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# THE USE OF GIS AS EDUCATIONAL DECISION SUPPORT SYSTEM (EDSS) FOR PRIMARY SCHOOLS IN FAGGE LOCALGOVERNMENT AREA OF KANO STATE, NIGERIA

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## ABSTRACT

*This paper analysed the spatial distribution of Primary schools in the area and the objectives are to make an inventory of the schools in the area, to create a geo-database of the schools in the area and to analyse the pattern of the schools in the area. About 30% of the Primary schools in the urban areas run double shift, There are over 2 million Primary School children in Kano State (47.7% female and 52.3% male), the primary school teacher ratio is 42 pupils per teacher. Data pertaining the addresses of all the primary schools in the area were sourced at the Ministry of Education Kano State. The coordinates of all the primary schools were taking using Global Position System (Garmin 76csx GPS model) and ArcGIS 9.3 with SPSS was used for the analysis. The analyses shows that the distribution of primary schools in the area is more concentrated in areas around the Fagge A, B and D than areas around Kurna, while the buffer zones shows that schools around Sabon Gari and Fagge are closer to the roads and Markets. The database shows there are 222 classrooms, 12,693 pupils and 558 teachers in the area. The tool of analysis (Nearest Neighbour) was used to analyze the pattern of the distribution and the result shows the value of 2.58 which is dispersed and the correlations indicated the R value of 0.837 and the result shows a perfect significant relationship between the number of teacher and pupils. The paper concluded Thus, the end product of the GIS will be part of an Educational Decision Support System that provides the user with a map of specific region with focus on the schools locations and all related information to assist decision-makers in either expanding current school or suggesting sites for new schools in Fagge and also for student and resources location/allocation. it recommends that some primary schools were over staffed and there is need for the use of GIS in the educational sector for planning.*

**Keywords:** Primary schools, pupil, teacher, geographic information system, education decision support system

## INTRODUCTION

The decision-making process in an organization or business should be planned and resolved in a comprehensive, reliable, and transparent manner. Managers equipped with information about their relevant organizational cultures, along with the knowledge transfer, can amend their knowledge management strategies to make their organizations more efficient. Quality and well-timed decision-making is fundamental in the success of any organization. It requires successful implementation of decision support tools to adequately inform the decision process. Education institutions, like the organizations in the private sector, are confronted lately with increasing pressures to improve the quality of education processes and management. Therefore, primary (basic) schools seek to apply more the accumulated data,

invest more resources in tools that allow them to collect and manage information directly, and involve teaching staff, students and the local community in decision-making processes.

Education systems in Kano State are facing new challenges to improve quality, efficiency and relevance on the one hand, and to respond to the ever-changing needs of their economies and domestic and regional labour markets. This required the establishment and institutionalization of a comprehensive decentralized Educational Decision Support Systems (EDSS) in the state which is formally structured and designed to collect, maintain and supply relevant, reliable and timely information to guide educational policy, planning and management decisions.

**Ratio of Teachers per pupil in primary school**

Kano State Universal Basic Education Board (SUBEB) was formed as regulatory and control parastatals in educational sector. It is a new formation in the overall structure of the state education system. With expansion in the school curriculum and the Millennium education challenges, information management of the large number of schools and students becomes more challenging.

The Educational system in Kano State has been in Systematic decline for over a decade. In response to this situation the government embark on the improving the education system and the lines of millions of Primary School aged children. The government is trying to put education at the forefront of its administration. About 30% of the Primary schools in the urban areas run double shift, this is attributed to the Population concentration makes most of this areas. There are over 2 million Primary School children in Kano State (47.7% female and 52.3% male) (www.kano@esspin.ng). According to ESSPIN report (2012) the primary school teacher ratio is 42 pupils per teacher. There are approximately 23,000 primary class rooms, 94.4% of which are usable, approximately 87 pupils per class room in primary, 35.4% of primary class room have sufficient seating and 61.5 have a good blackboard. 47.4% have no toilets; the average pupil to toilet ratio is 200:1. The worst LGA for pupil to toilet ratio at primary level is Nassarawa LGA with a ratio of 1214 pupil per toilet.

