CARD International Journal of Social Sciences and Conflict Management
Volume 2, Number 3, September 2017
ISSN: 2536-7234 (Print) : 2536-7242 (Online)
www.casirmediapublishing.com

Analysis of Spatial Distribution of Public Primary Schools in Kirfi Local Government Area, Bauchi State, Nigeria

Adam Modu Abbas; Abubakar A. Jajere & Yam, Abdullahi
Department of Geography
Federal University, Kashere, Gombe State
Email: dradamabbas28@gmail.com
Corresponding Author: Adam Modu Abbas

ABSTRACT
This study analyses the spatial distribution of public primary schools in Kirfi Local Government Area of Bauchi State, Nigeria. Both qualitative and quantitative approaches as well as descriptive cross sectional survey were employed to make an investigation of the phenomenon. Data were collected from 100 respondents by using in-depth interviews, measurements and observations. Nearest Neighbour analysis was used to determine the spatial distribution pattern of the public primary schools in the study area where the result reveals that schools are clustered and the value of Nearest Neighbour index (Rn) was computed and was found to be a Z-Value -7.124643 at 1887.595660 Meters Observed Mean Distance and 3608.025269 Meters Expected Mean Distance. The Z-Score of -7.124643 indicates less than one percent (≥1%) likelihood that the distribution pattern exhibits clustering because, the schools are located close to settlements. The result further reveals 'closeness to the schools' as the major factor, the longer the distance that pupils walk from home to schools the lower the level of patronage/enrolment. The influence also brings about dropouts and absentees. The study suggests strategies for improving accessibility of primary education to pupils in the study area and areas for further researches on the roles of geographic locations of schools.

INTRODUCTION

Spatial analysis and accessibility include any of the formal techniques which study entities using their topological, geometric, or geographic properties. Spatial analysis includes a variety of techniques, many still in their early stages of development, using different analytic

approaches and applied in fields as diverse as astronomy, with its studies of the placement of galaxies in the cosmos, to chip fabrication engineering, with its use of "place and route" algorithms to build complex wiring structures. In a more restricted sense, spatial analysis is the technique applied to structures at the human scale, most notably in the analysis of geographic data (Graham, 1985).

The development of any nation depends primarily on its ability to effectively utilise the intellectual resources available to her. The provision of broad and fair access to education is strongly advocated by both the promoters of social equality and justice as well as modern day democracy, who view education as a precondition for advanced development and competitive edge. Accessibility to public facilities here refers to the distance a citizen must cover to receive the desired service. Accessibility to primary school education therefore refers to the measure of the extent to which a country is able to satisfy household/Community demand for basic primary education. The ideal goal of government in providing services to maintain the capability of each neighbourhood in both urban and rural areas, school planning is a type of facility planning, and the distribution of schools is determined by the availability and openness for people's schooling. The practical importance of school location is based on the needs of the residents. The planning of the primary school is of vital importance for both urban and rural development. Article 28 of the UN Convention on the Rights of the Child recognises "the right of the child to education" and also obliges the state to "make primary education compulsory available and free to all". This indicator reflects the distance from a child's house-hold to the school he/she attends. Distance is measured through a proxy indicator: length of time travelled to reach the school attended, which is not necessarily the school nearest to the child's household. The school the child attends is defined as "far" if a child would have to travel more than 30 minutes to reach it, irrespective of mode of transport (Article 28 of the UN Convention on the Rights of the Child). Age 7 – 13 is defined as primary school age, and children age 14 – 17 are defined as secondary school candidates. Access to schools and other educational facilities is a necessary condition for achieving the right to education. A school's location and distance from home may pose a barrier to education. Access to schools is also hampered by poor roads, transport that is unavailable or unaffordable, and danger along the way. Risks may be different for young children, for girls and boys, and are likely to be

greater when children travel alone. For children who do not have schools near their homes, the cost, risk and effort of getting to school can influence decisions about regular attendance, as well as participation in extramural activities and after school events. Those who travel long distances to reach school may wake up very early and risk arriving late or physically exhausted, which may affect their ability to learn (Eray, 2012). Walking long distances to school may also lead to learners being excluded from class or attending school irregularly (Moller-jensen, nd; Masouleh *et al.*, 2009; Matisziw & Murry, 2009).

Principally, in addition to the inadequacy in the number of operational schools, some human factors, spatial location and problem of accessibility, other issues related to the existing primary schools may be militating against having larger school enrolment/patronage.

Nelson (2015) in his research on "Who Would Have Thought Distance to School Had Such an Impact on the Quality of Education?" shows how distance to school recurred as a major factor that was either directly or indirectly linked to the quality of education.

A number of studies have indicated the effect of geographic barrier though not in detail, on the effectiveness of primary school location and patronage by parents/pupils, examples of such studies include Owoeye *et al.*, 2010 which looked at the location of schools as it relates to academic performance of students in Ekiti state of Nigeria between 1990 and 1997, Masouleh *et al.*, (2009) applied GIS in education administration of Iran. Few researches however, have been dedicated to the correlation between school locations and catchment areas of the existing public primary school, distance of a school from home and pupils/parents patronage of schools. This study therefore looks at how the above listed factors affect pupils' accessibility and patronage of public primary schools to the pupils in the Study Area. To the knowledge of the researcher, there have been many studies of this kind in different areas in Nigeria and Bauchi state in particular, studies on locational analyses on health, transport, educational facilities, GSM masses, fuelling stations, vital registration centres and recreation centres have been carried out but no any research work of this kind has ever taken place in the Kirfi Local Government Area being a rural area with high rate of illiteracy.

This study therefore looks at how the above listed factors affect pupils' accessibility and patronage of public primary schools to the pupils in the Study Area. To the knowledge of the researcher, there have been many studies of this

kind in different areas in Nigeria and Bauchi state in particular, studies on locational analyses on health, transport, educational facilities, GSM masses, fuelling stations, vital registration centres and recreation centres have been carried out but no any research work of this kind has ever taken place in the Kirfi Local Government Area being a rural area with high rate of illiteracy. Thus, in the light of the fact that location of public primary schools plays very important role in the educational sector, research into it in a rural/young but rapidly developing LGA like Kirfi is quite worthy of undertaken. This is the focus of this research work. The aim of this study is to assess the levels of spatial distribution and accessibility of Public Primary Schools to the pupils in the study area. This broad aim would be achieved the following objectives; to:

i) Identify and map out the locations and catchment areas of the existing Public Primary Schools in the study area.
ii) Assess the accessibility levels of the existing Public Primary Schools in the study area.
iii) Determine the relationship between levels of patronage of the school services and maximum walking distance of a child to school.
iv) Identify optimum sites for further Public Primary School locations in the study area.

STUDY AREA

Kirfi is a Local Government Area in Bauchi State. It lies between Longitudes 10⁰49′11.819′′E and 10⁰13′53.712′′E, and Latitudes 10⁰40′10.247′′N and 10⁰6′53.806′′N. The Local Government Area is bordering Gombe State to the East and to the South by Alkaleri Local Government Area, North by Ganjuwa Local Government Area and some parts of Dukku Local Government of Gombe State, and finally to the West by Bauchi Local Government and Some Parts of Ganjuwa Local Government as seen on figure 1. Its headquarters is in the town of Kirfi (or Kirfin Kasa) (Figure 1). It has an area of 2,371 km² and a population of 147,618 at the 2006 census. The predominant ethnic group in the area is the Hausa. The Bure and Fulani languages are also spoken in the Local Government Area (Nigerian National Bureau of Statistics, 2010; Post Offices-NIPOST, 2012).

