CREATING A GEO- SPATIAL DATABASE FOR SECONDARY SCHOOLS' FACILITIES IN ZARIA EDUCATION ZONE, KADUNA STATE

BY

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A THESIS SUBMITTED TO THE SCHOOL OF POST GRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (MS.C) IN REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM (GIS)

DEPARTMENT OF GEOGRAPHY,
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DECLARATION

I declare that the work in this thesis entitled "Creating a Geo-Spatial Database for Secondary School Facilities in Zaria Education Zone, Kaduna State" has been carried out by me in the Department of Geography. The information derived from literature has been duly acknowledged in the text and a list of references provided. No part of this project thesis was previously presented for another degree or diploma at this or any other institution.

…….. … …… ……....

Name of Student Signature Date

CERTIFICATION

This thesis entitled "CREATING A GEO-SPATIAL DATABASE FOR SECONDARY SCHOOLS' IN ZARIA EDUCATION ZONE, KADUNA STATE", by Abdulkadir Yahaya MUHAMMED meets the regulations governing the award of the degree of Master of Science (Remote Sensing and Geographic Information System (GIS)) of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

School records are important but rarely kept well in many Secondary Schools and school management boards; this made the creation of database for Secondary Schools difficult. Since Zaria Education Zone was created, no research has been carried out to determine how Secondary Schools members of staff fare, what facilities are in place and what are not, and a host of other vital school requirements using Remote Sensing and Geographic Information System (GIS) technique. The research questions were set to understand the categories of facilities exist in the study area, characteristics of the geo-spatial facilities identified, and the geo-referenced of locating Secondary School in the study area and how they are pattern spatially. The objectives of the study were to identify the spatial facilities of Secondary Schools in the study area, explore the characteristics of spatial facilities identified, establish the geo-referenced of locating Secondary Schools in the study area and create a spatial database of facilities in the study area. To achieve these, Digital Mapping, Global Positioning System (GPS) Google Earth and some information from education board were used to collect, analyse and create Database. The study covers Zaria, Parts of Sabon Gari, Soba and Kudan Local Government Areas. The study found that, the schools were overcrowded in Zaria and Sabon Gari LGA, but sparsely in Soba and Kudan LGA which affect instructions and understanding. Most of the schools lack one facility or the other except Alhuda Huda College and Barewa College. The schools were also categorized into first, second and third generation based on their years of establishments. The study recommended that more schools and/or classes need to be constructed in order to keep pace with ever increasing school enrolments among other recommendations.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Education in Nigeria is managed by the three tiers of Governments (The Local, the State and the Federal). The Federal Ministry of Education takes responsibility for the policy formation and implementation at regional and national levels. The education system is divided into Kindergerten or Nursery, Primary Education, Secondary Education and Tertiary Education with hierarchy of systems in operations (Kayode, 2006). A lot of efforts have been made to measure universal education in Nigeria, but it was reported that the realization of Education for All will remain a dream as long as there is imbalance in the distribution of educational facilities (Kayode, 2006).

The Universal Basic Education (UBE), came as a replacement for Nigeria's Universal Primary Education scheme of the 6-3-3-4 system of primary education. The 9-3-4 system of education was designed in conformity with Millennium Development Goals (MDGs) and Education For All (EFA) (Kayode, 2006). The UBE involves six years of Primary School Education and three years of Junior Secondary School Education, culminating in nine years of uninterrupted schooling and transition from one class to another is automatic but determined through continuous assessment. This scheme is monitored by the Universal Basic Education Commission (UBEC), and has made it "*free", "Compulsory*" and right of every child. Therefore, the UBEC law section 15 defines UBE as early childhood care and education. The law stipulates a 9-year formal schooling, adult literacy and non-formal education, skills acquisition programmes and the education of special groups such as nomads and migrants, girl child and women, Almajiri, street children and disabled people (Aderinoye, 2007). One of the components of the MDGs is achieving Universal Basic Education for all boys and girls by the year 2015 (Aliyu, Sule and Youngu, 2012).

The National Policy on Education (2004) posits that the success of education to be achieved by all groups (boys and girls) is hinged on proper planning, efficient administration, adequate planning and effective siting. Within this context, the framework of action adopted at the World Education Forum in Dakar in 2000 to the goal of Education for all (EFA) was reaffirmed by Nigeria (Mark and Varghese, 2011).

Ogunsaju (1980) and Asiabaka (2008) reported that the quality of education that students receive bears direct relevance to the availability or lack of physical facilities and overall atmosphere in which learning takes place. These facilities play a pivotal role in the actualization of educational goals and objectives by satisfying the physical and material needs of teaching and learning Educational facilities were referred to by Adepoju and Fabiyi (2000), and Amnesty International (2012) as the basic structures necessary for learning such as; school buildings, furniture, laboratories, instructional materials, computer facilities, libraries, sport facilities, etc.

Watanbe (1992) and John (1996) reported that effective use of GIS by educators and planners to locate and establish coordinates of schools and the distribution of schools with detail characteristics of students' enrolment, class sizes, school accessibility and transportation networks integrate school data into digital format and make analyses and simulation of school infrastructure efficient and easy accomplish.

The central mission of ensuring success for learning centres on education reform initiatives that highlight the need for data in policy, management and instructional changes. A major emphasis of current reform initiatives is to help schools become genuinely accountable to students, parents and the broader community. The demands for accountability have been

accompanied by growing awareness of the need to provide evidence of a school's effectiveness (Holcomb, 1999).

Thompson and Hardin (2000) posited that the quality of planning and decision making process are strongly influenced by the data availability and data completeness. Eighty percent of time and costs occupied in developing GIS is allocated to database acquisition and integration.

While school mapping and GIS share the same philosophy of looking at education through geographical spectacles, the area of focus for school mapping is at micro-level. GIS, however, enable the user to work at any level, from the country as a whole right down to individual schools and then right up again to any chosen level of geographical aggregation. The most important goal of school mapping is to rationalize school problems and needs are analysed in each area, and proposals are made for rationalization and reorganization in each mapping area (John, 1999).

Students enrolment in Primary to Tertiary Institutions in Zaria metropolis have increased exponentially since independence, so the demand for physical structures like classrooms, laboratories, field plots and administrative buildings put pressure on school resources. In addition, are the space needed for site/buildings. While the need for space in schools increases, the population increase in urban Zaria has stretched the sanity of locations and physical planning of schools. Commercial buildings have distorted the beauty of educational institutions, made their visibility obscured and complicated location of facilities. The challenges of physical planning are also compounded by the inability of the Kaduna State Ministry of Education to provide the public with the exact spatial extent of her Secondary Schools and the database for the physical facilities. More so, there are no GIS

facilities in these schools that would provide the spatial location and the physical database for planning (Abdulkarim, 2006, 2007, and 2011).

This study aims to generate database of facilities and geo-reference of Secondary Schools. With Geographic Information System (GIS) as a technique, there are a number of possibilities to improve education at micro planning (DeGrauwe, Anfield, Tamiro and Parolin, 2002). GIS works is in four domains (Aronoff, 1989). i. Observing and measuring environmental parameters ii. Developing electronic maps which portray the true characteristics of locations iii. Monitoring changes of the locations in space and time and iv. Modeling alternatives for actions and processes operating in a location or an environment.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Databases have been created in many areas of life; the year 1960 saw the development of the world's first true operational GIS in Ottawa, Ontario, Canada by the Federal Department of Forestry and Rural Development. It was called the Canada Geographic Information System (CGIS) aimed at analyzing the data collected by the Canada Land Inventory (CLI) and to produce statistics to be used in developing land management plans for large areas of rural Canada (Tomlinson, 1987).

In 2005, GIS data-model used for school mapping planning, with attribute data was made available for problem solving and decision-making in Education in Jordan. Thus, the end product of the GIS application provided an Educational Decision Support System that provided Jordan with maps that focus on schools locations and all related information to assist decision-makers in either expanding current school or suggesting sites for new schools (Nedal, Reem and Moh'd, 2005).

In Ghana, GIS and Remote Sensing technique used to assess the community of Ashaiman, a home to about 400,000 people in a 40-square kilometer region revealed the status of their building structures and the schools' boarding facilities where most of the structures can best be described as shacks.. As a result, the additional facilities recommended accommodate more students and provided the community with more aesthetic appealing houses (*ArcNews* Magazine, 2008).

Studies carried out by (Abdulkarim, 2007), (Inobeme and Ayanwole ,2009), (Olamiju and Olujumi, 2011), (Aliyu,,Sule and Youngu 2011) and (Abbas, 2012) on education and the use of Geographic Information System for planning and creation of awareness in Nigerian Institutions of learning indicated a dismal relationship between teaching and spatial skills acquisition owing to inadequate database. In addition, the application of GIS in assessing and tracking educational facilities put by the advocates of Millennium Development Goals (MDGs) and the geo-referencing of public institutions in Zaria was lacking.

Literatures suggest that very few studies of this nature were conducted for both public and private Secondary Schools in Nigeria. A study conducted in Abuja Metropolis Area Council (AMAC) centred on GIS and Remote Sensing application in schools and meeting MDG targets, but did not provide how the application of GIS and Remote Sensing technology will enable the creation of geo-spatial database for use in institutions. The problem is that, limited information on the available database for learning with no adequate record of members of staff, students, facilities and infrastructure has denied parents best options in the choice of schools for their children within Zaria on one hand, and the options for siting and provision of physical facilities by the Kaduna State Ministry of Education on the other. Zaria Education Zone got the first school as early as 1910 and the numbers of schools continue to grow and multiply, yet standard database for schools and facilities is still

unavailable. This is the gap that the study intends to fill and provide in-depth information for further studies in related field. The study was set to answer the following research questions:

i. What categories of facilities exist in the study area?

ii. What are the characteristics of the geo-spatial facilities identified?

iii. What are the geo-referenced locations of the Secondary School in the study area?

iv. How are their spatial distribution patterned?

1.3 AIM AND OBJECTIVES

The aim of the study is to apply GIS technique to generate a geo-spatial database for Secondary Schools in Zaria Education Zone. To achieve the aim, the specific objectives were set to:

i. identify the geo-spatial facilities of Secondary Schools in the study area;

ii. explore and explain the characteristics of the geo-spatial facilities identified in the study area;

iii. establish the geo-referenced of locating Secondary Schools in the study area;

iv. create a geo-spatial database of facilities in the study area.

1.4 JUSTIFICATION FOR THE STUDY

This study envisaged to facilitate Kaduna State Ministry of Education in identifying areas within Zaria Education Zone that need intervention on issues of siting and accessibility to members of staff and students alike. The study is also envisaged as a base for geo-referenced information that can be employed for improving the location of existing schools, monitoring the distribution of schools and facilities in each Secondary School in Zaria Education Zone. Such data will consist of spatial database showing location of every school

within the zone, as well as attribute data showing details of school physical structures. Inspectors of education can use the geo-spatial data of the schools to plan the type of inspections to undertake and the exact location of the schools they wish to work in. The study was also undertaken with the hope of bridging the gap between the use of analogue and digital database in schools. The study outcome will also help design and enrich curriculum planning and review of geography syllabus that includes the studies in GIS. Other researches of similar features can be held to adapt the study in other locations. The study outcome could extend the frontiers of knowledge and be used for further researches.

1.5 SCOPE AND LIMITATION

The scope of this research covers Zaria Education Zone Secondary Schools. The spatial extent of the research covers Maigana, Zaria City, Tudun wada, Gaskiya, Wusasa, Likoro and Sabon-Gari. The temporal extent of the study covers only Public Secondary Schools as at 2013. The knowledge extent of the research covers identification, mapping, geo-referencing and generating of database on Secondary Schools. The limitation is that, the database created used simple data rather than complex which involve querying, use of primary and foreign key to eliminate redundancy and achieve normalcy; this is due to low computer literacy level of end-users which might not use the database created completely if it is done that way.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

The chapter presents a literature review aimed at facilitating the understanding of meaning of database, digital Mapping, Google earth and Global Positioning System (GPS) and the debate surrounding the topic within the academic literature. The chapter reviews the definition, concept, evolution and characteristics of database, Digital Mapping, Google earth and GPS.

2.2 CONCEPT OF DATABASE

Database is a collection of logical related data, designed to meet the information needs of an organization. It is a large repository of data used simultaneously by departments, institutions and even individual and group users. Instead of disconnected files with redundant data, all data items are integrated with a minimum amount of duplication (Connolly and Begg, 2005).

A general-purpose database management system (DBMS) is a software system designed to allow the definition, creation, querying, update, and administration of databases. Well-known DBMSs include MySQL, PostgreSQL, SOLiteM, Microsoft SQL Server, Microsoft Access, Oracle, Sybase, dBASE, FoxPro, and IBM D2. A database is not generally portable across different DBMS, but different DBMSs can inter-operate by using standards such as SQL and ODBC or JDBC to allow a single application to work with more than one database (Connolly and Begg, 2005).

2.3 DATABASE MANAGEMENT SYSTEM (DBMS)

A database management system (DBMS) is a suite of computer software that provides an interface between users and available data. Database referred as DBMS is an information manipulative process. In other instances, it is referred to as a collection of data in spreadsheet or on indexed cards. Processes of database fall into four main groups:

i. Data definition. Where new data structures, storage is set, data structured patterned and removing data structures from the database and modifying the structure of existing data.
ii. Update. Where data is inserted, modified and deleted.
iii. Retrieval. Where information either for end-user queries and reports or for processing by applications.
iv. Administration. Where data are registered and users are monitored and enforced performance and maintained data integrity, dealing with concurrency result, and recovering information if the system fails.

A DBMS is responsible for maintaining the integrity and security of stored data, and for recovering information if the system fails.

Often database and its DBMS conform to the principles of a particular database models. Database system consists of database models, and management systems with the process characteristics described above. Physically, database servers are dedicated computers that hold the actual databases and run only the DBMS and related software. Database servers are usually multiprocessor computers, with generous memory and RAID disk arrays used for stable storage. Hardware database accelerators, connected to one or more servers via a high-speed channel, are also used in large volume transaction processing environments. DBMSs

are found at the heart of most database applications. DBMSs may be built around a custom multitasking kennel with built-in networking support, but modern DBMSs typically rely on a standard operating system to provide these functions. Since DBMSs comprise a significant, computer and storage vendors often take into account DBMS requirements in their own development plans.

Databases and DBMSs can be categorized according to the database model(s) that they support (such as relational or XML), the type(s) of computer they run on (from a server cluster to a mobile phone), the query language(s) used to access the database (such as SQL or XQuery), and their internal engineering, which affects performance, scalability, resilience, and security. (Connolly and Begg, 2005).

