CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Mapping involves carrying out observation for the natural and artificial features on the earth surface and represent them in form that is understandable to the end user either as a chart, map or plan. Aliyu (2013) observed that mapping involves various stages of production which includes: reconnaissance, field observation, office Work and production of the final map. Reconnaissance involved going round the entire field/ project area to map to know the nature of the terrain and the type of equipment to be used with proper reconnaissance, GPS receiver instrument was used (Genovese 2005).

Field observation involves the actual distances and angular measurement, heights measurement depending on the types of instrument used. The instrument could be total station, smart station, theodolite, level instrument and global positioning system (GPS).

Office work involves processing of data acquired from the field. The processing involved adjustment of coordinates for the production of map. All the observed quantities are corrected in the office. Production of final map involved representing the features of the ground such as point, river, building, legend, scale and north direction on the map. Hence, surveying is the science and art of making all essential measurements to determine the relative position of points or physical and cultural details above or beneath the earth surface and to depict them in a usable form to establish position of points or details. According to Husby, (2009) digital mapping is the process by which a collection of data from a location is compiled and formatted into a virtual image. The primary function of this technology is to produce maps that give accurate representation of a particular area and detailing all features of interest that will be valuable to a user. Digital mapping can be found in a variety of computer application early digital maps had the same basic functional as paper i.e, they provide the virtual view of the terrain encompassing the surrounding area. However, as digital map has grown with expansion of GIS technology in the past decade, live traffic update, point of interest and service location have been added to enhance digital map to be more “user conscious”. Maps are updated to provide user with the most accurate reflection of a location, position which are the representation of the earth surface or part of it. One of the widely used of all map is the topographical map, a topographic map shows more than contour line to portray the shape and elevation of the land. The map render three dimensional ups and down of the terrain on a two dimensional surface: The map includes symbols that represent such features as building, streams, vegetation etc. These symbols are constantly refined to better relate to the features they represent, improve the appearance or readability of the map or reduce the production cost. Topographic mapping organized large scale public services such as building, water, oil, drainage, relief, gas, telecommunication lines, vegetation, electrics supplies sewage system, and others.

(Graham, 1990) observed that, without topographic map it may be impossible to access much of the information related to the environment shown on a map. Topographic survey should be used to establish the position and shape of natural and artificial features over a given topographic area or for establishing geographical information system (GIS) in order to be useful, topographical maps most show sufficient information on a map size that is convenient to us. This is accomplished by selecting a map scale i.e. neither too large nor too small and enhancing the map details through the use of symbols and colors, the content of topographic maps that is the information expressed in map symbols is generally highly standard, they are however a number of particular features which are determined by the scale and specific purpose of the map and the types of the terrain. Topographic survey should be employed to establish the position and shape of natural and artificial features over a given area. In order to be useful, topographic maps must show sufficient information on a map size that is convenient to use. This is achieved by selecting a map scale that is neither too large nor too small and by enhancing the map details through the use of symbols and contours. The information expressed in map symbol is generally highly standardized. There are however a number of particular features, which are determined by the scale and specific purpose of the map and the type of terrain. Also of concern is the provision of spatially referenced information used in the management of these complex networks that extend over the area. These utilities are highly desirable for economic and social well-being of the individual residing in the area. Often times these utilities require urgent maintenance or expansion to meet the increasing demand by fast growing economy. Cadastre as a multi-purpose inventory of the basic information on topography, Construction size and shape of landed properties, soil classification, land use degree to utilization for safe maintenance of structures on land, provide powerful tool for mapping utility services when digital technology is adopted. Therefore, to effectively manage utility services and the environment, it is necessary to adopt GIS technology to produce reliable and up- to -date map that can be used to analyze the nature of the terrain and infrastructure.

Strangler (1992) stated that, topographic map explains the characteristics of surface which include such features as relief, other natural and man-made features. Relief features includes hills, valleys, plains, summits, while other natural features consist of trees, streams, and lakes; artificial features are highways, railways, dams, wharfs, buildings, bridges etc.

Topographic survey is a survey conducted to obtain data needed for preparation of a topographic map. The data acquired is made up of horizontal and vertical locations of features to be depicted map.

1.2 Statement of the Problem

At this moment, most of the infrastructure distribution maps in Nigeria are in analogue form (paper maps) in fixed scales. The obvious disadvantages of this form of record keeping are many. The production as well as updating of such records are expansive and time consuming. There is little or no flexibility in handling the information on such medium.

It is necessary not only for an efficient distribution of utilities but for their construction, taking the location of lines and solving the problematic line and up- to–date map will minimize these problem. The advent of satellite imagery, its application and the use of computer and peripherals for various spatial analyses most especially in surveying and mapping had improved the method of data collection and extraction of information. The map, if produce will provide the basis of future inventory of the institutions feasibilities and also serve as a tool for the establishment of a geographical information system for the institution.

Base on the identified problem the solution is to produces a digital topographic map of the area and the analysis of the site that will give a guide on how the nature of the area is, for effective and meaningful development.

1.3 Aim and Objective

The aim of this project is to produce a digital topographic map for the Borno State University Maiduguri.

The above aim was achieved through the following objectives

i. To evaluate the nature of the topography of the study area
ii. To characterize the details features in the study area
iii. To produce the three (3D) model of the area
iv. To produce the digital topographic map of the study area

1.4 Justification

The basic map needed would represent land area of the institution showing the natural and artificial features of the area covered. The map will be adequate for other uses like adoption to plan for construction work. Similarly, the application of GIS to utility service management will bring about and increase ease in date communication and processing. Most of the problem inherent in the analogue system will be overcome by the application of digital technology and modern technique which has increased the efficiency and speed in mapping of utility services the revision of such maps which are in digital format is the ainless exercise and provides up- to- date information to effective management of the utility services. Spatial referenced data in digital form are really available for the production of maps of different scales and formats. Digital technology therefore provides convenient and quick access for mapping; it's cost effective and convenient for access.

The research work adopted the use of primary data (field work) and secondary data (satellite imagery) to produce the topographic map of the Borno state university site which justified the cause for the project that contained information that is current and had not attained review since the inception by the state. Considering the growing trend to have an up-to date and robust map that is flexible for both professional and non-professional uses, the state and the institution stand to use this map for effective land management, developing facilities and in taking decision making that serve as a base map or functional tools for future development of area.

1.5 Motivation of the Research

What motivated the researcher on this research topic is the production of topographic map and the site analysis that will show the relief and draping (3D visualization) analysis for the purpose of site planning and development using ArcGIS because to produce a topographical map and its analysis will be of importance to Borno state and the institution that is to be established, therefore, an up to date digital topographic map will make it easier to achieve the goal , since there will be need for physical infrastructural development for now and the future.

1.6 Scope of the Research

The scope of this research work was limited to the production of topographic map of Borno state university site as well as the spot height and to present report in form of digital map showing all details. The coordinate system that was use/adopted is Universal Transverse Mercator UTM, WGS84.

1.7 Study Area

The study area is Borno state university in Maiduguri metropolitan council (MMC). In Borno state is in the north eastern part of Nigeria zone 33 of the universal traverse Mercator projection system. It is bounded between the following coordinates; 1273930m E, 13023815m N; 12664081m E, 13085690m N; 12720435m E, 13034389m N and 12781124m E, 13263674m N situated at elevation of 325 meters above sea level respectively and is surrounded by Konduga and Jere Local Governments of the state. The study area is further described from Figure 1.1 and 1.2. Maiduguri also called Yerwa by its locals is the capital and largest city of Borno state in the north eastern Nigeria. The city sits along the seasonal Ngadda River which disappears into the firkin swamps in the area around Lake Chad. Maiduguri was founded in 1907 as a military outpost by the British and has since grown rapidly with a population 1,907,600 million as of 2012.

1.7.1 Location

It is Located in the North Eastern corner of Nigeria. Borno State occupies 70,898 square kilometers. Borno State occupies the greater part of the Chad Basin. Borno state shares borders with the Republics of Niger to the North, Chad to the North-East and Cameroun to the East. Within Nigeria, Borno State shares boundaries with Adamawa State to the South, Gombe State to the West and Yobe State to the North-West. Borno state derives its name from the ancient Borno Empire. The state is dominated by the Kanuri ethnic group, and is an example of the endurance of traditional political institutions in some areas of Africa. There, the emirs of the former Kanem-Bornu Empire have played a part in the politics of this area for nearly 1000 years. The location of the project site is at Njimtilo in the out sketch of Maiduguri along Damaturu - Kano road of Borno state capital in the north eastern part of Nigeria. It is bounded between the following coordinates; 1283930m E, 1309557m N; 1282332m E, 1305016m N; 1282785m E, 1309744m N and 1281797m E, 1309417m N situated at elevation of 325 meters above sea level respectively.

1.7.2 Climate and Vegetation

Three seasons have been identified: the cool dry harmattan season, hot dry season and rainy season that varies from time to time. Temperatures are high all the year round, with hot season temperatures ranging between 39°C and 40°C under the shade. In the southern part of the state, the weather is relatively mild. The rainy season lasts between the month of July – August in the extreme north, but is as high as 140days in the extreme south. The mean annual rainfall is over 800mm on the Biu Plateau but less than 500mm the extreme north around Lake Chad. Rainfall variability is over 100 per cent. Droughts are endemic and rainfall tends to have been in decline since the 1960s (Department of Meteorological Services, 1992). Relative humidity is generally low throughout the state, ranging from as low as 13 per cent in the driest months of February and March to the highest values of seventy to eighty per cent in the rainy season months of July and August. Two vegetation zones are identified in the state: Sudan savannah and southern Sahel. The semiarid nature of the Sahel and northern Sudan savannah makes the vegetation consist mainly of open acacia tree savannah. In the wetter south, scrub vegetation is interspersed with tall trees and woodland. Vegetation has been greatly modified in most places as a result of over-cultivation and over-grazing. Land degradation and desertification have been on the increase, causing the desert to advance southwards.

Borno state University of Maiduguri lies on 326m above sea level the prevailing climate in the area is known as a local steppe climate. During the year, there is little rainfall in Maiduguri and the project site. Average temperature is 25.0 ^{O}C and annual rainfall is 613mm. the driest month is January. Most precipitation fall in August with an average of 215mm, an average temperature of 30.0 ^{O}C and May is the warmest month, in January the average temperature 21.4 ^{O}C, it is the lowest average temperature of the year.

1.7.3 Soils

The soils of Borno State vary in colour, texture, structure, physico-chemical and other essential characteristics from the hilly south to the northern dune landscape. Vertisols dominate the flat plains close to Lake Chad; and also in the depressions. These are 'heavy dark clay soils (Firki) which develop wide cracks during the dry season. On the dunes are regosols which are shallow with weakly developed profiles. The volcanic and Basement Complex areas have fertile clayey loamy soils in the valley bottoms, but skeletal soils and rock outcrops occur along the gentle and steep slopes.

Borno state university of Maiduguri is predominantly sand having low moisture retention and high permeability. The physical properties, chemical properties and structural composition of the study area was sandy. The pH was neutral indicate that the pH range of 6.62 from surface, 6.74 subsurface and 6.84 beneath respectively and organic matter was very low from surface in the study area ranging from 0.81, 0.51and 0.28 respectively total nitrogen was very low from surface to beneath ranging from 0.13, 0.10 and 0.07 respectively. The cation exchange capacity also very low ranging from 4.56, 4.40 and 3.87 respectively.

1.7.4 Relief and Drainage

The Borno region is drained by two groups of rivers; one is bound towards the south draining to the Benue system, while the other is towards Lake Chad. The region is generally drained by seasonally flowing rivers, whose peak flows are recorded during the rainy season in the months of July and August. The Biu Plateau to the south is largely drained by the

Hawul River, which flows southwards and discharges its waters into the Gongola River. The River Yedzeram, which drains the southeastern and eastern parts of the region, takes its source from the Mandara Mountain and flows northeastward through the pediments and the relatively flat plains towards Lake Chad. However, the volume of water reaching Lake Chad has been drastically affected in recent years by drought and abstractions upstream.

Borno state university of Maiduguri relief are generally characterized by low lying locations with slope of less than 5 degree covering an area of 97.310 hectares of land making it extremely possible to drain which partly explain why flash flood during the rainy season.

1.7.5 Socio-Economy and Population

Agriculture is the main stay of the Borno economy, from the 1991 census show that the state has a total population of 2,596,589; and that males outnumber females by 58,033. The 1999 projected population data at the national annual growth rate of 2.8 per cent. The projected population figures currently put the population of the state at 3,178,225. Although the state has a large land area (69,435 sq.km), it is sparsely populated.

The location of the institution along Damaturu- Kano road of Maiduguri at the out sketch of the state have increase the economic activities in the area whereby a lot of people have patronized the area in terms of selling and buying of land for residential purpose, shops, motor parks and a lot have come into the state for educational tourist which this have added value the area and the state at large. Although the state university has a large land area (97.310 hectares), it is sparsely populated.

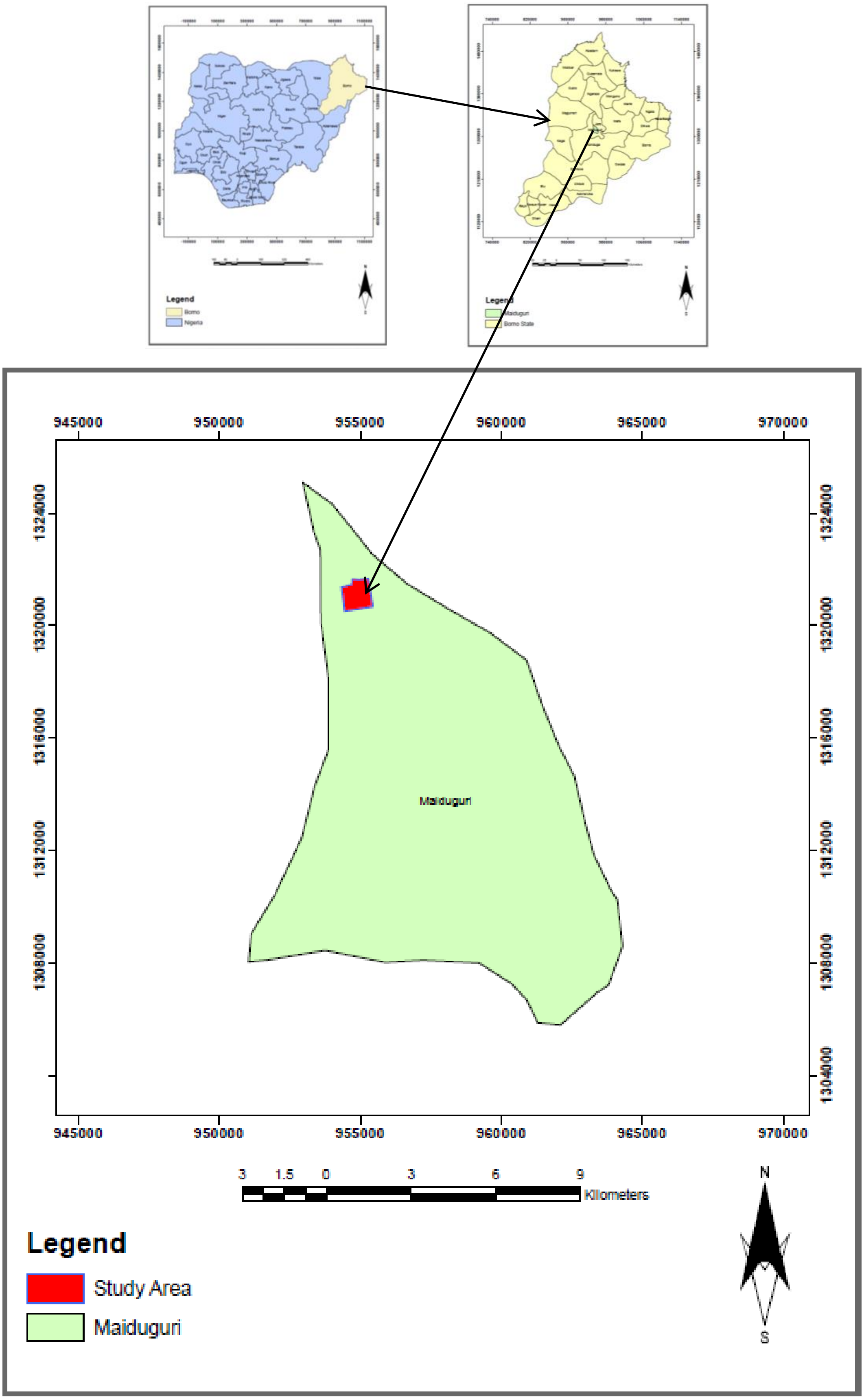


Figure 1.1: Map of Maiduguri showing Study area in Red.

