	Bare soil	Grassland	527688.069	941515.686	Change
36	Grassland	Grassland	527967.267	941666.338	No change
37	Bare soil	Bare soil	528968.679	941934.763	No change
38	Built-up	Grassland	530362.073	940788.906	Change
39	Grassland	Vegetation	529199.059	941295.686	Change
40	Bare soil	Bare soil	530313.065	941522.644	No change
41	Built-up	Built-up	529989.907	941418.494	No change
42	Bare soil	Bare soil	529006.122	941917.531	No change
43	Bare soil	Grassland	528133.189	941082.037	Change
44	Grassland	Grassland	530270.921	940815.684	No change
45	Bare soil	Bare soil	530432.803	940771.04	No change
46	Grassland	Vegetation	528689.625	941864.116	Change
47	Bare soil	Bare soil	530105.604	941567.772	No change
48	Grassland	Grassland	530007.463	941749.812	No change
49	Bare soil	Bare soil	530018.617	941040.93	No change
50	Vegetation	Built-up	529983.413	942197.53	Change

51	Bare soil	Vegetation	529152.379	941349.091	Change
52	Vegetation	Bare soil	529701.656	942356.432	Change
53	Grassland	Grassland	530194.39	941471.338	No change
54	Bare soil	Bare soil	530459.598	941004.723	No change
55	Built-up	Built-up	529807.512	942451.359	No change
56	Bare soil	Bare soil	528725.113	941529.512	No change
57	Grassland	Built-up	529407.885	942151.153	Change
58	Grassland	Built-up	529007.099	941271.791	Change
59	Bare soil	Bare soil	530383.984	941558.751	No change
60	Built-up	Built-up	530140.742	941003.007	No change
61	Bare soil	Bare soil	528257.124	941609.694	No change
62	Built-up	Built-up	530047.83	940887.308	No change
63	Built-up	Built-up	528382.235	941409.899	No change
64	Built-up	Built-up	529073.095	941973.451	No change
65	Bare soil	Grassland	530170.597	940745.395	Change
66	Grassland	Built-up	528093.868	941368.932	Change
67	Bare soil	Bare soil	529167.355	941855.985	No change
68	Built-up	Built-up	528809.041	941295.42	No change
69	Bare soil	Bare soil	530097.313	942086.274	No change
70	Built-up	Built-up	529200.778	941074.495	No change
71	Grassland	Grassland	530066.203	942218.664	No change
72	Built-up	Built-up	529493.212	941674.592	No change
73	Bare soil	Built-up	530451.005	941407.192	Change
74	Vegetation	Bare soil	529560.087	941576.674	Change
75	Bare soil	Built-up	530048.418	941374.159	Change
76	Vegetation	Vegetation	530638.054	940799.362	No change
77	Bare soil	Built-up	529566.758	941788.602	Change
78	Bare soil	Built-up	530490.604	940861.281	Change
79	Built-up	Built-up	529499.436	941925.105	No change
80	Grassland	Built-up	528776.96	941749.403	Change

81	Built-up	Bare soil	528521.904	941751.577	Change
82	Grassland	Grassland	528627.044	941331.333	No change
83	Bare soil	Bare soil	528512.162	941409.577	No change
84	Grassland	Built-up	529987.365	941589.719	Change
85	Grassland	Vegetation	530142.32	941875.378	Change
86	Grassland	Bare soil	528948.041	941922.142	Change
87	Grassland	Built-up	530020.015	942584.505	Change
88	Built-up	Bare soil	530345.349	941879.392	Change
89	Grassland	Built-up	529696.804	941483.639	Change
90	Grassland	Bare soil	528565.204	941618.374	Change
91	Bare soil	Built-up	530033.508	941614.799	Change
92	Built-up	Built-up	529990.707	940989.063	No change
93	Grassland	Grassland	528237.661	941737.538	No change
94	Built-up	Built-up	529913.569	940851.576	No change
95	Built-up	Built-up	527604.911	941456.065	No change
96	Grassland	Grassland	530369.107	941598.365	No change
97	Vegetation	Vegetation	528647.189	941952.996	No change
98	Bare soil	Grassland	528182.14	941652.173	Change
99	Bare soil	Grassland	528621.982	941806.389	Change