2.3.1 Applications of Database

Most organizations in developed countries today depend on databases for their business operations. Increasingly, databases are not only used to support the internal operations of the organization, but also to underpin its online interactions with customers and suppliers. Databases are not used only to hold administrative information, but are often embedded within applications to hold more specialized data: for example engineering data or economic models. Examples of database applications include computerized library systems, flight reservation system and computerized part inventory system (Philip and Joseph, 2005).

The database application in this study was the spatial facilities that aid teaching and learning and enables easy location and retrieval.

Client-server or transactional DBMSs are often complex to maintain high performance, availability and security when many users are querying and updating the database at the same

time. Personal, desktop-based database systems tend to be less complex. For example, File maker and Microsoft Access come with built-in graphical user interface.

2.3.2 General-Purpose and Special-Purpose DBMSs

A DBMS has evolved into a complex software system and its development typically requires thousands of person-years of development effort. Some general-purpose DBMSs such as Adabas, Oracle and DB2 have been upgraded since the 1970s. General-purpose DBMSs aim to meet the needs of as many applications as possible, which add to the complexity. However, the fact that their development cost can be spread over a large number of users' means that they are often the most cost-effective approach. However, a general-purpose DBMS is not always the optimal solution: in some cases a general-purpose DBMS may introduce unnecessary overhead. There are therefore many examples of systems that use special-purpose databases. A common example is an email system: email systems are designed to optimize the handling of email messages, and do not need significant portions of a general-purpose DBMS functionality (Philip and Joseph, 2005).

Many databases have application software that accesses the database on behalf of end-users, without exposing the DBMS interface directly. Application programmers may use a wire protocol directly, or more likely through an application programming interface. Database designers and database administrators interact with the DBMS through dedicated interfaces to build and maintain the applications' databases, and thus need some more knowledge and understanding about how DBMSs operate and the DBMSs' external interfaces and tuning parameters (Philip and Joseph, 2005).

General-purpose databases are usually developed by one organization or community of programmers, while a different group builds the applications that use it. In many

companies, specialized database administration maintains databases, run reports, and may work on code that runs on the databases themselves (rather than in the client application).

2.3.3 History of Database

With the progress in technology in the areas of processors, computer memory, computer storage and the sizes, capabilities and performance of databases and their respective DBMSs have grown in orders of magnitudes. The development of database technology can be divided into three eras based on data model or structure: navigational SQL/relational, and post-relational. The two main early navigational data models were the hierarchical model, epitomized by IBM's IMS system, and the Codasyl model (Network model), implemented in a number of products such as IDMS.

The relational model, first proposed (Codd, 1970) departed from this tradition by insisting that applications should search for data by content, rather than by following links. The relational model is made up of ledger-style tables, each used for a different type of entity. It was not until the mid 1980s that computing hardware became powerful enough to allow relational systems (DBMSs plus applications) to be widely deployed. By the early 1990s, however, relational systems were dominant for all large-scale data processing applications, and they remain dominant today (2012) except in niche areas. The dominant database language is the standard SQL for the relational model, which has influenced database languages for other data models.

Object databases were invented in the 1980s to overcome the inconvenience of object-relational impedance mismatch, which led to the coining of the term "post-relational" but also development of hybrid object-relational databases.

The next generation of post-relational databases in the 2000s became known as NoSQL databases, introducing fast key-value stores and document-oriented databases. A competing "next generation" known as NewSQL databases attempted new implementations that retained the relational/SQL model while aiming to match the high performance of NoSQL compared to commercially available relational DBMSs. (Philip and Joseph, 2005).

2.3.4 Relational DBMS

Edger Codd worked at IBM in San Jose, California, in one of their offshoot offices that was primarily involved in the development of hard disk systems. He was unhappy with the navigational model of the Codasyl approach, notably the lack of a "search" facility. In 1970, he wrote a number of papers that outlined a new approach to database construction that eventually culminated in the groundbreaking. In one of these papers, he described a new system for storing and working with large databases. Instead of records being stored in some sort of linked list of free-form records as in Codasyl, Codd's idea was to use a "table" of fixed-length records, with each table used for a different type of entity. A linked-list system would be very inefficient when storing "sparse" databases where some of the data for any one record could be left empty.

The relational model solved this by splitting the data into a series of normalized tables (or relations), with optional elements being moved out of the main table to where they would take up room only if needed. Data may be freely inserted, deleted and edited in these tables, with the DBMS doing whatever maintenance needed to present a table view to the application/user (Codd, 1970).

In the relational model, related records are linked together with a "key" The relational model also allowed the content of the database to evolve without constant rewriting of links

and pointers. The relational part comes from entities referencing other entities in what is known as one-to-many relationship, like a traditional hierarchical model, and many-to-many relationship, like a navigational (network) model. Thus, a relational model can express both hierarchical and navigational models, as well as its native tabular model, allowing for pure or combined modeling in terms of these three models, as the application requires. (ibid).

For instance, a common use of a database system is to track information about users, their name, login information, various addresses and phone numbers. In the navigational approach all of these data would be placed in a single record, and unused items would simply not be placed in the database. In the relational approach, the data would be normalized into a user table, an address table and a phone number table (for instance). Records would be created in these optional tables only if the address or phone numbers were actually provided (ibid).

Linking the information back together is the key to this system. In the relational model, some bit of information was used as a "key", uniquely defining a particular record. When information was being collected about a user, information stored in the optional tables would be found by searching for this key. For instance, if the login name of a user is unique, addresses and phone numbers for that user would be recorded with the login name as its key. This simple "re-linking" of related data back into a single collection is something that traditional computer languages are not designed for (ibid).

Just as the navigational approach would require programs to loop in order to collect records, the relational approach would require loops to collect information about any one record. Codd's solution to the necessary looping was a set-oriented language, a suggestion that would later spawn the ubiquitous SQL. Using a branch of mathematics known as tuple calculus, he demonstrated that such a system could support all the operations of normal

databases (inserting, updating etc.) as well as providing a simple system for finding and returning *sets* of data in a single operation (ibid).

Codd's modification of relational data model by Eugene Wong and Micheal Stonebaker (1973) resulted to evolution of INGRES coding for a geographical database project and student programmers to produce code. Beginning in 1973, INGRES delivered its first test products which were generally ready for widespread use in 1979. INGRES was similar to System R in a number of ways, including the use of a "language" for data access, known as QUEL. Over time, INGRES moved to the emerging SQL standard (ibid).

IBM itself did one test implementation of the relational model, PRTV, and a production one, Business System 12, both now discontinued. Honeywell wrote MRDS form Multics, and now there are two new implementations: Alphora Dataphor andRel. Most other DBMS implementations usually called relational are actually SQL DBMSs.

In 1970, the University of Michigan began development of the MICRO Information Management System based on D.L. Childs' Set-Theoretic Data model. Micro was used to manage very large data sets by the US Department of Labour, the U.S. Environmental Agency and researchers from the University of Alberta, the University of Michigan, and Wayne State University. It ran on IBM mainframe computers using the Michigan Terminal System. The system remained in production until 1998 (ibid).

2.3.5 Structured Query Language Database Management System (SQL DBMS)

IBM started working on a prototype system loosely based on Codd's concepts as System R in the early 1970s. The first version was ready in 1974/5, and work then started on multi-table systems in which the data could be split so that all of the data for a record (some of which is optional) did not have to be stored in a single large "chunk". Subsequent multi-

user versions were tested in 1978 and 1979, by which time a standardized query language– SQL– were added. Codd's ideas were establishing themselves as both workable and superior to Codasyl, pushing IBM to develop a true production version of System R, known as *SQL/DS*, and, later, Database 2 (DB2). Larry Ellison'S Oracle started from a different chain, based on IBM's papers on System R, and beat IBM to market when the first version was released in 1978. Stonebraker went on to apply the lessons from INGRES to develop a new database, Postgres, which is now known as. PostgreSQL is often used for global mission critical applications (the .org and .info domain name registries use it as their primary data store, as do many large companies and financial institutions) (ibid).

In Sweden, Codd's research was also read and Mimer SQLwas developed from the mid-70s at Uppsala University. In 1984, this project was consolidated into an independent enterprise. In the early 1980s, Mimer introduced transaction handling for high robustness in applications, an idea that was subsequently implemented on most other DBMS (ibid).

Another data model, the entity-relationship model, emerged in 1976 and gained popularity for database design as it emphasized a more familiar description than the earlier relational model. Later on, entity-relationship constructs were retrofitted as a data modeling construct for the relational model, and the difference between the two have become irrelevant (ibid).

2.3.6 Database Research

Research in Database technology has been an active research topic since the 1960s, both in academia and in the research and development groups of companies (for example IBM Research). Research activity includes theory and of prototype. Notable research topics have included models, the transaction concept and related concurrency control techniques,

query languages and query optimization methods, RAID, and more. The database research area has several dedicated academic journals (for example ACM transactions on database system-TODS, Data and Knowledge Engineering DKE) and annual conferences (e.g., ACM SIGMUND, ACM PODS, VLDB, IEEE ICDE) (ibid).

2.3.7 Database Languages

Database languages are special-purpose languages, which do one or more of the following:

i. Data definition - defines data types and the relationships among them
ii. Data manipulation language- performs tasks such as inserting, updating, or deleting data occurrences
iii. Query language- allows searching for information and computing derived information

Database languages are data-model-specific. Some notable examples include:

SQL is a standard relational model language supported by all relational DBMSs. It was one of the first commercial languages for the relational model. Despite not adhering to the relational model as described by Codd, SQL (pronounced as either "S-Q-L" or "sequel") has become the most widely used database language. Though often described as, and to a great extent is a declarative language, SQL also includes procedural elements. SQL became a standard of the American National Standard Institute (ANSI) in 1986 and of the International Organization for Standard (ISO) in 1987. Since then the standard has been enhanced several times with added features. However, issues of SQL code portability between major RDBMS products still exist due to lack of full compliance with, or different interpretations of the standard. Among the reasons mentioned are the large size, and incomplete specification of the standard, as well as Vendor lock in.

OQL is an object model language standard (by the Object Data Management Group) that has influenced the design of some of the newer query languages like JDQL and EJBQL, though they cannot be considered as different flavors of OQL.

XQuery is a standard XML databae query language.SQL/XML combines XQuery and XMLwith SQL

A database language may also incorporate features like:

i. DBMS-specific Configuration and storage engine management
ii. Computations to modify query results, like counting, summing, averaging, sorting, grouping, and cross-referencing
iii. Constraint enforcement (e.g. in an automotive database, only allowing one engine type per car)
iv. Application programming interface version of the query language, for programmer convenience (ibid).

2.3.8 Database Storage

Database storage is the container of the physical materialization of a database. It comprises the internal (physical) level in the database architecture. It also contains all the information needed (e.g., metadata, "data about the data", and internal database structures) to reconstruct the conceptual level and external level from the internal level when needed. Putting data into permanent storage is generally the responsibility of the database engine a.k.a. "*storage engine*". Though typically accessed by a DBMS through the underlying operating systems (and often utilizing the operating systems' file systems as intermediates for storage layout), storage properties and configuration setting are extremely important for the efficient operation of the DBMS, and thus are closely maintained by database administrators.

A DBMS, while in operation, always has its database residing in several types of storage (e.g., memory and external storage). The database data and the additional needed information, possibly in very large amounts, are coded into bits. Data typically reside in the storage in structures that look completely different from the way the data look in the conceptual and external levels, but in ways that attempt to optimize (the best possible) these levels' reconstruction when needed by users and programs, as well as for computing additional types of needed information from the data (e.g., when querying the database)

Some DBMS support specifying which character encoding was used to store data, so multiple encodings can be used in the same database.

Various low-level database storage structures are used by the storage engine to serialize the data model so it can be written to the medium of choice. Techniques such as indexing may be used to improve performance. Conventional storage is row-oriented, but there are also column oriented and correlation databases.

2.3.9 Database Security

Data Security deals with all various aspects of protecting the database content, its owners, and its users. It ranges from protection from intentional unauthorized database uses to unintentional database accesses by unauthorized entities (e.g., a person or a computer program). Database access control deals with controlling who (a person or a certain computer program) is allowed to access what information in the database. The information may comprise specific database objects (e.g., record types, specific records, data structures), certain computations over certain objects (e.g., query types, or specific queries), or utilizing specific access paths to the former (e.g., using specific indexes or other data structures to

access information). Database access controls are set by special authorized (by the database owner) personnel that use dedicated protected security DBMS interfaces (ibid).

This may be managed directly on an individual basis, or by the assignment of individuals and privileges to groups, or (in the most elaborate models) through the assignment of individuals and groups to roles which are then granted entitlements. Data security prevents unauthorized users from viewing or updating the database. Using passwords, users are allowed access to the entire database or subsets of it called "subschemas". For example, an employee database can contain all the data about an individual employee, but one group of users may be authorized to view only payroll data, while others are allowed access to only work history and medical data. If the DBMS provides a way to interactively enter and update the database, as well as interrogate it, this capability allows for managing personal databases.

Data Security in general deals with protecting specific chunks of data, both physically (i.e., from corruption, or destruction, or removal), or the interpretation of them, or parts of them to meaningful information (e.g., by looking at the strings of bits that they comprise, concluding specific valid credit-card numbers (ibid).

Change and access logging records who accessed which attributes, what was changed, and when it was changed. Logging services allow for a forensic database audit later by keeping a record of access occurrences and changes. Sometimes application-level code is used to record changes rather than leaving this to the database. Monitoring can be set up to attempt to detect security breaches (ibid).

2.3.10 Backup and Restore

Sometimes it is desired to bring a database back to a previous state (for many reasons, e.g., cases when the database is found corrupted due to a software error, or if it has been updated with erroneous data). To achieve this a backup operation is done occasionally or continuously, where each desired database state (i.e., the values of its data and their embedding in database's data structures) is kept within dedicated backup files (many techniques exist to do this effectively). When this state is needed, i.e., when it is decided by a database administrator to bring the database back to this state (e.g., by specifying this state by a desired point in time when the database was in this state), these files are utilized to restore that state (ibid).

2.4. CONCEPT OF GLOBAL POSITIONING SYSTEM (GPS)

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil and commercial users around the world. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver. (George, Daniel, Micheal, Etiene and Pascal, 2005).

The GPS project was developed in 1973 to overcome the limitations of previous navigation systems, integrating ideas from several predecessors, including a number of classified engineering design studies from the 1960s. GPS was created and realized by the United State Department of Defense (DoD) and was originally run with 24 satellites. It became fully operational in 1994. Roger L. Easton is generally credited as its inventor. (ibid)

Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS system and implement the next generation of GPS III satellites and Next Generation Operational Control System (OCX). Announcements from the Vice President and the White House in 1998 initiated these changes. In 2000, U.S. Congress authorized the modernization effort, referred to as GPS III.

