GIS of Spatial Distribution of Ordinary Levels Schools in Yola North Local Government Area of Adamawa State, Nigeria

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ABSTRACT

Observed Global positioning system coordinates of all post-primary schools in Yola North local Government Area were obtained These coordinates were used to create a digital map showing the location of post-primary schools within the study area. These coordinates were used to determine the distances from one point to its Nearest Neighbors in a particular unit area. The distances were computed using a computer program written in MATLAB 2009a programming language. The distances obtained were then used in determining the distribution pattern of these schools using Nearest Neighbor Analysis statistical tool, where the value of Nearest Neighbor index (R_n) was computed and was found to be R_n=1.1124. This result obtained indicates that random distribution pattern exists in the study area. The test of significance on the value of R_n was then computed using Z-distribution and from the value of Z obtained, it shows that the value of R_n is significant. A database was created using the attributes of the schools and different queries were generated from the geo-spatial database created as shown in figures 4.3 - 4.8. The analysis indicates that Nearest Neighbor analysis can favorably be used in determining the spatial distribution pattern of the post-primary schools and other facilities for a meaningful development. The study clearly depicts the process of using Nearest Neighbor analysis in determining the spatial distribution pattern of the post-primary schools. The study reveals how the schools were located on a digital map and the value of R_n shows that random pattern of distribution exists within the study area. The scale used for the unit area (A) exposes two schools without any Neighbor. Nearest Neighbor Analysis is recommended for determination of spatial distribution pattern of schools, since it shows clearly how these schools are distributed. Writing a computer program should be encouraged in calculating distances from coordinates using a programming language especially MATLAB.

Keywords: Mapping, Global Positioning System, MATLAB, GIS.

INTRODUCTION

Surveying and mapping is the bedrock of all physical and socio-economic development of all nations. Therefore the importance of this sector cannot be over emphasized. As a matter of fact, no sustainable development can take place effectively and efficiently without an inventory of human and land resources in their proper spatial context. Advancement in technology has resulted in tremendous growth in surveying and mapping practices around the globe today. The advent of computers and other electronic devices and sensors have given a rapid growth and great impact has been made on surveying and location concept as well as instrumentations.

In the last decade, the technology of surveying has rapidly changed, in that; many developing countries like Nigeria have been virtually left behind in the adaptation of the new technology. In the analogue (old) method in which many Nigerians are used to, the data acquired in surveying are used in mapping. These maps are presented in analogue forms which are quadrant to specific scales. For instance, a scale of 1:100,000 or 1: 500,000 standard map series. Modern technologies have changed all these; maps are now made and recorded electronically. Maps that are normally cumbersome to handle and store are now produced in digital format. The technology, which is principally a computer based makes it possible to display the map of an area covered by this facility on the screen with the advantages of varying the scales and formats to suit the user's need.

The Global positioning System (GPS) is a relatively new concept in position fixing in surveying. It is a satellite based system for rapid determination of position fixation practically on the earth (land, air or sea) and at any time with pin-point accuracy. The latest technology uses a specialized radio receiver called GPS receiver. It is designed to detect radio signals transmitted from the satellites and calculate positions based on such signals. Receivers intended for geodetic surveys have better accuracy and has an interface that allows rapid data collection. Additionally, in using the GPS for geodetic works, inter-visibility amongst stations is not required. The Global positioning System (GPS) has completely revolutionized the field of surveying and geo-informatics. It is a system that has many applications in various fields ranging from geodetic positioning, control densification, hydrographic surveying, mining surveying, etc. Its main advantage is in the economy of time and labor, culminating in the reduction of project cost (Idowu, 2003). GPS is a space satellite system that provides accurate information (altitude, bearings, and coordinates of points in absolute terms in three dimensions) to all users. These coordinates which are either rectangular coordinates (X, Y, Z) or geographical coordinates (φ, λ, h), plus other quantities of interest are referenced to a particular ellipsoidal datum, the WGS84 datum.

In GPS positioning, like in many other geodetic applications, the observed values are usually processed using a least squares procedure to obtain the estimates of parameters of interest. This does not require any information about the statistical distribution of observed values to estimate the parameters. However, information on the statistical distribution of the data and results are needed to determine the quality of the observations and hence the reliability of the parameters. Therefore, a statistical testing procedure to determine whether or not to accept the results relies solely on the statistical distribution of the observed quantities used in the least squares procedure.

Although, GPS has become a handy tool for surveying and mapping, statistical distribution of its measured data, which forms the basis for testing the reliability of its results, has not been practically determined. It is in light of the above, that the researcher wishes to investigate the distribution of all the post primary schools in the study area. Digital mapping has now become an indispensable tool in solving many environmental-based problems. The method used for producing digital maps are many, depending on the level of details required, the use to which the map will be put and the source of data.

Amuyunzu and Bijl (1999) successfully produced a digital map of elephant habitats in Kenya. The procedure of mapping land cover involved three stages:

(1) Data collection and pre-processing.
(2) Defining land cover types for the elephant habitat suitability rating model and
(3) Use of a decision rule to obtain the defined classes from satellite imagery.

Musa (2005) digitally produced a revised map of the Jimeta-Yola metropolis using a combination of SPOT XS images and hand held GPS unit. The GPS unit was used to carve out minor roads that ordinarily could not be seen on the satellite image by applying relevant geospatial techniques; a revised map of the town was created.

Nearest neighbor search (NNS), also known as proximity search, similarity search or closest point search, is an optimization problem for finding closest points in metric spaces. The problem is: given a set S of points in a metric space M and a query point $q \in M$, find the closest point in S to q. In many cases, M is taken to be d-dimensional Euclidean space and distance is measured by Euclidean distance or Manhattan distance. Donald K. in vol. 3 of The Art of Computer Programming (1973) called it the post-office problem, referring to an application of assigning to a residence the nearest post office.

Various solutions to the NNS problem have been proposed. The quality and usefulness of the algorithms are determined by the time complexity of queries as well as the space complexity of any search data structures that must be maintained. The informal observation usually referred to as the curse of dimensionality states that there is no general-purpose exact solution for NNS in high-dimensional Euclidean space using polynomial preprocessing and poly logarithmic search time.

Since the 1970s, branch and bound methodology has been applied to the problem. In the case of Euclidean space this approach is known as spatial index or spatial access methods. Several space-partitioning methods have been developed for solving the NNS problem. Perhaps the simplest is the k-d tree, which iteratively bisects the search space into two regions containing half of the points of the parent region. Queries are performed via traversal of the tree from the root to a leaf by evaluating the query point at each split. Depending on the distance specified in the query, neighboring branches that might contain hits may also need to be evaluated.

Alternatively the R-tree data structure was designed to support nearest neighbor search in dynamic context, as it has efficient algorithms for insertions and deletions. In case of general metric space branch and bound approach is known under the name of metric trees. Particular examples include vp-tree and BK-tree.
Using a set of points taken from a 3-dimensional space and put into a BSP tree, and given a query point taken from the same space, a possible solution to the problem of finding the nearest point-cloud point to the query point is given in the following description of an algorithm. (Strictly speaking, no such point may exist, because it may not be unique. But in practice, usually we only care about finding any one of

the subset of all point-cloud points that exist at the shortest distance to a given query point).

