

Identification, Characterization and Mapping of Health Facilities Gombe State Nigeria

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Abstract:- The importance of creation of geodatabase and mapping of healthcare facilities in Northeast Nigeria, Gombe state cannot be over emphasis, an adequate and equity access to healthcare facilities in Gombe state, Northeast Nigeria. study uses geospatial techniques to collect geoinformation of healthcare facilities, creation of geodatabase mapped and identified new suitable sites of healthcare facilities in Gombe state. Spatial queried database questions such as what, how much, what is where. Euclidean Distance used to generate distancehealthcare centersin the study area. Delineation of areas falls within 4 km radius from healthcare centers used as criterion. Delineated raster datasetusedidentified suitable proposed sites of healthcare facilities. Result shows that 669 healthcare centers identified in Gombe state, primary 616 (92.08%), Secondary 52 (7.77%), while tertiary facility1 (0.15%) healthcare center respectively. 47 (7.63%) private owned. Secondary health facility, 53.85% (28) 52 health facilities are public owned while the rest 24 (48.08%) are privately owned. 1 tertiary health facility in Gombe state public owned. Findings, research revealed 669 healthcare facilities in the study area, 661 primary, 52 secondary and 1 tertiary healthcare, 569 primary healthcare, 28public healthcareand 47 are private. secondary healthcare facilities 28 and 1 tertiary public owners and 24 secondary private owners, 16 new sites identified in all; 4 in Nafada, 3 each in Akko, Dukku, Kwami and Yamaltu/Deba LGAs respectively. Research recommends universal health coverage strategy, rehabilitations of other social amenities, needs for the provision of 16 more healthcare facilities in Gombe state.

Keywords:- Geodatabase, Creation, Mapping, Healthcare, Facilities.

I. INTRODUCTION

The provision of adequate basic health services in developing countries is becoming increasingly difficult by the day (Fanan and Felix, 2014). Rapid population growth, widespread poverty and lack of financial resources for the provision of health facilities/infrastructure are identified as the key factors responsible for the poor health care delivery systems in the developing world (Amer, 2007). In the health sector, much concern has been expressed pertaining to the pattern of distribution of health care facilities and level of utilization. According to Inyang (1994), distributive equity in healthcare facilities indexes accessibility. In other words, the level of access to health care facilities is a function of the degree of fairness in spatial distribution of the facilities. Accessibility in this context has spatial theme and signifies

the ease with which potential healthcare seekers get to the health facilities where healthcare services are delivered.

The provision of health care centres in Nigeria is a concurrent responsibility of the three tiers of government in the country (Abbas *et al.*, 2012). However, because Nigeria operates a mixed economy, private providers of medical health care have a visible role to play in health care delivery. The federal government's role is mostly limited to coordinating the affairs of the university teaching hospitals, federal medical centres (tertiary health care) while the state government manages the various general hospitals (secondary health care) and the local government focuses on dispensaries (primary health care) which are regulated by the federal government. Geographic Information System (GIS) is a valuable tool to assist health research planning, monitoring and evaluating health systems. GIS has been used by several scholars to combine different data and generates information required for decision making in health management. In 1854; John Snow demonstrated the utility of mapping disease outbreaks to gain insights as to their cause. Snow, an anaesthesiologist, mapped the highest density of cases that occurred in households, which used the public pump on Broad Street as their water source (Law *et al.*, 1998). Benachi and Yasui (1999) identified that there was a positive correlation between deprivation of health centres and mortality rate. In their analysis of 2,200 small areas of Spain, they obtained two indices of deprivation and they concluded that, there was excess mortality in deprived areas estimated at 35,000 deaths. Thus, they called for government intervention in the deprived small areas of the country. They also found that there are inequalities in other aspects related to health care, such as, waiting list times, or the access to preventive health services.

Olajuyinet *al.*, (1997) investigated the effect of location on the utilization of healthcare centres in Irewole local government area of Osun State, Nigeria. Data used in this research included population data, list of health facilities and their coordinates, and distance of the settlements to each health centre. They found that health centres were unevenly distributed among the settlements and that the distance was a paramount factor. Okafor *et al.*, (1977) analyzed the spatial distribution and efficiency of health centres in the old Bendel (now Edo and Delta) State. He created a data base of all the health centres in Benin and found that there were discrepancies between the population distribution and the distribution of health centres. Adejuyigbe (1973) used GIS technique to demonstrate the relationship between distance and patronage of health centres in Ife. He noted that attendance at each health centre in Ife region is a function of

both type of service available there and the distance from other centres providing similar services. Dzikwi and Abbas (2012) also used GIS to map the spatial distribution of rabies in Kaduna State, Nigeria. They used GIS to analyze record data obtained from the state ministry of agriculture and the archived map of the state to track the spread and management of the disease in the state.

The World Health Organization WHO (2004), describes GIS as “an excellent means of analyzing epidemiological data, revealing trends, dependencies and interrelationships that would be more difficult to discover using traditional tabular approach”. Site selection and distribution of health care centres are important components of an overall health system which has a direct impact on the burden of diseases that affect many countries in the developing world. The creation of health care centres database and mapping helps in showing the spatial distribution and information about location and their physical relations to each other. The purpose of using GIS in site selection and distribution of health care centres is that maps provides an added dimension to data analysis, which helps in visualizing the complex patterns and relationships. The use of GIS for measurement of physical distribution is well established and has been applied in many areas including retail site analysis, transport, emergency services and health care services (Wilkinson *et al.*, 1998).

WHO (2004) specified criteria for health care planning for third world countries and indicated that each service area should cover a 4km catchment area with a population of 60,000.00 for primary health care in order to have adequate and equity of access to health centres. In line with WHO (1997), this study therefore aimed to map the spatial distribution of health care centres, create a general health facility geodatabase as well as recommend new health center’s where it is necessary in North Eastern Nigeria using GIS technique.

II. MATERIALS AND METHODS

A. Study Area

This study looks at mapping health facilities in North Eastern Nigeria using Gombe state as a case study. Gombe state is one of the six states of the region came into being in 1996 having eleven local government areas and covering 20,265 Km² of land. Located in the Northeastern part of Nigeria between latitude 9°33’ and 11°19’ north of the equator; and longitude 10°28’ and 11°52’ East of the Greenwich Meridian (Figure 1). The state falls within the Sudan savannah and having a sub-tropical climate with unique dry season (November-March with humidity of less than 10% in December and January); and the rainy season (April-October) with an average rainfall of 923 mm average annual rainfall. The highest humidity (97%) is in August during the rainy season and the lowest (10%) is during the dry harmattan time in December and January. The temperature ranges between the minimum of 16 °C (in December/January) and maximum of 40 °C (in March/April); and 25.4 °C average annual temperature.

