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Research Article

Distribution of Primary Health Care Facilities in Kano Metropolis Using GIS (Geographic Information System)

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Abstract: This research examined the relevant of Geographical Information System (GIS) supporting Health planners on a micro-scale. In order to establish the usefulness of these functions, 6 core LGA`s of Kano Metropolis were selected. To accomplish the research objectives which were to create a database that could be used to analyze the type and spatial distribution of public primary health care facilities in the area? Data were obtained from primary and secondary sources; GPS was used to collect the coordinates of each healthcare facility and about 69 primary health facilities were discovered, the records from Kano State ministry of health. The map of the study area was geo referenced. The analysis was carried out with Arc View GIS 3.2a for GIS analysis and also the result shows that most of the healthcare facilities were clustered within Kano Municipal, Nassarawa, Tarauni and some part of Fagge LGAs. The underserved areas were like RijiyanZaki, BakinBulo, Danbare, other areas include Yan Raki.

Keywords: GIS, Kano metropolis, overlay analysis, primary healthcare facilities, planning

INTRODUCTION

Health care planning and GIS are two relevant fields that depend upon spatial data. Location of health facilities, patient distribution and characteristics are example of spatial data that are dealt with during local health planning. Part of Kano metropolis was selected as a case study to show how GIS can help local health planners and support their decisions. GIS and Health care facility is the geographical study in medicine, maps the progress of diseases, famines, toxic spills and disasters.

Access to health care is an important component of an overall health system which has a direct impact on the burden of diseases that affect many countries in the developing world. Measuring accessibility to health care therefore countries to a wider understanding of the performance of health systems within and between countries which facilitates the development of evidence based health policies. The creation of health care facility database and mapping which help in showing the spatial distribution and information about location and their physical relations to each other however GIS is an integration of computer hardware, software and geographically referenced data. The purpose of using GIS in health care facility is that maps provide an added dimension to data analysis, which helps in visualizing the complex patterns and relationships. Relationships among neighboring areas are explicit in a map which allows for the visualization of spatial patterns.

The use of Geographical Information System (GIS) for the measurement of physical accessibility is well established and has been applied in many areas including retail site analysis, transport, emergency services and health care planning (Wilkinson, 1999; Albert *et al*., 2000; Cromley and McLafferty, 2002).
In the context of health care planning ability of GIS to identify the geographical extend of health facility catchment area, which correspond to the area which contain the population utilizing this facility, is a particularly important analytical capability.

An associations between disease and social or environmental variables, predicting the spatial spread of a disease or efficient deployment of health care resources, the ability of GIS is hampered by the availability of clean data at fine Health care planning and GIS are two relevant fields that depend upon spatial data. Location of health facilities, patient distribution and characteristics are of spatial data that are dealt with during local health care planning such task cam be made during different GIS functions and models (Abubakar *et al*., 2008).

Public health and healthcare are important concern for developing countries and access to healthcare is a significant factor that contributes to a healthy population. GIS offers organizational and analysis tools that expand the effectiveness of your agency's response to growing demands and limited budgets. GIS plays an essential role in helping public health organizations understanding population health and make decisions with the powerful tools and situation that GIS

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technology brings to the desktop, your organization can improve understanding of community health need and design effective interventions. Since 1993, WHOs public health mapping and GIS programme has been leading a global partnership in the promotion and implementation of GIS to support decision making for a wide range of infection diseases and public health programme (WHO, 2000)

However, GIS and Remote sensing have capabilities that are ideally suited for use in infectious disease surveillance and control, particularly for the many vector borne neglected disease that are often found in poor populations in remote rural areas. They are also highly relevant to meet the demand of out break investigation and response, where prompt location of cases, rapid communication of information and quick mapping of the epidemics dynamics are vital. Until recently, the use of these tools in public health were largely limited in use due to major problems the prohibitive cost of hardware and the great complexity of GIS software that made it extremely time consuming as well as costly to extract information relevant to the practical demand of disease prevention and control.

STATEMENT OF THE RESEARCH PROBLEM

Urbanization in these third world counters bring to its wake many advantage and disadvantages. the disadvantages usually has to do with difficulties in controlling urban growth and making available resource to meet the increase needs and demands for essential public services like education, housing and most especially health (Adamu, 2001)

There are numbers of primary centers in Kano Metropolis area but it has not been established whether this primary health centers and facilities are adequate and equally distributed. This form the basis of this project i.e. to establish whether these centers /facilities are adequate and equally distributed within Kano metropolis.

Aim and objectives:

Aim: The aim of this research is to evaluate the spatial distribution of Primary health centers using GIS.

Objectives: To create a database and analyze the type, location and spatial distribution of public primary health care facilities in the study area.