The people are engaged in different kinds of professions ranging from civil service to different forms of businesses and various trades. The majority of the populations are predominantly farmers considering the savannah nature of the land. The main crops grown in the area are maize, rice, millet, sorghum,

beans, groundnut, watermelon, sweet potatoes, sugarcane, cassava etc. The tributaries of rivers Benue and Niger which pass through the local government gave it a unique feature of land and irrigation farming. Majority of the population of Kirfi Local Government Area of Bauchi State settle in rural areas, which have been grouped into thirteen wards with numerous pockets of settlements. The main Towns are Kirfi/Cheledi, Badara and Bara. The main modes of land acquisition include inheritance, family, borrowing, gift, pledge lease and purchase. However land is also acquired through government allocation either at state or local government levels. Also traditional rulers nowadays cultivate the culture of designing a lay-out for allocation or selling to the citizens although with little effort of registration (Aminu, 2016).

Currently, there are about 104 operational primary schools covering all the ten (10) political wards of the Local Government Area with approximately eight (10) schools per each ward.

RESEARCH METHODS

Types and Sources of Data Collection

In this research, two types of data were involved namely: Spatial data and Attribute data. Spatial data includes the coordinates of the existing public primary schools and settlements (Catchment area) collected through field survey by the researcher using Garmin GPS instrument.

Attribute data were obtained from the schools, Local Government Education Authority (LGEA), State Ministry of Land and Housing, Bauchi State and National Centre for Remote Sensing (NCRS), Jos through verbal interaction which includes: Names of the existing schools, places and where they are Located; Total enrolment of the schools; Names of the schools catchment areas, Political wards map of the study area, DEM Image of the study Area etc. Other secondary sources of data include library research, internet research and measurement of distances on maps and through GIS techniques.

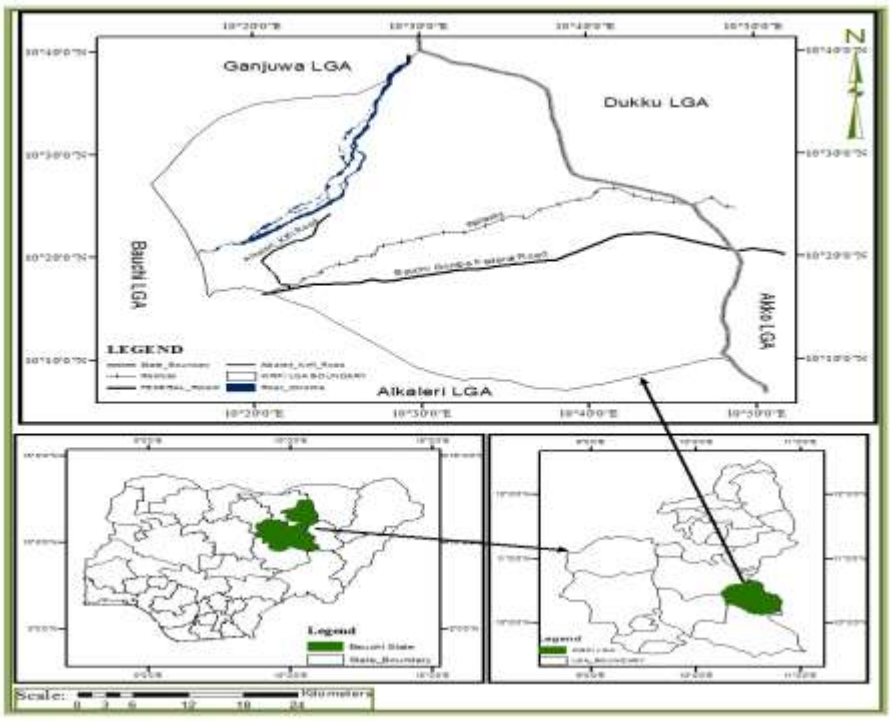

Figure 1: The study area; Kirfi Local Government Area (a), Bauchi State (b), Nigeria (c)
Source: ***Researcher's Analysis, 2017.***

The data collected were downloaded into the computer system for further processing, analyses and easy information retrieval. Digitizers, scanners, Google Earth software, GIS software (Arc GIS 10.1), window based excel were used by the researcher to convert analogue data to digital.

Techniques and Procedures of Data Collection

The procedure used in identifying and mapping out the locations and catchment areas of the existing Public Primary Schools in the study area, involves the researcher going to the field to capture the coordinates of each primary school and localities served or supposed to serve by the schools using a handheld Global Positioning System (GPS) receiver and the nature of the coordinates used includes; Northing (y) and Easting (x) (coordinates) for identification and mapping out the current operational public primary schools in relation to the localities within their Catchment Areas in the study area. To

run terrain analysis Digital Elevation Model (DEM) Image was source from source from National Centre for Remote Sensing (NCRS), Jos.

Road networks of all the sampled wards and settlements were acquired in the GIS platforms and accessibility was assessed using Euclidean distance measurements in order to assess the efficiency levels of the existing Public Primary Schools in the study area. All the accessibility characteristics were stored in a relational database system linked to the GIS database. The secondary data used, that is; the high resolution image and administrative maps were scanned, geo-referenced, and thematic features such as road network, political wards location, and other existing infrastructures were extracted using onscreen digitizing. GPS coordinate of schools, schools data (Names and address), have been properly geo-coded and integrated into ArcGIS database. All digitized thematic data were updated with Google earth image software.

According to Archer and Dalton (1968) in Abbas, A.M. (2012), "the essence of interviewing is tact, both in what is said and done." In-depth Interview was conducted to assess the levels of efficiency; patronage of the services and maximum walking distance as well as the names of localities and wards was all conducted with the members of the local education Authority and parents/pupils on their views and perceptions about present location of the primary schools and suggestions on improvement in the system. In all, 45 stake holders were randomly interviewed. The interviewees were either met in their homes or offices by the interviewers. The perceptions of all interviewees on impact and efficiency of the primary schools and problems of inadequacy of the schools as well as their most preferred locations were extracted from the interviews with them.

TECHNIQUES AND PROCEDURES OF DATA ANALYSIS

Data analysis consisted of a GIS data analysis for the spatial distribution, accessibility, and statistical analysis to show the representations of the results of the GIS analysis. Pupils point location distance to school can be used in analysis as either a policy-consistent binary variable, indicating whether or not mobility is occurring (based on a given cut-off distance), or as a continuous measure, indicating the extent to which mobility is occurring. Results using both of these approaches are presented here. Various distance-based definitions of what constitutes learner mobility have been advanced, ranging from travel of over 3 km. In current official policy, a school's catchment area is defined as the area

within a 3 km radius of the school, suggesting that this is felt to be the maximum distance a child should travel (Martin, 2010). Data collected from all the sources were analyzed and interpreted in line with the objectives of the study using mathematical, statistical and GIS techniques.