Source: Borno State Ministry of Land and Survey.

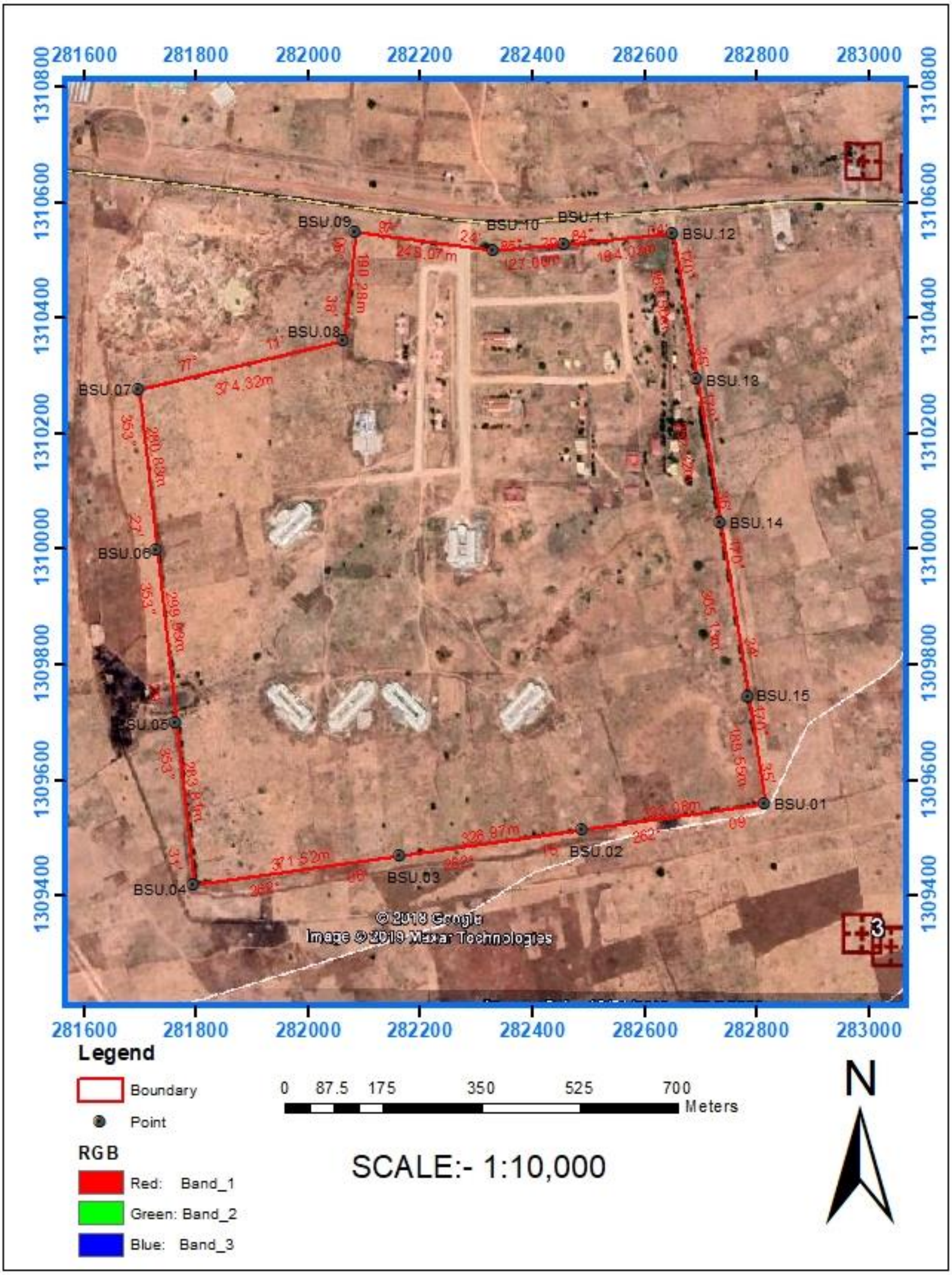


Figure 1.2: Map of Study area in Red.

Source: Borno State Ministry of Land and Survey.

CHAPTER TWO: LITERATURE REVIEW

2.1 Basic Topographic Mapping

The study is on the production of topographical map of propose Borno state university. A review of a similar study carried out by other prominent authors on the subject matter attempted to justify the gap of study.

Topographic surveying forms an integral part in land development issues. The techniques to produce those map/plans include traditional photogrammetry, satellite photogrammetry and terrestrial surveying using total station and or Global Positioning System (GPS) techniques. Surveying has been described as an essential element in every human development activity since the beginning of recorded history. It has been discovered to be an imperative requirement in the planning and execution of every forms of meaningful development (Bannister and Raymond, 1986). Provision of infrastructure; planning of towns and cities; management of hazardous natural events and human actions such as erosion, flooding, earthquakes and subsidence; coastal management; exploration and exploitation of minerals; sitting of industries; resources exploitation on the land and on the sea are dependent on land surveying products (Oriola, and Asonibare, 2011).

Bolstad, (2005) Topography of an area describes the surface characteristics of relief features of such area as depicted by hills, valleys and plains. It can be used to study and represent as a surface, any characteristic that has a continuously changing value other than elevation, for instance, population, geo-magnetic data and geo-chemical data. Topographical surveying involves the acquisition of topographic data of the features on the earth's surface, both man-made and natural in three-dimension (x y z). This employs the techniques of plane surveying and other special techniques to establish horizontal and vertical controls. The implications of the above is that no meaningful development can be embarked upon by an individual, government and any other agencies without information about the topography of the area where such development is to take place. Topographic information system can be derived from the topographic data with the employment of the analytical capabilities of geographic information system [GIS].

Geographic Information System (GIS) evolved as a new technology in surveying. It combines geographic data (location) and attribute data about object feature on the earth's surface with cartographic representation in order to perform spatial decision making using spatial analysis. According to Burrough (1986), GIS is a tool for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes. In short, GIS can be used to add value to spatial data (Sharma, 2006).

This is by allowing data to be organized and viewed effectively, by integrating them with other data, by analysis and by the creation of new data that can be operated on in turn to create useful information that can help decision making. GIS is unique in its ability to integrate data from variety of sources. A GIS can thus be described as a form of spatial decision support system.

A digital terrain model (DTM) is a topographic model of the terrain relief that can be manipulated by computer programs (Ndukwe, 2001). The data files contain the spatial elevation of the terrain in digital format which are usually represented as a rectangular grid. Vegetation, buildings and other man made (artificial) features are removed leaving only the underlying terrain. Modeling terrain relief using DTM is a powerful tool in GIS analysis and visualization. DTM can be stored in GIS database in several ways: - As a set of contour vectors, a rectangular grid of equal spaced corner/point height or an irregularly spaced set of point connected in triangles (TIN-Triangular Irregular Network). Digital technology was successfully introduced in the field of mapping in the late 1960‟s as means of speeding up map production. (Perera and Shanta, 2002). With the change in technology in the last two decades and the growth in the number of spatial information systems, the concept of topographic database has been introduced in several mapping-surveying organizations in the world, in order to deliver more Geo-information to the user community.

Buzai and Robinson (2010). Topographic Information System is very crucial in this present age in other to be able to update maps and retrieve necessary data at any given time with minimal efforts. Topographic Information System can be explained as the combination of human effort and computer-based tools for the collection, storage, analysis, manipulation and retrieval of various kinds of data relating to geographic features (man - made and natural) on the surface of the earth (Lexicon Universal Encyclopedia, 1989). In view of this, it is necessary to create Topographic Information System for different locations because the information generated from such system can be used for various purposes in physical planning and decision making in such locations. Some of the usefulness and advantages of this digital database for such system over the conventional maps include: -

i. Possibility of fast amendment and dynamic updating of data
ii. Fast capturing of data with Total Stations or GPS
iii. Analysis of many important spatial problems
iv. Versatility in integrating data collected from various sources
v. Flexibility output possibilities
vi. Provides bases for additional information with relative ease for production of maps.

Ezra, Muhammed, Namtari, and Mahmud (2014) Topographic maps represent all physical features and their locations as contour lines, shapes and elevations that include-valleys, mountains, plains, lakes, boundaries, transmission lines and major buildings and other facilities. The wide range of information provided by topographic maps make them highly useful to professional and recreational map users alike. These maps are used for defense purposes, engineering, energy exploration, natural resources conservation, environmental management, public works design, commercial and residential planning and outdoor activities like hiking, camping and fishing. These maps are also very vital in identifying areas vulnerable to flood and erosion. The advantage of having a 3D coordinate of a terrain and then recording the presence of man-made and natural features make it essential for management of land resources. Generally, for us to be able to comprehend physical features on land, the topographic map becomes an essential tool (Bannister, 2006).

There are various techniques used in collecting data for topographic maps. These include Tacheometry, an optical instrument process such as theodolites and levels, aerial photography, use of Global Positioning System (GPS), Total Station instrument and mapping using satellite radar (Muhammad *et al.*, 2014). However, the practice of modern surveying is undergoing rapid change due to availability of electronically controlled instruments, the widespread adoption of the Global positioning systems (GPS), and the proliferation of various Geographic and Land Information Systems (GIS/LIS) (Agajelu, 1994; Heinz and Scherer, 1997).Therefore, it is also possible to model topological relationships of various earth surface entities and analysis be performed to predict future trends, and that assist decision makers to facilitate working on spatial environment. Administrative authorities could create a spatial data instruction by which the database may easily be exchanged (Konecny, 2003; Diaz, 2006).

Elangovan (2006) Geography is the study of Earth’s features and patterns of their variations in spatial location and time. Many questions of agricultural production are geographic in nature as the production depends on the environment and prevailing socio-economic conditions, both of which vary spatially and in time. Examples are questions related to natural resources management, precision agriculture, agro ecological classification for land use planning, regional trends and patterns in technology adaptation, agricultural productivity and income, non-point source pollution from agricultural lands, etc. Answering these questions requires access to large volumes of multidimensional geographical (spatial) information of weather, soils, topography, water resources, socio economic status, etc. Further, answers to even apparently simple questions require that the data from several sources be integrated in a consistent form. Geographical Information Systems or GIS enable representation and integration of such spatial information. The traditional method of presenting geographical information in two dimensions is in the form of maps. Maps are graphic representations of the earth's surface on a plane paper they shape the way we visualize, assess and analyze spatial information Chang (2007).

Enemark (2008): A map consists of points, lines and area elements that are positioned with reference to a common coordinate system (usually latitude and longitude). They are drawn to specified scales and projection. Map scales can vary and depend on the purpose for which the maps are created. Projection is a mathematical transformation used to represent the real 3-dimensional spherical surface of the earth in 2-dimensions on a plane sheet of paper. The map legend links the non-spatial attributes (name, symbols, colours and thematic data) to the spatial data. The map itself serves to store and present data to the user. Such, analogue maps (on paper) are cumbersome to produce and use, particularly when there are a large number of them to be used for analysis. Computer based GIS facilitates both creation of maps and using them for various complex analyses. It allows working with geographic data in a digital format to aid decision making in resources management GIS is a generic term implying the use of computers to create and display digital maps. The attribute data which describe the various features presented in maps may relate to physical, chemical, biological, environmental, social, economic or other earth surface properties. GIS allows mapping, modelling, querying, analyzing and displaying large quantities of such diverse data, all held together within a single database. Its power and appeal stem from its ability to integrate quantities of information about the environment and the wide repertoire of tools it provides to explore the diverse data. The history of development of GIS parallels the history of developments in digital computers and database management systems on one hand and those in cartography and automation of map production on the other.

Harvey (2008). The development of GIS has also relied upon innovations made in several other disciplines –geography, photogrammetry, remote sensing, civil engineering, statistics, etc. GIS produces maps and reads maps. Its major advantage is that it permits identifying spatial relationships between specific different map features. It can create maps in different scales, projections and colours. But it is not just a map making tool. It is primarily an analytical tool that provides new ways of looking at, linking and analyzing data by projecting tabular data into maps and integrating data from different, diverse sources. This it does by allowing creation of a set of maps, each with a different theme (soils, rainfall, temperature, relief, water sources, etc.). From its early beginnings, GIS has been an integrating technology both from the point of view of its development as well as its use. This is because, once geographic information of any kind is translated into the digital form in a GIS, it becomes easy to copy, edit, analyze, manipulate and transmit it. This allows vital linkages to be made between apparently unrelated activities based on a common geographic location. This has led to fundamental changes in the way resource management decisions are made in a variety of situations - forest management, marketing management, utility management, transportation, as well as in agricultural, environmental and regional planning and management. Some potential agricultural applications where GIS can lead to better management decisions are: precision farming, land use planning, watershed management, pest and disease management, irrigation management, resources inventory and mapping, crop area assessment and yield forecasting, biodiversity assessment, genetic resources management, etc.

Gatrell (2009) In the analogue (old) method in which Many Nigerians are used to, the data acquisition in surveying are used in mapping theses maps are represented in analogue form which are quadrant to specific scale. For instance, a scale of 1: 100,000 or 1: 500,000 standard map series, modern technologies have changed all these; maps are now made and recorded electronically, maps that are normally cumbersome to handle and store are now produced in digital format. The technology, which is principally a computer based, makes it possible to display the map of an area covert by this facility on the screen with the advantages of varying the scale and formats to suit the user's need, though various stages of map production are still maintained. Digital mapping has now become an indispensable tool in solving many environmental based problems. The method used for producing digital maps are many, depending on the level of details required, the use to which the map will be put and the source of the data.

Thurston, Poiker, and Patrick (2003). The global positioning system (GPS) is a relatively new concept in position fixing in surveying. It is a satellite based system for rapid determination of position fixing practically on the earth (land or sea) and at any time with pin-point accuracy. The latest technology uses a specialized radio receiver called GPS receivers. It is designed to detect radio signal transmitted from the satellite and calculate positions based on such signals received intended to geodetic surveys have better accuracy and the has an interface that allows rapid data collection, additionally, in using the GPS for geodetic works, intervisibility among station is not required, the global positioning system (GPS) has completely revolutionized the field of surveying and Geoinformatics. It is a system that has many application in various field ranging from geodetic positioning, control densification, hydrographic surveying mining surveying e.t.c. its main advantage is in the economy of time and labour, culminating in the reduction of project cost (Idowu, 2003) GPS is a space satellite system that provides accurate information (altitude, bearing, and coordinate of points in absolute terms in three dimension) to all users these coordinates which are either rectangular coordinate (X,Y,Z) plus other quantities of interest are referenced to a particular ellipsoidal datum, the WGS84 datum.

Ayeni (2007) has made the previous definition of surveying to include 'the acquisition, processing, analysis, presentation and management of geospatial related information''. Hence the all-encompassing name of surveying discipline is surveying and Geo-informatics. The geographic information system (GIS) has a wide application in all facets of life.

According to Lngley (1999) the practice of modern surveying is undergoing rapid change due to the availability of electronically controlled instruments, the widespread adoption of the global positioning system (GIS), and the proliferation of various geographic land information systems (GIS/LIS). Nevertheless, the principles underlying these new technologies remain constant.

Traditional maps are abstraction of the real world, a sampling of important elements portrayed on a sheet of paper with symbols to represents physical objects. People who use maps must interpret these symbols. Topographic maps show the shape of land surface with contour lines or with shaded relief. Today, graphics display techniques such as shading base on altitude in a GIS can make relationship among map elements visible , heightening one's ability to extract and analyze information . A GIS can recognize and analyze the spatial relationships that exist within digital stored spatial data. These topological relationships as explained by Goodchild (1999). It allows complex spatial modeling and analysis to be performed. Topological relationships between geometric entities traditionally include adjacency (what adjoins what) containment (what encloses what), and proximity (how close something is to something else).

Topographic surveying is performed to determine the planimetric location and topographic relief of features in three dimensions. Topographic surveys are performed for detailed large-scale site plan drawings or maps at scales equal to or larger than 1 inch = 100 feet (1:1,200). Intermediate and small-scale maps are usually constructed by aerial photogrammetry or satellite remote sensing methods. A topographic map is a representation on paper that is designed to portray certain selected features of a section of the earth's surface plotted on some form of projection and to a certain scale; that primarily depicts the relief of the area or country mapped but shows also its drainage and cultural features; and that delineates all features in true latitude and longitude and therefore all parts in a rigidly correct relative positions (American Society for Photogrammetry and Remote Sensing 1989).