The idea is, for each branching of the tree, guess that the closest point in the cloud resides in the half-space containing the query point. This may not be the case, but it is a good heuristic. After having recursively gone through all the trouble of solving the problem for the guessed half-space, now compare the distance returned by this result with the shortest distance from the query point to the partitioning plane.

This latter distance is that between the query point and the closest possible point that could exist in the half-space not searched. If this distance is greater than that returned in the earlier result, then clearly there is no need to search the other half-space. If there is such a need, then you must go through the trouble of solving the problem for the other half space, and then compare its result to the former result, and then return the proper result. The performance of this algorithm is nearer to logarithmic time than linear time when the query point is near the cloud, because as the distance between the query point and the closest point-cloud point nears zero, the algorithm needs only perform a look-up using the query point as a key to get the correct result.

In some applications it may be acceptable to retrieve a "good guess" of the Nearest Neighbor. In those cases, we can use an algorithm which doesn't guarantee to return the actual Nearest Neighbor in every case, in return for improved speed or memory savings. Often such an algorithm will find the Nearest Neighbor in a majority of cases, but this depends strongly on the dataset being queried.

Nearest Neighbor analysis examines the distances between each point and the closest point to it (Fotheringham, et al., 1994 and Wulder, 1999). The Nearest Neighbor is a method of exploring pattern in Locational data by comparing graphically the observed distribution functions of event-to-event or random point-to-event Nearest Neighbor distances, either with each other or with those that may be theoretically expected from various hypothesized models, in particular that of spatial randomness (Upton, 1985), i.e. it describe distribution of points according to their spacing.

The Nearest Neighbor index measures the degree of spatial dispersion in the distribution based on the minimum of the inter-feature distances (Chou, 1997), i.e. it is based on the distance between adjacent point features. Such that the distance between points features in a clustered pattern will be smaller than in a scattered (uniform) distribution with random falling between the two.

Lawrence N. K. (2006) said that the spatial distribution of malaria risk was associated with elevation, and marginally with maximum temperature. The resulting map broadly agreed with expert opinion about the variation of risk in the country, and further showed marked variation even at local level. High risk areas were in the low-lying lake shore regions, while low risk was along the highlands in the country. The map provided an initial description of the geographic variation of malaria risk in Malawi, and might help in the choice and design of interventions, which is crucial for reducing the burden.

Various parties, from federal and local government to private industry and academia as well, have recognized the potential of GIS and ESDA in helping crime analysis. Crime Mapping Research Center of National Institute of Justice organized a "Multi-Method Exploration of Crime Hot Spots" intramural research project in 1997-1998 to investigate twelve crime pattern analysis methods, especially hot spot identification techniques, they includes GIS and Crime Analysis as one of its research themes and challenges in 1999 (Getis, 1999).

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). Spatial distributions with values at certain locations showing relationship with values at other locations are named spatial autocorrelation. Spatial cluster is positive spatial autocorrelation when similar values are spatially clustered together. On the opposite is the distribution with similar values separated / dispersed from each other, which is called negative spatial autocorrelation

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 (Boots et. al., 1988).

According to Wrigley et-al, (1996), there exist different methods for identifying and measuring spatial cluster. Spatial cluster analysis methods distinguish themselves from each other either because they are designed to answer different aspects of cluster questions (i.e. whether there exist clusters, where are the clusters, or to what intensity is the cluster), or because they are based on different philosophies to examine real world (i.e. observation scale, measurement of spatial separation, and subjectivity introduced during the interaction with data).

Onyeka (2007) pointed out that digital maps constitute the most effective means of presenting digital spatial data. The map could be an image map, a line map or a point map. Depending on the purpose, when the map is intended to serve a specific purpose, then a line map or point map may be preferred.

The objective of this paper to obtain coordinates of the schools, to create digital map showing the locations of the school, other is to determine their spatial distribution pattern using nearest neighbor analyzer statistical tool and finally to create database for the study area.

PROBLEM STATEMENT

Since the creation of Adamawa State, post primary schools have been established without considering how these schools are distributed. Lack of map showing the distribution pattern of the schools in the study area has made it very difficult for people to see at a glance how these schools are spread. This has necessitated the need to have a map that will show the distribution pattern of the post primary schools in Yola North L.G.A of Adamawa State. Also, to my knowledge, the use of statistical analysis to determine how and where these schools are located has not been utilized.

THE STUDY AREA

Location and Extent

The study area covers Yola North local Government Area of Adamawa State. The study area has the privilege of paved and earth roads as well as good drainage traversing some areas having proper water supply, Located between Latitude 9° 16/ N -9° 20/ N and 12° 26/ E - 12° 30/ E (Encarta Encyclopedia 2007), the area has some major social/ recreational facilities as a state capital. Adamawa State of Nigeria is one of nine states created 27th August, 1991 out of Gongola State with Yola as its state capital. The state is located at the north eastern part of Nigeria around the area where the River Benue Enters Nigeria from Cameroon Republic.

Population and Land Use

According to 2006 population census provisional result, the Yola North has an estimate population of 307,714 people with an approximate land area of 1104.30km^2 with a radius 3.522km. Majority of the population of Adamawa State settle in rural areas, which have been grouped into thirty seven districts made up of 478 settlements. The main urban centers are Jimeta, Yola Town, Mubi, Numan and Mayo-Belwa. The minor ones include Fufore, Ganye, Jada, Gombi, Maiha, Michika, Madagali, etc. 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. Land capitalization is however a major problem of agricultural development in Adamawa State. This involves acquisition of thousands of hectares of land by refined wealthy Nigerians for large scale commercial agriculture.

Climate

The study area lies within the Sudan savannah zone with marked dry and wet seasons. There used to be gradual increase in temperature from the months of January to April with the seasonal maxima which normally occurs in April. Temperature drops in the rainy season especially in the month of July to October. The movement of the inter- tropical discontinuity (I.T.D.), and associated zones of rainfall during the course of the year, is the major factor controlling rainfall and temperature variation in the study area. Temperature rises slightly after the rainfall ceases in the months of March-May and that could reach as high as 41^{o}C. In the months of December-February, the dry harmattan weather characterizes the area, which is cold and dusty. The movement of the wind by December sweeps across the study area and the movement continue eastward.

