ENVIRONMENTAL IMPACT ASSESSMENT FOR NEWX TOWN DEVELOPMENT IN BWARI FEDERAL CAPITAL TERRITORY NIGERIA

BY

ISA, Adamu Alhassan (B. URP, 1993)
MSc/Sci/6766/2011-2012
(MSc GIS & REMOTE SENSING)

A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN GIS AND REMOTE SENSING

DEPARTMENT OF GEOGRAPHY
FACULTY OF SCIENCE
AHMADU BELLO UNIVERSITY
ZARIA

OCTOBER, 2015

DECLARATION

I, Adamu Alhassan ISA declare that the research work reported in this dissertation titled ‘ “**Environmental Impact Assessment for New Town Development in Bwari, Federal Capital Territory, Nigeria”** was carried out by me in the Department of Geography, Faculty of Science, Ahmadu Bello University, Zaria, under the supervision of **Prof. E. O. Iguisi** and **Dr. A. L. Bello**. All information derived from literature has been duly acknowledged in the text and a list of references provided. No part of this work has been presented for another degree in any institution.

Adamu Alhassan ISA Date

CERTIFICATION

This dissertation titled **"Environmental Impact Assessment for New Town Development in Bwari, Federal Capital Territory, Nigeria"** by Adamu Alhassan Isa meets the regulation governing the award of Master of Science (GIS and Remote Sensing) degree in the Department of Geography, Faculty of Science, Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

…….. ……..

Prof. E. O. Iguisi Date
Chairman, Supervisory Committee

…….. ……

Dr. A. L. Bello Date
Member, Supervisory Committee

....

Prof. I.M. Jaro Date
Head of Department

....

Prof. K. Bala Date
Dean, Postgraduate school

DEDICATION

This dissertation work is dedicated to all those who, though capable of, but due to one reason or another beyond their control, have not been able to achieve their true capabilities and potentials academically.

ACKNOWLEDGEMENTS

All praise and gratitude is due to God Almighty, Who has made it possible for us all to be alive and carry out our various worldly pursuits.

I sincerely acknowledge with gratitude the efforts of my dessirtation Chairman Supervisory Committee Prof. E. O. Iguisi and Member, Supervisory Committee Dr. A. L. Bello for their constructive criticisms, suggestions and fatherly advice which led to the final achievement of this dream. Their kind gestures in the study have been priceless, May God continue to bless, reward and take them to their highest climax. May God guide and strengthen them in their future endeavours.

I acknowledge with gratitude the efforts of Mallam Mohammed Isma'il and Shehu Abbas for their concern throughout the duration of this study.

I cannot forget to acknowledge the efforts of our postgraduate coordinator Dr R.O. Yusuf and postgraduate seminar coordinator Dr Yusuf Obadaki for their hard work and concerns.

I sincerely appreciate the contributions and companionship of Abba Ahmed and entire GIS set of 11-12, my Profs in the making, Sunday Richard, Mallam Murtala Uba and Mallam Ahmad Mohammad. May the Almighty God make it possible for your true potentials to be achieved.

My appreciation also goes to the Management and staff of Town Planning Section of FHA, especially TPL Aminat Salawu. Special mention, gratitude and appreciation to my loving Mother, brothers, sisters and immediate family, ZeeBee, Amaan, Fatima and Aisha for their love, patience and moral support. Thank you all once more.

TABLE OF CONTENTS

CHAPTER THREE: THE STUDY AREA AND METHODOLOGY

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

ABSTRACT

Geospatial technology provides a mechanism for data collection, integration, measurement and output generation in its electronic environment, which models the spatial environment. The aim of this research is to carry out an Environmental Impact Assessment for the proposed New Town Development site in Bwari Area Council of the Federal Capital Territory, Nigeria using Geographic Information Systems and Remote Sensing. The data used include beacon sheet of the study area, the proposed new town development plan, ASTER and satellite images. The proposed new town development plan which was designed in AutoCAD environment was later imported into ArcGIS software environment for further analysis. Also the ASTER image and various baseline data were generated from ASTER other satellite imagery in ArcGIS environment. The analyses carried out include; slope, hill-shed, watershed, curvature, line density, flow direction and flow accumulation. The proposed new town development plan was overlaid on the baseline data to assess the major impacts. Also, the overlay analysis of the new town development plan on land used/land cover generated from satellite imagery were conducted in order to identify the areas that have major impact that are likely to be affected by the proposed new town development plan. The analysis revealed that the area that will be severely affected is the land use land cover classes as well as the watershed drainage basin, flow accumulation, flow direction (runoff) and stream order. It was found that the development have a higher impact of about 55.3 % on bare land, follow by vegetation of about 36.3 % affected, 6.4 % on water body, 1.1 % on rock outcrop and 0.8 % on the built up. Public Participation was also taken into consideration in the conduct of the research. Though the proposed new town development will have a lot of significant adverse effects on the study area and environs, proper mitigation measures will reduce the impact of the adverse effects. However, the positive effects/impacts of the project, as well as its multiplier effects will outweigh the negative impacts, if the project is eventually implemented. Based on the outcome of the research, it was recommended that afforestation should be embarked upon in order to combat the micro atmospheric condition of the study area and also the need for research to be carried out after the town development implementation, so as to assess or examine the impact on the air quality, pollution, noise pollution, drinking water.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Environmental Impact Assessment (EIA) is defined as the systematic identification and evaluation of the potential impacts or effects of proposed projects, plans, programs or legislative actions relative to the physical, chemical, biological, cultural and socio-economic components of the environment (Canter, 1996). The impact of an activity is any deviation or change from the baseline situation that is caused by the activity.

Another definition of EIA is “a process by which information about the environmental effects of a project is collected, both by the developer and from other sources, and taken into account by the relevant decision-making body before a decision is given on whether the development should go ahead or not" (Kom´ınkov´a, 2008). Also, the official website of the International Association for Impacts Assessment (IAIA, nd) defines EIA as the process of identifying the future consequences of a current or proposed action. On its part, the Province of New Brunswick, Canada (nd) views EIA as a process through which the environmental impacts potentially resulting from a proposed project are identified and assessed early in the planning process. It goes further to explain that EIA identifies steps that can be taken to avoid negative environmental impacts or reduce them to acceptable levels before they occur. EIA therefore represents a proactive, preventative approach to environmental management and protection. EIA is a key aspect of many large scale planning applications. It is a technique which is meant to help understand the potential environmental impacts of major development proposals. EIA can also be viewed as a formal process for identifying the likely effects of

activities or projects on the environment, and on human health and welfare means and measures to mitigate & monitor these impacts.

Since EIA requires the integration of often disparate information from numerous sources (Fedra, 1994), it is this functionality of Geographic Information System (GIS) that is usually extremely helpful. GIS has the power to combine information from various sources such as government policies, environmental monitoring programmes, project plans and environmental impact models.

Unprecedented growing rates of global human population and new town developments have tremendous stress on local, regional, and global air and water quality. There is therefore a necessity to better understand the factors that mediate the interactions between for example new town development and/or variations of environmental quality (Duh, Shandas, Chang and George, 2008). Landuse modifications, New Towns and infrastructure developments specifically could destroy the natural environments and pose serious threats to the biodiversity. Tools and measures must therefore be adapted to evaluate and remedy the potential effects or impact on biodiversity caused by human activities and developments.

It has been estimated by Chan and Easa (2000) that approximately 80% of information used in the preparation of development plans, programmes and projects are geographic in nature. Although the magnitude of such statement may not be verifiable, as spatial planning elements and approaches vary from country to country, Landuse Planning has an intrinsic spatial nature. Urban and Rural Planning, and the associated environmental assessment processes that accompany them, entail the consideration of both spatial and temporal aspects which in turn, establish specific needs for information management and analysis tools. The

requirements for spatially-specific approaches to data management and assessment are within the capabilities of GIS.

Within the Physical Planning profession, EIA plays important roles in the prediction and assessment of biodiversity-related impacts from planned developments (Gontier, M¨ortberg, and Balfors, 2010). EIA is one of the main legislative tools recognized to reduce anthropogenic adverse impacts on the environment. The purpose of EIA is therefore to ensure that the environmental effects of a proposed development are fully considered, together with its economic or social benefits. This should be considered before the new Town Planning application would be determined. EIA is thus an anticipatory, participatory environmental management tool. The extensive understanding of EIA as an anticipatory environmental management tool has made a significant consideration over the extent to which it is achieving its purposes. This has been measured in terms of EIA "effectiveness," especially as discussion has moved away from issues of procedural operation to the more practical oriented of EIA and its place in more comprehensive decision-making situations (Jay, Jones, Slinn, and Wood, 2007).

The environmental impacts of projects or actions generally include a comprehensive range of impacts. All these impacts vary in magnitude, as well as in their beneficial or adverse impacts (Rau and Wooten, 1980). Public participation is a fundamental principle of the EIA processes in both project related EIA and Strategic Environmental Assessment (SEA) of Policies, Plans and Programmes (PPPs). EIA is thus a participatory tool for supporting decision-making at project and strategic levels of decision making. The importance of public participation has been underlined by the Aarhus Convention (United Nations Economic Commission for Europe, 1998), which entered into force in 2001. Public participation is also an essential

component of the EIA processes regulated by the European EIA (EC, 1997) and SEA (EC, 2001) directives. It is also recognised in the National Urban Policy of Nigeria.

Public participation within EIA offers a variety of opportunities. For SEA, these have been summarized by Heiland (2005). Public participation increases the support for an adopted policy, plan, programme (PPP) or project through the involvement of external actors, enhances credibility of a selected PPP or project by including pertinent information and helps to avoid subsequent controversy, confrontation and/or delays in the decision-making process due to public opposition (Rauschmayer and Risse, 2005).

Public participation should be conducted at a point when no irreversible decisions have been made. The time period of the participation phase should be long enough to allow the public to become familiar with the PPP or project. The literature on public participation knows different expressions and terms, including "public participation", "public involvement", "stakeholder involvement", "consultation", "expressing opinions", "communication", "reporting", "access to information", "participatory approaches" and others. Fischer (2007) differentiates between four main categories: Participation; Consultation; Communication and Reporting.

Geographical Information Systems bring the opportunity to enhance predictable evaluation techniques (e.g., matrix-based assessments). It acts as graphic mediators of spatial knowledge and by providing an effective tool for the spatial and temporal analysis of environmental impacts. GIS has the potential to increase the objectivity and accuracy of the assessment, to improve both the understanding of environmental and planning concerns and the distribution

of information. Therefore, it helps to develop the effectiveness of strategic environmental assessment practice (González, Gilmer, Foley, Sweeney and Fry, 2011).

Burrough (1986) describes Geographic Information Systems (GIS) as "a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world." This tool box based definition of GIS already specifies the most important functions of GIS for Environmental Impact Assessment. The importance of each of these functions depends on the specific situation of the EIA for which GIS is applied. For large studies with huge data-sets for many different environmental aspects, carried out over a long period, the storage capacity may be most important. In other situations the analytical capacities of a GIS may be the most significant factor. One element that is not explicitly mentioned in Burrough's definition is the integrating capacity of a GIS.

GIS, with its capabilities, enables the spatial (and temporal) examination of critical considerations, increasing the objectivity and transparency of planning and environmental assessment. The application of GIS to Environmental Impact Assessment, can positively contribute to positive decision making in environmental matters. Although there is no legal requirement to incorporate spatial information in EIA, their inclusion provides a range of additional benefits to those provided by traditional analytical methods, such as matrices which commonly lack spatial and temporal dimensions. GIS addresses such shortcoming by identifying and defining any geographical and/or seasonal variability of and among potential impacts (Patil *et al.*, 2002; Vanderhaegen and Muro, 2005; González *et al.*, 2011). Moreover, GIS has the potential to provide significant advantages to current EIA reporting methods by increasing the speed of information generation; enabling the integration of multiple sources of information to provide new insights; providing the means for a systematic analysis that

facilitates the rapid and objective prediction of potential (cumulative) environmental effects; and conveying the results in graphical form that in turn, enables a visual and comparative examination of the aspects under scrutiny (João, 1998; Vanderhaegen and Muro, 2005; González et al., 2011). Therefore, it can be argued that GIS support transparent decision-making in environmental planning of new towns as results are demonstrably based on spatially-specific and objective evidence (Skehan and González, 2006; González et al., 2011).

1.2 STATEMENT OF THE RESEARCH PROBLEM

The official web site of Federal Housing Authority (FHA, 2010), FHA Nigeria, is a wholly owned Federal Government Agency, established under Decree 40 of 1973, now CAP 136 Laws of the Federation of Nigeria 1990. The Authority is supervised by the Federal Ministry of Lands, Housing and Urban Development and became partially commercialized in accordance with Decree No 25 of 1988 and charged with the following functions:

1. The preparation and submission from time to time, to the Government of proposals for National Housing Programme;
2. The making of recommendations to the Government on such aspects of urban and regional planning, transportation, communication, electric power, sewage and water supply development as may be relevant to the successful execution of housing programmes approved by the Government; and
3. The execution of such housing programmes as may be approved by the Government.

The web site goes further to state that for the Authority to carry out its functions/mandate effectively, section 4 (1) of the FHA Act (1990) granted the Authority the power to:

a. Acquire, hold and manage movable and immovable property;

b. Acquire, construct and maintain dwelling houses, schools, communal and commercial buildings and other structures;

c. Enter into contracts for the construction, maintenance, management or repair of any property;

d. Purchase or otherwise acquire any assets, business or other property where such purchase or acquisition is necessary for the proper discharge of its functions under this act;

e. Sell, let, lease or otherwise dispose of any property vested in the Authority.

In addition to the functions stated for the National Housing Policy (2012) further expanded FHA's functions to include:

a. Develop and manage real estate on commercial basis in all states of the Federation and the Federal Capital Territory (FCT);

b. Provide sites and services for all income groups with special emphasis on the low income group;

c. Provide low income and rural housing in all states of the Federation and Federal Capital from funds provided by the Federal Government and other sources;

d. Execute such housing programmes as may be approved by the Federal Government.

In furtherance of the mandates, FHA has numerous estates spread all over the Federation. FHA has also recently acquired land in Kwali and Bwari Area Councils of the Federal Capital Territory, Abuja for purpose of 'New Town Developments'.

The Nigerian Urban and Regional Planning Law (1992) has made it mandatory for all land developments to seek and get approval of the relevant Development Control Department prior to commencement of any land development. Also, the same section has made it mandatory for developers to submit a development plan for the approval by the Development Control Department. Similarly, the law has also made it mandatory for all applications for land development at the time of submitting application for development permit, to also submit detailed Environmental Impact Statement (EIS) for:

a. a residential land development in excess of 2 hectares; or
b. building development or to expand a factory or for the construction of an office building in excess of four floors or 5,000 square meters of let-able space; or
c. permission for a major recreational development.

Another regulatory framework, "Guideline for EIA Procedure" issued by the Federal Environmental Protection Agency (FEPA, 1995), states that for any housing development covering more than 50ha, it must be accompanied by an EIA, for consideration and subsequent approval, prior to commencement of development.

The proposed new town development site in Bwari, which has a combined land area of 330.044ha, therefore falls under the mandatory list of projects that require EIA, prior to approval and subsequent implementation of the project. The site was acquired in 2013 and preliminary draft designs are currently in progress. As at the time of this work, no EIA has been conducted for the site under reference.

The Google Earth Satellite image (2013) of the proposed site, as well as reconnaissance survey (2013) indicates existence of scattered developments. The two parcels of land that

make up the site are separated by the Abuja Light rail, which passes through the site, these is due to the fact that the site is currently mainly used for agricultural purposes. All these will be impacted upon by the proposed New Town development in the area. The site also has natural landscapes and vegetation suitable to wild life and fauna. There are also natural streams and gullies. The project will likely alter the natural drain and topography of the area, which in turn will have impact on fauna and other biodiversity in and around the site. The completed development will also have impact on livelihood, surface and ground water, agriculture as well as further development of the immediate surrounding area (coupled with the new light rail, new roads and proposed settlements likely to come up). Other areas that will also be impacted upon will include temperature and topography. Hence the need of EIA in order to assess the magnitude of proposed new town development plan on the study area.

Several studies have been conducted to show the importance of the application of GIS in Environmental Impact Assessment considerations in any development project. One of such works is that of Anji (1995) which evaluated of EIA on land use changes on ground water quality of a part of Hyderabad city, India, Using Remote Sensing, GIS and in situ studies". The work focused on spatial variations of deteriorating environmental quality with respect to ground water pollution and the role of GIS in effective assessment and mapping of ground water pollution patterns and monitoring its trends in Hyderabad metropolis. The methodology developed explores the correlation between the concentration levels of pollutants in urban ground water and urban land use and highlights the impacts of urban growth, population increase and land-use/land cover changes on the water quality status of Hyderabad city. The study concluded that there exists a linear and positive correlation between the impacts of land use changes and poor groundwater quality in most of the study area, under the 4 major classes of land-uses predominant in the area of study, viz. Residential, Waste land,

Agricultural and Industrial areas. Based on the identified impacts, appropriate long-term and short-term strategies for improving the groundwater table and quality in stress areas ware suggested for environmental management.

Sadler and Verheem (1996) noted that there exist limitations when using analogue method of maps overlay. They noted that maps tend to oversimplify and the specific interrelationships between environmental factors are not readily obtainable using traditional map overlays. Also, analogue map overlays cannot effectively describe ecosystem dynamics through time. Sadler and Verheem's work used analytical matrices, to the planning oriented multi-criteria analysis and recognised the framework and approaches for analysing cumulative effects that can be used in EIA. The framework has three components: Sources; Effects and; Processes.

Koomen, Veenbass and Poot (1997) presented a working application for the prediction of bird disturbance caused by motorways. Using variables such as maximum speed, the number of vehicles expected per day, possible noise barriers and the presence of woodland, an impact zone is constructed in which breeding birds are predicted to be disturbed. The underlying EIA relations were based on ecological fieldwork on how various constraints for highway construction are integrated in one map. Information from various sources on groundwater extraction areas, polluted soil spots, historical monuments and present and future urban areas were combined to identify possible corridors where road construction poses minimal environmental and social problems. The impact of three proposed motorway alternatives on existing natural areas were assessed through a simple overlay analysis of the surface area of the motorway designs with a natural area data-set, the area affected for each nature type was calculated. This initial score can subsequently be weighted to represent the relative

importance of each of these types. This rating however requires expert judgement to ensure meaningful results. GIS can also be used for more elaborate impact predictions.

AbuZeid and Wagdy (1999) used GIS to evaluate the Environmental Impact Assessment for Dam construction and irrigation system development in India. They showed that GIS can handle large data related to EIA and represented in an accurate way with less time consuming process. They started with EIA definition then the advantages of using the GIS with EIA. They concluded that GIS is considered as one of the important techniques that can be used for environmental scoping. The authors presented the benefits of using GIS for EIA of Dams construction projects which helped to select the optimal road location with less impact on the environment.

Bojórquez-Tapia, Diaz-Mondragón and Ezcurra (2001), in Mexico used GIS as a participatory-base for land suitability assessment where a set of environmental attributes ware defined as spatial analysis criteria for land use planning. The method they used included participatory workshops where the social, environmental and economic implications of developing lands were discussed. The information generated by stakeholders was integrated in a GIS-based multi-criteria analysis and thus found out that land uses could be allocated in a pattern that helped minimise conflicts and maximise consensus.

Antunes, Santo and Jordao (2001), proposed an elaborate integration of Geographical Information in their Spatial Impact Assessment Methodology. They argued that the information generated by the use of GIS in the impact identification and prediction stages of an EIA can be used more thoroughly in the assessment of impact significance. Through the calculation of aggregated measures of impact, the overall evaluation of environmental impact

is facilitated. They found out that GIS can provide visual nature of maps, which in turn provides a shared understanding that allows for easier communication between different groups, which leads to conflicts being resolved.

Wood's (2005) work on a public participation GIS approach for Landscape Planning Assessment in UK indicates that use of GIS support, offers an alternative and interactive mapping approach that benefits and empowers community groups when responding to local geographic issues. He concluded that this relatively new practice had potential as a means of extending knowledge networks. However, there were concerns with regard to access to technology; representatively and reliability of data; data ownership and manipulation; the responsiveness of data providers to public concerns and demands for information availability, with transparency of the decision-making process.

Abbas and Ukoje's (2009) work on Application of Remote Sensing (RS) and GIS to EIA for Sustainable Development focused on how to achieve sustainable development through the employment of EIA for all programmes and plans. They used the then proposed dredging of Lower Niger River (Warri to Bifurcation at Onyia segment) using Remote Sensing and GIS techniques to show how EIA can be carried out with the aid of GIS and RS. Their analysis however only concentrated on identification of areas and features likely (with likely coverage) to be impacted upon by the proposed dredging.

Based on the litereture reviewed, most of the research were carried out using the analogue methods of data analysis and interpretation and even those that involved the use of GIS and remote sensing, the works were mostly on either Landscape Planning Assessment like the research conducted by Woods (2005) and sustainable development through the employment

like work of Abbas and Ukoje (2009). None of such research was carried out on new town development in Nigeria particularly in Bwari Area Council of Abuja, hence the needs of such research to be carried in the study area with the aid of GIS and remote sensing. This research therefore focuses on using Remote Sensing and GIS techniques in carrying out EIA for the proposed new Town Development Site, located in Bwari Area Council of the FCT Abuja. This is the knowledge gap this work filled. It is against this background that this research answered the following questions:

1. What is the nature of the baseline conditions in the study area (Physical, biological and Socio-cultural)?
2. What are the baseline elements that likely to be affected by the Proposed New Town Development?
3. What are the likely magnitudes of the impacts?

1.3 AIM AND OBJECTIVES OF THE STUDY

The aim of this research is to carry out an Environmental Impact Assessment for the proposed New Town Development site in Bwari Area Council of the FCT, Nigeria using GIS and Remote Sensing.

The aim was achieved through the following specific objectives which are to:

i. characterise the baseline data for the study area.
ii. identify major impact areas that are likely to be affected by the new town development.
iii. assess the likely magnitude of the new town development on the identified impact areas.

1.4 SCOPE OF THE STUDY

The study area (New Town Development site in Bwari Area Council, FCT Abuja) falls within phase V of the Federal Capital Territory (FCT) and lies within Latitudes 9° 5' 11"- 9° 7' 2" North of the Equator and Longitudes 7° 22' 33"- 7° 25' 36" East of the Greenwich Meridian, having a landmass of approximately 330 hectares. The research focused on the use of Remote Sensing and GIS techniques in carrying out EIA for the proposed new town development site of FHA in Bwari Area Council of the FCT. Specifically, the spatial scope is limited to forming a baseline situation of the Physical, Biological and Socio-cultural elements of the environment; Identifying likely impact areas (if any), the likely magnitude and ; propose mitigation measures. However, as the EIA process also includes decision making and subsequent review during implementation of the project, this work will be limited to the review stage. Certain outcomes of meetings held with the communities and Bwari Area Council Officials will also be adopted in the course of carrying out the work, to serve as the Public Participation Inputs. The work covered baseline conditions as at 2014.

1.5 JUSTIFICATION OF THE STUDY

Man's physical Environment is very important. Awareness on the physical environment has been on the increase and consciousness on sustainable development has been employed as a means of ensuring the most effective and efficient use of the various resources for man's quest to develop. A first step to formulating policies and programmes for sustainable development is the assessment of elements in the physical environment.

The findings of this study will be useful as EIA functions both as a procedure within a project or planning process, and as a document which constitutes a basis for decision-making. It will therefore be useful to Federal Housing Authority as part of the documents required for global

approval from the Federal Capital Territory Administration, as well as serve as input into the planning process for the proposed new town development. It will also further assist professionals in the built industry, especially town planners to understand the advantage of using GIS techniques for better and efficient planning and execution of projects. The work will also add to the literature on academic works on similar and related fields, both as a source of reference and/or further development/follow-up on the current work.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews relevant literature, beginning with the concepts , its development/evolution, (Environmental Impact Systems in Nigeria, History of the Environmental Impact Assessment Policy) in Nigeria, EIA concept and legal basis in Nigeria, EIA System in Nigeria, Strength and Shortcomings of EIA in Nigeria, The need for Impact Assessments, EIA Processes, General Procedure for Conducting EIA, Methods used in EA, Methods and Techniques of Public Participation, The need for practical GIS methods in environmental studies/EIA, planning and monitoring, GIS, EIAs & Environmental Audits, Detailed Assessment of the Environment Identify Potential Impacts, Remote sensing and GIS applications in urban planning, Decision Support Tools (Manual and GIS Map Overlays), GIS Solutions for Environmental Management, GIS for Environmental Data Management and Analysis, The use of GIS in EIA and Advantages of EIA.

2.2 CONCEPTUAL ISSUES

2.2.1 EIA concept and legal basis in Nigeria

Globally, Environmental Impact Assessment (EIA) is recognized as a tool for achieving sustainable development. The main objective of the EIA is to ensure that potential environmental impacts are foreseen at the appropriate stage of project design and addressed before any decision is taken on the project. The EIA involves a systematic process for identifying, predicting and evaluating potential impacts associated with a development project. The EIA process must proffer mitigation measures to avoid, reduce or minimize the negative impacts on the environment, public health and property and may highlight the

foreseeable positive impacts. The mitigation measures entail identifying possible alternative site, project, process design, including that of not proceeding with the project. The EIA is not a one-off process which terminates in the production of a report on the effects of the project and associated mitigation measures. It also deals with monitoring the construction and operational phases which continues till the project is decommissioned. Thus, the post-closure care is also an integral part of the EIA process. EIA legislations and the required procedural guidelines for carrying out the EIA process became effective since the 1970s in developed countries. Nigeria took a giant leap when she promulgated her main EIA legislation (i.e. EIA Act No.86) in 1992. EIA is proclaimed in Principle 17 of 'Agenda 21' (Agenda for the 21st century) of the United Nations Conference on Environment and Development (UNCED), which was held on the 3rd to14th of June, 1992, in Rio de Janeiro, Brazil. It states that: "Environmental Impact Assessment as a national instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and subject to a decision of a competent authority**."**

The EIA Act No. 86 of 1992 makes the EIA mandatory for development projects likely to have adverse impacts on the environment prior to implementation. Prior to the enactment of the EIA Act in Nigeria, project appraisals were limited predominantly to feasibility studies and economic-cost-benefit analysis. Most of these appraisals did not take environmental costs, public opinion, and social and environmental impacts of development projects into consideration (Hussaini, 1999).