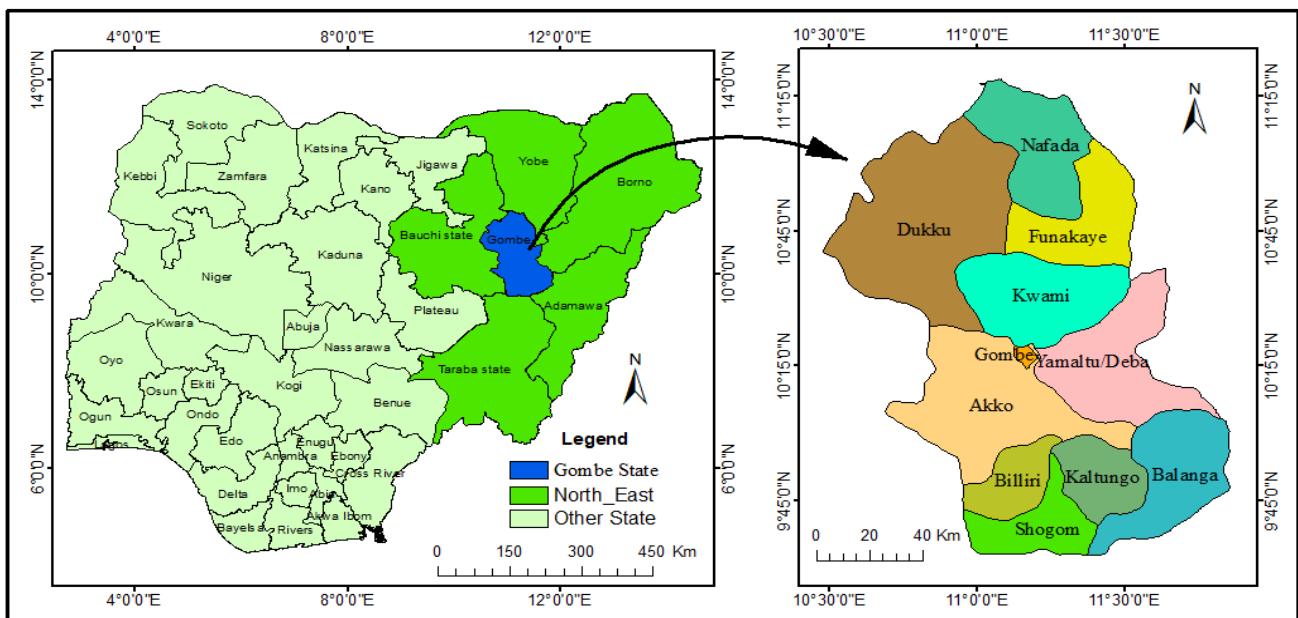


Fig. 1: The study area map

B. Procedure for Data collection

Both primary and secondary data was employed in this work, Collected and recorded health facility data forwarded to data management team where all the captured data keyed in to Excel sheet and saved in .csv format. The data management continuous by creating Health Facility Geo

database file, which in it state, LGA and ward boundaries as well as settlement and health facility feature classes were created and edited in ArcGIS application. Health facilities coordinates obtained by field survey were transforms to points map portraying their distribution within the study area. To attain quality assurance the created feature classes

and their attribute tables were cross check so as to detect errors and identify inconsistency. Health facility point map was further classified and portrayed in terms of level, ownership and service priority of the facility.

C. Data Analysis

Spatial search operation was carried out to test the generated database by looking for certain attributes within the neighborhood which were systematically defined. This gave rise to querying the database towards answering generic question such as what and how much of what is where. ‘Select By Attributes’ tool in ArcMap used to select features that match the selection criteria from the created geodatabase using SQL query expression; the following querying operation were performed.

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SELECT * FROM HEALTH_FACILITY_PTS
WHERE:
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- "LGA" = 'Yamaltu/Deba' AND "TYPE_2" = 'Primary Health Center'
- "LGA" = 'Akko' AND "OWNERSHIP" = 'Public' AND ("WARD" = 'Pindiga' OR "WARD" = 'Tumu' OR "WARD" = 'Kashere')

D. Delineation of Service Area and identification of Propose Health Facility Location

In order to have adequate and equity of access to health centres, WHO (2004) specified a criterion for health care planning for third world countries and indicated that each service area should cover a 4km catchment area with a population of 60,000 people. Therefore, to define areas covered by this designation, a Euclidean Distance tool was used in generation of distances of all cells with reference to source (health centers) within the study area. Then, Reclassified tool employed for the delineation of those cells (areas) falls within the 4 km radius from the health centers

as well as those that did not satisfy the criterion. In order to identify where to site new additional health facility, the delineated raster dataset was then converted to KML file format and imported into Google Earth environment where a systematic searching of all settlements outside the 4 km radius from the existing facilities where identified and their positional information retrieved and recorded.

III. RESULTS AND DISCUSSION

A. The Geo database Table and Mapping of Health Facilities

The study identified the health facilities (HF) on the field, collected their attributes and created a geodatabase for both the public and private health centres across primary, secondary and tertiary facility levels within Gombe state. The summary of the collected data was shown in Table 1; also the complete data was portrayed in appendix I. Table 1 shows the overview of the gathered and recorded health facility data, which indicates that there are 669 health centers across eleven LGAs in Gombe state, the captured health facilities are further classified base on their service levels and ownership. As the table shows, out of the 669 facilities, 616 belong to primary level, which correspond to 92.08% of the total facility count. Secondary health facilities have 52 count equivalent to 7.77%; while tertiary facility level have only one count and is proportional to 0.15% of the overall facilities. Furthermore, of the 616 primary facility level, 92.37% of them (i.e. 569 facilities) are public owned and the remaining 47 (7.63%) are owned by private health providers. At the secondary health facility level, 53.85% (i.e. about 28) of the 52 health facilities are public owned while the rest 24 (48.08%) are privately owned. There is only one tertiary health facility in Gombe state and is public owned.

Table 1: Summary of the Health Facility Count in Gombe State

LGA	Primary		Secondary		Tertiary		Total
	Public	Private	Public	Private	Public	Private	
Akko	81 (14.24%)	4 (8.51%)	5 (17.86%)	6 (25.00%)	0	0	96 (14.35%)
Balanga	57 (10.02%)	4 (8.51%)	3 (10.71%)	0 (0.00%)	0	0	64 (9.57%)
Billiri	67 (11.78%)	12 (25.53%)	1 (3.57%)	0 (0.00%)	0	0	80 (11.96%)
Dukku	63 (11.07%)	1 (2.13%)	1 (3.57%)	1 (4.17%)	0	0	66 (9.87%)
Funakaye	44 (7.73%)	5 (10.64%)	1 (3.57%)	3 (12.50%)	0	0	53 (7.92%)
Gombe	25 (4.39%)	6 (12.77%)	6 (21.43%)	12 (50.0%)	1	0	50 (7.47%)
Kaltungo	52 (9.14%)	7 (14.89%)	3 (10.71%)	2 (8.33%)	0	0	64 (9.57%)
Kwami	45 (7.91%)	0 (0.00%)	2 (7.14%)	0 (0.00%)	0	0	47 (7.03%)
Nafada	30 (5.27%)	0 (0.00%)	2 (7.14%)	0 (0.00%)	0	0	32 (4.78%)
Shongom	51 (8.96%)	5 (10.64%)	0 (0.00%)	0 (0.00%)	0	0	56 (8.37%)
Yamaltu/Deba	54 (9.49%)	3 (3.38%)	4 (14.29%)	0 (0.00%)	0	0	61 (9.12%)
Sub Total	569 (100%)	47 (100%)	28 (100%)	24 (100%)	1	0	669 (100%)
Grand Total	616 (92.08%)		52 (7.77%)		1 (0.15%)		669(100%)