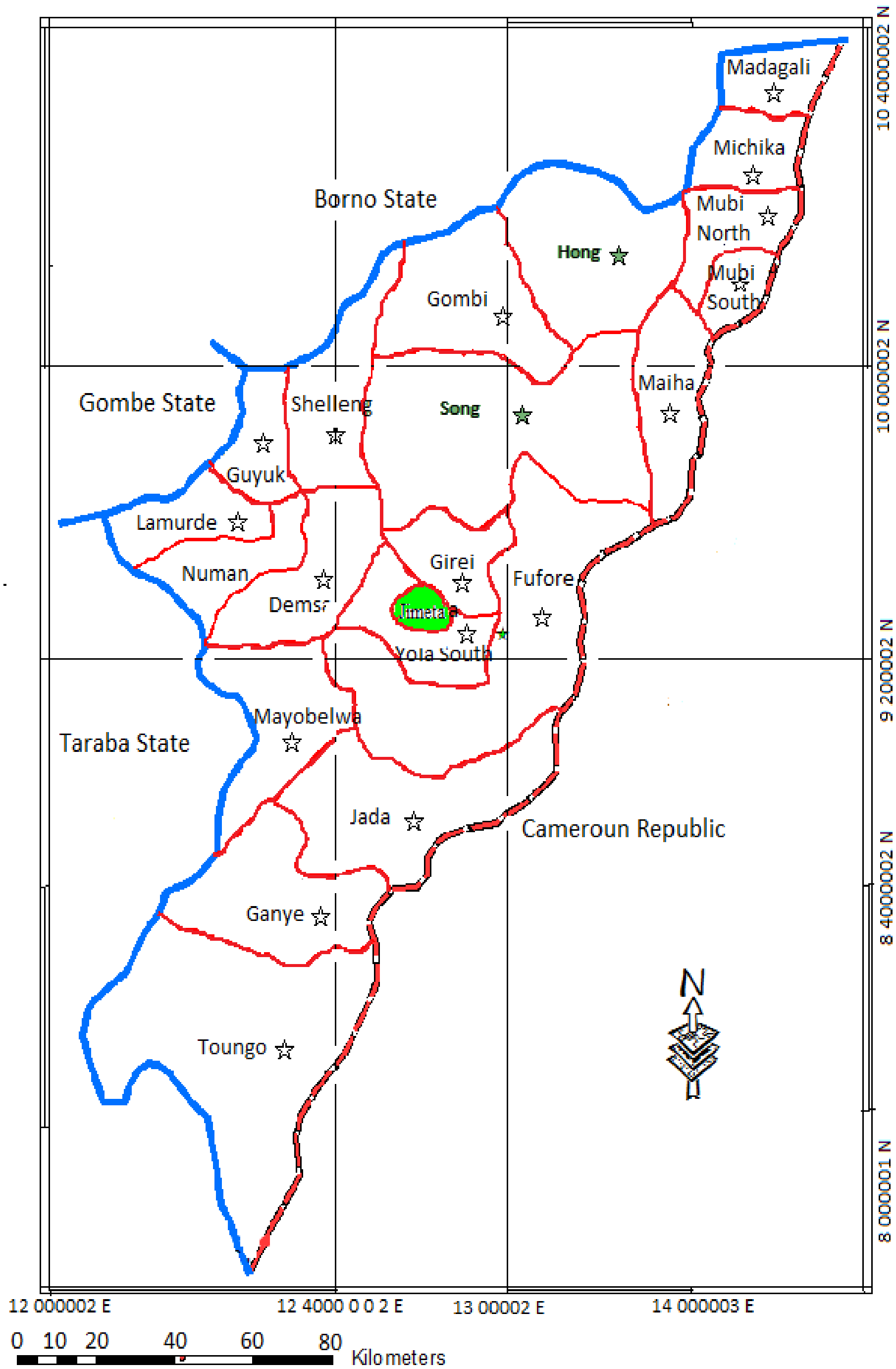
Soil and Vegetation

Like most areas in northern Nigeria, the soil of Yola-North are derived from the basement complex rock, however, there is some alluvial soil along the Benue flood plains. The soil of the study area is loamy and it drains easily when it rains. The vegetation consists of short, medium and shrubs, more especially in the months of August and September during which the area records higher amount of rainfall.

Relief and Drainage

River Benue is the major river in the study area. It rises from the highlands of Cameroon republic and flows south wards into Nigeria joining the river Niger at Lokoja. The state covers a land area of about 39, 742, 13 sq km, and is full of mountainous land forms that includes Numan plains. The state is also characterized by undulating Hills, rolling landscapes in the south and west and several rocky highlands in the east. The River Benue, which is the main river flows all year round with the peak in the months of August- October in the wet season. Some of the tributaries that drain into the Benue are Mayo Ine, Faro, Chouchi and Rugange which are all seasonal streams.

MAP OF NIGERIA SHOWING ADAMAWA STATE
Source: Ministry of Land and Survey, Yola (2009)



Map of Adamawa State Showing Yola-North L.G.A.

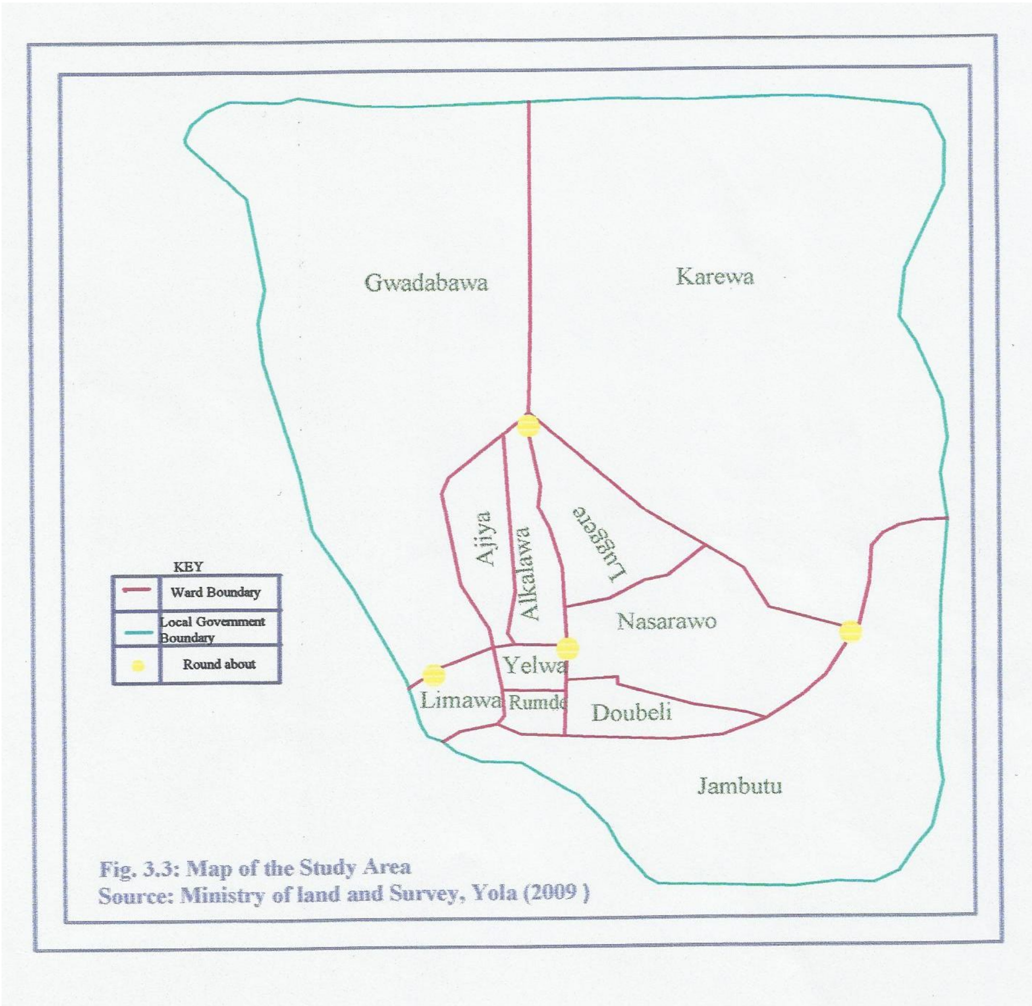


Fig. 3.3: Map of the Study Area
Source: Ministry of land and Survey, Yola (2009)

METHODOLOGY

General Statement

This chapter focuses on the fundamental methods and procedure adopted in this study. Political map of Adamawa state showing local government boundaries is obtained. With the use of GPS, coordinates of post-primary schools were picked. This section can be referred as the overall configuration of a piece of research work. This is to cover the study area, instrumentation, validity and reliability of instrument, method of data collection, data processing, analysis and presentation of result.