GIS and health care planning: The area of GIS has risen to prominence in the past 5-10 years with the recognition that health surveillance practices and health service allocation need to become more sensitive to the needs in local geographic areas (Gatrell and Loytonen, 1998).

The collection, storage and manipulation of geographic information have undergone a revolution in recent years with the development and wide spread availability of GIS software's. Today, many health care planners and official can benefit from education and training in the GIS field and this will give them the chance of influencing the progress of health surveillance, environmental health assessment and the geographic allocation of health resources. The rapid adoption of health care planning is actually a result of the following issues.

- The increasing availability of geo-coded health data that lead to having health information system
- The availability of digital geographic data micro and / or micro scale that has several GIS coverage with enormous attribute data such as addresses and land use, ownership etc
- The availability of spatial analysis tools, as separate software modules or embedded is GIS

All of the above issues have encouraged many heath organizations to use GIS and to benefit from its tools and functions. For example, the Center for Disease Control (CDC), the US world's premier disease tracking organization, has use GIS for at least a decade to study how disease spreads from place to place to study how toxic substances affect people's health (ESRI, 2000).

GIS has continued to be used in public health for epidemiological studies (Andes and Davis, 1995; Brigss and Elliot, 1995; Brown, 1991). By tracking the source of diseases and the movement of contagious, agencies can response more effectively to out breaks of disease by identifying at risk populations and targeting intervention (Collins *et al*., 1995)

Public health uses of GIS including track immunizations, conducting heath policy research and establishing service area and districts (Jones and Bentham, 1995). Today, many heath authorities have adopted information system that should contain the following elements:

- Perceived health problems with incidence rates
- Environmental, socio-economic and other risk factors, which influence health, underserviced, poor inaccessible areas and other geographic and demographic factors.
- Population sub group with specific health problems, health need and demand
- Heath services directed at health problems or risk factor for all or part of the population
- Health care input, e.g., staff, funds, capital resources medicine and equipment used etc.
- Health care output, e.g., number of client contacts, proportion of population reached for particular programmes and proportion of target population reached.

- Health care outcome, e.g., change in health status as a result of intervention of health care programme (Birkin *et al*., 2008)

This element together from what is known as HIPS (Health information and Planning System). A growing number of GIS studies as well as review articles indicate that GIS is a powerful tool for monitoring public health in various geographical locations. In the field of malaria control, GIS was mainly used for describing malaria risk, often limited to hospital-based morbidity and mortality (Yoshihisa *et al*., 2009).

In order to properly plan, manage and monitor any public health programme, it is vital that up-to-date, relevant information is available to decision-makers at all levels of the public health system. As every disease problem or health event requires a different response and policy decision, information must be available that reflects a realistic assessment of the situation at local, national and global levels. This must be done with best available data and taking into consideration disease transmission dynamics, demographics, availability of and accessibility to existing health and social services as well as other geographic and environmental features (WHO, 2002). Since 1989, the WHO Division of control of Diseases in Africa in Geneva has been interested in the application of GIS (Yoon, 1994). Frank (2006) developed a GIS quantitative methodology to optimally site new primary health care facilities so as achieve the maximum population level increase in accessibility health care he applied it in the rural community characteristics by considerable heterogeneity in population distribution and health care access.

Geographic Information Systems (GIS) provide ideal platforms for the convergence of disease-specific information and their analyses in relation to population settlements, surrounding social and health services and the natural environment. They are highly suitable for analyzing epidemiological data, revealing trends and interrelationships that would be more difficult to discover in tabular format. Moreover GIS allows policy makers to easily visualize problems in relation to existing health and social services and the natural environment and so more effectively target resources. Since 1993, WHO's Public Health Mapping and GIS programme has been leading a global partnership in the pro motion and implementation of GIS to support