Topography is basic to many earth surface processes and thus finds applications in Ecology, Hydrology, Security, Agriculture, Climatology, Geology and a host of other domains and constitutes the basic for explaining processes and predicting them through the process of modeling. The tremendous role of topographic mapping in national development continues to receive recognition by national, state and local governments. The importance of topographic mapping as a national project is therefore growing and accurate topographic map as its major products are considered as indispensable component of national geospatial data infrastructure the map existing mainly in Nigeria are classified by Balogun (2003) as small, medium or large (base on scale) and as either general or thematic (base on the content) as shown in Table 2.1. Thematic maps shows the distribution of either a single socio-cultural phenomenon such as population, land use, drainage and soil or biophysical event including weather and climate, geology, drainage and biogeography.

Table 2.1. Classification of Nigeria Topographic Map

Scale	General Map	Thematic Maps
Small	Small-scale general map e.g. one sheet Atlas Map of Nigeria	Small-scale thematic map e.g map of Nigeria showing vegetation distribution.
Medium	Medium- scale general map e.g. 1;50,000 Topographical Map	Medium-scale thematic Map e.g. 1:50,000 Vegetation, Soil and land use Map
Large	Large-scale general map e.g. 1:1,000 township or Cadastral Map	Large-scale thematic map e.g. 1:1,000 map showing property ownership or detail road network in Lagos

Source: Balogun (2003)

2.2 The Scope of using Topographical Maps

Choi (2000) state that it is important to understand what the users demand for information of land was when developing thematic map related to land. The demands for information of land could be classified as follows:

i. It was the original sheet of cadastral map computerized into a sheet of land cadastral map (forest cadastral map). This satisfied the demand for administration affairs handling on the basis of land cadastral map.
ii. It maintains the original shape and needs the accuracy.
iii. It is the edited cadastral map for parcel address made through matching each sheet according to administrative district or a reduced scale. This map was necessary to understand the present state by using real land cadastral map or to conduct basic analysis like writing out statistic and research. This continues land cadastral map had some problems such as miss matching between cadastral map and forest cadastral maps, discrepancy between current state and cadastral map, and miss matching between cadastral map edges.
iv. It was due to the problem causes in restoring expired survey control point, the problems with the control point and survey technique cause during the period of writing.
v. It ran short of accuracy compared with original map but it was used in administrative department.
vi. It was topographic cadastral maps and continuous cadastral map made by way of using topographic map and land cadastral map. They were necessary to overcome the double work when we establishing each plan drawing topographic map and notifying it. Because topographic-cadastral maps were edited in accordance with the real topography, there is only a little change in the shape of parcel. But the location was so accurate that they were necessary for the effect was light. The result of survey on the use according to each work of municipal self-government of plan and the expectation for the effect was high. The result of survey on the use according to each work of municipal self-government showed the 50% work was conducted at city offices and 57.6% work at district offices using land cadastral map and topographic map at the same time.

2.3 The Measures for Developing Topographic-Cadastral Maps

Choi (2000) supposed that the result of the surveys should serve as guides for developing topographic-cadastral maps, considering the scopes of use and analyzing the preliminary works.

A sheet of digital land cadastral map was produced after photocopying register of parcel coordinates and scanning land cadastral map. Next it was edited into continuous cadastral maps and develop topographic-cadastral maps by overlapping digital topographic Maps and cadastral maps. After producing respectively three kinds of maps such as a sheet of digital cadastral map, they could be used according to the purpose of use and usage. When digital topographic maps were chosen and used, they should be suitable to a reduce scale of land cadastral maps of target area to prevent repeated investment, to connect and integrate with other GIS afterward. Administrating zone map was produced through administrative district code (law district code) input in topographic- cadastral maps as attribute data. A sheet of digital cadastral map was produced for the following computerizing process of land cadastral map, based on the specification for digital cadastral map. There were two ways for topographic map, a base map. The other was to overlap topographic map on land cadastral map, base map. When using cadastral map as base map, there are so many different reduce scales that miss matching of edge area was caused. And the data of topographic map was too much for coordinate transformation to overlap it on land cadastral map. Consequently in this study precise process was presented and topographic- cadastral map was pilot produced based on the overlapping the land cadastral map. The map should be easy to edit, had a little information and was drawn mostly with a straight line considering digital topographic map as base.

2.4 Topographic Map in Nigeria

Balogun (1989) traced the events that led to (i) the establishment of the survey department in the latter half of the 19th century (ii) the motives behind early map production attempts in the country and (iii) the techniques adopted for the exercise. In response to the mapping activities within the French colony neighbors, a colonial survey committee of the British was established in 1950 to define the exact limit of national territories, show the areas and villages under the rule of native chief for land registration and settlement, the allotment of mining and forest concession and the organization of internal communication. This materialized into the establishment of a survey department in the latter half of the 19th century. The then surveyors were mainly British army personnel attached to colonial offices. The aim was to provide maps that would enhance the acquisition and demarcation of colonies as well as for the smooth administration at the national headquarters of Lokoja, Calabar and Lagos at one time or the other mostly.

Balogun (1992) categorized five distinctive eras of major mapping landmarks of the country under the directorate of overseas surveys between the periods of the amalgamation of its colonies in 1906, its being a protectorate in 1914 and attainment of independence in 1960. The period 1788-1861 marked the era of exploration and mapping of Nigeria Rivers. That of 1861-1910 was of colonial expansion, political consolidation and mapping of units.

Between 1910 and 1926 was for revenue searching and mapping for geologic survey, 1926-1939 for systematic triangulation, resection and traversing, and 1946-1960 for aerial survey and topographical mapping.

The first set of topographical maps for the country commenced around 1906 with the nations (old) series at the scale of 1:125,000. Conventional ground method of plane tabling triangulation, resection and traversing were employed. The focus was mainly on the economic region of the southern part of the country. About 14% of the country was covered between 1906 and 1944 when the world war II began. Most topographic map of Nigeria is prosily inadequate and out deflect tremendous development in the country. A lot of changes have taken place in Onitsha and its environs since the 1964 topographic map was adopted. Efforts have not been made to reflect these changes. This is why any planning especially urban planning based on the scale of 1:50000 topographic maps would face series of implementation problems, since most of the information on features are now outdated Ejikeme (2013). This inadequacy and out-datedness of 1:50000 topographic map series is indeed a major setback to physical development in Nigeria. These changes can be reflected on the map through the process of revision. Due to high cost of revision of topographic map using aerial photograph, all the Nigerian 1:50000 topographic maps are still being used today without revision against the United Nation Organization (UNO'S) recommendation revision period of 10years for areas of high human activities and 15 years for remote area. This means that the 1964 topographical maps of Onitsha and environs is 48 years old without revision. The recent availability of satellite imageries have made update of map easier, faster and cost effective. The use of contour lines generated from topographic map is undoubtedly more accurate than using SRTM data. Unfortunately, the Nigerian topographic maps which were produce 50 years ago have not been revised till date (Ihejirika 2011).

2.5 Surveying and Mapping in Sustainable Land Administration

The basic theoretical frame work for all land administration system in the world over is the delivery of sustainable development; this forms the bottom line for: economic, social and environmental development, as well as good governance. However, efficient socio-economic development and good governance required judicious planning, design and implementation, as well as rational use of land and its resources (FAO 2007). Hence, the need for map and map substitutes is indispensable in this regards. Furthermore, land administration system are the basis for conceptualizing right, restrictions and responsibilities related to people, policies and places. Property rights are normally concerned with ownership and tenure, whereas restrictions usually control use and activities on land; responsibilities relate more to a social, ethical commitment or attitude to environmental sustainability. This involves the provision of the relevant geographic information in terms of mapping and databases of the built and natural environment, and also providing secure tenure system, system for land valuation, land use management and land development. The work of the surveyors forms a kind of backbone in the society support social justice, economic growth and environmental sustainability. These are all key component within the reform agenda of the federal republic of Nigeria. Proper implementation of this vision requires the development of a workable land information system or national spatial data infrastructure (NSDI). Spatial data infrastructure (SDI) can therefore be defined as an organized structure responsible for the collection/collation, sharing handling and organization of spatially referenced data in such a format that enhances proper management, manipulation, analysis, storage/retrieval and easy accessibility of spatial information.

Topography is an important factor affecting soil erosion the amount of soil erodibility is relative to both slope length and slope steepness with topographical survey, horizontal and vertical points on the earth surface are determined relative to some control network. Consequently, the slope length and the slope steepness are determined to minimal centimeters.

2.6 Modern Technology

At the beginning, based on aero-photogrammetrical surveying topographic maps were prepared in scale of 1:25000. Other topographic maps in rest scales (1:50000, 100000 and 200000) were prepared by generalizing of existing topographic maps 1:25000. All topographic maps had the status of military secret data, and they were not allowed for civilian utilization. In total 210 map sheet were in scale 1:25000, 61 map sheet in scale 1:50000, 18 map sheet in scale 1;1000000, and 6 map sheets which cover Macedonian territory, as well as 2 map sheets which cover the eastern part of Albanian in border with Macedonia in scale 1:200000. All of them are in state coordinate system of former Yugoslavia, based on gauss-Kruger projection and ellipsoid of Bessel 1841, except one set topographic map in scale 1:50000 prepared in a geographic coordinate system based on Paris prime meridian. Serbo-Croatian language with Latin alphabet has been used for all set of topographic maps. Only the topographic map in scale 1:20000 has the legend with description for most used symbols Roger F. Tomlinson (2007).

The study for establishing of state base maps in the Republic of Macedonia "present the beginning of efforts for developing Macedonian own national cartography. Due to the situation in previous period till year 2003 in the governmental responsible institution for mapping foreign assistance was very important and necessary. In year 2003, japan international cooperate agency (JICA) stated the research on current situation with national mapping and GIS in Macedonia. After very fruitful cooperation between JICA and all governmental institutions, a project for producing of topographic maps in scale of 1:25000 followed by GIS database. The whole project was realized in a period from March 2004 to November 2006, in which around 60% of the territory was covered with new topographic maps."

Topographic maps are based on topographical surveys. Performed at large scale, these surveys are called topographical in old sense of topography, showing a variety of land mark, landscape information, properties and government boundaries. The first multi-sheet topographic map series of an entire country were prepared by the military to assist in planning for battle and for defensive emplacement. As such, elevation information was of vital importance. As involve, topographic map series became a national resource in modern nation in planning infrastructure and resource exploitation. In the United States, the national map-making function which had been shared by both the army corps of engineers and the department of interior migrated to the newly created United States geological surveys in 1879.

The topographic precision of satellite imagery over wide areas means high definition map products can be created to support applications at a national scale. Satellite imagery mapping, provide a multi-purpose resource, an enduring national assist to help fulfill the objective of many government departments' agencies as well as commercial companies. Inforerra, an EADS astrium company in 2011 created a satellite image map of Nigeria, designed to support applications across the economic, political and environmental spectrum like-traffic management, forestry, mineral exploration and border control, using SPOT 5 multi-spectral satellite imagery, Inforerra produced 88,000km2 continuous image mosaic of Nigeria. Compiled from 370 scenes at 5 meters resolution, the mosaic cover over 95% of the country. The individual scene acquired since 2002, have been selected to provide minimum cloud cover with highest spatial and radiometric quality. Satellite imagery creates a consistent quality image map with the following specification, 5m resolution simulate true color, orthorectified, 1:12,500 optimum scale, .25m positional accuracy, customer defined projection and format the Pro-Mark 3 system used for this project performs powerful surveys, in statics, stop and go or kinematic modes. With centimeter accuracy control and range far beyond that of an optical instrument pro mark 3 set a new standard for ease of use and performance, locating and surveying hard-to-find points is a snap with the navigation data collection capabilities.

Close, (2001) stated that, topographical map explains the characteristics of the land surfaces, which include such features as relief, other natural and man-made features. Relief features includes hills, valleys plains, summits, while other natural features consist of trees, streams, and lakes. Artificial feature are highways, railways, bridges, dams wharfs buildings etc. topographic survey is a survey conducted to obtain the data needed for preparation topographic map. The data required is made up of horizontal and vertical location of features to be depicted on the map a topographic map is two-dimensional representation of a three-dimensional land surface. Topographic maps are differentiated from other maps in that they show both the horizontal and vertical positions of the terrain. Through a combination of contour lines, colors, symbol, labels, and other graphical representations, topographic maps portray the shapes and location of mountains, forests, rivers, lakes, cities, roads, bridges, and many other natural and man-made features. They also contain valuable reference information for surveyors and map makers, including bench marks, base lines and meridians, and magnetic declinations. Topographic maps are used by civil engineers, environmental managers, and urban planners as well as by outdoor enthusiast emergency services agencies, and historians.

A distinction is made between the scales. Small scale, medium scale and large scale, Topographic maps, the scales, the projections, contents and precision of maps in each of these groups are relatively closed, small scale maps range from 1:200000 to 1:5000 and the large scales maps are of scales range 1:2000 to 1:500.

It has been described by Heinz, (1997), that the basic type of map used to represent land area covered as well as certain artificial features, known as cultural features, political boundaries, such as the limit of towns, countries, and states are also shown. Elevation on topographic maps are shown chiefly by used of super imposed control lines, connecting lines of equal elevation, to give a readable picture of the terrain. The distinctive characteristics of a topographic map is that shape of the earth‘s surface is shown by the contour are imaginary lines joint point of equal elevation on the surface of the land above or below a reference surface, such in mean sea level, contours make it possible to measure the height of mountains, depths of the ocean bottom, and steepness of the slopes.

A topographic show more than contours, the map includes symbols that represent such features as streets building, stream, and vegetation. These symbols are constantly refined to better relate to the features. Their represent improve the appearance or readability of the map, or reduced production cost, consequently within the same series, maps may have slightly difference symbols for the same feature. Examples of symbols that have changed include build up area, roads intermittent drainage, and same lettering styles.

Musa, (2006) reports that, from everyday activities of man the landscape changes rapidly. Based on this reason therefore, maps produced some years back soon lack details of recent development, hence map revision the process of updating earlier maps, is therefore necessary so as to incorporate recent changes in the land scape. Moreover, most of the existing maps are not registered onto any projection system which makes it difficult to ascertain the coordinate points on the map, hence calculation of area and distances of which is highly needed for geo-referencing are difficult if not impossible.

The simplicity, accuracy, versatility and most importantly the convenience associated with digital mapping, especially when addressing problems associated with map revisions, will beckon all those associated with maps and map making.

GIS provide a reliable base for topographic map update especially when high resolution satellite imagery (Quick Bird, spot imagery and others) is used, in updating of maps which made it easier and less costly.

As a tool, a GIS permits us to maintain, analyze, and share a wealth of data and information. From the relatively simple task of mapping the path of a hurricane to the more complex task of determining the most efficient garbage collection routes in a city, a GIS is used across the public and private sectors. Online and mobile mapping, navigation, and location-based services are also personalizing and democratizing GISs by bringing maps and mapping to the masses. Like several of the geographic concepts discussed previously, there is no single or universally accepted definition of a GIS.

In addition to recognizing the many definitions of a GIS, it is also constructive to identify three general and overlapping approaches to understanding GISs the application approach, the developer approach, and the science approach. Though most GIS users would probably identify with one approach more than another, they are not mutually exclusive. Moreover, as GISs and, more generally, information technology advance, the following categories will be transformed and reshaped accordingly. The application approach to GISs considers a GIS primarily to be a tool. This is also perhaps the most common view of a GIS. From this perspective, a GIS is used to answer questions, support decision making, maintain an inventory of geographic data and information, and, of course, make maps. As a tool, there are arguably certain skills that should be acquired and required in order to use and apply a GIS properly. The application approach to a GIS is more concerned with using and applying GISs to solve problems than the GIS itself. For instance, suppose we want to determine the best location for a new supermarket. What factors are important behind making this decision? Information about neighborhood demographics, existing supermarkets, and the location of suppliers, zoning regulations, and available real estate are all critical to this decision. A GIS platform can integrate such information that is obtained from the census bureau, realtors, the local zoning agency, and even the Internet. A suitability analysis can then be carried out with the GIS, the output of which will show the best locations for the supermarket given the various local geographic opportunities (e.g., demographics/consumers) and constraints (e.g., supply chain, zoning, and real estate limitations) that exist, it is the developer approach to GISs that drives and introduces innovation and is informed and guided by the existing needs and future demands of the application approach. As such, it is indeed on the cutting edge, it is dynamic, and it represents an area for considerable growth in the future.

The science approach to GISs not only dovetails with the applications and developer approaches but also is more concerned with broader questions and how geography, cognition, map interpretation, and other geospatial issues such as accuracy and errors are relevant to GISs and vice versa and it is also interested in the social consequences and implications of the use and diffusion of GIS technology. From exploring the propagation of error to examining how privacy is being redefined by GISs and related technology, GI Science is at the same time an agent of change as well as one of understanding.