A spatial analysis was performed on the set of the data acquired from the GPS. The coordinates (X, Y) of the schools was used to determine the distances from each point to its Neighbours, and the distances were then used in determining the distribution pattern of these schools and mapping of the schools in relation to their catchment settlements in the study area. Other Several GIS analyses carried out to achieve the set objectives of the study include:

The Proximity Analysis:

It includes buffering of the public primary schools serving the pupils location to show the proximity of point location of pupils up parcel to them and Query of houses or localities that fall within a given distance to the service (schools). Buffering can be defined as the creation of the zone of interest around a feature. It can be done on point, line or polygon feature. It can be either inside or outside the catchment area/polygon boundary or both. The Multiple Ring Buffer being another useful technique that was carried out shows a buffer zone that informs us about the coverage area of a particular school. In this study the buffers of the points and polygon features are carried out as buffer of schools in radius of 1-3km. Buffer of all the 61 public primary schools to observe the areas covered by the school in the four sampled Wards, where about 1220 point locations of the pupils are displayed. The locations outside the buffers are allocated to the nearest

Digital Terrain Analysis

Showing area that point location of pupils was obstructed by physical factors like hills, valleys etc. Using Digital Elevation Model (DEM) Image of the study area

The Nearest Neighbour Analysis

This examined the distance between each point and the closest point to it and measures the extent to which a particular pattern is clustered (nucleated), Random and Regular (uniform) and the Euclidean method that measure the

distance between two points along a straight line will be used in order to determine the spatial pattern of distribution of primary schools in the study area. The Average Nearest Neighbour tool measures the distance between each feature centroid and its nearest neighbour's centroid location. 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 analyzed is considered clustered. If the average distance is greater than a hypothetical random distribution, the features are considered dispersed. The average nearest neighbour ratio is calculated as the observed average distance divided by the expected average distance (with expected average distance being based on a hypothetical random distribution with the same number of features covering the same total area).

Different thematic maps of settlement (Point), Primary schools (Point), and other physical features such as roads, rivers etc were overlapped to create comprehensive map of the study area and the data collected from the field were then subjected to mathematical and statistical analysis, using mainly descriptive and inferential statistics such as percentages and charts.

RESULTS AND DISCUSSION

Mapping of the Existing Public Primary Schools and their Catchment Areas

The Spatial distribution of public primary schools in the study area is presented on figure and table 4. Names, locations, wards and the number of catchment for each school as well as geo-coordinates in Decimal Degree (DD) for easy computing in GIS environment are all shown. Figure 2 shows that, there are sixty one (61) public primary schools and ninety two (92) catchment area point locations in the four sampled wards of Kirfi Local Government Area, Bauchi State.

The process of establishing a digital map of both the spatial distribution of public primary schools and location of their catchment areas led to the implementation of actual location-allocation models. Figure 2 maps out the sixty one (61) current public primary schools in the four (4) sampled political wards and ninety two (92) settlements within their catchment area. Displayed locations for all settlements within their catchment area captured using GPS they indicate that Bara ward has the largest number of the schools with twenty (20) public primary schools making about one-third ($^1/_3$) of the total number of the schools (32.8%), followed by Beni ward with seventeen (27.9%), then Badara

ward with fifteen (15) that is about ¼ (one quarters) (24.6%) and lastly Wanka ward with Nine (9) public primary schools being the least comprising 14.7%. It is also noticed that only Bara community has about three primary schools because of its population. All these are presented on Figure 2 below

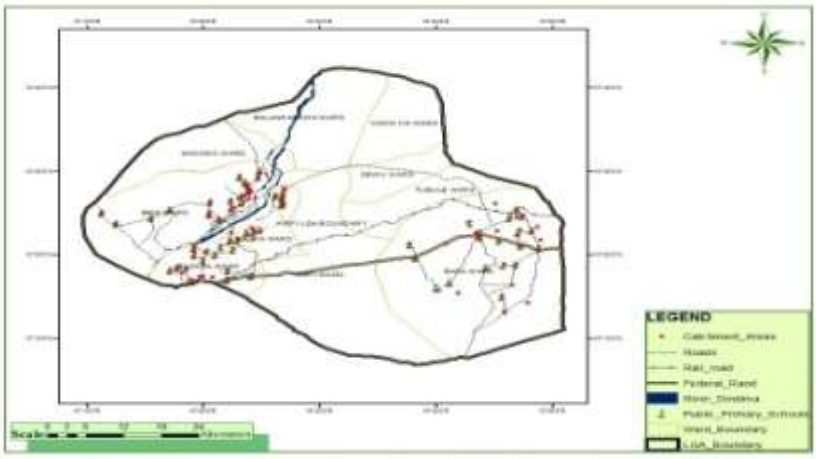

Figure 2: Schools Location and their Catchment Areas in the Four Sampled Wards
Source: ***Researcher's Analysis, 2017.***

Figure 2 above shows the number of public primary schools in percentage of the four (4) sampled political wards of Kirfi Local Government Area, Bauchi State.

Average Nearest Neighbour Analysis (ANNA)

The geo-coordinates of public primary schools captured was used to compute the distances from each school to its neighbours, that is **ANNA** which measures the distance between each feature centroid and its nearest neighbour's centroid location was performed in order to measure the spatial pattern of distribution of public primary schools in the study Area as shown on Figure 4.

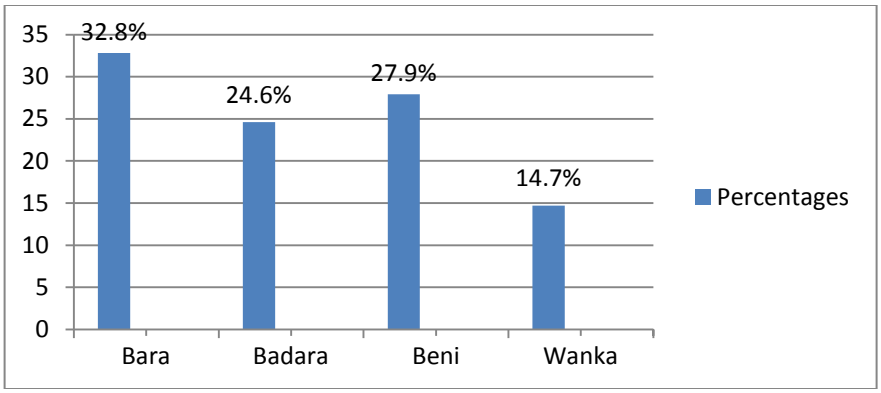

Figure: 3 Numbers of Public Primary Schools in the Four (4) Sampled Wards
Source: ***Local Education Authority, Kirfi Local Government Council (2017)***

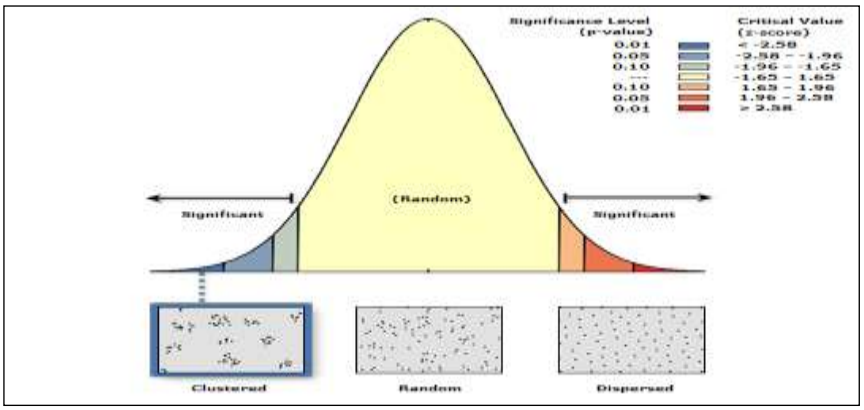

Figure 4: Clustered Pattern of Schools Spatial Distribution of Primary Schools
Source: ***Researcher's Analysis***

The Average Nearest Neighbour tool presented on Figure 4 above shows that distance between each school being the centroid and its nearest neighbour's centroid location are clustered. The average nearest neighbour ratio is calculated as the observed average distance divided by the expected average distance (with expected average distance being based on a hypothetical random distribution with the same number of features covering the same total area).