Jay *et al.,* (2007) noted that currently, EIA is practiced in over 100 countries of the world. While its effectiveness has been explored to a certain extent in some developed countries, the research in developing countries such as Nigeria requires consented effort. Even if most of

the scholars generally agree that EIA plays an important role in environmental decision-making, the effectiveness, accessibility and influence of EIA, and specifically the accuracy and the methods of the assessment can be openly questioned and criticized. The field scholars attempt measuring the EIA effectiveness either through the quality of EIA report and EIA procedural implementation or relate it to the viability and the role of EIA in factual development planning (Bailey, 1997; Baker and Wood, 1999; Simpson, 2001; Ogunba, 2004; Sakalauskiene *et al.,* 2004; Pinho *et al.*, 2006; Pölönen, 2006). The paper described current practice of EIA in Nigeria, the main strengths and weaknesses of the system and also provided the recommendations for further improvements.

2.2.2 Environmental Impact Assessment Policy in Nigeria

Sequel to the build-up of awareness was the formalization of Nigeria's environmental policies. This was jump-started only after the Koko incident in 1987. The Koko incident was an incident involving dumping of toxic waste in Koko, a southern Nigerian village, by an Italian ship. This caught the country unprepared, as it had neither effective environmental legislation nor environment controlling body to manage the incident effectively. As a reaction to the Koko incident, the Federal Environmental Protection Agency (FEPA) was established under Decree 58 of December 30, 1988. The next year, FEPA published its National Policy on the Environment. Then, the National Council on the Environment at its meeting in 1990 recognized EIA as an indispensable prerequisite for the effective implementation of the National Policy on the Environment, and directed that EIA be made mandatory for all development projects with effect from March 1991. The body also made environmental auditing mandatory for all existing industries and urged FEPA to establish guidelines and procedures for operation all over the country. At this time (1991), the environmental regulations operated in the petroleum industry were maturing from reactive control measures

to a proactive EIA system. This was occasioned by the release of Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGAS) in 1991. In 1992, in response to the realization that all sectors of the economy required EIAs, two distinct legislations emerged (in addition to that already operating in the petroleum industry), adding up to three separate Environmental Impact Assessment systems in the country. This was occasioned by the exigent situation (the Koko incident and international pressure) as well as the fact that the country was able to produce EIA legislations which were learnt from 20 years of evolution in countries such as the US and Canada.

The budding of three different EIA systems in 1992 is a matter that would generate some curiosity. An explanation is derivable from the process of evolution of the different systems. Nigeria's first EIA system evolved in the late 1960s, out of guidelines, standards and procedures for the petroleum industry environmental control. Over a period of 20 years, the EIA system in this industry evolved (in a manner quite in keeping with Gibson's model) Gibson (2002).

By contrast, the Town Planning EIA system promulgated into law in 1992 was not the result of a long evolutionary process. It was more or less jump-started by legislation and bears resemblance to the UK EIA system which was compulsorily created by an EU directive in 1988. Prior to the promulgation of the enabling decree, the urban and regional planners had operated various regulations for development control, which were usually derived from the UK Town Planning system. When under compulsion from the EU, the UK enacted its Town and Country Planning Regulations 1988 (which covers development activities, and specifies town planners as the principal environment assessors); Nigeria also developed a similar legislation in 1992. The third EIA system (the EIA Decree no. 86) was also jump-started into

Gibson's stage 2 by legislation in 1992. This system more or less follows the pattern of the US NEPA Act. The result was three independent systems: one for the petroleum sector (Governed by the Directorate of Petroleum Resources, DPR), another for the urban and regional planner's development control (governed by local government councils and the town planning divisions of the State Ministries of Lands), and yet another which attempts to span all sectors (governed by the FMENV). By 1992 all the three systems had in one form or the other advanced legislations stipulating proactive pollution control with measures including impact assessment, mitigation and project approval. Consequently at this point, all three systems came into the second of the stages of EIA evolutionary transition described by Gibson (2002). Sequel to 1992, FMENV issued procedural guidelines in 1995, while the DPR updated its guidelines in 1999. To date, no common procedural guidelines have yet been issued to regulate EIA practice for the urban and regional planners (Gibson, 2002).

The manner in which Nigeria's systems have developed (jump-starts rather than gradual development from reactive to proactive measures) suggests that some modification of Gibson's model would perhaps offer a truer picture of evolution in Nigeria.

2.2.3 EIA Processes

The Environmental Impact Assessment (EIA) process generally requires the completion of several stages, namely (Antunes *et al.,* 1996):

1. Project definition and characterisation of environmental baseline information;
2. Scoping and impact identification;
3. Impact prediction;
4. Impact evaluation;
5. Impact mitigation and compensation, and design of monitoring systems.

Although all EIA stages are essential for the overall objective of impact assessment and environmental planning, impact evaluation is particularly important because the results obtained in the previous stages are handled to determine the significance of environmental impacts. This allows the establishment of comparisons among alternatives and environmental components (e.g., air, water, and soil) in order to support decision-making about project acceptance and the need for mitigation or compensation. Duinker and Beanlands (1986) state that the matter of the significance of human-induced perturbations in the natural environment constitutes the very heart of EIA.

The significance of environmental impacts is largely dependent on the spatial distribution of the effects of the proposed action and of the affected receptors. The choice of the level of analysis (i.e., the extension of the study area considered in the EIA) to adopt for the assessment can also have a decisive influence on the evaluation results. However, in current EIA practice, this spatial dimension of impacts is often ignored or hidden in the overall decision-making process. This paper presents a new methodology for impact assessment—SIAM (Spatial Impact Assessment Methodology)—which aims to improve the evaluation of impact significance by considering explicitly the spatial dimension of the impacts. Therefore, it relies on the evaluation of the spatial significance of impacts, using information generated within the EIA process, with the support of Geographical Information Systems (GIS).

The evaluation of impacts significance always has a subjective dimension, arising from the integration of the values, experiences, and knowledge of the different actors that perform the evaluation. Although subjectivity can never be eliminated, the results of an evaluation may become more credible, if they are obtained by the application of a pre-defined methodology, with clearly stated assessment criteria, making full use of the information generated in the

previous EIA stages. This is the major objective of SIAM. The paper begins with a brief overview of current use of GIS for EIA. This is followed by the presentation of the proposed methodology. A case study dealing with the evaluation of environmental impacts of a proposed highway in Portugal is presented to illustrate in detail the practical application of the methodology.

2.2.4 The need for the impact assessment

In general, development growth has been viewed as positive effort and desirable for communities at large because it often leads to value-added actions such as, additional jobs, increased income for residents, and the enhancement of public facilities. However, it may also be accompanied by costs such as traffic congestion, reduction in air and water quality, and loss of open space. In addition, development decisions made by the authorities are too often made without a sufficient understanding of the consequences of those decisions on overall community well-being. Therefore, cautiously planned development is crucial for ensuring that growth is consistent with the long-range goals of the overall planning, particularly when it relates with the environmental considerations Urban Data Management Symposium (UDMS, 2011).

This demonstrates the importance of applying advanced modelling and projecting techniques in assessing the consequent environmental impacts. Thus, this research was conducted to develop a customised modelling system that integrates the strength of GIS in supporting PDSS *via* prediction of DIA for various projects. It is in this respect that a prototype of GIS based modelling that enables to anticipate development environmental impacts at an early stage of project planning has been established. It encompasses some selected key components of environment, economy and social, building up the system called e-DIA (UDMS, 2011. The working definition for e-DIA is “a computer system that helps early-prediction of the

environmental, social and economic impacts of development, in spatial and textual data, operated by using a structural computer model. The results will include a checklist of the possible environmental and socio-economic impacts that may require further considerations by the authorities in granting approval to applications for development".

It is anticipated that community at large would enjoy the benefits gained from the establishment of e- DIA, covering many aspects: addressing the range of potential impacts associated with a proposed development; offering early identification of potential impacts of proposed development; improving decision making process; increasing working efficiency; identifying resource needs and constraints; promoting fairness and consistency in the planning process.; allowing work process integration; and promoting user friendly impact assessment system (UDMS, 2011).

2.2.5 General Procedure for Conducting EIA

Two systematic processes can be adopted:

1, Organizing and Conducting EIA: - Organizing process is involved in developmental planning and technical assessment.

2, Integration of EIA as Planning and Management inputs.

1A) In EIA organization, the planning is a very crucial aspect of project description which includes :-

i), **Screening**: - Screening is seeking the regulatory compliance for the project and its specification through the Agency. In the regulatory process, the project is categorized into three head either it is considered as category 1 which is very sensitive; or category 2 which is

less or moderately sensitive and the third one is category 3 with no impact effect which commence construction after planning and conflict resolution phases.

ii) **Cost effective in your CBA**.

iii) Estimate land requirement and site identification.

iv) Selection of potential sites which attract land application / conflict resolution.

Base data collection involves baseline study and feasibility study (initial environmental evaluation) or preliminary evaluation for site definition, population and forecasts.

1B) in second EIA organization phase, detailed project description on technical assessment is carried which involved the following:-

Further expensive site investigation and field testing programs on land use relationship using Leopold metrics of identification and Battelle's evaluation method, but for Leopold technique involved matching project actions and environmental characteristics and conditions for Leopold method (Antunes *et al.*, 1996).

While Battelle evaluation on checklists of weighing environmental parameters according to their significance by assigning numbers.

1. Development of preliminary design criteria and costs. 2, Evaluation of alternatives. 3, Consideration of alternative on land application and cost effective. 3, Initiation of identification, prediction, and treatment or mitigation design.

2. Conducting EIA for impact assessment: This process involved the following:-

i) Probable impacts of proposed action on the environment such as a) Positive and Negative effects

b) Direct and Indirect consequences c) Short and long term consequences.

ii) Alternative to the proposed action

1. Those that might enhance environmental quality 2, those that might avoid some or all adverse effects 3, Cost benefit of alternatives.

iii) Probable adverse environmental effects.

1. Which cannot be avoided 2, Adverse and unavoidable impacts 3, Mitigative action for avoidable adverse impacts

iv) Relationship between short term uses of environment and long-term productivity, maintenance / enhancement. Irreversible and irretrievable commitments of resources analysis.

3, Integrating EIA for decision making process.

a) Consultation and Public participation b) Reviewing for systematic appraisal of the quality of the EIS.

4, Description of Legislative Development

The International Organization for Standardization (ISO) Standard 14011 covers EIA and includes key steps for carrying out the assessment. These steps include the scope of EIA. EIAs have often been criticized for having too narrow spatial and temporal scope. At present no procedure has been specified for determining a system boundary for the assessment. The system boundary refers to 'the spatial and temporal boundary of the proposal's effects'. This boundary is determined by the applicant and the lead assessor, but in practice, almost all EIAs address the direct, on-site effects alone. Project planning and decision making should include the integrated consideration of technical, economic, environmental, social and other factors. The inventory compiled forms a check list of descriptors for the physical, biological and cultural environment.

The environmental Impact Assessment and its model study address the following environmental effects.

i. **On biophysical and resources**:- The biophysical environment refers to the relation of flora and fauna of an area such as species of trees, grasses, fish, and herpes to fauna, birds and mammals to physical environment of geology topography, surface water and ground water resources, water quality, air quality and climatology. For overall interest of a ecological system, biodiversity factor and any rare or endangered plants and animals species are considered special reference data.

ii. **Social And Cultural Impacts:**- The social and cultural impacts is the vital factors in Nigeria where most displaced slavery and vulnerable towns and ethnic minorities have response to the ill-treatment and non-public participation to EIA development. Pollution climate change, biodiversity cons and lack of construction restoration or rehabilitation are well known occurrence due to inadequate mitigated and poor environmental regulation enforcement. These lead to major controversies such as vandalization of oil pipelines and youth unrest and militancy.

Robert (2005) opined that the social and environmental assessments have not yet become the norm, some assessments are weak, some assessment teams try to protect the multinational proponent rather than the impacted people or the environment, and the mitigation measures provided in the assessments are not always sustainably implemented.

In spite of EIA legislative broad potential as an influential tool of environment decision making; EIA legislation in Nigeria has primarily been implemented in relation to the seating of new projects.

The policy roots in EIA in Nigeria can be found to be first launched in 1988 with Decree No 58 of the Federal Governmental Agency (FEPA) and was amended by Decree No 14 of1999. The decree places on FEPA the overall responsibility for the protection and development of the environment and biodiversity conservation and sustainable development of Nigeria's natural resources in general. The Agency is also empowered to prepare comprehensive national policy on environment and conservation of natural resources including procedure for environment impact assessment for all development projects. In fact, in line with the Global Agenda 21, which Nigeria also attended and in Agenda 21 summit it identifies major priorities that alleviate of poverty, promotion of forestation program particularly in the semi-arid zone, and also suggest mitigation of effects of drought. This is essentially designed to integrate environmental development which seeks to attain sustainable development.

The environmental impact study is only guided by the implementation of the terms of Reference (TOR) provided by the ministry of Environment which based on social, economic, biological and physical criteria.

In 1999, Nigeria constitution (Article) enshrines the basic right of every Nigeria citizen to participate, individually or in a group, in matters which may affect their political, social, cultural and economic life. There exist legislative instruments which endorse and facilitate every Nigerian citizen the rights to participate in decision making that may affect the environment or indigenous peoples rights. Hence of legislative instruments promulgate the proponent a sound legal framework for involving public participation. Despite this, EIA process and procedures still encountered impediment hindering realization of effective public participation because of poor organized and developed institutional framework to implement the legal requirements. There is often a lack of resources within government and representing

institutions which tends to limit the amounts of consultation and facilitation. In fact, yet to mature initiated public participation is a recent notably legislative EIA process that should have encouraged public hearing process FEPA (1986).

2.2.6 Methods used in EA

Types of methods in relative usage include; Analogs, Checklists, Decision-focused checklist, Environmental cost benefit analysis, Expert opinion, Expert system, Indices or indicators, Laboratory testing, Landscape evaluation, Literature reviews, Mass balances, Matrices, Baseline monitoring, Field monitoring, Networks, Overlay mapping, Photographs/photomontages, Qualitative models, Quantitative models, Risk assessment , Scenario building and Trend extrapolation.

Whilst the use of assessment methods and techniques would normally be left to the discretion of practitioners, they may also be prescribed in regulation or guidelines. In this context, EA methods and techniques will differ, according to the sector and tier of application. SEA of a regional land use plan, for example, will require the application of different methods and techniques as an EIA for a road construction project (see Fischer, 2007).

Frequently used methods and techniques:

i. Analogs

Analogs are used to draw on experiences of similar actions in other policies or jurisdictions, countries or regions. In this context, monitoring data should be used to provide for a sound analogy to the possible impacts of a proposed action.

ii. **Checklists**

Checklists have been described as an ad-hoc method (Sadar, 1996). Within checklists, prescribed lists of parameters are used. These provide for environmental parameters to be

checked for possible impacts. In this context, no direct cause – effect links need to be established. The potential benefits of simple checklists include (Sadar, 1996): to apply a simple method for identifying relevant environmental factors for consideration in both, EIA and SEA, to encourage discussion during the early stages of the assessment process and to represent the collective knowledge and judgement of those who developed them.

Checklists may range from a simple listing of environmental factors to a listing that incorporates mathematical modelling. An exhaustive approach should be followed to ensure that nothing has been left out. There are also limitations when using checklists. For example, neither are checklists able to discover interdependencies, connectivities or synergisms between interacting environmental components, nor are they able to describe variations of environmental conditions. Finally, they do not provide information on specific data needs.

iii. Expert opinion

Opinions and perspectives from recognized experts in relevant fields are often used in an attempt to resolve complex situations in a relatively short period of time. In this context, consultations or workshops may be used. Consultations are frequently conducted with a help of questionnaires. Workshops may include structured meetings, for example, with a problem solving focus for developing alternatives.

iv. Mass balances

Following Canter (1998), mass balance calculations refer to the analysis of existing situations and conditions with those that may result from proposed actions. They are mostly used in the context of air and water emissions as well as solid and hazardous wastes. Mass balance methods have a particular high utilization in project EIA processes.

v. Matrices and interaction diagrams

Matrices usually take the form of a grid diagram or a two-dimensional table for cross-referencing a list of actions with environmental impact parameters. In this context, activities

associated with various phases of a project or strategic action can be listed along one axis, with environmental components listed on the other. Inputs into a matrix can either be qualitative or quantitative. The simplest matrices indicate only the occurrence of an impact without any references to magnitude or significance. In more sophisticated matrices, quantitative estimates of impact magnitude and significance can be combined with a weighting scheme, leading to an „impact score". The advantages of using matrices have been described by Sadar (1996) to include: a visual description of the relationship between two sets of the proposal being assessed, an identification of the impacts of different phases of a project or strategic action and an identification of separate site-specific impacts affecting a region as a whole (even though it may be better to describe different aspects of a proposal, using separate matrices).

Several types of matrices have been used in EA practice (for example, Leopold matrix, Peterson matrix, Component Interaction Matrix). The best known example is probably the Lepold Matrix (Lepold et al., 1971, see Figure 16.1), representing a pioneering approach to EIA. This matrix was designed for the assessment of impacts associated with most types of construction projects, listing 100 different project actions along one axis and 88 environmental characteristics and conditions along the other, including aspects of both, the biophysical and socio-economic environments.

v. **Qualitative models**

Qualitative models refer to descriptive methods where relevant information is utilized to address the implications of actions that can result in changes to environmental components. It is a method usually based on expert opinion, i.e. professional judgement.

vi. Moderately used methods and techniques Decision-focused checklists

These represent lists of environmental factors, including information on measurement, impact prediction and assessment. They are useful for the comparative evaluation of alternatives, and

may be used, for example, for ranking environmental factors and associated impacts in order of their relative importance, thus providing a basis for selecting the preferred action.

vii. Indices or indicators

Indices or indicators comprise selected features or parameters of environmental media or resources, representing broader measures of the quality/quantity of such media or resources. Indices may specifically refer to either, numerical or categorized information which can be used in describing the affected environmental and impact prediction and assessment, typically based on selected indicators and their evaluation (Canter, 1998). Figure 16.2 provides for an example of transnationally approved indicator set for a regional plan case study.

viii. Laboratory testing

This method is useful for impact identification and impact prediction at the project (i.e. EIA) level. It involves conducting specific tests or experiments to gain both, qualitative and quantitative information on predicted impacts of a certain type of project in a given location.

ix. Landscape evaluation

Methods and techniques of landscape evaluation are being used for visual and amenity assessment when focusing on the description of affected environments. Landscape evaluation is based on indicators, criteria and thresholds. Important information can be aggregated into overall scores. Landscape impacts include direct and indirect impacts of actions upon landscape elements and features, as well as impacts on the general landscape character and quality of surroundings area. Landscape evaluation can be linked with carrying capacity assessment. This is a tool used in land use planning assessment for setting development thresholds according to sensitivities of environmental and social systems. This method is particularly useful in the assessment of cumulative impacts and sustainability thresholds.

x. Literature reviews

Literature reviews can be used in the EIA process at different procedural stages (e.g. impact identification, impact prediction, impact assessment). Similar to analog methods, this method is about the collection of information on types of actions and their impacts. Literature reviews may allow EA practitioners to identify the linkages between policy actions and environmental impacts, using documents like state of the environment reports and/or environment policy plans.

xi. Networks

These are used to identify the structure, key elements and interactions in a given system, using e.g. decision flowcharts and loop analysis. A network diagram visually describes cause-effect linkages. In this context, different levels of information can be displayed. The relative dependence of one factor on the condition of another may be indicated by various arrow widths and heights. Negative and positive feedback loops can also be identified, if the nature of the interrelationship is indicated.

xii. Overlay mapping

The overlay mapping technique is based on a set of maps of project effects, or environmental characteristics or themes (biophysical, social, aesthetic), for example, in order to provide for a composite characterization of a regional environment. Impacts can then be identified by noting the affected environmental characteristics within the project area boundaries. Overlay mapping is normally used to identify areas which are compatible with the proposed action. There are some limitations when using this method, as follows (Sadar, 1996): maps tend to oversimplify, specific interrelationships between environmental factors are not readily obtainable using traditional map overlays and map overlays cannot effectively describe ecosystem dynamics through time.

xiii. Photographs/photomontages

Photographs and photomontages are visualisation methods related to landscape evaluation (Canter, 1998) that can be applied in order to describe affected environments, as well as for impact prediction. They can be helpful to analyse the visual quality of the project site/affected area and the potential visual impacts of proposed actions. Their advantage is that they can show the development within real landscape and from known viewpoints. Various CAD systems help with their application. Photomontages are actually the superimposition of an image onto a photograph in order to create a realistic view of proposed potential visual changes. Figure 16.6 shows examples of computer generated and hand painted photomontages.

xiv. Quantitative models

These are mathematical models that are used specifically for addressing expected changes in environmental media or resources. They range from simplified to very complicated models (for example three dimensional computer-based models) that may require extensive data input. In most cases, models are used for the description or prediction of changes in properties of the system over a time period. Quantitative modelling is most effective when environmental factors are easily quantifiable, so that they can easily be assigned a mathematical value.

xv. Low usage of methods and techniques Environmental cost-benefit analysis

This is used to select the best option for achieving set targets or goals at least cost (environmental or financial). It is based on identifying a benefit–cost ratio for choosing between different options.

xvi. Expert systems

Expert systems represent task-specific models which may or may not be computer based. They incorporate both, knowledge and experience of experts from different fields and from

relevant disciplines. Knowledge is fed into a structured decision-making analytical tool. Expert systems are based on value judgements and best-guesses about likely outcomes.

xvii. Baseline monitoring and field studies monitoring

Baseline Monitoring is a measurement method utilized to establish existing environmental conditions and interpret the significance of anticipated changes of proposed activities. Field study monitoring represents a specialized approach. Here, monitoring of actual impacts, resulting from specific types of projects can be conducted.

xviii. Risk assessment

This is a method focusing on the assessment of strategic risks of a proposed action. In this context, trends that may undermine objectives and quality standards generating potential relevant damages and costs need to be considered.

xxi. Scenario building

Scenarios are used for projections to outline and compare means and conditions of the implementation of a proposed action based on reasoned assumptions. It is commonly used in land use and transport planning.

xxii. Trend extrapolation

Following Canter (1998), this method refers to utilization of historical trends, extending them into the future based upon assumptions. These are related to either continuing or changed conditions.

2.2.7 Methods and Techniques of Public Participation

Public participation is a fundamental principle of environmental assessment (EA) processes in both, project related environmental impact assessment (EIA) and strategic environmental assessment (SEA) of policies, plans and programmes (PPPs). EA is thus a participatory tool

for supporting decision-making at project and of strategic levels of decision making. The importance of public participation has been underlined by the Aarhus Convention (United Nations Economic Commission for Europe, 1998), which entered into force in 2001. Public participation is also an essential component of the EA processes regulated by the European EIA (EC, 1997) and SEA (EC, 2001) Directives. Public participation within EA offers a variety of opportunities. For SEA, these have been summarized by Heiland (2005).

Aschemann (2004) mentioned the use of maps and plans, hearings, meetings, media (e.g. print media, radio, television, Internet), use of the qualified public, workshops and roundtables. Moreover, Heiland (2005) named flyers or leaflets, exhibitions, public displays and other methods.

Aschemann (2004) allocated the different methods and techniques mentioned above to the three categories “information”, “consultation” and “more active measures/methods Other methods and techniques include e.g. the use of Geographic Information Systems (GIS) and other information and communication technology (ICT) tools, the Delphi methodology, future and/or agenda conferences, the “open space” method, site visits, staffed telephone lines and others - including suitable combinations of different methods. The methods and techniques should be chosen, depending on the spatial and administrative level of the project or PPP subjected to the EA process, as a local transport plan requires other methods than a national waste management policy. Thus, for projects or PPPs of small municipalities, the whole population could be invited to attend workshops or hearings, whereas at national level this would be impossible. The use of the internet should be seen only as an additional measure for participation, as, for example, elderly people or the majority of people in

developing countries often do not have access to it. Any confidentiality issues should be disclosed in advance.

There is no "cooking recipe" for selecting the most suitable and appropriate participation methods and techniques. Rather, tailor-made solutions have to be found that should take into account the subject of the EIA or SEA, considering its contents and level of detail as well as its stage in the decision-making process. Moreover, that different methods and techniques require different amounts of time and money needs to be taken into account, e.g. to set up an internet homepage is normally cheap, whereas a TV spot tends to be very expensive. The maintenance and update of an internet homepage could be time consuming, whilst the public display of a map could be done quickly. Additionally, the environmental and demographic profile of a country, its environmental problems and its stage of economic, social and technological development should be kept in mind when choosing appropriate (public) participation methods and technique (United Nations Environment Programme, 2002).

2.3 LITERATURE REVIEW

2.3.1 The Evolution of Environmental Impact Systems in Nigeria

Dan-Habu, (1996), Okorodudu-Fabura, (1988) and Isichei, (2000) show that the initial focus of environmental awareness and legislation in Nigeria was on the petroleum industry. The initial belief in the country was that only the petroleum sector required close environmental monitoring. Environment legislations came in the form of pollution reduction measures that reacted to local problems within the petroleum industry. Several industry regulations—under the authority of the Petroleum Act, 1969—were promulgated to regulate the exploration of petroleum in Nigeria, and control pollution. The regulations were more reactive than

proactive and bear a resemblance to the first of the Canadian EIA evolutionary stages, as noted by Gibson (2002).