In light of the rapid rate of technological and GIS innovation, in conjunction with the widespread application of GISs, new questions about GIS technology and its use are continually emerging. One of the most discussed topics concerns privacy, and in particular, what is referred to as locational privacy. In other words, who has the right to view or determine your geographic location at any given time? Your parents? Your school? Your employer? Your cell phone carrier? The government or police? When are you willing to divulge your location? Is there a time or place where you prefer to be "off the grid" or not locatable? Such questions concerning locational privacy were of relatively little concern a few years ago. However, with the advent of GPS and its integration into cars and other mobile devices, questions, debates, and even lawsuits concerning locational privacy and who has the right to such information are rapidly emerging. As the name suggests, the developer approach to GISs is concerned with the development of GISs. Rather than focusing on how a GIS is used and applied, the developer approach is concerned with improving, refining, and extending the tool itself and is largely in the realm of computer programmers and software developers. For instance, the advent of web-based mapping is an outcome of the developer approach to GISs. In this regard, the challenge was how to bring GISs to people via the Internet and not necessarily how people would use web-based GISs.

The developer approach to GISs drives and introduces innovation and is guided by the needs of the application approach. As such, it is indeed on the cutting edge, it is dynamic, and it represents an area for considerable growth in the future. The definitions and approaches to GISs described previously illustrate the scope and breadth of this special type of information technology. Furthermore, as GISs become more accessible and widely distributed, there will always be new questions to be answered, new applications to be developed, and innovative technologies to integrate. One notable development is the emergence of what is called the geospatial web. The geospatial web or geo-web refers to the integration of the vast amounts of content available on the Internet (e.g., text, photographs, video, and music) with geographic information, such as location. Adding such geographic information to such content is called geotagging and is similar to geocoding. The integration of geographic information with such content opens up new ways to access, search, organize, share, and distribute information. Mapping mash ups, or web-based applications that combine data and information from one source and map it with online mapping applications, are an example of the geo-web at work. There are mash ups for nearly everything that can be assigned a location, from restaurants and music festivals to your photographs and favorite hikes. Several examples of such mapping mash ups can be found on the Internet at sites such ashttp://googlemapsmania.blogspot.com.

Lehman, (2010) said mapping is required for three dimensional things in order to be comprehensible, the topographical method of mapping is usually employed to provide both planimetric and elevation (relief) of features. There are various methods of showing relief such as hachure’s, hill shading, contouring, contour line is a line all parts of which are at a given elevation above sea level. Its representation of a horizontal plane with the earth’s surface means sea level is zero contour, this makes it more advantageous than other methods of showing relief. Topographical map also employ the use of conventional symbols, which are used to represent physical features such as building, vegetation, stream streets etc. There are various survey methods of producing topographical map, starting from the early conventional methods. Using theodolite, tachometers and tape to modern digital methods, Photogrammetry and Remote Sensing method. Topographic surveys were first used to assist the military in planning for defensive emplacements, such information was vital to the military to provide them with information on elevation of the terrain.

Rom-Say, (1983) used the concept of topographic map to show different elevations on a map developed to allow the accurate depiction of land features on a flat-two dimensional map to portray the shape and elevation of the land, Topographical maps render the general terrain configuration showing the undulating nature of the earth surface.

Gray, (2010) observed that, topographic maps show the way landscape when viewed from above, and contain data for a wide range on natural features such as mountains, plains, valleys, bodies of water and human-man-made structures such as roads, buildings, radio/television towers, transmission lines etc. Topographic map explains the characteristics of the land surfaces, which include such features as relief other natural and man-made features consist of trees, streams and lakes. Artificial features are highways, railway, bridges, dams, rails, building and others.

Topographical maps usually portray both natural and artificial features. They show and name works of nature including mountains, valleys, plains, lake, rivers, and vegetation. They also identify the principal works of man, such as roads, boundaries, transmission lines and major buildings, the most widely used of all maps is the topographic map. The facilities that most distinguishes topographic maps from other maps is the use of contour line (Roy, 2004).

It has been described by Heinz, (1997) that the basic type of map used to represent land areas is the topographic map. Such maps show the natural features of the area covered as well as certain artificial features, known as cultural features. Political boundaries, such as the limits of towns, countries, and state, are also shown. Elevations on topographic maps are shown chiefly by use of superimposed contour lines, connecting points of equal evaluation, to give a readable picture of the terrain. The distinctive characteristic of a topographic map is that the shape of the Earth’s surface is shown by contour lines. Contours are imaginary lines that join points of equal elevation on the surface of the land above or below a reference surface, such as mean sea level. Contours make it possible to measure the height of mountains, depths of the ocean bottom, and steepness of slopes. A topographic map shows more than contours. The map includes symbols that represent such features as streets, buildings, streams, and vegetation. These symbols are constantly refined to better relate to the features they represent, improve the appearance or readability of the map, or reduce production cost. Consequently, within the same series, maps may have slightly different symbols for the same feature. Examples of symbols that have changed include built-up areas, roads, intermittent drainage, and some lettering styles.

Topographic surveys are three-dimensional. They employ the techniques of plane surveying and other special techniques to establish both horizontal and vertical control. The relief or configuration of the terrain and the natural or artificial features are located by measurement and depicted on flat sheet to a topographic map. Contour lines, connecting points of same elevation, are used to portray elevations at any one of various intervals measured in meters or feet (Donald, 1996; Regis, 1996).

When there is a heavy downpour within a short period of time resulting in rainfall excess, existing drainage capacity could not adequately take it, leading to a stagnation of surface runoff for some period leading to flooding (Ward, 1978). In the developing world, poor planning and inadequate drainage systems are the main causes. In this case human interference is viewed in the context of urbanization resulting in a new physical landscape and a new ecosystem (Akintola, 1978).

The process of producing topographical map and analysis involves updating an existing map by observing the changes that occurred on the land over the years which are absent in the old map and reflect them on the newly produced map which will as a guide for feature development. Traditional maps are abstraction of the real world, a sampling of important elements portrayed on a sheet of paper with symbols to represent objects. Topographic maps show the shape of land surface with contour lines or with shaded relief (Roy, 2004).

2.7 The Use of Satellite Imagery

Satellite imageries are rich and play a vital role in providing geographical information Mammaduh (2012) satellite and remote sensing images provide quantitative and qualitative information that reduces complexity of field work. Satellite remote sensing technologies collect data/images at regular intervals. The volumes of data receive at datacenters is huge and it is growing exponentially as the technology is growing at rapid speed as timely and data volumes have been growing at an exponential rate. There is a strong need of effective and efficient mechanism to extract and interpret valuable information from massive satellite image classification is a powerful technique to extract information from huge number of satellite images.

Satellite image classification is a process of grouping pixel into meaningful classes Anders (2003). It is a Multi-Step workflow. Satellite images classification can also be referred as extracting information from satellite images classification is not complex, but the analyst has to take many decision and choices in satellite images classification process. Satellite image classification involve in interpretation of remote sensing images, spatial data mining, study various vegetation types such as agriculture and foresters e.t.c. and studying urban and to determined various land uses in an area.

Ndukwe, (2001), has similarly, observed that topographic maps provide us with the structures for storing geographical knowledge and experience, without which we would find it difficult to orient ourselves in a large environment. Would be dependent upon that close familiar world of personal experience and would be hesitant since many of us lack explorer's intrepid sense of adventure to strike out into unfamiliar terrain. This has made maps very important in military intelligence.

Close, (2001) stated that, topographical map explains the characteristics of the land surfaces, which include such features as relief, other natural and man-made features. Relief features includes hills, valleys plains, summits, while other natural features consist of trees, streams, and lakes. Artificial feature are highways, railways, bridges, dams wharfs buildings etc. topographic survey is a survey conducted to obtain the data needed for preparation topographic map. The data required is made up of horizontal and vertical location of features to be depicted on the map a topographic map is two-dimensional representation of a three-dimensional land surface. Topographic maps are differentiated from other maps in that they show both the horizontal and vertical positions of the terrain. Through a combination of contour lines, colors, symbol, labels, and other graphical representations, topographic maps portray the shapes and location of mountains, forests, rivers, lakes, cities, roads, bridges, and many other natural and man-made features. They also contain valuable reference information for surveyors and map makers, including bench marks, base lines and meridians, and magnetic declinations. Topographic maps are used by civil engineers, environmental managers, and urban planners as well as by outdoor enthusiast emergency services agencies, and historians. He has observed that, without topographical information it may be impossible of to access much of the topographic information shown in a map, Peterson and Neumann (2000) said topographic survey should be used to establish the position and shape of natural and artificial features over a given area or for establishing the geographical information system. In order to be useful, topographic maps most show sufficient information on a map size that is convenient to use. This is accomplished by selecting a map scale that is neither too large nor too small and by enhancing the map details through the use of symbols and colors. The content of topographic maps that is, the information expressed in map symbols is generally highly standardized. There are, however, a number a particular features, which are determined by the scale on specific Purpose of the map and the type of terrain.

A destination is made between small scales (survey), medium scale, and large scale topographic maps. The scales, projections, contents and precision of maps in each of these groups are relatively close. Small scale maps includes maps with scale range of 1:1,000,000 to 1:500,000; the medium scales map range from 1:200,000 to 1:5000; and the large scales maps of scale range 1:2000, to 1:500.

Leyk (2010) enumerate that, topographic maps show the way landscape appear when viewed from above, and contain data for a wide range of natural features (mountains, plains, valleys, bodies of water) and human made structures (roads, buildings, radios,/televisions towers).

Ghilani and Wolf (2008) asserted that they are two different types of maps, plan metric and topographic, there are both prepared as a result of mapping surveys. The former depicts natural and cultural features in the plan(x-y) views only. Objects shown are called plan metric features. Topographic maps also include plan metrics features, but in addition there show the configuration of the earth's surface. Geographic information system in a more broad definition is a digital system for the acquisition, management, analysis and visualization of spatial data for the purpose of planning, administering and monitoring the natural and socioeconomic Environment.

GIS is a collection of computer hardware, software and geographic data of all form of geographically reference information. GIS is a technology that offers a radically different way in which maps are produced and used to manage communities and industries. GIS is defined as including the procedures, operating personnel and spatial data go into the system. A GIS creates intelligent super maps through which sophisticated pinning and analysis can be performed. Geographic information system technology can be used for land management, road, planning, underground infrastructures, natural resources management such as forestry, agriculture, mining, environmental impact assessment, urban planning, land cover and changes detection, law enforcement, census data and natural hazard. Long ago, when a map was needed, drafts persons, geographers and a crew of surveyors would combine their resources and developed a map on paper. Today it can be drawn on a computer screen using a computer aided drafting (CAD). Autodesk Map, ESRI Arc Map or other mapping software program. The program is then connected to a database containing a varies of detailed information related to items on the map. Updates are made quickly and conveniently. The entire map or just portions of it, may be selected to be printed on a plotter.

2.8 Review of Related Literatures

Digital mapping has now become an indispensable tool in solving many environmental-based problems. The methods used for producing digital topographic map are many depending on the level of details required, the use to which the map will be put and to the source of data.

Bannister and Raymond, (1986) The techniques to produce those topographical map/plans include traditional photogrammetry, satellite photogrammetry and terrestrial surveying using total station and or Global Positioning System (GPS) techniques.

Bolstad, (2005), Oriola, and Asonibare, (2011). Provision of infrastructure; planning of towns and cities; management of hazardous natural events and human actions such as erosion, flooding, earthquakes and subsidence; coastal management; exploration and exploitation of minerals; sitting of industries; resources exploitation on the land and on the sea are dependent on land surveying products. This employs the techniques of plane surveying and other special techniques to establish horizontal and vertical controls. This was used to carve out minor roads that ordinarily could not be seen on the satellite image by applying relevant geospatial technique; a revised map of the town was created. Harvey (2008) and Burrough (1986), GIS is a tool for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes. In short, GIS can be used to add value to spatial data (Sharma, 2006). The procedure of mapping land cover involves three stages (i) data collection and processing (ii) defining land cover terrain rating model and (iii) use of decision rule to obtain the defined classes from satellite images. Therefore, it is also possible to model topological relationships of various earth surface entities and analysis be performed to predict future trends, and that assist decision makers to facilitate working on spatial environment. Administrative authorities could create a spatial data instruction by which the database may easily be exchanged (Konecny, 2001; Diaz, 2006).

Topographic Information System can be explained as the combination of human effort and computer-based tools for the collection, storage, analysis, manipulation and retrieval of various kinds of data relating to geographic features (man - made and natural) on the surface of the earth. In view of this, it is necessary to create Topographic Information System for different locations because the information generated from such system can be used for various purposes in physical planning and decision making in such locations. (Lexicon Universal Encyclopedia, 1989).

Buzai and Robinson (2010) and Onyeka (2007) Pointed out that This employs the techniques of plane surveying and other special techniques to establish horizontal and vertical controls. The map could be an image map, a line map or a point map, depending on the purpose, when the map is extended to serve a specific purpose, then a line map or point map may be preferred. Leyk (2010) enumerate that, topographic maps show the way landscape appear when viewed from above, and contain data for a wide range of natural features (mountains, plains, valleys, bodies of water) and human made structures (roads, buildings, radios, /televisions towers). Geographic information system in a more broad definition is a digital system for the acquisition, management, analysis and visualization of spatial data for the purpose of planning, administering and monitoring the natural and socioeconomic Environment. Thurston, Poiker, and Patrick (2003). The global positioning system (GPS) is a relatively new concept in position fixing in surveying. It is a satellite based system for rapid determination of position fixing practically on the earth (land or sea) and at any time with pin-point accuracy. It is a system that has many application in various field ranging from geodetic positioning, control densification, hydrographic surveying mining surveying e.t.c.

Ezra, Muhammed, Namtari, and Mahmud (2014), for us to be able to comprehend physical features on land, the topographic map becomes an essential tool, therefore, there are various techniques used in collecting data for topographic maps. These include Tacheometry, an optical instrument process such as theodolites and levels, aerial photography, use of Global Positioning System (GPS), Total Station instrument and mapping using satellite radar (Muhammad *et al.*, 2014). Topographic surveying is performed to determine the planimetric location and topographic relief of features in three dimensions. Topographic surveys are performed for detailed large-scale site plan drawings or maps at scales equal to or larger than 1 inch = 100 feet (1:1,200). Intermediate and small-scale maps are usually constructed by aerial photogrammetry or satellite remote sensing methods. (American Society for Photogrammetry and Remote Sensing 1989). As a result of survey, a sheet of digital land cadastral map was produced after photocopying register of parcel coordinates and scanning land cadastral map. Next it was edited into continuous cadastral maps and develop topographic-cadastral maps by overlapping digital topographic Maps and cadastral maps Choi (2000). The first set of topographical maps for the country commenced around 1906 with the nations (old) series at the scale of 1:125,000. Conventional ground method of plane tabling triangulation, resection and traversing were employed. The focus was mainly on the economic region of the southern part of the country Ejikeme (2013). From everyday activities of man the landscape changes rapidly. Based on this reason therefore, maps produced some years back soon lack details of recent development, hence map revision the process of updating earlier maps, is therefore necessary so as to incorporate recent changes in the land scape. GIS provide a reliable base for topographic map update especially when high resolution satellite imagery (Quick Bird, spot imagery and others) is used, in updating of maps which made it easier and less costly. Musa, (2006) Satellite and remote sensing images provide quantitative and qualitative information that reduces complexity of field work Mammaduh (2012).

The above reviewed literatures from various authors were able to demonstrate the production of topographical map with different approaches and determination of spatial distribution pattern with different analysis. Different approaches software and other method of analysis were also used. But none of the author used the ArcGIS, Surfer 11 and AutoCAD 2016 software to topographical map, of all the studies reviewed, mapping was not carried out in Borno state university of Maiduguri. It is in line with the above observation as a missing link of knowledge that the researcher decided to use GPS with total station survey to produce a digital topographical map of the study area and to use above listed software to determine the nature of the terrain and the flow accumulation pattern of the flash flood of the study area as a contribution to knowledge. This is to proof that instead of using a single software or instrument to acquire, process and analyses terrain pattern, their alternatives to carry out all the operation since it is interoperable and Integra table with the same result.

CHAPTER THREE: METHODOLOGY

3.1 Research Design

This chapter discusses the general procedure and approach to the research project. It describes the materials/equipment's and the methodologies to achieve the aim of the research project through its set objectives, and it discusses the data types and sources, instruments and the method of data acquisition, data processing and presentation. The flow Diagram below explains the process of how the researcher capture, plotting boundary, details and the production of contour, topographic map and analysis.