**GIS and School Mapping as EDSS**

School mapping using GIS is one of the ways to meet these challenges. The digital mapping of schools in terms of spatial and social coverage will be an essential instrument for SUBEB if it needs to use GIS mapping technology as EDSS.

According to Burrough, (1998) GIS is a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes and Smith *et al* (1987) lamented that GIS is a database system in which most of the data are spatially indexed and upon which a set of procedure operated in order to answer queries about spatial entities in the database. It is a decision support system that involves the integration of spatially referenced data in a problem solving environment. While (ESRI) Environmental Systems Research Institute, California (1990), defined GIS as an organized collection of computer hardware, software and personnel to efficiently capture, store, update, manipulate, analyse and display all forms of geographically referenced information. "GIS is a computer based information system which attempts to capture, store, manipulate and display spatially referenced data (in different points in time), for solving complex research, planning and management problem." (Fischer and Nijkamp, 1993)

School mapping comprises physical location analysis of the primary schools. In order for this to be accomplished knowledge of the settlements and population of the area is required. Accessibility analysis is done on the basis of the location and attributes of roads, houses, and other infrastructures as layers. Accessibility and spatial analyses make it easy for necessary

decisions to be made (Hite, 2008). GIS is a system of hardware, software and procedure designed to support the capture, management, manipulation, analysis, modularity and display of spatially referenced data for solving complex planning and management problems. "(Nyerges, 1992) GIS is a computer system capable of assembling, storing, manipulating and displaying geographically referenced data i.e. data identified according to their locations. "(Aronoff, 1989)

The application of GIS in school mapping as a term that has been much used in educational planning; it covers a wide range of educational planning and management issues and relates to allocation of resources, efficiency in the delivery of services and improving efficiency of learning. Mapping is a tool commonly used to reveal the relationships between the distribution of schools and the distribution of school age population to be served by them in a given area. GIS database provides a comprehensive framework and organization of spatial as well as non-spatial data and has become a focused tool to help planning and decision making. Mapping of schools along with the information on administrative boundary and the biophysical layers such as major road network and major settlements provides the ground reality in terms of geographic coverage.

GIS is typically used in most application field as an advance and technologically elegant tool. Even if GIS is considered as simply a better tool. The progress in presentation, preparation and flexibility appear to justify consideration of the benefits that GIS provides to micro-planning as potentially highly significant (Hite, 2008. GIS were originally developed for scientific land management purposes. One of the earliest found in the 1960s was Canada Geographic Information System, which was built for the collection and analysis of land use data and the production of statistics for land use management plan in Canada (Johnson and Pellikka, 2005). GIS mapping allows visualization of field survey results and provides essential information and help in the economizing the financial and human resources. The GIS is a user-friendly mapping method demonstrated in this study is a practical and feasible method for field researchers and Educational staff monitoring team that engaged analyzing the distribution of facilities in a geographically diverse area.

According to Tobler's "first law of geography", "everything is related to everything else, but near things are more related than distant things" (Tobler, 1979). When considering the distribution of a particular phenomenon, the 'law' explained some the relationship between the distance phenomena and the closest which are in clustered use to have similar relationships or characters example giving by Aliyu *et. al*., (2013) spatial distribution could indicate patterns of underlying process. Incidents exposed to the impact of similar process tend to follow similar locating pattern. Hence, study on spatial cluster could reveal information about the underlying geographical process that generates the spatial pattern, which can further aid the comprehension of underlying geographical process and its relationship with the phenomenon under investigation. Crime hot spot appears when crime occurrences impacted by environmental backcloth are spatially clustered. Investigating spatial pattern of crime could shed light on uncovering the secret veil of crime environmental backcloth.

The advancement in the field of geographical information systems (GIS) had contributed greatly to a number of studies dealing with measures of spatial access to educational facilities and resources. In developing countries, GIS and school mapping (SM) technique are often used to create the necessary conditions for achieving universal primary and secondary education (UPE and USE) and increasing access to educational facilities for socially disadvantaged populations (Hite 2008).