In addition to GPS, other systems are in use or under development. The Russian Global Navigation Satellite System (GLONASS) was developed contemporaneously with GPS, but suffered from incomplete coverage of the globe until the mid-2000s. There are also the planned European Union Galileo Positioning System, Chinese Compass Navigation System and Indian Regional Navigational Satellite System. (ibid)

2.4.1 Evolution of GPS

The design of GPS is based partly on similar ground-based radio-navigation systems, such as LORAN and the Decca Navigator developed in the early 1940s, and used during World War II. In 1956, the German-American physicist Friedwardt Winterberg proposed a test of general relatively (for time slowing in a strong gravitational field) using accurate atomic clocks placed in orbit inside artificial satellites. (To achieve accuracy requirements, GPS uses principles of general relativity to correct the satellites' atomic clocks. Additional inspiration for GPS came when the Soviet Union launched the first man-made satellite, Spuntnik in 1957. Two American physicists, William Guier and George Weiffenbach, at Johns Hopkins's Applied Physics Library (APL), decided on their own to monitor Sputnik's radio transmissions.Within hours they realized that, because of the Doppler effect, they could pinpoint where the satellite was along its orbit from the Doppler shift. The Director of the APL gave them access to their UNIVAC to do the heavy calculations required. The following spring, Frank McClure, the deputy director of the APL, asked Guier and Weiffenbach to

investigate the inverse problem – pinpointing the user's location given that of the satellite. (The Navy was developing the submarine-launched Polaris missile, which required them to know the submarine's location.) This led them and APL to develop the Transit system. In 1959, ARPA (renamed DARPA in 1972) also played a role in Transit. (John, 2009).

The first satellite navigation system, Transit, used by the United States Navy, was first successfully tested in 1960. It used a constellation of five satellites and could provide a navigational fix approximately once per hour. In 1967, the U.S. Navy developed the Timation satellite that proved the ability to place accurate clocks in space, a technology required by GPS. In the 1970s, the ground-based Omega Navigation System, based on phase comparison of signal transmission from pairs of stations, became the first worldwide radio navigation system. Limitations of these systems drove the need for a more universal navigation solution with greater accuracy. (George, Daniel, Micheal, Etiene and Pascal, 2005).

While there were wide needs for accurate navigation in military and civilian sectors, almost none of those were seen as justification for the billions of dollars it would cost in research, development, deployment, and operation for a constellation of navigation satellites. During the Cold War Arms race, the nuclear threat to the existence of the United States was the one need that did justify this cost in the view of the United States Congress. This deterrent effect is why GPS was funded. It is also the reason for the ultra secrecy at that time. The nuclear tried consisted of the United States Navy's Submarine-Launched Ballistic Missiles (SLBMs) along with United States Air force (USAF) strategic bombers and Intercontinental Ballistic Missiles (ICBMs). Considered vital to the nuclear deterrence posture, accurate determination of the SLBM launch position was a force multiplier. (George, Daniel, Micheal, Etiene and Pascal, 2005).

Precise navigation would enable United States submarine get an accurate fix of their positions prior to launching their SLBMs. The USAF, with two-thirds of the nuclear triad, also had requirements for a more accurate and reliable navigation system. The Navy and Air Force were developing their own technologies in parallel to solve what was essentially the same problem. To increase the survivability of ICBMs, there was a proposal to use mobile launch platforms (such as Russian SS-24 and SS-25) and so the need to fix the launch position had similarity to the SLBM situation. (George, Daniel, Micheal, Etiene and Pascal, 2005).

In 1960, the Air Force proposed a radio-navigation system called MOSAIC (Mobile System for Accurate ICBM Control) that was essentially 3-D. A follow-on study called Project 57 was worked in 1963 and it was "in this study that the GPS concept was born." That same year the concept was pursued as Project 621B, which had "many of the attributes that you now see in GPS" and promised increased accuracy for Air Force bombers as well as ICBMs. Updates from the Navy Transit system were too slow for the high speeds of Air Force operation. The Navy Research Laboratory continued advancements with their Timation (Time Navigation) satellites, first launched in 1967, and with the third one in 1974 carrying the first atomic clock into orbit. (George, Daniel, Micheal, Etiene and Pascal, 2005).

Another important predecessor to GPS came from a different branch of the United States military. In 1964, the United States Army orbited its first Sequential Collation of Range (SECOR) satellite used for geodetic surveying. The SECOR system included three ground-based transmitters from known locations that would send signals to the satellite transponder in orbit. A fourth ground-based station at an undetermined position could then use those signals to fix its location precisely. The last SECOR satellite was launched in 1969. Decades later during the early years of GPS, civilian surveying became one of the first fields

to make use of the new technology, because they could reap benefits of signals from the less-than-complete GPS constellation years before it was declared operational. GPS can be thought of as an evolution of the SECOR system where the ground-based transmitters have been migrated into orbit. (George, Daniel, Micheal, Etiene and Pascal, 2005).

2.4.2 Basic Concept of GPS

A GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth. Each satellite continually transmits messages that include

i. the time the message was transmitted
ii. satellite position at time of message transmission

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite using the speed of light. Each of these distances and satellites' locations define a sphere. The receiver is on the surface of each of these spheres when the distances and the satellites' locations are correct. These distances and satellites' locations are used to compute the location of the receiver using the navigation equation. This location is then displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units show derived information such as direction and speed, calculated from position changes. (Agnew, 2007).

In typical GPS operation, four or more satellites must be visible to obtain an accurate result. Four sphere surfaces typically do not intersect. Because of this we can say with confidence that when we solve the navigation equations to find an intersection, this solution gives us the position of the receiver along with accurate time thereby eliminating the need for a very large, expensive, and power hungry clock. The very accurately computed time is used only for display or not at all in many GPS applications, which use only the location. A

number of applications for GPS do make use of this cheap and highly accurate timing. These include time transfer traffic signal timing, and synchronization of cell phone base stations (Agnew, 2007).

Although four satellites are required for normal operation, fewer apply in special cases. If one variable is already known, a receiver can determine its position using only three satellites. For example, a ship or aircraft may have known elevation. Some GPS receivers may use additional clues or assumptions such as reusing the last known altitude, dead reckoning inertial navigation or including information from the vehicle computer, to give a (possibly degraded) position when fewer than four satellites are visible (Agnew, 2007).

2.4.3 Structure

The current GPS used worldwide consists of three major segments. These are the space segment (SS), a control segment (CS), and a user segment (US). The U.S. Air Force develops, maintains, and operates the space and control segments. GPS satellites broadcast signals from space, and each GPS receiver uses these signals to calculate its three-dimensional location (latitude, longitude, and altitude) and the current time. (George, Daniel, Micheal, Etiene and Pascal, 2005). The space segment is composed of 24 to 32 satellites in medium earth orbit and also includes the payload adapters to the boosters required to launch them into orbit. The control segment is composed of a master control station, an alternate master control station, and a host of dedicated and shared ground antennas and monitor stations. The user segment is composed of hundreds of thousands of U.S. and allied military users of the secure GPS Precise Positioning Service and tens of millions of civil, commercial, and scientific users of the Standard Positioning Service (ibid).

2.4.4 User Segment

GPS receivers come in a variety of formats, from devices integrated into cars, phones, and watches, to dedicated devices such as garmin GPS. Secure GPS Precise Positioning Service, and tens of millions of civil, commercial and scientific users of the Standard Positioning Service. In general, GPS receivers are composed of an antenna, tuned to the frequencies transmitted by the satellites, receiver-processors, and a highly stable clock (often a crystal oscillator). They may also include a display for providing location and speed information to the user. A receiver is often described by its number of channels: this signifies how many satellites it can monitor simultaneously. Originally limited to four or five, this has progressively increased over the years so that, as of 2007, receivers typically have between 12 and 20 channels (ibid).

2.4.5 Applications

While originally a military project, GPS is considered a *dual-use* technology, meaning it has significant military and civilian applications. GPS has become a widely deployed and useful tool for commerce, scientific uses, tracking, and surveillance. GPS's accurate time facilitates everyday activities such as banking, mobile phone operations, and even the control of power grids by allowing well synchronized hand-off switching.

2.4.6 Restrictions on Civilian Use

The U.S. Government controls the export of some civilian receivers. All GPS receivers capable of functioning above 18 kilometres (11 mi) altitude and 515 metres per second (1,001 kn) or designed, modified for use with unmanned air vehicles like e.g. ballistic or cruise missile systems are classified as munitions (weapons) for which State Department export licenses are required. This rule applies even to otherwise purely civilian units that only

receive the L1 frequency and the C/A (Coarse/Acquisition) code and cannot correct for Selective Availability (SA), etc.

Disabling operation above these limits exempts the receiver from classification as munitions. Vendor interpretations differ. The rule refers to operation at both the target altitude and speed, but some receivers stop operating even when stationary. This has caused problems with some amateur radio balloon launches that regularly reach 30 kilometres (19 mi). These limits only apply to units exported from (or which have components exported from) the USA – there is a growing trade in various components, including GPS units, supplied by other countries, which are expressly sold as ITAR-free (ibid).

2.5 ROLES OF GOOGLE EARTH

Is a virtual globe and geographical information program that was originally called Earth Viewer 3D. This technology was developed by Keyhole Inc, a Central Intelligence Agency (CIA) and acquired by Google in 2004. Earth surfaces are mapped by the superimposition of images obtained from satellite images, aerial photograph and GIS 3D globe.

The product, re-released as Google Earth in 2005, is currently available for use on personal computer running Windows 2000 and above, Mac OS X 10.3.9 and above, Linux Kernel: 2.6 or later (released on June 12, 2006), and Free BSD. Google Earth is also available as browser plug-in which was released on May 28, 2008. It was also made available for mobile viewers on the iPhone OS on October 28, 2008, as a free download from the App store, and is available to Android users as a free app in the Google play store. In addition to releasing an updated Keyhole based client, Google also added the imagery from the Earth database to their web-based mapping software, Google Maps. The release of Google Earth in

June 2005 to the public caused a more than tenfold increase in media coverage on virtual globes between 2004 and 2005, driving public interest in geospatial technologies and applications. As of October 2011 Google Earth has been downloaded more than a billion times. (Google Inc).

For other parts of the surface of the Earth 3D images of terrain and buildings are available. Google Earth uses Digital Elevation Model (DEM) data collected by NASA's Shuttle Radar Topography Mission (SRTM). This means one can view the whole earth in three dimensions. Since November 2006, the 3D views of many mountains, including Mount Everest, have been improved by the use of supplementary DEM data to fill the gaps in SRTM coverage (ibid).

Many people use the applications to add their own data, making them available through various sources, such as the Bulletin Board System (BBS) or blogs. Google Earth is able to show all kinds of images overlaid on the surface of the earth and is also a Web Map Service client. Google Earth supports managing three-dimensional Geospatial data through Keyhole Markup Language (KML).

Google Earth is simply based on 3D maps, with the capability to show 3D buildings and structures (such as bridges), through model program software. In prior versions of Google Earth (before Version 4), 3D buildings were limited to a few cities, and had poorer rendering with no textures. Many buildings and structures from around the world now have detailed 3D structures; including (but not limited to) those in the United States, Canada, Australia, Ireland, India, Japan, United Kingdom, Germany, Pakistan and the cities, Amsterdam and Alexandria. In August 2007, Hamburg became the first city entirely shown in 3D, including textures such as façades. The 'Westport3D' model was created by 3D imaging firm AM3TD using long-distance laser scanning technology and digital photography

and is the first such model of an Irish town to be created. As it was developed initially to aid Local Government in carrying out their town planning functions it includes the highest resolution photo-realistic textures to be found anywhere in Google Earth. Three-dimensional renderings are available for certain buildings and structures around the world via Google's 3D Warehouse and other websites. In June 2012, Google announced that it will start to replace user submitted 3D buildings with auto-generated 3D mesh buildings starting with major cities. Although there are many cities on Google Earth that are fully or partially 3D, more are available in the Earth Gallery. The Earth Gallery is a library of modifications of Google Earth people have made. In the library there are more than just modifications for 3D buildings there are models of earth quakes using the Google Earth model, 3D forests, and much more (Google Inc).

In 2009, Google added a feature that enable users monitor traffic speeds at loops located every 200 yards. In version 4.3 released on April 15, 2008, Google Street View was fully integrated into the program enabling the program to provide an on the street level view in many locations.

On January 31, 2010, the entirety of Google Earth's ocean floor imagery was updated to new images by SIO, NOAA, US NAVY, NGA, and GEBCO. The new images have caused smaller islands, such as some atolls in the Maldies, to be rendered invisible despite their shores being completely outlined.

2.5.1 Uses of Google Earth

Google Earth has variety of uses among which are:

i. Viewing areas subjected to widespread disasters. This was how the January 12, 2010 Haiti Earthquake images of Haiti were made available on January 17.
ii. Application by teachers to improve on teaching strategies which are adopting Google Earth in the classroom for lesson planning, such as teaching students geographical themes (location, culture, characteristics, human interaction, and movement) to creating maps.
iii. Exploring and placing bookmarks on the Moon, Mars and other cosmic territories.
iv. Guiding directions, street names, objects, cities and establishments.
v. Providing catalogue of information pertaining to the user's location. Example, spotting gas stations, restaurants, museums and other public establishments in their vicinity.
vi. Google Earth can also function as a hub of knowledge, pertaining the users location. By enabling certain options, one can see the location of gas stations, restaurants, museums, and other public establishments in their area. Google Earth can also dot the map with links to images, YouTube videos, and Wikipedia articles relevant to the area being viewed.
vii. Enabling the creation of custom image overlays for planning trips, hikes on handheld GPS units.
viii. Facilitating researches by scholars.

2.6 DIGITAL MAPPING

This is the process of producing maps from spatial data in numeric form rather than in graphical or analogue form. It also refers to a computerized compilation and production of maps or plans using information in a digital format (Ndukwe, 2001). Digital mapping (also called digital cartography) is the process by which a collection of data is compiled and

formatted into a virtual image. The primary function of this technology is to produce maps that give accurate representations of a particular area, detailing major road arteries and other locations of interest. The technology also allows the calculation of distances from places and the area coverage of spatial entities. Though digital mapping can be found in a variety of computer applications, such as Google Earth, the main use of these maps is with the Global Positioning System (GPS) satellite network, used in standard automotive navigation system (Ndukwe, 2001).