When Table 1 look at the local government wise level, Akko LGA have the highest number of health facility centers which is amount to 96 counts, equivalent to 14.35% of the total facilities inGombe state. Of this number, 85 belong to primary level while 11 facilities belong to

secondary level and there is no count for tertiary health facility level in the LGA. Out of the 85 facilities at primary level, 81 are public owned and 4 belong to private health providers. Similarly, of the 11 secondary level facilities, 5 are public owned while 6 are privately owned. Next to Akko

LGA in term of health facility number is Billiri LGA where 80 facilities recorded, this is 11.97% of the entire facility in Gombe state. Seventy nine out of these facilities belong to primary health level and the remaining one is of secondary level hence, there is no tertiary health facility in the LGA. Furthermore, 67 out of 79 of those facilities belong to primary level are public owned while 12 are owned by private providers in Billiri LGA. Dukku LGA follows with 66 (9.87%) health facility counts as shown in Table 1, 64 out of these are at primary level while 2 are at secondary level. Of the 64 primary level facilities, 63 are public owned and the remaining 1 is privately owned. And there is one HF each recorded for public and private owned at secondary level. Balanga and Kaltungo LGAs follow with the same health facility numbers each have 64. Balanga have 61 and 4 public and privately owned primary level facilities respectively, while Kaltungo have 52 and 7 public and privately owned primary level facilities respectively. At secondary level, both LGAs have 3 public owned facilities, and Kaltungo have 2 privately owned while Balanga have nothing. Both LGAs have no tertiary health facility

Table 1 also reveals that Yamaltu/Deba LGA follows Balanga and Kaltungo LGAs with 61 health facilities which equal to 9.12% of the total health facilities in Gombe state. Primary level health facility gets 57 counts, secondary level gets 4 and there is no count for tertiary health facility. Upon the primary level HF, 54 are public owned and 3 belong to private health providers, while the 4 secondary level

facilities are all public owned. Shongom LGA is the next with 56 HF counts which is 8.37% of the total facilities in Gombe state and all are at primary level in which public and private owned each get 54 and 3 facilities respectively. Fifty three HF were captured in Funakaye LGA which is equivalent to 7.92% of the total facilities in Gombe state. Of the 53 facilities, 49 are at primary level and 4 belong to secondary level, and nothing belongs to tertiary level. Forty four out of 49 primary level facilities are public owned and the remaining 5 are privately owned. Three out of four secondary level facilities are privately owned and one belongs to public owned facility. The number of health facilities in Gombe LGA amount to 50 counts; this is equivalent to 7.47% of the total facilities. Primary, secondary and tertiary facility level each has 31, 18 and 1 facilities respectively. Upon primary level ones, 25 belong to public owned facilities while 6 belong to private health providers. Likewise for secondary level, 6 are public owned and 12 are privately owned facilities. Table 1 also shows that there are 47 (7.03%) health facilities in Kwami LGA. Open which 45 are at primary level and 2 are at secondary level and all are public owned facilities; and there is no any belong to tertiary level. Nafada LGA recorded the lowest health facility number with which recorded 32 counts. All the facilities are public owned ones open which 30 belong to primary level and 2 belong to secondary level, and no tertiary level facility recorded. Figure 2 below shows the distribution of health facility in Gombe state.

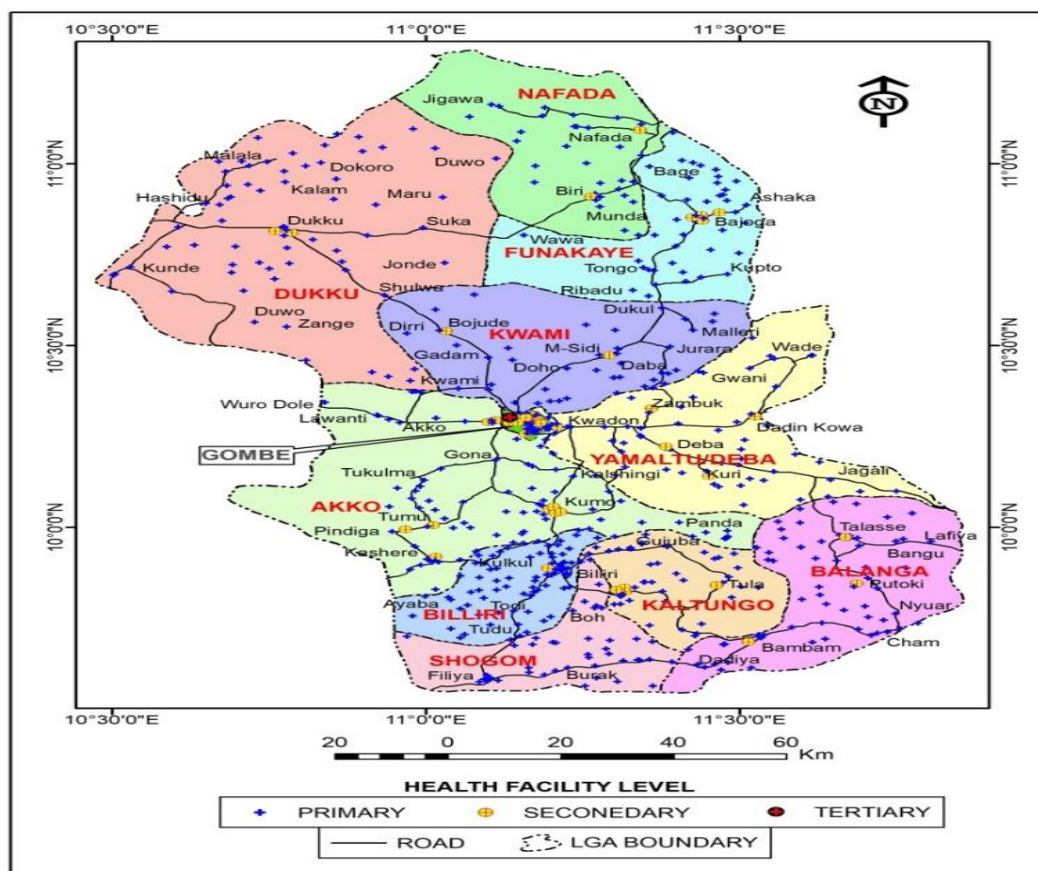


Fig. 2: Distribution of Health Facility Level in Gombe State

Figure 2 shows the distribution of health facility level in Gombe state. There is well distribution of primary level HF in most of the LGAs in the state, with the exception of western Akko and Yamaltu/Deba LGAs, northern and south western Nafada, western Funakaye and northern Kwami LGAs. This was due to the absent or disperse of settlements (or population) at such places. Figure 3 portrays the distribution of health facility ownership in Gombe state;

as in figure 2 the public owned facilities are well distributed within the state. While there is skipped in the distribution of privately owned which mainly concentrated in the central (around Gombe LGA), southern (around Billiri LGA) and north eastern (in Funakaye LGA) part of the state. Health facilities Service Level in Gombe state were also reveals in Table 2.