Source: Generated by Author

Appendix-D

Selected sample line data for line shift analysis

point	Selected Line Samples with their difference for shift									
1	X_Google	XO-XG	Y_Google	YO-YG	X_Orthoto	XO-XI	Y_Orthoto	YO-YI	X_IKON	Y_IKON
	530417.63	0.76	942086.18	-1.48	530418.39	6.61	942084.70	-2.31	530411.78	942087.01
	530471.11	0.76	942095.59	-1.48	530471.87	6.61	942094.11	-2.31	530465.26	942096.42
	530497.97	0.76	942103.8	-1.48	530498.74	6.61	942102.32	-2.31	530492.12	942104.63
	530507.46	0.76	942108.33	-1.48	530508.22	6.61	942106.85	-2.31	530501.61	942109.16
	530516.47	0.76	942113.56	-1.48	530517.24	6.61	942112.08	-2.31	530510.62	942114.40
	530525.06	0.76	942120.02	-1.48	530525.82	6.61	942118.54	-2.31	530519.21	942120.86
	530533.55	0.76	942129.06	-1.48	530534.31	6.61	942127.58	-2.31	530527.70	942129.90
	530542.13	0.76	942141.09	-1.48	530542.89	6.61	942139.61	-2.31	530536.28	942141.93
	530550.05	0.76	942154.46	-1.48	530550.82	6.61	942152.98	-2.31	530544.20	942155.29
	530557.10	0.76	942168.27	-1.48	530557.86	6.61	942166.79	-2.31	530551.25	942169.10
	530565.90	0.76	942185.13	-1.48	530566.66	6.61	942183.65	-2.31	530560.05	942185.96
	530578.48	0.76	942208.72	-1.48	530579.24	6.61	942207.24	-2.31	530572.63	942209.55
	530596.13	0.76	942243.90	-1.48	530596.89	6.61	942242.42	-2.31	530590.28	942244.74
	530616.72	0.76	942282.82	-1.48	530617.48	6.61	942281.34	-2.31	530610.87	942283.65
	530636.55	0.76	942320.85	-1.48	530637.31	6.61	942319.37	-2.31	530630.70	942321.68
	530650.86	0.76	942348.01	-1.48	530651.62	6.61	942346.53	-2.31	530645.01	942348.85
	530670.17	0.76	942385.42	-1.48	530670.93	6.61	942383.94	-2.31	530664.32	942386.25
	530698.14	0.76	942436.61	-1.48	530698.91	6.615	942435.13	-2.31	530692.29	942437.44
	530720.05	0.76	942478.85	-1.48	530720.82	6.61	942477.37	-2.31	530714.20	942479.69
	530737.97	0.76	942511.25	-1.48	530738.73	6.61	942509.77	-2.31	530732.12	942512.08
	530769.95	0.76	942574.12	-1.48	530770.71	6.61	942572.64	-2.31	530764.10	942574.95
	530792.33	0.76	942619.78	-1.48	530793.1	6.61	942618.30	-2.31	530786.48	942620.61
	530839.09	0.76	942714.98	-1.48	530839.85	6.615	942713.50	-2.31	530833.24	942715.82
	530893.33	0.76	942817.47	-1.48	530894.09	6.614	942815.99	-2.31	530887.48	942818.31
	530909.28	0.76	942849.40	-1.48	530910.04	6.615	942847.92	-2.31	530903.42	942850.24
	530933.49	0.76	942896.45	-1.48	530934.25	6.615	942894.97	-2.31	530927.64	942897.29
	530964.43	0.764	942955.61	-1.48	530965.19	6.614	942954.13	-2.31	530958.58	942956.45
	530977.81	0.76	942977.95	-1.48	530978.58	6.615	942976.47	-2.31	530971.96	942978.79
	530997.62	0.76	943008.19	-1.48	530998.39	6.615	943006.71	-2.31	530991.77	943009.02
	531017.04	0.76	943036.31	-1.48	531017.81	6.615	943034.83	-2.31	531011.19	943037.14
	531047.82	0.76	943081.54	-1.48	531048.58	6.615	943080.06	-2.31	531041.97	943082.37
	531068.99	0.76	943115.82	-1.48	531069.76	6.614	943114.34	-2.31	531063.14	943116.66
	531075.37	0.76	943135.49	-1.48	531076.13	6.615	943134.01	-2.31	531069.52	943136.32
	531082.14	0.76	943163.98	-1.48	531082.90	6.615	943162.50	-2.31	531076.29	943164.81