Nigeria also participated in the May 1982 10th Anniversary of the Stockholm Conference, which reaffirmed participants' commitment to the protection and enhancement of the quality of the human environment. In April 1982, Nigeria hosted the 69th Inter-Parliamentary Union Spring Meetings at which the Committee on Education, Culture and Environment adopted a draft resolution on the 'State of the World Environment Ten Years after the UN Conference on the Human Environment' and the steps to be taken for improvement including the fields of national and international legislation. Participation in such international conferences served to build awareness, policy and preliminary institutions (Okorodudu-Fabura, 1988).

Dan-Habu, (1996), Okorodudu-Fabura, (1988) and Isichei, (2000) pointed out that the law that governs EIA practice in Nigeria as adopted in 1992 is the main document explaining the system and principles of EIA in Nigeria. In Nigeria there are three independent EIA systems in operation —the EIA Decree 86 (1992), the Town and Country Planning Decree 88 (1992) and the Petroleum Act (1969). Ogunba (2004) observed that whilst the current practices of the three EIA systems in Nigeria were at different stages of evolution, the EIA schemes (the Town and Country Planning Decree) has not evolved satisfactorily, whereas the other two EIA systems (Petroleum Act and EIA Act) have produced intricate legislations and guidelines, but fall short of first-rate practice. Additionally, there are several supporting orders exploring the provisions for public involvement in the processes of screening, drafting the guidelines, scoping, reporting, etc.

Ogunba (2004) pointed out that public opinion must be considered when taking the final decision regarding the likelihood of significant effects and the need of a full EIA study

(Ogunba, 2004). In a typical Impact Mitigation Monitoring (IMM) exercise, the following statutory actions are carried out: Facility inspection, Interactive session with project managers on the Mitigation Checklist for the EIA of that project, Interview and interaction with the action party responsible for ensuring full implementation of a particular action, Inspection and Verification of the parameters that shall be monitored to ensure effective implementation of that action, Check the timing for the implementation of the action to ensure that the objectives of mitigation are fully met, Interact with project Engineers and Technicians on mitigation measures that are not applicable, or not enforceable or still not practicable in line with good environmental principles with a view to finding out practical alternatives (Ogunba, 2004).

2.3.2 Strength and Shortcomings of EIA in Nigeria.

i. Nature of the administrative setup

The legislative provisions and guidelines for EIA in the country are quite comprehensive. However, 57 % of the respondent agreed that lack of implementing mandatory requirements for EIA including no use of powers to impose fines resulting in the development and operation of many projects, is likely to cause environmental and socioeconomic impacts, without undergoing an EIA. Furthermore, proponents take the responsible authorities for granted for lack of coordination in enforcement machinery. Thus, projects for which EIA is carried out, may take place after procurement of site or even after start of construction and hence EIA becomes just a formality. Similar trend was also noted in Lithuania (Kruopienė, *et al.,* 2009).

ii. **Weak coordination**

Sixty percent of the respondents agreed that coordination among EIA proponents/consultants, Department of Petroleum Resources and Federal Ministry of Environment, local financial institutions and the line departments are generally weak. This is leading not only to the inadequate consideration of concerned departments' views in the EIA report but also to the start of development works prior to getting EIS and certificate.

iii. Few EIA production per annum

The EIA production rate of the country has been approximately 23 per annum during the last five years (Suleiman, 2007). Respondents agreed that there is slow pace of EIA production in Nigeria (67%). Data regarding average time of approval of an EIA are not available. Some of the EIA reports are not yet approved. However, this is not an indication that all such projects are stopped. How many projects for which EIA was required by law but have been developed during the last seven years without EIA is also unknown. The investigation of these aspects may provide useful insights into the cause of delays as well as the weight given to various types of impacts and to the public opinion during review.

iv. Inadequate screening and scoping

The unit in DPR and Federal Ministry of Environment responsible for screening and processing initial environmental examination (IEE) of public sector projects appear to be one of the causes of no or late initiation of EIA studies, if so required under the law. Being an in-house department for government projects, it sometimes ignores the requirement of EIA due to political pressure. Furthermore, inadequate involvement of stakeholders and the concerned experts during scoping is resulting in a thin coverage of environmental and socio-economic issues in the EIA reports (Suleiman, 2007).

v. Limited scope of EIA review

EIA review process involves third party participation that ultimately enhances the quality of EIA study and final report. This third party involvement in the review can be marked as a salient feature of the EIA process in Nigeria. Although, an independent EIA review commission does not exist in Nigeria, more resources are expected to be allocated by the government to transform third party involvement into formal review bodies. Fifty-five percentage of the respondent agreed that some anomalies exist in the process due to lack of technical capacity and subjective review. Political pressure is also causing approval of poor quality EIA reports (Suleiman, 2007).

vi. Poor quality of EIA reports

The quality of EIA report is a reflection on the competence of the EIA consultants and the review committee members. The overall quality of EIA reports is unsatisfactory. The lack of experience of EIA consultants and approval authorities along with reluctance on part of the proponents to allocate sufficient resources are some of the impediments to a better quality EIA. In addition to that, there is no code of conduct for EIA consultants; not even any requirement of registration. In many cases, a consultant's role has been limited to highlight the economic benefits and justify the project forgetting environmental approval.

vii. Weak public participation

The active public participation is considered to be the key strength of the EIA process in Nigeria. This topic gets the most important place from respondents (79%). According to the official national requirements (guides for public information and participation in EIA Act 1995), the general public is informed about EIA process and has a realistic chance to actively participate throughout all phases of the application: from the very beginning (screening process) up to the final development consent. The mass media and local municipalities are involved in spreading the information. Moreover, the applicants and regulators must follow

the legal requirement to organise a series of presentations on the intended projects that may be requested/organized at any stage, e.g. in a screening procedure (Suleiman, 2007).

Public opinion must be considered at all times and only highly qualified arguments may serve as grounds for its refusal. However, the major drawback is that general public in Nigeria is comparatively indifferent and poorly informed about the potential negative environmental effects, and especially the long-term impact. The training of personnel, the guidelines, the discussions on EIA are usually in English. Quite often, the affected public is not adequately informed of the issues at hand or able to interpret the EIA reports. These difficulties are partially alleviated by public hearings where explanations can be provided face- to- face by the Project Proponents and EIA consultants (Suleiman, 2007).

viii. Inadequate implementation of mitigation measures and monitoring.

Quite often, EIA are approved on the basis of proposed mitigatory steps and monitoring. Post-EIA monitoring has been poorly implemented so far. The implementation of an environmental management plan, mitigation measures and post-decision monitoring are some of the weakest facets of Nigeria's EIA system. These weaknesses can be explained by the lack of adequate workforce, logistics and enforcement machinery. While the project proponents (usually industrialists and government departments) are highly influential, responsible agencies are considered among the weakest government agencies. Political manifestos, generally speaking, are to encourage investment in the development sector. There is a need to transform political will in favour of development but not at the cost of environment (Suleiman, 2007).

Ix The rational for the adoption of EIA in Nigeria can basically be anchored on the following;

1. To achieve Reactive pollution control through measures responding to identified local problems (usually air, water, or soil pollution), with solutions considered to be technical

matters to be addressed through closed negotiation of abatement requirements between government officials and the polluters.

2. To ensure Proactive impact identification and mitigation through impact assessment and project approval/licensing, still focused on biophysical concerns (though now integrating consideration of various receptors) and still treated as a largely technical issue with no serious public role (but perhaps expert review)

3. To achieve Integration of broader environmental considerations in project selection and planning through environmental processes with consideration of socioeconomic as well as biophysical effects obligatory examination of alternatives, aiming to identify the best options environmentally as well as economically, and public reviews (that reveal expert conflicts and uncertainties, and consequently the significance of public choice).

4. To achieve Integrated planning and decision making for sustainability, addressing policies and programmes as well as projects, cumulative and global effects, with review and decision processes devoted to empowering the public, recognizing uncertainties and favouring precaution, diversity, adaptability, and so on, expecting positive steps towards sustainability.

2.3.3 Need for practical GIS methods in environmental studies (EIA, planning and monitoring)

A Geographical Information System (GIS) is a computer-based tool for handling spatial data. In the digital format used, the information is more condensed than conventional types of data storage. In such a system, large quantities of data can be maintained and retrieved at greater speeds and lower costs per unit than is the case with conventional methods. A GIS also performs manipulations and analysis of the available information (Aronoff, 1989).

Strömquist and Larsson, (1994) found that large projects where EIAs are required for environmental planning and monitoring, there is apart from the need for a practical way to collect the data, also a need for practical methods of retrieving and storing the gathered information. Finding tools for comparative studies of different types of spatial data is also desirable. In this respect, GIS is a tool that might be well suited. In all environmental issues there is a spatial component and where most EIAs are concerned, there is a wide range of data to be handled. EIAs are often expensive enterprises and also frequently have a short time-span to work in. In this context, the need for a practical method of dealing with the gathered information is apparent. However, Yapa (1991) states that in order to be effective a GIS must be introduced in the organisational context in such a way as to maximise the use of the system within the whole organisation. This is particularly true for developing countries as the situation in these countries are quite different in many respects from what the case is in the West where the GIS technology was developed. Unfortunately, there have been frequent examples of the introduction of GIS as a pure "add-on" technology. With these often failed attempts in mind, GIS should not be viewed as a scientifically objective and value-free technology. It should rather be looked upon as a product of the industrial societies of the West. In the socio-economic context, there are obviously different conditions in the West and in developing countries. This also has implications for the transfer of the GIS technology to the developing world. The application, research, training and education concerning GIS in developing countries may need approaches that are quite different from the existing methods. In order for

GIS to fulfil its potential as a tool for development, it must thus be adapted to the particular social, economic and political reality of each nation. Hence, it is necessary to involve the indigenous scientists as they have knowledge of the GIS technology and the development situation and needs of their respective countries (Taylor, 1991).

Teeffelen *et al.* (1992) found an evident that GIS technology offers many opportunities for improved handling and analysis of spatial data in a number of different applications. At the same time the many constraints to the effectiveness of GIS, particularly in developing countries, should be stressed. Many of these are common to most applications and three categories can be distinguished according to van.

2.3.4 Decision Support Tools (Manual and GIS Map Overlays)

ESRI (2005) pointed out that the manual and GIS map overlay technique has always been extremely useful in identifying areas that have high environmental sensitivity. The technique entails the separate mapping of various critical environmental features - wetlands, steep slopes, soils, floodplains, bedrock outcrops, wildlife habitats, vegetative communities, and cultural resources at the same scale as the project's site plan. The environmental features are mapped on transparent plastic in different colours. The maps are then overlain on the project map to highlight the areas of highest environmental sensitivity.

Nowadays Geographical Information Systems (GISs) are used to computerise the overlay process. Environmental features are mapped, and the mapping digitised and stored in the GIS database. The mapped features can be combined to produce computer-generated displays of one or more environmental features in a specified geographical area. If the GIS mapping is conducted systematically, information acquired on specific projects can be combined, and the GIS database becomes more detailed over time. Even if resources or time do not allow you to physically construct overlays or to use a GIS system, comparing the maps of information about the setting with maps or plans that you have of the proposed action can be very useful.

The comparison should explore how various kinds of resources/areas may or may not overlap with the geographic area affected by the proposed action. The Environmental Assessment Practitioner will need to be careful about comparing maps of different scales, so you will often not have a precise indication of areas of overlap, but you will be able to see areas of potential conflict that need to be investigated further ESRI (2005).

2.3.5 GIS Solutions for Environmental Management

Responsible and successful environmental management is necessary for protecting and restoring the natural environment. The interdependency of the earth's ecosystems and the human impact on the environment present complex challenges to governments and businesses as well as scientists and environmentalists in every discipline ESRI (2005). Geographic information system (GIS) technology is used to support and deliver information to environmental managers and the public. GIS allows the combination and analysis of multiple layers of location-based data including environmental measurements. The environmental application areas of GIS are varied in terms of potential users, environmental spheres, and the specific environmental issue being investigated.

2.3.6 GIS for Environmental Data Management and Analysis

Joa˜o and Fonseca (1996) pointed out that GIS were used for all EIA stages. The most frequent use was for the presentation of results, followed by analysis/modelling and data preparation. GIS have also been used for the presentation of environmental baseline information and project description, through the preparation of thematic maps for the several environmental descriptors.

ESRI (2005) opined that on a scientific level, GIS for environmental analysis is used to explore the spatial relationships, patterns, and processes of geographic, biological, and physical phenomena. The two primary methods of geospatial analysis include quantitative mapping and thematic mapping. A quantitative map shows how much of something is in a selected area. It is a spatial representation of numeric values such as temperatures, population density, elevation, pollution levels, and so forth. A thematic map demonstrates a specific feature or concept such as judicial boundaries, soil types, or flood zones ESRI (2005). The combinations of data for environmental geospatial analysis are endless.

Spatial analysis employs the data-mining technology of a geographic database, or geodatabase. With it, you can document different layers of separate information sets and use spatial analytic tools to mine datasets across a diverse range of disciplines. The geodatabase provides the common data access and management framework for ArcGIS. It defines the types of data that can be used in ArcGIS—features, rasters, addresses, attributes, networks, topologies, survey measurements, and relationships— and controls how they are represented, accessed, stored, managed, and processed ESRI (2005). The ArcGIS geodatabase offers useful features such as

• Quality assurance and control of new data can be assessed and transaction histories recorded and presented sequentially.

• Data can be modelled to allow those responsible for data management and collection to have control over its quality.

• Data can be versioned to allow multiple users to carry out simultaneous updates with long transactions.

• A variety of data formats can be filed and processed for spatial visualization. Geospatial analysis offers insight about the environment and reveals management options. GIS

incorporates powerful tools to model the relationships among geographic data for geospatial analysis. Here are some examples of tools and applications useful for advanced geospatial analysis of environmental geographic data.

Surface Interpolation: Visiting every location in a study to measure the height, magnitude, or concentration of a phenomenon is usually difficult or expensive. Surface interpolation functions create a continuous surface from sample locations and make predictions from sample measurements to create continuous surface representation. Use

ArcGIS Spatial Analyst tools to choose the best interpretation method for your specific data. Each interpolation method produces predictions using different calculation methods from inverse distance weighted to kriging.

Temporal Analysis: Observing environmental change over time indicates trends and patterns. ArcGIS Tracking Analyst provides tools for display and analysis of time series data. It is useful for playing back historical data, integrating temporal data within the

GIS, and charting and analysing change in historical or real-time data ESRI (2005).

2.3.7 Remote sensing and GIS applications in urban planning.

Tiwari, (2006) opined that planning is a widely accepted way to handle complex problems of resource allocation and decision-making. It involves use of collective intelligence and foresight to chart direction, order harmony and make progress in public activities relating to human environment and overall development. In order to provide more effective and meaningful direction for better planning and development necessary support of the organization has become essential. Hence the need for a suitable information system is increasingly being felt in all planning and developmental activities, whether these are for urban or rural areas. The positive aspects of urbanization have often been overshadowed by

deterioration in the physical environment and quality of life caused by the widening gap between supply and demand for basic services and infrastructure.

Dhawale and Landge, (2000) pointed out that the complexity of urban development is so dramatic that it demands immediate attention and perspective physical planning of the cities and towns The dynamic nature of urban environmental necessitates both macro and micro level analysis. Therefore, it is necessary for policy makers to integrate remote sensing with urban planning and management. Traditional approaches and technique designed for towns and cities may prove to be inadequate tools when dealing with metropolis. New approaches are required, and new methods must be incorporated into current practice. Until recently, maps and land survey records from 1960 to 70 were used for urban studies, but now the trend has shifted to use digital, multispectral images acquired by EOS and other sensors.

Patkar, (2003) noted that remote sensing can provide an important source of data for urban land use/land cover mapping and environmental monitoring. Urban land cover/use mapping has received an increasing amount of attention from urban planners and scientists including geographers. A numbers of significant studies were made for environmental quality management. Thus, various techniques have been applied for mapping urban land use/land cover. It helps in encroaching urban problems even of very small magnitude and dire.

CHAPTER THREE

THE STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter gives a description of the study area and methods involved in achieving the aim and objectives of the study.

3.2 THE STUDY AREA

3.2.1 Location, Position and Size of the Study Area

The study area for this research work is FHA's newly acquired site near Kuchiko village in the Bwari Area Council of the FCT. The site consists of two parcels of land (Plots 7674 and 7675) with a combined land area of 330.044ha. The two sites are however separated by a corridor of 100m, reserved for Abuja Light Rail Project work currently on-going.

The sites are close to the Law School in (Bwari). The area lies between Latitudes 9° 5' 11''-9° 7' 2" North of the Equator and Longitudes 7° 22' 33''-7° 25' 36" East of the Greenwich Meridian. It shares boundary with proposed Kuchiko layout schemes of the FCTA to the North, South and East. It also shares boundary to the West with Niger State as show in figure 4.I

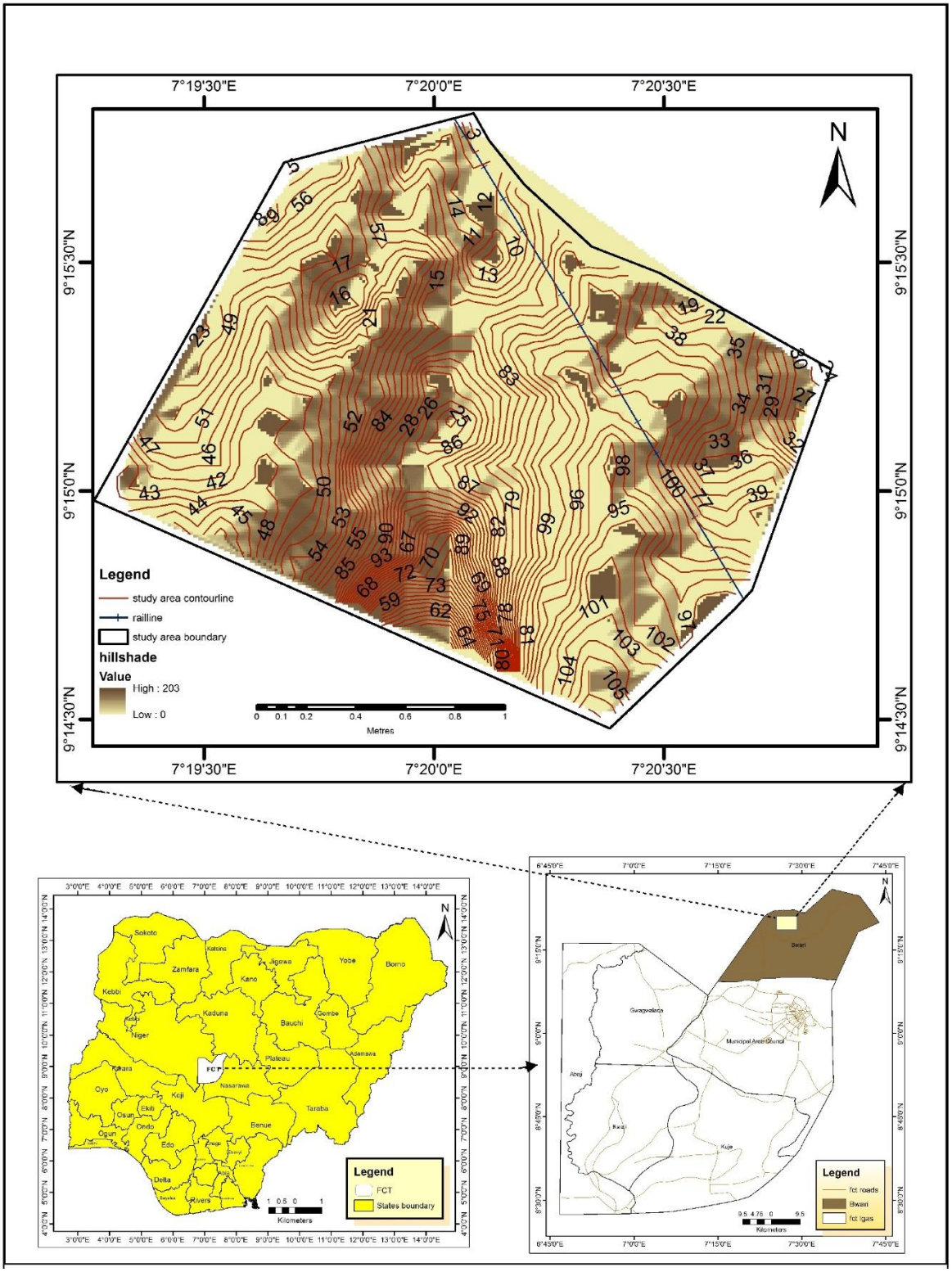

Figure 4.1 Map of the Study Area
Source: Modified from Administrative Map of Nigeria 2014

3.2.2 Climate

The FCT experiences Aw or Tropical Continental climate according to Trewartha's modification of Koppen's climatic classification (Money, 1976). The Aw climate is characterized by six months dry season from November to April and six months rainy season from May to October.

However, within these seasons is a brief harmattan season that is occasioned by the north east trade wind and the attendant dust haze, increased cold and dryness. Weather conditions in Abuja are influenced by its location within the Niger Benue trough on the windward side of the Jos Plateau and at the climate transition zone between the essentially 'humid' south and the 'sub-humid' north of the country. The climatic dictates of the FCT are essentially from the South West to the North Westdue to the rising elevation from the Gurara valley in the south west, to the Bwari-Aso hills and the Agwa-Karuhills to the north east (Money, 1976).

The rainy season begins from March and ends in October, when daytime temperatures reach 28 °C (82.4 °F) to 30 °C (86.0 °F) and night time lows hover around 22 °C (71.6 °F) to 23 °C (73.4 °F). In the dry season, daytime temperatures can soar as high as 40 °C (104.0 °F) and night time temperatures can dip to 12 °C (53.6 °F). Even the chilliest nights can be followed by daytime temperatures well above 30 °C (86.0 °F). The high altitudes and undulating terrain of the FCT act as a moderating influence on the weather of the territory (Money, 1976).

The climate of the region has a direct effect on the human activities of farming in the area. Yam moulds are usually prepared in the dry season and planting of yam tuber seedlings done

just before the rains set in. The major human activity in the study area for the proposed development is farming.

3.2.3 Soil and Vegetation

On the aforementioned rock types, Zonal Tropical Ferruginous soils have developed through the process of laterisation. The soil structure of the area is thin with texture generally stony to gravelly sand with smaller occurrences of loam (Ojigi, 2005). The vegetation is southern Guinea Savannah biome characterized by deciduous trees scattered among grasses. However, some of the areas are forested because they have not suffered much de-vegetation while some of the forests fringe the streams which are relatively wet all over the year (Money, 1976).

3.2.4 Geology, Relief and Drainage

The underlying rocks of the FCT consist basically of Basement Complex and sedimentary rocks. The Basement Complex rocks made up of igneous and metamorphic rocks cover about 48 % of the total area and in some places the land is occupied by hills and dissected terrain (Mabogunje, 1977). The rocks consist mainly of schists, gneiss and older granite. The mountain ranges together with some isolated inselbergs are believed to have been poured out of volcanoes within the Tertiary period. The areas underlain by the sedimentary rocks cover about 52 % of the total area of the Federal Capital Territory and largely constitute the undulating plains. These plains form present day remnants of erosional processes of the Quaternary period.

Towards the south west of the Federal Capital Territory there exist sand ridges with outliers of sandstone capping. Sandstone and clay also occur in significant proportions of parts of Abaji and Kwali Area Councils. These areas are easily dissected and indeed exhibit very

glaring evidences of severe gully erosion (Balogun, 2001). Okechukwu (1974) and Kogbe (1978) also described the geology of the Federal Capital Territory as almost predominantly underlain by high grade metamorphic and igneous rocks of Precambrian age. These rocks consist of gneiss, migmatites and granites and schist belt outcrops along the eastern margin of the area. The belt broadens southwards and attains a maximum development to the south-eastern sector of the area where the topography is rugged and the relief is high. In general, the rocks in the FCT are highly sheared.

The topography is rugged and undulating with the basement rocks outcropping as hills and inselbergs. The Gwagwa plains occurring at the west of the FCT are underlain by migmatites and gneisses, and stand about 305m in the south-west and 516m in the east above mean sea level. These plains form part of River Usumanu that originates in the Bwari-Aso hills. The drainage pattern generally varies from trellis to dendritic. The area is drained by many rivers in and around Abuja including Rivers Gwagwalada and Usmanuwhile Rivers Wupa, Wosika and other smaller seasonal southerly-flowing streams form the tributariesand drain the study area. These rivers depend on rainfall for their recharge. As such, their volumes are high in rainy season and decrease appreciably in the dry season (Balogun, 2001).

3.2.5 Population and Human Activities

Abuja is the capital city of Nigeria. It is located in the centre of Nigeria, within the Federal Capital Territory (FCT). It is a planned city, and was built mainly in the 1980s. It officially became Nigeria's capital on 12 December 1991, replacing Lagos, which is still the country's most populous city. At the 2006 census, the city of Abuja had a population of 776,298, making it one of the top ten most populous cities in Nigeria. The unofficial metropolitan area of Abuja is well over three million, which would make it the fourth largest urban area in

Nigeria only surpassed by Lagos, Kano and Ibadan. As the results of human activities, from 1980 to date, the changes in urban land use(s) and surface cover has been on the increase due to massive social, economic and construction activities in the designated areas of the FCT (Ojigi, 2005).

The study area and its vicinity are ideal and conducive for human habitations, agricultural activities and settlement development. This is evidenced with the urban town of Bwari with its rich cultural, Educational and Commercial nature. The accompanying plates show the baseline situation of Bwari Urban Centre. The area is also rich in infrastructure such as tarred and untarred road networks, electricity, drainage as well as facilities such as primary school and institute of legal studies.

3.3 METHODOLOGY

This section describes the various types of data, sources and methods that were employed in the study.