The summary of Nearest Neighbour Analysis on table 1 reveals a Z-Value of -54.903853 at 110.714746 Meters Observed Mean Distance and 620.806342 Meters Expected Mean Distance. The Z-Score reveals less than one percent (≥1%) likelihood that the distribution pattern is by random chance. Therefore, since the index (average nearest neighbour ratio) is less than 1, the

pattern exhibits clustering, but had it been the index is greater than 1, the trend would have been considered trending toward dispersion. The equations used to calculate the average nearest neighbour distance index (1) and z-score (4) are based on the assumption that the measured points are free to be located within Kirfi Local Government Area. For example, there are no barriers, and all features are located independently of one another. The p-value is a numerical approximation of the area under the curve for a known distribution, limited by the test statistic.

Table 1: Average Nearest Neighbour Summary-Data Set Information

Observed Mean Distance	Observed Mean Distance	Nearest Neighbour Ratio	z-score	p-value
110.714746	620.806342	0.178340	-54.903853	0.000000

Source: ***Researcher's Analysis***

The Accessibility Levels of the Existing Public Primary Schools in the Study Area

Accessibility to public primary schools in the study area can be examined on certain geographic relationship between provisions and needs. It is believed that accessibility is a concept that serves as an indicator of rural deprivation, and as a variable in location analysis. Accessibility can be quantified in many ways but for the purpose of this research, the total (or average) travel distance, travel time, cost, accessibility in terms of terrain, and road network for all the pupils attending the primary school in the area are considered. Children's travel to school is moderated by school choice, as this influences enrolment patterns and has the potential to increase the distance travelled by children (Pooley, Turnbull, and Adams, 2005) "The Journey to School in Britain since the 1940s: Continuity and Change".

Accessibility in Terms of Distance

Buffering being the creation of the zone of interest around a feature which was done on point locations of schools in relation to the pupils point locations in the study area determines the maximum walking distance pupils covered to school which also affect the levels of patronage of the service offered by the schools.

Figure 5 below shows the buffered schools' point locations (Coordinates) in radius of 1km, 2km and 3km, (multiple ring buffering). It indicates the

displayed ninety two (92) school catchment area point location in relation to the point locations of the sixty one (61) schools in the sampled wards under study. The displayed Catchment area point location outside the buffers zone of 3km indicate that, the pupils walking distance in these areas is greater than 3km, this affect the level of patronage by the pupils in these areas.

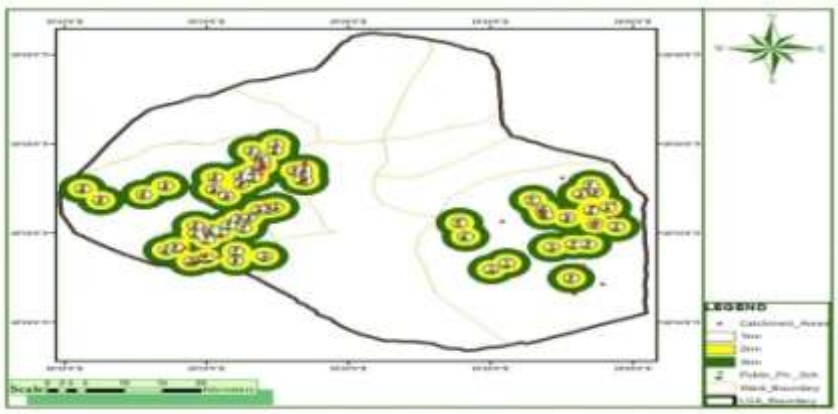

Figure 5: Buffer Zone of Schools Point Location in Radius of 1km- 3km in Relation to Schools Point Location
Source: ***Researcher's Analysis 2017***

Table 2 below shows the summary distance travelled to public primary school by pupils in the study area which shows that out of 400 pupils point locations in Bara ward, more than three quarter (¾) that is 85.3% of the pupils are located within 1km, 6% are within 2km, 3% are in 3km and 5.5% are located outside the buffer zone who travel more than 3km to reach schools every day.

Buffer Zone of Pupils Point Locations in Radius of 1km- 3km

Figure 6 shows that some catchment areas that fall outside the buffer zone of 3km in Bara ward are Kashere village (catchment area of Zangoma Primary School), Garin Malam Sani, Sabon-Garin Bani and Rugan Udawa (catchment area of Bani primary school) and Finally Jamari village (catchment area of Kalajanga Primary School).

Table 2: Distance Travelled to Public Primary School Pupils in the Study Area

LOCATION (WARD	DISTANCE FROM HOME TO SCHOOL								TOTAL AVERAGE DISTANCE TRAVELLED	
	0-1km/%		2km/%		3km/%		> 3km/%			
Bara ward	341	85.3%	24	6%	13	3.2%	22	5.5%	400	100%
Badara ward	268	89.3%	31	10.3%	1	0.4%	0	0%	300	100%
Beni ward	305	89.7%	30	8.8%	5	1.5%	0	0%	340	100%
Wanka ward	172	95.6%	8	4.4%	0	0%	0	0%	180	100%
TOTAL	**1086**	90%	**93**	7.3%	**19**	1.3%	**22**	1.4%	**1220**	100%

Source: ***Researcher's Analysis 2017***

This has seriously affected the level of patronage of pupils living in these areas based on the in-depth interview conducted by the researcher in the course of the research as well as the school enrolment data which indicates the addresses of pupils gotten from various schools under study.

Badara ward has a good coverage of public primary schools. The ward has 15 public primary schools as seen on Figure 6 below. It shows that out of 300 pupils' point locations in Badara ward, 89.3% (almost 90%) of the pupils are located within 1km, 10.3% are within 2km, 0.4% are within 3km and with 0% located outside the buffer zones, it indicates that none of them (the pupils) travel more than 3km to school.