Instrumentation

The instruments used are classified as: -

1. **Hardware**
   i. Computer Laptop (specification: 140 GB hard disk, 1G RAM, DUO CORE Processor)
   ii. Garmin 60, hand held Global Positioning System (GPS);
   iii. Scanner (HP Scan jet 5300c);
   iv. Printer (HP Printer DeskJet 710c)

2. **SOFTWARE**
   i. Integrated Land and Waters Information System (ILWIS) 3.1 GIS package.
   ii. Arc view GIS, version 3.2a
   iii. AutoCAD 2007.
   iv. MATLAB2009a programming software.

DATA ACQUISITION

In this paper, two types of data were involved namely: Spatial data and Attribute data

SPATIAL DATA

Coordinates of the existing schools was collected through field survey using proMark-3 GPS instrument. Analogue map of Nigeria, Adamawa and the study area was obtained from Ministry of Land and Survey, Yola.

ATTRIBUTE DATA

The attribute data was obtained from the various schools through verbal interaction which includes the following:

1. Names of the existing schools
2. Names of the places where they are Located
3. Area of the schools
4. Owners of the schools
5. Total enrolment of the schools
6. Number of classrooms each school has, etc.

DATA QUALITY

The quality of data used in any surveying work can be determined by the validity and reliability of such data. The validity of the data is measured by the precision of the instrument used and the reliability of the data is determined by the accuracy of the data. Therefore it can be agreed that the instrument to be used for data collection is reliable and the person to carry out the observation has the required experience to do the field work (Idowu, 2005). The basic data to be used for this study are the GPS observed coordinates of the institutions, which is to be used in analyzing the distribution pattern of the schools. Subsequent to the identification of user's data need and collection, sourcing for the identified data was commenced. The coordinates of the various institutions was collected using GPS instrument by the researcher. The spatial data was derived from analogue map of Adamawa state. The map is obtainable at the Ministry of Land and Survey, Yola. While the source of the attribute data was provided by the vice principal, administration of each school.

SPATIAL ANALYSIS

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 Neighbors, and the distances were then used in determining the distribution pattern of these schools. For the purpose of this work, the researcher uses the Nearest Neighbor Analyser (NNA) statistical tool.

NEAREST NEIGHBOUR ANALYSER (NNA)

NNS= Nearest Neighbor Statistics

$R_n = \frac{D_m}{D_e}$ --------------------------- (4)

D_m = Observed mean distance in areas under consideration.

D_e = Expected mean distance.

$D_e = \frac{1}{2\sqrt{P}}$ --------------------------- (5)

Where P= density of points in A, i.e number of points per unit area.

i.e $P = \frac{n}{A}$ ----------------------- (6)

$R_n = 2D_m\sqrt{\frac{n}{A}} = 2D\sqrt{P}$ ---------- (7)

Where n= number of points in the area concerned

$0 < R_n < 2.15$ --------------------- (8)

The following results will be arrived at the end of the analysis, which will be considered to determine the pattern of distribution of these schools within the study area, the value of R_n after the analysis will be:

R_n= 0 implies that the distribution of points is clustered

R_n= 1 implies that the distribution of points is random

R_n= 2.15 implies that the distribution of points is Regular.

Finally, test of significance of R_n will be carried out using the following

Formulae:

$$\sigma^2_{D_e} = \left(\frac{0.26136}{\sqrt{NP}}\right)^2 \text{-------------------------------} (9)$$

N= Number of measurements of distances between pairs of points.

$$Z = \frac{D_e - D_m}{\sigma^2_{D_e}} \text{--------------------------------------} (10)$$

Nearest neighbor analysis examines the distances from each point and the closest point to it, and then compares it to expected values for a random sample of points from a CSR (complete spatial randomness) pattern.

USING GPS FOR POSITION FIX

GPS is to be switch on using the power button (key) which will be pressed and hold for about 2 seconds, status page would appear while the GPS acquires satellite. As sufficient satellite signals have been acquired, the status page will be replaced by the position page. Press mark to capture a position, press ENTER to confirm. The lower left - hand corner of the page (position) shows your current latitude and longitude in degrees. When the receiver is looking for a particular satellite, the corresponding signal strength bar will be blank and the sky view indicator will be highlighted. Once the receiver has found the satellite, a hollow signal strength bar will appear, indicating that the satellites have been found and the receiver is collecting data from it. The satellite number in the sky view will no longer appear highlighted. As soon as the GPS has collected the necessary data to calculate a fix, the status field will indicate a 20 or 20 status. Marking a position allows you to mark and store up positions by pressing MARK. The mark position page will appear, showing the capture position and a default three digit name. To save a default name and symbol, press ENTER to
Confirm the "SAVE".

SCANNING

The data (analogue maps) are converted to digital through image scanning. The common way to capture paper maps into digital format is to use a format resolution scanner. A scanner uses a light - sensitive device to detect monochrome, 'Grey scale or color reflectance from a map and produce a raster at fixed resolution.
However, a scanner was used to convert the map in to digital form; the details on the analogue map was captured and stored in a file.

GEO-REFERENCING

Geo-referencing refers to the location of a layer or coverage in space as defined by a known coordinate reference system, such as UTM rectangular grid coordinate (x, y) or geographical coordinate latitude and longitude (ф, λ). If the map is not geo-referenced you cannot see real terrain coordinate (real world coordinate).

CREATION OF COORDINATE SYSTEM

The maps that are obtained after importing a digital format, attention is paid to the maps system of projection so as data input are made to be compatible (i.e. all digitize maps and GPS coordinates to be of same Reference system). Option is made by either user defined coordinates or coordinates of certain UTM zone.

MAP PROCESSING

The map was process using ILWIS 3.1 and ARCHVIEW 3.2a GIS packages. The Rectangular coordinates (X, Y) of the schools obtained was used to determine the distances of the pair schools in the study area. The distances calculated were then used to determine the spatial distribution pattern of the schools using Nearest Neighbor Statistical tool.

CREATION OF DATABASE OF THE SCHOOLS

The digital map produced was exported in to GIS software (Arc view 3.2a) in other to produce the required database. The individual layers after exporting was saved as dxf files format, bearing the names of the types of the features they contained. This gave the number of the layers equal to the number of the files that were saved.

Arc view then created a table automatically for each theme and related each of the rows/records to its corresponding point, arc or polygon as the case may be depending on the features contained in each theme. In this study, the table concern was created as the schools table. Hence the parcel theme was brought in to the Arc view environment as a polygon theme.