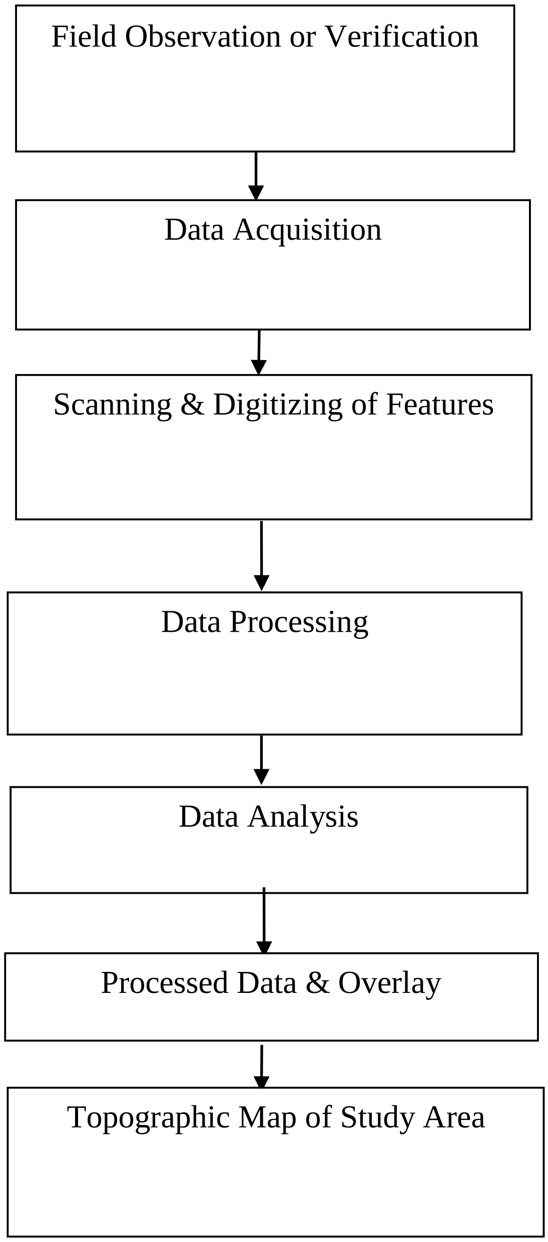


Figure 3.1: Flow-Diagram of Conceptual Framework

3.2 Instrument and Materials

3.2.1 The Hardware Equipment

The following are hardware equipment used for the project

1. Hand held GPS (Garmin 76)
2. Sokkia 520 Total Station
3. Computer (Hp Laptop)
4. Printer (Hp laser jet D5720)

3.2.2 The Software Packages

The ArcGIS 10.4.1 Software package was used for the project work, Surfer 11 was used to generate the Grid Vector Map and the 3D Map of the study area and the AutoCAD 2016 was use for the plotting of the boundary of the project site.

3.3 Reconnaissance survey (recce)

Reconnaissance involved two aspects, via, field and office recce. The word reconnaissance denotes field exploration of the area under consideration before actual survey. Proper planning and visitation of the project site was carried out. During felid recce, stations were identified and temporary points (TP) established and marked at suitable points taking into consideration the indivisibility, sustainability, durability and free from disturbances. The preliminary traverse stations were permanently marked while subsidiary points were temporary marked. Office recce looked into consideration of the type of instrument employed in the field work and methodology of the survey.

3.3.1 Method of Data Acquisition

The primary and secondary method of data collection were employed; the primary method of data collection involve the use of global positioning system (GPS) was used to acquire the coordinate direct from the control point along the boundary, and the Total Station by means of direct field observation in the course of establishing both horizontal and vertical controls as well as picking details from the field of natural and artificial features e.g. buildings, trees, foot paths, electrics poles and spot heights at various locations. while the secondary method of data acquisition is from satellite imagery, the satellite image of the project site was capture/ downloaded from google earth and exported through the use of computer system connected to the internet for further data processing.

3.3.2 Test and adjustment of instrument

1. It is a requirement in every aspect of survey, that the instrument to be used should be tested for error. Temporary adjustment was carried out and the Vertical circle reading was precisely equal to zero at the zenith point /line.
2. Line of sight was perpendicular to the tilting and vertical axis
3. Vertical axis was vertical
4. The tilting axis was perpendicular to the vertical axis of each point/line; the following terms are used to minimized the accumulation of error at the process of carrying out the survey.

3.3.3 Horizontal collimation error

The collimation error was but eliminated by observe reading on two faces (i.e. face right and left). For this type of error there is an onboard calibration use to determine the value of C on the total station equipment. The error was test by sighting a reflector placed at a distance of 100m from the instrument station. From the reflector was then sight so that the error displayed as 0.002m.

3.3.4 Observation

During the in-situ check, the total station instrument was set on the existing control centered and leveled. The angular mode was first displayed by the total station and orientation also set by inputting the back bearing to the back station. The mode was changed from Angular mode to coordinate mode by pressing the coordinate mode icon. F4 button was pressed to change observation page (page 1) to inputting page (page 2) and coordinates of the occupied station were then inputted into the instrument after pressing F3. F2 button was press to inputted height of reflector and press F1 and inputted height of instrument. A reflector was set on the next control station to be checked and bisected with the telescope of the instrument. Automatically the coordinates of the station displayed. The angular mode was changed and vertical angle displayed and the angular mode was change to distance mode, horizontal and height difference displayed. Then the data are recorded. The instrument was moved and setup on the station that was check (first) and the above procedure repeated to check then next station. The procedure was continuously repeated until all the stations required were checked. This procedure was used in the boundary and detail observation. Details of data collected are presented in Table 3.1. The STN shows the boundary points, followed by the Easting; Northing coordinates of the points and height of that station. Also co-ordinates of Easting, Northing and height of all the detail are showed.

Table 3.1: Boundary Coordinate

Station	Easting (m)	Northing (m)	Height (m)
BSU.01	282816.452	1309557.832	337.218
BSU.02	282489.624	1309512.891	339.489
BSU.03	282165.565	1309468.759	339.165
BSU.04	281797.712	1309417.671	337.483
BSU.05	281765.115	1309699.801	337.317
BSU.06	281731.721	1309997.783	339.652
BSU.07	281699.093	1310276.901	339.015
BSU.08	282064.712	1310359.883	337.471
BSU.09	282086.528	1310548.809	339.301
BSU.010	282332.801	1310516.904	339.555
BSU.011	282459.612	1310526.887	338.712
BSU.012	282652.721	1310546.914	338.706
BSU.013	282694.456	1310294.499	337.668
BSU.014	282735.903	1310045.376	337.691
BSU.015	282785.734	1309744.568	337.570

3.3.5 In-situ Check

Before any control is to be used in survey work it has to be checked to ensure that they are in their proper and accurate position in terms of angular measures and distances from the time of establishment to present day. The processes involved in achieving this task are called in-situ check. In –situ check was carried out on the following station.

Angular check; the bearing of various lines joining the two stations were computed from the coordinate and to further deduce the angles between the lines. The total was used on the field to measure the angle between the ground stations.

Linear check; the distance of the various lines joining the three stations were computed from the above coordinates and the total station was used on the field to measure the distances between the ground stations. Comparing the computed and measured angles gave a permissible discrepancy and thus the distances are in-situ. See computation below. The computation of angles, distances and heights of control points is within the permissible limit, however the control point are in situ.

Table 3.2: Coordinates of Existing Controls

Station name	Northing(m)	Easting(m)	Height(m)
BO 179	1309980.153	283298.612	335.656
BO178	1309555.289	283238.351	337.435

Table 3.3: Angular Check

ST	Computed angle	Measured angle	Discrepancy
BO 179	188° 02´ 09"	188° 01´ 39"	00º00´30"
BO 178	270° 16´ 18"	278° 16´ 16"	00º00´02"

Table 3.4: Linear Check

Distance	Computed Distance(m)	Measured Distance(m)	Discrepancy(m)
BO 179, B0 178	249.214	248.954	0.26
BO 178, BO 179	249.143	248.953	0.19

Table 3.5**:** Height Check

St	Computed Height(m)	Measured Height(m)	Discrepancy (m)
BO 179	335.656	334.995	0.005
BO 178	337.435	336.993	0.007

3.3.5 Boundary Demarcation

By means of a traverse survey, frame work of stations and control points are established in their position, measuring the distance between the station and the angle subtend at the various stations by their adjacent station, for the purpose of this project, total station was used to measure direct coordinate since the total station is an incorporation of the electronic distance measurement (EDM).

The instrument was set on the existing control and temporary adjustment was carried out. Coordinate of station were then inputted in the instrument and orientation also set by inputting the hearing to the back station (also known) and sighted with instrument. A reflector was held on the first station to be fixed and bisect with the telescope of the instrument. Automatically the coordinates, distance, bearing (back/ forward), vertical and horizontal angles are all display.

The instrument was moved and setup on the next station that was used to fixed the (first station) and the above procedure repeated to fix the next station. The procedure was continually repeated until all the stations required are fixed to have a closed loop traverse.

3.3.6 Beaconing

A beacon is a permanent survey mark of any kind of concrete, iron or stone used to demarcate plot corners of a rectangular layout. A beacon must be placed at each corner of the plot and at the intersection of boundary with important roads. The face of the beacon must bear an arrow; the practice is usually to a point the arrow in the direction of the traverse towards the next forward beacons. For the purpose of this project, beaconing were carried out simultaneous with demarcation haven temporally mark the point during recce.

3.3.7 Detailing

Detailing is the process of picking features both natural and artificial such as trees, roads electric poles, spot heights, building etc. during the detailing, radiation method was used with a total satiation instrument by setting the instrument on a suitable point (i.e. the boundary and subsidiary control points) the coordinates of various Details are picked from their various positions of features.

3.3.8 Data Quality

Quality of data to be used for any experiment can be determined by the validity and reliability of such data based on the, assumption that the observer of such data are trust worthy and experienced (Nwadialor, 2008). The validity of the data is measured by the precision of the instrument used while the readability of data is determined by the accuracy of such data. In order to ensure optimal data quality, the GPS receiver was initialized to log in data at hour interval for static observation of the mater station and 30 second interval for the over. The observed coordinate obtained was compared with that obtained from the office of surveyor general of the ministry of land and survey Borno State.

The total station is the instrument that was used for the purpose of this project the accuracy of the instrument and the number of set ups (I.e. number of stations) of the boundary as well the subsidiary station determines the data quality. The sets of reading taken will also determine the data quality.

The production of topographic map is a cadastral job and therefore will record a third degree order with linear accuracy of 1:3000 and angular accuracy of 30'' $\sqrt{n}$, where n=number of stations.

3.4 Data Processing

The primary and secondary data were process through the use of various software such as: AutoCAD 2016, Surfer 11 and ArcGIS 10.4.1

3.4.1 Plotting

Plotting can be defined as the mechanical/ electronic (i.e. computerized) or mathematical process (manually) by which point detail located is positioned in relation to their geographical or grid coordinates. In this research, the ArcGIS 10.4.1 Software package was used to plot the boundary, details, contour, and generate the digital terrain mode (DTM).

3.4.2 Importing and Edith in Arc GIS 10.4

The Coordinates are added to the Arc GIS environment from Excel using the CSV comma delimited so as to enable the ArcGIS to read the file.

In order to display the various layers of the EXCEL in different themes depending on the vector component (i.e. points, lines and polygons) the Arc GIS recognizes, but converted into shape file (ship) format which is a fault layer for Arc GIS.

3.4.3 Conversion of Excel CSV Comma Delimited to Shape File

The Excel CSV comma delimited features are compatible format which the Arc GIS recognizes, but the layers attribute table content cannot be edited until various layers are converted into shape file (.ship format which is a default format layer for Arc GIS)

Initially all layers in the CSV comma delimited file possess a single attribute table but when each layer was converted to shape file format, it enables each to contain its personal database.

3.4.4 Contour interpolation

Using the converted spot height (shape file) data format, the contour map was produced on clicking on special analyst tool box/surface/contour. These displayed a dialog box, on the dialog box, and specify the contour interval and click ok. These automatically produced the contour of the study area on the ArcGIS. Also text was written using the text box and edit.

3.4.5 Generation of Digital Terrain Model

Digital terrain model is numerical representation of features in terms of elevation and plan metric measurement was obtained by sampling a topographic surface, and height information that provides a continuous description of the terrain surface, for the purpose of the research, data in the form x, y, z was used to produce the terrain model using the ArcGIS 10.4.1 Software.

3.4.6 Map Overlays Contour Map

Plotting the various layers are produce in ArcGIS and overlaid to produce a single topographic map depicting all the features of the research area in both plan metric and elevation.

3.4.7 Production of Different Maps

The digital topographic map of the study area contour map, detailed map and the spot height/digital terrain model of the study area were created in the Arc GIS layout window. To produce each of the information maps, each map layer required on the table of the content of the view window and ones that are not required at the time switch it off and vice versa.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Presentation of Results

Based on the primary and secondary data collected from the field and office, the data were used to produce various maps from processed data which gave a clear topographic map of the study area. The map was compiled from the field observation. A vector map file containing the road network, a script file containing the place names, of selected areas and a vector file containing built up areas were overlaid or super-imposed. The appropriate map details such as scale, bar legend, map title, north arrow and corner coordinates were later added.

4.1.1 Contour Map

This is the contour map of the study area and describes the terrain which means the line of equal interval, the position of points at different height, in the northern part of the study area lower point and some area within the area as shown in the map are higher point.

4.1.2 Updated Topographic Map

Present the topographic map overlaid on the study area and also showed settlement, schools, road network, clinic, stream and etc. The map produce contour and it is characterized by having different elevation to date.

Figure 4.1 gives a descriptive information on how the spot height are spatially distributed in the research site, this map gives the description on how the changes in elevation within the environments are, the highest point in the study area is 342m above sea level that is spotted at the North West (NW) direction and is coloured in white and the lowest point is 335m above sea level along the North Eastern (NE) part of the area coloured in green, in between the highest and the lowest point there gradual changes in descending order. This implies that the terrain is sloppy in nature.

Figure 4.2 is the contour map of the research area that describes the terrain, line of equal height within the site that provide valuable information about the terrain it shows the possible route on the sloppy nature of the area. From the map the contour shows the highest point is from the north western part of the area gradually descending to the north eastern part of the area with a lowest area, that show the area will have a high concentration of flood direction from any other part of the area to that direction.

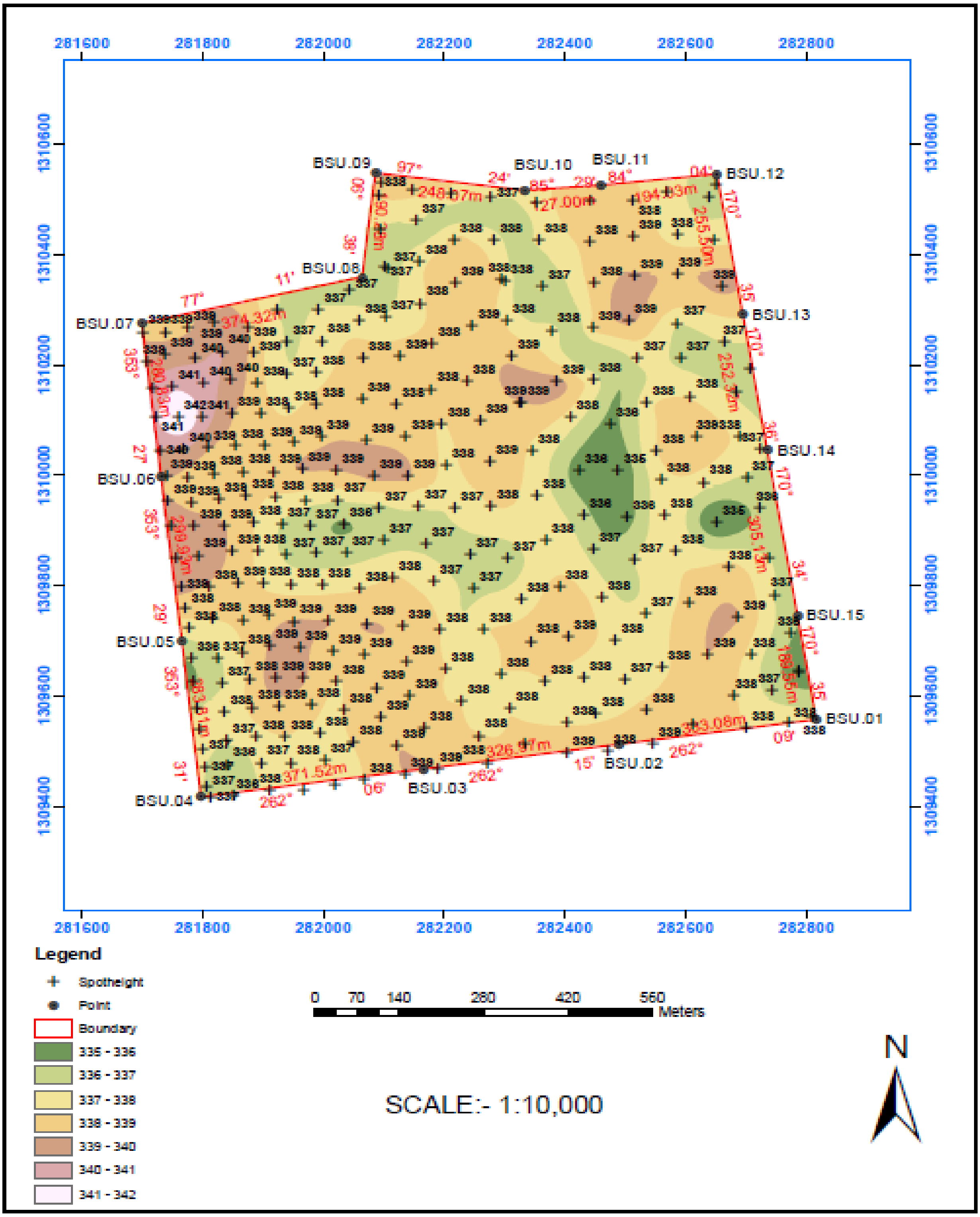


Figure 4.1: Spot Height Map of the Study Area.