3.3.1 Reconnaissance Survey

Reconnaissance survey was carried out to acquaint the researcher with the knowledge of the study area and to help in preliminary field data collection techniques such as the extent of the different sections of the parcels of land and the relationships of parts of the localities.

3.3.2 Types of Data Required

The types of data used for this study include:

i. Beacon sheet perimeter survey of the study area, with coordinates.
ii. Landsat 8 ETM^{+} image (30m resolution) of the study area and environs for rainy season (August) for the year 2013 and dry season (February) for the year 2014.

iii. Also, shuttle Radar Topographic Mission Image for the study area was acquired.

iv. Existing literature from journals, textbooks, conference proceedings, seminar papers, thesis, reports and web references.

3.3.3 Type and Sources of Data

The data sources and data used for this study have been summarised in table 3.1.

Table 3.1: Summary of Type and Sources of Data employed for the study.

S/No	Type of Data Required	Source of Data	Purpose
1	Beacon sheet perimeter survey of the study area with coordinates.	Was acquired from the Land Survey Unit of FHA Abuja.	Was used to plot and map out the size of study area in the ArcGIS 10.1 environment.
2	Landsat 8 satellite Image of August 2013 (wet season) and Feb 2014 (dry season).	Global Land Cover Facility (www.ftp//glcf/landsat)	Used to generate the land use land cover for the study area. All were done in ArcGIS 10.1 environment. Also used as some of the baseline data for the EIA analysis.
3	Shuttle Radar Topographic Mission Image. DEM, slope, aspect, coverture, contour and hillshed.	Shuttle Radar Topographic Mission (SRTM) with 90m resolution was downloaded from Global Land Cover Facility (www.ftp//glcf/landsat)	Used to generate the Digital Elevations Model (DEM) data, this in turn was used to generate contour map and run other site analysis for the study area as parts of the baseline data for the research.
4	Literature from thesis, journals, textbooks, conference proceedings, seminar papers, reports and web references	Secondary sources of data.	Used to gather relevant information for the study, literature and methodologies etc.

Source: Research work, 2014.

3.3.4 Fieldwork

The field work was embarked upon to enable collection of relevant field data as well as ground trothing was done and coordinates of the location of the location of the study area was obtained with the aid of Global Positioning System (GPS).

3.3.5 Software and Hardware Requirements.

(i) ESRI ArcGIS 10.1 was used for thematic layer generation/ extraction of the various theme maps. These were later used for subsequent analysis.

(ii) Erdas Imagine 9.2 was used for digital image-processing of the satellite imagery

(iii) MS Office 2007 was used for report writing and subsequent presentations of the work.

(iv) Hardware used includes Laptop, Scanner and Printer.

3.3.6 Data Processing

Remotely sensed data are not free from internal and external errors such as radiometric and geometric distortions. Since the data to be used were auto-rectified, there is no need for geometric and radiometric correction to be performed on them. However, the major pre-processing was done on the image that was geo-referencing. (Arc GIS 10.1) was used in processing and analyzing images as well as other geographic data acquired for this research.

3.3.6.1 Image Geo-referencing

The datasets along with Topographic map was georeferenced or georectified (registration) to a geographic coordinate system. The image was imported into Erdas Imagine 9.2 environment was rectified to a common projection (Universal Traverse Mercator). According

to Wilford (1977), the UTM projection unlike the Geographic Coordinate System (latitude/longitude) is more reliable since its measurements are cited in linear, decimal units, rather than in angular, non-decimal units (Wilford, 1977). This was done to translate the images real world coordinate to digital format so that it can be matched with other relevant and related maps that was used in this study. The georeferencing involves registering data to the real world was carried out by assigning geographic information like location and position, to the data sets (images). This helps in identifying the existence of those data sets in physical space as well as establishes their location in the real world.

3.3.6.2 Image Sub-setting

Landsat (ETM +) imagery of 2014 with spatial resolution of 30m was used for the study. The portion of interest (Bwari Area Council) was subset from the larger scenes using ArcGIS 10.1 software since the satellite images comes in bands and cover large area.

3.3.6.3 Image Classification

In classifying the images into various classes, supervised classification technique was performed using maximum likelihood classification (MLC) algorithm. This technique enables analysts to generate training classes based on the actual land-use/land-cover themes present within the study area and helps in curtailing ambiguity that is associated with the unsupervised technique of image classification according to Liu, Skidmore and Oosten (2002). The MLC is the most widely and commonly used with remotely sensed data, and is proven to yield the best classification result (Jensen, 1996). The attribute and statistics from the classification result was generated and used for post-classification comparison between the satellite imagery and new town development plans.

Based on the prior knowledge of the area and reconnaissance survey, a classification scheme after Anderson, Hardey, Roach and Witmer, (1976) was adopted and modified for this study. The classification scheme utilise five (5) classes thus Urban/Built-up, vegetation, water body, bare land and rock out crop.

3.3.7 Data Analysis

This section presents the various data analytical techniques used for this study.

3.3.6.1 Characterization of Baseline Data

In order to achieve this objective, working folder was created and all relevant data stored in the folder. ArcGIS 10.1 environment was activated and the data frame was geo-referenced. The working folder was linked to the ArcGIS 10.1 environment. Shapefiles were then created in ArcCataloque that led to the creation of several theme layers that represents raster and vector layers.

The Beacon sheet coordinates of the study area was then plotted in order to delineate the study area. Baseline data on Landuse/Land cover; DEM; Contour map; Slope Analysis; Viewshed; Watershed; Line Density; Hill shade; Aspect; Flow accumulation and Stream Segmentation for the study area were developed in ArcGIS 10.1 environment using surface analysis tool under data management extension tool in the ArcGIS software and letter characterised.

3.3.6.2 Identification of major impact areas that are likely to be affected by the New Town Development

In order to achieve this objective the proposed layout plan of the study area, initially designed in AutoCAD 2012 environment was imported into the ArcGIS 10.1 environment (in .dfx format), rasterised and overlaid on the various thematic maps generated in objective one. During the overlay, the area of all of the feature classes (layers) was also calculated and the resultant effect of the new town development on the study area was obtained.

3.3.6.3 Assessment of the likely impact of new town development on the identified impact areas.

In order to achieve this objective, the impact areas identified in objective 2 was used as indicators to assess the likely impacts. It was done by finding the difference or percentage change in the landuse/land cover from the baseline situation of the study area to the likely landuse/land cover change, and the proposed new town plan, if the proposed development plan is implemented. For areas that exceed certain threshold levels, mitigation measures were proposed. The Rau and Wootan (1980) Matrix method was used to summarise the comprehensive range of impacts, which vary in magnitude as well as in their beneficial or adverse effects.

Also, the public participation was carried out by group discussion forum from the selected set of people by the village head of the study area and was done in focus group discussion.
During the focus group discussion, issues on the nature of the propose plan, the benefits and constrains of the project were discussed and the results of the findings is presented in chapter for of this research under the data analysis and presentation of results.

CHAPTER FOUR

RESUTS AND DISCUSSION

4.1 INTRODUCTION

The chapter shows the results of the data analysis for the EIA of Federal Housing Authority's New Town Development in Bwari Area Council of the FCT Abuja. The results are presented in form of maps and tables using various analytical tools in the ArcGIS environment.

4.2 CHARACTERISING THE BASELINE DATA

Prior to carrying out any assessment, Baseline data must be collected. This data serves as a basis for comparison with any changes or impacts that will occur as a result of the implementation of any development plan or action. The baseline data will be on all aspects and will include that on the Physical, Social and Economic aspects of the Study Area. The baseline data were characterised on the basis of Landuse/Land cover using Landsat 8 image and DEM. Contour map, aspect, Slope, curvature, Line Density, Hill shade, raster map, watershed, stream order, Flow accumulation, flow length, flow direction, drainage basin and stream feature, for the study area was extracted from ASTER image. The land use plan was developed from the proposed FHA Bwari new town development plan for the study area. The characterised baseline data for the study area is shown in figures 4.1-4.6. All the baseline data are characterised in three, namely; the terrain analysis, the hydrology and land use type.

4.2.1 Terrain Features

The terrain features comprise the DEM; Contour map, Aspect, Slope, Curvature, Line Density and Hill shade.

4.2.1.1 Generation of DEM

The results of the analysis from the DEM in figure 4.1 show that the elevation is highest in the Northwest and Southwest portions of the study area. The highest value is about 577m above sea level and the lower value is about 466m above sea level located towards the South-eastern part of the study area. Figure 4.1 shows the DEM of the study area generated from ASTER image extract of the study area.

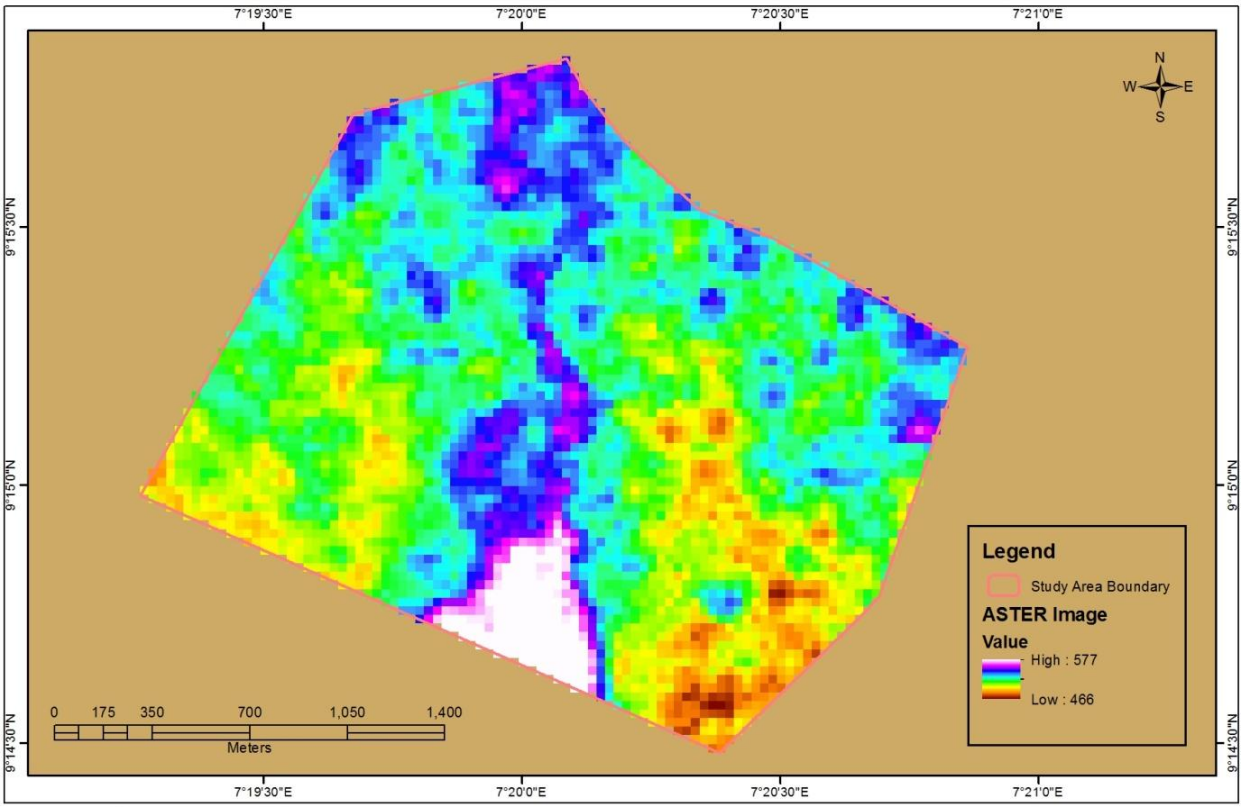

Figure 4.1 Digital Elevation Model
Source: Author's Analysis

4.2.1.2 Generation of Contour Line Map

The contour line map was generated and is shown in figure 4.2. It shows that all the area with lowest contour values have more drainage concentration than the area with the highest values.

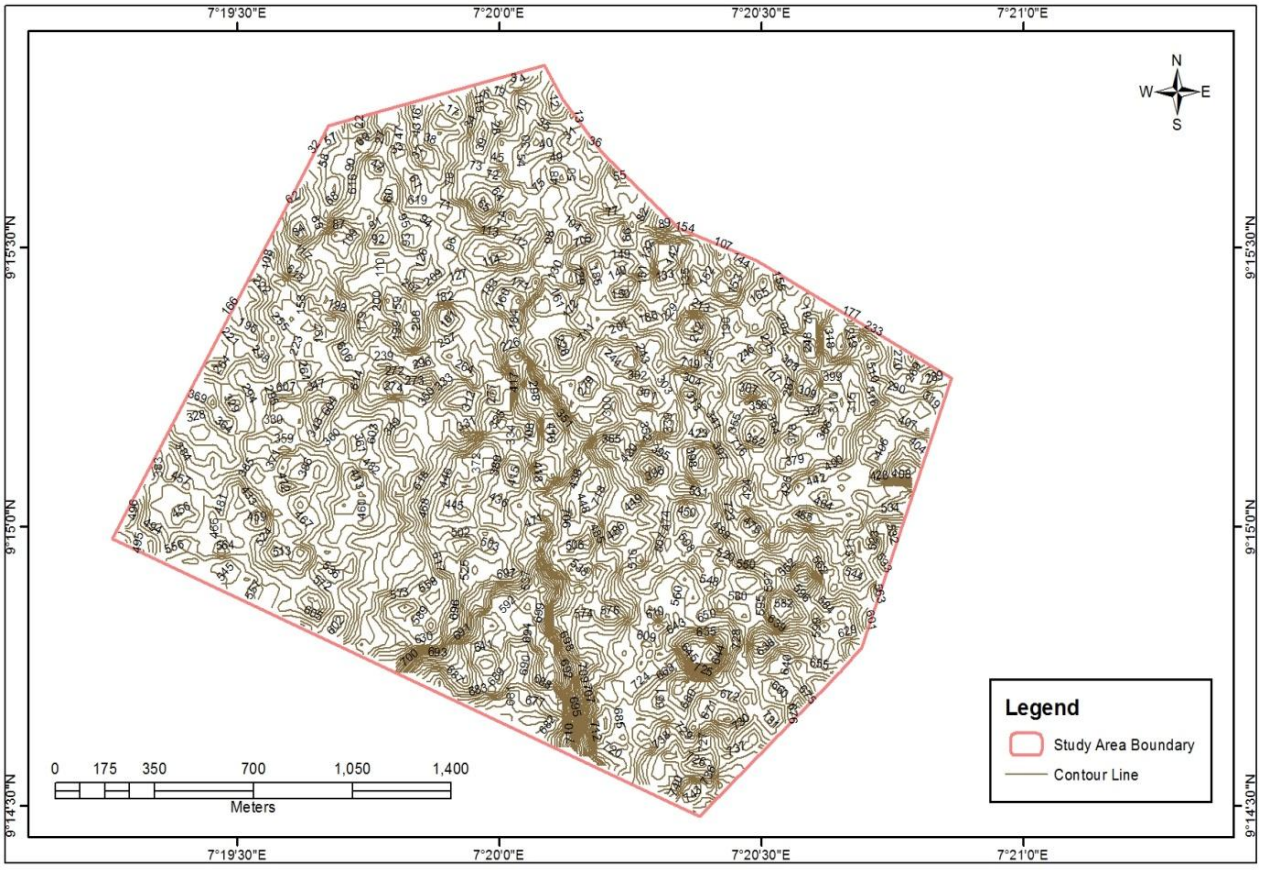

Figure 4.2 Contour Line of the Study Area
Source: Author's Analysis 2014

4.2.1.3 Generation of Aspect Map Layer

The Aspect shown in figure 4.3, indicate the downslope direction of the maximum rate of change in value from each cell to its neighbors in the study area. It can be thought of as the slope direction. The values of each cell in the output raster indicate the compass direction that the surface faces at that location. The value of each cell in an aspect grid indicates the direction in which the cell's slope faces. Flat slopes have no direction and are given a value of 0. It can also be used to calculate the solar illumination for each direction in a region as part of a study to determine the diversity of life at each site. Southerly slopes is region identify locations that are likely to be hit first by runoff.

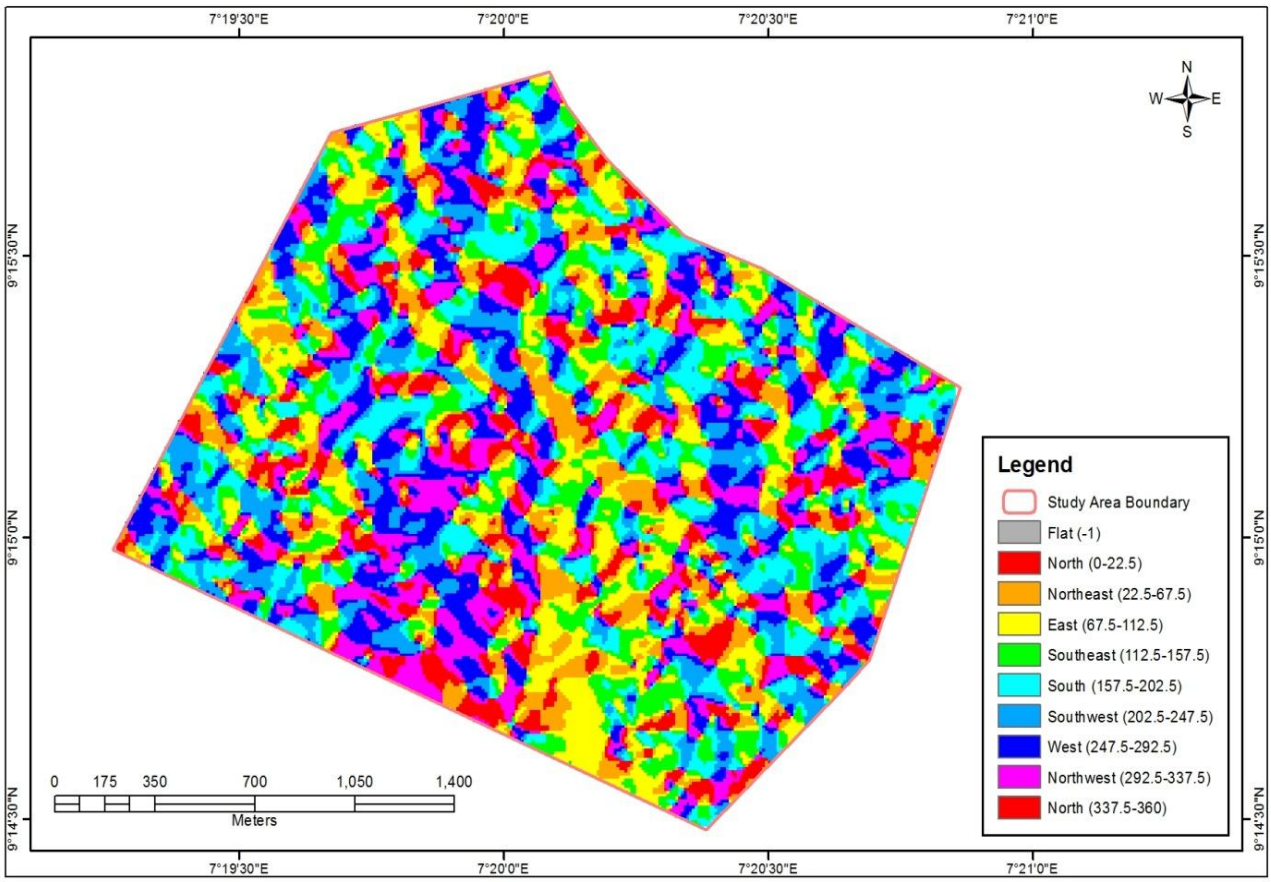

Figure 4.3 Aspect of the Study Area
Source: Author's Analysis 2014

4.2.1.4 Generation of Slope Map

Figure 4.4 show the result of slope value in the study area. The highest slope value is >40.0^{o} and the lowest slope value is 5.0 ^{o}. The area with the highest slope is located at the southern portion of the parcel of land, while that of the lowest point is located in the northern part of the area. Based on the analysis and other consideration, the landuse plan of the new town development has the recreational located in the areas with highest slope. This is with a bid to minimise the cutting and filling of the area under reference.

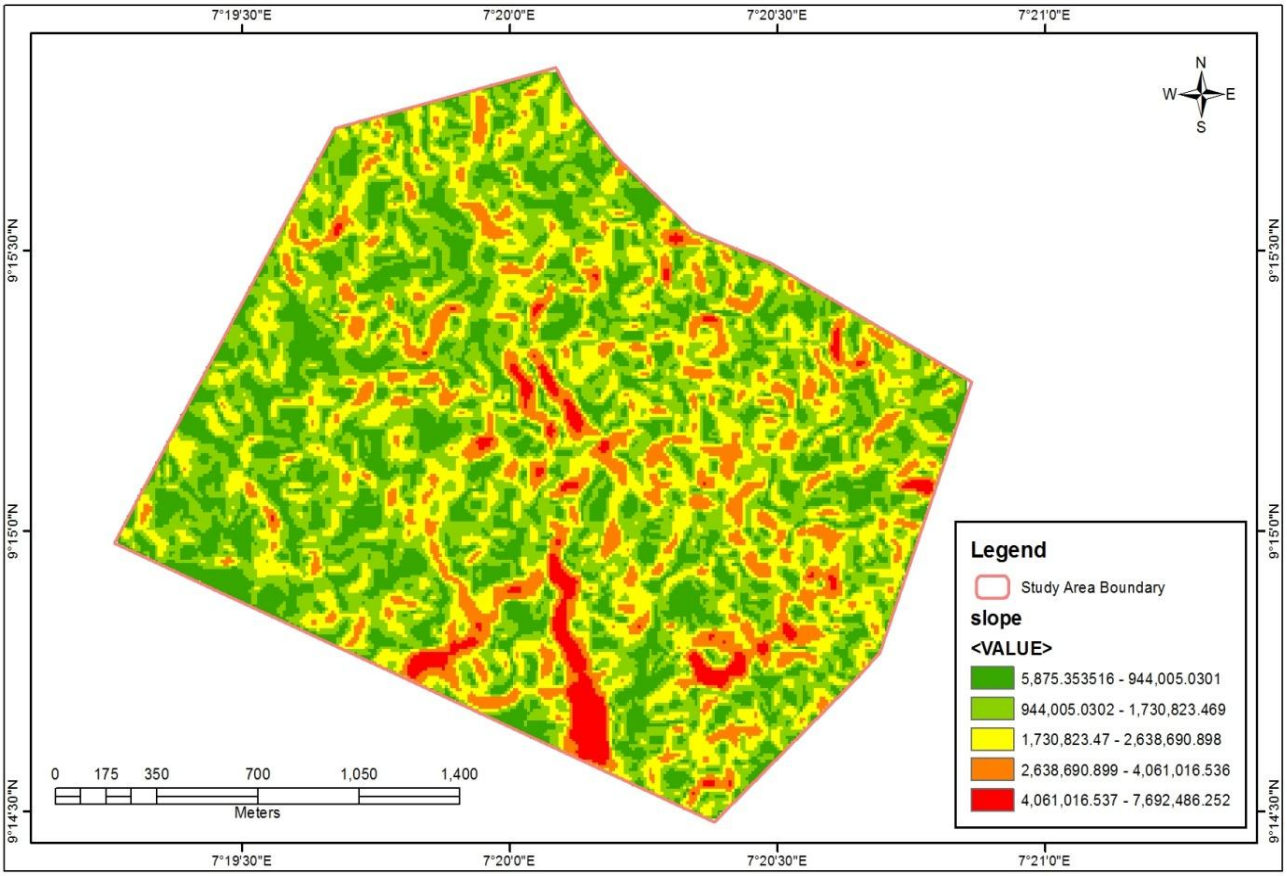

Figure 4.4 Slope of the Study Area
Source: Author's Analysis 2014

4.2.1.5 Generation of Curvature Map Layer

The analysis on curvature carried and shown in figure 4.5 indicate that positive and negative values were arrived at. The positive values indicate that the surface is upwardly convex as evidenced with cells of pixels of the image, whose value ranges from 14805572282.73 - 84370816252.988. The negative values indicates that the surface is upwardly concave at pixel cell ranges from 80765370368 - 14450838732.8. A value of zero indicates that the surface is flat. In these analyses, most of the values are not zero and therefore shows that the surface is not flat but hilly and steeped in some areas and relatively flat in other areas.