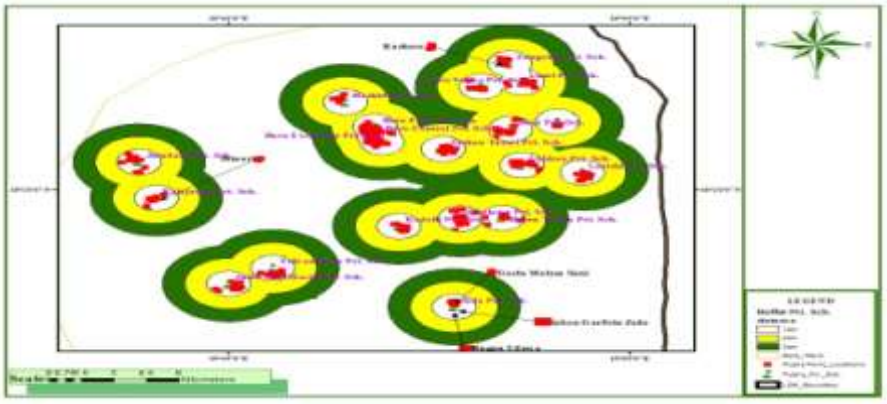

Figure 6: Buffer Zone of Schools Point Location in Radius of 1km- 3km of Bara Ward

Source: ***Researcher's Analysis 2017***

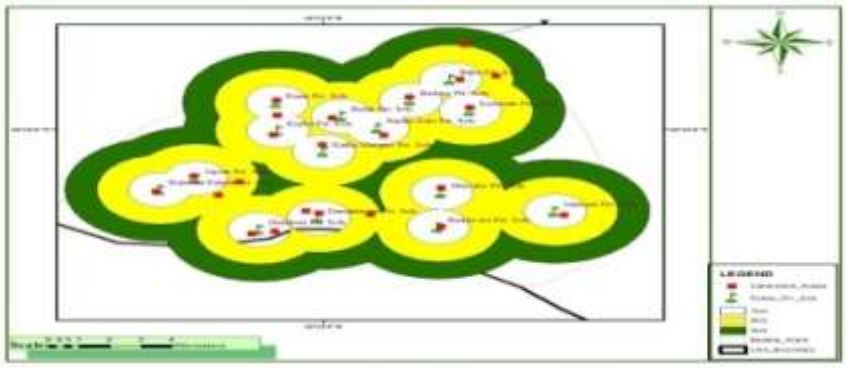

Figure 7: Buffer Zone of Schools Point Location in Radius of 1km- 3km of Badara Ward
Source: ***Researcher's Analysis 2017***

Beni ward is another ward that has a good coverage of public primary schools. The ward has 17 public primary schools as seen on figure 8 below. It shows that, out of 340 pupils' point locations in the ward, 89.7% (almost 90%) of the pupils are located within 1km, 8.8% are within 2km, 1.5% are in 3km and with 0% located outside the buffer zones, which also indicates that none of them (the pupils) travel more than 3km to school. This can be seen on figure 8 below.

Figure 8: Buffer of Schools Point Location in Radius of 1km- 3km of Beni Ward
Source: ***Researcher's Analysis, 2017***

Lastly, Wanka ward has the least number of public primary schools with 17 public primary schools as seen on Figure 9 below. It shows that out of 180 pupils' point locations in the ward, 95.6% of the pupils are located within 1km,

4.4% are within 2km, while 0.0% in 3km and with 0% above 3km, which also indicates that none of them (the pupil) travels more than 2km and 3km to school.

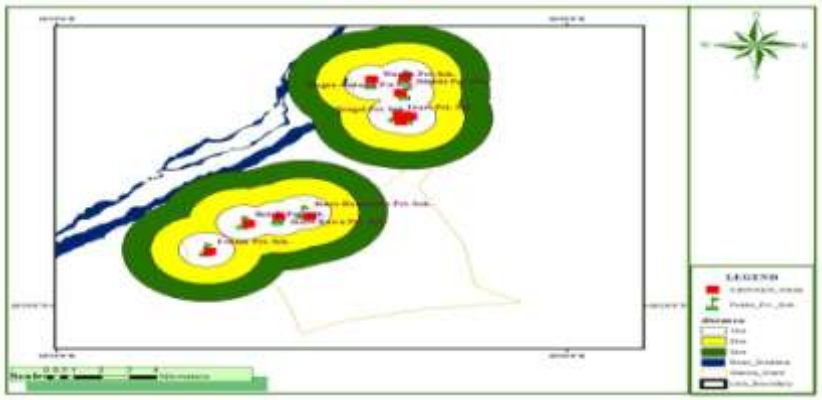

Figure 9: Buffer of Schools Point Location in Radius of 1km- 3km of Wanka Ward
Source: ***Researcher's Analysis, 2017***

Generally, distance travelled to school has some measure of relationship with offences like absenteeism, delinquency, truancy, lateness, indiscipline, and non-attendance at school. According to 3 when the distance travelled to school is too far for the child, besides fatigue, there is the tendency for the child to lose interest at school and begin to be truant, and may drop out of school completely, this affect some catchment areas that travel above 3km to school, areas like Kashere, Sabon garin Bani, and Jamari. Parents are only comfortable to let their children walk to primary schools when they are old enough. Unfortunately this could be at an age older than the recommended seven (7) years. AIT News Hour (2008) also reported that, statistics in Nigeria today show that more than fifty percent of primary school pupils drop out of school yearly, and this is worse in some North-eastern states. It has also been observed that cases abound where children travel more than 3km and above to school on foot as the case may be.

Accessibility in Terms of Road Network

The researcher found out that most common means of transport used by pupils who live long distances away from schools are walking or cycling as seen on table 3 The road infrastructure in most of the rural areas in the study

area are quite poor with no or very few vehicles plying the routes and in some areas motorist are seen only seasonally

Table 3: Means of Transport from Home to School of the Respondents

WARD	Bicycle %		Tracking %		School Bus %		Private %		Commercial %		TOTAL	
Bara	5	20%	15	60%	0	0%	3	12%	2	8%	**25**	**100%**
Badara	5	20%	20	80%	0	0%	0	0%	0	0%	**25**	**100%**
Beni	10	20%	15	60%	0	0%	0	0%	0	0%	**25**	**100%**
Wanka	2	20%	23	92%	0	0%	0	0%	0	0%	**25**	**100%**
TOTAL	**22**		**73**		**0**		**3**		**2**		**100**	

Source: ***Researchers' Analysis, 2017***

Access to road network can be linked to the higher school enrolment of pupils. Figure 10 shows that schools that are more closer to federal and state roads that pass the Local Government Area have more enrolment than those far from the roads. To find this, the researcher buffers the federal and state roads in the study area as shown below on figure 10. The researcher considers schools that fall inside the buffer zone as more accessible schools.

