Locational Analysis of Police Stations in Bauchi Metropolis, Bauchi State, Nigeria Using GIS

[1]Emengini, E. J., [1]Ikharo I. B., [1]Ejikeme, O. J.
[1]Department of Surveying and Geoinformatics, Faculty of Environmental Sciences,
Nnamdi Azikiwe University, Awka.

Abstract
Given the security problems in Nigeria particularly in the North, the need for geospatial analysis of security in Bauchi metropolis in relation to police stations cannot be overemphasized. Apart from the prevalence of security problems in the area, current analyses are inadequate, and almost non-existent. To tackle this problem, Global Positioning System (GPS) was used to take the coordinates of police stations in Bauchi Metropolis. The attribute data relating to the number of police personnel in each station were collected using interview and documented data. Simple ratio was used to analyze the data while ArcGIS was used to show the map of the distribution. Nearest neighborhood analysis shows that the distribution of police stations is random in the area. One and two kilometre buffer zones were generated and the result shows that the old city of Bauchi and the eastern part of the metropolis were fully served. On the contrary, the western and southern parts were not adequately served. The ratio of population in the area to a police is 898:1 which is far below the United Nation recommended figure of 450:1. Considering the population growth, the study recommends review of police stations provision in the area as well as increasing the work force as means of achieving a holistic security for the metropolis.

Keywords: Metropolis, Bauchi, Security, Police Station, Buffer Zones, GIS.

Introduction

For the past decade, Bauchi metropolis has had influx of people that have put the town's infrastructure under stress. With the growing population, an increasing demand for land use, water supply, security, high cost of living and high traffic of vehicular and human movement are experienced in the area. This in itself has contributed to the concentration and congestion of urban dwellers in the metropolis thereby creating hot spots for possible miscreants among the populace. “Akinbileje *et al.,* (2012) had projected that by 2017 people will be living in cities and towns than rural areas and developing world is likely to have become more urban in character than rural”. This is the experience of Bauchi metropolis.

It is well recognized all over the world that peace and security of life and property are the primary conditions for progress and development of any society (Arase *et al.,* 2007). In every society, developed or developing, insecurity has become a way of life as some have taken to it as means of livelihood. Therefore, the need to provide security becomes indispensable for the peace and progress of the people, the community and the nation at large. This can be achieved through the instrumentality of the police force. Akuul (2011) defines policing as the measures and actions taken by a variety of institutions and groups both formal and non-formal in the society to regulate social relations and practice in order to secure the safety of members of community as well as conformity to the norms and values of society. This form of control process is necessary in Bauchi metropolis for adequate surveillance of her territory and populace. This control must be equipped with tools to sanction any erring one.

Geographic Information Systems (GIS) have played a major role in identifying that framework by delineating the boundaries of community and making them practical,

useful units of geographic space.This creates a sense of belonging to an area, which can serve as a mechanism to rally other communities together, draw attention to their issues, and highlight what the locality has to offer, or represent the area as a collective in a political arena (Wilson *et al.,* 2009). Even with the advantage of modern GIS technologies, community boundaries are difficult to define. Difficulties arise because of the scale and complexity of the interlocking edges within the community and the lack of data to represent locations that are within these boundaries.Thus, a range of boundaries may define the same community, varying because of the factors and data used to create each community map.

Claims of successful use of GIS in policing have been reported in a number of cities and countries of the world. Compstat was credited with significant reduction of crime and improvement in neighborhood quality of life in New York City (Henry, 2002; Kelling and Sousa, 2001). As means to prevent murders and aggravated succession of firearms, the Chicago Police Department's (CPD) Deployment Operations Centre deployed GIS technologies to present crime information in geographic context. The first six months of GIS deployment, the CPD recorded18% decrease in crime occurence compared with the same period the year before (Anne, 2004).In addition, several regional centres in America have been created to facilitate the application of geospatial crime analysis, such as the Baltimore County Police Department's Regional Crime Analysis GIS (RCAGIS) and San Diego's Automated Regional Justice Information System (ARJIS) (David and Alex, 1999).This innovation is yet to be adopted in Nigeria though efforts are on to equip states with GIS offices nationwide.Potential uses for the technology are limited only by the imaginations of individuals in the field. Dambazau (2007) explained that there is a general belief that the Nigerian Police has been with a strength of personnel that is far below the capacity required to police the estimated Nigerian population of approximately 120 million, considering the minimum United Nations standard.Fajemirokun *et al.,* (2006) used spatial and attribute data acquisition for their work on a GIS approach to crime mapping and management in Victoria Island of Lagos, Nigeria. The work failed to address actual documented crime scene owing to its assumed number of crime incidences to areas with more crime tendencies. On the other hand, Ahmed and Salihu (2013) examined the spatial distribution of police stations in Kano metropolis. GPS was used to measure the coordinates of the stations in the area and other data pertaining to the number of police personnels in each station were sourced from interview and documentation. The work failed to vividly show how the inferential statistic (chi square test) arrived at the no significant relationship between police station and population distribution as was inferred.