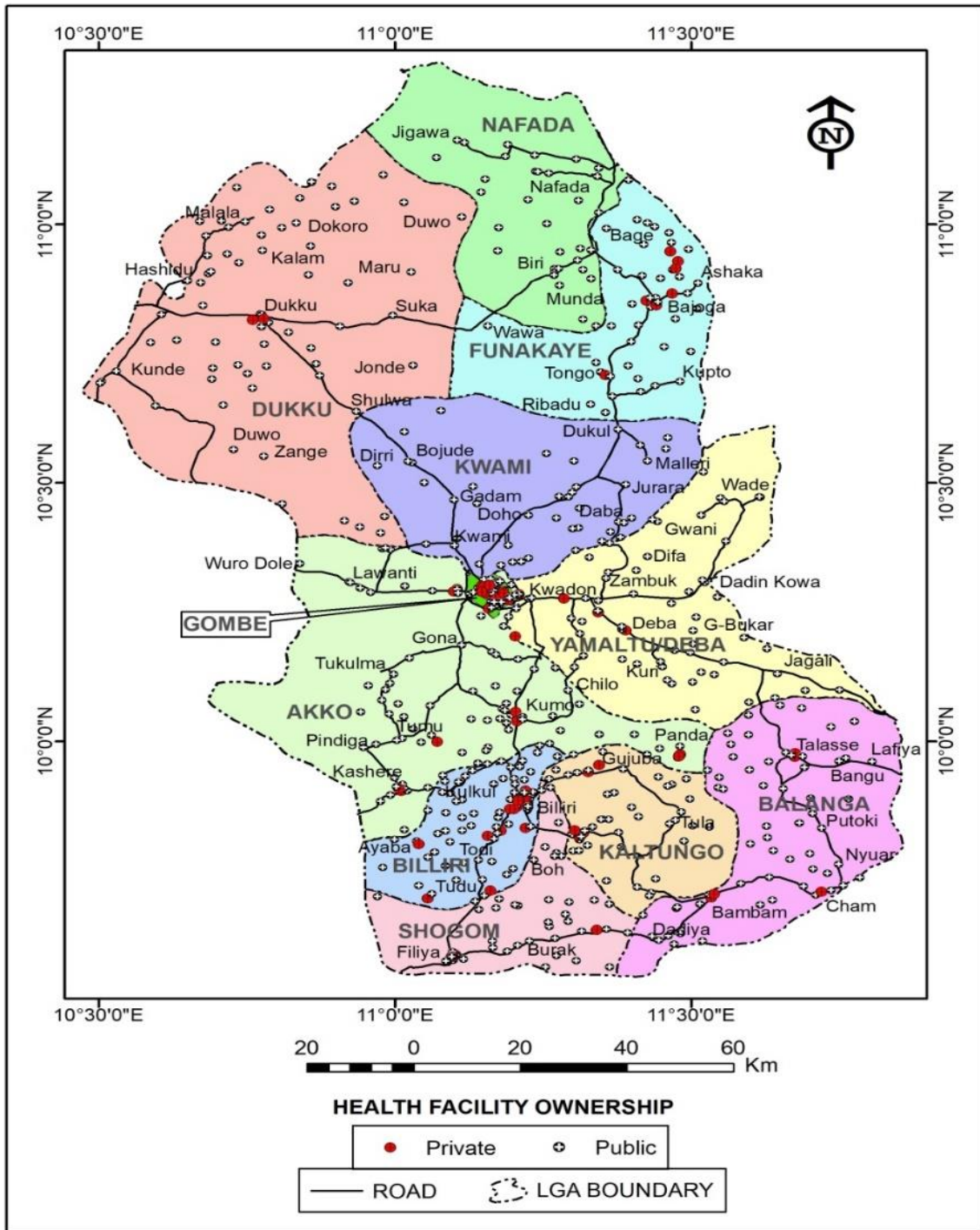


Fig. 2: Distribution of Health Facility Ownership in Gombe State

Table 2: Health Facility by Service Level in Gombe State

LGA	HP	HC	HCR	PHCC	CH	GH	SH	TH	PH	TOTAL
Akko	25	42	5	11	2	2	0	0	9	96
Balanga	22	22	13	2	2	1	0	0	2	64
Billiri	20	31	9	9	0	1	0	0	10	80
Dukku	19	31	0	13	0	1	0	0	2	66
Funakaye	1	27	13	2	0	1	0	0	9	53
Gombe	4	7	3	14	2	1	1	1	17	50
Kaltungo	20	21	14	0	1	1	0	0	7	64
Kwami	22	11	12	0	2	0	0	0	0	47
Nafada	0	6	23	1	1	1	0	0	0	32
Shongom	12	31	10	0	0	0	0	0	3	56
Yamaltu/Deba	20	24	10	1	3	1	0	0	2	61
Total	165	253	112	53	13	10	1	1	61	669
%	24.66	37.82	16.74	7.92	1.94	1.49	0.15	0.15	9.12	100

Note: HP = Health Post, HC = Health Clinic, HCR = Health Center, PHCC = Health Care Center, CH = Cottage Hospital, GH = General Hospital, SH=Specialist Hospital, TH =Teaching Hospital and PH = Private Hospital/Clinic.

The statistics of the health facilities base on their service level in Gombe state is reveals in Table 2. Of the 669 health facilities, 165 are health post corresponding to 24.66% of the total HF; this level is the lowest in terms of healthcare service delivery. Open this value, Akko has 25, Balanga 22, Billiri, Kaltungo and Yamaltu/Deba 20 each, Dukku 19, Shongom 12, Gombe 4, Funakaye 1 and Nafada nil. Table 2 also shows that, there are 253 health clinics out of the 669 health facilities corresponding to 37.82% of the total facilities in Gombe state. Akko LGA has the highest number with 42 health clinics, Billiri and Dukku and Shongom each has 31. Funakaye goes with 27, Yamaltu/Deba with 24, Balanga 22 and Kaltungo 21, while Kwami, Gombe and Nafada each have 11, 7 and 6 health clinics respectively. Among the 669 health facilities, 112 belong to health center service level which is the same as 16.74% of the whole facilities in Gombe state. Out of this value (112), Nafada has 23, Kaltungo 14, Balanga and Funakaye each have 13, Kwami possessed 12, Shongom and Yamaltu/Deba each gets 10, while Billiri, Akko and Gombe have 9, 5 and 3 respectively; and nil for Dukku LGA.