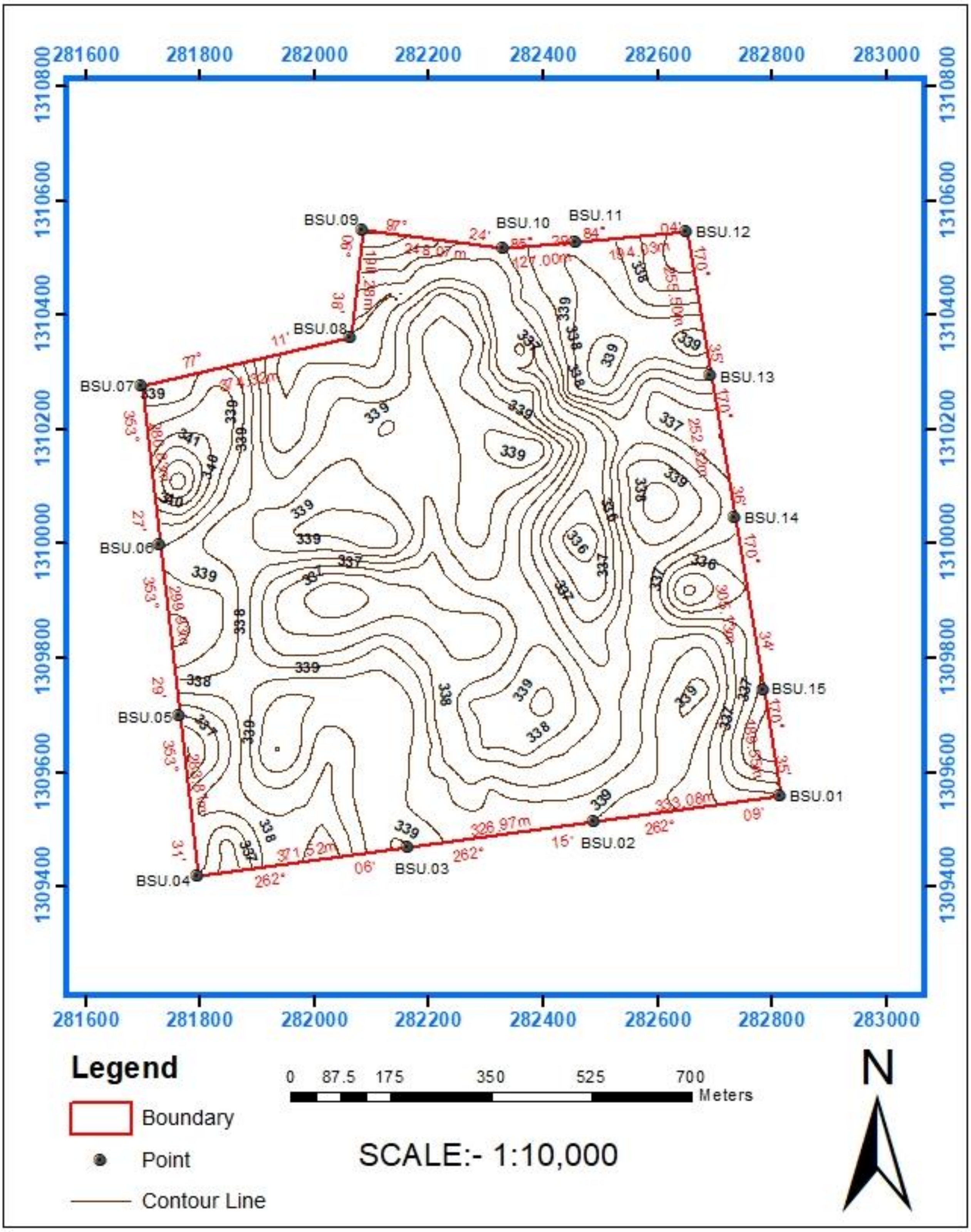
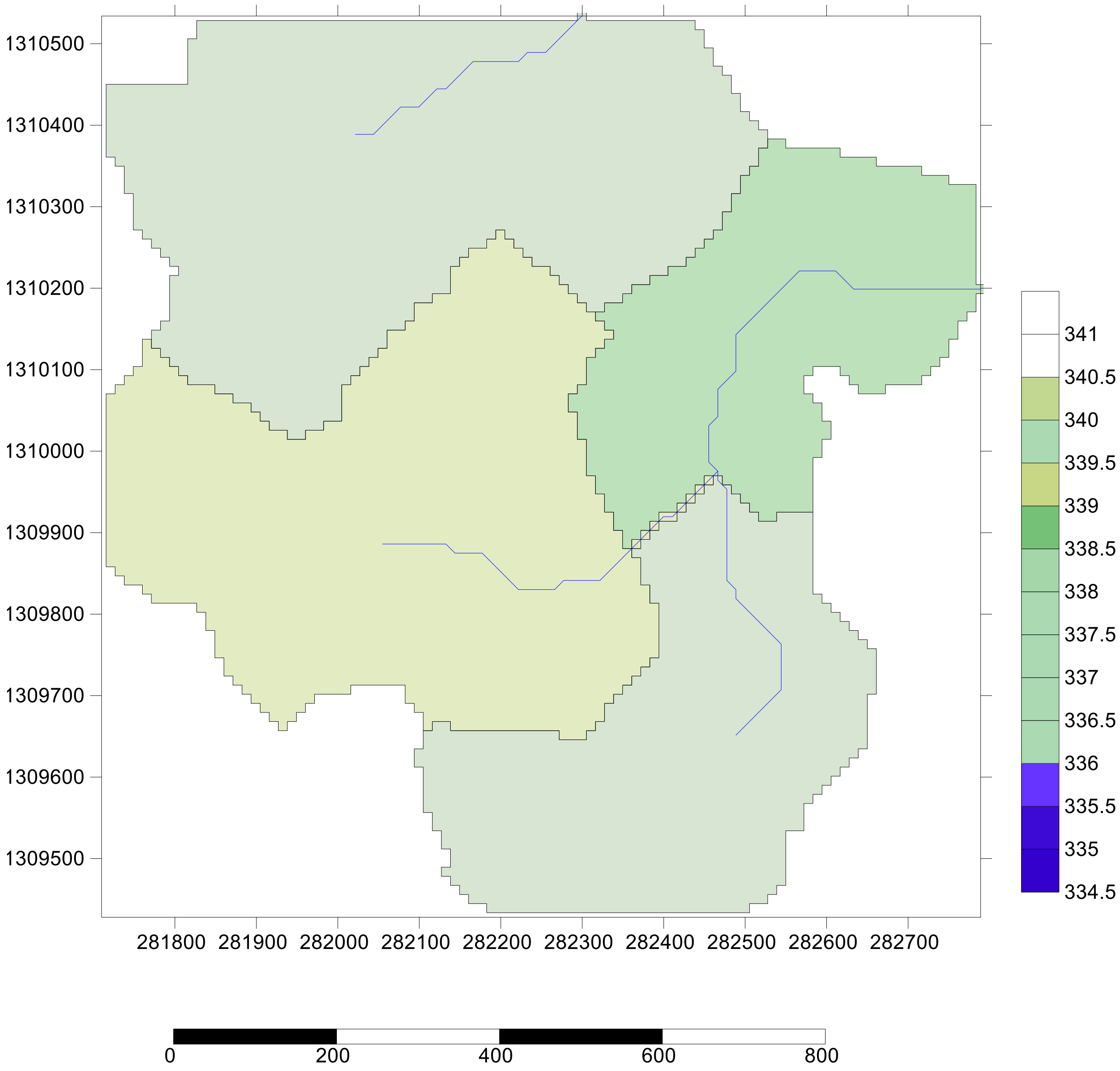


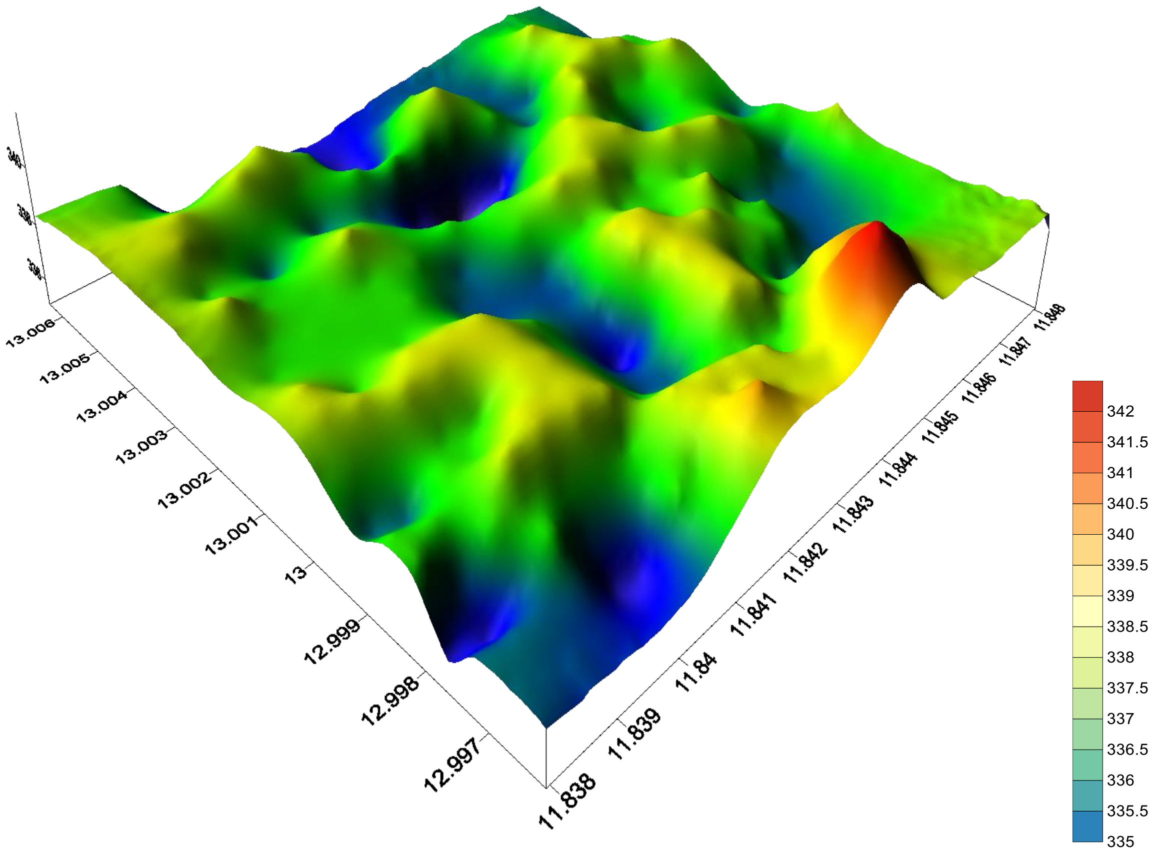
Figure 4.2: Contour Map of the Study Area.

Figure 4.3 is the water shade map of the study area, this map shows the possible mouth of a bay, or any stream channel to link the outflow of the water. From this map the highest elevation in the area is within the range of 340m – 342m above sea level in white colour gradually descending from 340m – 339m, then 339m – 336m and from 336m – 334m that is the lowest terrain and is colour in blue.



Figue 4.3: Water Shade Map of the Study Area

Figure 4.4 is the 3D surface map that discribe the nature of the terrain in term of horizontal line, vertical line or height of the area. From the map the highest point is described by a red. Then gradually descending to yellowish colour, gray colour down to the lowest point that blue. It has shown the possible location of waterlog within the area.



Figue 4.4: 3D Surface Map of the Study Area

Figure 4.5 is the detail survey map that describe the type of features that are within the study area, were boundary of the area is in red, station points in black, tress in green colour with the high concentration of trees in the north eastern part of the site and spatially distributed along fence and within the area, the building area spatially build up within the area. The roads network is in dark connected line and the foot path linking the road and some of the buildings within the project site.

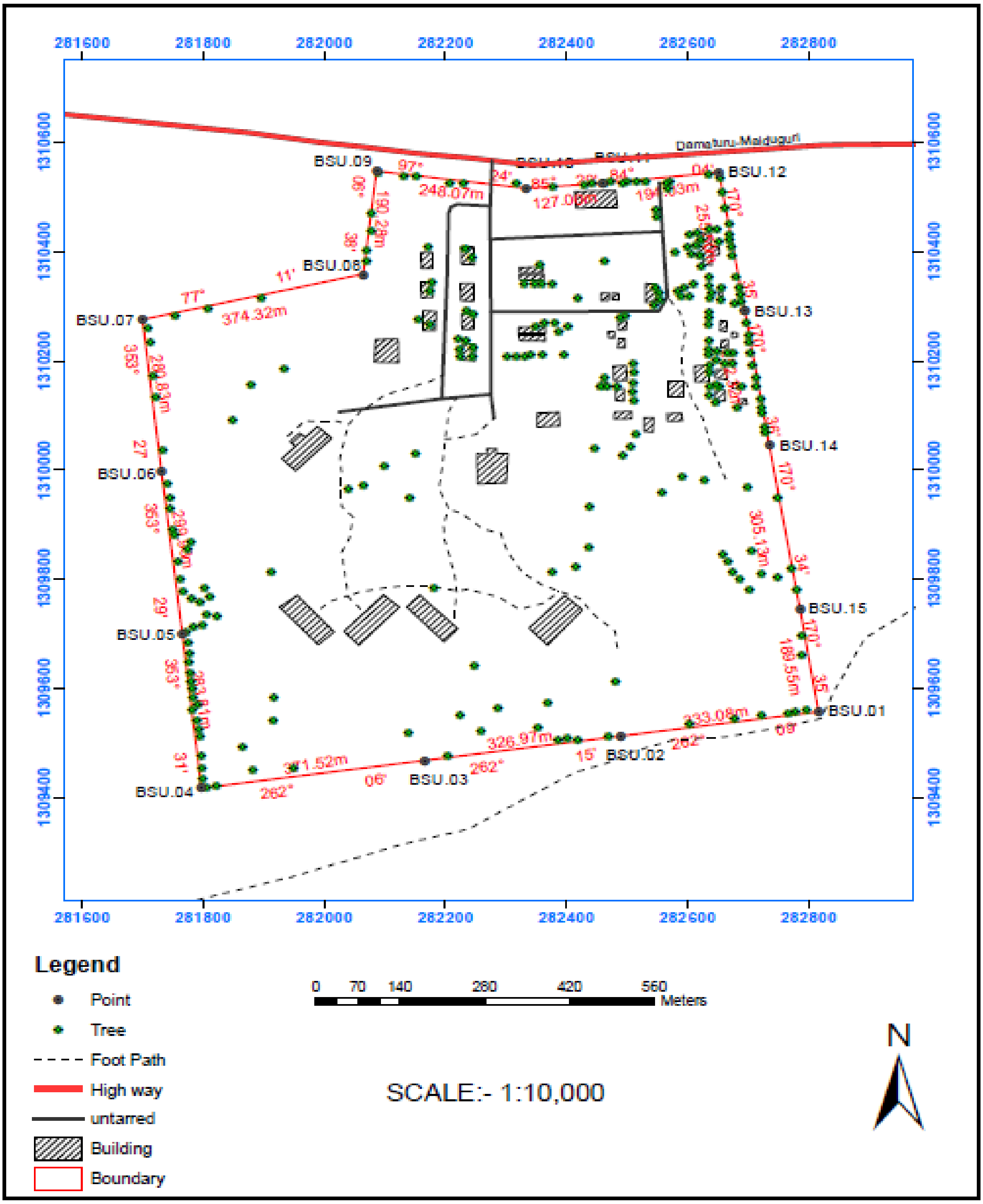


Figure 4.5: Detail Survey Map of the Study Area

Figure 4.6 represent the elevation of the earth surface in the area and the sloppy nature of the terrain with the various difference in height from the highest point of 342m approximately with the purple colour and the lowest point of 335m with the red colour. The greenish, red and yellow colour represent the undulation in between the highest points and the lowest point within the environments. The spatially distributed green dark spot represent the position of tress in the area with at least high concentration toward the north east and along the boundary line.

