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A Geospatial Assessment of Health Care Facilities (A Case Study of Alimosho Local Government Area)

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ABSTRACT

This project deals with the use of geospatial processes and analysis in viewing or accessing various facilities used in healthcare services across Alimosho Local Government Area. It highlights and explains the principles, challenges, and advantages in using a geospatial approach in assessing health care infrastructure.

The progress in GIS and increased awareness about it has provided numerous opportunities for health care administrators and government at all levels to improve their monitoring and evaluation capabilities. Information on availability and adequacy of health care facilities is not readily available, and this is what has prompted this study. As such, this study incorporates data obtained from relevant authorities in the health sector coupled with comprehensive analysis using GIS to arrive at reasonable overview of the health care infrastructure within the local government area with a view to ascertaining whether there is any imbalance.

The locations of several health care facilities which consist of hospitals, clinics and pharmacies were ascertained using Global Positioning System (GPS) and their addresses were collected from the Ministry of Health to create a database using Microsoft excel. Additional information comes from questionnaires issued to the facility management and that serves as attribute data for both the database and visual map. Parameters such as ownership and category were also included in the database. The softcopy map was imported into ArcGIS 10.2. The results obtained have shown that geospatial analysis can be used as an effective approach in assessing health care facilities at all levels.

Key words: GIS, Geo spatial, Health care facilities, etc.

INTRODUCTION

It is widely known and accepted that health is a crucial component of human wellbeing (Philips, 1990). It is defined with reference to World Health Organization (WHO 1947, 1948) as not merely the absence of disease or infirmity, but also as a state of complete physical, psychological and social well-being. The need for healthcare varies in space and so the organization of provision necessarily has a spatial component. In Nigeria, healthcare system is divided into three, namely: the primary, secondary and tertiary health care (Osa, 1992).

Essentially, geographic accessibility to a great extent determines the use of health care services while factors such as urban spatial form can influence equitable provision of health care services than others (Hodge and Gatrel, 1976). Also, it is cited in (Raheem, 1999). Distance to health care facilities was recognized as a significant barrier to health care access in the U.S in the 19th century (Hunter, Shannon et al, 1986). By the middle of 1970, many attempts were made to measure spatial accessibility of health service locations.

A GIS is described as a set of tools for collecting, storing, retrieving at will, transforming, and displaying spatial data from real world for a particular set of purposes (Burrough, 1986). GIS has a geo-coding function that enable the conversion of any address data into point coverage. Digitized data from existing maps can provide layers (roads, networks, residential districts and land use) on which data can be overlaid. The Network Analysis function of GIS defines the shortest path between patient's location and health care centre.

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Basically, the challenge in many countries is to reach the whole population with adequate health care services and to ensure their utilization (Park, 2002 cited in Akingbola, 2009). However, despite the "health for all" declaration by WHO (World Health Organization), health care services continue to be either sub-standard or low in access, expensive or under-utilized (Park, 2002 cited in Akingbola, 2009).

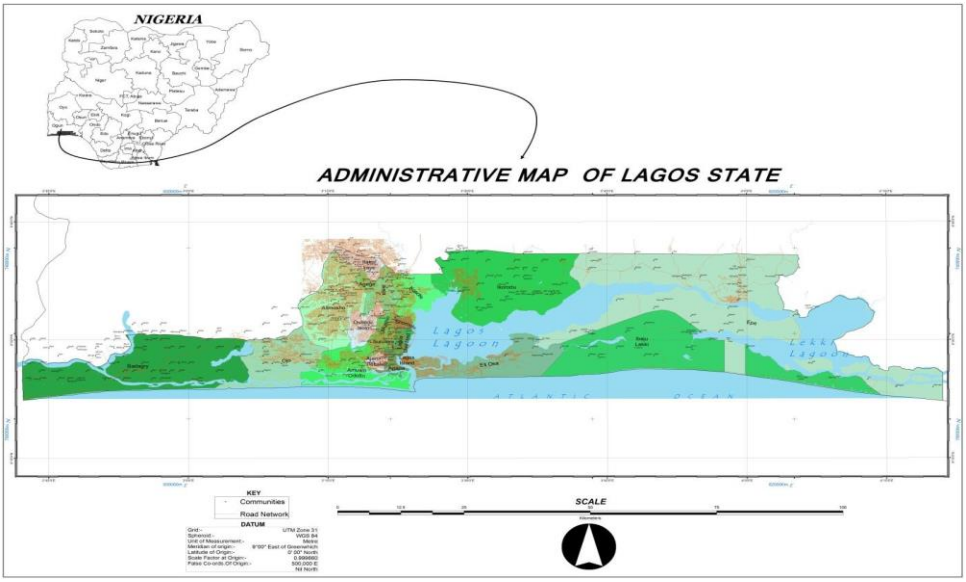

Figure 1.1: Administrative map of Lagos state

Available health services are unevenly distributed. Tertiary hospitals in secured areas where large populations concentrate and without adequate first- contact capacity in their proximity, tend to be overcrowded with patients suffering from common conditions (WHO, 2010). Conversely, many peripheral primary health care (PHC) facilities are under used, because of the poor services they provide, lack of access, competition by alternative provider (perhaps backed by NGOs or charities). User fees have been identified as a leading cause of low utilization of health services. Informal charging by health workers may also deter service consumption (WHO, 2010). The ability to locate health facilities and identify their capabilities in terms of services and hours of operation has been underscored due to lack of proper mapping facilities. Unlike in the developed world where all health facilities are of equal standard, in the developing world it is different.

Therefore, those needing medical help would be wondering as to which facility to visit? Does the chosen health facility operate 24 hours? Do they have pharmacy? Do they have beds? At some instances, laboratories are also required for the purpose of blood transfusion and examination of pathogens. It has however also become evident that there are inadequate data and information to formulate and implement appropriate policies and programs to manage these challenges (Onokerhoraye, 1999).

The Study Area

Alimosho is a local government area situated in Lagos state in south western Nigeria. It is in the Ikeja division of the state and is the largest local government in the state. It is a populated place with a population of 2,047,026 as claimed by Lagos state government. It lies on a latitude 6°36' 39''N and on longitude 3° 17'46''E and is located at an elevation of 44m above sea level. It occupies an approximated area of – and its UTM position is EH33. The source of Alimosho is the Alashua River which is located on the axis of Oki and Alagitan in Alimosho.

It was established in 1945 and it was under the then Western region. Its secretariat/office is situated at Onilu village. It is further divided into 6 local council development areas (LCDA) such as Igando Ikotun LCDA, Akowonjo LCDA, Agbado Okeodo LCDA, Mosan Okunola LCDA, Egbe Idimu LCDA and Ayobo Ipaja LCDA etc.

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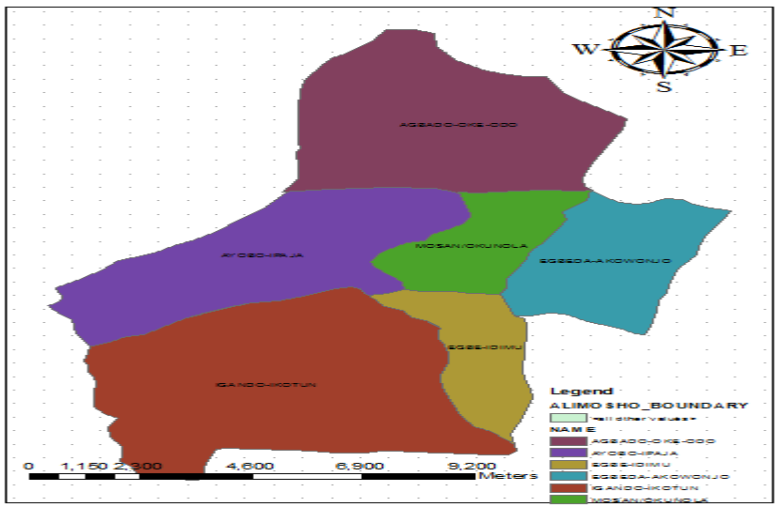

Fig 1.2 Map Shewing study area, Alimosho local government area

Aim and Objectives of the Project

The aim of this study is applying geospatial assessment of health facilities in Alimosho local government area of Lagos State. This aim could be achieved with the

The objectives of the study are:

- To acquire relevant spatial and attribute data of all public healthcare facilities within the study area.
- To design a geo database of all public health facilities with their respective attribute data
- To determine if the available, facilities in the study area are in conformity with given standards by World Health Organization (WHO) and Ministry of Health (MOH) and to proffer solutions to the problems or challenges.
- To analyze the extent and rate of usage as compared to the number of patients using these facilities
- To produce maps showing locations of these facilities

Scope of the Project

The scope of the project is stated as follows:

- The goals of the project includes creation of a reliable database of the public health care facilities in the local government through questionnaires, sourcing information from relevant authorities and stakeholders, Performing spatial analysis and queries of various kinds with the aim of presenting information about the different types of facilities present in relation to the population around such facilities, etc
- Location of the health care facilities on a generalized map of Alimosho L.G.A in Arc GIS 10.2 environment and a database design using Microsoft Excel,
- The project deliverables include customized maps, statistical tables, and questionnaires, amongst others.

Benefits of Geospatial Analysis To the Health Sector

Recent advances in geographic information systems and mapping technologies have created new and vast opportunities for health administrators, monitoring practitioners to enhance planning, analysis, monitoring and management of health systems. From Dr. John Snow's cholera death mapping in the mid nineteenth century to the latest internet based mapping where massive information can be shared across the world, health mapping has continued to evolve. Since, much of the data used and generated by health and social service sector has a spatial dimension; geospatial analyses is particularly useful to health practitioners and administrators for smooth planning and hitch free management of health programs, services and facilities. The merits of

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geospatial analysis and GIS in general over other traditional methods used in health management, research and planning are enormous.

LITERATURE REVIEW

Introduction to Geospatial Analysis and Geographic Information System

According to (Adeola, 2007), Geospatial analysis is a method of combining, examining, and mapping various types of geographically referenced data (demographic, statistical, topographic, epidemiological, and other data) into information that can be used for program planning and decision-making.

Similarly, as shown in (Akingbola, E.O. 2009), Geographic Information System is an automated system or computer-based methodology or tool used to collect, store, manipulate, retrieve and analyze spatial or geo referenced data. In a more generic sense, GIS is a tool that allows users to create interactive queries or user created searches, geo spatial analysis of information, edit data and maps, and present the results of all these operations.