	531091.15	0.76	943199.77	-1.48	531091.91	6.614	943198.29	-2.31	531085.30	943200.61
	531114.43	0.76	943295.12	-1.48	531115.20	6.615	943293.64	-2.31	531108.58	943295.95
	531137.09	0.76	943389.50	-1.48	531137.86	6.615	943388.02	-2.31	531131.24	943390.33
	531147.19	0.76	943431.65	-1.48	531147.95	6.615	943430.17	-2.31	531141.34	943432.49
	531160.70	0.76	943483.68	-1.48	531161.47	6.615	943482.20	-2.31	531154.85	943484.52
	531168.82	0.76	943517.26	-1.48	531169.58	6.614	943515.78	-2.31	531162.97	943518.09
	531186.20	0.76	943593.70	-1.48	531186.96	6.615	943592.22	-2.31	531180.35	943594.54
	531205.74	0.76	943673.28	-1.48	531206.50	6.615	943671.80	-2.31	531199.88	943674.11
	531229.34	0.76	943766.82	-1.47	531230.11	6.615	943765.34	-2.31	531223.49	943767.65
	531249.24	0.76	943849.44	-1.48	531250.01	6.615	943847.96	-2.31	531243.39	943850.27
	531268.95	0.76	943928.59	-1.48	531269.71	6.615	943927.11	-2.31	531263.1	943929.42
	531274.87	0.76	943954.71	-1.48	531275.63	6.614	943953.23	-2.31	531269.02	943955.54
	531283.59	0.76	943992.60	-1.48	531284.36	6.615	943991.12	-2.31	531277.74	943993.44
	531293.49	0.76	944030.14	-1.48	531294.25	6.614	944028.66	-2.31	531287.64	944030.98
	531302.72	0.76	944066.62	-1.48	531303.48	6.615	944065.14	-2.31	531296.87	944067.46
	531309.61	0.76	944091.47	-1.48	531310.37	6.615	944089.99	-2.31	531303.76	944092.31
	531317.59	0.76	944125.54	-1.48	531318.36	6.615	944124.06	-2.31	531311.74	944126.38
	531320.95	0.76	944138.85	-1.48	531321.71	6.615	944137.37	-2.31	531315.10	944139.69
	531330.37	0.76	944174.75	-1.48	531331.14	6.614	944173.27	-2.31	531324.52	944175.58
	531335.18	0.76	944193.23	-1.48	531335.94	6.615	944191.75	-2.31	531329.33	944194.06
	531338.3	0.76	944207.58	-1.48	531339.06	6.615	944206.10	-2.31	531332.44	944208.41
	531341.61	0.76	944224.38	-1.47	531342.37	6.614	944222.90	-2.31	531335.76	944225.21
	531344.48	0.76	944242.22	-1.47	531345.24	6.615	944240.74	-2.31	531338.63	944243.06
2										
	530243.43	-0.03	943062.07	-1.53	530243.40	0.997	943060.54	-1.69	530242.40	943062.23
	530280.27	-0.03	943159.62	-1.53	530280.23	0.997	943158.09	-1.69	530279.24	943159.78
	530302.88	-0.03	943218.57	-1.53	530302.84	0.997	943217.03	-1.69	530301.85	943218.73
3										
	530915.88	-0.93	944810.35	0.27	530914.95	-2.11	944810.62	0.096	530917.06	944810.52
	530940.69	-0.93	944872.70	0.27	530939.75	-2.11	944872.97	0.096	530941.87	944872.88
	530952.72	-0.93	944900.40	0.27	530951.78	-2.11	944900.68	0.096	530953.9	944900.58
4										
	528615.36	-0.12	944193.02	-1.69	528615.24	-3.22	944191.33	0.784	528618.46	944190.54
	528745.37	-0.12	944522.60	-1.69	528745.25	-3.22	944520.91	0.784	528748.48	944520.13
	528872.10	-0.12	944853.40	-1.69	528871.97	-3.22	944851.71	0.784	528875.20	944850.92
	528963.15	-0.12	945080.13	-1.69	528963.03	-3.22	945078.44	0.784	528966.26	945077.65
5										
	525257.33	1.00	941018.65	0.18	525258.34		941018.84			
	525089.09	1.00	941051.16	0.18	525090.10		941051.34			
	524999.19	1.00	941070.54	0.18	525000.19		941070.72			