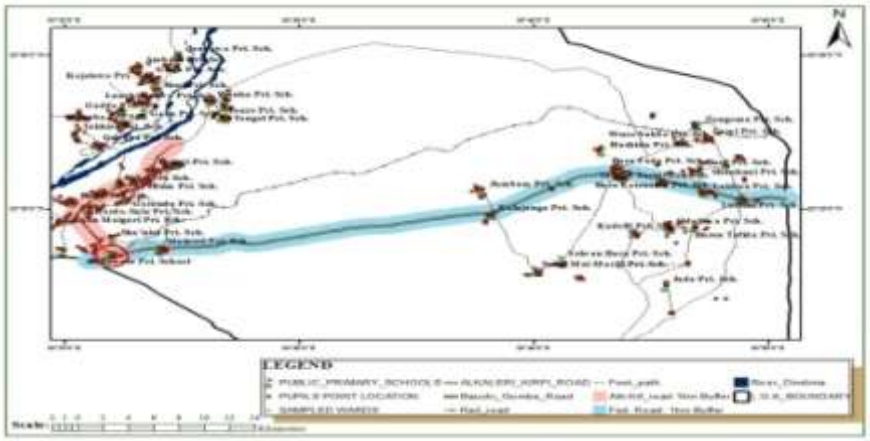

Figure 10: Road Network in Radius of 1km in the Study Area
Source: ***Researcher's Analysis, 2017***

Each public primary school is obliged to make an annual statistical enrolment return to Local Education Authority (LEA) in the first instance to the year. This return is compiled and forwarded to the State Universal Basic Education Board (SUBEB), Bauchi State by the LGEAs. The statistics include enrolments by sex; qualifications of teachers, number and quality of buildings. But for the purpose of this study, the researcher limits this to the names of schools, total enrolment by sex and the grand total as seen on table 4 below. Statistics on enrolments by sex and grade are available for many years from annual reports of the SUBEB, but the first published statistics are for 2016\2017. It indicates that, Bara Central Primary School has the highest population of school enrolment with one thousand, six hundred and seventy one (1671), followed by Badara primary school with nine hundred and forty four (944) pupils and the least in population is Dikkiti Primary School with the total of thirty nine (39) pupils.

Figure 11 and table 4 show the summary of the 2016/2017 school enrolment where the boys are having the highest population of 8101 slightly more than half (56.2%) and girls have 6303 (43.8%).

Table 4: Primary School Names by Wards and 2016/2017 Pupils' Enrolment

S/N	NAME OF SCHOOL/WARD	STUDENTS ENROLMENT		
		BOYS	GIRLS	TOTAL
1.	Bara Central Pri. Sch./Bara Ward	895	776	**1671**
2.	Tashan Turmi Pri. Sch./ "	189	149	**338**
3.	Lakkau Pri. Sch./ "	160	98	**253**
4.	Lariski Pri. Sch./ "	154	118	**272**
5'	Lomi Pri. Sch./ "	122	96	**218**
6.	Shankaru Pri. Sch./ "	107	122	**229**
7.	Zangoma Pri. Sch./ "	193	172	**365**
8.	Wuro Yabbe Pri. Sch./ "	94	95	**189**
9.	Bara Fada Pri. Sch./ "	215	154	**369**
10.	Hashidu Pri. Sch./ "	115	126	**241**
11.	Bani Pri. Sch./ "	90	100	**190**
12.	Buren Tafida Pri. Sch./ "	95	69	**164**
13.	Kadolli Pri. Sch./ "	158	140	**298**
14.	Jada Pri. Sch./ "	107	64	**171**
15.	Yelwan Bara Pri. Sch./ "	84	10	**94**
16.	Kalajanga Pri. Sch./ "	157	177	**334**
17.	Jumbam Pri. Sch./ "	94	67	**156**
18.	Sale Mai Maciji Pri. Sch./ "	95	69	**164**
19.	Odulawa Pri. Sch./ "	73	42	**115**
20.	Bara Extension Pri. Sch./ "	112	95	**207**

21.	Badawere Pri. Sch./Badara Ward	84	81	**165**
22.	Kafin Maigari Pri. Sch./ "	158	78	**236**
23.	Badara Pri. Sch./ "	579	365	**944**
24.	Baba Pri. Sch./ "	152	129	**281**
25.	Gorondo Pri. Sch./ "	82	69	**151**
26.	Hardo-Sule Pri. Sch./ "	88	56	**144**
27.	Butta Pri. Sch./ "	69	84	**153**
28.	Kurba Pri. Sch./ "	60	61	**121**
29.	Kuna Pri. Sch./ "	79	56	**135**
30.	Jojoto Pri. Sch./ "	100	38	**138**
31.	Dembori Pri Sch./ "	104	118	**222**
32.	Dandalmari Pri. Sch./ "	163	98	**261**
33.	Sha'iska Pri. Sch./ "	39	59	**98**
34.	Mainari Pri. Sch./ "	115	81	**196**
35.	Kumbin Fulani Pri. Sch./ "	76	56	**132**
36.	Jannawa Pri. Sch./ Beni Ward	42	31	**73**
37.	Bunduru Pri. Sch./ "	94	67	**161**
38.	Badaki Pri. Sch./ "	90	37	**127**
39.	Beni Pri. Sch./ "	240	163	**403**
40.	Lanchikinewo Pri. Sch./"	105	60	**165**
41.	Kojelewo Pri. Sch./ "	102	86	**188**
42.	Gaka Pri. Sch./ "	155	66	**221**
43.	Sharaba Pri. Sch./ "	159	132	**291**
44.	Guyaba Pri. Sch./ "	173	153	**326**
45.	Takkira Pri.Sch./ "	142	76	**218**
46.	Woso Pri. Sch./ "	106	93	**199**
47.	Gujamba Pri Sch./ "	84	64	**148**
48.	Kudullu Pri. Sch./ "	79	73	**152**
49.	Ginja Pri. Sch./ "	62	41	**103**
50.	Gadda Pri. Sch./ "	81	56	**137**
51.	Ambara Pri. Sch./ "	96	85	**181**
52.	Tumburuwal Pri. Sch./ "	53	61	**114**
53.	Taure Pri. Sch./ Wanka Ward	164	100	**264**
54.	Wanka Pri. Sch./ "	219	153	**372**
55.	Tongel Pri. Sch./ "	71	42	**113**
56.	Rugan Auduwa Pri. Sch./"	69	84	**153**
57.	Jauro Hammadu Pri. Sch./"	98	99	**197**
58.	Jauro Kawu Pri. Sch./ "	123	134	**257**
59.	Feltum Pri Sch./ "	137	97	**234**
60.	Dikkiti Pri. Sch./ "	18	21	**39**
61.	Bedoji Pri. Sc./ "	82	61	**143**
	TOTAL	8101	6303	14404

Source: ***Statistics Unit, Planning Research & Statistics Department, Kirfi L.G.E.A (2017)***

Accessibility in Terms of Terrain or Topography

Terrain is another factor that serves as a barrier to access to public primary schools in the study area. The Hill-shade analysis performed below on Figure 11 shows the hypothetical illumination of a surface by determining illumination values for each cell in the raster. This was done by setting a position for a hypothetical light source and calculating the illumination values of each cell in relation to neighbouring cells. It has greatly enhanced the visualization of a surface for analysis or graphical display using good transparency. Default, shadow and light are shades of gray associated with integers from 0 to 181 (increasing from black to white).