Aguglino, R., & Rodriguez, M. (1994) explained that geospatial data analysis applied to point data typically entails analysis of point distributions in space and of the relationship between point distributions and other spatial features. The objective of the analysis would be to determine if the point pattern is dispersed, random, or clustered. Common techniques for analysis for distribution of features include: Quadrant count analysis, nearest neighbour analysis, Buffering etc

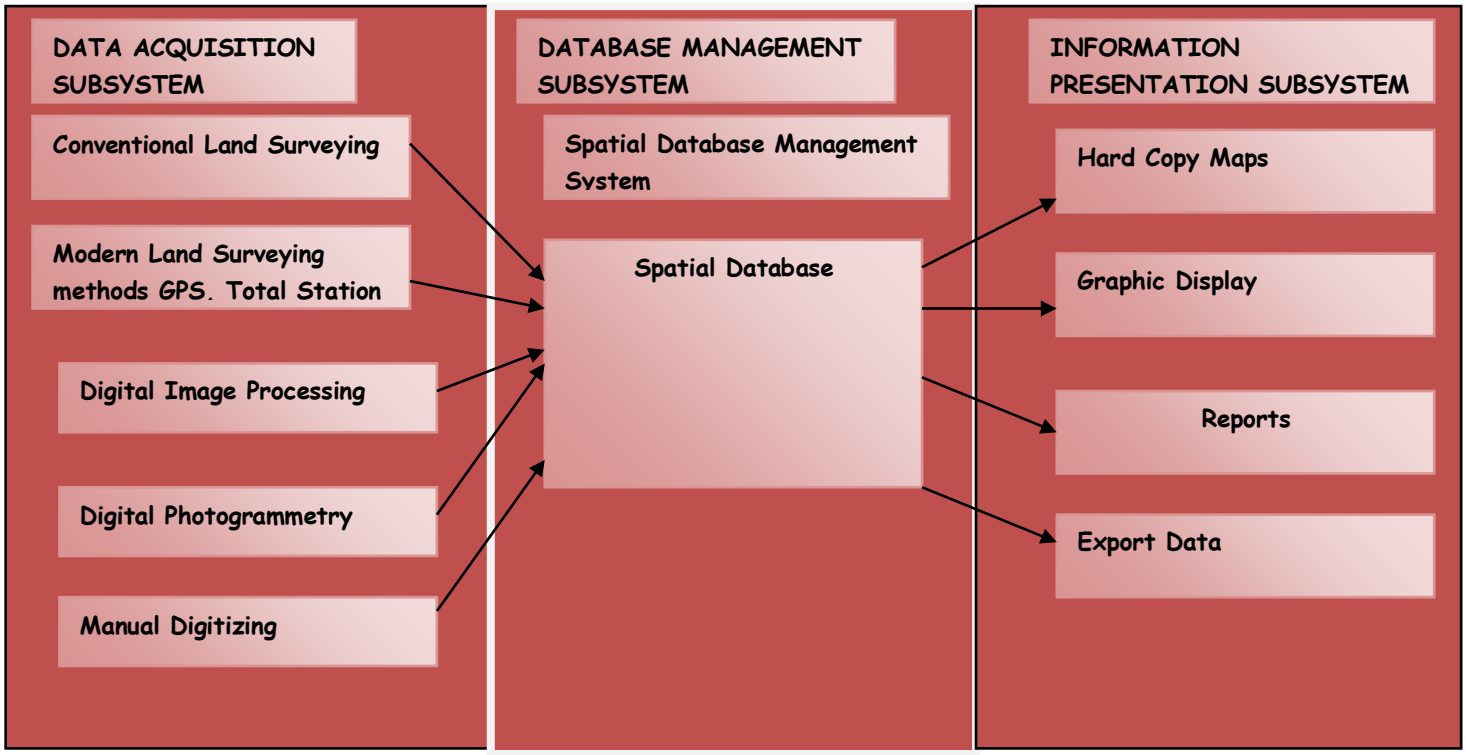

Figure 2.1: Figure 2.3: GIS Subsystems (Source: Burroughs, 1986)

Boysen, K. (2000) concluded that health facilities range from small clinics and doctor's offices to urgent care centres and large hospitals with elaborate emergency rooms and trauma centre. They can be divided into health centres, (primary, secondary, tertiary), clinics, maternity centres, orthopaedic centres, pharmacies and mobile clinics. These facilities will be discussed below.

Hospitals

A hospital is an institution providing medical and surgical treatment and nursing care for sick or injured people. It is a health care institution providing patient treatment with specialized staff and equipment. (Oxford,

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2011) showed that the word hospital was coined from the Latin word *hospes*, meaning stranger of foreigner, hence a guest. The word *hospitium* was derived this and it signifies hospitality, which is the relation between guest and sheltered, hospitable reception and friendliness.

There are different kinds of hospitals such as: general hospitals which are the best known type of hospitals and usually have emergency department to take care of accident and emergencies and deal with many kinds of diseases, long term care hospitals (LTCHs) which focus on patients who, on average, stay more than 25 days, a teaching hospital which performs two major functions which are providing medical assistance to people and teaching to medical students and nurses, district hospital which are usually the major health care facility in its region. They offer intensive care to patients in need of it. Other kind of hospitals include specialist hospitals including rehabilitation hospitals, children's hospitals, geriatric (seniors') hospitals, trauma centres, psychiatric hospitals, and others for treating certain diseases.

In Alimosho LGA there are over 300 hospitals (both private and public) receiving service from LAWMA, according to statistics by the Healthcare Facilities Monitoring and Accreditation Agency (HEFAMAA), an Agency of Lagos State Ministry of Health.

Primary Health Centre

The Primary Health Centre (PHC) refers to the basic structural and functional unit of the public health services in developing countries. PHCs were established to provide accessible, affordable and available primary health care to people, in accordance with the Alma Ata Declaration of 1978 by the member nations of the World Health Organization (WHO). It is meant to address the main health problems in communities by providing preventive, curative and rehabilitative services..

As shown in Cromley, E. K., & McLafferty, S. (2002), Primary Health Centres (PHC) is the cornerstone of rural healthcare. Primary health centres and their sub-centres are supposed to meet the health care needs of rural population. PHCs generally consist of one or more doctors to lead the PHC and pharmacist, a staff nurse, and other paramedical support staffs.

Badru, (2003) explained that in a nutshell a primary health care centre or facility is a small unit which provides a family with the health services other than those which can only be provided in a hospital. Primary health care covers, the primary health care centre, the primary health care clinic and the primary health care post. Other health issues in their care are family planning and immunization. Services provided at the primary health centres vary based on the type of PHC facility in Nigeria.

Secondary Health Care Centre

Secondary Healthcare refers to a second tier of health system, in which patients from primary health care are referred to specialists in higher hospitals for treatment. Examples of secondary types are comprehensive health centres and general hospitals. The comprehensive health centres are usually owned by private individuals or group of individuals while the general hospitals are owned by government.

A look at Lagos state ministry of health reveals that there are about 26public secondary health care centres in Lagos mainly general hospitals some of which include Agbowa General Hospital. Ajeromi General Hospital, Alimosho General Hospital, Apapa General Hospital, Badagry General Hospital, Ebute Metta Health Centre, Epe General Hospital, Gbagada General Hospital, General Hospital Lagos, General Hospital, Akodo. Others include General Hospital, Orile-Agege, Harvey Road Health Centre, IfakoIjaiye General Hospital, Ijede Health Centre, Ikorodu General Hospital, Isolo General Hospital, KetuEjinrin Health Centre, Lagos Island Maternity Hospital, Mainland Hospital, Yaba, Massey Street Children Hospital, Mushin General Hospital, Onikan Health Centre, Somolu General Hospital, and Surulere General Hospital.

General hospitals have provisions for accident and emergency unit and diagnosis unit [including X-ray, scan machines and other pathological services] among other services (Badru, 2003). The status of being a second layer of health institutions imposes certain acceptable standards and level of infrastructure.

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According to the Medical and Dental Council of Nigeria, there should be a minimum of three doctors who are to provide medical, surgical, paediatric and obstetric care in any general hospital. Furthermore, the general hospital incorporates the facilities of the primary healthcare into its own to play its role as a second tier health institution. As a matter of fact, to be so qualified, it should provide simple surgical services, supported by beds and bedding for minimum of 30 patients. There should also be ancillary facilities for proper diagnosis and treatment of common ailments. General hospitals are often within the control of state governments and private individuals or group of individuals.

However, going by World Health Organization (WHO)'s standard of 1; 1600, Nigeria posts a poor doctor-patient ratio of 1: 3500. Currently, all the medical schools graduate between 3500 and 4,000 new doctors annually. Meanwhile, a country like India has just one doctor for every 1,700 people.

More so, a nurse –patient ratio (which is defined as how many patients one nurse provides care for at one time) depends on many factors such as: severity of the patients that the nurse is providing care for e.g. in an ICU, the nurse –patient ratio may be 1:1 or 1:2: if a nurse works in another unit where the patients are not as sick, the nurse-patient ratio can be 1:5. Some hospitals units have criteria that dictate the amount of patients a nurse can care for.

Tertiary Health Centre

A tertiary referral hospital (also called a tertiary hospital, tertiary referral centre, or tertiary care centre, or tertiary centre) is a hospital that provides tertiary care, which is health care from specialists in a large hospital after referral from primary care and secondary care. This is a specialized consultative health care for inpatients. The patients are admitted into these centres on a referral from primary or secondary health professionals. Tertiary health care is provided in a facility that have personnel and facilities for advanced medical investigation and treatment. Services provided include cancer management, neurosurgery, cardiac surgery and a host of complex medical and surgical interventions. Advanced diagnostic support services and specialized intensive care which cannot be provided by primary and

Erinosho, 2005; Badru, 2003 stated that apart from the provision of infrastructure for health matters, there is also the need for availability of teaching materials and specialists in such fields as surgery, general medicine, paediatrics, obstetrics, dentistry, otolaryngology and psychiatry among other disciplines. To this end, each department should have a certain number of consultants with its own out patients, consultation sessions, ward units, surgical sessions and skilled personnel and auxiliary staff to man these units. The table below shows the distribution of health establishments in Nigeria between 1987 -1991.