2.6.1 Digital mapping comprises three options, namely:

i. *Data capture* or data acquisition involves converting the data into digital forms.
ii. *Data processing* is the transformation of data into structures for different functions.
iii. *Data presentation* transmits data to users through or visual displays.

Digital mapping is a technique in Geographic Information System (GIS) and Remote Sensing.

2.7 CONCEPT OF GIS

2.7.1 Data Input

This involves entering or transferring the analogue or digital geographical data (map aerial photograph, or satellite imagery) and statistical (attribute) data into the GIS. The data input function thus enables GIS to convert the original input data into a machine-readable GIS-compatible format (Uluocha, 2007). Data input operate at three levels; geo-referencing, registering the source materials, and analogue data conversion which this study adopted.

2.7.1.1 Geo-referencing:

It is also known as geo-rectification, geo-locating, geo-coding or geo-registering is the process of assigning spatial location identity to pieces of information. It is a process of giving cartographic materials such as digital satellite imagery, aerial photograph, and map or a

statistical data real world coordinate systems and map projections. Geo-referencing is commonly achieved by using coordinate systems. Examples of coordinate system are the spherical (geographic) coordinate system and the rectangular coordinate system. Non-coordinate systems include Postal Address and Postal Codes (or ZIP codes in use), Telephone Codes, Place Names, Enumeration Areas (EAs), House Numbering or Street Addresses, etc.

2.7.1.2 Registering the source materials:

This is the process of indicating to the computer the specific portion of the earth's surface. The source materials pertain to by entering the coordinate values of a minimum of three or four known locations (Control Points) on the source material. Before digitizing a cartographic source material or data for use in GIS environment, (geo-rectify) the data, whether in analogue or digital format, registered or geo-rectified.

2.7.1.3 Analogue data conversion:

Is a process of data capture or conversion of analogue geographic data to computer compatible format achieved through input devices such as digitizer, scanner and joy stick. The choice of the devices used depends on certain availability, the volume or scale of work to be digitized, nature of the input data, the kind of data processing to be executed, and the type of output expected (Uluocha, 2007).

2.7.2 Data Storage:

Data storage is a function GIS. A typical GIS is equipped with commands and facilities to store both spatial and non spatial in a number of formats or file structures. GIS data are normally stored in any of the common computer storage devices available. Geographic data are often large; hence a storage device with a large storage capacity is often required for GIS operations according to (Uluocha, 2007).

2.7.3 Data Manipulation:

Geographical (map) data and the attribute (tabular) data held in GIS is subjected to manipulative operations, to generate results. Some of the standard data manipulative functions perform in GIS are: data integration, map overlay analysis, cartographic functions, buffering, network analysis, feature measurement, database querying or searching, and geospatial analysis.

2.7.3.1 Map overlay analysis:

GIS map overlay analysis is often accomplished through map algebra techniques. Map algebra is an operation in which new maps are calculated using mathematical or statistical formula or expressions. With the aid of map algebra a number of thematic map layers are combined in overlay operations and new information that was not present in the individual map is derived (Western and Farifteh, 1997). Each of the map layer used in an overlay function represents the spatial distribution of a particular attribute of feature over a common study area. The map overlay operations are used to transform the map layers into new map layers in order to extract information useful to the user (Takeyama and Couchlelis, 1997).

2.7.3.2 Cartographic functions:

The range of cartographic functions a GIS may perform includes changing map scale, co-ordinsate conversion, transformation of projections, map annotation (lettering, map embellishment (e.g. adding legends, neat lines, north arrow, title, etc). map composition and cartographic modeling (Uluocha, 2007).

2.7.3.3 Buffering:

A buffer is a polygon created around a point or polygon feature on a map. The polygon could be of constant width (equidistant) or variable – width from the feature being buffered. Usually, buffer zones form new polygons, and these could be used in conjunction

with other map layers of the same area for overlay operations. The buffering function of GIS enables the users to accomplish some other manipulative tasks, including proximity analysis.

2.7.3.4 Network Analysis:

Network Analysis is an important function in some sector such as Transportation, Utilities and Hydrographic. The three main types of network analyses are: network tracing, network routing and network allocation

2.7.3.5 Address Matching:

It is also called geo-coding, is the process by which GIS automatically links an address record in a tabular file to corresponding street section in a map file. The address matching provides useful information about the location of point features. For instance, through address matching, the street address of a building such as its street number, street name, street type, the side of the road it is located, etc. could be known.

2.7.3.6 Feature Measurement:

One common measurement exercise is feature enumeration, which involves counting or totaling the number of a discrete feature within a definite geographical area. Another feature measurement operation is measuring the distance (horizontal and vertical) between two objects. GIS can be used to compute the perimeter as well as area (size) and shape index of polygon features (Uluocha and Ogbale 2007).

2.7.3.7 Database Querying or Searching:

Probes database for specified relationships or conditions among features or data items. A query is represented in a way that DBMS are organized and processed. Querrying operates on spatial and non-spatial data. Spatial query involves locating features within a spatial database using spatial search criteria (Pratt and Adamski 2005). Querying could be conducted on or among points, lines and areas (polygon) features. Non spatial query does not entail the use of latitude and longitude or other location information in answering the search

question (Uluocha, 2007) reported in answering the search question. Non-spatial querying or searching functions one feature or place is snot queried in relation to another.

2.7.3.8 Geospatial Analysis:

Is a unique of statistics that describe spatial relationships among sample data. Several geo-statistic operations involve spatial interpolation which is the process of using sample points which known values at other points (Myers, 2006). The basic concept of geo-statistics is that of scales of spatial variation. It has common characteristics with GIS and spatial statistics in general (Myers, 2006).

2.7.4 Data Output:

The data sub-system in GIS is used to obtain copies of the result of a data manipulation operation. Based on the choice of the user, the output may be in form of soft copy or hard copy. The output could be graphic displays or tabular reports. The data output sub-system should be capable of allowing the user to prepare or format the document for the final printing or plotting.

This study was also guided by these processes in data presentation.GIS helps in making the presentation of data more attractive than traditional static maps. Projecting tabular data onto maps helps in recognizing unexpected situations which, now noticed, call for closer examination. When considering geographical (spatial) factors, the analysis becomes finer and more precise, increasing the likelihood that ensuing strategies will be more pertinent. More flexible assistance can be provided in prospective planning at multiple levels or units of analysis: national, regional, provincial/district, and local. Expanded holistic representation and exploration of the contexts of schooling through the direct and dynamic use of multiple sources of influential data such as those found in census, utilities, land use, and databases which are otherwise very difficult to include in education planning and management but are needed for essential considerations for school progress and increased public appeal and

utility. Extensive control of scale of complexity: extensive flexibility in how much data are displayed or explored at a given time, with changes in unit analysis are among the immediate considerations of this study. This task can be achieved through employing techniques in Geographic Information System (Aronoff, 1989).

Geographic Information is characterized with measurements, mapping, monitoring and modeling which are enhanced through GIS (Olaleye, 2005). Geographic Information System is also a system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the earth. GIS is a highly dynamic field, growing at very rapid pace of technological change and increasing number of applications (Davis, 2001). Wiegand (2001) extended that GIS allows the user to visualise and analyse spatial information in ways that, reveal hidden relationships, patterns and trends. In the strictest sense, it is a computer system capable of integrating, storing, editing, analyzing, sharing, and displaying geographically referenced information. In a more generic sense, GIS is a tool that allows users to create interactive queries (user created searches), analyze the spatial information, edit data, maps, and present the results of all these operations. GIS technology can be used for scientific investigations, resource management, asset management, environmental impact assessment, urban planning, cartography, criminology, history, sales, marketing, and regional or school mapping. The use of Geographical Information Systems (GIS) has become an increasingly important element in schools in recent years and spatial understanding is a key factor of using GIS (Biebrach, 2005).

Analysis of school microclimate fieldwork would involve creating graphs on a spreadsheet and commenting on patterns. Using GIS, students are able to rapidly create spatially located graphs which led to significantly improved analysis and geographical interpretation. The ability to perform spatial operations on databases and generate graphic output that would be laborious or impossible to do manually (NRC, 2006) is a key benefit of

GIS. Many spatial temporal works would have been laborious and time consuming without GIS, thus reducing the time available for detailed analysis. GIS Use varied resources, including maps, visual media and Geographical Information Systems' (QCA, 2007).

The concept of space or spatial awareness is a key concept which Lambert (2006) defines as the ability to recognise, interpret and understand spatial patterns, distributions and relationships. GIS, is used to interpret and analyse different maps to select information and identify relationships between spatial patterns (Dells, 2007). GIS is structured around seven key concepts (place, space, scale, interdependence, environmental interaction, changing physical and human processes and diversity).

2.7.5 Applying Remote Sensing and GIS for the Mapping of Basic Education Schools in Adamawa State

One of the major problems hindering the proper planning, monitoring and administering of the numerous basic education schools spread over Adamawa State is the lack of an accurate, up to date map, showing the location of the schools. While convention ground survey could produce such a map, the time, money and drudgery involved makes this option very unattractive. By mapping out the basic education schools in Adamawa State (Nigeria), this work demonstrates how remote sensing and GIS could be employed to carry out the task with little stress. It also highlights some typical problems that should be anticipated. Satellite images were used to extract and create the base map, while the GPS was used to pick the coordinates of the schools. The map produced was more accurate and cartographically superior to the hand drawn maps. The manner in which local government boundaries are generated and stored, the attitude of stakeholders and the low computer literacy level of end-users are among the problems that should be addressed if digital mapping is to be fully embraced (Musa and Tukur, 2006).

2.7.6 Application of Geo-spatial Information System to Assess the Effectiveness of the MDG Target in AMAC Metropolis-Abuja, Nigeria

This study aims to assess the effectiveness of the MDG target as it concerns, the state of education in Abuja Municipal Area Council (AMAC) metropolis-Nigeria. One of the educational challenges faced in developing countries is how to know which school to send children to. This is mainly due to lack of detailed information as to, what school offers, what type of education, and at what fee. But with Geospatial Information Systems (GIS) providing information about primary and secondary schools, Millennium Development Goals' (MDGs') vision of literacy for 15-24 year olds will be achieved.

The development of geospatial database information system of primary and secondary schools for Garki and Wuse districts, Abuja, was embarked upon to provide timely, consistent and accurate information to decision makers for use in achieving this particular target of the Millennium Development Goals (MDGs). The delay in achievement of this target is not because governments in developing countries aren't putting maximum effort, but because these governments are choosing to put the cart before the horse. Sustainable literacy level cannot be achieved without an effective framework charged with the collection, storage, query, analysis and management of the relevant data. What is needed is a system that provides government with data about all educational facilities within required proximity and determines availability of the required facilities. GIS is that decision making technology, which integrates 'spatially referenced data' with a problem solving environment. The method employed was to acquire both spatial and attribute data of every primary and secondary school in Garki and Wuse districts. The spatially referenced database was created using Microsoft Access 2007 and ArcGIS 9.2 software. The database was queried and the results of the queries analyzed. The results showed that 60% of the schools didn't have access to Internet. Twenty-one (21) percent had no library. Sixty-three (63) percent of schools were

also found to lack Elementary Science Laboratory as stipulated in the National Policy on Education. It was also observed that, the closest distance between public schools to Area 1 and Wuse Central bus-stops are 0.769 and 1.15 m, respectively (Aliyu, Sule and Youngu, 2012).

Table 2.1 DATABASE FOR PUBLIC SCHOOLS IN AMAC AREA COUNCIL, FCT

S/NO.	SCHOOL NAM	AVERAGE N.	SCH_LIB	SCI_LAB
1.	G.S.S. AREA 10	60	YES	NO
2.	J.S.S DARUM, AREA 10	90	YES	NO
3.	MODEL SCI PRI SCH, GARKI 1	50	YES	NO
4.	GOVT. SCI. TECH. COL. AREA 3	100	YES	YES
5.	J.S.S. AREA 11	50	NO	NO
6.	J.S.S. ZONE 6	49	YES	NO
7.	G.D.S.S. WUSE 1	50	YES	NO

CHAPTER THREE

THE STUDY AREA AND METHODOLOGY

3.1 INTRODUCTION

This chapter establishes the conceptual framework and methodology of the research. It presented the research design, data sources, instrumentation and data collection procedure. Characteristics of the study area were also summarized.

3.2 THE STUDY AREA

The study area is located in Zaria, situated between latitude 11^0 15' and 11^0 3' N and longitude 7^0 3'E and 7^0 45'E. It is situated in Kaduna State of Nigeria and extends from Zaria (figure 4.1), to parts of Soba (figure 4.2), Sabon Gari (figure 4.3) and Kudan Local Government Areas (figure 4.4). With land area of about 9,000 square kilometer, it is bounded to the North West by Giwa Local Government Area, Katsina State and Makarfi Local Government to the North, Kajuru Local Government to the South, Kubau Local Government to the South East and Igabi Local Government to the South West (figure 3.1).

3.2.1 Climate

The study area falls within the Tropical Continental climate type with pronounced dry season, lasting up to seven months (October-May). During the dry season, a cool period is usually experienced between November and February. This emanates from the influence of the North-easterly (NE) winds (the Harmattan) which control the tropical continental air mass coming from the Sahara. This weather prevails over most parts of the country. The NE winds are characterized by hazy to dusty conditions and low temperatures, as low as 10^0C at night. In the afternoons, up to 42^0C is sometimes recorded. The humidity also drops to less than 15% in December/January. The study area also experience a brief period of hot and dry weather in March and April, followed by a progressive incursion of Tropical Maritime air

mass of Atlantic Ocean which displaces the NE (Harnattan) winds. During this short period, the mean daily maximum temperatures are fairly stable, and they range from 38^0C to 42^0C. After that, the South Westerly (SW) Monsoon winds laden with moisture bring the rain in thunderstorms and squalls with heavy fall of high intensities. The rainy season lasts from May to September/October with long-term annual rainfall of 1040 mm in about 90 days. (www.abu.edu.ng).

3.2.2 Vegetation

The vegetation of Zaria falls within the guinea savanna zone which is characterized by grassland with scattered trees and woody shrubs vegetation. Artificial vegetation in some parts of the study area like Zaria and Sabon Gari are created. There are farms, gardens, mangoes trees, silk cotton and baobabs, shrubs and a number of grasses. However, increase in human population with its concomitant demands for housing; fuel wood and poor land management have great impact on the natural vegetation thereby reducing it drastically (Lawal, 2008).