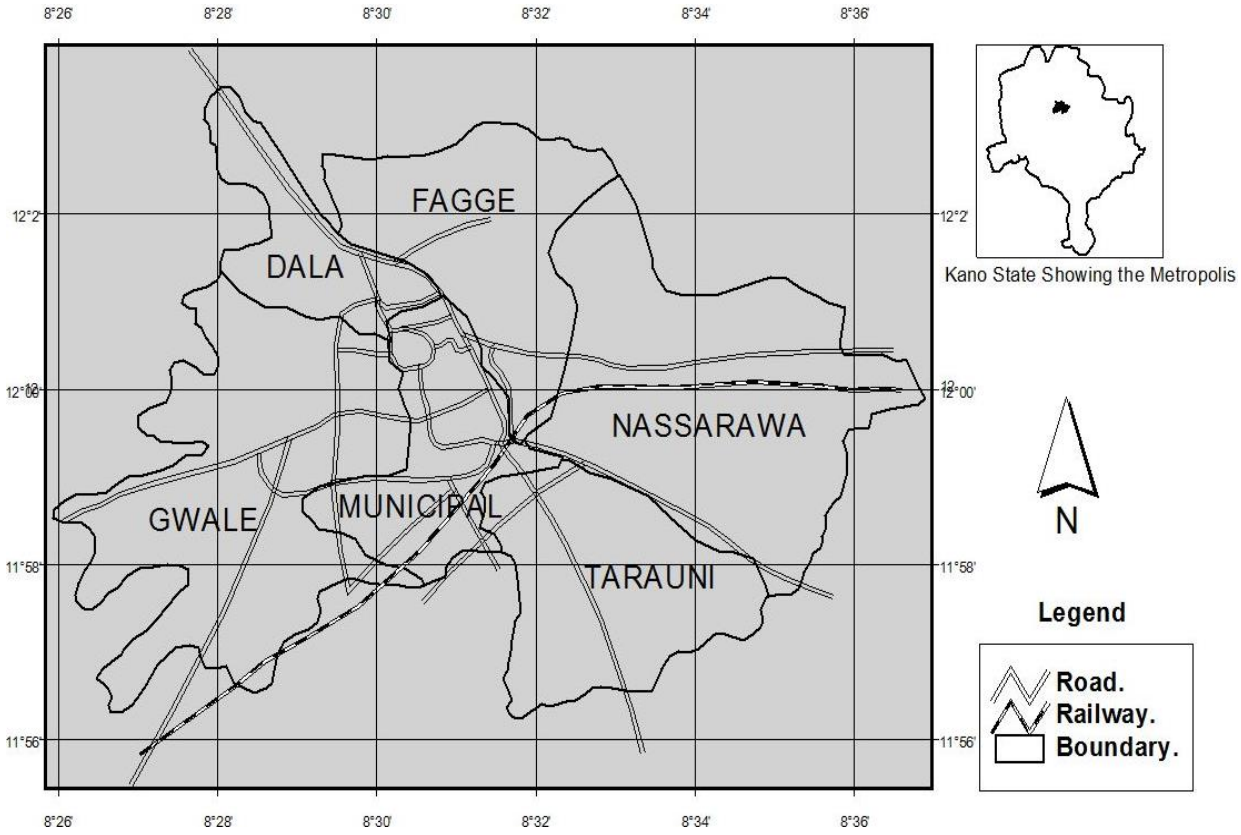

Fig. 1: Showing kano metro polis (6 core LGAs)

decision-making for a wide range of infectious disease and public health programmes. The utility of GIS for health research hinges critically on data quality. Whether helping in detection of disease spatial resolutions (Oppong, 2007).

Public health uses of GIS include tracking child immunizations, conducting health policy research and establishing service areas (Jones and Bentham, 1995). Managing experience of the decision makers in public Nowadays, health and health care are considered as models are required to help them to decide regarding any an important factor in the quality of life of individuals.

In 2002 in Ayuthaya, Thailand, GIS was used for examining effects of different factors on public health, showing disease distribution, performing specific analyses, visualization and providing of information on health care and also helping in different decision making. Data used in this study include: population data, data concerning infectious diseases and their occurrence locations. In this study, dependence of spreading disease on time was studied using statistical regression analyses. One of the advantages of this study is the simultaneous use of spatial and statistical analysis which provides powerful tool for decision making process. Among all examined diseases, pneumonia had a direct relation with time and highest dependence coefficient (94 %) and its distribution in crowded areas was high.

Study area: Metropolitan Kano encompasses all the eight local governments of Dala, Fagge, Gwale, Municipal, Nassarawa, Tarauni, part of Kumbotso and Ungogo. Figure 1 this is in addition to part of local governments which was integrated in to local metropolis for planning purposes. It lies from Latitudes 11^0 52'N to 12^0 7'N and Longitudes 8^0 22.5`E to 8^0 47'E and is 1549ft. above sea level. Kano metropolis is bounded by Minjibir LGA on the North East and Gezawa LG. to the East. While Dawakin Kudu LG. to the South East, Madodi and Tofa LGA's to the South West and lastly Dawakintofa LG. to the North West. (Ahmed, 2010)

The climate of Kano is typical dry and wet climate. Annual rainfall is about 850 – 870mm. The temprature is averagely warm to hot through out the year at about 27^0C (Olofin and Tanko, 2002).

Today metropolitan Kano made up of the declared urban area in accordance with the Land Use Act is contained within 60sq km. While the built up metropolitan Kano is contained within 48sq km. (Marafa, 1992).