The result of the fieldwork (Table 2) also shows that 53 facilities are used as Primary Health Care Center (PHCC) equivalent to 7.92% of the 669 HF in Gombe state. Open this number, Akko LGA have 11, Gombe 14, Dukku 13, Billiri 9, Balanga and Funakaye each possessed 2, Nafada and Yamaltu/Deba 1 each, and nil each for Kwami and Shongom LGA. There are 13 Cottage Hospital or equivalent in Gombe state which amount to 1.94% of the HF in Gombe state. Among this value, 3 are in Yamaltu/Deba LGA, 2 each for Akko, Balanga, Gombe and Kwami. Also, Kaltungo and Nafada have one each, while Billiri, Dukku, Funakaye and Shongom have none. Similarly, there are 10

General Hospital (GH) which correspond to 1.49% of HF in Gombe State. Open these GHs, 2 are in Akko, one each in Balanga, Billiri, Dukku, Funakaye, Gombe, Kaltungo, Nafada and Yamaltu/Deba; while none exist in Kwami and Shongom LGAs. There are only one Specialist and Teaching Hospital in Gombe state and both located in Gombe LGA; each has 0.15% as its proportion of HF in the state. Private owned Hospital/clinic (PH) sum up to 61 counts which is the same as 9.12% of the facilities in the state. Gombe LGA recorded high with 17 PHs, follows by Billiri with 10, then Akko and Funakaye with 9 each. Likewise, there are 7 PHs in Kaltungo LGA, 3 in Shongom, 2 each in Balanga and Dukku and Yamaltu/Deba, while there is absent of PH in Kwami and Nafada LGAs.

Figure 4 displays the distribution of HF in Gombe state according to their service level. The lower hierarchy of the facilities such as primary health care center, health center, health clinic and health post where well scattered throughout the state. This indicates that primary health facilities are the most physically accessible level of healthcare providing basic healthcare services to the largest proportion of the population which are mostly dwell in rural areas. The figure also portrays that there are ten cottage hospitals or equivalent distributed in Gombe state and it further indicates that the facility was not found in Dukku, Funakaye, Kwami and Shongom LGAs. Ten general hospital or equivalents were displays by Figure 4; all the LGAs in Gombe state have at least one except Kwami and Shongom LGAs. The only specialist and general hospital in Gombe state are in Gombe LGA and are represented with black and red circular background respectively and with a yellow plus (+) symbol on each.

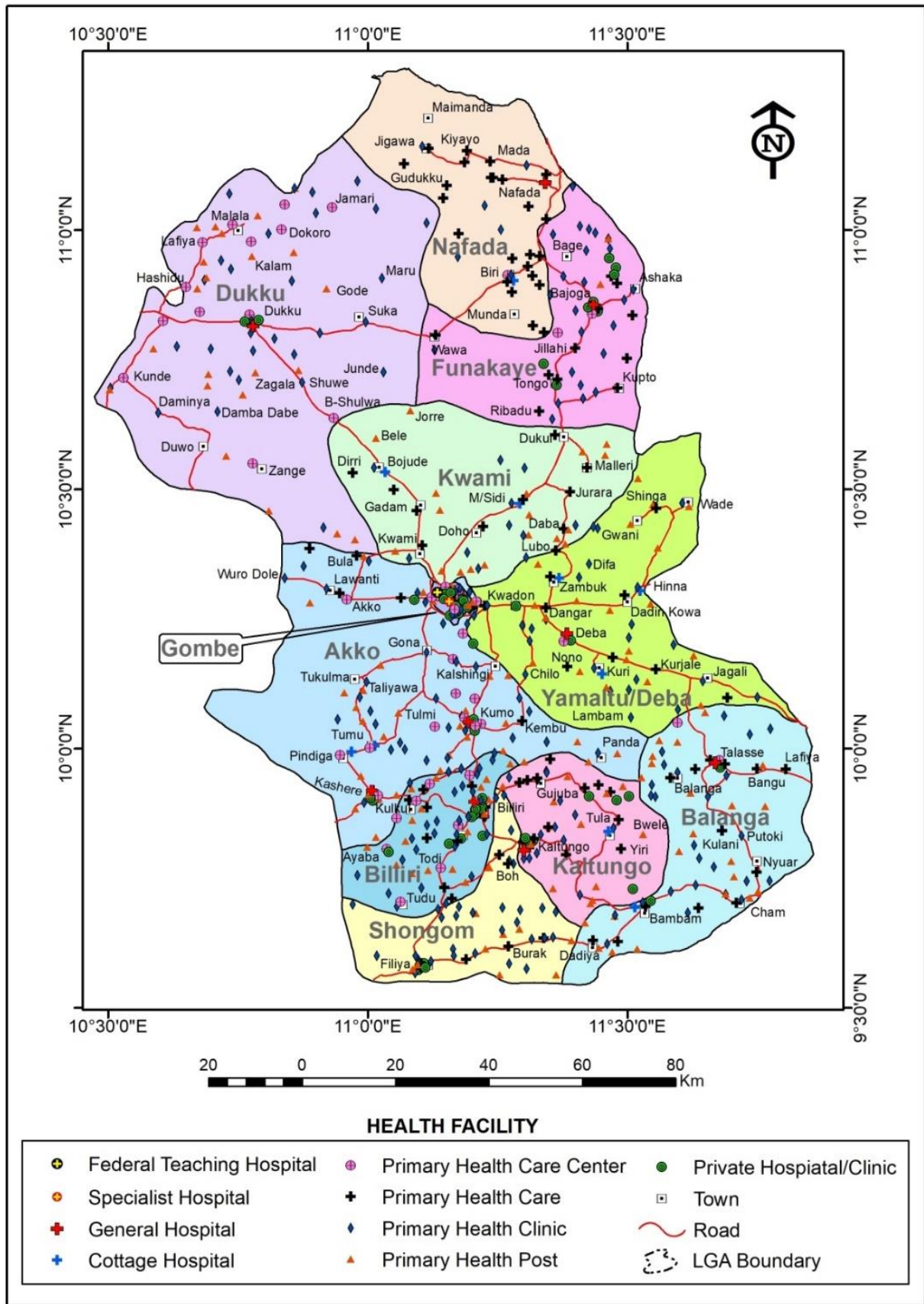


Fig. 4: Health Facility Service Level

B. Geo database Query

Spatial search operation was used to test the created geodatabase by searching for certain attributes within the geodatabase, which must be systematically defined. This gave rise to querying the geodatabase towards answering

generic question such as what and how much of what is where. Figure 5 shows the result of HF geodatabase query using “Select By Attributes” tool where the distribution of selected facilities retrieved and graphically portrayed.