Thus, this work will employ GIS and focus on identifying the spatial analysis and attributes as well as buffer analysis to determine area coverage, while putting population, area extent and land use, personnel and distribution of police stations within the Bauchi metropolis into consideration. The base map of Bauchi State showing boundary locations will be acquired and the street guide map of Bauchi Metropolis showing the road networks digitized. A geospatial analysis of security in Bauchi metropolis in relation to police stations is timely, not only because of the prevalence of the problem but because current analyses are inadequate, and almost non-existence characteristically. The challenge was to create a digital map and database containing all the police stations, police posts in Bauchi metropolis and find their proximity and spatial relationship with other points such as markets, school, medical centres, banks, religious centres and hotels.

The motivation for this study stems from that fact that the current locations of the police stations do not ensure effective coverage of the areas under their jurisdictions. It is either the stations are clustered at one point, or sparsely distributed in others. The need for police officers to make sound decisions and take swift actions cannot be over emphasized and these decisions, which are mostly spatially related, can be aided by knowledge of network analysis using GIS.

The Study Area

Bauchi State is an administrative division of Nigeria, located in the North-Eastern part of the country. It forms one of the states making up the Federal Republic of Nigeria. Bauchi State is located between latitudes $9^{0}3^{1}$N and $12^{0}3^{1}$N of the Equator and longitude $8^{0}50^{1}$E and 11^{0}E of the Greenwich Meridian (see figure 1). The state is bordered by seven states: Kano and Jigawa to the north, Taraba and Plateau to the South, Gombe and Yobe to the east and Kaduna to the West. Bauchi State occupies a total land area of 49,359km^2 representing about 5.3% of Nigeria's total land mass.