Population: Kano metropolis is today one of the fastest growing cities in Nigeria and the largest in the whole of the Northern part of the country. In1931, the population of Kano metropolis was 96,805 persons. This figure rose to 130,170 persons in 1952 and by 1963, it was 295,432 (Maiwada, 2000). According to the 1991 population census, Kano state had a figure of 5,810,340 people, out of which Kano metropolis accounted for 1,432,255 representing 24.3% of total population of the state (Bala, 2000). But according to 2006 census, Kano state was 9,383,683 while that of Kano metropolis was 2,165,223 (Census, 2006).

METHODOLOGY

Secondary data: Map of Kano metropolitan was extracted from topographic map of Kano state produced by Cartography unit Bayero University Kano (BUK) at a Scale of 1:250,000 traced and scanned. Information from the Ministry of Health (Kano State) about the address, location**,** Ward, name and types of healthcare facilities was collected. Population data was obtained from the National Population Commission of all the study area, Kano State. Journals about information pertaining literatures of GIS and Health, text books for GIS and health, thesis of the related topics and other relevant information from the Internet were used.

Primary data: Data were gathered through Ground – Truthing Observations (GTOs) in the field. The research method employed in mapping HCFs consisted of pre-field –work: Collection of the coordinates of the Primary Health Care Centers using Global Position System (Germin 76 model GPS) Hand-held type and post field-work. The scanned map was first geo - referenced, then, on screen digitized and computer image processing applied, using vector graphic techniques afforded by ArcView GIS 3.2a release.

Image georeferencing: The scanned map was georeferenced with the aid of the points selected (Junctions) on the map (Kabuga junction, FCE junction, Gyadigyadi round about, Court road junction, BUK road junction, SabonGari Market junction and Kofar Dan Agundi junction, these places were visited to confirm their location and positions using GPS. Some slight modifications were however made on the tie (coordinates) to ensure a good match with the ties on the existing map. This was done with view to minimizing error during digital projection and transformations. Image 'on-screen' digitizing was performed through ArcView GIS version 3.2a windows operating environment. The map was 'on-screen' digitized under the following three main themes the Road networks (lines), the Boundaries of the sixlocal governments (Polygons) and the Health Centers (Points)

OVERLAY ANALYSIS USING THE ATTRIBUTE DATA

Three major different features classes were mainly point, polygon and lines. The point is the health care facilities; their attribute data were initially typed in Microsoft Excel format and transformed into text (ms Dos). The database included HCFs name, location address, type of health facilities, wards

Distributions of health care facilities: Types of primary healthcare in Kano metropolis:

Dispensary and health post: Is the type of health institution where minor treatments are giving to patients. Its establishment is to provide easy access to resident of a particular community or neighborhood and they should therefore, be located within residential area. A population of 15,000 – 20,000 in any community should be serve by dispensary health post, so that minor cases of treatment which do not require the attention of a specialist medical personal could be immediately attended to, are this type of institution provided out patient.

Maternal and child health centers: Here the type of health institution which provide service in gynecology, family planning and nutrition. In order, maternity clinic or home is provided to serve an area of 20, 000 – 30, 000 people.

Health clinic and comprehensive health centers: Is the type of institution, which provide in – patient and concern with the treatment of disease that are very common cases like fever, Malaria, Ulcer and antenatal care service. In this institution patient are usually admitted.

Table 1: Distributions of health care facilities in six core L.G.A. of Kano metropolis field work (2009)