Table 1: Number of Health establishments in Nigeria (1987 - 1991).

Establishments	1987	1988	1989	1990	1991
General Hospital	763	987	987	897	897
Pediatric	----	----	----	---	1
Maternity	3090	3172	3172	3133	3349
Orthopedic Specialist	3	3	3	3	3
Medical Health Centers	---	----	-----	-----	985
Dispensaries	---	---	---	---	8405
Teaching Hospital/Specialist	14	14	14	14	14
Others	8764	9471	9471	9716	9962
Total	12,734	13,647	13,647	13,961	23,616

Sources: Adebanjo and Oladeji, 2006.

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Based on estimates done by the Federal ministry of Health in 1991, the table below shows the number of beds in the various hospitals across Nigeria.

Table 2: Hospital beds by types of hospital [1990].

Type of Hospital	No of Bed Proportion	(%)
General Hospital	56,688	53.0
Maternity	20,370	19.0
Teaching Hospitals	7,130	6.7
Orthopaedics	733	0.7
Others	22,025	20.6
Total	106,946	100.0

Sources: Adebanjo and Oladeji, 2006.

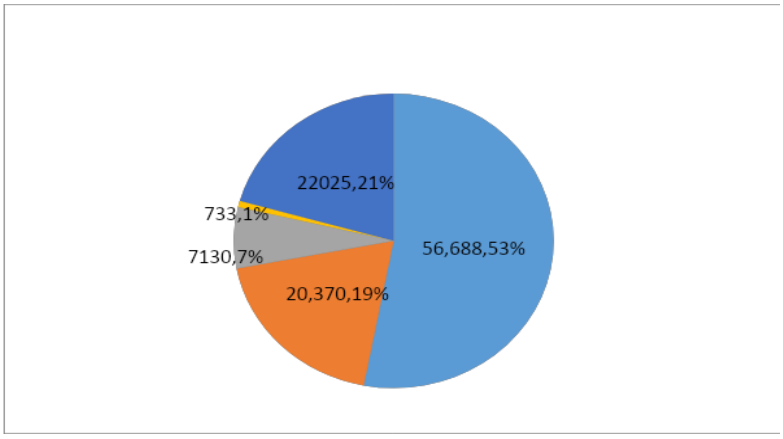

Fig 2.2: Pie Chart showing percentage of bed proportion

From Tables 1 and 2, the total number of all types of hospital including dispensaries, psychiatric hospitals, leprosaria and others was about 23,616. The general hospitals and maternity centres alone had 897 and 3349 respectively. We can compare these figures with number of infrastructures provided for effective delivery services (Table 2). To take beds, for instance among others, there were 106,946 beds. However, with 56,688 bed spaces, this translates to 63 spaces for each hospital in 1991. This is far above the minimum number of 3 spaces re- commended by Medical and Dental Association of Nigeria (MDLAN).

In Lagos, according to Healthcare Facilities Monitoring and Accreditation Agency (HEFAMAA), an Agency of Lagos State Ministry of Health, there are registered: 26 General Hospitals, 256 Public Healthcare Centres, 2,886 Private Hospitals/Clinics/Laboratories/Ophthalmic/Dental/Diagnostic Centres, and estimated 160 Trado-Medical Centres

Maternity Centres

It is a healthcare facility, staffed by nurse-midwives, midwives and/or obstetricians, for mothers in labour, who may be assisted by doulas and coaches. It is also called a birthing centre. By attending the labouring mother, the doulas can assist the midwives and make the birth easier.

Wang, F. H., & Luo, W. (2005) concludes that a birth centre presents a more home-like environment than a hospital labour ward, typically with more options during labour: food/drink, music, and the attendance of

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family and friends if desired. Other characteristics can also include non-institutional furniture such as queen-sized beds, large enough for both mother and father and perhaps birthing tubs or showers for water births. The decor is meant to emphasize the normality of birth.

METHODOLOGY

The data used in this project includes both primary and secondary data. Primary data were collected by obtaining position/co-ordinates of the facilities and then administering of questionnaires in each hospital in the study area. Secondary data include acquired maps of the study area; population figures for the settlements in the study area; names and locations of public and private hospitals /health centres and in the study area; yearly in patient and outpatients figures into public and private and hospitals /health centres, statistics of public and private hospitals /health centers, the doctors and other health practitioners, among others. The data were analyzed and presented by the use of simple statistical tables to explain the location and distribution of health facilities in the study area.

Data Acquisition

Spatial Data

This describes the relative or absolute data of geographic features. Spatial data are data that have a spatial component; it simply means that data are connected to a place on the earth. The spatial data includes:

- ✓ Points of interest
- ✓ Roads

Below is a table showing how the spatial data was acquired;

Table 3.1: Datasets and sources

S/N	Data sets	Format/Units	Source
1	GPS Coordinates of Hospitals in Alimosho LGA	UTM (metres)	Field work
2	Map of Alimosho	GeoTiff	Lagos state ministry of Physical Planning and Urban Development
3	Alimosho Road network	Shapefile	Data vendor

Some Field Survey Activities Involved in Acquisition of Attribute Data

1. A letter was submitted to Alimosho Local Government Area Office for the acquisition of relevant data of all health centres and facilities and for permission to access such facilities.

2. A letter was also submitted to the Ministry of Health at Alausa, Ikeja to gain access into the various health centres to carry out the project easily.

3. Other letters were written to the National Population Commission, Lagos Office for statistical data and the Lagos State Ministry of Physical Planning and Urban development for soft copy and hard copy maps of Alimosho LGA.

4. Questionnaires were produced and used in the various health facilities across Alimosho.

After carrying out the above procedures, the following were also done:

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- We carried out some inspections of the hospitals and health facilities available and checked how conducive the facilities are.
- The location and address of each hospital (mainly public health centres) and health facilities in the local government were compiled.

The data for the project will be obtained from the following sources:

1	Primary health centres data	MICROSOFT WORD	Field work and Alimosho L.G.A Authority Office
2	Secondary health centre data	MICROSOFT WORD	Field work

Hardware

- HP 630 Laptop with installed (RAM) of 4GB, 32 bit operating system, X-64 based processor and Intel core of CPU M3800@ 2.53GHZ
- Survey/Questionnaires
- Hard copy maps
- Hand held Garmin GPS Receiver
- Mobile Phones equipped with camera

Hand held Garmin GPS

A GPS (figure 3.3) is a continuous multipurpose positioning system that provides real-time position determination with an all-weather capability. GPS coordinates of the sampled points were also recorded.

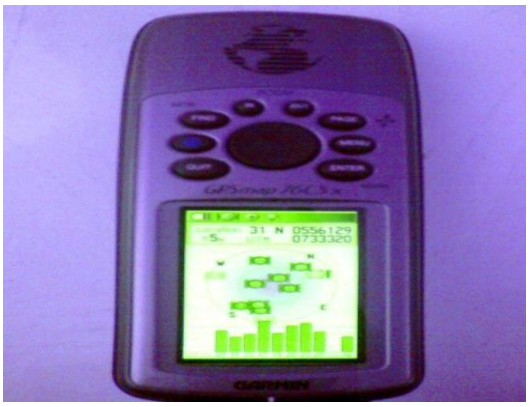

Figure 3.1: The hand held GPS unit used

Global Mapper

Global Mapper is a geographic information system (GIS) software package currently developed by Blue Marble Geographics that runs on Microsoft Windows. Global Mapper handles both vector, raster and elevation data, and provides viewing, conversion, and other general GIS features. The global mapper conversion tool was used to carry out some co ordinate conversions.

The GPS

A GPS (Figure 3.3) is a continuous multipurpose positioning system that provides real-time position determination with an all-weather capability. GPS coordinates of the sampled points were also recorded.

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Software Used

- Arc Gis 10.2
- Microsoft Word 2010
- Microsoft Excel
- Google Earth with Google Map Street Guide
- Elshayal co-ordinate converter
- Global Mapper co-ordinate converter

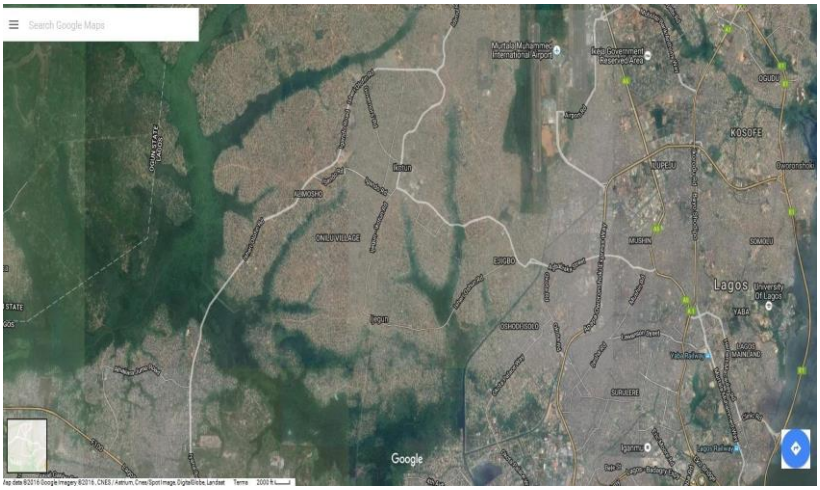

Figure 3.2: Google Earth imagery aided in viewing study area

ESRI's **ArcGIS** is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database. ArcGIS lets us perform the full range of GIS tasks—from geo database design and management to data editing, from map query to cartographic production and sophisticated geographic visualization and analysis. It is where the core work of GIS occurs.

Data base Design/Creation

This is simply designing or creating a compilation of different data pieces.

Database Creation

All attribute data were inputted in the attribute tables of the corresponding shape files during edit sessions on ArcMap. In doing this, fields were first created on the attribute table. For alphanumeric characters, the 'text' field type was used while the 'float' field type was used for numbers. In creating the fields, the following steps were taken.

1. In ArcMap, right-click the shape file layer in the table of contents and click Open Attribute Table.
2. Click the Options button and click Add Field.
3. Type the field name in the Name text box.
4. Click the Type drop-down arrow and click a type.

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5. Click in the Field Properties list and type the properties.