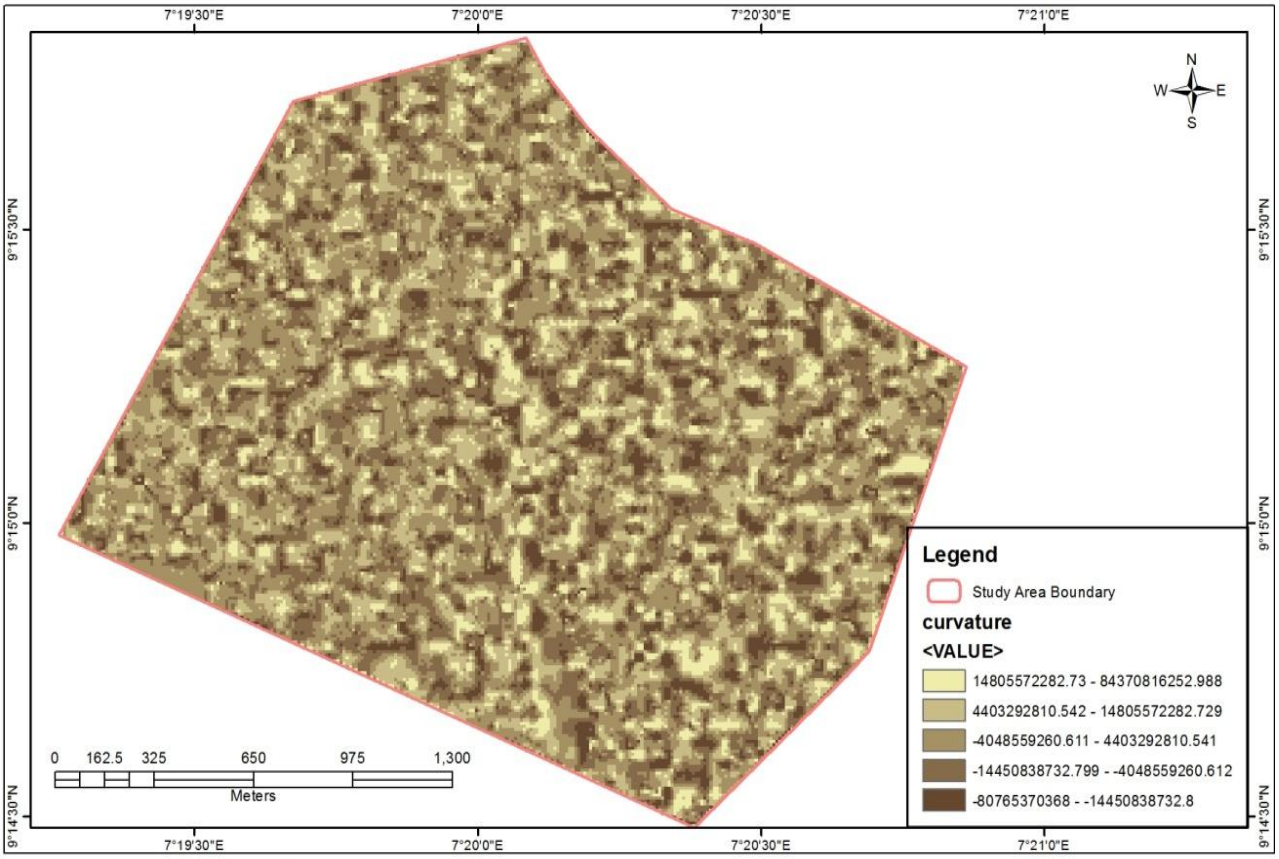

Figure 4.5 Curvature of the Study Area
Source: Author's Analysis 2014

4.2.1.6 Generation of Line Density Map Layer

The line density calculates the density of the contour line in the neighborhood of each output raster cell, the highest value is 8,350,612.753 km/km2 and the lower values is 511,689.8438 km/km2 respectively. Larger values of the radius parameter produce a more generalized density raster while the smaller values produce a raster that shows more detail as presented in figure 4.6.

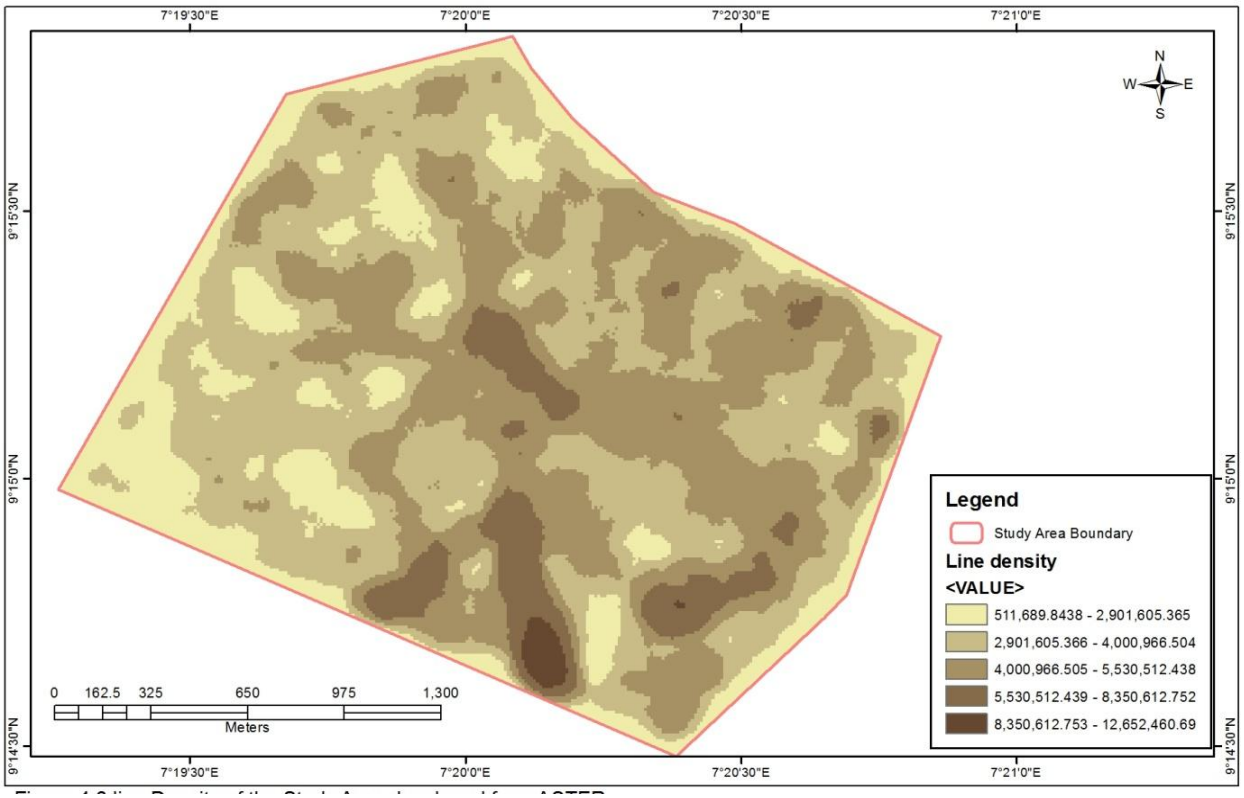

Figure 4.2 Line Density of the Study Area
Source: Author's Analysis 2014

4.2.1.7 Generation of Hillshed Layer

The hillshed analysis is shown in figure 4.7. The result shows the illumination value for each cell in the study area, it also shows the location of the sun in the sky, the default shadow and lights are in shades of grey associate with integers from 0 to 180^{o}, increasing from dark brown to light brown. The shadow shows low sun angle.

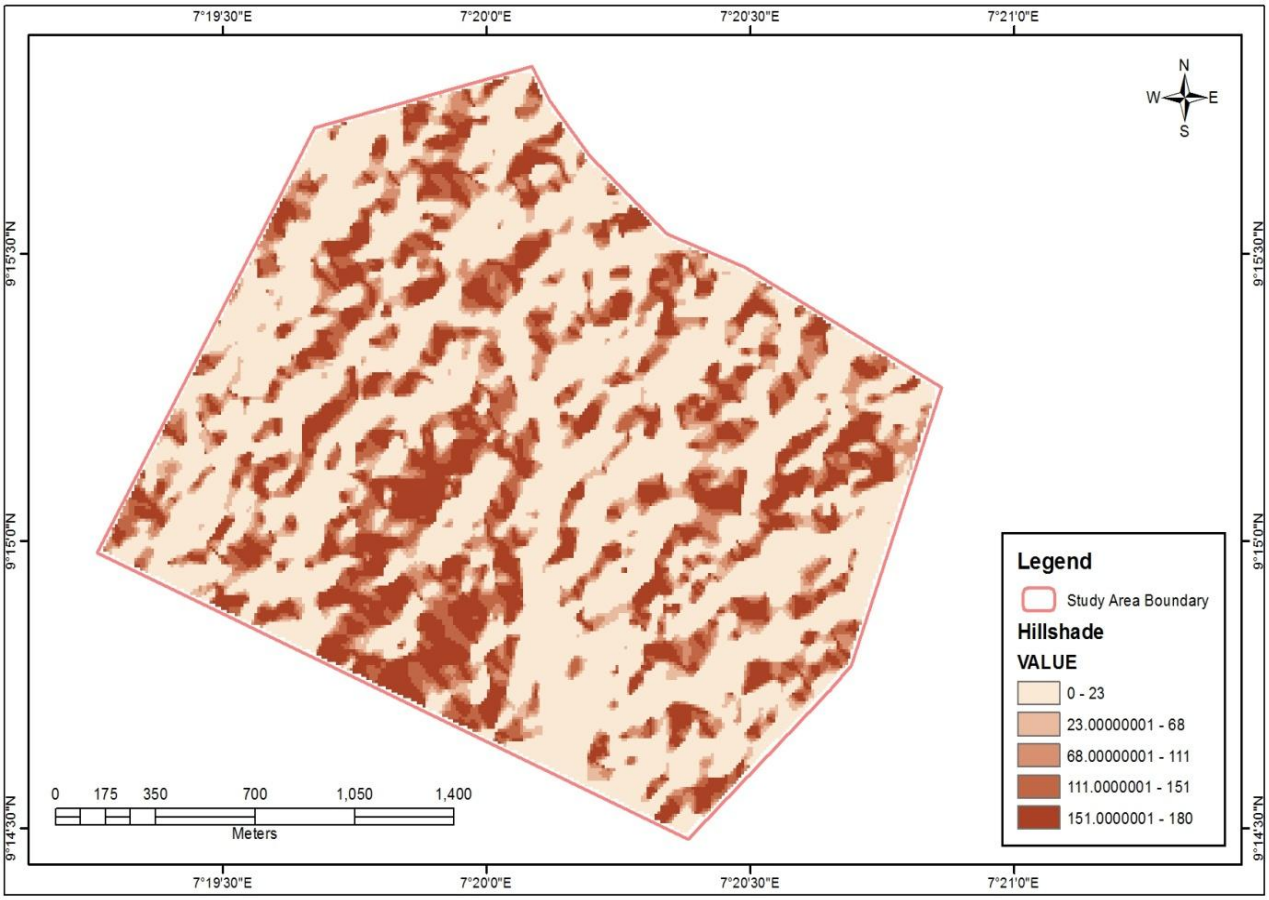

Figure 4.7 Hillshade of the Study Area
Source: Author's Analysis 2014

The baseline data was characterised so as to address shortcomings by identifying and defining any geographical and/or seasonal variability among potential impacts. This is one of the importances of GIS as opined by Patil et al., (2002), Vanderhaegen and Muro (2005), and González et al (2011).

4.2.2 The Fluvial Geomorphology

To analyse the fluvial geomorphology of the study area under reference, the following baseline data were used. Raster map, watershed, stream order, flow accumulation, flow length, flow direction, drainage basin and stream feature.

The raster and watershed of the study area are shown in figures 4.8 and 4.9, the raster image was extracted from the ASTER image of the study area and further developed and generates all the hydrological data for the study area. It has a highest value of 540.65m and the lowest value of 467.483m above sea level. The watershed analysis shows the upslope area that tributaries flow, generally water to a common outlet as concentrated drainage. The study area contains smaller watersheds, called sub-basins. The boundaries between watersheds are termed drainage divides. It has a minimum value of 1 and maximum value of 5, the minimum value shows that the lower basin while the highest value indicate the places of higher basin in the study area.

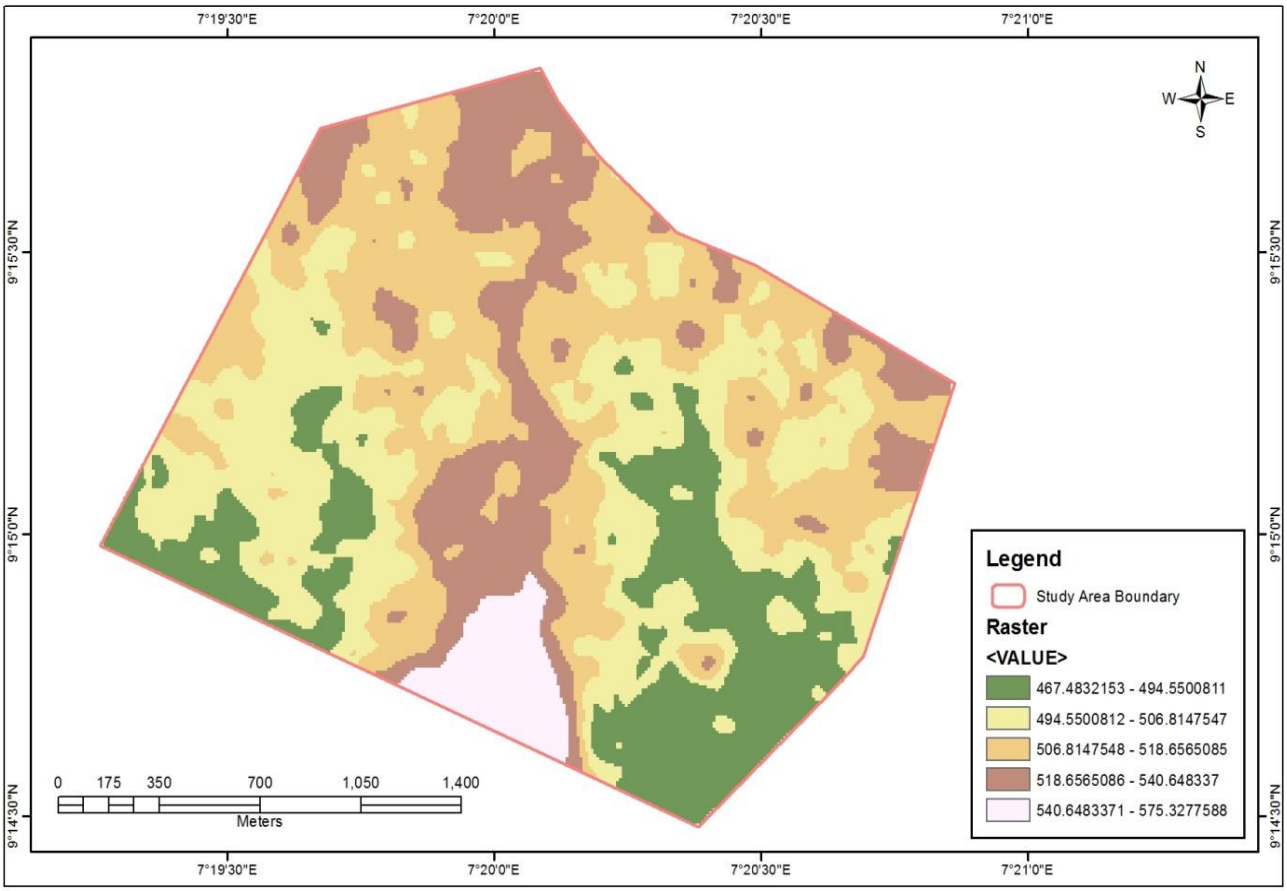

Figure 4.8 Raster Map of the Study Area
Source: Author's Analysis 2014

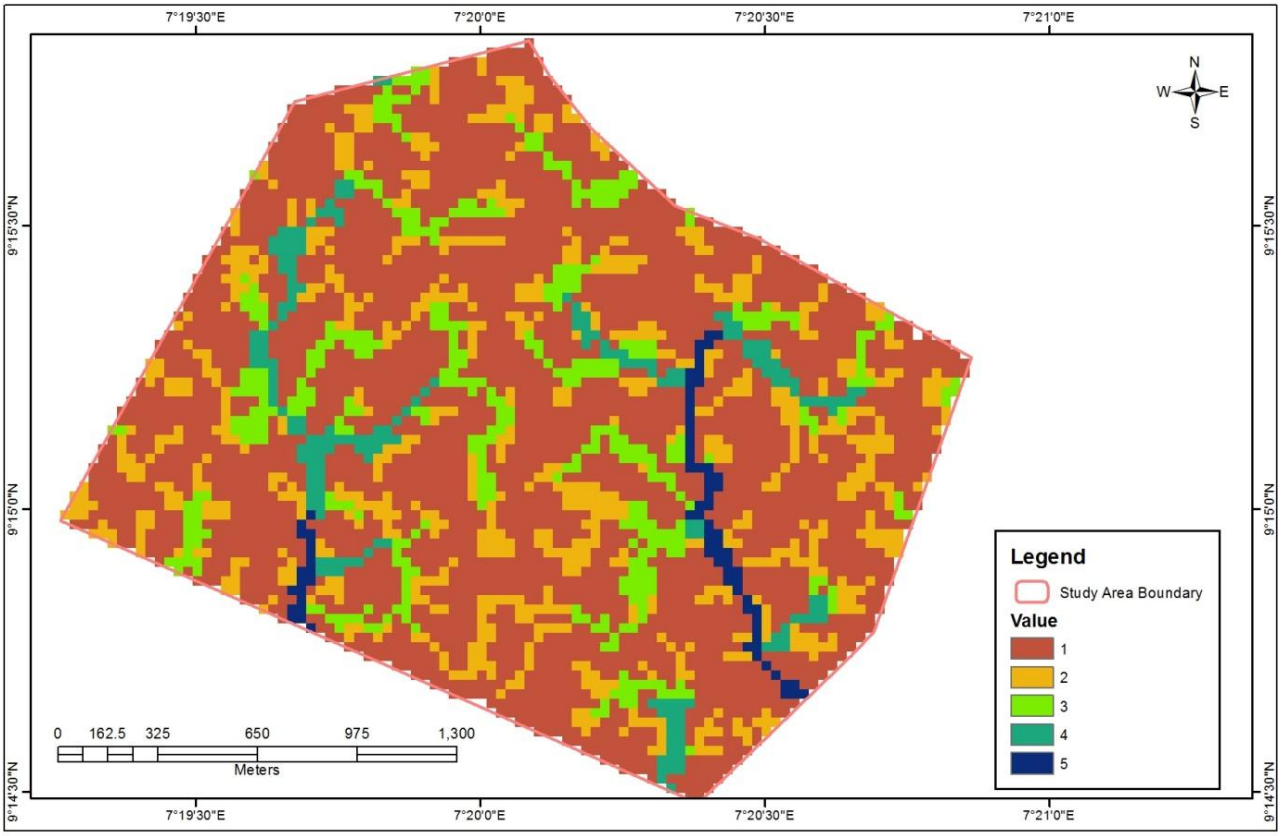

Figure 4.9 Watershed Map of the Study Area
Source: Author's Analysis 2014

The stream order is shown in figure 4.10. Stream ordering analysis method was carried out to a numeric order to links in a stream network. This order is a method for identifying and classifying types of streams based on their numbers of tributaries. Some characteristics of streams can be inferred by simply knowing their order. For example, first-order streams are dominated by overland flow of water; they have no upstream concentrated flow. The upstream segments are always assigned an order of 1. All exterior links are assigned an order of 1 and the highest with the order of 5. However, the orders are additive. For example, the intersection of two first-order links creates a second-order link, the intersection of a first-order and second-order link creates a third-order link, and the intersection of a second-order and third-order link creates a fifth-order link, (Tarboton, and Rodriguez, 1991).

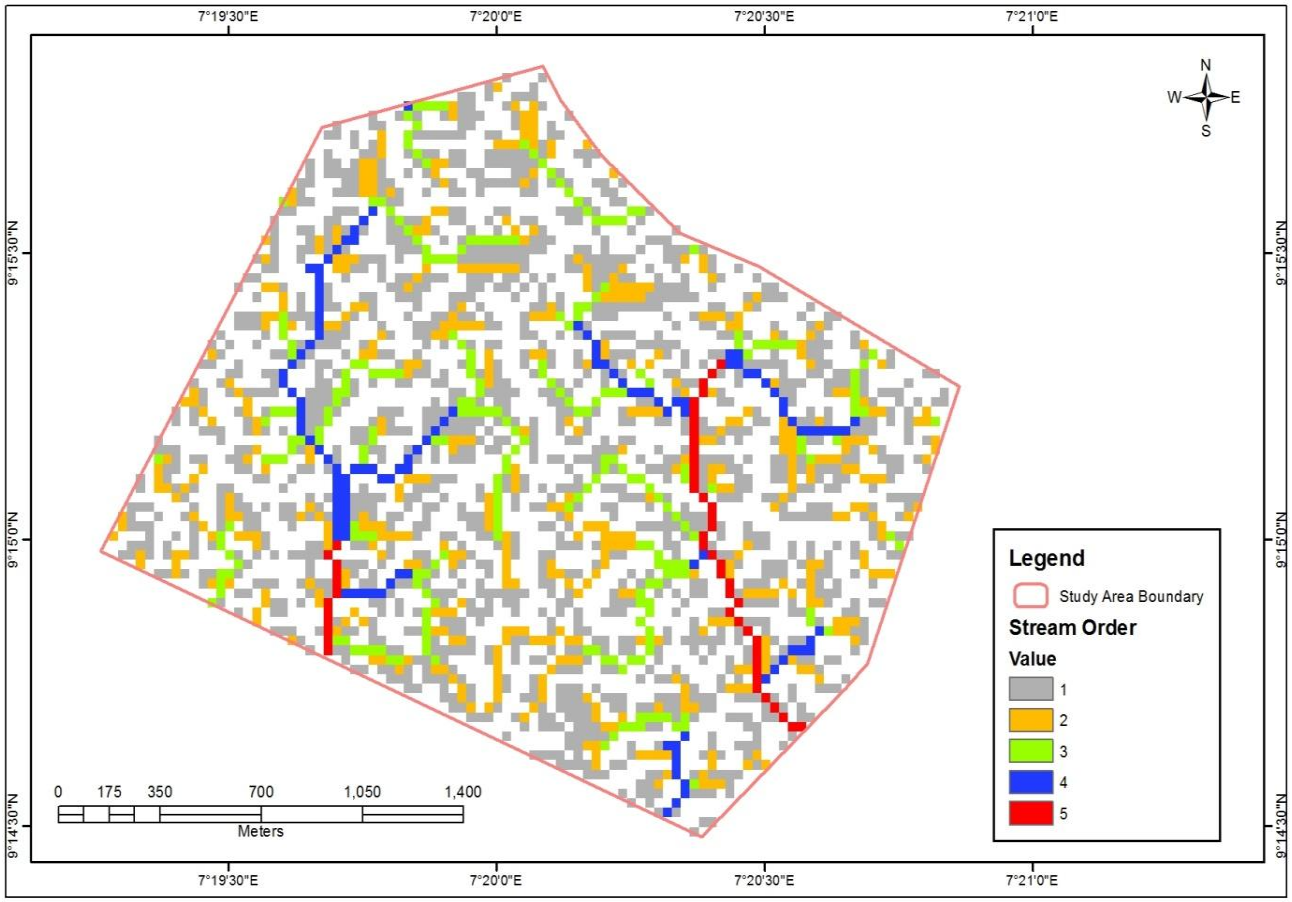

Figure 4.10 Stream Order of the Study Area
Source: Author's Analysis 2014

The study area has a flow accumulation value of 3.242m concentration and lower value of 2m respectively as showed in figure 4.11. the calculated accumulated weight of all the cells flowing in to each down slope cell with the output raster, the cells with 3.2m has a high flow accumulation and concentrated flow and it is also used to identify a stream channel.

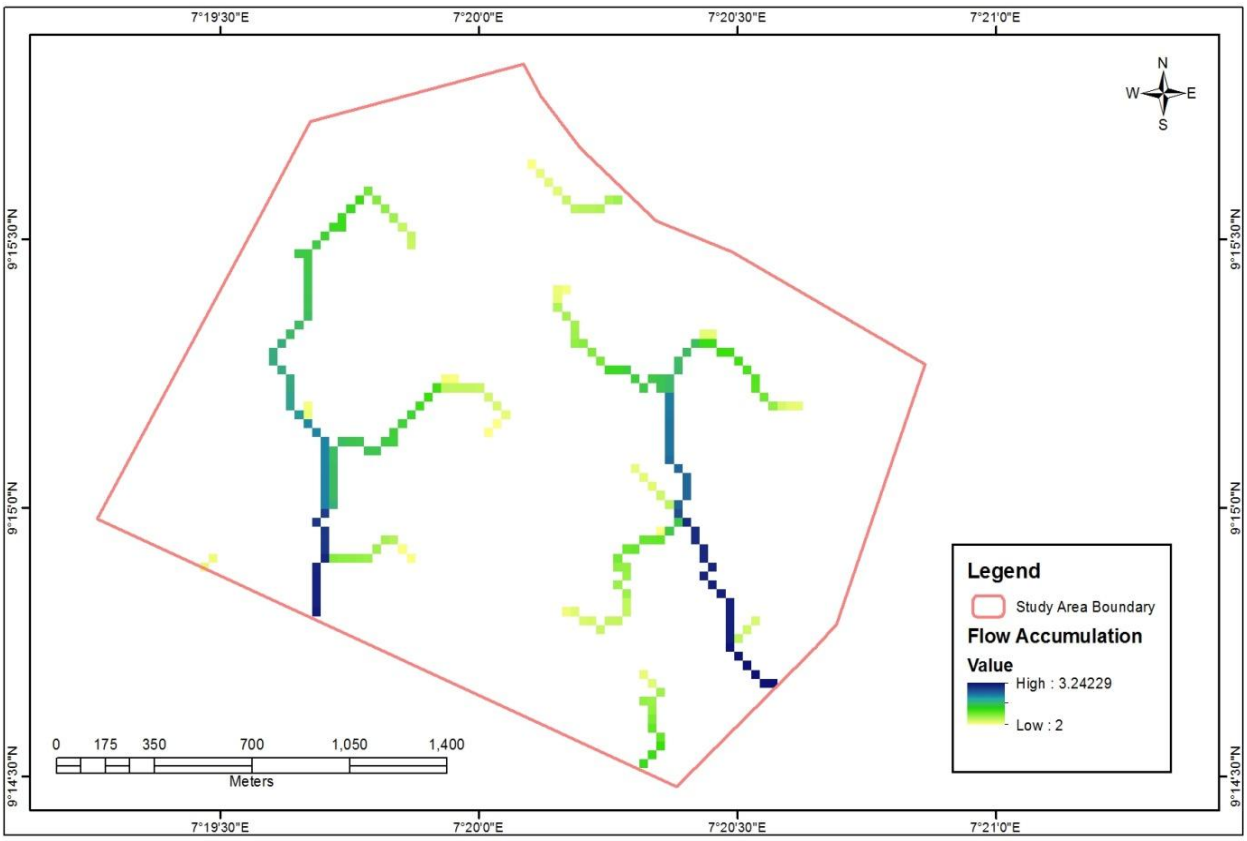

Figure 4.11 Flow Accumulation of the Study Area
Source: Author's Analysis 2014

Also with a flow length of 0.0226185m upstream and 0.000265506m length downstream weighted distance along the flow path for the study area concentration of the basin, as show in figure 4.12.