S/N	L. G. A.	Name of health facilities	Location (place)	Type of facilities	Ward	Latitude	Longitute
1	Fagge	Danrimi Dispensary	Rijiyar lemo	Dispensary	Kwachiri	12.03436	8.489817
2	Fagge	Galadima Health clinic	Fagge	Health clinic	Fagge B	12.00102	8.52865
3	Fagge	Jaba dispensary	Kwanar jaba	Dispensary	Kwachiri	12.03436	8.545072
4	Fagge	Kwachi clinic	Kwachi	Health Clinic	Kwachiri	12.01987	8.524487
5	Fagge	Middle Road Maternal and Child Health	Sabon Gari	Maternaland child health	Sabon Gari	12.01769	8.537519
6	Fagge	Rijiyar lemo health clinic	Rijiyar Lemo	Health clinic	Kwachiri	12.01769	8.491453
7	Fagge	Sabo garba maternal health care clinic	Fagge	Maternal and child health	Fagge A	12.00102	8.531458
8	Fagge	Tudun bojuwa health clinic	Tudun Bojuwa	Healthclinic	Kwachiri	12.02992	8.509035
9	Fagge	Yan mata dispensary	Yan Mata	Dispensary	Yan Mata	12.0288	8.517973
10	Nassarawa	Badawa disp.	Badawa	Dispensary	Giginyu	12.00102	8.581483
11	Nassarawa	Dawakindakatahealth post	Dawakin Dakata	Health clinic	Dakata	12.01769	8.584019
12	Nassarawa	Giginyu basic health post	Giginyu	Health clinic	Giginyu	11.98436	8.569081
13	Nassarawa	Gama health post	Gama	Health post	Gama	12.05102	8.542264
14	Nassarawa	Gwagwarwa health post	Gwagwarwa	Health post	Gwagwarwa	12.01769	8.545958
15	Nassarawa	Gwagwarwa maternity	Gwagwarwa	Maternity and child health	Gwagwarwa	12.03436	8.546433
16	Nassarawa	Hotoro health clinic	Hotoro	Health clinic	Hoto Kudu	11.95102	8.587158
17	Nassarawa	Hotoro health post	Hotoro	Health post	Hoto Arewa	11.96769	8.586394
18	Nassarawa	Hotoro maternity	Hotoro	Maternity and child health	Hoto Kudu	11.96769	8.586725
19	Nassarawa	Kawo health post	Kawo	Health post	Giginyu	11.98436	8.58455
20	Nassarawa	Kawaji health post	Kawaji	Health post	Kawaji	12.00102	8.579667
21	Nassarawa	Kaura goje health post	Kaura Goje	Health post	Kaura Goje	11.98436	8.538756
22	Nassarawa	Ladanai health post	Ladanai	Health post	Hoto Arewa	11.98436	8.554614
23	Nassarawa	School health clinic	Sch. Of Health Tech.	Health clinic	Gama	11.98436	8.529589
24	Nassarawa	Tokarawa health post	Tokarawa	Health post	Kawaji	12.00102	8.511394
25	Nassarawa	Tudun murtala health post	Tudun Murtala	Health post	Tudun Murtala	12.00102	8.548264
26	Nassarawa	Tudun Wada Health Post	Tudun Wada	Health post	Tudun Wada	12.02886	8.564883
27	Dala	Adakawa health post	Adakawa	Health post	Adakawa	12.02358	8.497208
28	Dala	Fuskar arewa health clinic	Kadawa	Health clinic	Kabawaya	12.03211	8.494298
29	Dala	Goburawa health post	Goburawa	Health post	Goburawa	12.02421	8.49782
30	Dala	Hajiya umma zana health post	Kurna	Health clinic	Goburawa	12.03436	8.489867
31	Dala	Kofar ruwa health post	Kofar Mazugal	Health Post	Kofar Mazugal	12.00102	8.517033
32	Dala	Kofar Ruwa Health Clinic	Kofar Ruwa	Health Clinic	Kofar Ruwa	12.01769	8.499167
33	Dala	Kurna Health Clinic	Kurna	Health Clinic	Goburawa	12.03436	8.506533
34	Dala	Mhc Dala	Dala	Maternal & Child Health	Dala	12.00102	8.507339