TABLE CREATION

The table for the schools was created as explain above. The creation of the tables involved editing the schools table so created. This involves deleting unwanted columns and creating new columns of interest.

The new columns of interest were the resultant normalized tables. The attribute table created was shown below.

SPATIAL QUERY

The spatial database generated can be queried either by location or by attribute. The query builder in the Arc view was used to build several queries to test its authenticity. Some examples of the queries carried out include:

(1) Show all the schools owned by the Government.
(2) Show all the schools that were established in year 2000
(3) How many schools have an enrolment over 500 pupils
(4) How many schools are owned by religious bodies

The query builder command/icon was used to raised the queries and also the identify tool was also used to raise some of the answers by double clicking on any of the points.

TABLE1: PRESENTATIONS AND ANALYSIS OF RESULTS

S/N	ABBREVIATION	FULL NAME	Easting Coordinates	Northing Coordinates
1	GBBJSS	Govt. Boys Junior Boarding Sec. Sch. Demsawo. Jimeta	218036.291	1026809.156
2	St Peters	ST. Peters Seminary, Yola	218910.000	1025580.000
3	Light of Life	Light of Life Academy, Jimeta.	218584.000	1025527.000
4	Bekaji	Govt. Day Junior Sec. Sch. Bekaji.	219260.000	1024691.000
5	Kay Academy	Kay Academy, Karewa	219094.000	1023206.000
6	SUHER	Suher International School. Jimeta.	220853.000	1025212.000
7	SUCCESS	Private Success International School. Bekaji	218944.000	1025217.000
8	EL-SHADDAI	El-Shaddai Model School, Yola.	218800.000	1025262.000
9	CONCORDIA	Concordia College, Jimeta.	218503.000	1024465.000
10	KAREWA	Govt. Day Sec. Sch. Karewa	219320.000	1023070.000

11	NADI	NADI International School	221612.000	1022440.000
12	FCE Model	FCE Model Sec. Sch. Yola	222085.000	1023722.000
13	GGYOLA	Govt. Girls Sec. Sch. Yola, Dougirei	221641.000	1024087.000
14	GMMC	General Murtala Mohammed College, Yola	219724.000	1023364.000
15	YELWA	Yelwa Govt. Day Junior Sec. Sch.	220173.000	1026784.000
16	RUMDE	Govt. Day Junior Sec. Sch. Rumde ward. Jimeta	220361.000	1027335.000
17	UCAIE	Usmaniyya College for Arabic and Islamic Education, Demsawo.	218446.851	1027056.159
18	Demsawo	Govt. Junior Sec. Sch. Demsawo.	218235.479	1026997.667
19	LUGGERE	Govt. Day Sec. Sch. Luggere	219469.833	1025711.467
20	AMA	Aliyu Mustafa Academy, Upper Luggere. Jimeta.	219326.772	1025839.572
21	HICAIE	Hayatu Iyawa College for Arabic and Islamic Education, Luggere. Jimeta.	218884.812	1025983.700
22	CAPITAL	Bisima'u Capital Govt. Day Sec.	217811.960	1026348.906

		Sch. Jimeta.		
23	Jambutu	Govt. Day Sec. Sch. Jambutu	216611.348	1027948.076
24	Wisdom	Jambutu Wisdom Academy.	216724.515	1027410.951
25	BOSCO	BOSCO Comprehensive School. Jambutu.	217088.995	1027119.250
26	DOUBELI	Doubeli Govt. Day Sec. Sch. Jimeta	219948.044	1027150.322
27	GWADABAWA	Govt. Day Sec. Sch. Gwadabawa. Jimeta.	221346.534	1026472.561
28	LADI ATIKU	Ladi Atiku Govt. Girls Junior Sec. Sch. Jimeta	220986.792	1025371.282
29	OLD GRA	Govt. Junior Sec. Sch.	220707.376	1025109.345
30	IQRA	IQRA Academy, Jimeta. Yola	220729.084	1024973.000
31	GGJBSS	Govt. Girls Boarding junior Sec. Sch. Dougirei.	221641.000	1024087.000

PRESENTATION OF RESULTS

The Result of the data collected and analysis carried out were presented in the tables and figures below. Table 4.1 below shows the Names and the coordinates of the various schools found within the study area

.

Table1: Showing the coordinates of the schools.

These coordinates obtained was used to create a map showing the location of these schools as shown in figure below. The following program was used to compute the distances from each school to its neighbors. These distances obtained were used in carrying out the nearest neighbor analysis.

Contents

A program to compute distances from observed GPS coordinates.

INPUT: E,N, (Eastings and Northings)

OUTPUT: dist (distances)

Written by Mahmud Aliyu Raji v12.1 28 May 2012

Load Data

```
clear all;close all; clc
cd /Users/imuhammedad/Desktop
load schoolscoord.txt
E=schoolscoord(:,2);
N=schoolscoord(:,3);
```

Set condition

if nargin >2, disp('wrong data entry'), return, end

```
if length(E) ~= length(N),
    disp('data incomplete or in wrong column order')
        return,
end
```

```
clear d1 d2 d3 d4 d5 d6 d7 d8
g1=[E(24) E(23) E(25);N(24) N(23) N(25)]';
for q=1:2
d1(q)=sqrt( ( g1(q+1,1)-g1(1,1) )^2 + ( g1(q+1,2)-g1(1,2) )^2 );
end
```

```
g2=[E(1) E(22) E(17) E(18);N(1) N(22) N(17) N(18)]';
for q=1:3
d2(q)=sqrt( ( g2(q+1,1)-g2(1,1) )^2 + ( g2(q+1,2)-g2(1,2) )^2 );
end
```

```
g3=[E(2) E(3) E(21) E(20) E(19) E(8) E(7);N(2) N(3) N(21) N(20) N(19) N(8) N(7)]'
for q=1:6
d3(q)=sqrt( ( g3(q+1,1)-g3(1,1) )^2 + ( g3(q+1,2)-g3(1,2) )^2 );
end
```

```
g4=[E(9) E(4);N(9) N(4)]';
d4=sqrt( ( g4(2,1)-g4(1,1) )^2 + ( g4(2,2)-g4(1,2) )^2 );
```

```
g5=[E(10) E(5) E(14);N(10) N(5) N(14)]';
for q=1:2
d5(q)=sqrt( ( g5(q+1,1)-g5(1,1) )^2 + ( g5(q+1,2)-g5(1,2) )^2 );
end
```

```
g6=[E(29) E(30) E(6) E(28);N(29) N(30) N(6) N(28)]';
for q=1:3
d6(q)=sqrt( ( g6(q+1,1)-g6(1,1) )^2 + ( g6(q+1,2)-g6(1,2) )^2 );
end
```

```
g7=[E(26) E(15) E(16);N(26) N(15) N(16)]';
for q=1:2
d7(q)=sqrt( ( g7(q+1,1)-g7(1,1) )^2 + ( g7(q+1,2)-g7(1,2) )^2 );
end
```

```
g8=[E(13) E(12) E(31);N(13) N(12) N(31)]';
for q=1:2
d8(q)=sqrt( ( g8(q+1,1)-g8(1,1) )^2 + ( g8(q+1,2)-g8(1,2) )^2 );
end
```

```
clc
distance=[d1';d2';d3';d4;d5';d6';d7';d8']
%%Program ends
```

```
distance =
  548.9171
  466.8352
  512.0102
  479.1346
  274.2485
  330.2802
  404.4850
  490.9954
  575.0622
  336.4877
  364.5888
  790.0158
  263.7650
  499.6519
  137.6130
  178.1696
  382.9939
  429.8802
  452.3700
  574.7704
   76.0000
```