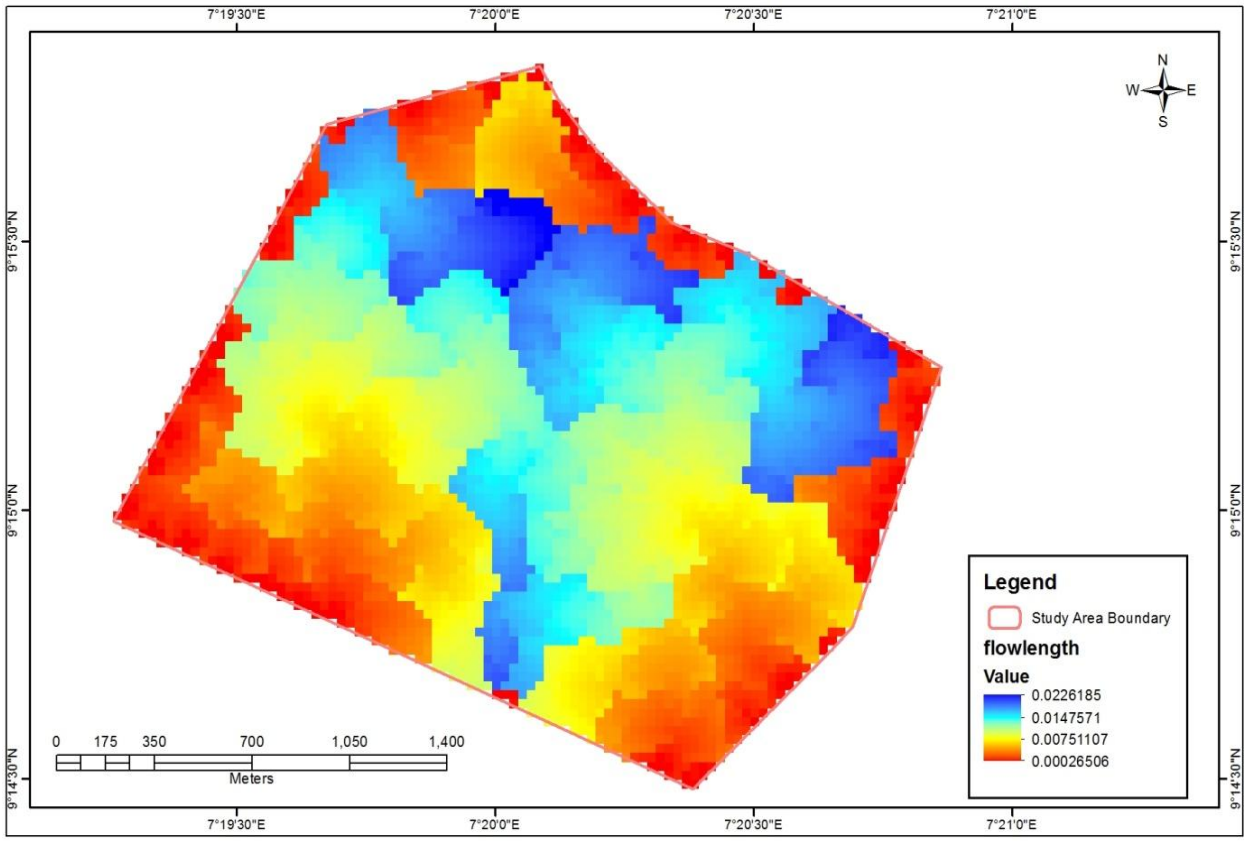

Figure 4.12 Flow Length of the Study Area
Source: Author's Analysis 2014

Again figure 4.13 show network flow direction and specifies the direction of flows through the stream network, ratio of the maximum change ranges between 1% - 12.8% in elevation from each cell along the direction of flow, to the path length centre of the cell. There are eight valid output directions relating to the eight adjacent cells into which flow could travel. This approach is commonly referred to as an eight-direction (D8) flow model and follows an approach presented in Jenson and Domingue (1988).

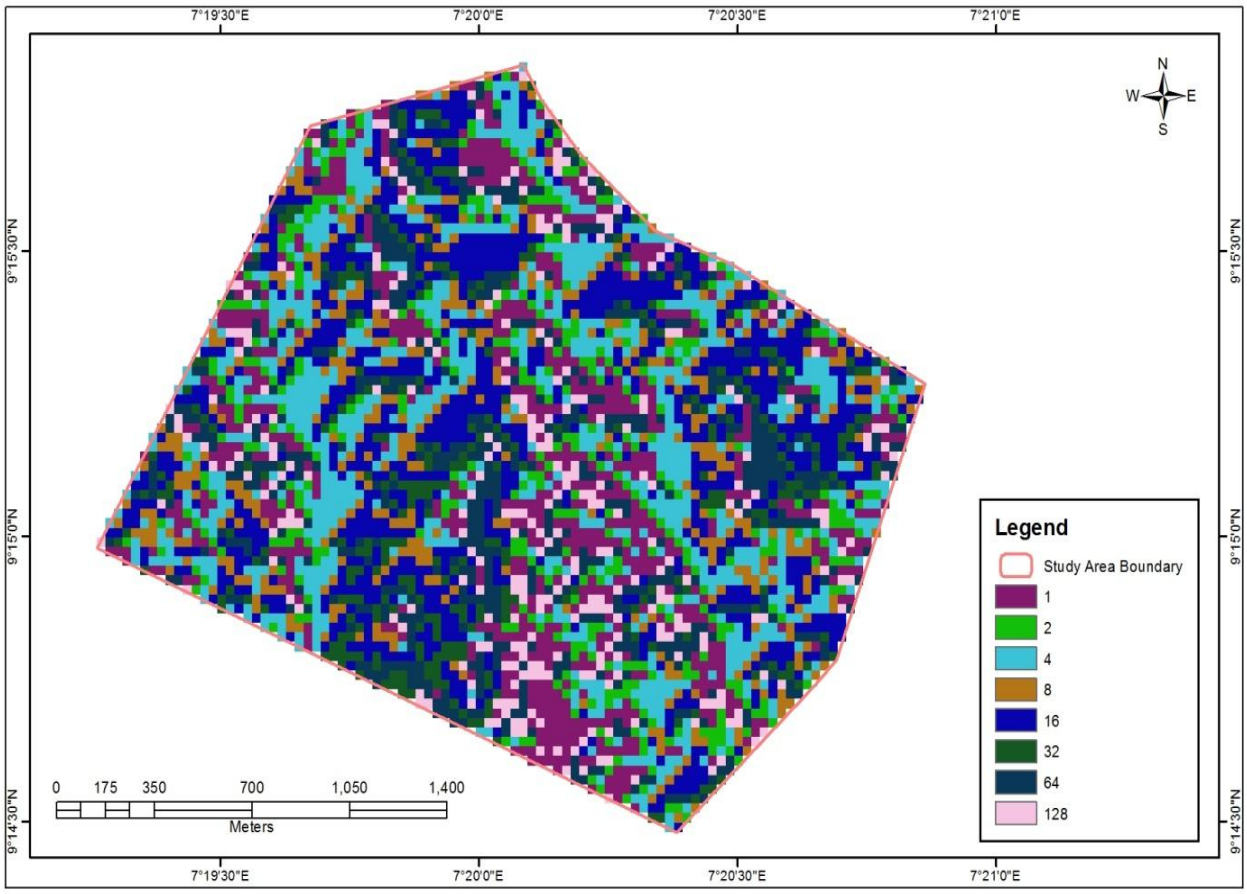

Figure 4.13 Flow Direction of the Study Area
Source: Author's Analysis 2014

Figure 4.16 show the drainage basin and stream feature: the drainage basin is delineated with an analysis window and the analysis identified ridge lines between basins. This is done to fine all sets of connected in the study area that belong to the same drainage basins and its found that the study area has the maximum value between 48m to 1m lower. The stream feature of the study area is vectorised intersecting and shown linear features of the same value as it was overlaid in figure 4.16, supported by Tarboton, and Rodriguez (1991) that drainage are linear in nature.

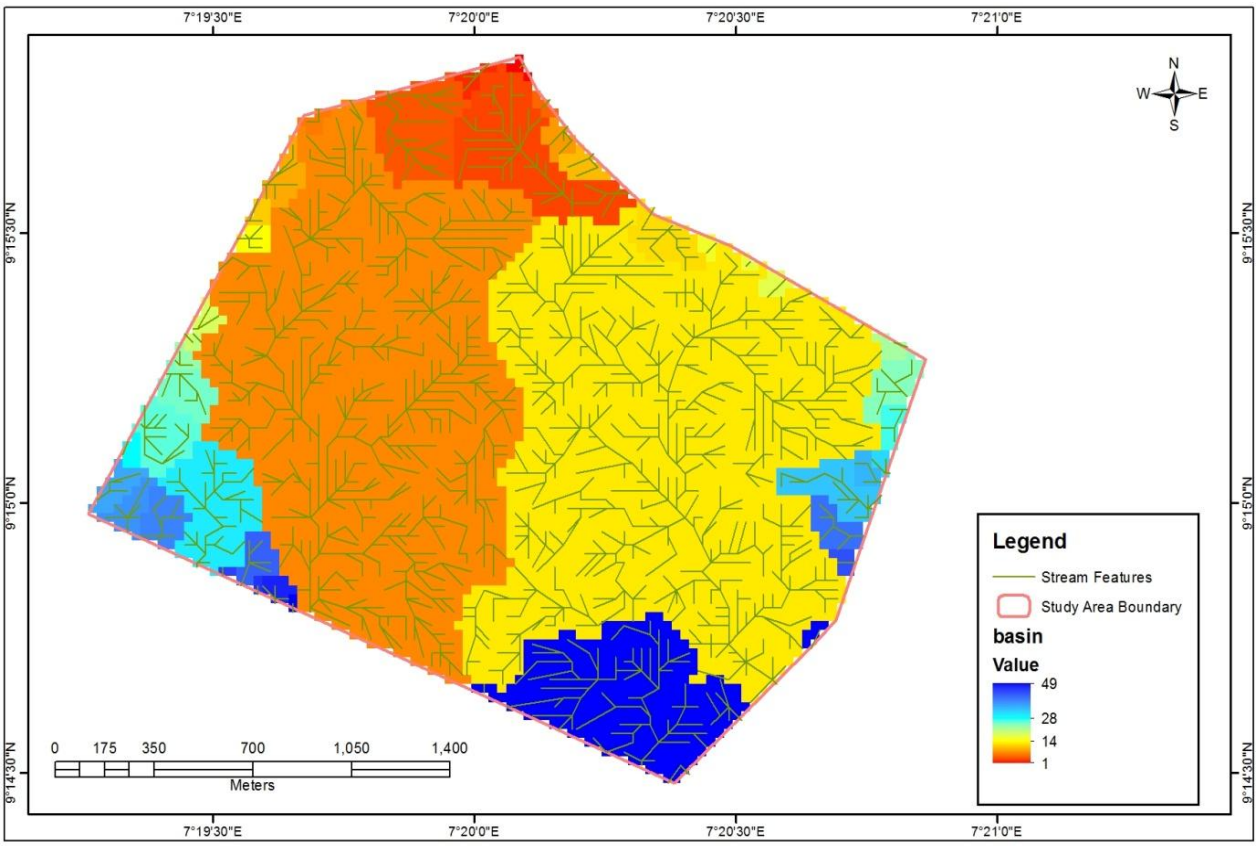

Figure 4.14 Drainage Basins and Stream Feature of the Study Area
Source: Authour's Analysis 2014

4.2.3 Land use type

The landuse type comprises of the land use land cover generated from the satellite image and the new town plan development. The land use land cover type of the study area was categorised into five classes, namely; bare ground, water body, vegetation, rock outcrop and built-up area. On the bases of the analysis, it was found that the bare land covered about 48.05% of the study area, water body comprises of about 7.35% of the area, vegetation covered about 37.7%, rock outcrop covered 3.6% and build up area covered about 3.3% of the study area as show in figure 4.14 and table 4.2. In the study area development plan, seven land use classes were designed, namely, religion institution and it covered 1.82% of the total land use, public/semi-public land covered about 7.27%t of the study area, educational area covered 3.64% of the land of the study area, green/recreational area covered 8.67% of the study area, residential area covered about 48.36% land use of the study area,

neighbourhood/commercial covered about 9.91% and circulation/roads covering about 20.33% of the total land use of the study area as show in figure 4.15 and table 4.2 respectively. The effect as the result of landuse modifications for new towns and infrastructure developments specifically destroy the natural environments and pose serious threats to the biodiversity in the study area, also in support of the finding by (Duh, Shandas, Chang and George, 2008).

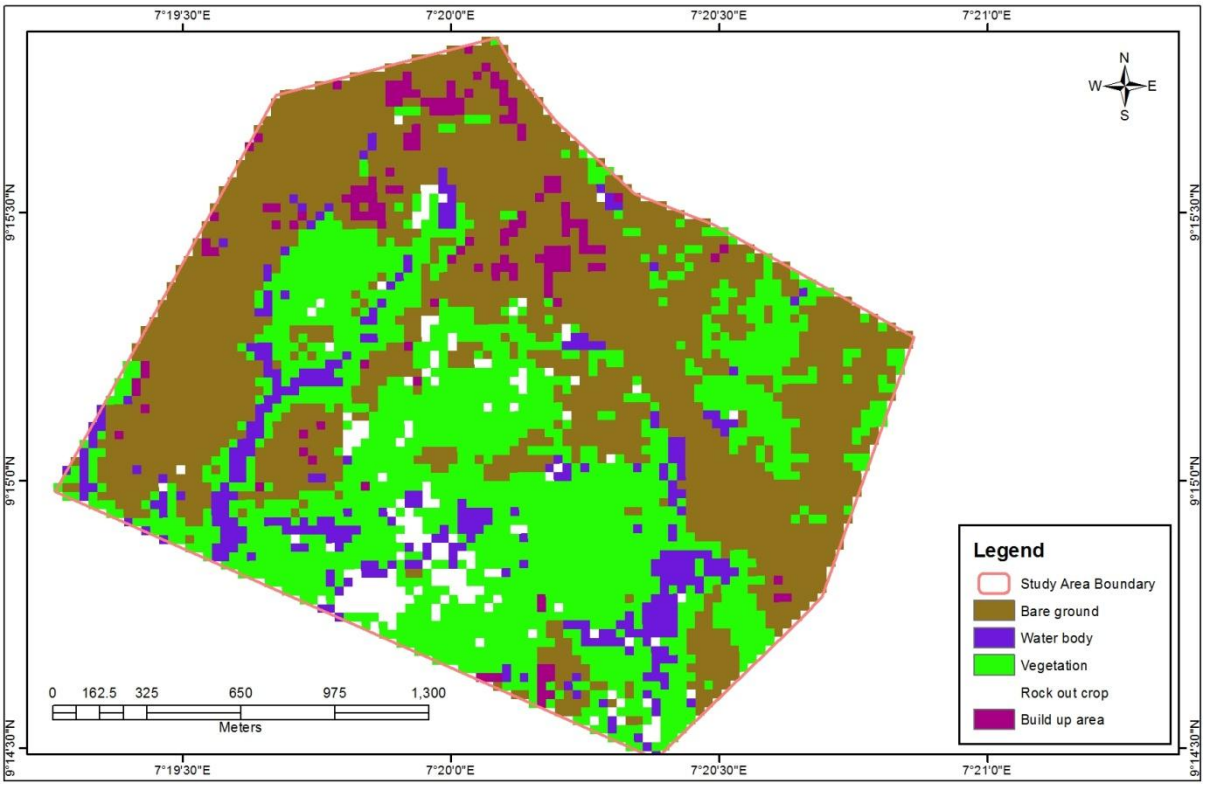

Figure 4.15 Land Use/Land Cover of the Study Area

Source: Author's Analysis 2014

Figure 4.16 Land Use of the Study Area
Source: Author's Analysis 2014

Figure 4.1 to 4.16 show the base line data needed for the EIA of the new town development in Bwari area council of this study area.

Table 4.1 Land use/land cover classes of the study area

S/NO	Land use classes	Area (m^2)	Percentage
1	Bare land	158.66	48.05%
2	Vegetation	131.12	39.71%
3	Built-up area	4.27	1.29%
4	Water body	24.30	7.36%
5	Rock out crop	11.85	3.59%
Total		330.2	100.00%

Source: Author's Analysis 2014

Table 4.2 New Town Development Plan of the study area

S/NO	Land use classes	Area (Ha)	Percentage
1	Neighbourhood/Commercial	32.72	9.91 %
2	Religious	6.00	1.82 %
3	Public/Semi Public	24.01	7.27 %
4	Educational	12.03	3.64 %
5	Green/Recreational	28.63	8.67 %
6	Circulation/Roads	67.13	20.33%
7	Residential area	159.68	48.36 %
	Total	330.20	100.00 %

Source: Author's Analysis 2014

The result of propose plan have an effect on the physical, biological, cultural and socio-economic components of the environment because all the physical baseline data have been altered supported by (Canter, 1996) that most proposed plan have a potential impact on the environment

4.2.3 Public Participation:

As noted in the preceding chapters, Public Parturition is an integral part of all successful EIAs, but due to time constraints, the various consultative session held between the Officials of the Bwari Area Council, Federal Housing Authority and Stake Holders is being used.

The meetings were held to enumerate farm and others vested interest holdings on the proposed site with a view to compensate same. The findings reveal that there were no major

built up area on the site but mainly farm lands and plantations. As at the time of writing this report, there was a stalemate with the indigenes insisting on being compensated for their farmlands in another location, as against any monetary compensation. More consultations will be held in the year 2015 with a view to finding amicable resolutions.

4.3 IDENTIFICATION OF THE MAJOR IMPACT AREAS LIKELY TO BE AFFECTED BY THE NEW TOWN DEVELOPMENT

The major impact areas identified likely to be affected are based on the results of overlay analysis ware as follows; Vegetation, bare land, water body, rock outcrop, built-up area, flow direction, flow direction, hill-shed, drainage basin and stream features as shown from figures 4.17 to 4.24 and from tables 4.3 to 4.7 respectively.

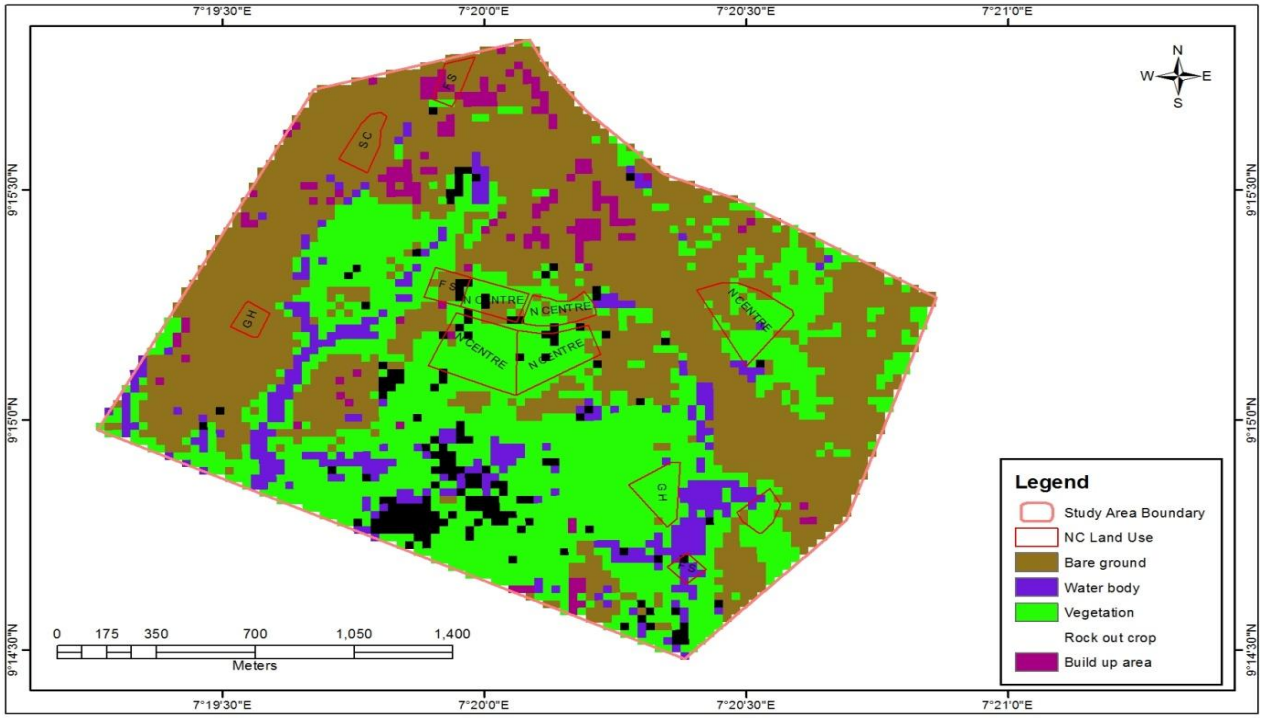

Figure 4.17 Overlay Neighbourhood and Commercial on Land use Land cover Classes of the Study Area

Source: Author's Analysis 2014

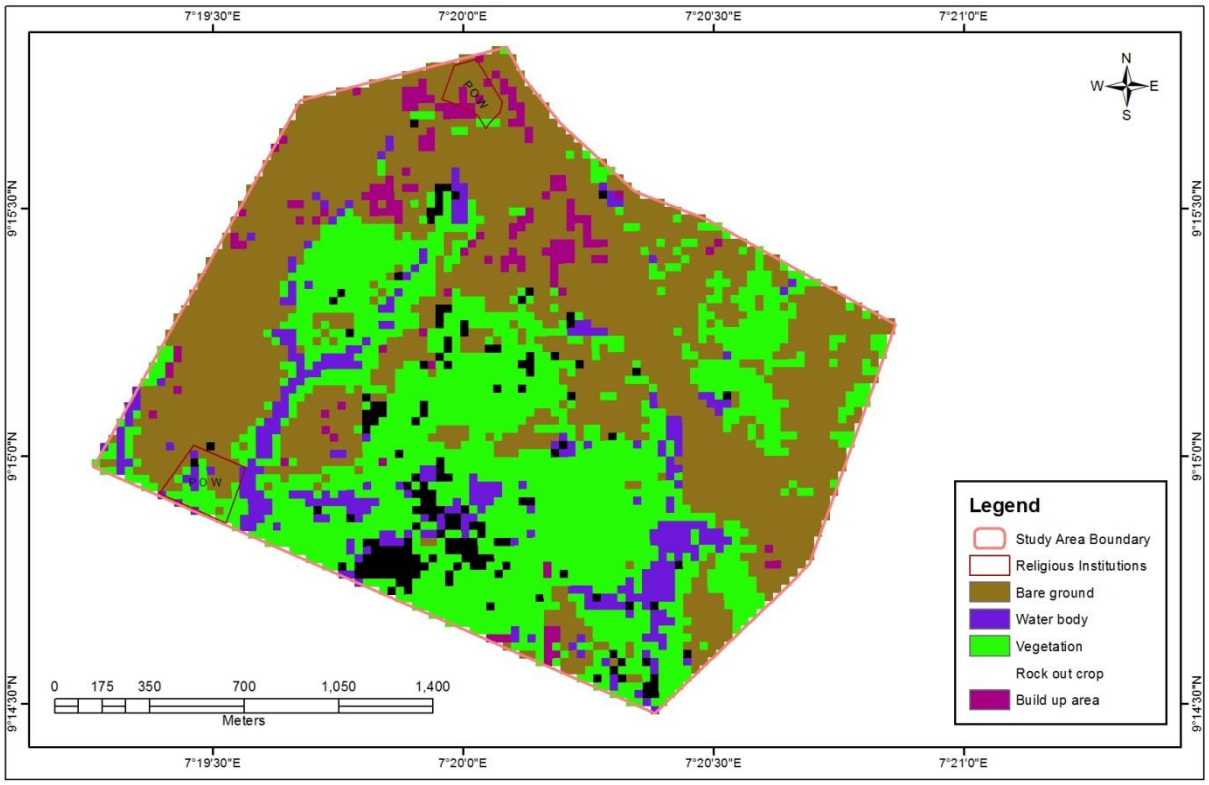

Figure 4.18 Impact of Religious Institution Land use on Land use Land cover Classes of the Study Area