Coordinate system transformation

This was done by first assigning the datasets their true projection (GCS WGS84) on ArcCatalog. Then the data frame on ArcMap was set to a projected system (WGS84 UTM Zone 31N). The datasets were then exported using the coordinate reference information of the data frame. As such, the transformation to a projected space was successful

Points of Interest

The various points of interests include:

- All primary health centres and secondary health centre.
- The roads in the area of study are also considered for analysis in order to consider the proximity of each health facility to the area and the distance of hospitals to people.

Below is a list of public health centres (both Primary and Secondary) with their coordinates:

Table 3.2 Primary Healthcare centres in Agbado Okeodo LCDA

S/N	PRIMARY HEALTH CENTERS	ADDRESS	CO ORDINATES (Northings, Eastings)
1	Aboru PHC	Yisa Street, Agbado Okeodo LCDA,Alimosho.	6° 37’ 27.21’’N 3° 16’ 4.27’’E
2	Agbado PHC	Kajola, Agbado Okeodo LCDA, Alimosho.	6° 39’ 55.70’’N 3° 165’ 30.33E
3	Agbelakale PHC	12, Manna Street, Agbado Okeodo LCDA, Alimosho.	6° 38’ 17.26’’ N 3° 17’ 19.41’’ E
4	Agbenugba PHC	Agbenugba Village, Agbado Okeodo LCDA, Alimosho.	6° 39’ 23.58’’ N 3° 14’ 51.74’’ E
5	Aminkale PHC	AIT Road, Aminkale, Agbado Okeodo LCDA, Alimosho	6° 40’ 0.08’’N 3°15’ 42.34’’E
6	Isale-Odo PHC	Agbado, AgbadoOkeodo LCDA, Alimosho.	6°40’ 49.24’’N 3° 15’ 26.76’’E
7	Meiran PHC	A2 Meiran Road, Agbado Okeodo LCDA, Alimosho.	6° 39’ 54.73’’N 3° 16’ 49.09’’E
8	Ogundimu PHC	Aboru, Agbado Okeodo LCDA, Alimosho.	6° 38’ 11.38’’N 3° 17’ 1.73’’E
9	Okeodo PHC	26 Old Ota Road, Agbado Okeodo LCDA, Alimosho.	6° 38’ 56.36’’ N 3° 13’ 41.58’’ E

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Table 3.3 Primary Healthcare Centres in Ayobo Ipaja LCDA

S/N	PRIMARY HEALTH CENTERS	ADDRESS	CO- ORDINATES
1	Bada PHC	Bada Village, Ayobo Ipaja, Alimosho.	6° 35’ 38.03’ N 3°13’41.705’’ E
2	Baruwa PHC	Baruwa, Ayobo Ipaja, Alimosho.	6° 35’ 38.81’’ N 3° 16’ 6.825’’ E
	Ipaja PHC	Ayobo Road, Ayobo Ipaja, Alimosho.	6° 15’ 14.706’’ N 3° 36’ 15.508’’ E
4	Isefun PHC	Isefun, Ayobo Ipaja,Alimosho.	6° 36’ 32.09’’ N 3° 15’ 29.62’’ E
5	Olorunisola PHC	Olorunisola,Ayobo Ipaja, Alimosho.	6° 40’ 28.58’’ N 3° 15’ 30.04’’ E

Table 3.4 Primary Healthcare Centres in Egbe Idimu LCDA

S/N	PRIMARY HEALTH CENTERS	ADDRESS	CO-ORDINATES
	EgbeAgodo PHC	Egbe Agodo, Egbe Idimu LCDA, Alimosho	6° 33’ 59.43’’ N 3° 16’ 40.81’’ E
	H/AMH PHC	Idimu, Egbe Idimu LCDA, Alimosho.	6°34’ 57.74’’ N 3° 16’ 26.52’’ E
3	Isheri PHC	Isheri/Olofin, Egbe Idimu LCDA, Alimosho.	6° 33’ 30.83’’ N 3° 15’ 0.1’’ E
4	Liasu PHC	Egbe- Liasu, Egbe Idimu LCDA, Alimosho.	6° 3’ 22.08’’ N 3° 16’ 51.78’’ E
5	Ogbomosotedo PHC	Ogbomosotedo, Egbe Idimu LCDA, Alimosho	6° 34’ 17.35’’ N 3° 16’ 53.79’’ E

Table 3.5 Primary Health Centers in EgbedaAkowonjo LCDA

S/N	PRIMARY HEALTH CENTERS	ADDRESS	CO-ORDINATES
1.	Akowonjo PHC	100 Akowonjo Road, Egbeda Akowonjo, Alimosho	6° 35’ 58.51’’ N 3° 17’ 54.01’’ E

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Table 3.6 Primary Healthcare Centres in Igando Ikotun LCDA

S/N	PRIMARY HEALTH CENTERS	ADDRESS	CO-ORDINATES
1.	Egan PHC	Akesan Road, Igando Ikotun, Alimosho	6° 32’ 43.16’’ N 3° 14’ 0.57’’ E
2.	Ikotun PHC	Ikotun Idimu Road, Igando Ikotun, Alimosho	6° 33’ 8.944’’ N 3° 16’ 8.829’’E
3.	Okerube PHC	Okerube/Abaranje, Igando Ikotun, Alimosho	6° 33’ 44.15’’ N 3° 16’29.92’’ E

Table 3.7 Primary Healthcare Centres in Mosan Okunola LCDA

S/N	PRIMARYHEALTH CENTERS	ADDRESS	CO ORDINATES
1.	Abesan Estate PHC	Abesan/Jakande Estate, Mosan Okunola, Alimosho	6° 31’ 35.04’’ N 3° 15’ 46.35’’ E
2.	Akinogun PHC	Balogun Ladega Street, Pako Bus Stop, Mosan Okunola, Alimosho.	6° 36’ 31.62’’ N 3° 17’ 3.46’’ E

Table 3.8 Secondary Health Center in Alimosho LGA

S/N	PRIMARY HEALTH CENTERS	ADDRESS	CO-ORDINATES

Conformity To Recognized Standards

After the necessary analysis has been carried out, conformity of various results to recognized standards such as World Health Organization (WHO)’s standards, Ministry of Health (MOH)’s standards will be determined and some solutions will be proffered to existing challenges.

Data Analysis

The following analyses will be performed:

- Spatial analysis
- Statistical analysis.

Spatial Analysis

Spatial analysis uses spatial information to extract new and additional meaning from GIS data. In this research, spatial analysis is carried out using a GIS application. These applications have spatial analysis tools for feature statistics or geo processing such as buffering.

Other operations adopted include:

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Query generation

Data analysis is one of the most important features of the ArcGIS software. The real strength of GIS comes in when a relational database has been linked with the graphics in real time. A good GIS allows the user to select attributes in the database and to view the results on an interface displayed which can be printed as hard copy, and all these were achieved.

Spatial Analysis by Spatial Queries

Database query can be referred to as the selection of various combination tables for examination; it involves the retrieval of information stored in the database using structured query language (SQL). SQL is a database sublanguage for querying and modifying relational databases. The single criteria analysis refers to the situation whereby a single condition is used to query a database. It completely leaves out a possibility of combining more than one criterion or condition in generating the desired output.

Spatial Analysis by Feature Identification

Analyzing spatial data by feature identification is basically a fast and flexible method of accessing a section of the database with respect to the feature identified. In order for this to be carried out, the 'identify tool' was used. The identify tool was picked from the tool bar in the ArcGIS 10.2 environment and health facility was clicked. With this, the information window showing the information of that record was displayed. This involves:

Selecting by location

Using **select by location** tool can help to select features based on their relation to features in another layer. For instance, if you want to know how many homes were affected by a recent flood, you could select all the homes that fall within the flood boundary. One can use a variety of selection methods to select the point of interest, line or polygon features in one layer that are near or overlap the features in the same or another layer.

Selecting by attribute

One of the selection methods you can use to select features is to select features using an attribute query. This is performed using the **select by attributes** tool. Select by attributes allow you to provide a SQL query expression that is used to select features that match the selection criteria.

Steps for using **select by attribute** on ARC GIS;

- Click **selection> select by attributes** dialog box.
- Choose the layer to perform the selection
- Specify the selection method.
- Enter a query expression using one of the following methods:
- Create a query using the expression building tools.
- Type a query into the selection window.
- Load a query saved to disk.
- Validate your query expression by clicking **Verify.**
- Click **OK** to execute your selection expression and work with the selection results.

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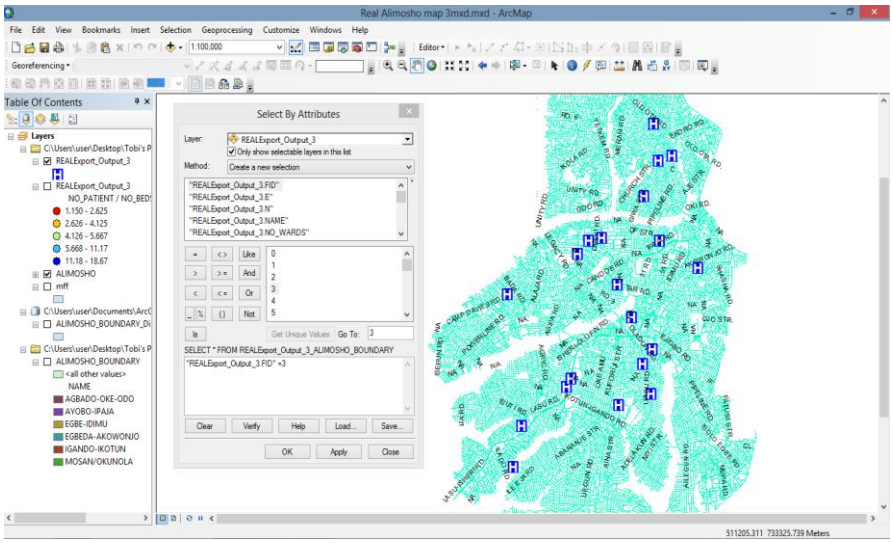

Fig 3.3 Image showing the ‘‘Select by Attribute” dialog box

Proximity Analysis

Generate Near Table

This determines the distances from each feature in the input features to one or more nearby features in the near features, within the search radius. The results are recorded in the output table.