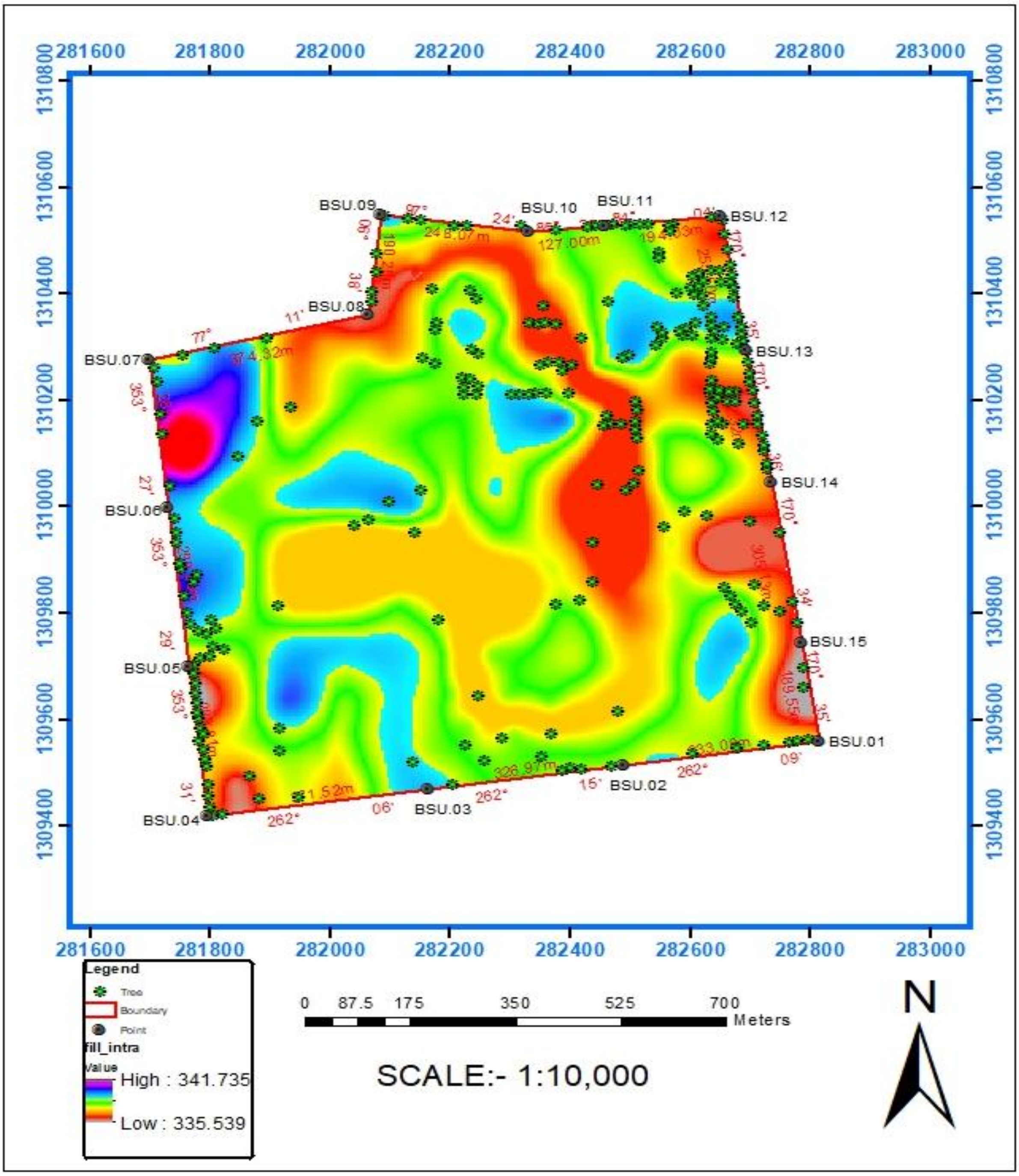


Figure 4.6: Digital Elevation Model (DEM) of the Study Area

Figure 4.7 describe the cumulative count of that naturally drain into outlets. This is use to find the drainage pattern of the terrain as input of the operation of the flow direction operation. From the above map the concentration of the flow is from north- west, then south ward to the north direction in a link connected format that naturally flows. This can be used to create drainage network with the area.

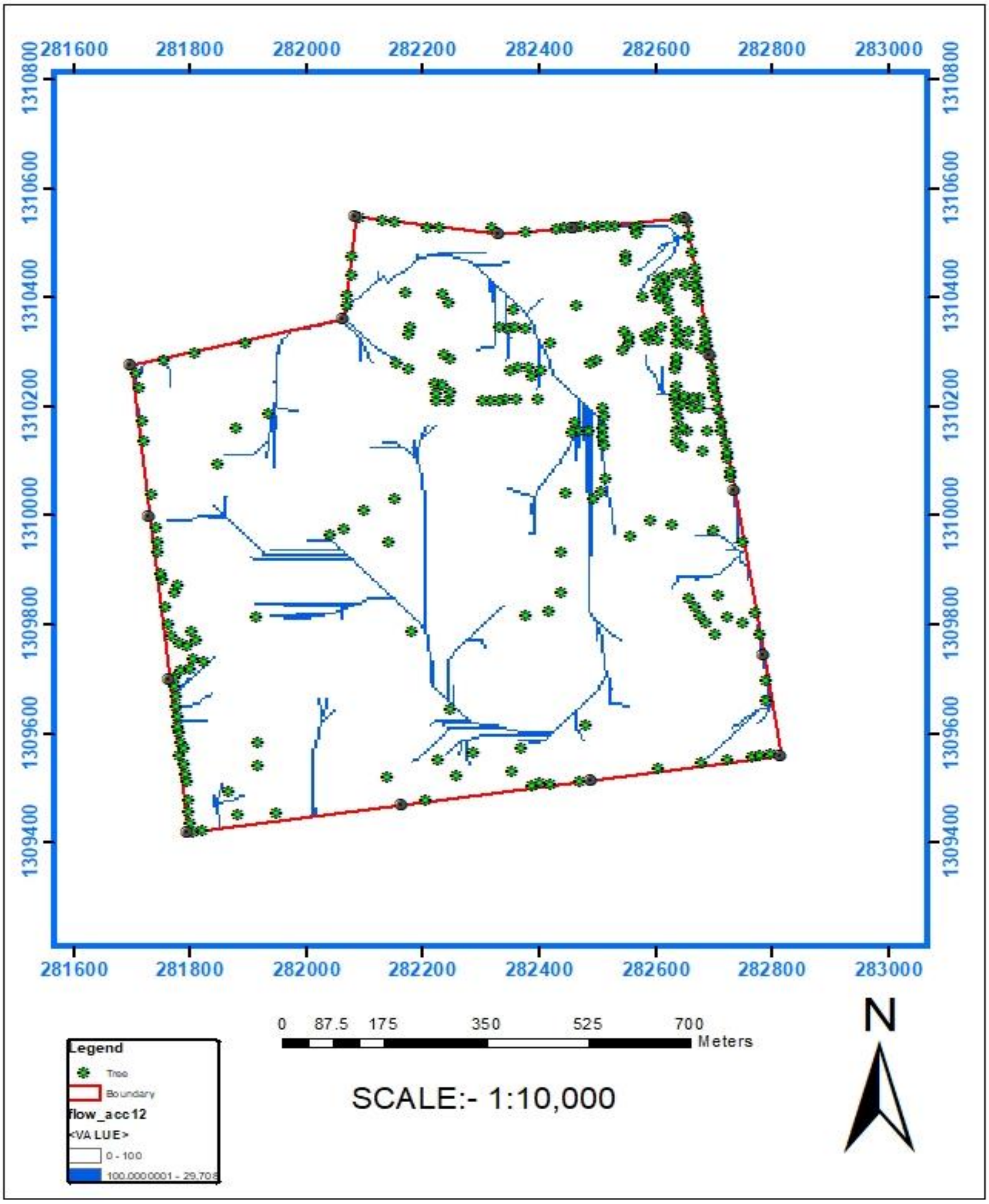


Figure 4.7: Flow Accumulation Map of the Study Area

Figure 4.8 shows the different stages in elevation along the stream even though they are connected in form of lines thereby increasing the efficiency of a given stream. With this waste removal is intended to increase in turn makes waste and quality problems easier to identify. The dark blue colour indicate where the flow start above the yellow line connecting gray colour that is above the brown colour that signified the lowest terrain in the area.

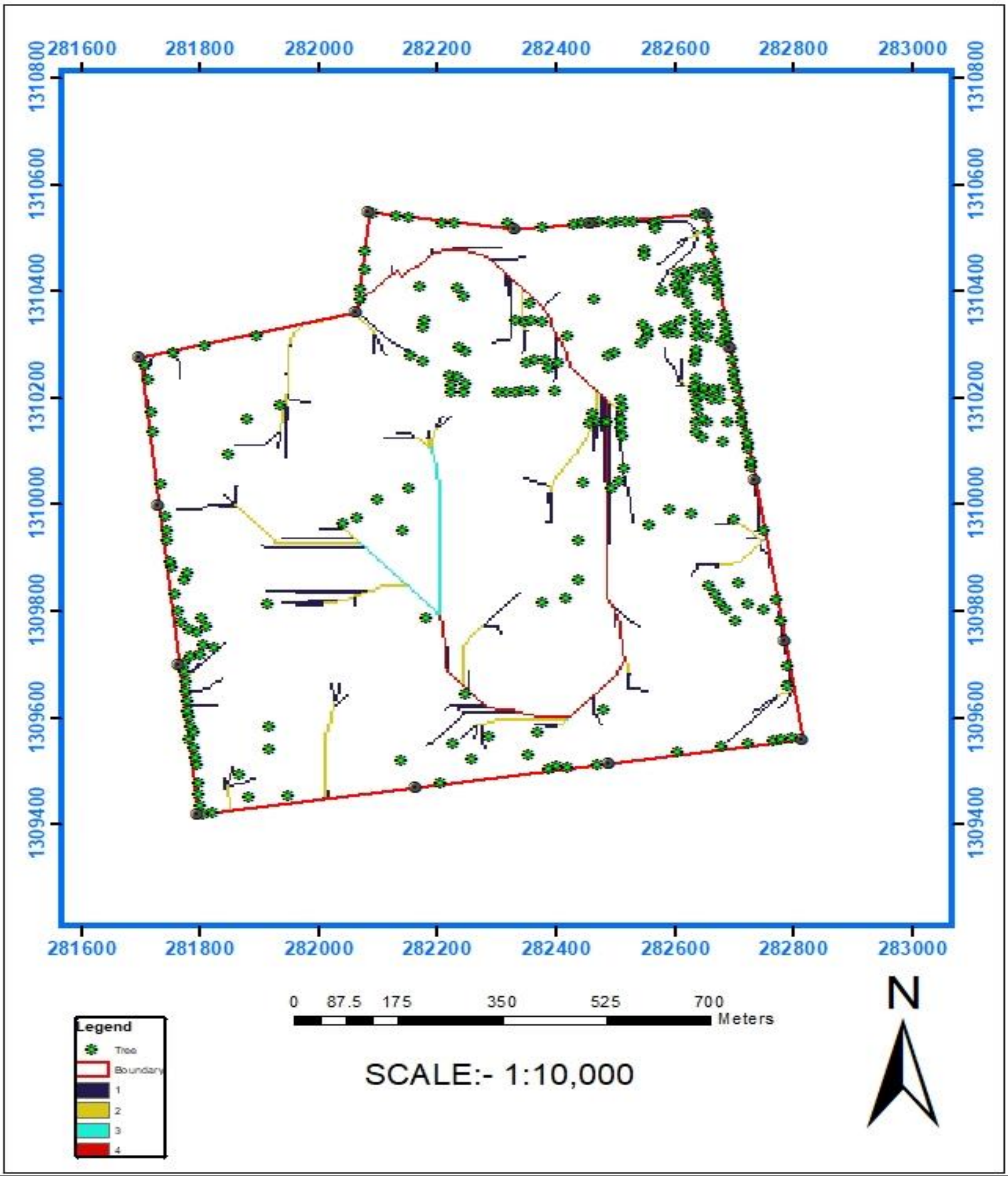


Figure 4.8: Stream Line Map of the Study Area.

Figure 4.9 is the line density map that shows where the line features are concentrated. The value from 0-30 indicate shallow flow concentration, there's increase in flow at 30-61, while there's pressure averagely from 61-92 and there's high pressure at 92- 123 which the accumulation flow direction within the project site.

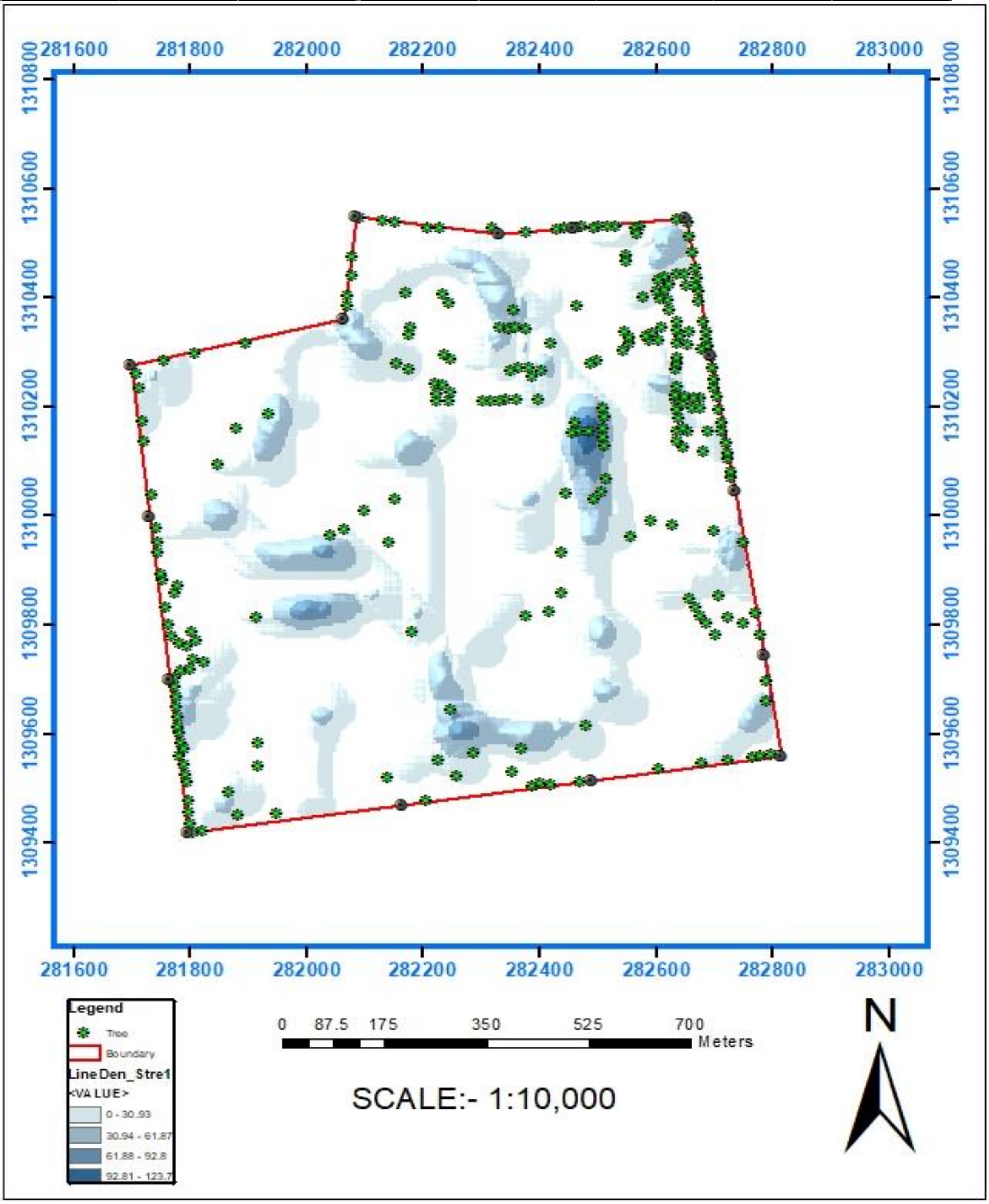


Figure 4.9: Line Density Map of the Study Area

Figure 4.10 is the stream dissolve map that defines the closeness of spacing of stream channels, this is a measure of how well or how poorly a watershed is drained within the site drain channels can be connected from the blue then to yellow, green and then red which is lowest direction of flow.