Table 1: Continue

35	Dala	Yalwa Health Center	Yalwa	Health Clinic	Yalwa	12.00102	8.508989
36	K.M.C	Emir`S Palace Health Clini	Unguwar Gini	Health Clinic	Kankarofi	11.98436	8.518117
37	K.M.C	Fuskar Gabas Health Clinic	Kofar Waqambai	Health Clinic	Shahuchi	12.00102	8.523072
38	K.M.C	Gandun Albasa Mordan Phc	Gandun Albasa	Health Clinic	Sheshe	11.96769	8.527433
39	K.M.C	Kwalli Dispensary	Kwalli	Dispensary	Kankarofi	11.98436	8.521419
40	K.M.C	Madatai Health Clinic	Madatai	Health Clinic	Sheshe	11.98436	8.523864
41	K.M.C	Marmara Mch	Marmara	Maternal & Child Health	Sheshe	11.98436	8.5245
42	K.M.C	Mayanka Health Clinic	Mayanka	Health Clinic	Zaitawa	12.00102	8.524503
43	K.M.C	Nulge Staff Clinic	Tudun Wuzurchi	Health Clinic	Tudun Wuzurchi	11.98805	8.521592
44	K.M.C	Sharada Mhc	Sharada	Maternal & Child Health	Sharada	11.95102	8.488947
45	K.M.C	Tukuntawa Health Clinic	Tukuntawa	Health Clinic	Sharada	11.95102	8.506794
46	K.M.C	Yakasai Zumunta Health Clinic	Yakasai	Health Clinic	Yakasai	11.98436	8.519667
47	K.M.C	Yan Awaki Health Clinic	Yan Awaki	Health Clinic	Zaitawa	12.00102	8.523875
48	Gwale	Aisami Dispensary	Aisami	Dispensary	Kabuga	11.98436	8.478856
49	Gwale	Dorayi Health Clinic	Dorayi	Health Clinic	Dorayi	11.95102	8.479164
50	Gwale	Duka Wuya Health Clinic	Gadon Kaya	Health Clinic	Kabuga	11.96769	8.494997
51	Gwale	Dorayi Babba Health Clinic	Dorayi Babba	Health Clinic	Dorayi	11.96769	8.465103
52	Gwale	Filin Mushe Mhc	Filin Mushe	Maternal & Child Health	Gwale	11.98436	8.512258
53	Gwale	Fuskar Yamma Health Post	Galadanchi	Health Post	Galadanchi	11.98436	8.513492
54	Gwale	Ja`En Phc	Ja` En	Comprehensive Health Clinic	Dorayi	11.95102	8.489153
55	Gwale	Kofar Waika Health Post	Waika	Health Post	Goron Dutse	11.98436	8.481992
56	Gwale	Kofar Na`Isa Health Post	Kofar Na`Isa	Health Post	Gwale	11.96769	8.523383
57	Gwale	Kabuga Phc	Kabuga	Comprehensive Health Clinic	Kabuga	11.98436	8.474567
58	Gwale	Sabon Sara	Sahara	Health Post	Mandawari	11.98436	8.502494
59	Gwale	Unguwar Dabai Health Post	Unguwar Dabai	Health Post	Goron Dutse	12.00102	8.499353
60	Tarauni	Darmanawa Post Health	Darmanawa	Health Post	Gyadi Gyadi Kudu	11.95102	8.542542
61	Tarauni	Gyadi Gyadi Kudu Health Post	Gyadi Gyadi Massallacin	Health Post	Gyadi Gyadi Kudu	11.96769	8.545711
62	Tarauni	Hausawa Mch.	Murtala	Maternal & Child Health	Babban Giji	11.95102	8.5327
63	Tarauni	Hotoro Health Clinic	Hotoro	Health Clinic	Hotoro	11.96769	8.586075
64	Tarauni	Ja`Oji Mch	Jaoji	Maternal & Child Health	Gyadi Gyadi Arewa	11.98436	8.539364
65	Tarauni	Kundila Health clinic	Kundila	Health clinic	Daurawa	11.95102	8.559986
66	Tarauni	Tarauni Health clinic	Tarauni	Health clinic	Tarauni	11.96769	8.553028
67	Tarauni	Unguwa Uku Kau Yen Aluh Health Clinic	U/Uku	Health clinic	U/Uku Kauyen Alu	11.95102	8.561028
68	Tarauni	U/Uku chikin gari mch	U/Uku	Maternal and child health	U/Uku Cikin Gari	11.93436	8.56725
69	Tarauni	Yar akwa health post	Yar Akwa	Health Post	Unguwar gama	12.01769 11.93	8.538122 8.53

Table 2: Showing the population and health care facilities in the area field work and Npc 200

S/N	L.G.A	No. Hcf	Population	Percentage
1	Dala	9	418,759	13.04%
2	Fagge	9	200,095	13.04%
3	Gwale	12	357,827	17.39%
4	Municipal	12	371,243	17.39%
5	Nassarawa	17	596,411	24.64%
6	Tarauni	10	221,844	14.50%
	Total	69	2,166,179	100%

In Table 1 shows the name, type, address, ward and coordinates of all the primary health centers in the metropolis (69 centers) however, all the attribute data collected were converted into MS DOS in excel so that Arc View GIS can `recognize` it and that can help in the overlay analysis. The concept of overlay analysis is one of the major GIS procedures that are used for several studies. It manipulate spatial data organize in different layers to create combination of features according to logical conditions specify in Boolean algebra (Chou, 1997).

However, the analysis shows that the distribution of PHC in Kano Metropolis is uneven (Fig. 2) some areas are well served meaning that there are concentration within Municipal, Nassarawa and Tarauni L.G.As each among them has PHC centers in every ward of the local government. While in Gwale have fairly distribution of PHC the number of population tallies with the PHC in said LGA (Table 2).