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Table 2: Analysis of the Distribution of the Schools

School No.	Nearest Neighbor	Distance= D(m)
1	2	507.8762
2	3	421.7978
3	6	416.9832
4	1	790.0158
5	2	381.7085
6	3	232.9255
7	2	441.1251
8	2	325.3852
9	---	---
10	---	---
Total	23	3517.8173

From Equation (4), the nearest neighbor statistics is given as:

$$R_n = 2D_m\sqrt{\frac{n}{A}} = 2D_m\sqrt{P}$$

$$D_m = \frac{3517.8173}{10} = 351.7817\text{m}$$

n= 10

A= 4,000,000m^2

$$P = \frac{10}{4,000,000} = 0.0000025$$

$$R_n = 2(351.7817)\sqrt{0.0000025}$$

R_n= 2(351.7817) x 0.00158

R_n= 703.5634 x 0.00158
R_n= 1.1124

From eqn. (5) and the value of R_n, the distribution of schools in Yola North LGA is random.

TEST OF SIGNIFICANCE OF R_n

H_o: If $Z < Z\propto$, then R_n is significant
H_I: To reject H_o

From eqn. (6), we have

$$\sigma^2_{De} = \left(\frac{0.26136}{\sqrt{NP}}\right)^2$$

$$\sigma^2_{De} = \left(\frac{0.26136}{\sqrt{21x0.0000025}}\right)^2$$

$$\sigma^2_{De} = \left(\frac{0.26136}{\sqrt{0.0000525}}\right)^2$$

$$\sigma^2_{De} = \left(\frac{0.26136}{0.00725}\right)^2$$

$$\sigma^2_{De} = 1366.4852$$

From eqn. (7)

$$Z = \left(\frac{D_e - D_m}{\sigma^2_{De}}\right)$$

Where:

$$D_e = \frac{1}{2\sqrt{P}}$$

$$= \frac{1}{2\sqrt{0.0000025}}$$

$D_e = 316.2278$

Therefore, $D_m = 351.7817$
$D_e = 316.2278$
$\sigma^2_{De} = 1366.4852$

Then:

$$Z = \left(\frac{316.2278 - 351.7817}{1366.04966}\right)$$

$$Z = \left(\frac{-35.5539}{1366.04966}\right)$$

$Z = -0.02603$

Taken

Since Z < Z , we accept H_o that R_n is significant.

The Ownership of the schools in percentage was presented in the Pie chart and table below:

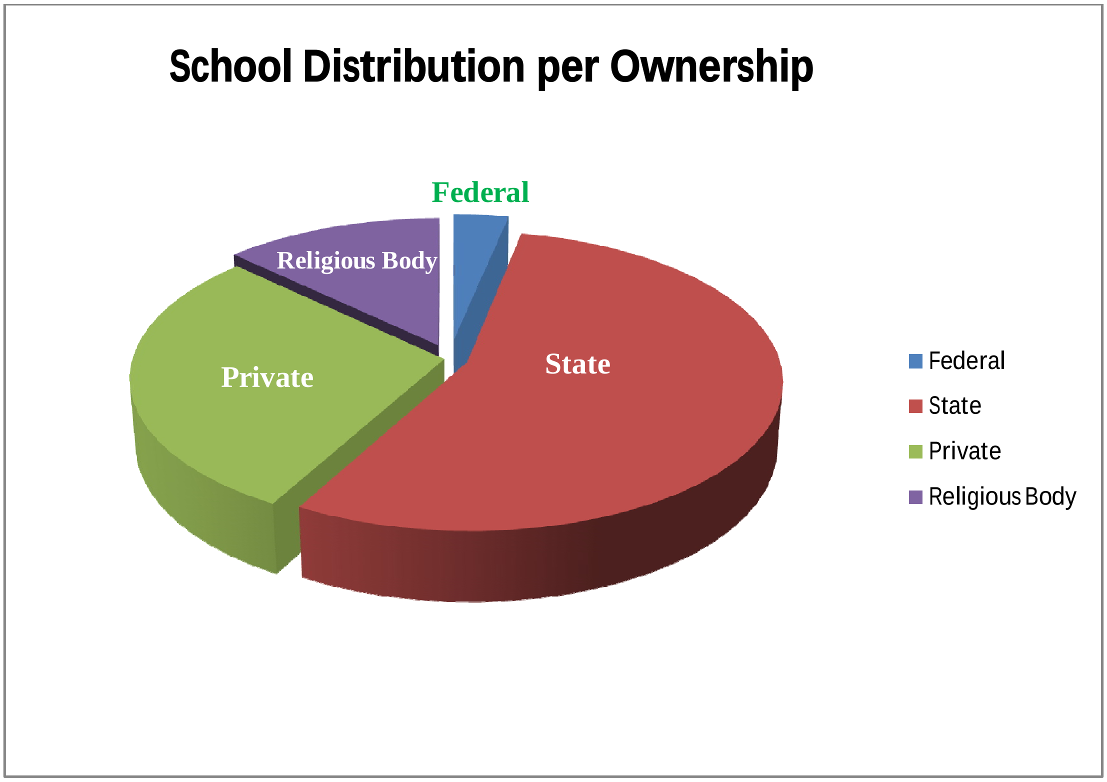

Figure 1.1: pie chart showing the percentage of the ownership of the schools.

Ownership	Number of schools	percentage
Federal	1	3.23%
State	17	54.84%
Private	9	29.03%
Religious Body	4	12.09%
TOTAL	31	100%

Table 3: showing the number of schools and their percentage.