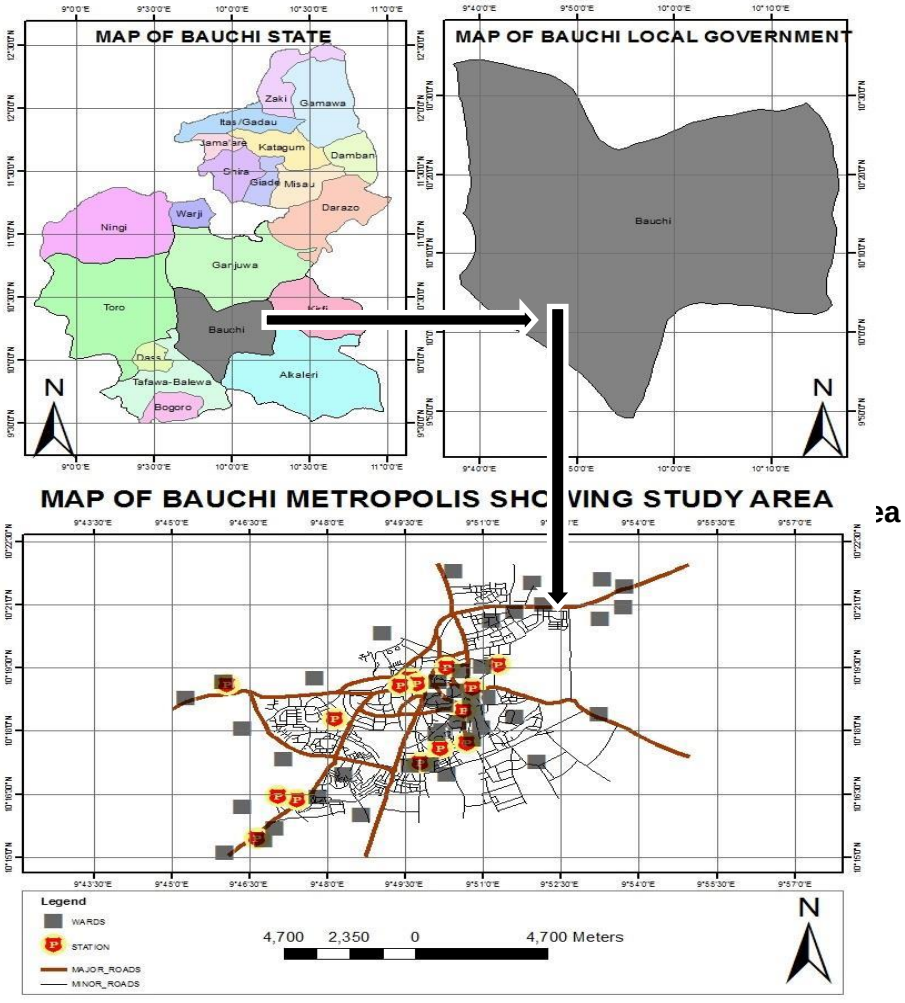


Figure 1. Map showing Bauchi state, LGA and Study Area
Source: Bauchi State Ministry of Lands and Housing

Materials and Methods

Data Capture

The primary data were collected by oral interview with police officers, through carefully selected questions. Also, global positioning system (GPS) was used to collect the co-ordinates of each of the (15) police stations in the study area. The co-ordinates of the police state headquarter and the metropolitan offices were also collected. The secondary data were collected from the police headquarters in Bauchi, from where the names and addresses of all the 15 police stations (divisions) together with their strength where collected. Demographic data of the population of the area were collected from the National Population Commission (NPC), Bauchi.

Base Map and Data Model

The street guide map of Bauchi metropolis was obtained.Geocalc was used to convert the local coordinate system to UTM System, and then georeferenced. The database also included the names of the station, the roads and the street name. But not all the streets had labels, most especially those on the outskirts of Bauchi.Vector data model was adopted for this research. Vector data model is a representation of an object-based model as a collection of nodes areas and polygon.

Using Georeferencing in ArcMap simply implies the registration of coordinates in the map to be digitized. Digitizing is the act of tracing features in an already existing map for the purpose of putting or converting them to a vector format. The digitizing method used in this work is the onscreen method of digitizing using ArcMap 10.0.

Results and Discussion

The final result is a digit map of Bauchi metropolis. This is presented in print form (i.e. paper map) for public usage and in the original digital format for experts and GIS analyst; this digital copy is subject to query and further improvement. The attribute table obtained is a general attribute table containing locations, name, and features present in the layer. It must be noted here that all these capabilities enumerated above are for those who can have access to the digital map still in the digital environment or GIS environment.

Police Stations and Personnel Distribution

The total number of police stations in the area is fifteen (15) as shown in table 1. The stations are not even distributed, also the number of personnel.

Table 1: Number of Police Stations and Personnel

OID	Station	Count_Station	Sum_Personnels
0	Division	5	446
1	Headquaters	1	870
2	Outpost	7	22
3	School	1	82
4	Zone	1	527

The Headquarters has the highest number of police personnel, this may be attributed to the fact that it is the headquarters with different departments; example is the Criminal Investigation Department (CID).

The result of the spatial distribution of police stations in Bauchi metropolis shows an uneven distribution of police stations in the metropolis (see figure 2) the map which shows this distribution also revealed that

the concentration of the police stations is within the central part of the area. The concentration of the police stations within the central area cannot be explained by the Christellars central place theory, which explains that, the location of services is based on seize of community, population, accessibility and proximity, putting into consideration, threshold and range.