This tool behaves the same as the Near tool. However, instead of updating the input features, it creates a new output table. Moreover, it can find as many near features as specified by the maximum number of closest matches’ parameter. The following are involved;

The output table contains three fields—IN_FID, NEAR_FID, and NEAR_DIST—by default. Additional fields are added to output depending on the optional parameters selected as explained in the parameter entry.

1. IN_FID—Stores the feature ID of the input feature.
2. NEAR_FID—Stores the feature ID of the nearest feature.
3. NEAR_DIST—Stores the distance from the input feature to the nearest feature.

The value of this field is in the linear unit of the input features coordinate system.

- The output table can be joined back to the input feature class or a near feature class using the IN_FID or NEAR_FID fields.
- Both input features and near features can be point, multipoint, line, or polygon.
- If no value for Search Radius is specified, a radius is used large enough so that all near features can be incorporated in the distance calculation. If the default search radius is used (no radius is specified) the output table can be quite large. For example, calculating distances from 1,000 points in one feature class to 1,000 points in another feature class can produce an output table containing 1 million records. Use the search radius to limit the number of output records.
- Both Input Features and Near Features can be the same dataset. In that case, when the input and near features are the same record, that result will be skipped so as not to report that each feature is 0 units from itself.

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Buffer analysis

- Buffering usually creates two areas: one area that is within a specified distance to selected real world features and the other area that is beyond. Buffer zone is the area that is within the specified distance. A buffer zone is that area that serves the purpose of keeping the real world features distant from one another.

- In a GIS application, buffer zones are always represented as vector polygons enclosing other polygon, line or point features

- The buffer tool creates buffer polygons to a specified distance around the input features. The buffer routine traverses each of the input feature's vertices, and creates buffer "offsets", then from those offsets creates the buffer features. The parameters on the buffer tool control many aspects of the offsetting process, as well as how the resulting buffer features are assembled.

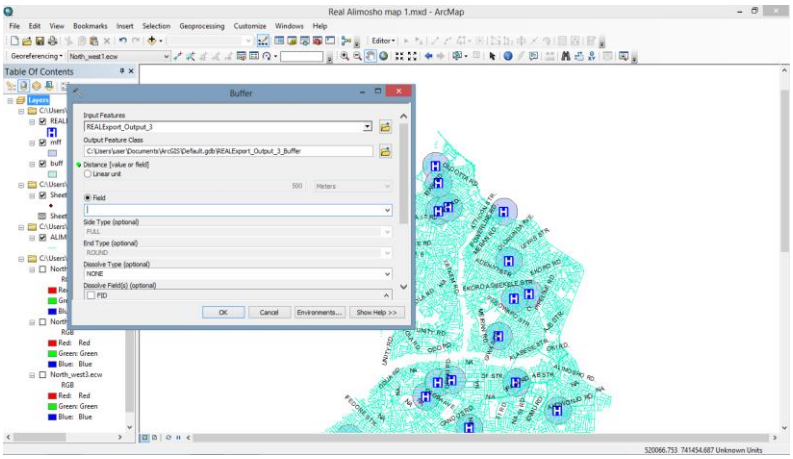

Figure 3.4: The buffer analysis dialog box

The Average Nearest Neighbour Index

The average nearest neighbour tool on ArcGIS calculates a nearest neighbour index based on the average distance from each hospital to its nearest neighbouring hospital. It then averages all these nearest neighbour distances. If the average distance is less than the average for a hypothetical random distribution, the distribution of the features being analysed are considered clustered. If the average distance is greater than a hypothetical random distribution, the features are considered dispersed. The equations used to calculate the Average Nearest Neighbour Index are based on the assumption that the points being measured are free to locate anywhere within the study area (for example, there are no barriers, and all cases or features are located independently of one another).

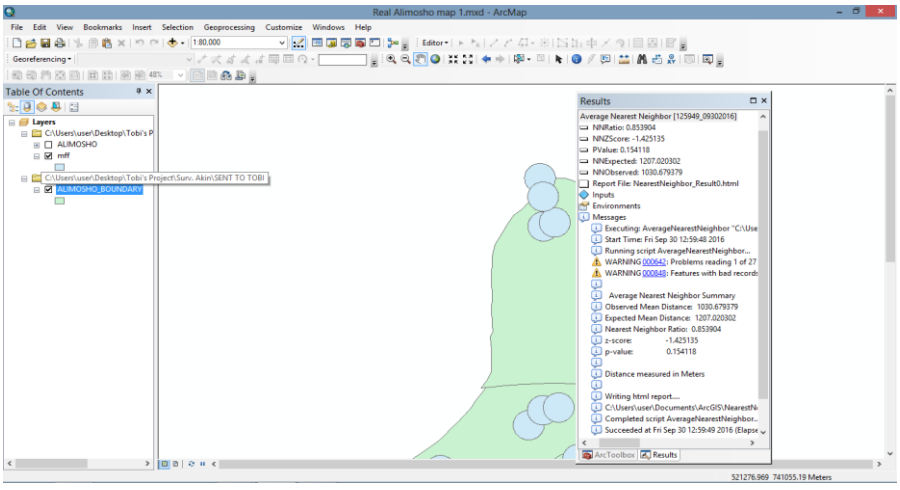

Fig 3.5: Average nearest neighbour analysis dialog box

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Creation of hyperlinks

Two ways of defining hyperlinks are by the use of field-based hyperlinks or by defining dynamic hyperlinks. With field-based hyperlinks, the target document or URL that will be launched is specified for each feature in a field in the layer's attribute table. Unlike field-based hyperlinks, with dynamic hyperlinks we do not use an attribute field to supply the hyperlink targets. The names of targets specified are stored in the map or in a .lyr file and are not tied to the underlying database. For the purpose of this work, dynamic hyperlinks are used to link the pictures of these health facilities. Once this is done, the hyperlink has been established and can then be validated.

This was done by first assigning the datasets their true projection (GCS WGS84) on Arc Catalog. Then the data frame on ArcMap was set to a projected system (WGS84 UTM Zone 31N). The datasets were then exported using the coordinate reference information of the data frame. As such, the transformation to a projected space was successful.

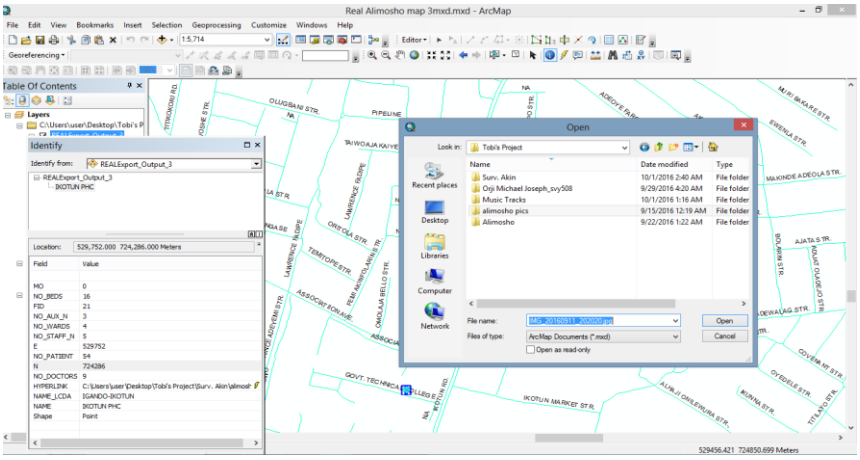

Figure 3.6: Setting hyperlinks to the document (pictures)

The analysis performed here involved comparing and determining the various ratio which include ratio of number of patients (average per week) to number of doctors, number of patients to number of staff nurse, ratio of number of patients to wards, ratio of number of patients to nurses(auxiliary), amongst others.

Directional distribution (standard deviational ellipse) spatial statistics

This measures whether a distribution of features exhibits a directional trend (whether features are farther from a specified point in one direction than in another direction).

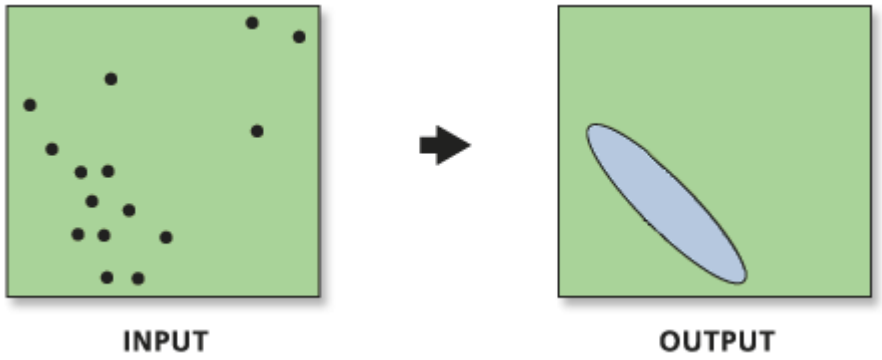

Fig 3.7: Figure showing the directional distribution

Usage tip: this tool honours the environment output coordinate system. Feature geometry is projected to the output coordinate system prior to analysis. All mathematical computations are based on the output coordinate system spatial reference.

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If the underlying spatial pattern of the features is concentrated in the center with fewer features toward periphery (spatial normal distribution), a one standard deviation ellipse polygon will cover approximately 68 percent of the features; a two standard deviation ellipse will contain approximately 95 percent of the features; and three standard deviations will cover approximately 99 percent of the features in the cluster.

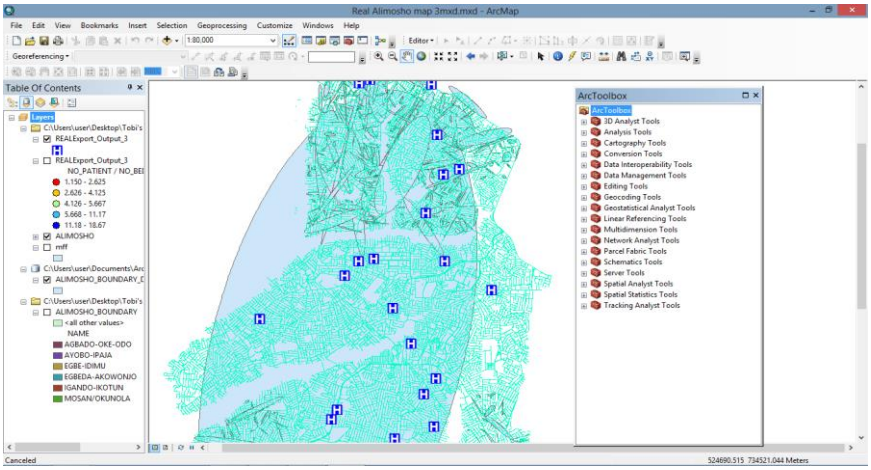

Fig 3.8: Image showing directional ellipse

Tools or other procedures that create shape files from non-shape file inputs may store or interpret null values as zero. This can lead to unexpected results. Current map layers may be used to define the input feature class. When using layers, only the currently selected features are included in the analysis.