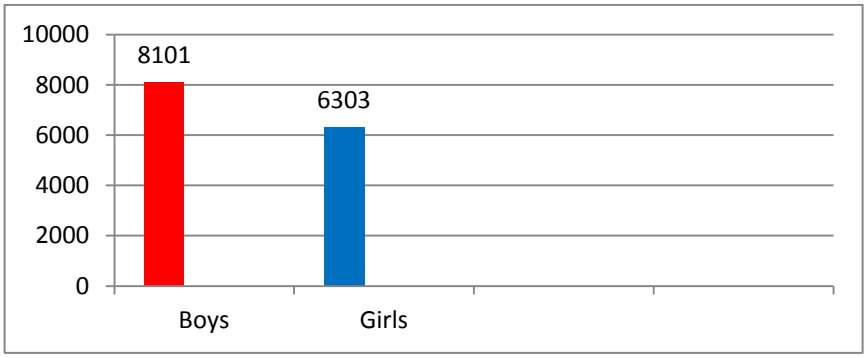

Figure 11: Bar chart Representation of 2016/2017 Boys and Girls Enrolment, Kirfi LGEA

Source: ***Researcher's Analysis 2017***

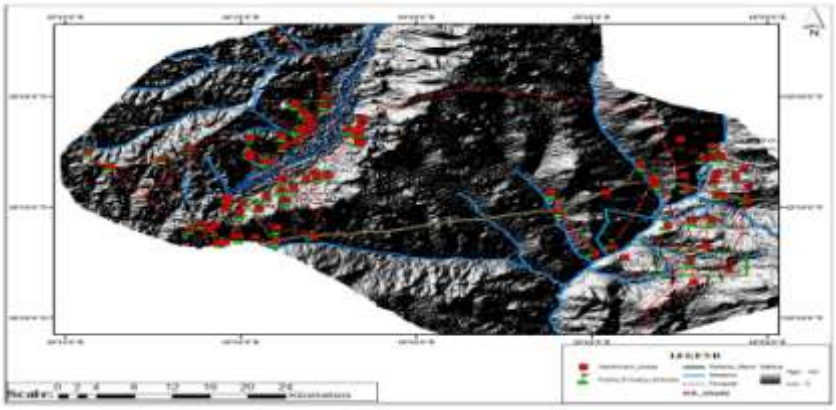

Figure 12: Hill-shade Analysis using Digital Elevation Model Image for the Terrain of the Study Area

Source: ***NCRS Jos, 2017***

Figure 12 above displays the catchment areas, point location of public primary schools, roads, river Dindima and other streams. The terrain vividly shows that there are areas that are blocked by stream to schools. One of these settlement areas is Garin malam sani under Jada Primary school.

Relationship between Levels of Patronage of the School Services and Maximum Walking Distance by the Pupils

Distance travelled to school has some gauge of relationship with patronage in the study area. According to Arubayi and Duze (2005), when the distance travelled to school is too far for the child, besides fatigue, there is the tendency for the child to lose interest at school and begin to be truant, and may drop out of school completely. Therefore, in order to assess the relationship between levels of patronage of the services and maximum walking distance a child travel to school. The researcher found out some factors responsible for pupils' choice of school as listed on table 5 below.

Table 5: **Factors Responsible for Pupils' Choice of School**

NAME OF SCHOOL	PUBLIC PRIMARY SCHOOLS	PERCENTAGE
Closeness to House	52	52%
Affordability of fees	10	10%
Quality of school	05	5%
Close and affordable	20	20%
Closeness and quality	4	4%
Affordability and quality	9	9%
TOTAL	**100**	**100%**

Source: ***Field Survey, 2017***

Table 5 shows that slightly more than half were admitted on the basis of proximity to houses as a criterion which is the highest, followed by Closeness and affordability of school fee carrying 20%, while Affordability of fees has 10%. Affordability and quality having 9%, while quality of schools goes with 5%, and finally 4% were for closeness and quality. This implies that majority of pupils attend schools because of the closeness to their houses. This further shows that most of the children are from poor family background.

Pupils' Point Locations and the Schools Being Attended

Parent/guardians also admitted that, they are only comfortable to let their children walk to primary schools that are closer to their houses in the study area. Therefore, the researcher takes the pupils point locations and schools they attend to see the actual relationship between the effect of distance and schools patronage as seen on figure 13.

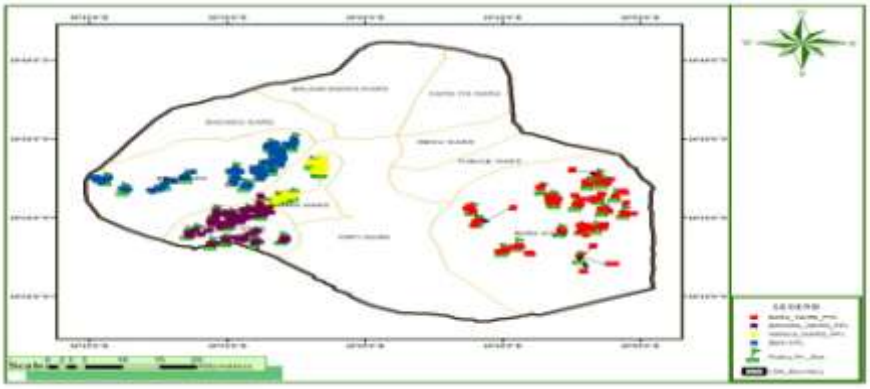

Figure 13: Pupils point location and the school they attend in the study area
Source: ***Field Survey, 2017***

The above figure shows the pupils point location and the school they attend in the study area where by all indications show that majority of the pupils attend schools that are closer to their residential homes. To view this more vividly, figure 14 shows some pupils' point locations that belong to Badara ward but because of their proximity to Wanka ward, instead of the pupils to patronise Baba public primary school (which is in their political ward) they patronised Feltum Primary school of Wanka ward because of their proximity.

It can be concluded that, the closer the schools are to pupils' point locations the more patronage the school receives.

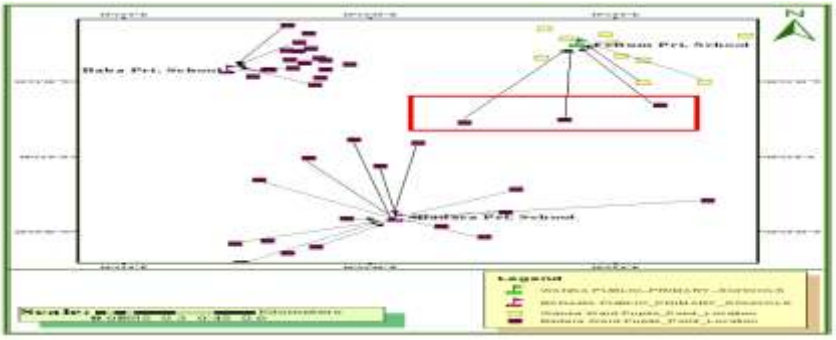

Figure 14: Pupils Point Locations that are Patronising Schools outside their Political Ward Boundary
Source: ***Field Survey, 2017***

How Distance Affect Enrolment Status of Public Primary Schools

Generally, table 8 shows the clear representation of pupil's school enrolment in the four sampled wards of the study area. The table show how school enrolment decreases as the distance from location of school increases. For example, table 9 shows that Bara central primary school with its catchment area within the radius 1km has more enrolment than its counterpart, Jada primary school with its three catchment areas far from the school service centre.