Source: Author's Analysis 2014

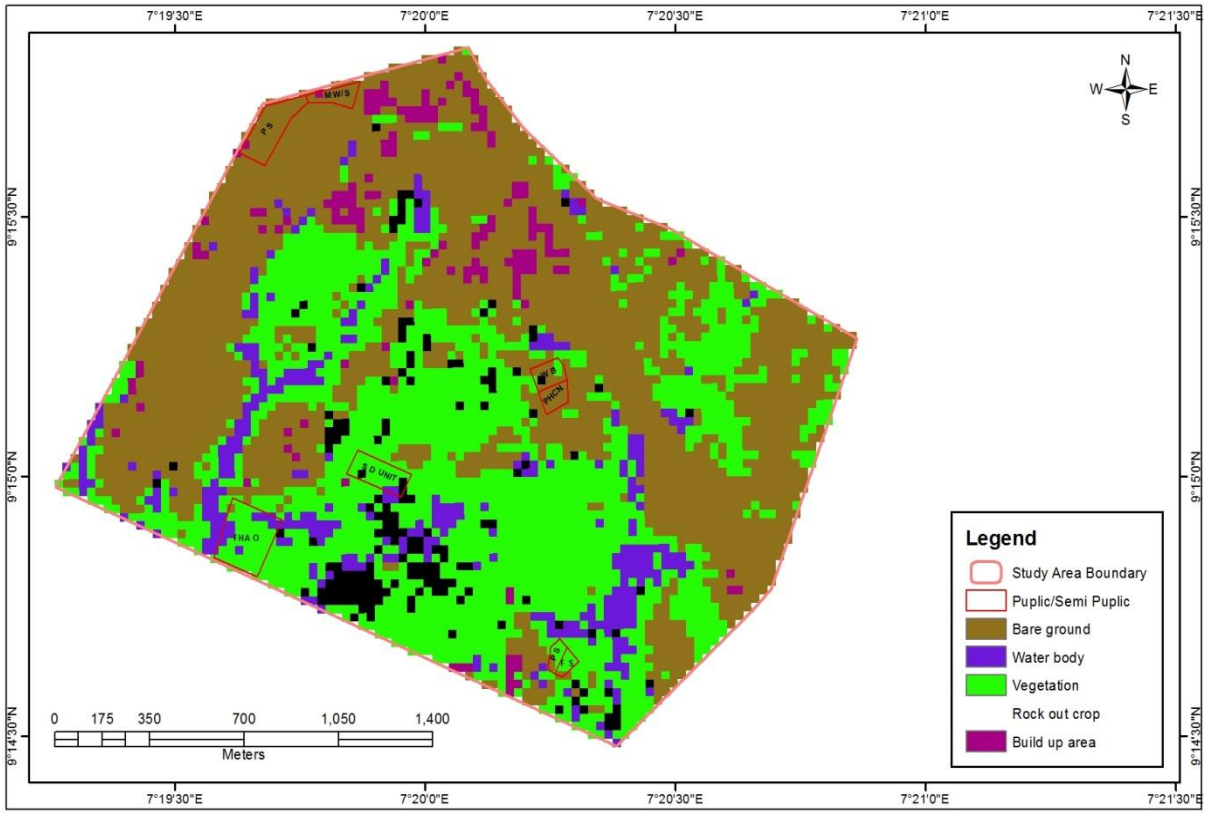

Figure 4.19 Impact of Public/Semi Public Land use on Land use Land cover Classes of the Study Area

Source: Author's Analysis 2014

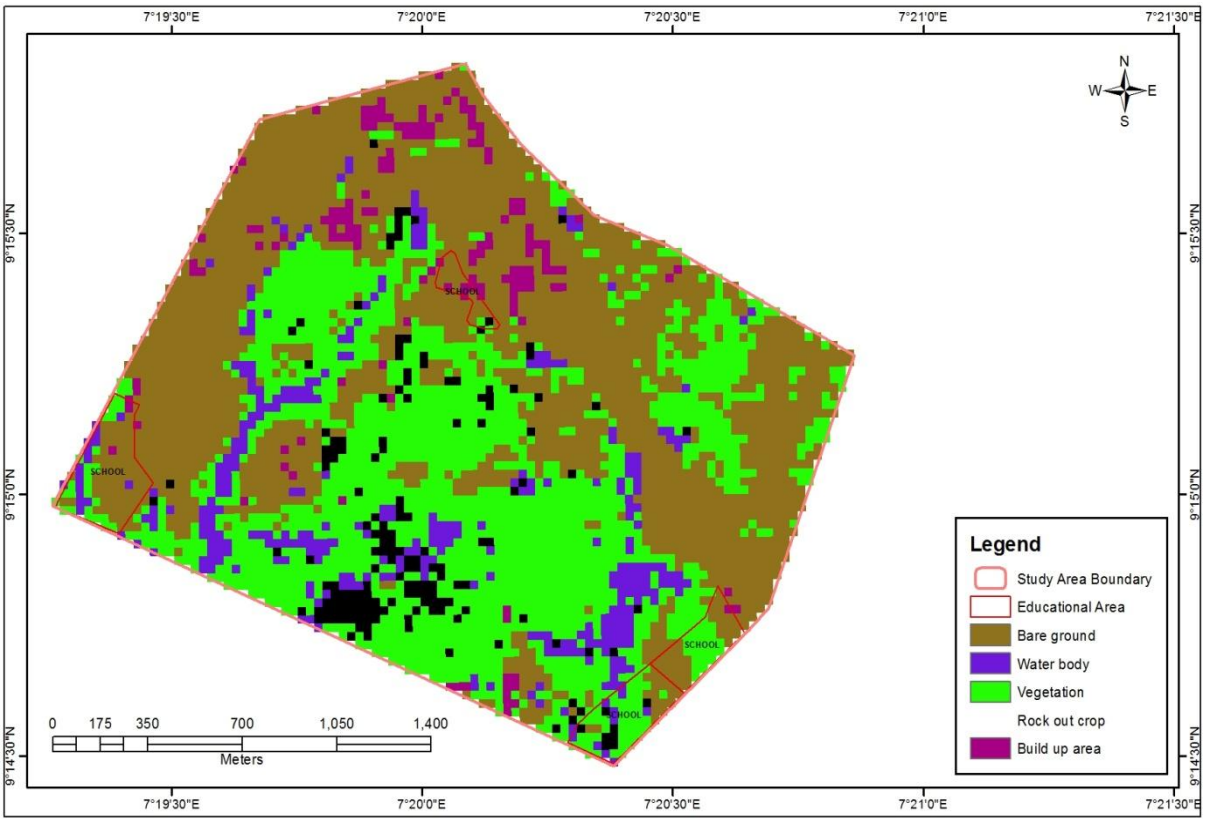

Figure 4.20 Impact of Education Area Land use on Land use Land cover Classes of the Study Area
Source: Author's Analysis 2014

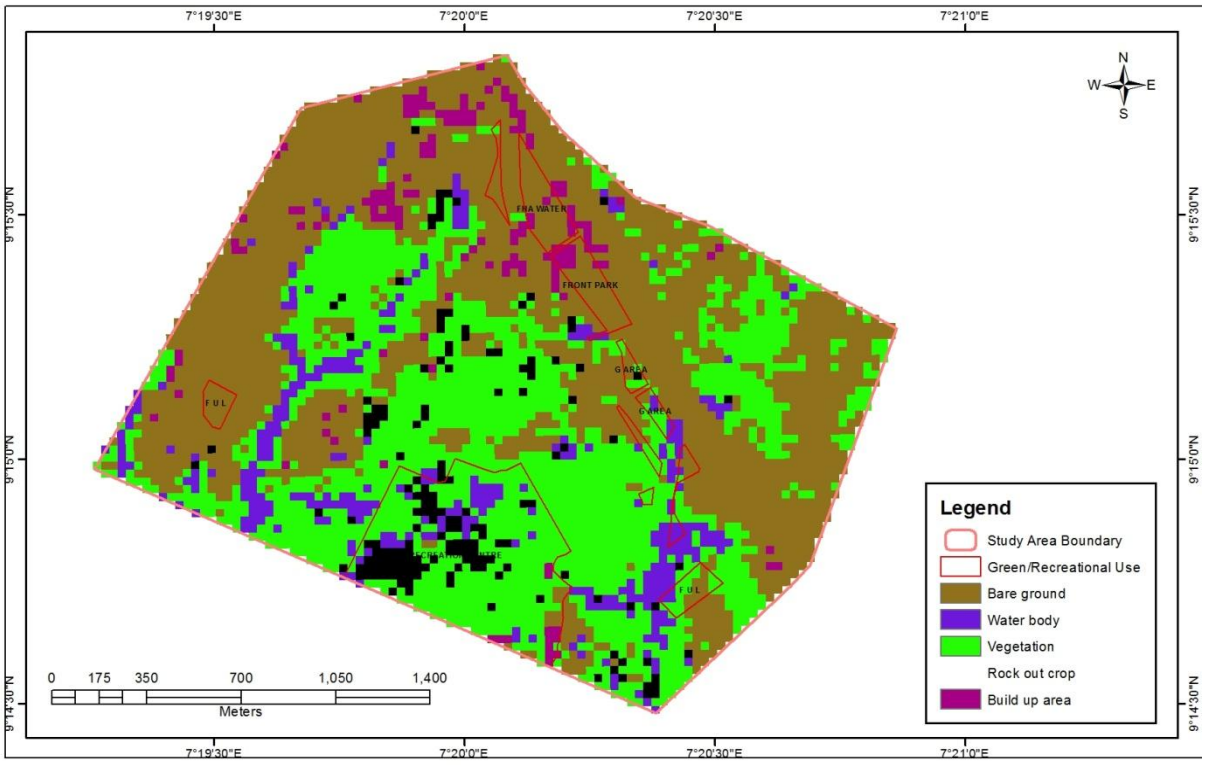

Figure 4.21 Impact of Green/Recreational Land use on Land use Land cover Classes of the Study Area
Source: Author's Analysis 2014

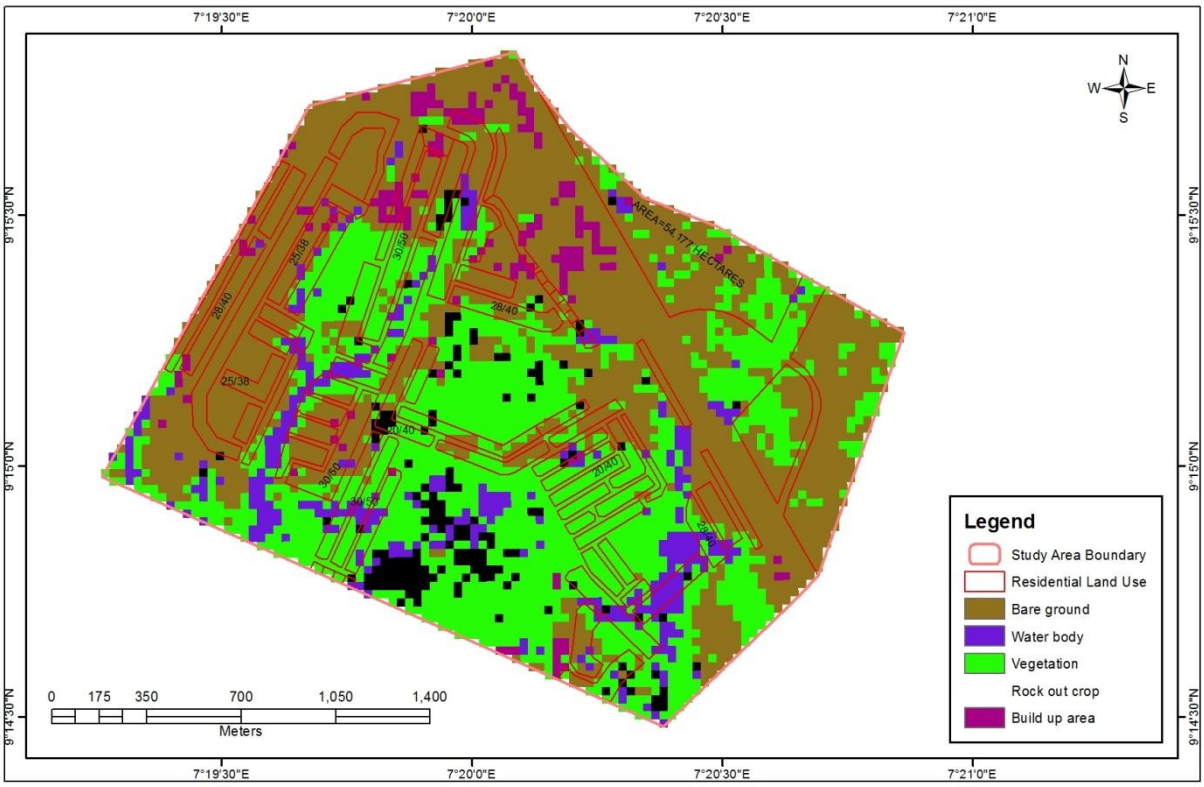

Figure 4.22 Impact of Residential Land use on Land use Land cover Classes of the Study Area
Source: Author's Analysis 2014

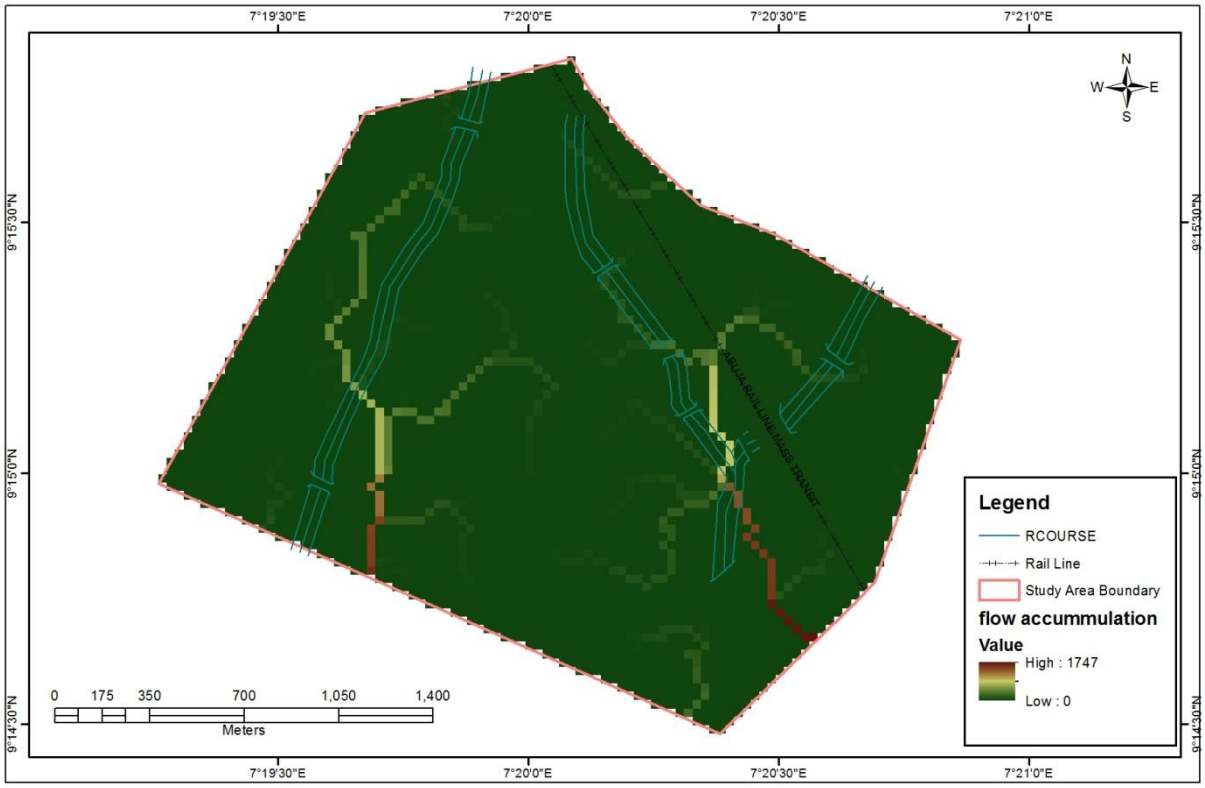

Figure 4.23 Impact of Water course on Flow Accumulation of the Study Area
Source: Author's Analysis 2014

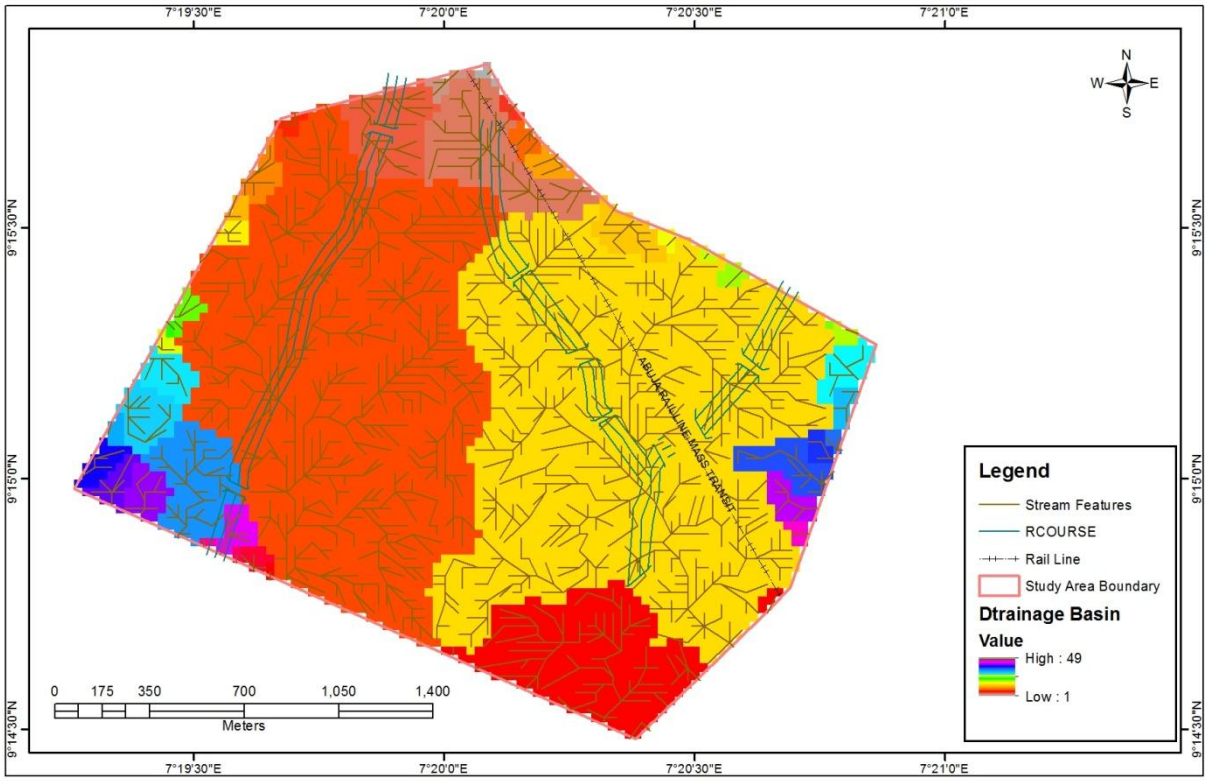

Figure 4.24 Impact of Water course on Drainage Basin and Stream Features of the Study Area
Source: Author's Analysis 2014

The new town development plan designed by FHA was overlaid on the baseline data maps generated for the study area in order to calculate the magnitude to which each class will change with the implementation of the new town development plan. Following the overlay of water coarse of the new town development on flow accumulation, flow direction, watershed, drainage basin and stream feature, it was found that the water course channels of the new town development may have to be re-channelled. The hydrology of the study area will completely be affected as show in figure 4.23 and figure 4.24, and also the minor gully-stream channels will be cut-off and these will have a severe effect on the water table. Also, some of the stream features will be cut off during the construction as show in figure 4.24.

The total of the area coverage by overlaid analysis in hectares is shows from table 4.3 to 4.7 respectively

Table 4.3 Impact of Existing Bare-land land cover on the New Town Development Plan

S/NO	Land use classes	Area (Ha)	Percentage
1	Neighbourhood/Commercial	1.27	0.80 %
2	Religious Institution	2.82	1.77 %
3	Public/Semi Public	10.42	6.57 %
4	Educational	5.27	3.33 %
5	Green/Recreational	13.73	8.65 %
6	Circulation/Roads	20.72	13.06
7	Residential area	104.43	65.82 %
	Total	158.66	100.0 %

Source: Author's Analysis 2014

The result of the analysis in table 4.3 show that residential areas of the proposed plan encroach to about 65.82% followed by circulation roads and green as well as recreational areas. This implies that residential land use will be significantly affected than any land use. This is similar with the research finding by (Canter, 1996) that most proposed plan has a potential impact on the environment.

Table 4.4 Impact of Existing Vegetation Land cover on the New Town Development Plan.

S/NO	Land use classes	Area (Ha)	Percentage
1	Neighbourhood/Commercial	18.50	14.11 %
2	Religion Institution	1.46	1.11 %
3	Public/Semi Public	9.39	7.16 %
4	Educational	3.20	2.44 %
5	Green/Recreational	13.58	10.36 %
6	Circulation/Roads	14.62	11.15%
7	Residential area	70.37	53.67%
	Total	131.12	100.00%

Source: Author's Analysis 2014

Also, the result of the analysis in table 4.4 show that residential areas of the proposed plan encroach to about 53.67% followed by circulation roads which accounted for 11.15% and green as well as recreational areas with 10.36% respectively. This implies that residential land use will be significantly affected than any land use as well. This is similar with the research finding by Abbas and Ukoje (2005) that GIS and remote sensing is suitable for identifying impact in development.

Table 4.5 Impact of Existing Built-up Landcover on the New Town Development Plan

S/NO	Land use classes	Area (Ha)	Percentage
1	Neighbourhood/Commercial	0.54	12.55 %
2	Religion Institution	0.50	11.70 %
3	Public/Semi Public	0.89	20.92 %
4	Educational	0.64	15.10 %
5	Green/Recreational	1.39	32.62 %
6	Circulation/ Roads	0.31	7.11
7	Residential area	0.00	0.00 %
	Total	4.27	100.00 %

Source: Author's Analysis 2014

Again, table 4.5 shows that green and recreational areas of the proposed plan encroach to about 32.625 and 20.92% of public/semi-public followed educational area which accounted for 11.70%. This reveals that built-up of the new town development plan will be affected by the plan which is in support of the finding by Duh, Shandas, Chang and George, (2008).

Moreover, table 4.6 shows that residential areas of the proposed plan encroach to about 53.30% followed by neighbourhood/commercial 11.20% circulation roads 7.21%. This implies that residential land use will be significantly affected than any land use. This is similar with the research finding by (Canter, 1996) that most proposed plan has a potential impact on the residential areas.

Table 4.6 Impact of Water body land cover on the New Town Development Plan

S/NO	Land use classes	Area (Ha)	Percentage
1	Neighbourhood/Commercial	2.68	11.20 %
2	Religion Institution	1.06	4.35 %
3	Public/Semi Public	1.64	6.74 %
4	Educational	1.06	4.35 %
5	Green/Recreational	3.12	2.85 %
6	Circulation/Roads	1.80	7.21%
7	Residential area	12.94	53.30 %
	Total	24.30	100.0%

Source: Author's Analysis 2014

Table 4.7 Impact of Rock Outcrop landcover on the New Town Development Plan

S/NO	Land use classes	Area (Ha)	Percentage
1	Neighbourhood/Commercial	5.56	46.90 %
2	Religion Institution	0.000	0.00 %
3	Public/Semi Public	2.47	20.84 %
4	Educational	1.11	9.39 %
5	Green/Recreational	2.47	20.84 %

6	Circulation/Roads	0.01	0.07
7	Residential area	0.23	1.96%
	Total	11.85	100.0 %

Source: Author's Analysis 2014

The results of the overlay of the new town development feature classes on the land use classes of the study area and the rates of impact is show from table 4.3 to table 4.7. The proposed plan has an effect on the physical, biological, cultural and socio-economic components of the environment because all the physical baseline data have been altered the environmental set up of the proposed area, this is similar with the research finding by (Canter, 1996) that most proposed plan have a potential impact on the environment.

4.4 ASSESSMENT OF THE LIKELY MAGNITUDE OF IMPACT OF NEW TOWN DEVELOPMENT ON THE IDENTIFIED IMPACT AREAS.

Table 4.8 show the results of the analysis of the areas that are impacted by the proposed new town development in the study area.

Table 4.8 Likely Impact of the New Town Development on the Existing Land Use

S/No	Land use class	Existing LULC	Proposed Land Use Plan	Change due to Development	Percentage
1	Bare land	22.68	414.724	-392.04	55.3 %
2	Vegetation	17.79	275.253	-257.46	36.32 %
3	Built-up area	15.5	9.373	5.627	0.79 %
4	Water body	3.47	49.154	-45.68	6.44 %

5	Rock out crop	1.69	9.774	- 8.08	1.15 %
Total					100.00%

Source: Author's Analysis 2014

Table 4.8 shows the areas that are likely to be mostly impacted from the baseline situation, based on results of this study. Baseline conditions will be impacted upon based on the implementation of the proposed development plan especially on the landuse/ landcover classes. Though almost all the baseline conditions will be affected by the development proposed plan of the new town in the study area as support by (Duh, Shandas, Chang and George, 2008) that any proposed plan for new town development has impact on the proposed plan but the magnitudes of the impacts varies from the different landuse classes which is the same in this research finding as shown in table 4.8. The new town development will have a higher impact of about 55.3 % on bare lands, 36.32 % on vegetation, 6.44 % on water body, 1.15 % on rock outcrop and about 0.79 % on the built up area. Again, all the physical and biological features and setting of the study area will be completely affected. The results show that the major areas to be impacted upon are the loss of vegetal covered and biodiversity supported by (Canter, 1996). Which means that the proposed new town development have an impact in the study area but the impacts varied in their magnitudes though the magnitudes of the impact is not that significant to stop the project implementation as shows in table 4.8.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

Baseline data was generated for the study area and various overlay analysis have been conducted in order to identify the areas that will have major impact that are likely to be affected by the proposed new town development plan. The study shows that the area that will be severely affected is the land use land cover classes generated from 2014 image and also the watershed drainage basin, flow accumulation, flow direction (runoff) and stream order that are affected. Again, the identified area that will be impacted by the new town development was assessed. It was found that the development will have a higher negative impact of about 55.3 % on bare land, followed by vegetation of about -36.32 %, 6.44 % on water body, 1.15 % on rock outcrop and 0.79 % on the built up.

Also, the consultation meetings from Public Participation were also taken into consideration in the conduct of the research. Though the proposed new town development will have a lot of significant adverse effects on the study area and environs, proper mitigation measures will reduce the impact of the adverse effects. However, the positive effects/impacts of the project, as well as its multiplier effects will outweigh the negative impacts, if the project is eventually implemented. The findings was is support of the research conducted by Rivas *et al*. (1994) that GIS play a vital role in the evaluation of impacts of land-use plans, based on the computation of impact indices obtained by the overlay of the proposed land uses with thematic maps. Also, Smith and Spaling (1995) refer several studies where GIS have been applied for the evaluation of cumulative effects through time series analysis. The importance and potential of using GIS to adopt a spatial approach to assess environment, also acknowledged by (Eade and Moran, 1996; Martinho et al., 1998).