3.2.3 Soil

The soil in Zaria region is relatively deep red-brown to red-yellow tropical ferruginous soils. Most of the soil contains 30-40 percent clay. It is good moisture retention land and very poor in sustaining intensive agriculture for a long period. Fadama is the term used to explain this type of soil. In some cases, it persists to supply water even during the dry season while in other areas shaduf method of irrigation has to be used even along the river banks (www.abu.edu.ng).

3.2.4 Drainage

The river Galma forms the main focus of the drainage systems in Zaria region. Although Galma carries water throughout the year, most of its tributaries such as River Samaru dry up between January and May. The main tributary of Galma; Kubanni, is another

river of economic importance in the region. The valleys of the streams are generally wide, shallow and not incised especially in the northern part of Zaria. To the west and north-west, the valley bottoms are alleviated and are singularly flat, wide and level (Udo, 1970).

3.2.5 Relief

The bedrock geology is predominantly metamorphic rocks of the Nigerian basement complex consisting of biotite, gneisses and older granites. There are rocky granitic residuals form inselbergs of varying shapes and sizes, and constitute the main local relief (relative relief is less than 150m) here and there with, Madarkaci and Jushi hills with Kufena hill standing out very prominently. The valleys are shallow but wide, stretching several tens of kilometers into the headwater areas with gentle sloping valley sides; imperceptibly grading into moist to marshy alleviated bottomlands or floodplains, called Fadama in Hausa. Although stream valley incisions and dissections of the high plains are evident in several areas, they are due more to anthropogenic influences and climatic factors than regional geologic instability (Udo, 1970).

3.2.6 Economy

Zaria's economy is a combination of primary, secondary and tertiary. Staples are guinea corn and millet, and cash crops include cotton, groundnuts and tobacco. The study area is considered by some to be a main centre of Hausa agriculture, not only is Zaria a market town for the surrounding area, it is the home of numerous artisans, from traditional crafts like leather work, dyeing and cap making, to tinkers, print shops and furniture makes. It is also the centre of textile industry that for over 200 years has made elaborately hand embroider robes that are worn by men throughout Nigeria and West Africa. There are a number of commercial activities from trading, hawking, commercial cycling but to mention a few Banking, educational, recreational, hotels are some of the tertiary economic activities found (Gihring, 1984).

3.2.7 Transportation

Because Zaria is north of the rail junction at Kaduna, it has equal rail access to the seaports at Lagos and Port Harcourt. However, currently only the railway to Lagos is functional, as the eastern line of Nigeria's rail network is not operational. This means the study area has access to Lagos and Kano to the north, not Port Harcourt. The study area is also accessible from Jos, Sokoto, Katsina and Kaduna by road. This means the study area has access to the northern and southern parts of the country. (Gihring, 1984). Inter city transport is conducive with commercial buses, tricycles and motor cycles available.

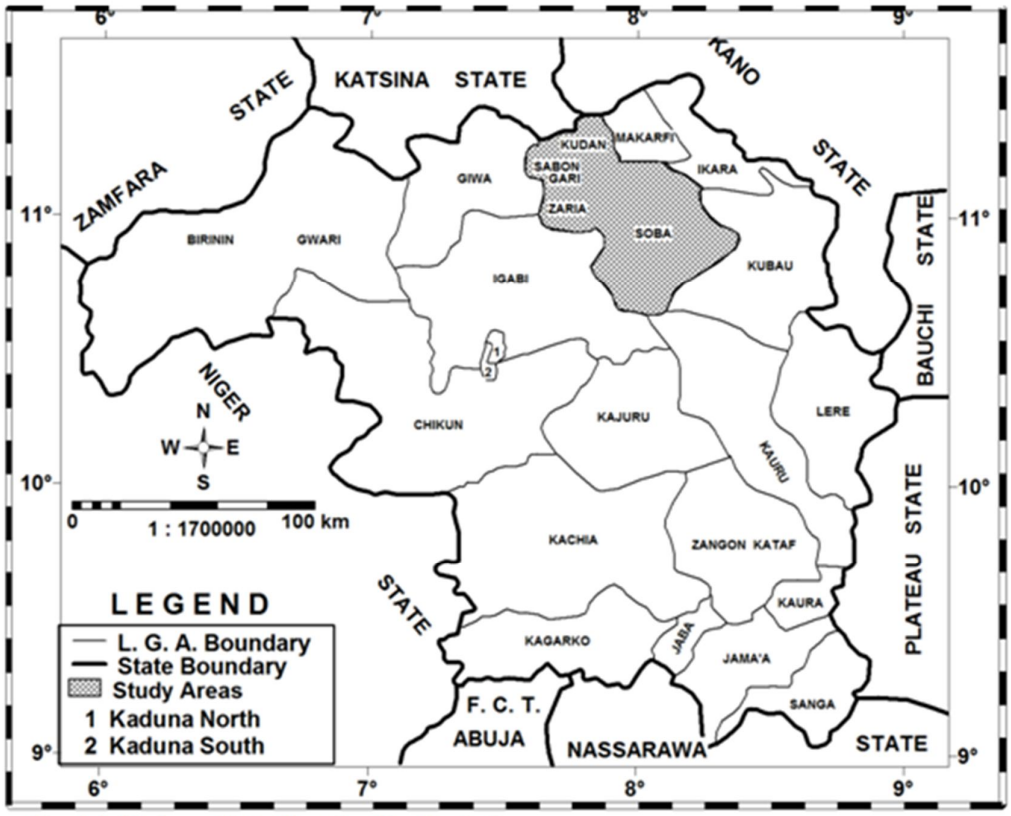


Fig. 3.1: Kaduna State Showing the Study Area.

Source: Field Survey, 2013.

3.3 DATA AND METHODOLOGY

3.3.1 Types and Sources of Data

The materials used for this study was Google Pro 2011 which was sourced through the internet. Field work was carried out to obtain information on location of schools, data on number of classrooms, number of teachers, minimum distance to schools, maximum distance to schools, facilities in schools but to mention a few. Field observation; in-depth interviews, field measurement and administration of questionnaire were carried out to collect relevant first hand information about the study area critical for achieving the specific aim and objectives of this study.

High speed memory digital electronic computer hardware Hewlett Packed (HP) Pavilion DV4 Laptop was used and Garman 76CSX handheld Global Positioning System (GPS) receiver was also used for marking of locations during field work using ILWIS 3.3.

3.3.2 Data Acquisition and Assemblage

Trips were made to obtained area and coordinates of each school using the Germin 75S Handheld GPS Receiver. A trip was also made to the schools for the administration of checklist. The checklist asked for data such as school name, year of establishment, number of staff, number of students in each class (JSS 1 to SSS 3), number of classrooms in each class (JSS 1 to SSS 3). The checklist provides a platform for comparison between the lists of facilities of Secondary Schools' in Zaria Education, from Ministry of Education, Zaria Education Zone. The data collected were useful for various types of analysis done and greatly assist in the efficient and effective planning and management of school resources.

The digital base map was obtained by digitizing Google Pro 2011 satellite image. A list showing public Secondary Schools in the study area was obtained from the state Ministry of Education.

In digitizing the domain classes, the Google satellite image was used to map the features. First, it was downloaded from the internet so that the satellite image could be seen for accurate mapping. Coordinate of the Google earth image was acquired then, the geo-referencing exercise was followed after the Google earth image was downloaded. The digitizing exercise then started by creating the segments, the polygons, the lines and the points that were created. A layout is then created to merge the polygons, the lines and the points in ILWIS 3.3.

3.3.3 Data processing of spatial and Remotely Sensed Data

This involved the processing, analysis and extraction of relevant spatial information about the study area from sources such as satellites images, and maps. The following steps were employed:

3.3.3.1 Geo-referencing and Digitizing

All the maps that were used for this study were geo-registered to their true geographic coordinates by creating a common geographical coordinate system for them using zone 32 of Minna datum to facilitate geo-spatial processing and analysis. On-screen digitizing was then carried out to collect all relevant vector based data which may either be in zero dimensions as points, one dimension as lines, or two dimensions as areas or polygons. These were carried out using ILWIS 3.3 by Environment System Research Institute (ESRI).

3.3.3.2 Ancillary Data Analysis

Supplementary data for this study generated through questionnaires was analyzed using appropriate simple descriptive statistics such as percentages and tables.

3.3.4 Database Creation

The following data were collected and used to develop the database for the study, they are:

i. Satellite image showing the study area

ii. Schools control points.

iii. List showing school names and addresses

iv. Checklist administered to schools in the study area

All the necessary information for each school was entered into its layer's attribute table and stored for analysis. This was done by adding required number of fields (columns) to the table and entering the data for all the schools in their corresponding records (rows) on Microsoft Excel.

3.3.5 Plotting

The coordinates of the schools were copied in notepads and saved. Distribution of the coordinates used is shown in table 4.4.

The following steps were taken to import the files into ILWIS 3.3:

In the main bar "t***ools***" was right – ***clicked***, a dialog box appeared and the "***Add XY Data***" was selected.

The "Add XY Data" window appeared and the browse to folder button was clicked. The folder in which the school coordinates file was saved was browsed and added.

The filed for the X and Y coordinates (i.e. Eastings and Northings) were specified and the coordinate system of the input coordinate was selected, applied and ok.

The locations of the schools were automatically added to the map as point data.

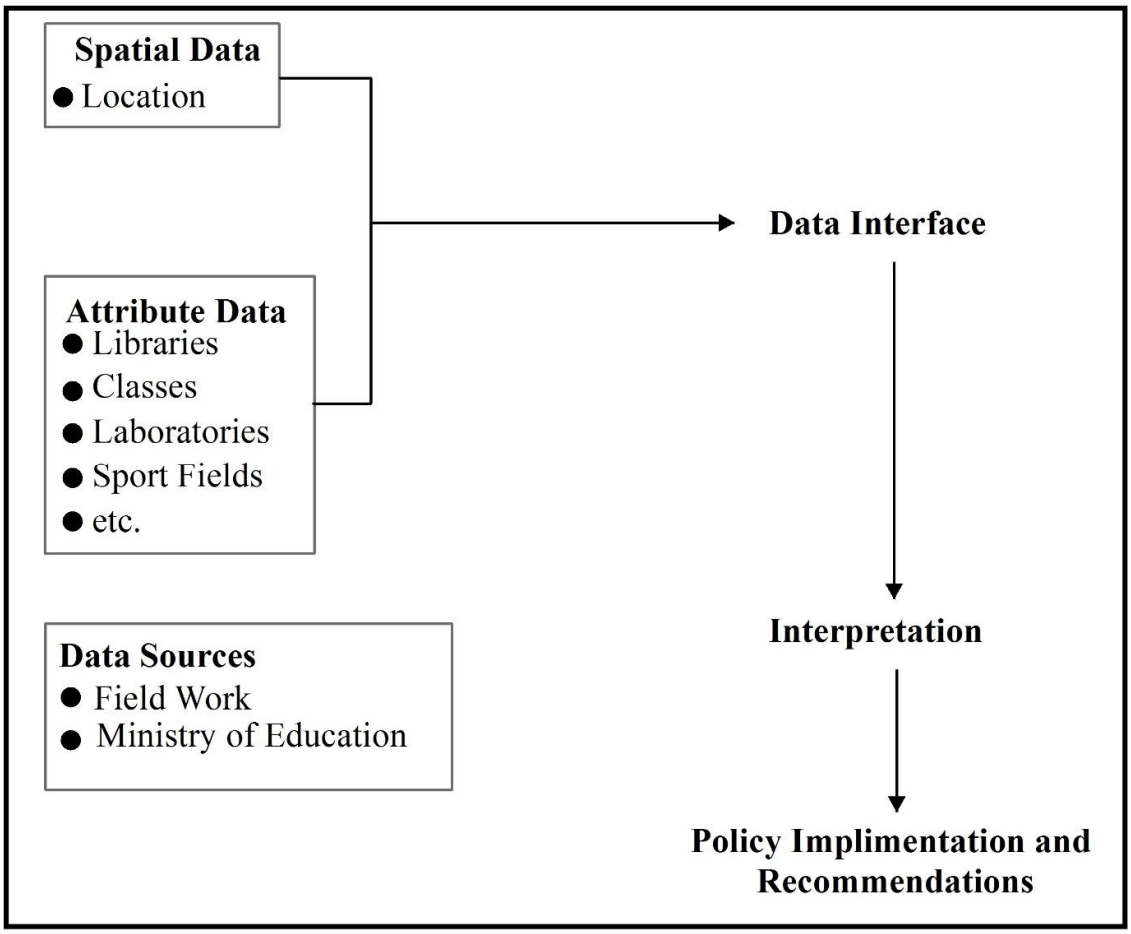


Table 3.1 Conceptual Framework

Source: Field Survey, 2013.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

The chapter presents the results of the research work with a table showing school coordinates and another presenting the database created for schools in the study area. Maps for the study area were also presented.

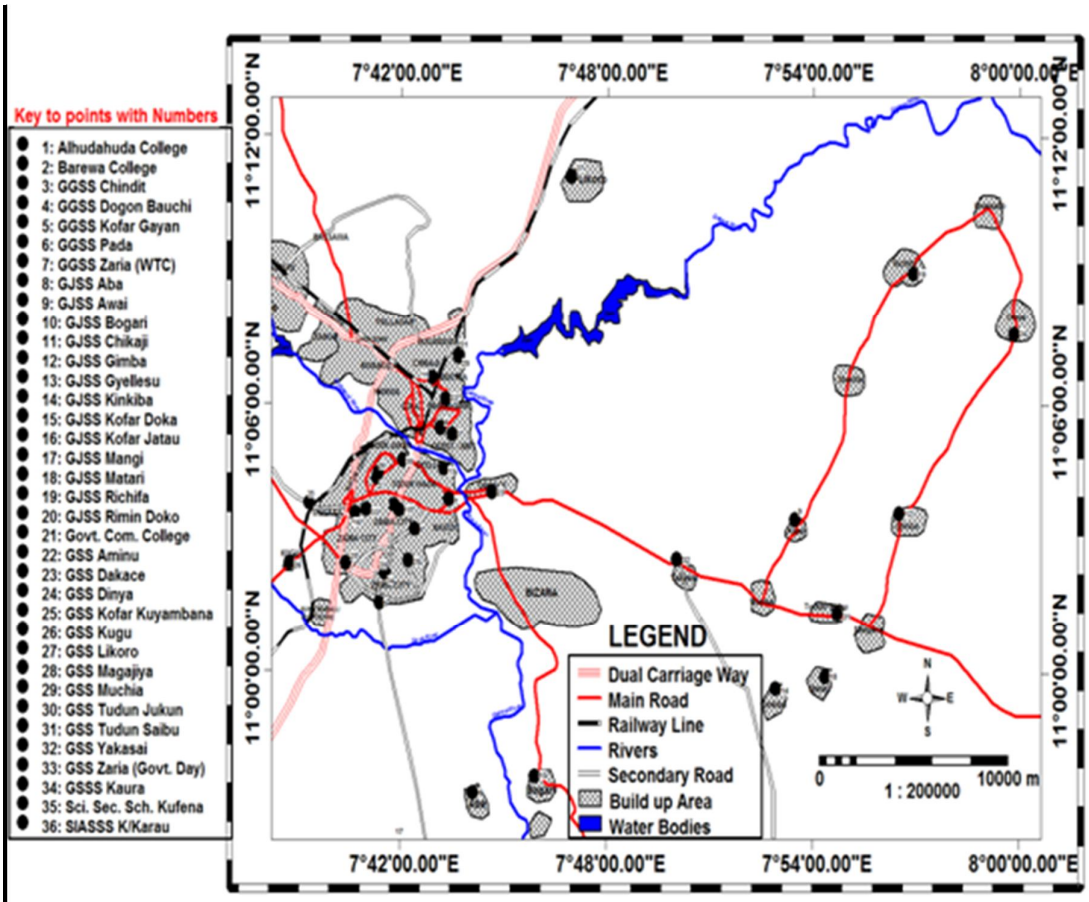


Fig 4.1: A Map Showing the Spatial Distribution of Public Secondary Schools in Zaria Education Zone.