Statistical Analysis

This involves creating different graphs and charts; such as pie charts, bar graphs representing different variables and showing their relationship such as ratio of patients to doctors, ratio of patients to beds, ratio of patients to medical staffs, doctors, etc of each health facility.

Map Production

Various customized maps will be generated after some of the analysis would have been done. Such maps include those depicting patient to doctor ratio, number of patients to beds, ratio of staff nurses to patients, etc.

RESULTS AND ANALYSIS

The objectives of this study form the basis of all the analysis carried out in this chapter

Spatial distribution of the health facilities (public)

Firstly, the coordinate data was recorded in a geographic coordinate system: (X) and (Y). The positions of the hospitals were overlaid on a base map of the area on ArcGIS using the 'Add XY Data' tool. To add a table of X, Y coordinates to the map, the table must contain two fields, one for the x-coordinate and one for the y-coordinate. In order for the points to be displayed, numeric fields were used on Microsoft Excel for entering the coordinate values. A well annotated and symbolised map was created on Arc Map to show the geographical distribution of these points.

At the start of this exercise, about 100 health facilities in Alimosho LGA were considered. Of this number, we were able to map the public health facilities which consisted of about 25 primary health centres and a secondary health centre.

This was so as the focus of the project was shifted to mainly public health facilities owing to unreliable and inaccurate data of private health facilities. A well-prepared questionnaire was distributed to select hospitals to retrieve information for input into the database.

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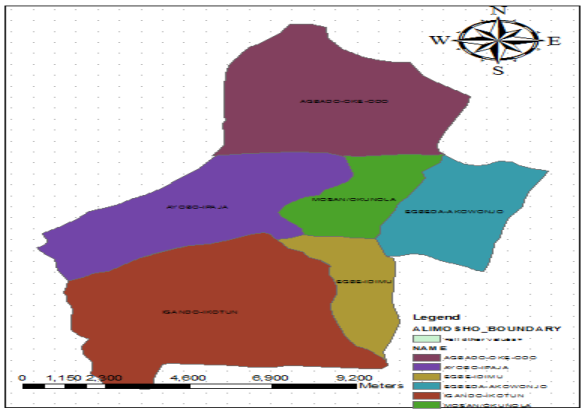

Fig 4.1: Digitized Map of Alimosho LGA

Basically, there are 26 public health centres in Alimosho. It is well shown in the table below:

Table 4.1: Shows the total number of health centres (both primary and secondary health centres in each Local Council Development Area

S/No	LCDAs	No of Health facilities	Total(%)
1.	Agbado-Oke-Odo	9	34.62%
2.	Igando-Ikotun	4	15.38%
3.	Egbe-Idimu	5	19.23%
4.	Egbeda-Akowonjo	1	3.85%
5.	Ayobo-Ipaja	5	19.23%
6	Mosan/Okunola	2	7.69%
Total		26	100

Statistical Analysis

Looking at the questionnaire, results show that most respondents (patients) were not satisfied with the facilities, number and quality of personnel as there were several responses in the negative concerning the condition of the various facilities such as number of beds, wards, ambulance, etc.

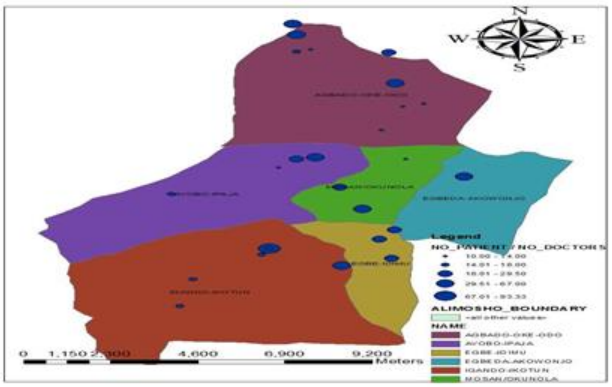

Fig 4.2: Map shewing the ratio of doctors to patients across all the Primary Health Centres

From the map, it can be observed that most of the health centres have a patient to doctor ratio hovering around 29-67 patients to 1 doctor. This of course is very poor and makes access to quality and prompt health care for the people very difficult.

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This has shown that Agbado Okeodo has more health centres with a patient to doctor ratio lying in between 10-14 patients per day which is still above the recommended standard of 1: 1600 per year.

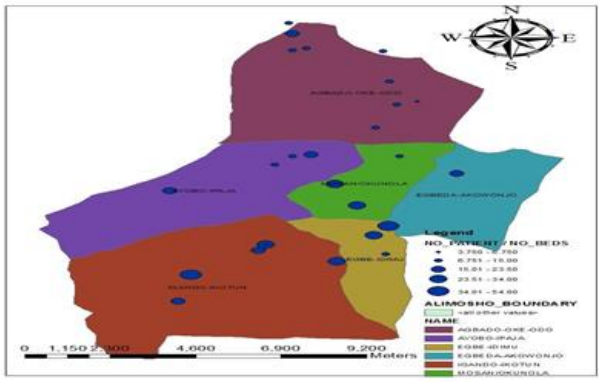

Fig 4.3: Map shewing ratio of beds to number of patients across PHC's

This has shown that most health centres have a higher number of patients to beds available. This is so as the minimum ratio above of 1;4 or 6patients is not acceptable by standards.

The map in figure 4.3 above shows that Baruwa PHC and Isefun PHC have the highest ratio of beds to patients while Ipaja and Isheri PHC's have the lowest. This implies that there are not enough beds to cater for the average number of patients usually recorded in such health centres.

Also, most of the staff especially the medical staff complained of poor working conditions, poor remuneration, inadequate and obsolete equipment. It can be inferred from the map in figure 4.2 that in Agbado Okeodo, there are 9 public health centres with an average of 1 doctor to 10 to 14 patients (being the lowest ratio) daily which gives a poor ratio going by the WHO standards of 1:1600 yearly.

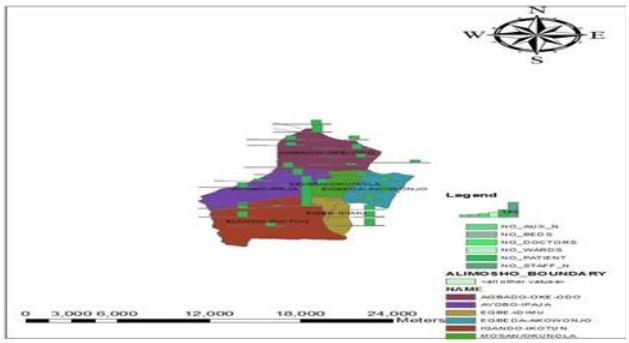

Fig 4.4: Map shewing the ratio of patients to all facilities and staffs across all the PHC's

For the general hospital, it should provide simple surgical services, supported by beds and bedding for minimum of 30 patients. But this is not the case as the ratio for Alimosho general hospital is lower than this standard.

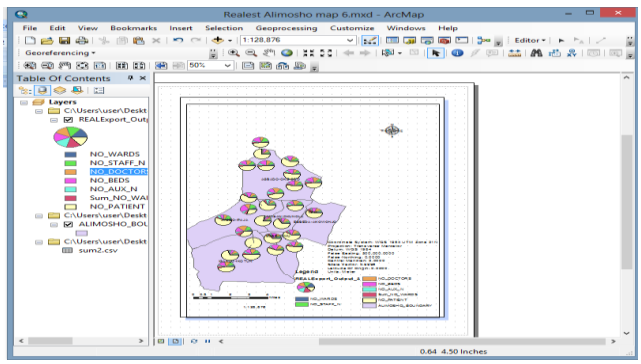

Fig 4.5: Map shewing the ratio of patients to all facilities and staffs across all the PHC's

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The Figure 4.4 and Fig 4.5 above shows the pie chart of centres with the ratio of their facilities and personnel in each health centre to their patients, namely:

- Number of wards represented with dark blue bar
- Number of doctors represented with the orange bar
- Number of staff nurses with the green bar and
- Auxiliary Nurses with the light blue bar
- Number of beds represented with the purple bar

Results of Spatial Analysis

Spatial queries

A query for instance is how many hospitals are within 50 metres of an interconnecting route,

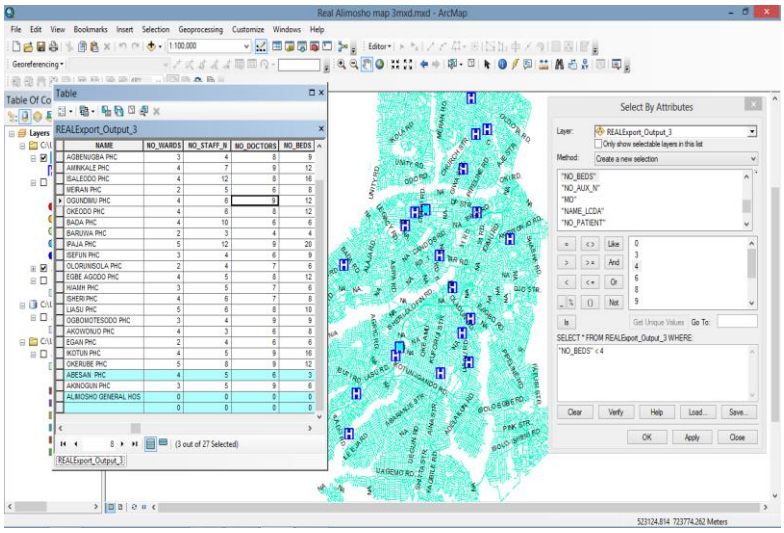

Fig4.6: A query showing health centres having less than 4 beds

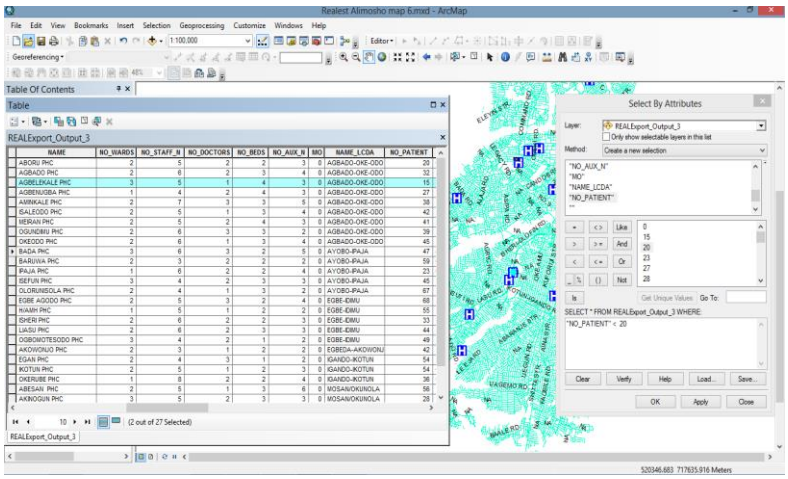

Fig 4.7: Query showing health centre having less than 20 patients

Spatial Analysis by Feature Identification

The identify tool was picked from the tool bar in the ArcGIS 10.2 environment and a hospital was clicked. With this, the information window showing the information of that record was displayed.