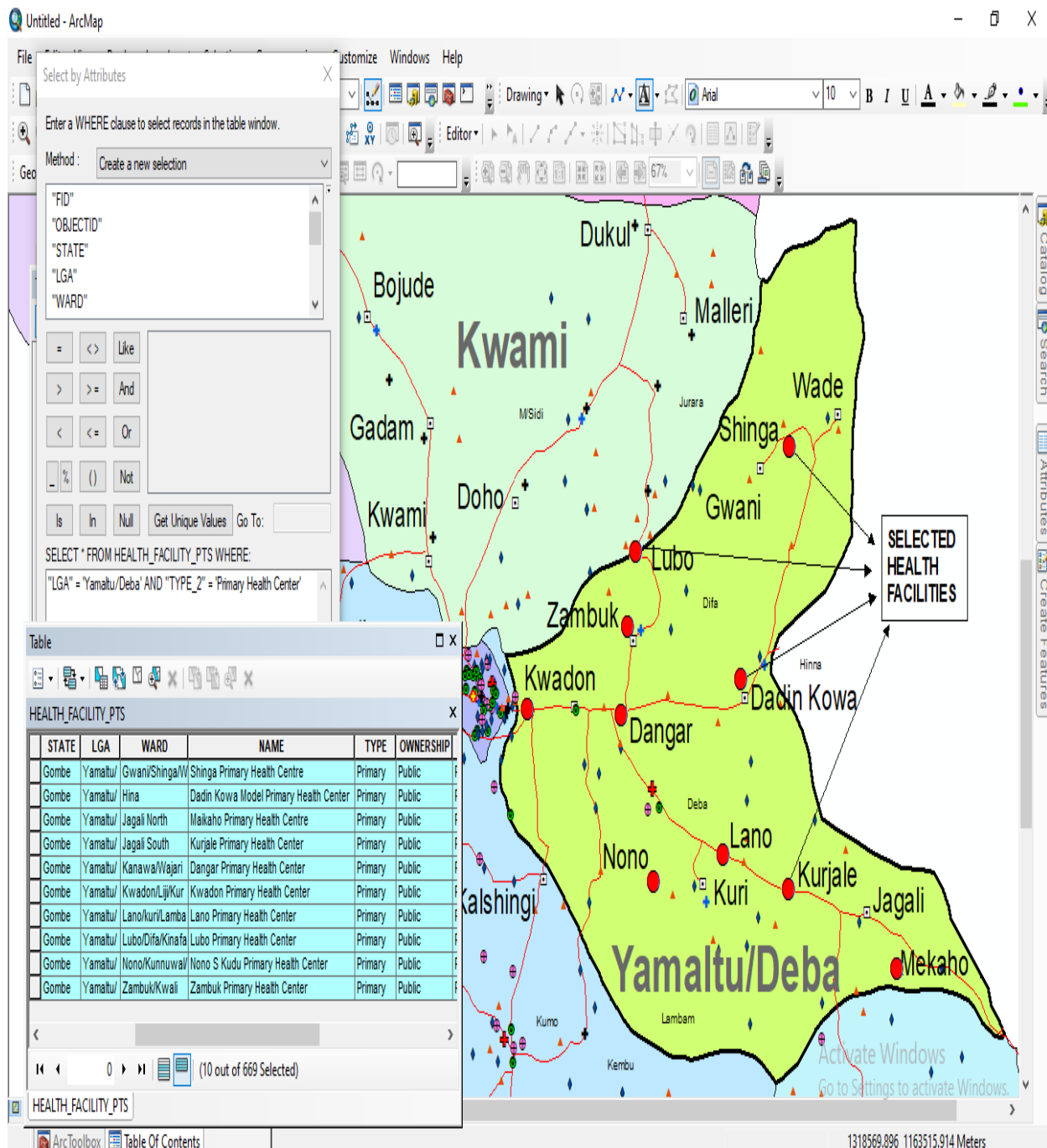


Fig. 5: Geodatabase Testing by SQL technique

The SQL query expression used for the retrieval of spatial features shown in Figure 5 was given below as thus:

"LGA" = 'Yamaltu/Deba' AND "TYPE_2" = 'Primary Health Center'

The above SQL expression asking the application to retrieved all health facilities that are spatially located in Yamaltu/Deba LGA whose service type is primary health centers. The result presented ten selected features both in tabular and graphic forms. The ten selected features were

highlighted in cyan and red colours both in the table and map respectively. Another spatial query was performed to retrieve all public owned HF in Pindiga, Tumu and Kashere wards of Akko LGA (see Figure 6).