Source: Field Survey, 2013.

Figure 4.1 is the generic map for the study area at a glance. Between Zaria and Sabongari Local Government Areas (shown west of the map), the spatial distribution of schools is nucleated and most of the schools in the study area are found there with overcrowded classes because of high of patronage. The spatial distribution in Soba Local Government (shown east of the map) is linear and the schools are sparsely populated because of low patronage; attributed to semi urban nature of the area. At the upper part or the northern part of the map, it is Government Secondary School Likoro, the only school within the study area in Kudan Local Government Area. At Zaria and Sabongari Local Government Areas, the distance from one school to another is not more than two kilometers. In fact, many schools share boundary with one another and as in the case of Government Commercial College and Government Secondary School Muciya. Some schools use same premises or compounds and facilities as in the case of Government Girls Secondary School Chindit and Government Secondary School Chindit.

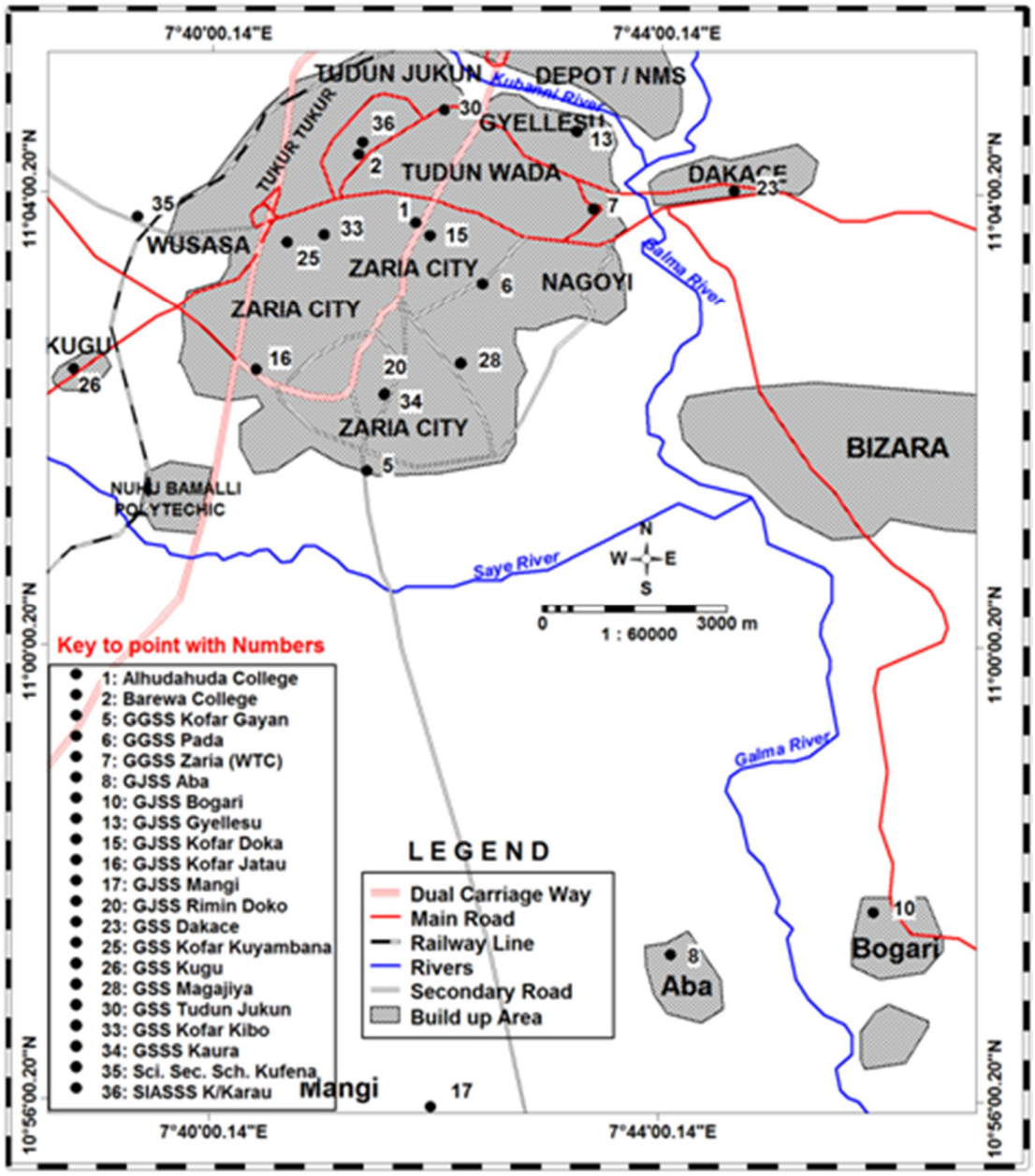


Fig 4.2: Part of Zaria LGA Showing the Spatial Distribution of Public Secondary Schools in Zaria Education Zone

Source: Field Survey, 2013.

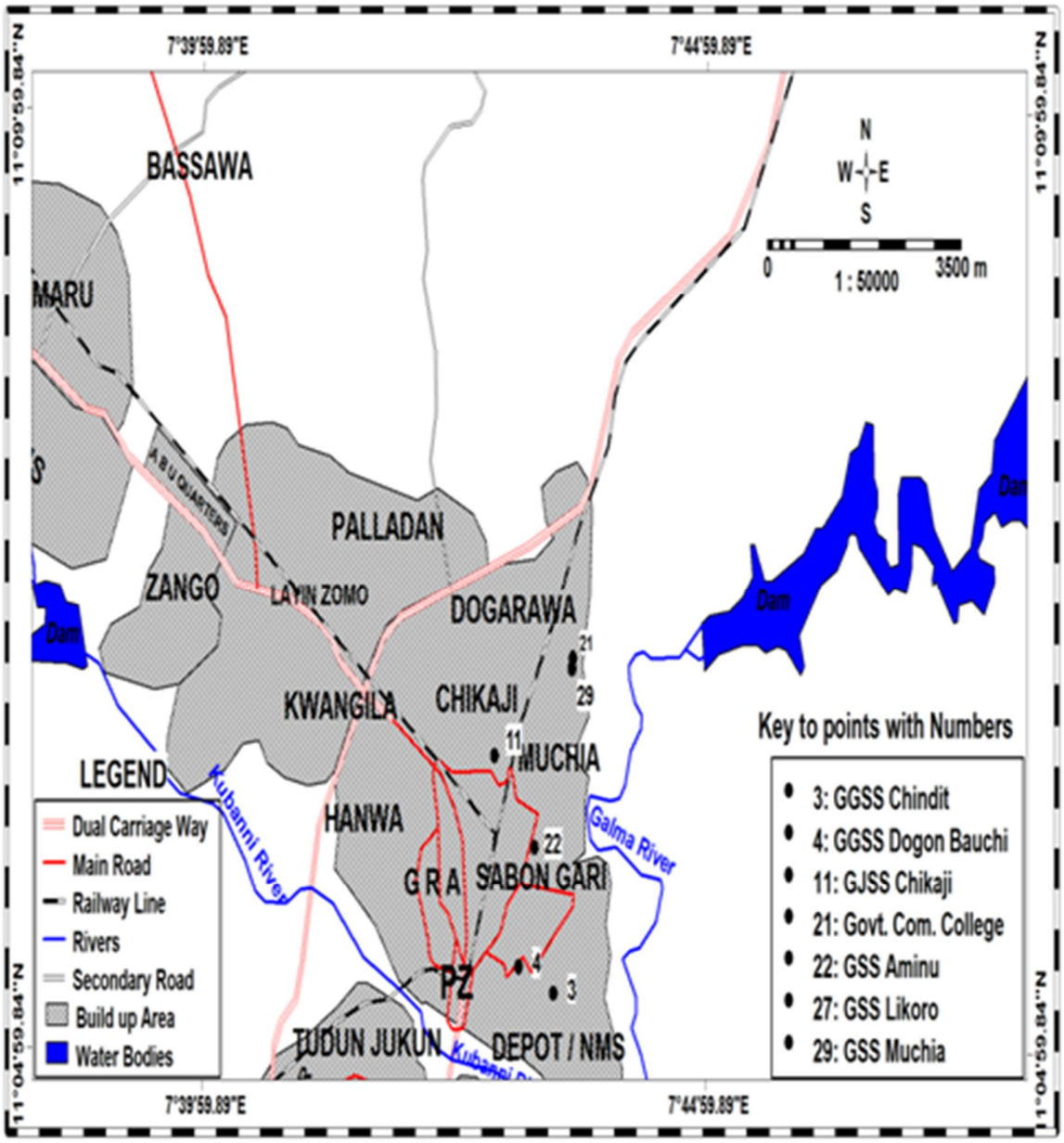


Fig 4.3: Part of Sabon Gari LGA Showing the Spatial Distribution of Public Secondary Schools in Zaria Education Zone.

Source: Field Survey, 2013.

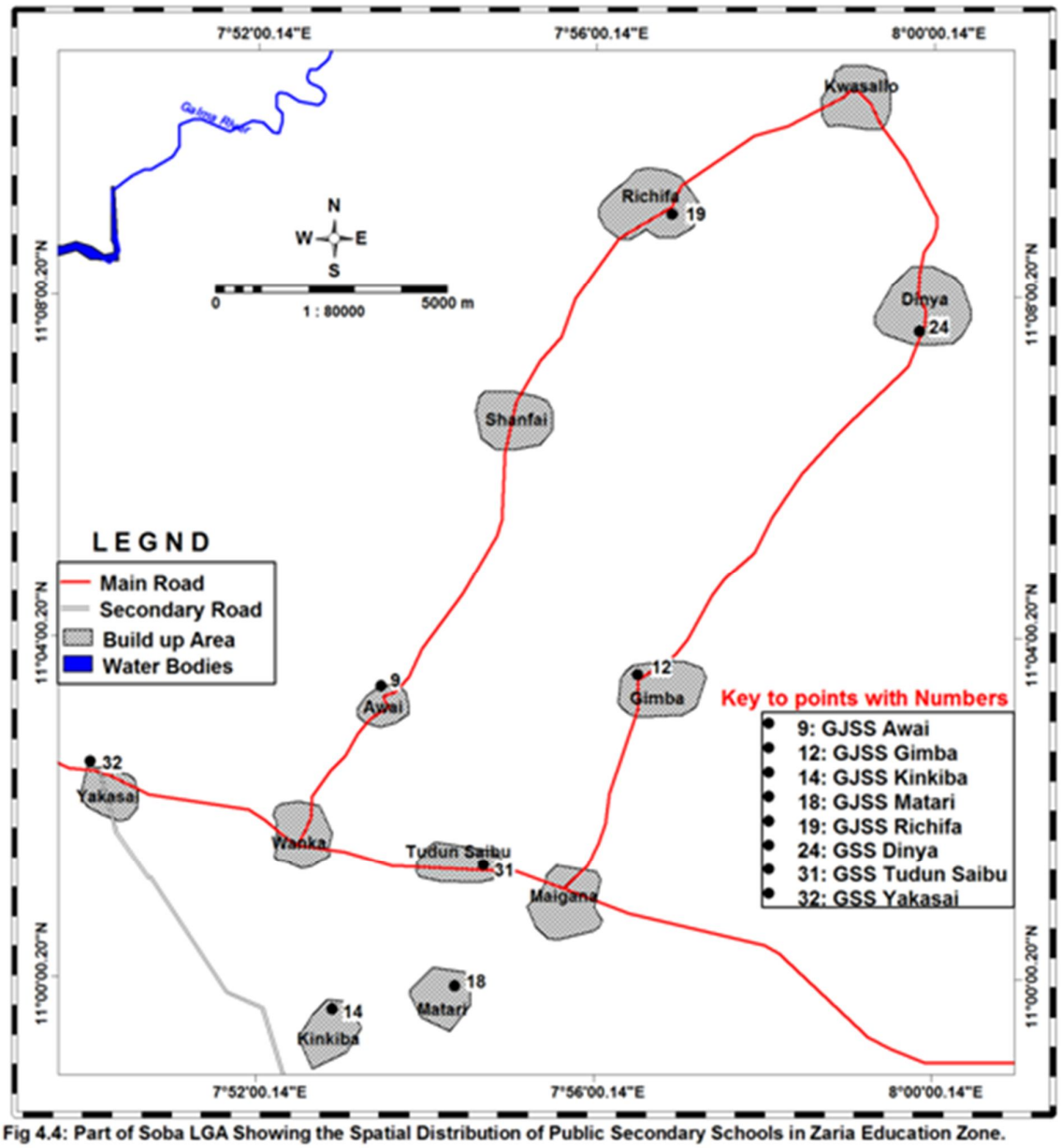


Fig 4.4: Part of Soba LGA Showing the Spatial Distribution of Public Secondary Schools in Zaria Education Zone.

Source: Field Survey, 2013.