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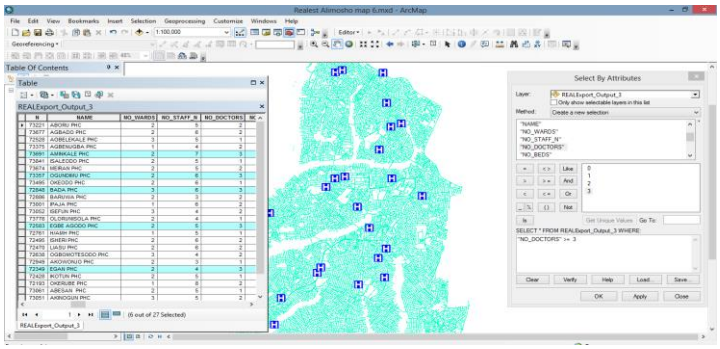

Fig 4.8: A spatial query showing health centres having 3 or more doctors

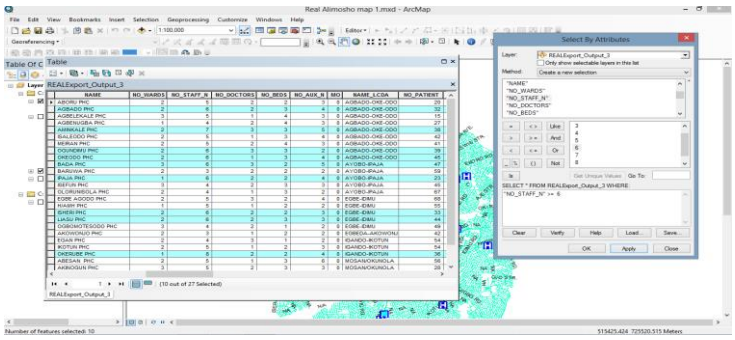

Fig 4.9: A spatial query showing health centres having 6 or more staff nurses

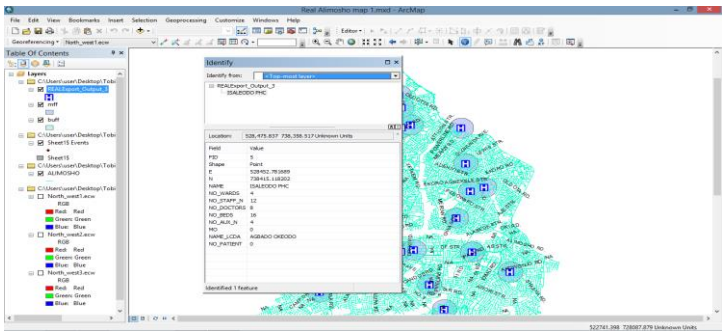

Figure 4.10: Feature identification of Isale Odo PHC showing all its attributes

Proximity Analysis

A 500m buffer around each hospital was created (figure 4.1). From this, we can see that there are still so many underserved areas with little or no hospitals. We also observe a concentration of hospitals in some LCDA's such as Agbado Okeodo.

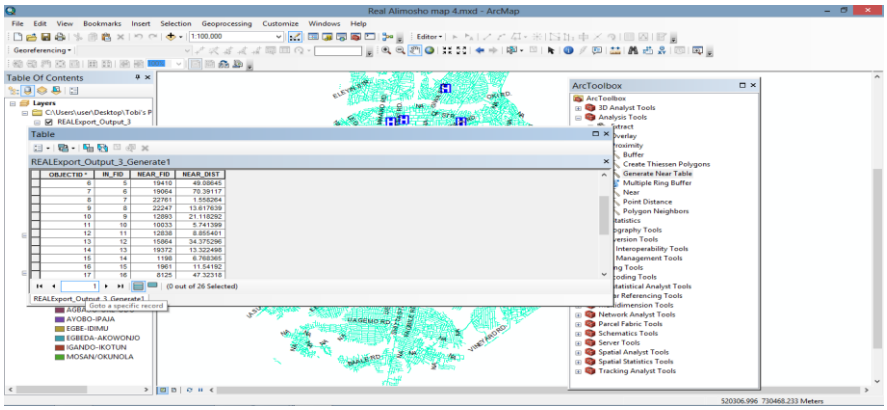

Fig 4.11 Image showing the Generate table between the hospitals in the Local government

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Buffering Analysis: The outcome of the analysis is shown below;

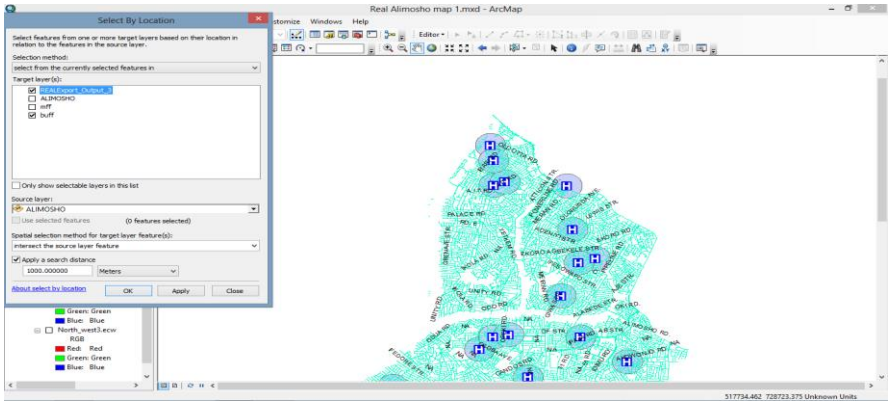

Figure 4.12: Figure showing the buffer zones of 500 metre buffer around each hospital

From the figure above which shows a 500m buffer around each hospital, we can see that there are still so many underserved areas with little or no hospitals. We also observe a concentration of hospitals in the commercial nerve

Multiple Ring Buffer Analysis

It was noticed that the hospitals are not evenly distributed over the area. As the multiple ring buffer analysis shows, some areas are well served by these hospitals while others are not. Patients outside of these buffer zones would spend longer time in transit. Also, it is noticed that some hospitals have overlapping buffer regions. This means that individuals within these zones are well served because they have a multitude of choices from which to pick from. The hospitals are highly clustered in some areas leaving other areas with little or no presence.

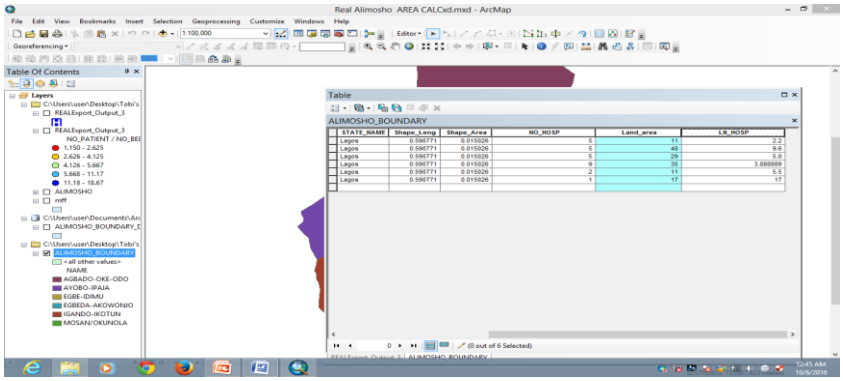

Fig4.13: Image showing land area of each LCDA and hospital density

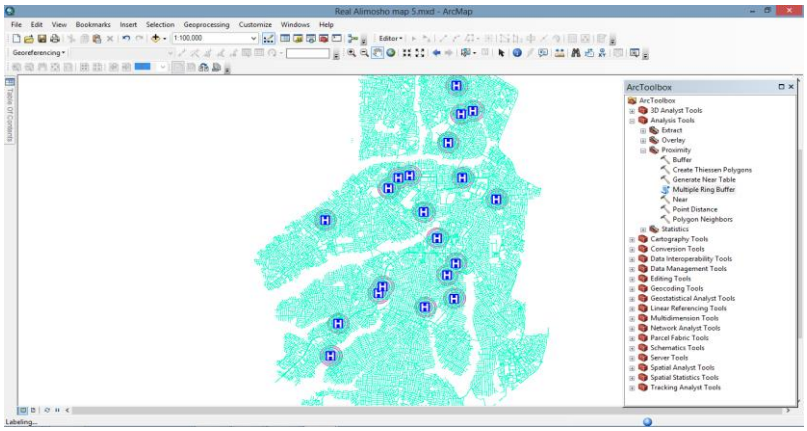

Fig 4.14: Image showing a 100m, 200m, 300m, 400m, 500m ring buffers around each health facility.

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The figure above shows the various areas within certain radii of each health centre such as 100m, 200m, 300m, 400m and 500m. This helps in determining the number of streets and households within such radii that each centre would serve.