5.2 CONCLUSION

The results of the various the drainage basin will be completely affected again with the flow accumulation and also the stream feature, the flow direction (runoff) will be re-channel as show by the overlaid of the new town development plan on the identify baseline data. Also, the overlay analysis of the new town development plan on land used/land cover generated from satellite imagery were conducted in order to identify the areas that have major impact that are likely to be affected by the proposed new town development plan. The analysis revealed that the area that will be severely affected is the land use land cover classes as well as the watershed drainage basin, flow accumulation, flow direction (runoff) and stream order. It was found that the development have a higher impact on bare land, vegetation, water body, rock outcrop and the built up.

To improve eisting situation, a comprehensive assessment approach is essential to to present research in the study area, to provide information to stakeholders and a platform for discourse that's why Geographic Information and Remote Sensing is employed in environmental impact assessment within the study area which will help planner in agaitation for better and efficient decision in Bwari Area Council, Federal Capital Teritoty Abuja.

5.3 RECOMMENDATIONS

The following recommendations are made based on the findings of the study.

1. The results of the analysis show that most of the vegetation of the area will likely be cleared in the course of implementing the new town development plan. As a result there is need to encourage afforestation in order to improve the adverse effects of the micro atmospheric conditions of the study area.

2. It is recommended for research to be further carried out after implementation of the new town development plan. This is necessary as EIA is a continuous process, with a view to assess impacts on air quality, pollution, noise pollution, drinking water, etc.

3. There is need to encourage further works on EIA using geospatial techniques due to its potentials, as carried out in this study. Chan and Easa (2000), pointed out that it has been estimated that approximately 80% of information used in the preparation of development plan, programmes and projects are geographic in nature, hence the need for geospatial techniques to be employed in EIA studies.

4. There is also the need for institutions to create awareness on the role and importance of Geospatial techniques in carrying out EIA works, through workshops and public media.

REFERENCES

Abbas, I. I. and Ukoje, J.A. (2009). Application of Remote Sensing (RS) and Geographic Information Systems (GIS) to Environmental Impact Assessment (EIA) for Sustainable Development. *Research Journal of Environmental and Earth Sciences* 1(1): 11-15.

Abu-Zeid, K. and Wagdy, A. (1999). *Assessment of Environmental Impacts for Irrigation Projects, a Decision Support System.* World Commission on Dams (submission serial No. opt081). (www.dams.org/kbase/submissions/showsub.php?rec=opt081).

Anji, M.R. (1995). Evaluation of impacts of land use changes on ground water quality of a part of Hyderabad city, India, using remote sensing, GIS and in-situ studies (*Academic project*).

Antunes, P. Santos, R. and Jordao, L. (2001). The Application of Geographical Information Systems to Determine Environmental Impact Significance. *Environmental Impact Assessment Review* 21(6), pp. 511-535.

Abdullah, M.F. Abdullah, A. and Zahari, R.K.(2010). GIS Implementation in Malaysian

Statutory Development Plan System, in *Handbook of Research on E-Planning: ICTs for Urban Development and Monitoring*, pp. 435-454. Ed C.N. Silva. New York: Information Science Reference.

Alshuwaikhat, H.M. (2005). Strategic environmental assessment can help solve environmental impact assessment failures in developing countries," *Environmental Impact Assessment Review*, vol. 25, no. 4, pp. 307–317.

Alshuwaikhat,H.M.(2005). Strategic environmental assessment can help solve environmental impact assessment failures in developing countries, *Environmental Impact Assessment Review*, vol. 25, no. 4, pp. 307–317.

Anderson, J. R., Hardey, E., Roach, J., Witmer, R.E. (1976). A Land Use and Land Cover Classification System for use with Remote Sensor data. *US geological survey professional paper*, 964, 28. Washington, DC.

Aronoff, S., (1989). *Geographical Information Systems: A Management Perspective.* WDL Publ., Ottawa. 294 pp. ISBN 0 921804 91 1

Aschemann, R. (2004). *Public Participation and Consultation: The Experiences of Europe.* Module 2, Session 2.4 of Strategic Environmental Assessment Distance Learning Course (World Bank, China State Environmental Protection Administration, International Association for Impact Assessment), available at http://info.worldbank.org/ etools/library/latestversion.asp?35155, last accessed on August 15th, 2014.

Bailey J (1997). Environmental Impact Assessment and Management: an under explored relationship. Environ Manage; 21(3):317–27.

Baker A, and Wood Ch (1999). An evaluation of EIA system performance in eight EU countries. Environ Impact Asses Rev 19:387–404.

Balogun, O. (2001), The Federal Capital Territory of Nigeria: *geography of its development, Ibadan university press, Nigeria.*

Bateman, I. J.,, Brainard J. S. and Lovett, A. A. (1995). Modelling woodland recreation demand using Geographical Information Systems: a benefit transfer study. *CSERGE Working Paper* GEC 95-06.

Belčáková, I. and Finka, M. (2000). Strategic Environmental Assessment of land use/spatial plans in EU and SR, in Gal, P. and Belcakova, I. (eds) *Current legislation and standards of spatial planning in social transformation and European integration,* FA STU Bratislava.

Bello N. (2001). NDDC Votes N1 billion to dredge canal, others in Ondo State; *Guardian Newspaper*, Thursday, 7 February 2002, P7.

Bojórquez-Tapia, L. Diaz-Mondragón, S. and Ezcurra E. (2001). GIS-based Approach for Participatory Decision Making and Land Suitability Assessment. *International Journal of Geographical Information Science* 15 (2) 129-151.

Burrough, P. A.and McDonnell, R. (1998). Principles of Geographical Information Systems. Oxford: Clarendon Press.

Canter, L. W. (1996). *Environmental Impact Assessment (Second Edition)*. McGraw-Hill, Inc. New York. ftp://www.energia.bme.hu/pub/hullgazd/Environmental%20Engineers'%20Handbook/Ch02.pdf

CEC (1997). Directive 97/11/EC, of 3rd March, amending Directive 85/337/EEC on the Assessment of the Effects of Certain Public and Private Projects on the Environment. *Commission of the European communities. Official Journal of the European Union,* L0011, 3.1997.

CEC (2001). Directive 2001/42/EC, of 27th June, on the Assessment of the Effects of Certain Plans and Programmes on the Environment, Luxemburg. Commission of the European Communities. *Official Journal of the European Union*, L197/30, 21.7.2001.

Chan, Y and Easa S. (2000). Looking Ahead. In: Easa, S and Y Chan (eds.) Urban Planning and Development Applications of GIS, pp. 253–256. *American Society of Civil Engineers*: Reston, Virginia.

Davidson, D. A. (1992). The evaluation of land resources. London: Longman Scientific and Technical, 1992.

Davis, Bruce E. (1996). *Geographic Information Systems: a visual approach,* first edition, OnWord Press.

Dhawale, A.K. and Landge, S.D. (2000). Remote Sensing and GIS Based Inputs for the Preparation of a Development Plan of Pimpari-Chinchwad Municipal Corporation (PCMC) Area for the Year 2018", *Proceedings of Geomatics 2000 :* Conference on Geomatics in Electronic Governance, 21-22 January, 2000, C-DAC, Pune. 22-33.

Draft Procedure and Guideline for EIA and EMP– (2008). Procedures Made Under Part Iii of the Regulations For Strategic Environmental Assessment And Environmental Impact Assessment (EIA). Government Gazette of the Republic Of Namibia. Windhoek – April 2008.

Dokken, D.J. White, K.S. (Eds.). Climate Change 2001: Impacts, Adaptation, and Vulnerability. *Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK.

Duh, J. D. Shandas V. Chang H., and George L. A. (2008). Rates of urbanisation and the resiliency of air and water quality," *Science of the Total Environment*, vol. 400, no. 1–3, pp. 238–256.

Duinker, P. N. and Beanlands. G. E. (1996). The significance of environmental impacts: an exploration of the concept. Environ Manage 1986;10(1):1– 10.

Eade, J. and Moran, D. (1996). Spatial economic valuation: benefits transfer using Geographical Information Systems. J Environ Manage 1996;48:97– 110.

EC-European Commission, (1997) *Council Directive 97/11/EC* of 3 March 1997 amending Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment. *Official Journal of the European Communities,* No. L 73: 5-15, Brussels.

EC-European Commission, (2001). *Directive 2001/42/EC* of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment. *Official Journal of the European Communities,* No. L 197: 30-37, Brussels. Fischer, T. B. (2007) *The Theory and Practice of Strategic Environmental Assessment,* Earth scan, London.

Eedy, W. (1995). The use of GIS in environmental assessment. Impact Assess;13:199– 206..

Environment Impact Assessment Act 1992 -Section (1(a).

ESRI (2005). All rights reserved. GIS Solutions for Environmental Managementthe. Copyright © 2005. @esri.com, and www.esri.com are trademarks, registered trademarks, or service marks of ESRI in the United States, the European Community, or certain other jurisdictions. Pp 2-9.

Federal Environmental Protection Agency (1986). Decree 58, Nigeria.

Federal Environmental Protection Agency (1995). Nigeria: environmental impact assessment procedural guidelines. Abuja.

Fedra, *K. (*1994*).* Environmental Monitoring. In: Survival by Technology. *Proceedings of the European Forum on Technology*. 15-17 September 1993. www.ess.co.at/STAFF/kfpubs.htm

FEPA (1995). Federal Environmental Protection Agency *Environmental Impact Assessment procedural Guidelines.*

FHA Act. (1990). http://www.nigeria-law.org/LFN-1990.htm last viewed 16-06-2014.

Fischer, T. B. (2007). *The Theory and Practice of Strategic Environmental Assessment,* Earthscan, London.

Funne G.E. (2001). The Roles and Responsibilities of Professionals in the Implementation of

the EIA Act. 86, 2001; *A workshop presentation on Environmental Impact Assessment, organized by the Nigerian Institute of Quantity Surveyors*, 13-14th November 2001.

Geertman, S. (2002). Participatory Planning and GIS: a PSS to Bridge the Gap. *Environment and Planning*. B, Planning & Design, 29, pp. 21-35.

Gocmen, Z.A. (2009). GIS Use for Planning in Wisconsin's Public Agencies. Paper presented at the 11th International Conference on Computers in Urban Planning and Urban Management.

Gontier M., M¨ortberg U., and Balfors B., (2010). Comparing GIS based habitat models for applications in EIA and SEA, *Environmental Impact Assessment Review*, vol. 30, no. 1, pp. 8–18.

González A., Gilmer A., Foley R., Sweeney J., and Fry J, (2008). Technology-aided Participative Methods in Environmental Assessment: *An International Perspective. Computers, Environment and Urban Systems*, 32, 303–316.

González, A, A Gilmer, R Foley, J Sweeney and J Fry (2011). Applying geographic information systems to support strategic environmental assessment: Opportunities and limitations in the context of Irish land-use plans. *Environmental Impact Assessment Review*, 31(3), 368–381.

Goodchild, M.F. Parks B.O. and Steyaert L.T. (1993). *Environmental Modelling with GIS*. New York, Oxford University Press.

Haklay, M., Feitelson, E., and Doytsher, Y., (1998). The Potential of a GIS-Based Scoping System: an Israeli Proposal and Case Study, *Environmental Impact Assessment Review*, 18(5), pp. 439-459.

Hastings, D.A., and Clark, D.M, (1991). GIS in Africa: Problems, challenges and opportunities for co-operation. *International Journal of Geographical Information Systems.* vol. 5, no. 1. p. 41-58.

Heiland, S., (2005). Requirements and Methods for Public Participation in SEA, in: Schmidt, M., Joao, E. and Albrecht, E. (eds) *Implementing Strategic Environmental Assessment*, Springer, Berlin.

Hussaini I. (1997). Environmental Impact Assessment Procedures: *Seminar presentation at a training workshop organised by KEPA*; P.3.

Isichei, A. O. (2000). Environmental impact assessment and environmental evaluation reports. Paper presented at the Workshop of the Nigerian Corrosion Association, Warri (27th March).

Joa˜o E, Fonseca A. (1996). The role of GIS in improving environmental assessment effectiveness: theory vs. practice. Impact Assess;14:371– 87.

Jay S., Jones C., Slinn P., and Wood C., (2007). Environmental impact assessment: retrospect and prospect," *Environmental Impact Assessment Review*, vol. 27, no. 4, pp. 287–300.

Jensen, J.R. (1996). *Introducing digital Image Processing; A Remote Sensing Perspective* (2nd ed). Upper Sadle River NJ: Prentice Hall.

João, EM, (1998). Use of Geographic Information Systems in Impact Assessment. In: Porter, A and Fittipaldi J (eds). Environmental Methods Review: Retooling Impact Assessment for the New Century, pp. 154–163. *The Army Environmental Policy Institute*: Atlanta.

Jordan, G. and Shrestha, B., (2000). A Participatory GIS for Community Forestry User Groups in Nepal: Putting People Before the Technology. *International Institute for Environment and Development*; Participatory Learning and Action Notes 39.

Kathuria V., (2007). Informal regulation of pollution in a developing country: evidence from India," *Ecological Economics*, vol. 63, no. 2-3, pp. 403–417.

Kogbe, A.C. (1978). Nigeria: Physical Setting.www.onlinenigeria.com/links/abujaadv

Kom´ınkov´a D., (2008). Environmental impact assessment and application— part 1, in *Encyclopedia of Ecology*, J. S. Erik and F. Brian, Eds., Academic Press, Oxford, UK.

Koomen, E., Veenbass, G. and Poot, G. (1997). Quantitative Analysis of Bird Disturbance in Environmental Impact Analysis, in Geographic Information: *Third Joint European Conference & Exhibitionon Geographic Information*, Vienna, Austria. P. 669-675. *http*://dare.ubvu.vu.nl/handle/1871/32652 last viewed 16-06-2014.

Kruopienė, J., Židonienė, S. and Dvarionienė, J. (2009). Current practice and shortcomings of EIA in Lithuania. Environ Impact Asses Rev. 29: 305–309.

Lee, N., (2006). Bridging the gap between theory and practice in integrated assessment, *Environmental Impact Assessment Review*, 26: 57-78.

Liu, X.H., Skidmore, A.K. and Oosten, V.H. (2002). Integration of Classification Methods for Improvement of Land-cover Map Accuracy, *ISPRS Journal of Photogrammetry and Remote Sensing*, 56, 257-268.

Nouri J., Mahvi A. H., Younesian M., Nabizadeh R., and Hashemi I., (2007). Environmental impacts assessment of industrial estate providing with managerial process. *Iranian Journal of EnvironmentalHealth Science and Engineering*, vol. 4, no. 2, pp. 121–126.

Mabogunje, A.L. (1977). Report of the Ecological Survey of the Federal Capital Territory: *The Environment Planning Studies Programme*, Vol. 1., University of Ibadan, Ibadan.

Manual, UNEP Economics and Trade Branch (2014), available at

http://www.unep.ch/etu/publications/EIAMan_2edition_toc.htm, last accessed on August 18th, 2014.

Martinho, S., Santos, R., Antunes, P. and Jorda˜o, L. 91998). Using natural assets attributes to produce economic value maps. Paper presented at the Fifth Biennial Meeting of the International Society for Ecological Economics, Santiago, Chile, 1998.

McCormick, N.; Critchley, M., Lavalle, C., Kasanko, M., Demicheli, L., Barredo, J., Engelen, G., (2003). Mapping and Modellingthe Impact of Land Use Planning and Management Practices on Urban and Peri-Urban Landscapes in the Greater Dublin Area. In K. Fullerton y A. Munro (Eds.) 8th *EC-GI & GIS Workshop*: A Work in Progress. Dublín, July 3-5, 2002. See also: http://moland.jrc.it

Money, D.C.(1976). *Climate, Soil and Vegetation*. University Tutorial Press,London , pp 95-1082

Munn, R.E., (1975). Environmental Impact Assessment: Principles and Procedures. Scope Report 5; Toronto.

National Housing Policy(2012) : National Housing Policy

Nigerian Urban and Regional Planning Law (1992). *Approval of a Planning Authority before development*: Section 28; http://www.placng.org/lawsofnigeria/node/288 last accessed on June 14th, 2014

Nigerian Urban and Regional Planning Law (1992). Submission of detailed environmental impact statement: Section 33; http://www.placng.org/lawsofnigeria/node/288 last accessed on June 14th, 2014

New Brunswick, Canada Official website (nd). Environment and Local Government: http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/environmental_impactassessment.html last accessed on February 5th, 2014.

Nouri J., Mahvi A. H., Younesian M., Nabizadeh R., and Hashemi I., (2007). Environmental impacts assessment of industrial estate providing with managerial process, *Iranian Journal of EnvironmentalHealth Science and Engineering*, vol. 4, no. 2, pp. 121–126.

Obaidullah, N. and Rizwan, H. (2008). Evaluation of environmental impact assessment system in Pakistan. Environ Impact Asses Rev. 28: 562–571.

Ogunba, O. A. (2004). EIA systems in Nigeria: evolution, current practise and shortcomings. Environ Impact Asses Rev; 24:643–60.

Ojeshina, (1998): the Implications of energy utilization on the environment; Seminar presentation on Facility management organized by International Facility Management Association – 26th August, 1998.

Ojigi, M. L, (2005). Digital Terrain Modeling & Drainage Analysis of the Northern part of

Abuja Phase II Dev. Area, Using Geospatial Techniques. An Unpublished Ph.D. Thesis in Remote Sensing Applications. Federal University of Technology, Minna Nigeria pp.178.

Okecbukwu, C. C. (1974). Fluvial geomorphic interrelationships in some river catchments in the Nigerian Pre-Cambrian Basement Complex, *Ph.D. thesis*, University of Ibadan.

Okorodudu-Fabura, M. T. (1988). Law of environmental protection materials and text. Ibadan, Nigeria: Caltop Publications.

Patil, AA, AP Annachhatre and NK Tripathi, (2002). Comparison of Conventional and Geo-Spatial EIA: A Shrimp Farming Case Study. *Environmental Impact Assessmen Review*, 22(4), 361–375.

Patkar, V.N. (2003). Directions for GIS in Urban Planning", GIS@development, http://www.gisdevelopment.net/application/urban/overview/urban0042pf/htm. *Map Asia Conferences, Urban Planning.*

Petts, J., (2003). Barriers to Deliberative Participation in EIA, *Journal of Environmental Assessment Policy and Management*, 5: pp. 269-293.

Pinho, P., Maia, R. and Monterroso, A. (2006). The quality of Portuguese Environmental Impact Studies: *the case of small hydropower projects*. Environ Impact Asses Rev; 27(3):189–205.

Pölönen, I. (2006). Quality control and the substantive influence of environmental impact assessment in Finland.Environ Impact Asses Rev; 26:481–91.

Provincial Law Gazette of Styria, (2007). *Styrian Spatial Planning Act* 1974 as of 2007, No. 47/2007, Graz (in German language).

Rauschmayer, F. and Risse, N., (2005). A framework for the selection of participatory approaches for SEA, *Environmental Impact Assessment Review*, 25: 650-666.

Rau J. G. and Wooten D. C., (1980). *Environmental Impact Analysis Handbook*, McGraw-Hill, New York, NY, USA.

Rivas, V, Gonzalez, A., Fischer, D. W. and Cendrero, A (1994). An approach to environmental assessment within land-use planning process: northern Spanish experiences. J Environ Plann Manage;37: 305– 22.

Robert Goodland, (2005). Editor on Social and Environmental Impact Assessment , Oil and Gas Pipeline –IAIA 2005 Conference, Virginia, USA.

Nedović-Budić, Z., (2000). Geographic Information Science Implications for Urban and Regional Planning. *URISA Journal*. Vol. 12 (2), pp. 81-92.

Sadler, B. and Verheem, R. (1996). Strategic Environmental Assesment. Status, Challenges and Future Directions, *Ministry of Housing, Spatial Planning and the Environment*, The Hague, Netherlands.

Sakalauskiene G., Hansen F. T. and Raulinaitis, M. (2004). Assessment of hydro power plants effect on river water quality. Environ Res Eng Manage; 3(29):14–20.

Sankoh, O. A. (1996). *An evaluation of the analysis of ecological risks method in Environmental Impact Assessment*. Environ Impact Assess Rev 1996;16:183– 8.

Sankoh, O., Bonner, D., Determann,. T, Gersten, J., Gropp,. A, Hoelters, I., Krueger, N., Lehmann, U., Marty, C., Strauss, K. and Wegner, H. (1993). *Finding and assessing route alternatives*. J Environ Manage 1993;38: 323– 34.

Schaller, J. (1992). GIS helps measure impact of new Munich airport. GIS Eur 1992, June.

Schneider, S., Sarukhan, J., Adejuwon, J., Azar, C., Baethgen, W., Hope, C., Moss, R., Leary, N., Richels, R., Van Ypersele, J.P., (2001). Overview of impacts, adaptation, and vulnerability to climate change. In: McCarthy, J.J., Canziani, O.F., Leary, N.A.,

Siebenhüner, B and Barth, V., (2004). The Role of Computer Modelling in Participatory Integrated Assessment. *Environmental Impact Assessment Review*, 25, 367-389.

Singh A., Lou H. H., Yaws L. C., Hopper J. R. and Pike R. W., (2007). Environmental impact assessment of different design schemes of an industrial ecosystem, *Resources, Conservation and Recycling*, vol. 51, no. 2, pp. 294–313.

Simpson, J. (2001). Developing a review package to assess the quality of EA reports of local Authority structure and local plans in the UK. Environ Impact Asses Rev; 21:83–95.

Skehan, CD and A González, (2006). Spatial Data Management Requirements and Strategic Environmental Assessment. Unpublished paper presented at the Society of Chartered Surveyors, *EuroSDR & Dublin institute of technology joint workshop*, 31 de October, Dublin, Ireland.

Smit B, Spaling H. (1995). Methods for cumulative effects assessment. Environ Impact Assess Rev ;15:81– 106.

Strömquist, L. and Larsson, R-Å, (1994). Practical Approaches to Applied Remote Sensing as Illustrated by the SAMOZ Project in Mozambique. *UNGI Rapport no. 86*. Uppsala University, Inst. of Earth Sciences. Pp.122

Strömquist, L., Larsson, R-Å and Olovsson, S., (1994). Applied Use of Satellite Data in Developing Countries. *Experiences from environmental studies in Mozambique* – the 69 SAMOZ project. Acta Universitatis Upsaliensis. *Nova Acta Regiae Societatis Scientiarum Upsaliensis*, Ser. V:C, vol. 4. p. 23.

Suleiman, A. O. (2007). *Environmental Impact Assessment in Nigeria*: Akwa Ibom State EIA Train the Trainer Workshop.

Szergo, J. (1994). Estimating and mapping the impact of environmental influences on a dynamic population: II. Proc EGIS'94 Conf, Paris, pp. 997–1006.

Taylor, D.R.F. (1991). GIS in Developing Countries – Preface. *International Journal of Geographical Information Systems.* vol. 5, no. pp.1-3.

Tiwari, D.P. (2006). Remote Sensing and GIS for efficient Urban Planning, GIS Development.

Towers, G. (1997). GIS Versus the Community. Applied Geography, 17 (22), pp. 111-125.

United Nations Economic Commission for Europe, (1998). Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, *Aarhus Convention, June 25th, 1998, Geneva*

United Nations Environment Programme, (2002). *UNEP Environmental Impact Assessment Training Resource Manual*, UNEP Economics and Trade Branch, available at http://www.unep.ch/etb/publications/EIAMan2editionToc.php, last accessed on February 5th, 2014.

Urban Data Management Symposium (UDMS, 2011). Application of Gis-Planning Decision Support System In Predicting Development Impact Assessment**.** September 28-30, 2011, Delft, *The Netherlands International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Volume XXXVIII-4/C21. P 52.

USAID (2005). Environmental Guidelines for Small-Scale Activities in Africa: *Environmentally Sound Design for Planning and Implementing Development Activities*, U.S. Agency for International Development, Office of Sustainable Development, Draft Version, January 2005, www.encapafrica.org.

Usman, A. I. (2001). General Principles of environmental Protection Laws; *workshop presentation on Environmental Impact Assessment organized by the Nigeria Institute of Quantity Surveyors*; 13-14th November, 2001.

Vanderhaegen, M and E Muro, (2005). Contribution of a European Spatial Data Infrastructure to the Effectiveness of EIA. Environmental Impact Assessment Review, 25(2), 123–142.

Van Teeffelen, P., Van Grunsven, L., Verkoren, O., (1992). Epilogue, Dealing with the constraints of GIS applications in developing countries. In: van Teeffelen, P., van Grunsven, L., Verkoren, O. (Eds.), *Possibilities and constraints of GIS applications in developing countries. Nederlandse Geografische Studies 152,* Utrecht.

Ventura, S. J., Nieman, B. J. and Moyer, D. D (1988). A multipurpose land information system for rural resource planing. J Soil Water Conserv; 43:230– 43.

Ventura, S. J. and Wang, H. L. (1996). *A method to assess the allocation suitability of recreational activities: an economic approach*. Environ Manage; 20: pp. 85 –193.

Vlado, V., (1993). GIS-based Information System for Evaluation of Compatibility Between Settlement Activities and their Environmental Settings. PAP-4/GIS/W.1/3. Split: PAP/RAC. pp. 11. ENG.

Wilford, P. C. (1977). Using the UTM Grid System to Record Historic Sites, National Register Bulletin. U.S. *Department of the Interior, National Park Service*. Retrieved January 10th, 2014 from http://www.nps.gov/nr/publications/bulletins/pdfs/nrb28.pdf,

Wood, J., (2005). How Green is My Valley? Desktop Geographic Information Systems as a Community-Based Participatory Mapping Tool. *Area*, vol. 37 (2), pp. 159-170.

Yapa, (1991). Is GIS appropriate technology*? International Journal of Geographical Information Systems.* vol. 5, no. 1. pp. 41-58