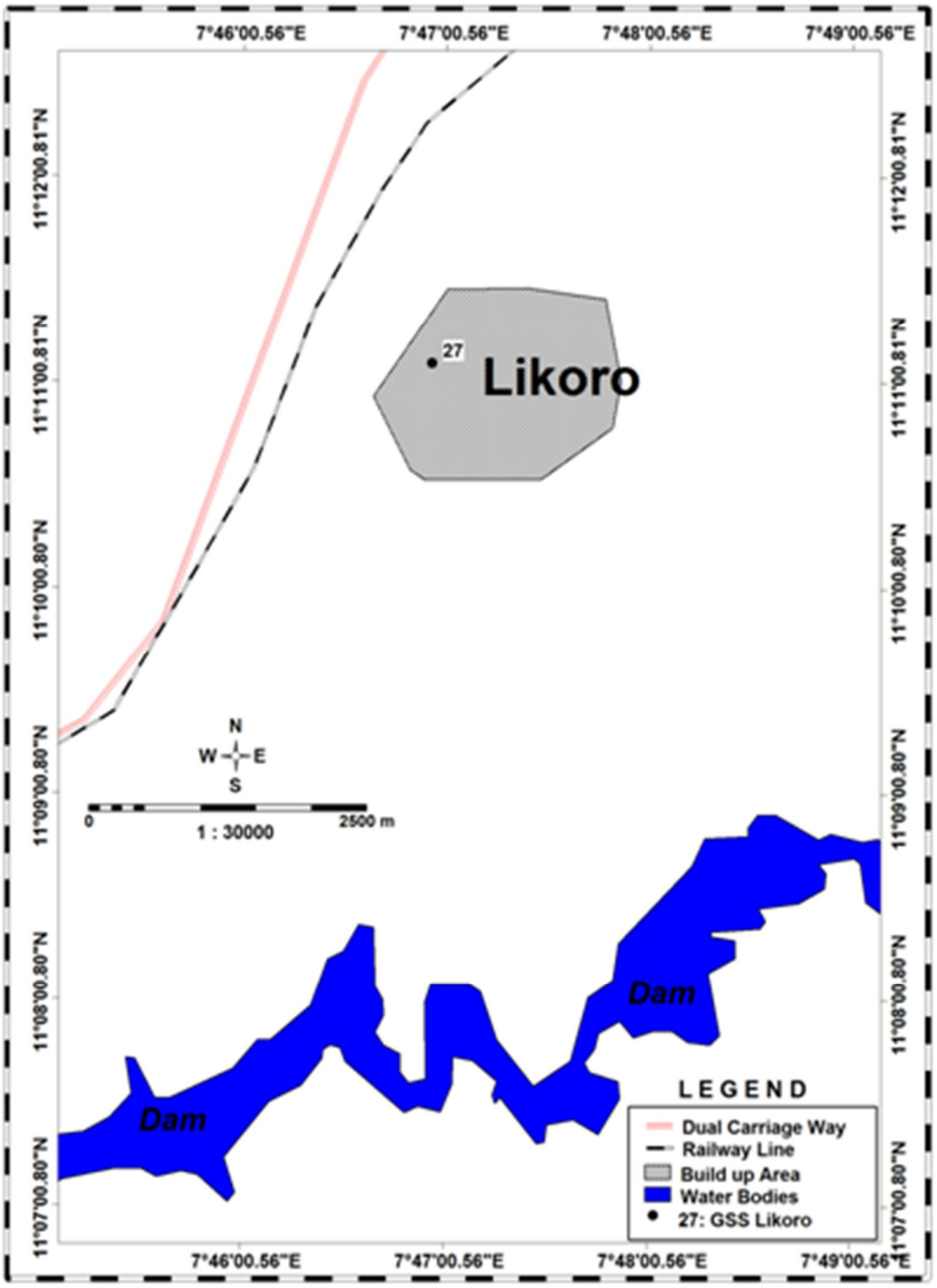


Fig 4.5: Part of Kudan LGA Showing the Spatial Distribution of Public Secondary Schools in Zaria Education Zone.

Source: Field Survey, 2013.

A total of fourty nine (49) checklists were distributed to 49 Secondary Schools' Principals in the study area to obtain information on attribute data (physical facilities) and compare with the list collected from the state ministry of education. Science Secondary School, Kufena and Government Commercial College, Zaria, were included in the research because of their relative proximity and spatial locations and facilities in place, but they are not managed by Zaria Education Zone, but Science Schools Management Board and Commercial and Technical School Board respectively.

The field work result shows that the number of schools keep on increasing and so the number of staff and students enrolment. In most of the schools visited especially the ones in Zaria and Sabon Gari Local Governments, the schools were overcrowded. 80% of the Schools had over 100 students per class and a population of 50-100 students was recorded in only 11% of the schools visited in the study area and 9% of the schools had less than 50 students in a class which were mostly in Soba Local Government and Kudan Local Government. The reason for the low number of students in Soba and Kudan Local Governments areas of the study area is because they are semi-urban Local Governments as against Zaria and Sabon Gari Local Governments with lower population and some children prefer going to farms and even those who attend schools find it difficult to go regularly during rainy season because of agricultural activities.

Table 4.1: Presents Information on Geographical Location/Coordinates of Secondary Schools in Zaria Education Zone generated by GPS

SHAPE	EASTHINGS	NORTHINGS	SCH_ NAME
POINT	380469	1215924	GJSS MATARI
POINT	357166	1229284	GJSS R/DOKO
POINT	355582	1222738	GJSS K/JATAU
POINT	359686	1228336	GJSS CHIKAJI
POINT	361796	1211146	GJSS ABA
POINT	360275	1224534	GJSS GYALLESU
POINT	367039	1236573	GSS LIKORO
POINT	390492	1230054	GSS DINYA
POINT	365090	1211833	GJSS BOGARI
POINT	358405	1220763	GJSS MAGAJIYA (JNR)
POINT	357908	1222832	GJSS K/DOKA
POINT	384414	122651	GJSS GIMBA
POINT	362229	1230579	GJSS MUCHIA (JNR)
POINT	356741	1224163	BAREWA COLLEGE
POINT	378892	1222404	GJSS AWAI

Contd.:Table 4.1: Presents Information on Geographical Location/Coordinates of Secondary Schools in Zaria Education Zone generated by GPS

POINT	360731	1225953	GSS CHINDIT (JNR)
POINT	358758	1222063	GGSS PADA (JNR)
POINT	381100	1218535	GSS T/SAIBU
POINT	352114	1220681	GSS KUGU
POINT	357662	1223074	ALHUDA HUDA COL
POINT	356808	1224351	SIASSS K/KARAU
POINT	358131	1224886	GSS T/JUKUN
POINT	385165	1232577	GJSS RICHIFA
POINT	384453	122594	GJSS KINKIBA
POINT	356874	1219020	GGSS K/GAYAN
POINT	362829	1227394	GSS DAKACE
POINT	360391	1227394	GSS AMINU S (SNR)
POINT	361076	1229145	GSS MUCHIA (SNR)
POINT	357148	1220250	GSSS KAURA
POINT	357406	1224297	GSS K/KIBO (SNR)
POINT	359839	1223326	GGSS PADA (SNR)
POINT	372624	1220791	GSS YAKASAI
POINT	360104	1226214	GSS D /BAUCHI (SNR)
POINT	360123	1226000	GSS D /BAUCHI (JNR)
POINT	355081	1220660	GGSS K/KUYAMBANA
POINT	360731	1225953	GSS CHINDIT (SNR)
POINT	362829	1223563	GSS DAKACE
POINT	360477	1222343	GJSS MAGAJIYA(SNR)
POINT	385165	1232577	GJSS RICHIFA
POINT	357906	1208688	GJSS MANGI
POINT	356180	12222865	GSS K/ KIBO (JNR)
POINT	362004	1229111	GSS AMINU (JNR)
POINT	357406	1224297	GSS K/KIBO (SNR)
POINT	360553	1223269	GGSS KONGO (WTC)
POINT	362229	1230579	GSS MUCHIA (SNR)
POINT	361070	1229240	COMMERCIAL COL
POINT	355582	1222738	GSS K/JATAU
POINT	360339	1225002	GSS T/WADA
POINT	353155	1223161	SCI SEC SCH KUFENA

Source: Field Survey, 2013.

A geographic coordinate system is a coordinate system that enables every location on the Earth to be specified by a set of numbers or letters. The coordinates are often chosen such that one of the numbers represents vertical position, and two or three of the numbers represent horizontal position. A common choice of coordinates is latitude, longitude and elevation. (ordnancesurvey.co.uk). It is also presented as Easting and Northing as used in this

work. To achieve or acquire the coordinates, a GPS was used and the reading obtained was presented on table 4.1 above.

Table 4.2, presents the database and abbreviation was used to represent schools identification, members of staff, number of students, computer laboratory, library, Physics, Chemistry and Geography, Biology laboratories, number of classes, schools establishment years, sport facilities, and qualifications of members of staff. For full meaning of the abbreviation as presented in Table 4.1 in the next page, see page 81 (appendix). The schools mapped were presented in figures 4.1, 4.2, 4.3, 4.4 and 4.5 in page 48, 50, 51, 52 and 53.

Table 4.5: Database Created for Zaria Education Zone Public Secondary Schools

SOURCE: Zaria Education Zone, Ministry of Education Kaduna State and Field Survey, 2013

4.2 Number of staff

From table 4.2, Sheikh Ibrahim Arab Special Secondary School (SIASS) had 84 staff. This school had the highest number of staff which corresponds to the number of students, 1559. The schools with least number of staff were GJSS Richifa and GJSS Aba with 4 members of staff only, but students' number is unavailable. One reason why Sheikh Ibrahim Arab Special Secondary School had the highest number of staff and students was because it was the only school that combines western and Islamic school Studies founded and funded by the State Government. The history of Zaria is accompanied with Islamic scholarship and as western education penetrates the city, a lot of people try to enroll in both western and Islamic schools. To buttress the point, the National Board of Arabic and Islamic Studies (NBAIS), an organ of examinations body in Nigeria has it is headquarters in Zaria because of the importance of the town in Islamic and western education.

4.3 Schools with computer laboratory

Table 4.2 shows the only four schools that have computer laboratory; Alhuda Huda College, Barewa College, Government Commercial College Zaria and Government Girls Secondary School Kongo (WTC). These are the first generation and second generation schools established long ago. For instance, Alhuda Huda College was established in 1910, Barewa College was established in 1921 and Government Girls Secondary School was established in 1981. The old boys/girls associations assist them with some facilities which ordinarily are not found in other government schools. In addition, the Ministry of Education gives priority to these schools when allocating and distributing some instructional materials. For example, a modern hall capable of accommodating 300 students at a time was newly built at Alhuda-Huda College by the State Government in 2010 to celebrate centenary years of establishment. Similar work has been carried out in Barewa College where a hall by name Sultan Abubakar II was built by the old boys of the college, including the Sultan of Sokoto whom the hall was named after.

4.4 Schools establishment

From table 4.2, eleven (11) of the Secondary Schools were established in 1990. Nine were established in 2004, two schools were established in 1989, four schools were established in 1981. The oldest school from the table is Alhuda Huda College, established in

1910, followed by Barewa College, established in 1921. During Babangida's regime, there was a policy to introduce more schools in the neighbourhood in the 1990's. Consequently, more schools were established in the 90's that is why most of the schools were established in that year. These 1990's school are not far away from many schools predate them. For istance, Government Secondary School, Kofar Doka is not up to 300 metres from Alhuda Huda College. Government Secondary School Kongo, is not up 1000 metres from Government Girls Secondary School Kongo. Government Secondary School, Muciya, is sharing fence with Government Commercial College.

4.5 Schools libraries

Table 4.2 shows that, only nine schools have library. They were: Alhuda Huda College, Barewa College, Government Secondary School, Zaria, Government Girls Secondary School, Dogon Bauchi, Government Secondary School Chindit, Government Girls Secondary Schools Chindit, Science Secondary School Kufena, Government Girls Secondary School, Zaria and Government Commercial College, Zaria. Coincidently, these are the only schools that have all the facilities in place as they were established when government provided all the school requirements and equipment.

4.6 Schools laboratories

Table 4.5 shows only nine schools have laboratories in Biology, Chemistry and Physics They were: Alhuda Huda College, Barewa College, Government Secondary School, Zaria, Government Girls Secondary School, Dogon Bauchi, Government Secondary School Chindit, Government Girls Secondary Schools Chindit, Science Secondary School Kufena, Government Girls Secondary School, Zaria and Government Secondary School, Tudun Saibu. Other schools such as: Government Secondary School Aminu, Government Secondary School Magajiya, Government Girls Secondary School Pada, Government Secondary School Kofar Kuyanbana, Government Senior Secondary School, Kaura, Government Secondary School Tudun Jukun and Government Secondary School, Dakace have multi user laboratory or general laboratory. Others were either Junior Secondary Schools only or Senior Secondary Schools only without laboratory. Most of such schools were newly established.

4.7 Sports facilities

From Table 4.5, all schools have sports facilities in football except Sheikh Ibrahim Arab Special Secondary School; it is the only Secondary School that combines western and Islamic Secondary education in the Education Zone.

Other schools like Alhuda Huda College, Barewa College, and few others have other sports like table tennis, basketball, volleyball and handball. It is on record that extra curricula activities are also part of educational planning.

4.8 Classes

From Table 4.2, Barewa College had the highest number of Classes with 37; Barewa was followed by Government Girls Secondary School Kongo (WTC) with 32. Alhuda Huda College Senior had 27 classes. but most schools had nine (9) classes.

4.9 Number of arms per Class

From Table 4.2, Government Secondary School Chindit and Government Secondary Tudun Jukun had the highest number of arms per class. In each of their classes, they had six arms. Schools like Alhuda Huda College, Barewa College, Government Girls Secondary School Chindit, Government Girls Secondary Kongo, and Government Secondary School Zaria had five arms per class. There were few schools with four arms per class. They were: Government Secondary School Aminu and Government Secondary School Tudun Saibu. The rest of the schools have either three or the record is not available.

4.10 Number of Students

From Table 4.2, the highest number of students was found in Government Secondary School Aminu with 1660, Sheikh Ibrahim Arab Special Secondary School had 1559, Government Secondary School, Kofar Kibo Senior had 1552, Government Girls Secondary School Dogon Bauchi had 1313, Government Girls Secondary Chindit had 1225, Government Secondary School Tudun Jukun had 1203, Government Secondary School Chindit had 1314, Government Girls Secondary School Kongo had 1223, Alhuda Huda College Junior and Senior had 1225 and 1110 respectively. Government Secondary School, Kofar Kibo Junior had 1301 and Government Junior Secondary School Tudun wada had 1200. The rest of the schools do not had up to 1000 students.