6										
	528300.49	0.36	944627.32	0.38	528300.85	-2.33	944627.71	0.704	528303.18	944627.01
	528290.89	0.36	944602.22	0.38	528291.25	-2.33	944602.60	0.704	528293.59	944601.90
7										
	526787.92	0.01	943066.13	-0.97	526787.94	-6.67	943065.16	1.693	526794.61	943063.47
	526801.18	0.01	943107.79	-0.96	526801.2	-6.67	943106.82	1.694	526807.87	943105.12
	526809.52	0.01	943140.26	-0.96	526809.53	-6.67	943139.29	1.693	526816.20	943137.60
	526816.95	0.01	943175.67	-0.97	526816.97	-6.67	943174.70	1.693	526823.64	943173.01
	526826.56	0.01	943216.23	-0.96	526826.58	-6.67	943215.27	1.693	526833.25	943213.57
	526840.47	0.01	943276.13	-0.96	526840.48	-6.67	943275.16	1.693	526847.15	943273.47
8										
	529572.89	-0.39	941765.02	0.50	529572.49		941765.53			
	529588.62	-0.39	941765.54	0.50	529588.23		941766.04			
	529607.25	-0.39	941767.20	0.50	529606.85		941767.70			
	529624.30	-0.39	941769.90	0.50	529623.91		941770.40			
	529648.85	-0.39	941776.70	0.50	529648.46		941777.21			
	529824.30	-0.39	941857.08	0.50	529823.91		941857.58			
9										
	529620.25	0.34	941533.96	-0.77	529620.60		941533.19			
	529676.22	0.34	941260.63	0.22	529676.57		941260.86			
10										
	530664.87	1.31	941205.50	0.09	530666.18	3.307	941205.59	1.587	530662.87	941204.01
	530794.74	1.31	940919.33	0.09	530796.05	3.307	940919.43	1.587	530792.75	940917.84
11										
	530210.75	-0.11	942212.72	-1.41	530210.64	1.27	942211.31	0.424	530209.37	942210.89
	530274.27	-0.11	942071.43	-1.41	530274.16	1.27	942070.02	0.424	530272.89	942069.60
	530284.26	-0.11	942051.28	-1.41	530284.15	1.27	942049.87	0.424	530282.88	942049.44
12										
	528743.14	0.62	942036.44	-1.58	528743.76	2.544	942034.86	-1.46	528741.22	942036.33
	528825.66	0.62	942244.47	-1.58	528826.29	2.545	942242.89	-1.46	528823.74	942244.35
13										
	530282.39	0.42	945960.64	0.34	530282.81	5.733	945960.98	0.081	530277.08	945960.90
	530252.29	0.41	945884.53	0.34	530252.71	5.732	945884.87	0.081	530246.98	945884.79
14										
	528852.32	0.10	941898.76	-0.68	528852.42		941898.07			
	528915.60	0.10	941888.04	-0.68	528915.70		941887.36			
	528952.12	0.10	941878.12	-0.68	528952.23		941877.43			
	528984.73	0.10	941868.91	-0.68	528984.83		941868.22			
	529008.06	0.10	941861.65	-0.68	529008.17		941860.96			
	529068.18	0.10	941849.23	-0.68	529068.28		941848.54			

	529243.34	0.10	941815.33	-0.68	529243.44		941814.64			
	529127.75	0.10	941837.84	-0.68	529127.85		941837.15			
15										
	530889.89	-0.45	940707.15	-0.46	530889.44	-0.21	940706.68	0.624	530889.66	940706.06
	530960.21	-0.45	940550.02	-0.46	530959.76	-0.21	940549.55	0.623	530959.98	940548.93
	530986.44	-0.45	940490.70	-0.46	530985.99	-0.21	940490.23	0.624	530986.21	940489.61
16										
	531900.55	0.54	940312.65	-1.01	531901.09		940311.63			
	531973.04	0.54	940356.15	-1.01	531973.59		940355.13			
	532042.86	0.54	940406.25	-1.016	532043.41		940405.23			
	532094.39	0.54	940446.45	-1.01	532094.94		940445.44			
	532189.20	0.54	940533.81	-1.01	532189.75		940532.79			
	532286.51	0.54	940646.77	-1.01	532287.05		940645.75			
	532351.03	0.54	940737.36	-1.01	532351.58		940736.35			
17										
	530536.06	0.22	939801.14	-0.24	530536.28		939800.90			
	530625.71	0.22	939805.38	-0.24	530625.94		939805.13			
	530682.35	0.22	939812.20	-0.24	530682.57		939811.96			
	530735.48	0.22	939820.25	-0.24	530735.70		939820.01			
18										
	531277.32	0.75	940022.94	-0.78	531278.07		940022.15			
	531391.06	0.75	940074.98	-0.78	531391.81		940074.20			
19										
	528842.54	0.52	945141.76	0.23	528843.07		945142.00			
	528964.61	0.53	945092.99	0.23	528965.14		945093.22			
20										
	530134.25	0.78	942382.91	-0.29	530135.04	4.519	942382.62	1.425	530130.52	942381.20
	530153.94	0.78	942337.13	-0.29	530154.73	4.519	942336.84	1.425	530150.21	942335.42