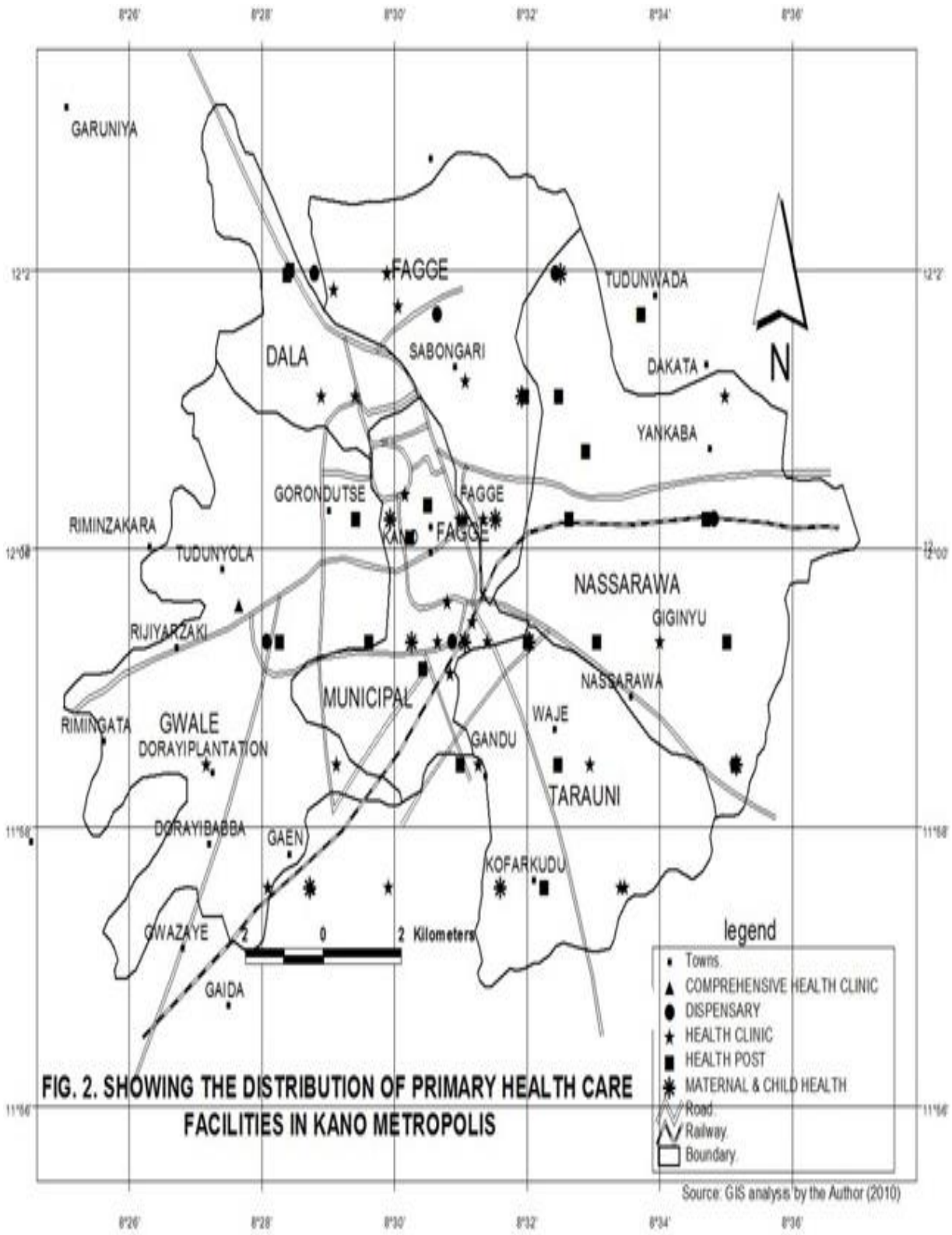

FIG. 2. SHOWING THE DISTRIBUTION OF PRIMARY HEALTH CARE FACILITIES IN KANO METROPOLIS

Fig. 2: Showing the distribution of primary health care facilities in Kano metropolis