4.11 Staff Qualification

From Table 4.2, the spatial distribution of teaching staff in Secondary Schools in Zaria Education Zone shows that 14 members of staff hold Masters Degree out of which two were from Government Secondary School Zaria, two from Government Girls Secondary School Pada Senior, Government Girls Secondary School Chindit has two, Sheikh Ibrahim Arab Special Secondary School had two, Government Girls Secondary School Dogon Bauchi also got two, Government Secondary School Tudun saibu Junior had one, Government Junior Secondary School Kofan Doka had one, Government Junior Secondary School Magajiya had one and Barewa College got one also.

In the case of Degree holders, 401 degree holders were spatial distributed across the Secondary Schools. Barewa College had the highest number of teachers with degree qualification 26, Government Girls Secondary School Dogon Bauchi had 25, Government Secondary School Zaria had 23, Sheikh Ibrahim Arab Special Secondary School had 20, Government Secondary School Kofan Kuyanbana got 18, Government Secondary School Chindit both Senior and Junior had 15, Government Girls Secondary School Kongo 13, Government Girls Secondary School Dogon Bauchi Junior had 12, Alhuda huda College has 11, Government Secondary School Magajiya and Government Secondary School Chikaji both Senior and Junior got 10 each. The rest of the schools had less than 10 degree holders.

On the issue of Higher National Diploma (HND), the spatial distribution shows that; Barewa College had the highest with five, Government Secondary School Kofan Jatau had four, Government Girls Secondary School Dogon Bauchi got three and the rest of the schools were having two, one or none. One reason for the low number of HND holders is because it is not actually required officially for school teaching unlike NCE and Degree.

In the case of National Certificate on Education (NCE), Government Junior Secondary School Kofar Doka tops the list with 29 holders, Government Junior Secondary School Pada had 28, and Government Secondary School Zaria had 26, Government Secondary School Kofar Kuyambana and Government Junior Secondary School Rimin Doko both had 23, Government Girls Secondary School Junior and Government Secondary School Chindit Junior both got 20, Government Junior Secondary School Magajiya had 19, Alhuda Huda College Senior and Junior, Government Secondary School Tudun Jukun and Government Secondary School Chindit Junior both got 17. Government Junior Secondary School Kofar Jatau and Government Secondary School Muciya Junior both have 16.

Government Secondary School Kaura and Sheikh Ibrahim Arab Special Secondary School had 15 each. Government Junior Secondary School Gyallesu had 14. Government Girls Secondary School Kongo has 13. Government Girls Secondary School Magajiya Senior has 12. Government Junior Secondary School Bogari and Government Junior Secondary School Chikaji had 11. Three schools had 10. They are: Government Girls Secondary School Dogon Bauchi Senior, Government Secondary School Muchiya Senior, Government Secondary School Aminu Senior. The rest of the schools had less than 10 NCE holders.

Others could be OND, Higher Islamic Certificate, etc. and Sheikh Ibrahim Arab Special Secondary School had 38, the highest, Government Junior Secondary School Kofar Jatau had 11, Alhuda Huda College Senior and Government Secondary School Chikaji had 4 each and Government Secondary School Zaria Junior has 3. Other schools were 0, 1 or 2.

4.12 Accessibility

Majority of the schools are accessible by cars, buses, tricycles, motorcycles, bicycles or foot except for Government Junior Secondary School Aba, Government Junior Secondary School, Bogari and Government Junior Secondary School Mangi were fair score were recorded. The only two schools that are poorly accessible especially during rainy season were: Government Secondary School, Kugu and Government Secondary School Matari.

CHAPTER FIVE

SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY AND CONCLUSION

The study shows how limited information on the available database for learning has denied parents best options in the choice of schools for their children within Zaria on one hand and the options for placing and provision of physical facilities by the Kaduna State Ministry of Education on the other. The study provided information on the available facilities in Secondary Schools and geo-spatial distribution of teachers based on their qualifications and their number within the study area.

A trip was made to schools in the study area and coordinates of each school were obtained using the Germin 75S Handheld GPS Receiver. Data on the list of schools, number of staff, students and related data were also obtained from the Ministry of Education Kaduna State Zonal Office, Zaria.

A digital base map was obtained by digitizing Google Pro 2011 satellite image. In digitizing Google Pro 2011 satellite image, the image was used to map the features. First, it was downloaded from the internet so that the satellite image could be seen for accurate mapping. Coordinate of the Google earth image was acquired then, the geo-referencing exercise was followed after the Google earth image was downloaded.

Geospatial database for Secondary Schools in Zaria Education Zone shows that most of the schools with the best of facilities were those schools established long ago. In other words, first generation schools have more facilities than the second or third generation schools. Schools like Alhuda Huda College and Barewa College are the first generation schools; Science Secondary School Kufena, Government Commercial College, Zaria, Government Secondary School Chindit, Government Girls Secondary School Kongo, Government Secondary School, Kofar Kibo and Government Girls Secondary School, Kofar

Gayan are the second generation schools. The rest of the schools established from 1990's are classified under the third generation.

Alhuda Huda College is the oldest school, it was established in 1910, then comes Barewa College which was established in 1928. The second generation schools were established between 1970s and 1980s. These schools have almost all the facilities required, but the quality of teaching in them at present is another issue.

Barewa College had the highest number of staff 85, Sheikh Ibrahim Arab Special Secondary School had 84, Government Girls Secondary School Kongo had 80 and at the bottom, Government Junior Secondary School Richifa and Government Secondary School Aba had only four (4) members of staff each.

Most schools were spatially located or found in Zaria and Sabon Gari Local Government Areas; they were nucleated spatially and congested with students. There were few in Soba Local Government Area which were linear spatially and only one in Kudan Local Government Area, Government Secondary School Likoro. Most schools established from late 1980's and early 1990's to date were neighborhood schools. In other words, they were schools established close to people to reduce long distance journey. Example of such schools are: Government Secondary School Magajiya both Senior and Junior, Government Secondary School Kaura, Government Secondary School Pada both Junior and Senior, Government Secondary School Aminu both Senior and Junior, Government Secondary School Yakassai, Government Secondary School Likoro, Government Secondary School Kofar Kuyambana, Government Secondary School Muchia both Junior and Senior, Government Secondary School Tudun Jukun and Government Secondary Rimin Doko.

Few schools had teachers with Masters Degree, they were: Government Secondary School Zaria, Government Girls Secondary School Pada Senior, Barewa College,

Government Girls Secondary School Chindit, Senior, Sheikh Ibrahim Arab Special Secondary School Karau Karau, Government Secondary School Magajiya, Government Junior Secondary School Kofar Doka, Government Secondary School Tudun Saibu Junior and Government Girls Secondary School Dogon Bauchi, Senior.

There were some schools which were divided into Junior and Senior but share the same compounds or premises. Such schools include: Alhuda huda College, Government Secondary School Magajiya, Government Girls Secondary School Pada, Government Secondary School Aminu, Government Secondary School Kofar Kibo, Government Secondary School Chindit, Government Secondary School Tudun Jukun, Government Secondary School Yakassai and Government Secondary School Kofar Kuyambana. These schools have different teachers, principals and other school requirements. In the case of Government Secondary School Chindit, not only it was divided into Junior and Senior, but also divided into males and females where a system of rationing is adopted. Males go to the school in the morning for a month while females go in the afternoon and vice versa.

5.2 RECOMMENDATIONS

Since schools facilities are many and hardly can government provide enough, the important ones should be provided by government. Many schools lack these facilities and the few with them, are inadequate. Area of Database is also critical as far as education planning and administration is concerned. The following recommendations will go along away in increasing the frontier of knowledge.

i. Understanding of database and utilization needs a good knowledge of computer especially programmes like DB2 and Microsoft Access because the created data is supposed to be accompanied with a query or a search engine which will enable people search for whatever information needed without duplication. Hence, all

Secondary Schools should be beneficiaries of Information and Communication Technology (ICT) this is against what is obtainable from the study, where only four schools were benefiting.

ii. Database creation for schools' facilities should include among other things, simplification to cater for all categories of users. In this regard, efforts should be made by ministry of education to improve teachers' skills in ICT through capacity building workshops, seminars, etc this will have an impact or transfer of knowledge from the teachers to the students with ease.

iii. Data on distance or distance analysis from settlements to schools is needed to know the average distance covered by students and staff from their residences to schools this will help parents who are interested in closeness for choosing their children's schools and it will also help school's management in preparation for lessons time table.

iv. Government should ensure that ICT statements are translated into reality. An ICT policy implementation commission should be funded and powered to provide ICT facilities in the schools and monitor their use.

v. Computer/ICT education should be made compulsory for all Secondary Schools. At present, the National policy on education 4th edition has made computer education an elective course in high schools. This means only those who elect it will have computer in high schools.

vi. The spatial distribution of schools in Zaria Education Zone is inadequate because you find more than 100 students in many schools receiving instructions in a class which is not conducive for effective learning and against the standard of 40 students per class. So, government should build more schools or/more classes to decongest the existing ones.

vii. More staff are needed to keep pace with ever increasing students in Zaria Education Zone. Some schools like Government Secondary School Bogari have only four teaching staff and other schools that have good number of staff lack adequate teachers in English, Mathematics, Geography, Biology, Chemistry, Physics, Fine Arts, Wood work, Metal work and Accounting.

viii. The schools' sports facilities are supposed to be divided into say; football, basketball, basketball, tennis, race, etc. Most of the schools have only football pitches. Sports as an extra curricula activity are important for effective learning as the saying, "all work no play makes jack a dull boy".

ix. Geospatial database for primary school is also needed in Zaria Education Zone to establish a data bank for the primary schools because primary education is the basic or foundation for all levels of education. subsequent researchers should work on that.

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CHECK LIST

DEPARTMENT OF GEOGRAPHY, FACULTY OF SCIENCE AHMADU BELLO UNIVERSITY, ZARIA

The researcher is an M.sc student of the above mentioned department, conducting a research entitled, "**Creating a Geospatial Database for Secondary Schools' Facilities in Zaria Education Zone, Kaduna State".**

Information given will only be used for academic purpose and will be treated with utmost confidentiality.

Thank you.

1. School Name……
2. School Address…….
3. School Category……...
4. LGA of School……
5. School Year of Establishment……..
6. Number of Male Teachers……
7. Number of Female Teachers……
8. Number of Male Non-Teaching Staff…….
9. Number of Female Non-Teaching Staff……...
10. Number of Teachers with M.sc……
11. Number of Teachers with Degree……
12. Number of Teachers with HND……...
13. Number of Teachers with NCE……
14. Number of Teachers with OND/HSC…….
15. Number of Male Students in JSS 1…….
16. Number of Female Students in JSS 1……...
17. Number of Male Students in JSS 2…….
18. Number of Female Students in JSS 2……...
19. Number of Male Students in JSS 3……..
20. Number of Female Students in JSS 3……...
21. Number of Male Students in SSS 1…….
22. Number of Female Students in SSS 1……..
23. Number of Male Students in SSS 2…….
24. Number of Female Students in SSS 2……..
25. Number of Male Students in SSS 3…….
26. Number of Female Students in SSS 3……..
27. Total Number of Classroom…….
28. Total Number of Arms per Classroom…….
29. Presence of Biology Laboratory……...

30. Presence of Chemistry Laboratory……..
31. Presence of Geography Laboratory……
32. Presence of Physics Laboratory……...
33. Presence of Computer Laboratory……
34. Total Number of Libraries……
35. Total Number of Workshops……
36. Total Number of Sports Facilities……
37. Total Number of Toilet Facilities……
38. School Accessibility level……
39. School Area Coverage……..

For Researcher's use only

School Coordinate:
X Coordinate
(NORTHINGS)……
Y Coordinate
(EASTHINGS)……

Appendix

Abbreviation	Meaning
SCH_ID	School Identification
N_STF	Number of Staff
C_LAB	Computer Laboratory
LIB	Library
B_C_P_L	Biology, Chemistry and Physics Laboratories
GEN_LAB	General or Multipurpose Laboratories
YR_EST	Year of Establishment
S_FC	Sport Facilities
N_CL	Number of Classes
N_C_P_C	Number of Classes per Class
N_STUD	Number of Students
M_AB	Holders of Masters and Above
Degree	Holders of Degree
HND	Holders of Higher National Diploma
NCE	Holders of National Certificate on Education

OTHERS	Other qualifications

Schools abbreviations and meaning

GSS AM S	Government Secondary School Aminu Senior
GSS MC S	Government Secondary School Muciya Senior
GSS DNY	Government Secondary School Dinya
GSS LKR	Government Secondary School Likoro
GGSS KG	Government Girls Secondary Schoo Kofar Gayan
GSS KR S	Government Secondary School Kaura Senior
GSS K/KIBO	Government Secondary School Kofar Kibo
GSS MG S	Government Secondary School Magajiya Senior
GGSS P S	Government Girls Secondary School Pada Senior
GSS YAK	Government Secondary School Yakasai
BAREWA	Barewa College
GSS TS S	Government Secondary School Tudun Saibu Senior
GGS DB S	Government Girls Secondary School Dogon Bauchi Senior
GSS KK	Government Secondary School Kofar Kuyambana
GGS CH S	Government Girls Secondary School Chindit Senior
GSS KGU	Government Secondary School Kugu
ALHUD S	Alhuda Huda College Senior

ALHUD J	Alhuda Huda College Junior
SIASSS	Sheikh Ibrahim Arab Special Secondary School
GSS TJK	Government Secondary School Tudun Jukun
GSS CH S	Government Secondary Secondary School Chindit Senior
GGSS K	Government Girls Secondary School Kongo
GJSS MAT	Government Junior Secondary School Matari
GJSS R/D	Government Junior Secondary School Rimi Doko
GSS DAK	Government Secondary School Dakace
GJSS K/J	Government Junior Secondary School KofarJatau
GJSS CKJ	Government Junior Secondary School Cikaji
GJSS ABA	Government Junior Secondary School Aba
GJSS GYA	Government Junior Secondary School Gyallesu
GJSS BOG	Government Junior Secondary School Bogari
GSS MG S	Government Secondary School Magajiya Senior
GSS MG S	Government Secondary School Magajiya Junior
GJSS KD	Government Junior Secondary School Kofar Doka
GJSS GMB	Government Junior Secondary School Gimba
GJSS	Government Junior Secondary School Muciya
GJSS AW	Government Junior Secondary School Awai

GSS CH J	Government Secondary School Chindit Junior
GJSS RCH	Government Junior Secondary School Richifa
GJSS MG	Government Junior Secondary School Margi
GJSS KNK	Government Junior Secondary School Kinkiba
GGSS DB J	Government Girls Secondary School Dogon Bauchi Junior
GSS AM J	Government Secondary School Aminu Junior
GSS K/KIBO	Government Secondary School Kofar Kibo
GJSS TW	Government Junior Secondary School TudunWada