Several studies has shown mapping the distribution of facilities and analyzing to show how they are distributed, it could be clustered, dispersed or randomly distributed and to see whether the facilities serves the people of the area. The use of GIS for analyzing the distribution of facilities is not new in Kano State, like the study of Ahmed *et al* (2013) found out that the distribution of Police Stations in Kano Metropolis are in Random with 0.733. Also Kibon and Ahmed (2013) Shows that the distributions of Health facilities in Kano Metropolis are in clustered. Indeed, many studies have shown that GIS can be use in analysing a facility distribution. But at this level this particular paper will make an attempt in taking a micro-planning in the education sector, there are few attempts and initiatives involving GIS at the State level by the Ministry of Environment were a unit will be provided for GIS popularly known as Kano GIS (KANGIS), but none of this is provided for the Educational Sector in the State.

## THEORETICAL FRAMEWORK

### Central Place Theory

It is possible to use the central place theory as a basis for the explanation and provision of activities in space. Although the central place theory developed by Christaller (1933) aims at the study of marketing function of settlements in relation to its location, it can also be applied to the location and spacing of service centres such as primary schools. The central place theory was developed based on the following assumptions.

1. There is an isotropic surface with equal movement and ease in any direction.
2. There is uniform distribution of population and purchasing power.
3. There is a uniform terrain and resource endowment.

Besides the foregoing. There are some sub-assumptions based on the Economic- rationality of man. These assumptions include:

a. Individuals will tend to utilize the closet facilities to them.
b. If the threshold for a particular good or service is available, the good or services will be provided.

The central place theory focuses on the concept of tributary areas which can also be described as catchment area. These tributary areas of central places can be organized into a system of hierarchy. There are smaller or lower order central places which have smaller tributaries and in most cases fall within the tributary areas of larger or higher order central places. Which have larger tributary areas. “Each order performs a specific group of central functions and the centres in that order has populations which fall within a certain range” (Abler et al. 1972).

A physical analogy using magnets corks and a tub of water illustrates the best location of central places. If the magnets are placed on corks and then placed in a tub of waler. The repelling force of opposite poles of magnets pushes the corks far from each other. Such that each cork is at a vertex of an equilateral triangle. Such maximum spatial dispersion is referred to by mathematicians as close packing” (Hartshon, 1992).

It is posited that, if centres are located at the vertices of an equilateral triangle and it is assumed that there is a uniform population distribution, the population will always patronise closest centre. This implies that the tributary area will be hexagonal. “The hexagon offers the best balance of geometric packing properties and closely approximates the market area” (Hartshon. 1992).

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## Aim

The aim of this paper is to analyze the spatial distribution of primary schools in Fagge LGA of Kano State and provide Educational planners detailed demographic and education- related data on the GIS environment.

## Objectives

I. To make an inventory of the schools in the area
II. To create a geo-database of the schools in the area
III. To analyse the pattern of the schools in the area

## Study Area

It is a Local Government Area within the greater Kano area. Its headquarters are in the suburb of Waje. It has 10 wards for population census and election purposes. It has an area of 21 $km^2$ and a population of 198,828 as at the 2006 census. The area is located between latitude $11^0$ 59' 28'' to latitude $12^0$ 4'' 18' and longitude $8^0$ 28' 17'' to longitude$8^0$ 32' 59''