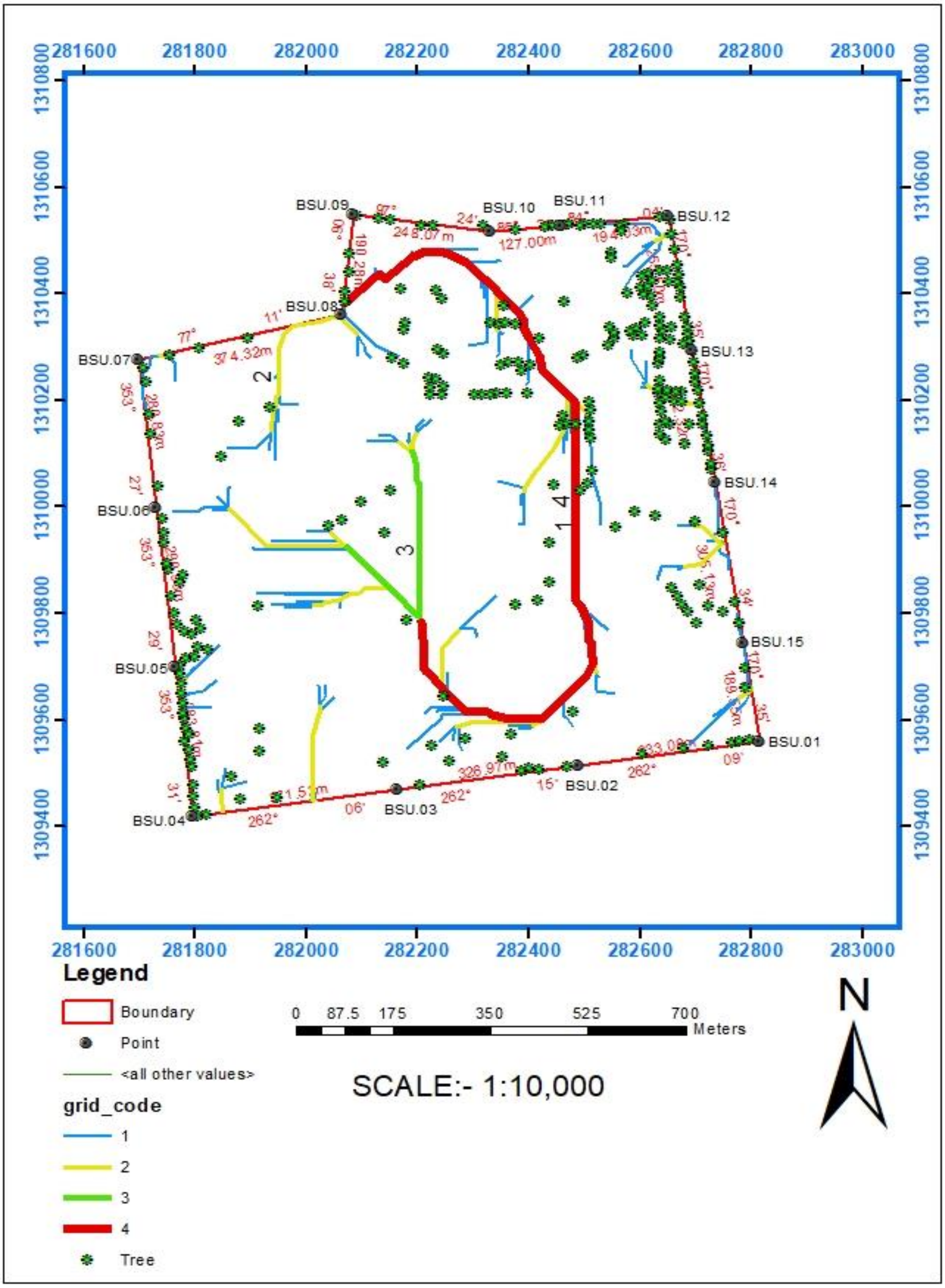


Figure 4.10: Stream Dissolve Map of the Study Area

Figure 4.11 is the digital terrain model (DTM) of the study area was produce from the acquired data using ArcGIS software to show the terrain nature of the study area base on the research it has been identified that the area is relatively undulated and spatially distributed around the project site. The area with blue is the relative below the white colour that represent the highest point on the ground and is connected with the yellow line below the blue, then green and the red colour that signifies the lowest points within the area. This information will serve as a guide for drainage construction and other meaningful features that will be constructed in the near feature and it will reduce control excess waste in terms of costing, time management and promote adequate utilization of materials or resources toward having some speedy developments.

Figure 4.12 is the topographical map of the study area that shows a detail and accurate dimensional representation of the natural and artificial feature within the area of the project site. The natural features are tress in green colour and Contour lines in brown that depict the nature of the area while the artificial features are the road black colour, foot path in spotted black dash, buildings in block shape, fence in red line that define the extend of the boundary area of the project.

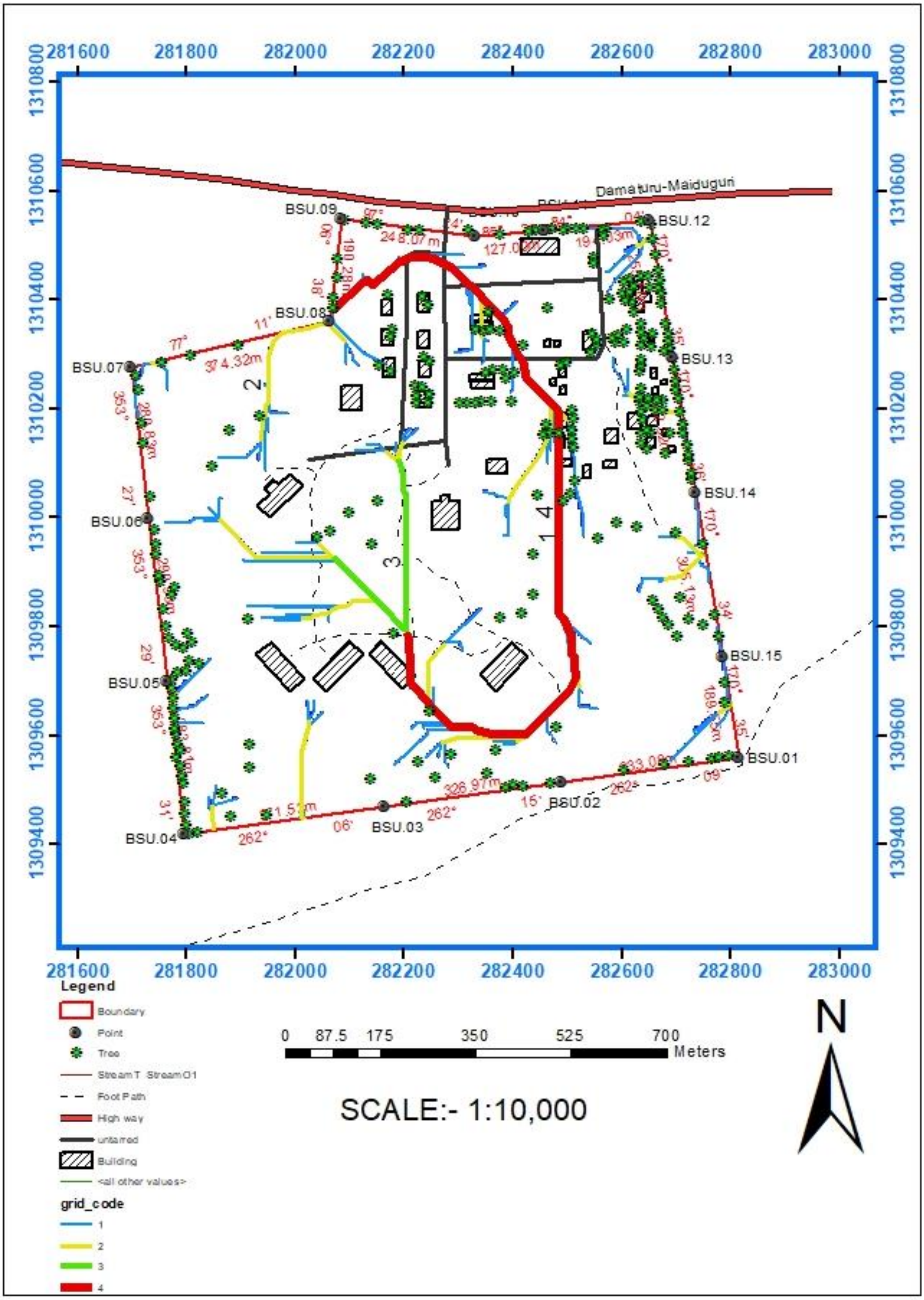


Figure 4.11: Drainage Density Map of the Study Area

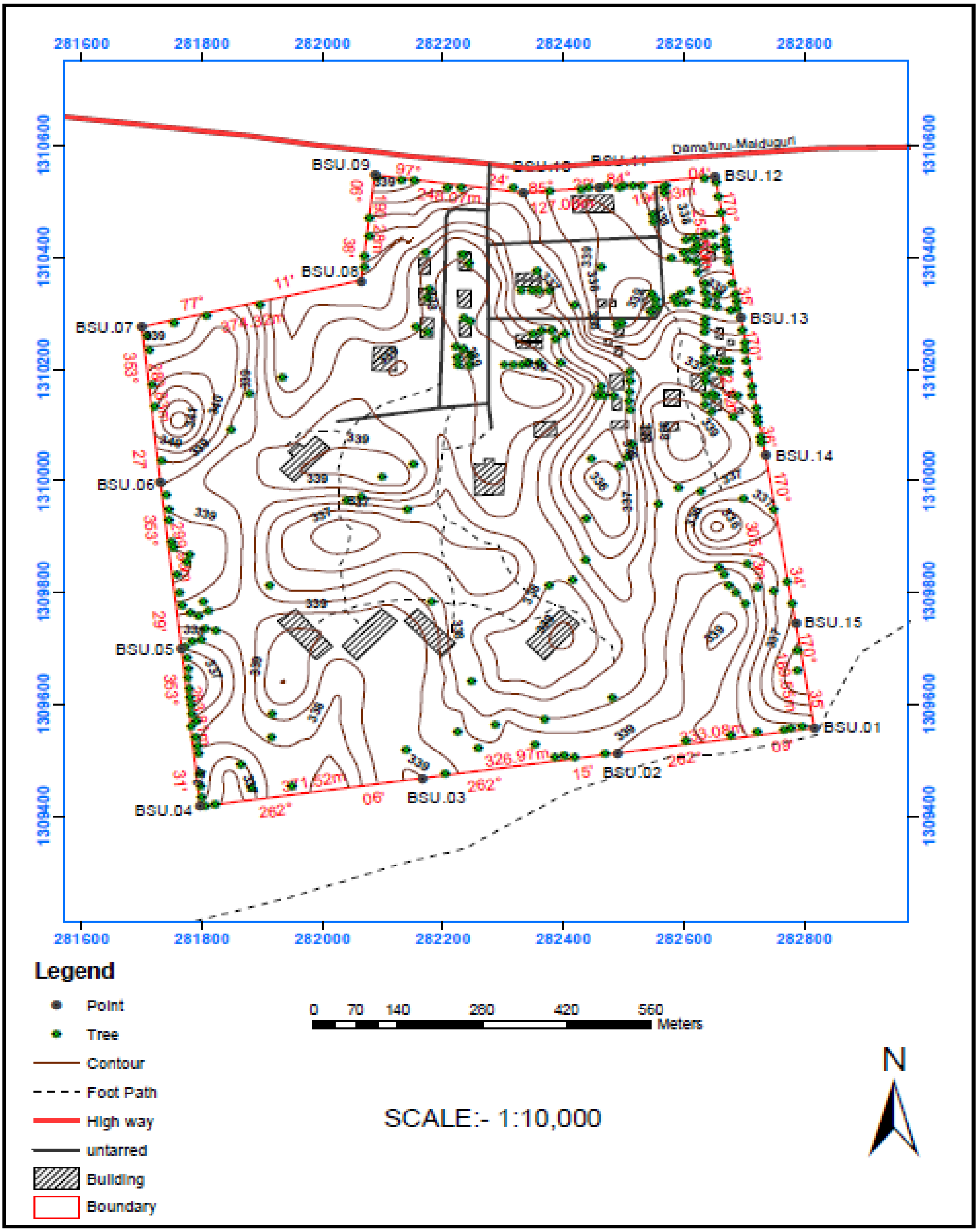


Figure 4.12: Topographical Map of the Study Area

4.2 Discussion of Results

The descriptive information on how the spot height are spatially distributed within the study area are shown in Figure 4.1. This map describes how the changes in elevation with the highest point been 342m spotted at the North West (NW) part and the lowest point 335m above sea level along the North Eastern (NE) part of the study area respectively. This implies that the terrain is sloppy in nature.

The contour map (Figure 4.2) of the study area describes the terrain, line of equal height within the site that provide valuable information about the topography and also showed the possible natural flow routes. This map shows the highest point from the north western part gradually descending to the north eastern part of the area, indicating a high concentration of flood direction from part to another.

Figure 4.3 shows the possible mouth of a bay, or any stream channel to link the outflow of the water from the study area. It mapped the highest elevation within the range of 340m – 342m, gradually descended from 340m – 339m, then 339m – 336m and from 336m – 334m. This map discribe the nature of the terrain in term of horizontal line, vertical line or height of the area with the highest point been 342m and the lowest 335m which implies the height diference of 7m. It generally shows the possible locations of waterlog within the area.

The detail survey map that describe the type of features and their spatial distribution across the study area. The buildings, road networks, connection lines (foot paths), natural features such as trees and others within the project site are spatially situated as shown in Figure 4.5.

The DEM of the study area in Figure 4.6 showed sloppy terrain with various difference in height from the highest point of 342m and the lowest point of 335m. The undulation between the highest points and the lowest points within the area are represented by colour, the spatially distributed green dark spot represent the position of tress in the area with high concentration toward the north east and along the boundary line.

The cumulative count of the natural drain into outlets which can be used to find the drainage pattern of the terrain as input of the flow direction was mapped as shown in Figure 4.7. It indicated that the concentration of the flow is from north-west, then south ward to the north direction in a link connected pattern that naturally flow and can be used to create drainage network with the area.

The digital terrain model (DTM) of the study area was produce from the acquired data using ArcGIS software to show the terrain nature of the study area base on the research it has been identified that the area is relatively undulated and spatially distributed around the project site. The area with blue is the relative below the white colour that represent the highest point on the ground and is connected with the yellow line below the blue, then green and the red colour that signifies the lowest points within the area. This information will serve as a guide for drainage construction and other meaningful features that will be constructed in the near feature and it will reduce control excess waste in terms of costing, time management and promote adequate utilization of materials or resources toward having some speedy developments.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

From the analysis of the result display above, we can now strongly ascertain that the use of GIS has improved the ability to perform complex spatial analysis and modeling operations in supporting planning management and future decision making in relation to the production of topographic map. Also from the forgoing it is clear that the application of GIS technologies in the planning and authority will be more efficient than the manual Approach because data can be easily acquired, processed, stored and edited. The data can be added, removed or corrected when, where and how necessary. the data processed becomes information which can be presented inform of graphics or tables and the presentation can be in soft or hard copies or simply on the screen which in turn are used for fast and effective decision making.

5.2 Conclusion

At present necessary for every society to acquire, store and retrieved information about land and its features either natural or manmade such as utilities and infrastructures for the up to date and purpose of planning and administration therefore an up to date digital topographic map will make it easier to achieve this goal. And based on the available records there is no topographical map covering the area Borno State University. The aim of this research was achieved by producing the digital topographic map of the university at the scale of 1:10,000. The boundary and detail coordinate were obtained using total station instrument. The boundary coordinate was used to plot the boundary while details coordinates obtained from the total station where use to plot and obtained a detail plan at the end a combined Topographical map is produce.

5.3 Recommendations

i. The data used to generate the contour was obtained from the field work; the researcher recommend the use of the GIS and Remote Sensing techniques to determine the spot height to see the precision, accuracy and checks in further studies.

ii. The researcher recommends the creation of database and map update of the study area.

5.5 Contribution to knowledge

Considering the growing trend in Surveying and Geoinformatics, (Science and Technology) most of the surveying work can be carried out with little or no drudgery, thus the aim and objective of this project was achieved which contains topography information that is current and had not attained review with the modern survey technology and software's. Also to study the general characteristics of the study area without visiting the area or the physical ground. With the knowledge of characteristics of contours, it is easy to visualize whether study area is flat or undulating.

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