Attributes of Mah pro.shp

Shape	ID	School Name	Location	Ownership	Owner	Year_estab	Land_mass	Teaching_s	Non_teachi	Total_enro	Number_of_
Point	1	GDSS Karewa	Karewa GRA	Government	State	1990		46	6	590	12
Point	2	Kay Academy	Karewa GRA	Private	Mrs KP	1984		24	14	600	16
Point	3	GMMC Yola		Government	State	1920		123	48	2471	37
Point	4	GDJSS, Bekaji	Bekaji Housing E	Government	State	2009		41	2	400	11
Point	5	Concordia Colleg	Karewa new exten	Private	HRH Chief J.J. F	1996		59	126	522	19
Point	6	El-Shaddai Model	Beside 75 strike	Private	Mrs. K.R. Stephe	1996		31	5	1675	16
Point	7	Private Success	Behind NNPC Mega	Private	Mrs. N. Zoaka	2006		16	10	172	6
Point	8	GDSS, Jambutu	Near Nyakore, Ja	Government	State	2004		38	5	415	19
Point	9	Wisdom Academy	Opposite Sangama	Priivate	Mr. and Mrs Timo	1999		20	4	450	16
Point	10	BOSCO Comprehen	After Jambutu Ca	Private	Mrs Nkechi O.	2003		22	3	278	13
Point	11	Capital GDSS	Along Numan Road	Government	State	1992		80	15	1750	20
Point	12	GBBJSS, Demsawo	Demsawo ward, Ji	Government	State	2009		16	4	128	4
Point	13	GJSS, Demsawo	Demsawo ward, Ji	Government	State	2006		45	4	726	9
Point	14	Usmaniyya CAIE	No. 29, Demsawo	Private	Alh. Bala Hamman	1996		25	4	400	13
Point	15	Light of Life Ac	Behind Diamond B	Religious Body	Upper room Missi	2004		17	3	73	10
Point	16	ST. Peters semin	Galadima Aminu w	Religious Body	Catholic Bishop	1965		15	13	215	6
Point	17	Hayatu Iyawa Col	Opposit Nurses h	Religious Body	JIBWIS, Adamawa	2003		63	5	450	12
Point	18	Aliyu Mustafa Ac	Bahuse Street, U	Private	Barr (Mrs) A.I.P	1984		70	25	2850	45
Point	19	GDSS, Luggere	Bahuse street, U	Government	State	1996		82	15	520	14
Point	20	GDSS, Doubeli	Atiku Abubakar w	Government	State	1990		75	15	1800	30
Point	21	Yelwa GJSS	Yelwa ward, Jime	Government	State	2008		63	0	755	16
Point	22	GDJSS, Rumde	Choci street, Ji	Government	State	2008		65	2	977	15
Point	23	GDSS, Gwadabawa	M/street, Cleark	Government	State	1994		65	12	649	10
Point	24	Ladi Atiku GDJSS	Nepa road, OLD G	Government	State	2007		45	3	374	9
Point	25	Suher Internatio	Ibrahim Attah st	Private	Alh. A.U. Borkon	2007		12	12	122	5
Point	26	GJSS, Old GRA	Nepa Road	Government	State	2009		41	0	495	13
Point	27	IQRA Academy	Nepa Road, Jimet	Religious Body	FOMWAN, Adamaw	1992		64	15	873	36
Point	28	GGSS, Yola	OLD GRA, Jimeta	Government	State	1955		112	46	2275	58
Point	29	GGJBSS, Yola	Dougirei, Jimeta	Government	State	2009		19	1	226	6
Point	30	Model Sec. Sch.	FCE Quart.	Government	Federal	2007		28	0	276	5
Point	31	NADI INT. School	Dougirei, Jimeta	Private	Hajiya Dijatu Ba	2006		13	3	61	0
Point	0										0

Table 1.2: showing the attribute table of the schools.

The results of all the queries above were shown in the figures below:

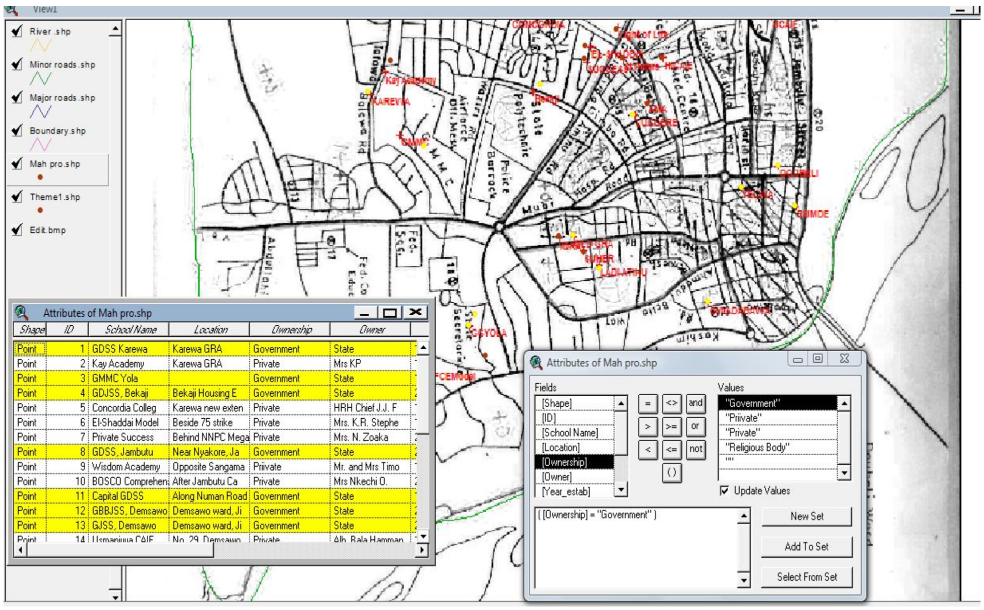

Fig. 1.3: showing the result of query 1.

The yellow color displays all the schools owned by government.

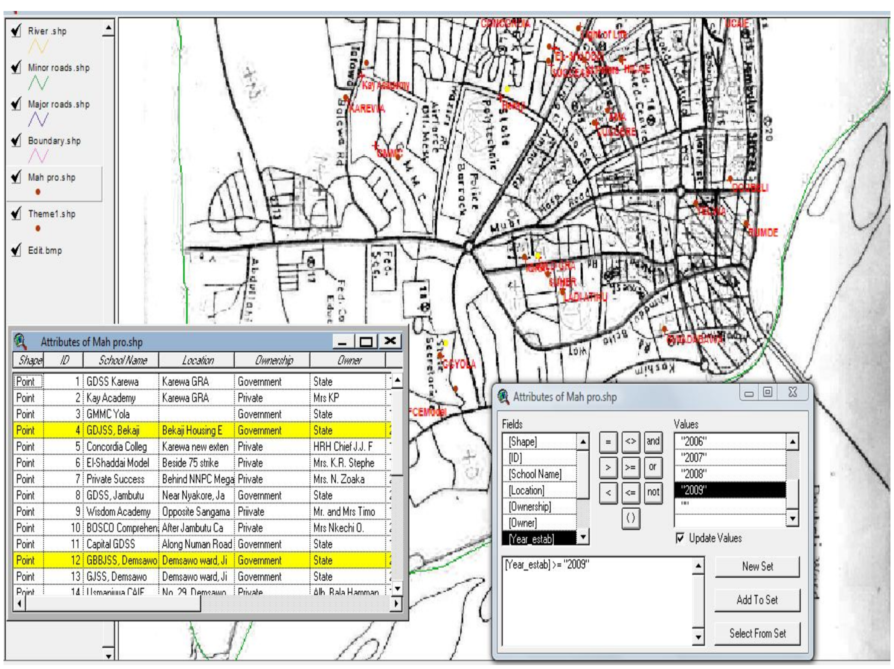

Fig. 1.4: showing the result of query 2.

The yellow color displays all the schools that were established in year 2000.