Recommendations for Optimum Location of Public Primary Schools in the Study Area

To identify optimum locations as potential vital Public Primary Schools and best boundaries for their catchment areas in the study area, the researcher interviewed the pupils and parents/guardians. The perceptions of all interviewees on impact and efficiency of the primary schools and problems of inadequacy of the schools as well as their most preferred locations were ascertained. The result shows that, there is still need for more schools in areas like Kashere village, Jamari, Garin ma[lam sani, Rugan udawa and Sabon garin Jada all in Bara ward. The perceptions of all interviewees on impact and efficiency level of the primary schools services. Therefore, proposed sites can be seen on the figure. The figure deduced that Bara Ward has the highest number of Public Primary schools (20), with about thirty five (35) catchment areas around them. Some are located far from the schools. Therefore, it is suitable to have additional primary schools within the areas to be able to reduce walking distance of pupils in these areas. To have the accurate distance covered, the

researcher buffer the schools point location to 1km – 3km in order to find out areas suitable for proposed location of new schools.

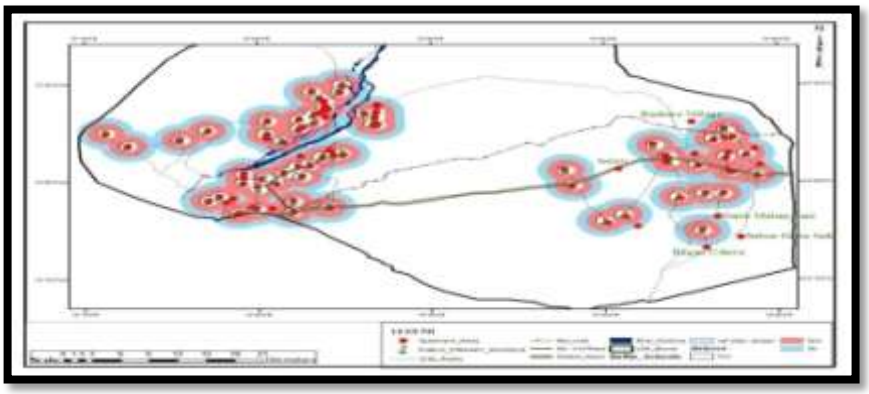

Figure 15: Buffer Zone arround the public Primary schools
Source: ***Author's Analysis, 2017***

From the buffer created above around the public primary schools, it is observed that there is a limited coverage between Kashere, Mainari, Rugan Udawa and Garin Malam Sani villages all in Bara ward. This implies that if additional primary schools are to be located, it would give a maximum coverage within the area which would help in reducing distance barrier that is denieying the pupils access to Primary education. It is noted that the establishment of accessible primary schools would complement the efforts of one of the components of the Sustainable Development Goals (SDGs) in achieving universal basic education for all boys and girls by the year 2020.

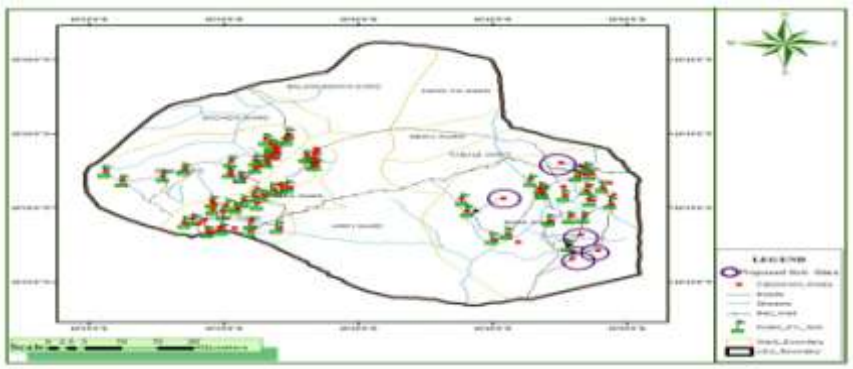

Figure 16: Spatial Distribution of Primary Schools and their Catchment Areas
Source: ***Author's Analysis, 2017***

CONCLUSION AND RECOMMENDATION

Conclusion

The study assesses the levels of spatial accessibility and efficiency of the current public primary schools to the people of Kirfi LGA and identified areas where new potential public primary schools should be optimally located. Based on the aim of the research and the foregoing results, the study is concluded as follows:

Inadequacy of number of public primary schools especially in the rural areas with the consequence problem of accessibility calls for adoption of measures which include additional 2-4 public primary schools in Bara political ward as identified by this study keeping existing locations fixed. This is because it is observed that the relocation of an existing centre is not only difficult but also not viable economically and politically. But if optimal location criterion such as the demand weighted distance (trek able distance) modelled by this study is adopted for any future additional locations geographical accessibility and efficiency level of public primary schools coverage can be improved.

The study portrays the use of average nearest neighbour analysis in determining the distribution pattern of primary schools in the study area. The study shows that the distribution of primary schools in the study area is clustered (uneven). The clustering pattern shows urban biasness in the distribution of schools which is a signal of huge differential and paucity in the distribution of public primary schools among the various wards. In the case of the study area, most of the schools are located based on the clustered distribution of the localities being in rural Areas. It is therefore, important that government and other stakeholders strive to ensure that distribution of schools is even across the Local Government for easy accessibility.

Recommendation

It is recommended that, the use of GIS technology as a planning tool can be employed to enhance the location of educational infrastructure for equivalent and proper distribution. The authorities in-charge of approval and location of new primary schools should as a matter of policy always take into consideration the maximum distance of one kilometre between schools. More schools should be established in communities where the pupils' population exceeds the minimum recommended. These will help in effective achievement

of the Education for All (EFA) by the Sustainable Development (SDGs) goals of 2020.

For further investigation there are numerous areas relating to the spatial distribution of public primary schools that can be carried out in addition to the fact that even this study can still be replicated in other Local Governments.

REFERENCES

Abbas, A. M. (2012): Locational Analysis of Vital Registration Centers and Implications on Birth Registration Coverage in Gombe State, Nigeria.

AIT News Hour (2008)

Aminu A. (2016). Analysis of Smallholder Farmers' Adaptation Strategies to Rainfall Variability in Kirfi Local Government Area, Bauchi State, Nigeria.

Arubayi and Duze (2005)

Burrough, P. (1998), Principles of Geographic Information System: New York, Oxford University. New York: Oxford University.

Eray, Okan (2012). Application of Geographic Information System (GIS) in Education*: Journal of Technical Science and Technologies*, Vol.2, pp 53-58.

Masouleh, F. A. N., Murayama, Yuji & Rho'Dess, Todd Wendell (2009). The application of GIS in education administration: Protecting students from hazardous roads. Transaction in GIS Vol. 13, No. 1, Pp 05-123, Blackwell Publishing Ltd.

Matisziw, T. & Murry, A. (2009). Sitting a facility in continuous space to maximize coverage of a region. Socio-Economic Planning Sciences, Vol. 43, pp. 131-139.

Moller-jensen, Lasse (n.d.). Data Considerations for Location-Allocation Modeling of Public School Districts in Copenhagen. University of Copenhagen. Retrieved from http://gis.esri.com/library/userconf

Nigerian National Bureau of Statistics, 2010; Post Offices-NIPOST, 2012).

Nelson, Muhia, (2015) *"Who Would Have Thought Distance to School Had Such An Impact On The Quality Of Education?"* The Education Research Program at APHRC in Collaboration with the Iganga Mayuge Demographic and Health Surveillance System (IMHDSS)

Pooley, Turnbull, and Adams, 2005

Post Offices-NIPOST, 2012).