Some centres have overlapping buffer ring; this implies that households around such areas would have choices on which health facilities to visit and ultimately have slightly better access to health care than some other areas.

Hyper linking

Validating the hyperlink involves setting the hyperlink properties on the 'Display' tab of the feature class (shape file) properties dialog box. Once this is done, the hyperlink tool is selected and used to click the feature. The hyperlink operation was important because it lets us access documents (pictures) related to the sample points within the ArcGIS environment. Also, with it we are able to provide additional information about the sample points to other people who will be using the maps with ArcMap.

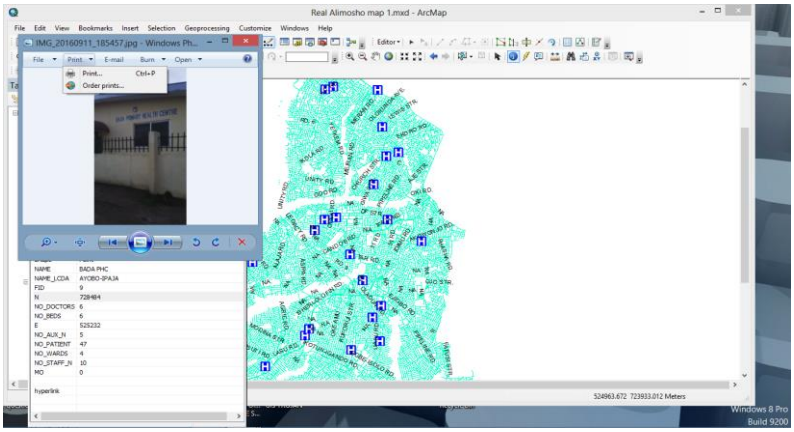

Figure 4.15: Validating the picture hyperlink to Bada Primary Health Centre

More importantly, the hyperlinks enable us create a link between our files in ArcGIS and external files such as pictures of the health facilities. This will enable other people working with our map to be able to view more information.

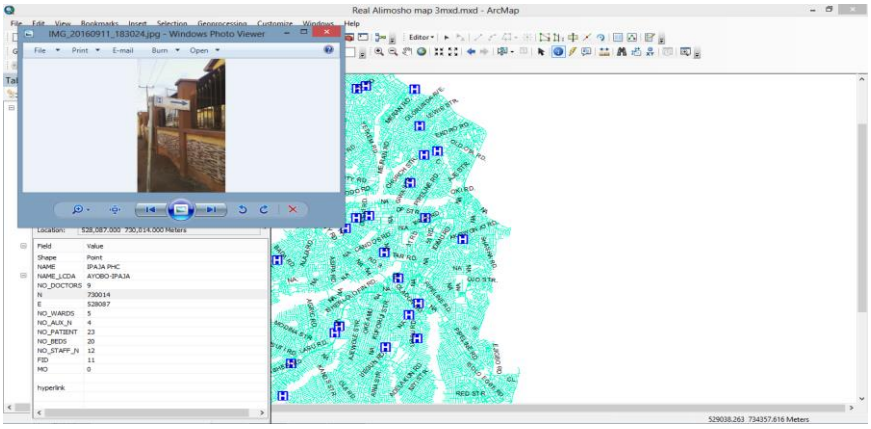

Figure 4.16: Hyperlink of the sample point location at Ipaja Health Centres

Directional distribution (standard deviational ellipse) spatial statistics

The above spatial statistics performed on the data allows you to see if the distribution of features is elongated and hence has a particular orientation.

While you can get a sense of the orientation by drawing the features on a map, calculating the standard deviational ellipse makes the trend clear. You can calculate the standard deviational ellipse using either the

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locations of the features or the locations influenced by an attribute value associated with the features. The latter is termed a weighted standard deviational ellipse.

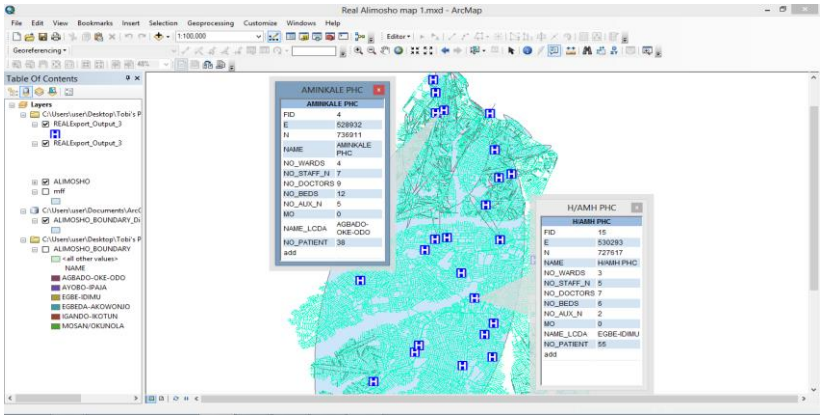

Fig 4.17 Image showing the directional ellipse with the HTML pop up of Aminkale PHC and H/AMH PHC

Central Feature

It identifies the most centrally located feature in a point, line, or polygon feature class.

- The feature associated with the smallest accumulated distance to all other features in the dataset is the most centrally located feature; this feature is selected and copied to a newly created Output Feature Class.
- Accumulated distances are measured using EUCLIDEAN_DISTANCE or MANHATTAN_DISTANCE, as specified by the Distance Method parameter.
- Calculations based on either Euclidean or Manhattan distance require projected data to accurately measure distances.
- For line and polygon features, feature centroids are used in distance computations. For multipoint, polylines, or polygons with multiple parts, the centroid is computed using the weighted mean centre of all feature parts. The weighting for point features is 1, for line features is length, and for polygon features is area.
- Map layers can be used to define the Input Feature Class. When using a layer with a selection, only the selected features are included in the analysis.

DISCUSSION

The analysis carried out was based on the objectives of the study. They were implemented successfully. Firstly, the coordinates of the hospitals were acquired from field and displayed on a map of the study area. As a result, it was possible to visually see their spatial distribution over the area. Also, to analyse this spatial distribution further, a nearest neighbour test was run. The results of the test showed a high level of uneven concentration of the hospitals within the business district of study area. The creation of different maps and database helped to show the various analyses distinctly.

SUMMARY, RECOMMENDATIONS, CONCLUSIONS

Recommendation

The population of the local government is increasing due to the rural-urban migration that has been on the increase in recent years. Therefore, existing facilities are not sufficient and won't go round for all, and the necessity of establishing others is essential. Although, proximity of some of the existing facilities to the users

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and access to road has satisfied the criteria of WHO (World Health Organisation) to a certain extent, population has not. The WHO (1997) set out a criterion for citing health facilities based on population. An area with a population of 500 people should have access to at least 1 health centre with the main equipment. Although there are 25 public facilities which unfortunately are not equipped fully to the standard required, population-wise the L.G.A is still below average. Considering this huge population, we suggest additional facilities be made.

However, our proposition here has considered areas with higher population that has grown dramatically not only during the 1993-2006 periods but after 2006.

Beyond the successful output of the various analysis implementations, it is important that such analyses are incorporated in the planning of public health infrastructure. Support of administrators and the government is more than essential. It is important that GIS is incorporated in site analysis before citing of hospitals.

- More doctors, nurses and other medical staffs should be employed.
- More beds, equipments and facilities should be provided.

Conclusion

The ability to visually assess the locations of objects on the Earth's surface, rather than trying to interpret numbers on spreadsheets, is a key element leading to the use of a GIS. By integrating GIS into their work, health administrators stand the chance of digitalizing their operations and logistics control to levels never before imagined.

Based on the project, it is imperative that more health facilities should be built and equipped in each Local Council Development Area especially in areas with very low hospital per land area figures.

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APPENDIX I

Pictures from Site

Fig A: Ogbomotesodo Phc

Fig B: Baruwa Primary Health Centre

Fig C: Ipaja Primary Health Centre

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Fig D: Bada Prrimary Health Centre

APPENDIX II

QUESTIONNAIRE

Department of Surveying and Geoinformatics,

Faculty of Engineering,

University of Lagos,

Akoka – Lagos.

15th of August, 2016.

Dear Sir/Ma,

Geospatial Assessment of Health Care Facilities (A Case Study of Alimosho…..L.G.A.)

We are undergraduate students of the above named department and university**,** carrying out a research on "A Geospatial Assessment of Health Care Facilities (A Case Study of Alimosho…. L.G.A)".

There is no right or wrong answer, please be frank as possible.

This is entirely for an academic purpose and all information given would be treated with strict confidence.

Thanks for your Co-operation in anticipation

Leigh Olaoluwa David and Mebude Oluwatobiloba Questionnaire For Patients

Instruction: Please indicate by ticking the appropriate option from the list following each question below:

Section A

Biographic Data

1	Sex	Male	Female			
2	Age range	15-20	21-30	31-40	41-50	51-60

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3	Academic qualification	Primary school certificate	SSCE	OND/NCE	Others	
4	Marital Status	Single	Married	Divorced	Widowed	Separated
5	Position	Doctor	Nurse	Pharmacist	Physician	Patient

Section B

Instruction: Please indicate by ticking the extent to which you agree or disagree with the question below:

Note: 1 Strongly Agree, 2 Agree, 3 Undecided, 4 Disagree, 5 Strongly Disagree

SN	QUESTION	ANSWERSS
1	The health care facilities are insufficient compared to the population in the LCDA	
2	The physicians are not enough compared to the population of patients.	
3	There is need for urgent improvements in Alimosho health care delivery System.	
4	There is need for the construction of new facilities.	
5	There is need for the upgrade of the existing facilities	
6	There should be increase in the number of physicians employed.	
7	Do you think there is no proper distribution of health care facilities within the LCDA	
8	Have you heard of Geospatial information system before?	
9	A proper adoption of the Geospatial Information System will help in Proper distribution of the health care facilities within the Alimosho L.G.A	
10	Adoption of the Geospatial Information System will make for effective Planning and resource allocation	

Questionnaire for the Hospital Staffs

1	How many wards are in your hospital	
2	How many doctors are in your hospital	
3	How many nurses are in your hospital	
4	How many beds are in your hospital	
5	Chief medical officers/doctors	
6	How many Auxillary Nurses are in the hospital	
7	How many Health assistants	
8	How many Pharmacy technician	
9	How many Optometrist	
10	Bed spaces	