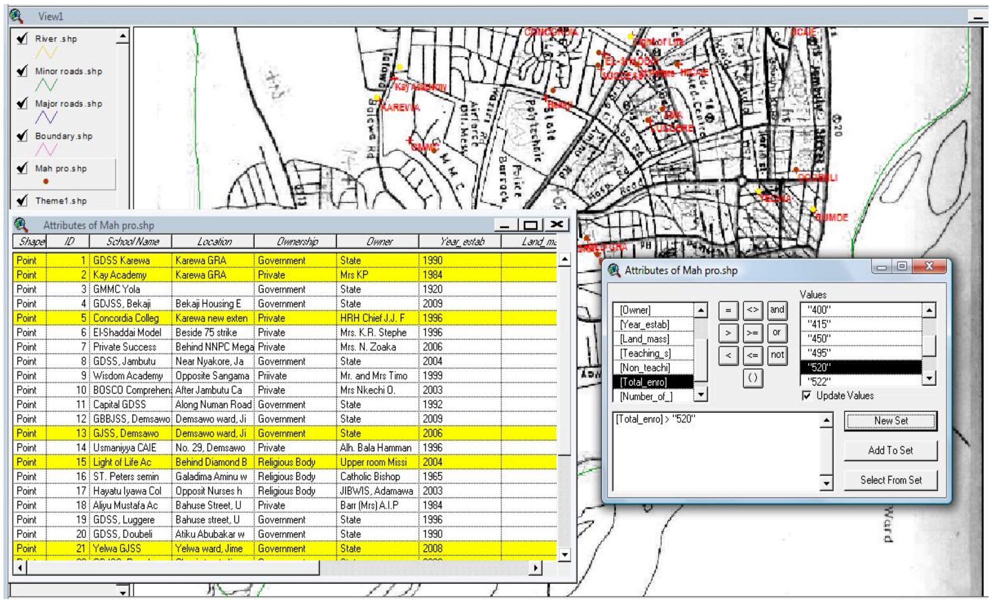

Fig. 1.5 shows the result of query 3.

The yellow color displays all the schools that have enrolment over 500 pupils.

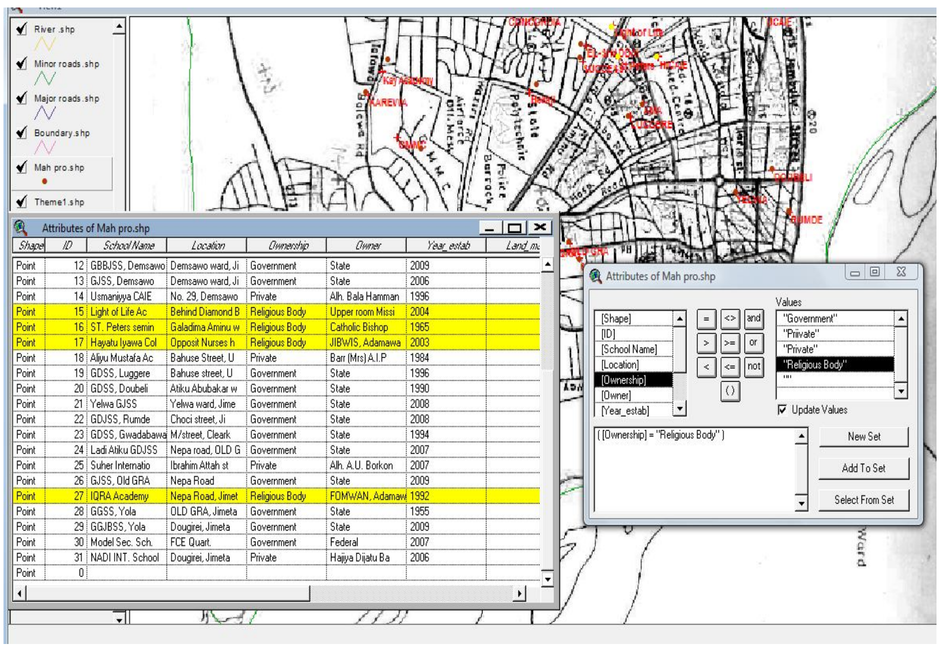

Fig1.6 showing the result of query 4

The yellow color displays all the schools that were owned by religious bodies.

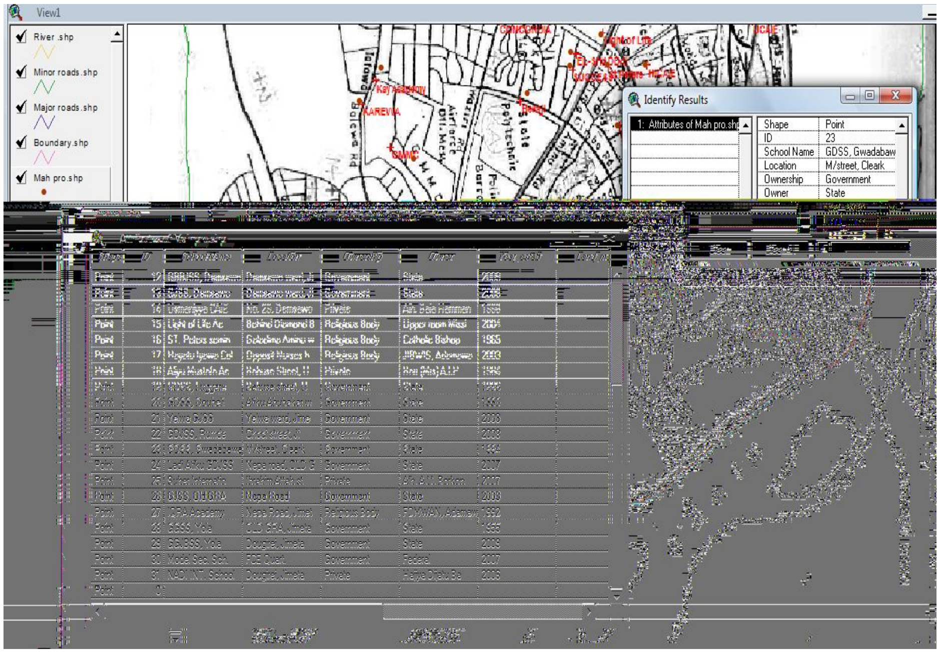

Fig 1.7: showing query using identify tool.

CONCLUSION

The study clearly depicts the process of using Nearest Neighbor analysis in determining the distribution pattern of the post-primary schools. The study reveals how the schools were located on a digital map and the value of R_n shows that random pattern of distribution exists within the study area. The potentials of GIS technology in database design and creation has also been demonstrated and found to be more efficient than the manual approach. The database created shows at a glance how the attribute and spatial data were connected. Some of the queries carried out show the capabilities of the GIS in manipulating data to solve environmental problems. Since the distribution pattern of post primary schools in Yola north L.G.A is random, students would find it hectic to travel long distances to attend some of the day schools. This may result in financial implications that some of the students may not even attend school.

RECOMMENDATIONS

Based on the analysis of result, research findings and conclusion of this study, the following recommendations were made.

1. Nearest Neighbor Analysis is recommended for determination of spatial distribution pattern of schools, since it shows clearly how these schools are distributed.
2. The Government should use the findings as a guide together with their policies in establishing schools.
3. Writing a computer program should be encouraged in calculating distances from coordinates using a programming language especially MATLAB.
4. That all the remaining local governments should determine the location and distribution of their post -primary schools using Nearest Neighbor Statistical tool.

5. That the creation of database to show at a glance all the information of the post primary schools is recommended.
6. Further research should be carried out to improve on this work.

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