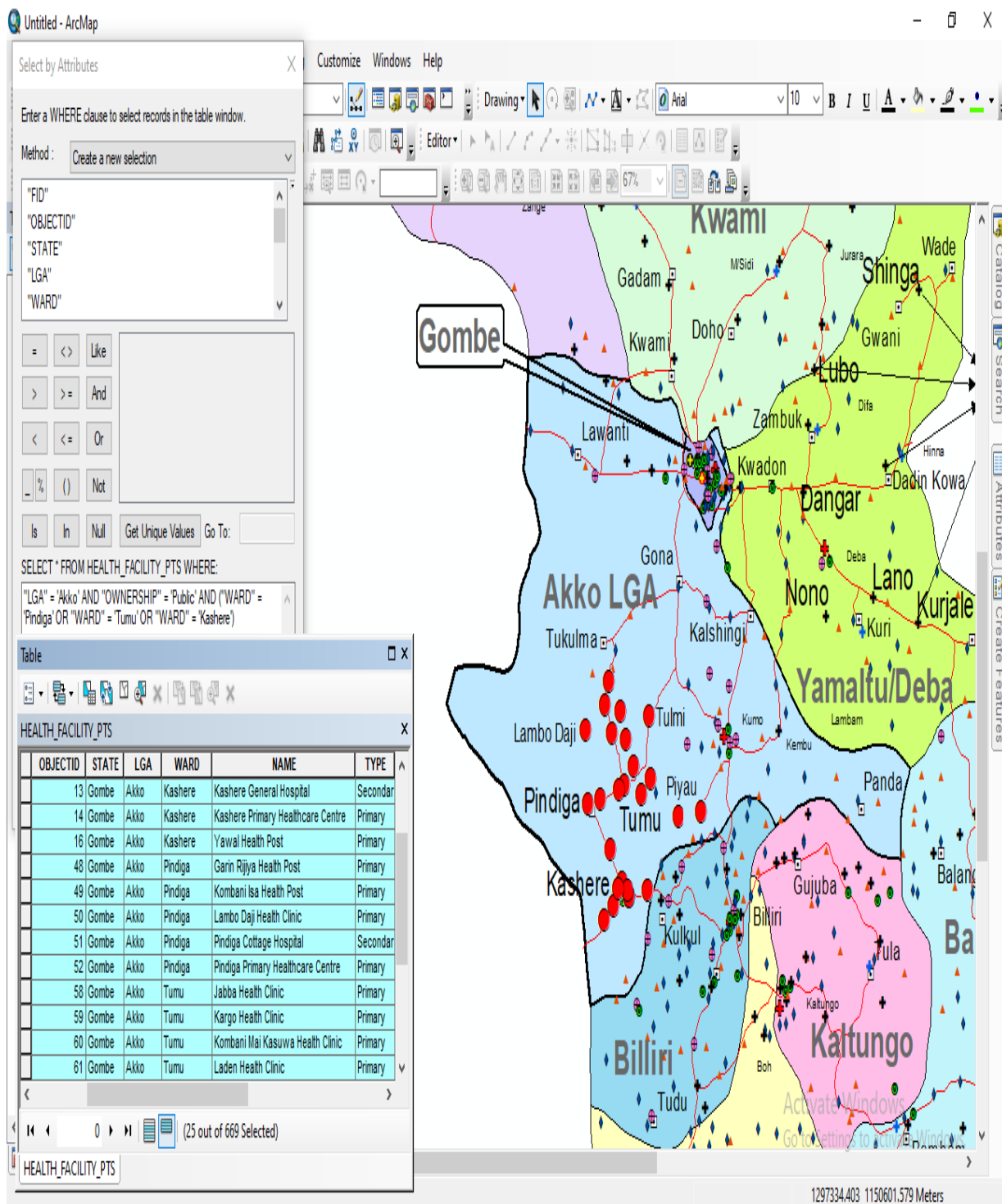


Fig. 6: Geodatabase Testing by SQL technique

The SQL expression used in retrieving the highlighted facilities in Figure 6 was given below.

"LGA" = 'Akko' AND "OWNERSHIP" = 'Public' AND ("WARD" = 'Pindiga' OR "WARD" = 'Tumu' OR "WARD" = 'Kashere')

IV. IDENTIFICATION OF NEW HEALTH FACILITY SITES

Prior to identifying and proposing of additional HF sites in Gombe state, a buffer was generated around each facility using the WHO guide line for third world countries which states that each HF service area should cover an area

of 4km radius. Figure 7 shows this delineation and extend of the combined (overlapping) service areas in brown colour and the outreach areas in yellow colour. The identified outreach areas are western Akko and Yamaltu/Deba LGAs, northern and south western Nafada, western Funakaye, northern Kwami and some parts of southern Dukku LGA.

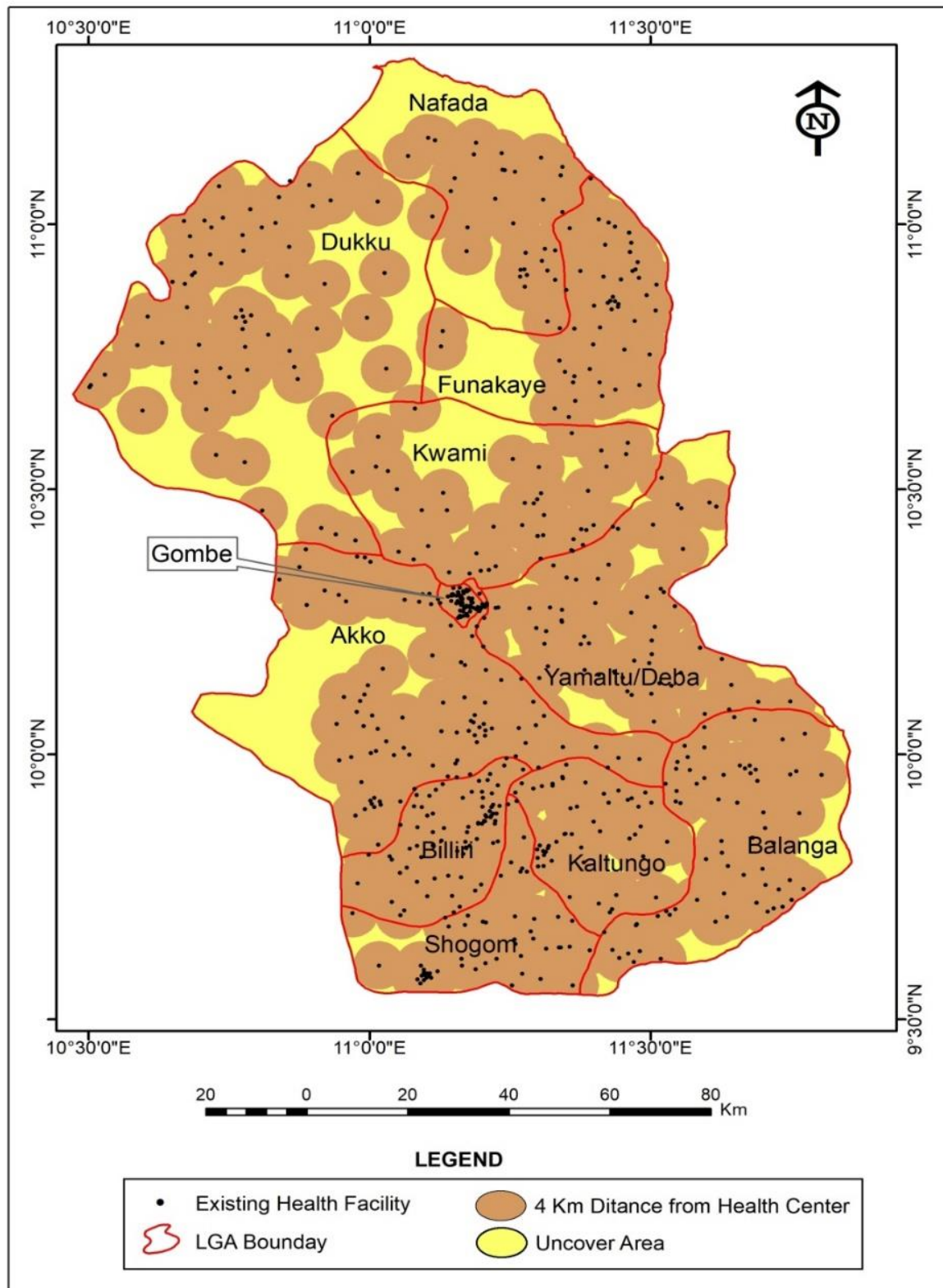


Fig. 7: Health Facility Service Area

In order to locate new sites for the development of HF, the demarcated service area map was then changed to KML file format and opened in Google Earth engine where the outreach areas were zoom-in and systematically detecting any available settlements therein and ‘placemarks’ were

placed at each identified location. Coordinates of the identified placemarks were retrieved and recorded. The positions of propose new facility sites were displays on figure 8 and their coordinates given in Table 3.