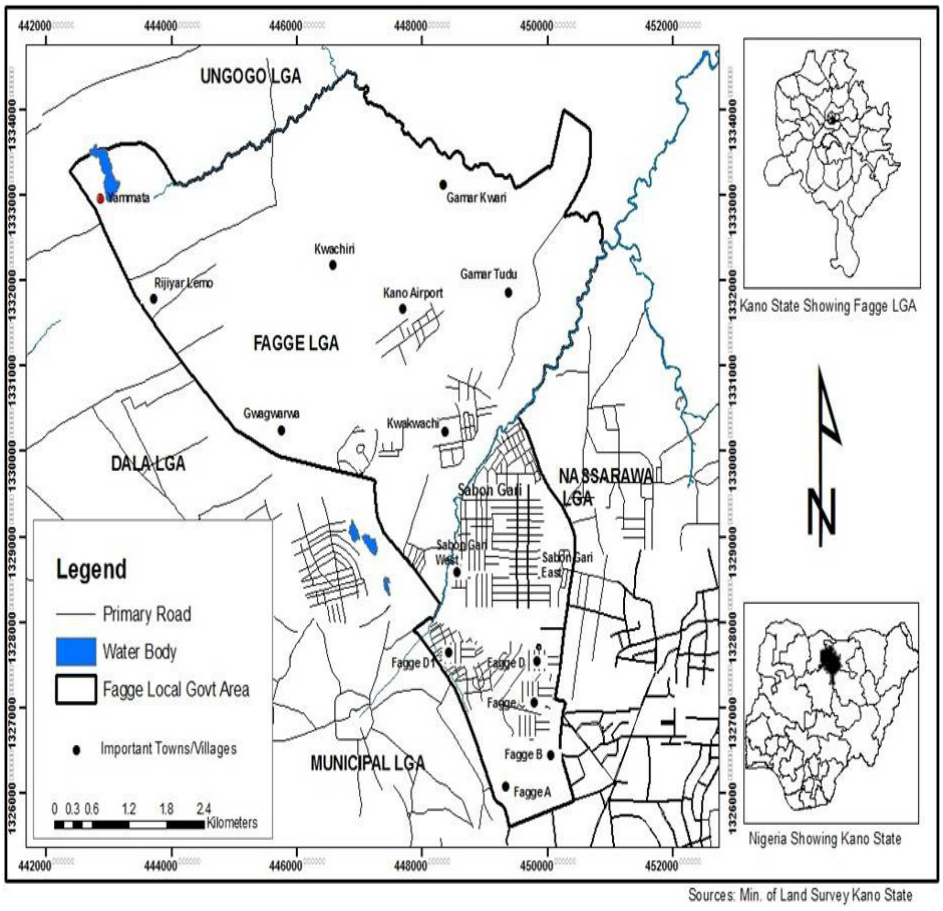


Figure 1. Fagge Local Govt. Area (Study Area)

## MATERIAL AND METHODS

Primary and secondary data will be used. The primary data are the coordinates of the location of schools obtained using the Global Positioning System (GPS) and the secondary data are the topographic maps of Fagge LGA. Kano State, the names and number of the schools, a

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detailed EMIS (Educational Management Information Systems) of the schools and data from textbooks, articles, journals, newspapers and the internet.

**Data Source and Acquisition**

For the study, a map of Fagge LGA was acquired from the Cartographic Laboratory, Department of Geography, Bayero University Kano, Kano. Census data was sourced from National Population Commission, Kano Office and data about the schools were acquired from Kano Educational Resource Department, Fagge Local Education Authority and Kano State Universal Basic Education Board. Road/Street data was also extracted from the Metropolitan Map produced by the Kano State Ministry of Environment. Satellite image of Fagee was extracted from Kano Metropolis sourced from National Remote Sensing Center (NRSC) Kano center. A Global Positioning System (Garmin 76csx GPS model) was used in obtaining the coordinates of the schools during the Ground Truthing. ArcGIS 9.3 was used for the analysis. A ststistical software (SPSS) was used to find the correlations