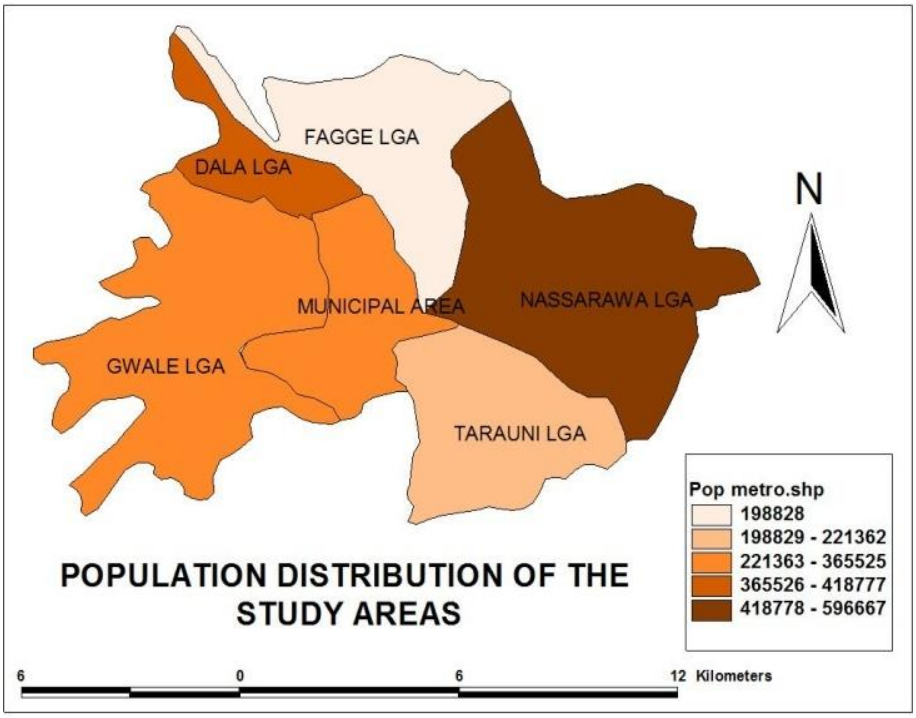

Fig. 3: Population distribution of the study areas

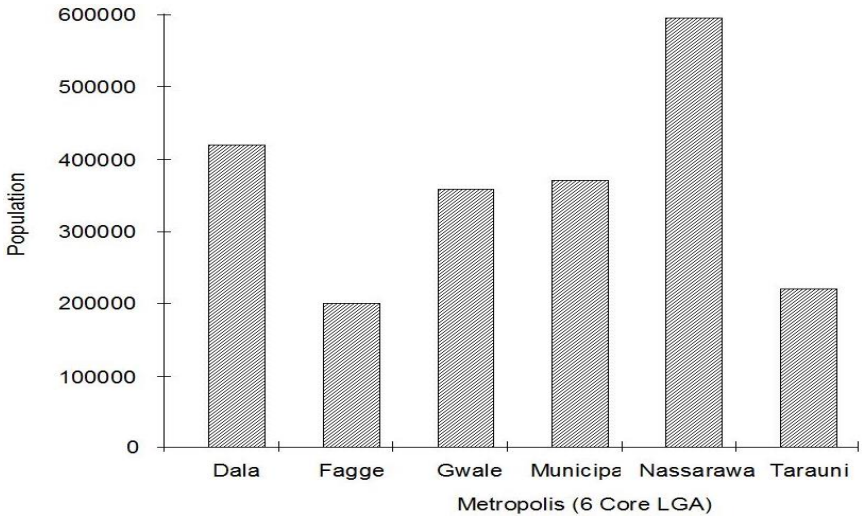

Fig. 4: Showing the population distribution (Census, 2006)

Private health facilities outnumbered the public health facilities in Tarauni L.G. In all there are 25 health facilities but private has 16 facilities while public has 9. Furthermore, the number of wards in private sector outnumbered that of public this could be as the result of spatial distribution of hospital establishment through the area (Fig. 3 and 4).

CONCLUSION AND RECOMMENDATIONS

After the analysis it is found that healthcare facilities has been provided but not equally distributed. Healthcare planning is a challenging field that depends on spatial data such as location and characteristics of health center demand. Today, health's planners have

several tasks to cover to assure that health service is provided at the best location by using GIS. GIS is used to analyze the center catchment as well as studying the spatial distribution of the PHC in the area. The results of this application are very useful for health planners because they evaluate the level of service provision at the selected area.

Its concluded that the existing health facilities is not marching the available demand because most of these facilities were clustered within the radius of Aminu Kano Teaching Hospital (AKTH) areas like RijiyarZaki, Jan Block (Red bricks) also in the other hand area around Kurna which were neglected. And in the case of maternal child care it is only 2 Comprehensive and only one maternal and childcare healthcare facility which were situated at Gwale LGA., however, distance and time is one of the fundamentals when discussing about maternal health. Lastly, Municipal, Nassarawa and Tarauni are well served while Gwale distribution and Dala and Fagge is in contrast of all of the above mentioned, the distribution is very poor in respect with population. Therefore, it could be said that there is inequality in the distribution of primary healthcare in the areas.

GIS mapping allows visualization of field survey results and provides essential information in targeting limited financial and human resources for the control of diseases within the area. The user-friendly GIS mapping method demonstrated in this study is a practical and feasible method for field researchers and health staff monitoring disease risk in a geographically diverse area. The developed map indicates the uneven distribution of health facilities.

The findings show that:

- There are only 2 Comprehensive HCF
- The distribution of PHC is uneven in the area the western part is not well served
- In terms of manpower about 4344 among which only 2 Doctors, 9 Nurses/Midwifery that can take the Population of more than 2,165,223

Lastly, there is need for health policy planners to examine the current situation with a view of addressing the inequality in the distribution of facilities and manpower. There is need for the ministry of health on the application of GIS and Health; these should include an interdisciplinary team of scientist, including health policy experts, environmental scientist, geographers, in addition to statistics and GIS scientists.

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