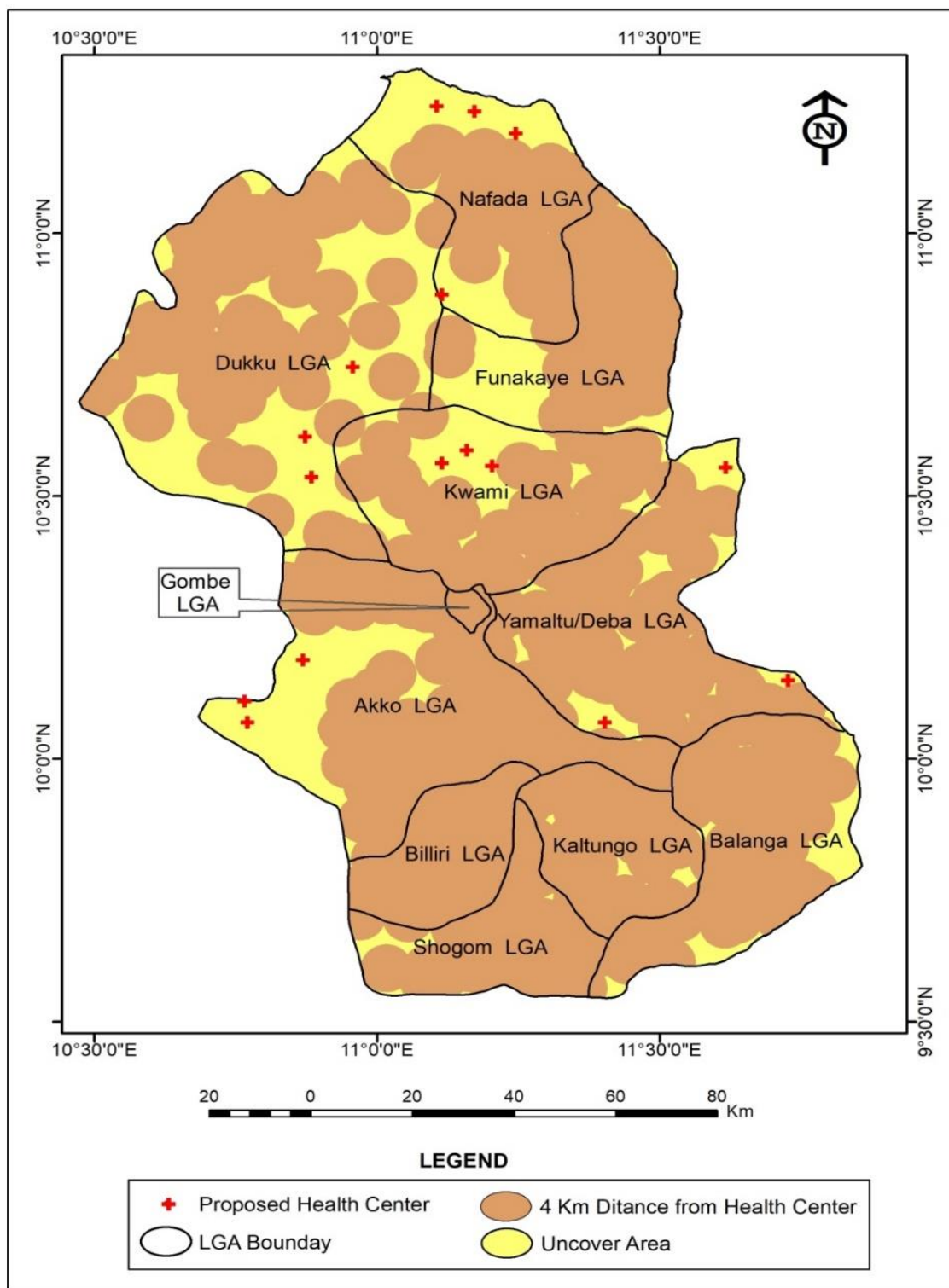


Fig. 8: Location of the Proposed Health Facility

Figure 8 and Table 3 shows the location of the new health facilities recommended for development in Gombe state. Nafada LGA has the higher number of the proposed HF where four locations identified, while Akko, Dukku,

Kwami and Yamaltu/Deba LGAs each have three sites. The outreach areas where no HF is place were farm lands, forest, hills or waterbody, hence there are no settlements and therefore, no facility was proposed.

Table 3: Coordinates of the Proposed Facility Sites

S/NO	EASTINGS	NORTHINGS	LGA
1	693462	1118025	Akko
2	694128	1113533	Akko
3	704815	1126788	Akko
4	704897	1173693	Dukku
5	706237	1165270	Dukku
6	714110	1188434	Dukku
7	731452	1168317	Kwami
8	736273	1171033	Kwami
9	741186	1167841	Kwami
10	729926	1243480	Nafada
11	731254	1203813	Nafada
12	737290	1242435	Nafada
13	745252	1237872	Nafada
14	763492	1114019	Yamaltu/Deba
15	786468	1167853	Yamaltu/Deba
16	798975	1123097	Yamaltu/Deba

V. FINDINGS

- Geodatabase table of the captured HF was generated and its revealed that there are six hundred and sixty nine HFs in Gombe state
- Among the identified HFs, six hundred and sixty one are at primary healthcare level, fifty two belong to secondary level and only one is at tertiary level
- Five hundred and sixty nine HFs of the primary healthcare level are owned by public health providers while forty seven are privately owned. Of those secondary health facilities, twenty eight belong to public owners and twenty four to private owners. The only tertiary HF is public owned
- There is no any privately owned primary and secondary HF in Kwami and Nafada LGAs. In the other hand, there is no private owned secondary HF in Balanga, Billiri, Shongom and Yamaltu/Deba LGAs
- There is no General Hospital exist in Kwami and Shongom LGAs
- Fifty percent of the privately owned HF are duel in Gombe LGA which is the administrative headquarters of the state
- The only Specialist and Teaching Hospital are located in Gombe LGA
- Sixteen sites were identified for the new HF development within the state; four in Nafada, three each in Akko, Dukku, Kwami and Yamaltu/Deba LGAs.
- Different maps showing HF level, ownership, service and combined catchment were produced.

VI. CONCLUSION

Despite their number, the distribution of health facilities across Gombe state is non-uniform especially in respect of healthcare services. A complete local government (Shongom) lacks any secondary health facility and another (Kwami) lack general hospital. And in general, only few places health facility is not in existence. This study has successfully showcased the capability of GIS as a veritable tool for decision support system for location selection for new health facility. Finally, GIS technology has the potential to transform health surveillance, quick and easy access to large volume of data. GIS is valuable in strengthening the whole process of epidemiological surveillance information management and analyses. Moreover, this system provides analytical support for the planning, programming, and evaluation of activities and interventions in the health sector.

VII. RECOMMENDATIONS

In light of the findings of this research, the following recommendations are made:

- Due to the non-uniformity of health facility services in Gombe state, WHO Universal Health Coverage (UHC) strategy if adapted should be responsive to the variation in health facility distribution across the state
- Additional investments are needed in some parts of the state to improve access to higher healthcare services by constructions of bridges and rehabilitation of dilapidated roads to make easy access and reduce travel time to those healthcare centers.
- Local government in collaboration with state government should provide sixteen primary health centers in the identified areas so that to deliver health services to all throughout the state.

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