## GIS ANALYSIS

### Distribution of Primary Schools in Fagge LGA

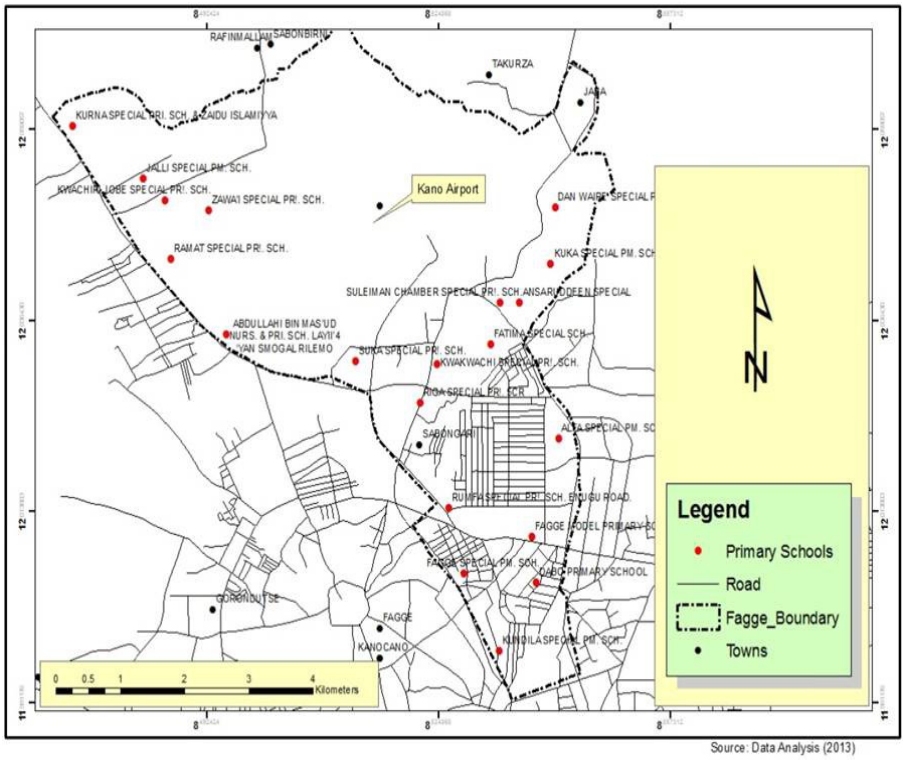


Figure 2. Showing the Distribution of Primary School in Fagge LGA

The spatial distribution of Primary school in the area (Figure 2) shows that there is concentration of schools around the local government headquarters and areas around the eastern part are having more schools than the eastern part, while the populations of pupils in the primary schools (Figure 3) shows also that there more pupils than other places especially at the headquarters of Fagge. The analysis shows that 20 schools were identified and these schools are government-owned primary schools. The schools are situated all over the local government in the different wards. Fagge A, C, Gwagwarwa and Kwachirin Jobe has four schools each, Kwachirin Dikko and Gamar Kwari has 2 schools each while Fagge B, D, Mazugal and Gamar Tudu has one school each.

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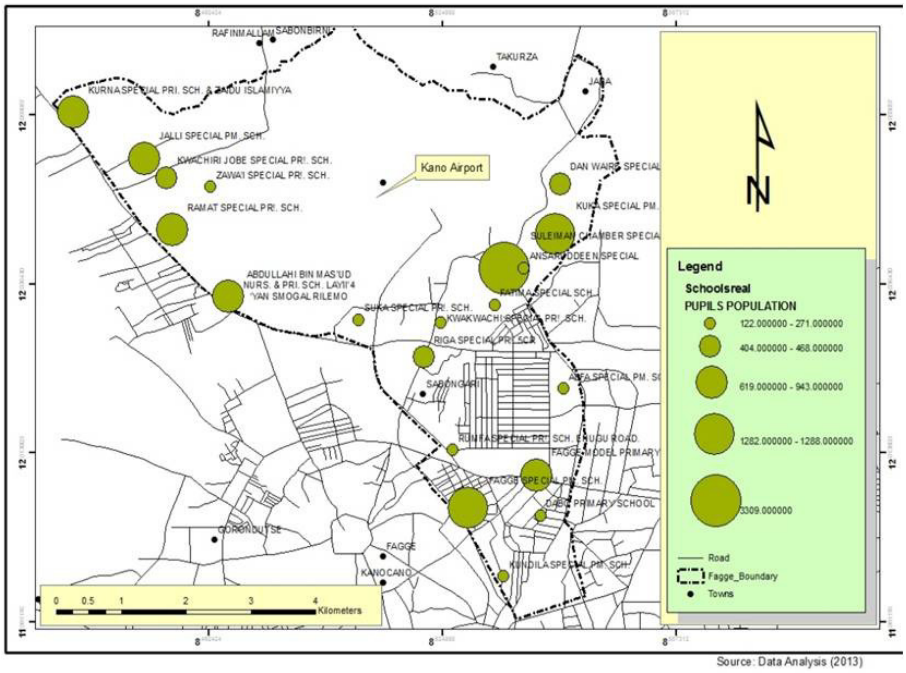


Figure 3. Showing the Population of Pupils in Fagge LGA

Figure 4 showing the 300m buffer zones around the schools to determine the area of influence of the schools and their expected distance from the road. The result shows that schools are few in the local government area because it is one of the busiest commercial areas in Kano State. It also shows that this area has limited space for the establishment of schools because of the presence of markets and the international airport in the area. In Fagge A, B, C and D wards, there are more schools because the area has well accessible roads. In the other areas around Kurna, accessibility is poor so the schools are sparsely located.

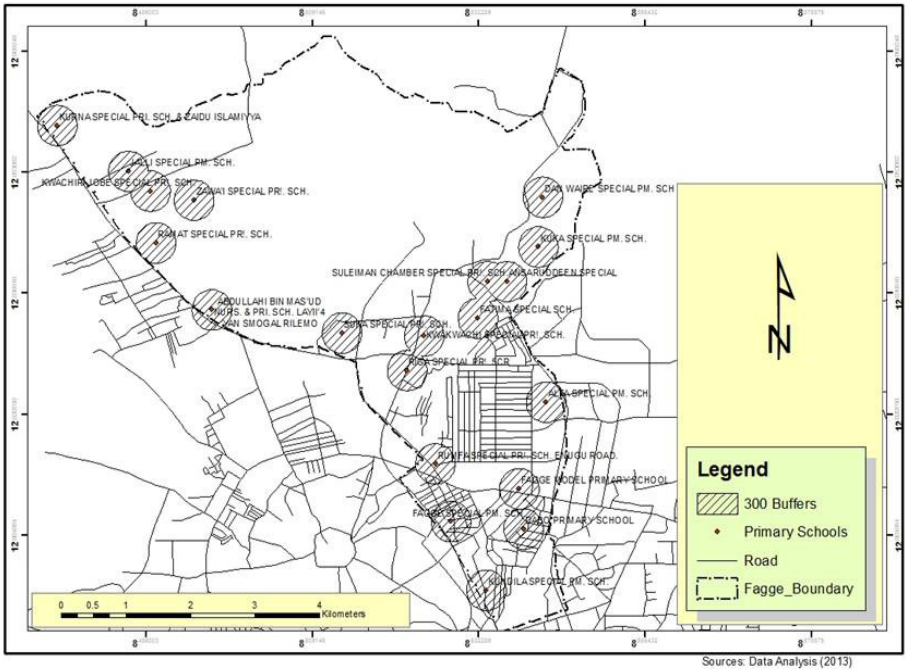


Figure 4. Showing the 3 meter Buffer Zone in the area

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## Geo-database of Primary Schools

**Table 1. Showing the Database of Primary Schools in Fagge LGA**

| *S/N* | *Primary Schools* | *No of Classrooms* | *Pupils Poplation* | *Teachers Population* | *Lattitude* | *Longitude* |
|---|---|---|---|---|---|---|
| 1 | Abdullahi Bin Mas'ud Nurs. & Pri. Sch. Layii'4 'Yan Smogal Rilemo | 17 | 805 | 45 | 8.337596 | 12.025531 |
| 2 | Alfa Special Pm. Sch. | 6 | 173 | 18 | 8.54306 | 12.024527 |
| 3 | Ansaruddeen Special | 11 | 164 | 18 | 8.535022 | 11.939126 |
| 4 | Dabo Primary School | 6 | 159 | 15 | 8.529998 | 12.006442 |
| 5 | Dan Waire Special Pm. Sch | 9 | 404 | 25 | 8.501866 | 11.850209 |
| 6 | Fagge Model Primary School | 13 | 943 | 47 | 8.505885 | 11.892407 |
| 7 | Fagge Special Pm. Sch. | 27 | 1282 | 50 | 8.514928 | 11.878843 |
| 8 | Fatima Special Sch. | 5 | 152 | 13 | 8.41094 | 11.972283 |
| 9 | Jalli Special Pm. Sch. | 14 | 619 | 40 | 8.293383 | 12.074762 |
| 10 | Kuka Special Pm. Sch. | 17 | 1288 | 55 | 8.540548 | 12.043114 |
| 11 | Kundila Special Pm. Sch. | 6 | 122 | 12 | 8.524975 | 11.957211 |
| 12 | Kurna Special Pri. Sch. & Zaidu Islamiyya | 12 | 619 | 35 | 8.449621 | 11.971277 |
| 13 | Kwachiri Jobe Special Pri. Sch. | 11 | 452 | 20 | 8.337596 | 12.025531 |
| 14 | Kwakwachi Special Pr!. Sch. | 6 | 154 | 12 | 8.457157 | 11.94415 |
| 15 | Ramat Special Pr!. Sch. | 15 | 920 | 39 | 8.515932 | 11.863773 |
| 16 | Riga Special Pr!. 5cr | 11 | 468 | 30 | 8.514928 | 11.841167 |
| 17 | Rumfa Special Pr!. Sch. Enugu Road. | 6 | 166 | 16 | 8.537031 | 11.919032 |
| 18 | Suka Special Pr!. Sch. | 8 | 271 | 28 | 8.429025 | 11.988859 |
| 19 | Suleiman Chamber Special Pr!. Sch. | 16 | 3309 | 20 | 8.521458 | 11.914511 |
| 20 | Zawa'i Special Pr!. Sch. | 6 | 223 | 20 | 8.405414 | 12.037588 |

Source: Min. of education Kano State and Field work (2013)

Table 1 showing the geo-database of the primary schools in the area with their coordinates (latitudes/longitudes), names of the schools, number of classrooms, population of pupils and population of teachers. The total number of 20 schools, 222 classrooms, 12,693 pupils and 558 teachers in the area were identified. This shows that the ratio of pupil per teacher is 1:23 meaning that in every 23 pupil there is 1 teacher and when compared with the Kano State standard of teacher pupil ratio of 1:42. It means the distribution of teachers in the area is fairly good.

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Suleiman Chamber special primary school is the school with the highest number of pupils and teachers followed by Kuka special primary school then Fagge special primary school. Fagge special primary school has the highest number of classrooms with 50 teachers. The number of classrooms in Abdullahi Bin Mas'ud Nursery and primary school is more than that of Suleiman Chamber special primary school and Kuka special primary school even though their pupils are more in number.

Fatima special nursery and primary school has the lowest number of classrooms with 152 pupils, 3 streams and 13 teachers, followed by Alfa special primary school, Dabo primary school, Kundila special primary school, Kwakwachi special primary school, Rumfa special primary school and Zawai special primary school with 6 classrooms each. Kuka special primary school has the second highest number of teachers but with 8 streams whereas Fagge special primary school that has 50 teachers has 14 streams. The distribution of the variables is not even.

## Pattern Analysis

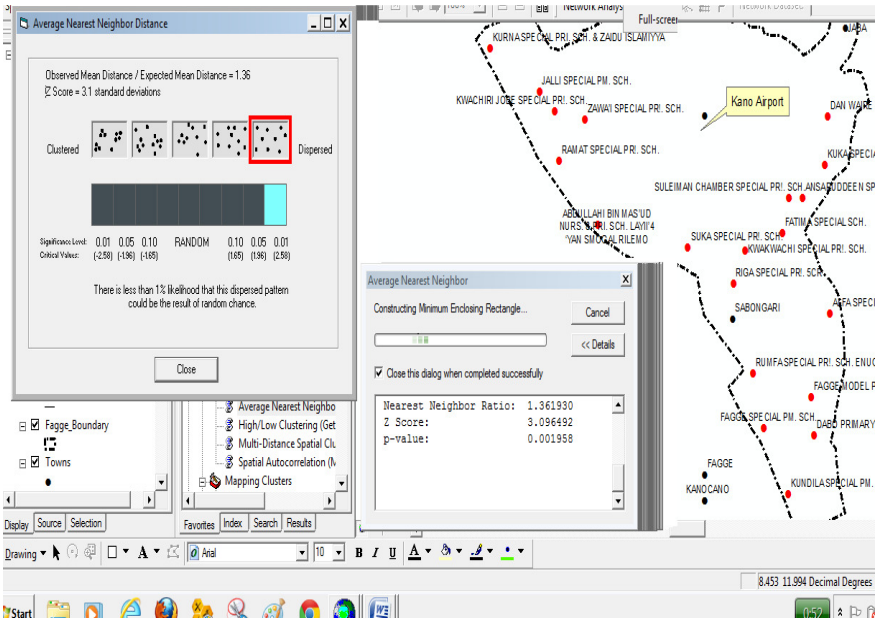


Figure 5. Nearest Neighbour Analysis of Primary Schools in Fagge LGA

The extension of ArcGIS 9.3 was used for the analysis of the nearest neighbor using the spatial statistics from the toolbox by selecting the Average near Neighbour. The result shows that the distribution of primary schools in the area (Figure 5) shows a dispersed with a significant level of 0.01 and a critical value of 2.58, while the Z score shows 3.1 standard deviation. The randomness shows 1% likelihood that is dispersed pattern could be the result of random chance. This indicated that several factors are attributed to the randomness, even though there areas like the Airport and some places at the northern part of the LGA which is having less development in terms of population.

## The Correlation between the Teacher and Pupils

The number of teachers and pupils were tested for correlations and it shows that the number of teachers and the number of pupils (enrolment) are highly and perfectly correlated to each other with R value 0.837 i.e. one is dependent on the other as it increases, the number of students increase alongside the number of teaching staff and vice versa.

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**Table 2. Showing Correlation table**

| | *Teachers* | *Enrolment* |
|---|---|---|
| Teachers Pearson Correlation | 1 | .837+* |
| Sig. (2-tailed) | 20 | .000 |
| N | | 20 |
| Enrolment Pearson | .837** | 1 |
| Correlation Sig. (2-tailed) | .000 | 20 |
| N | 20 | |

** Correlation is significant at the 0.01 level (2-tailed).

The number of teachers in each school increases as the number of pupils increase because when there is increase in enrolment there is also need for more teachers to be recruited. There are exceptional cases in some schools where there are more pupils but lesser teachers. For instance, Kwachirin Jobe special primary school has 452 pupils and 20 teachers whereas Zawai primary school has the same number of teachers but 223 pupils. Suka special primary school 271 pupils and 28 teachers, Kuma special primary school has 619 pupils with 35 teachers while Jalli primary school has the same number of schools but with 40 teachers, Abdullahi Bin Mas'ud has 805 pupils with 45 teachers while Ramat special primary school has a higher number of pupils (920) with a lesser number of teachers (39). In most schools, the number of pupils and teachers increase simultaneously. Therefore there is a perfect significant relationship between the number of teachers and pupils implying that the research hypothesis is accepted.

## CONCLUSION AND RECOMMENDATION

The application of GIS as Educational Decision support system summarizes the phases and process of building the EDSS through GIS in Fagge LGA of Kano State. The paper attempted to show how GIS could be use in the planning process and decision-based using the technology. As a result of its capabilities, the use of GIS technology in decision making in all spheres in Nigeria has become inevitable.

Findings revealed that the use of technology (GIS) for education planning have been proved to be very important in the decision making in fagge LGA by providing the planners integrated geographic scenario of location of schools. GIS mapping and Education Management Information System (EMIS) are strong analytical system that would be more applicable to make educational policy and well-structured. It also shows that the analysis of database gives complete way out for educational planning and management as DSS.

The study recommend for the use of referenced data on educational institutions especially the educational agencies as they can be very useful while using school mapping to ensure efficient and equitable distribution of schools and educational resources, they are also useful for the determination of efficient route(s) for effective school supervision. Secondly, a unit should be provided which will be responsible for data collection and analysis and staff training for the use of GIS in the Education Management Information System (EMIS).

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