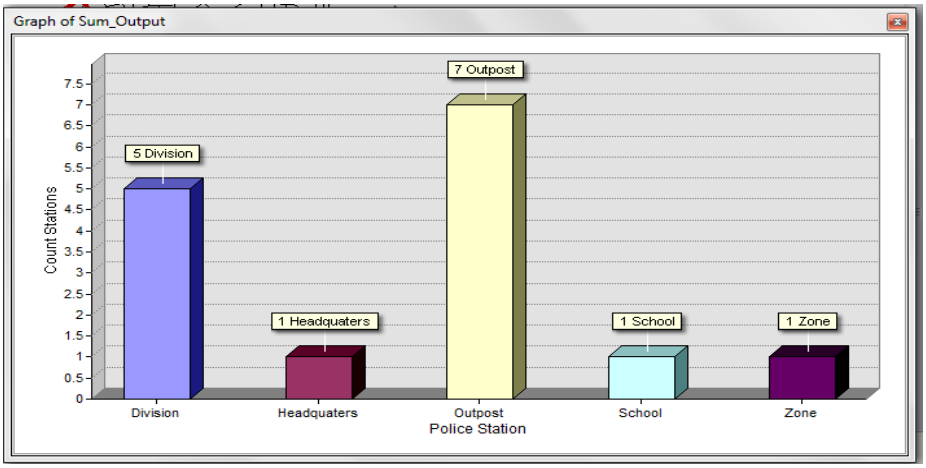


Figure 2. Distribution of Police Station in Bauchi Metropolis

To ascertain this unevenness spread of the distribution, nearest neighbourhood analysis was used. Theresult shows that the pattern of the distribution is random. In other words, the police stations are not distributed evenly.

Distribution of Manpower

Like the number of police stations, man power is not evenly distributed in the area. Nearly half of the personnel (47%) are found in the headquarters, while the remaining half is shared by the other police stations(see figure 3).Comparison was made between the personnel and the different police stations that is the Divisions, Headquarters, Outpost, School, and Zone. The police personnel are categorized into three ranks. The senior officers include the Assistant Superintendent and the rank above; the inspectors and junior officer (below inspector ranks).The research findings also revealed that in all stations, there are more junior officers than inspectors and senior officer.

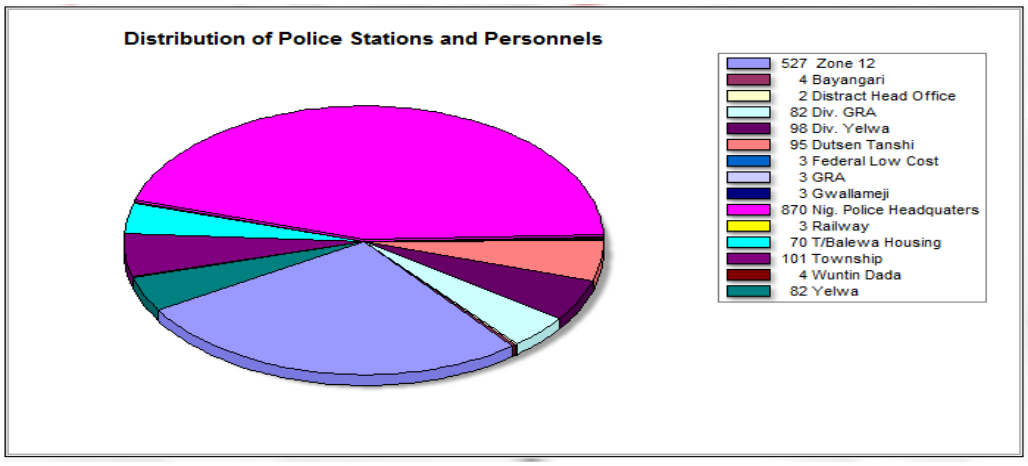


Figure 3. Police Manpower Distribution

Ratio of Police Men to Population

A simple ratio was used to find the relationship between police personnels distribution and population distribution as shown in table 2.By the United Nations standard the ratio of population to one police is 450:1. Using this ratio the value in table 2 is obtained. By this result it shows that the required security is lacking for Bauchi populace is lacking implying that the police work force is inadequate.

Table 2: Ratio of Police Personnel to Population in Bauchi Metropolis

METROPOLIS (2006 POPULATION)	RATIO
493,730	898:1

From the above table using the 2006 population census, Bauchi metropolis has the ratio of population to police strength 878:1. In essence, it has not met the UN standard ratio of four hundred and fifty people to one police.

Buffer Zones

There is no standard distance for citing stations in the country. However, 1km and 2km buffers were created on the map to identify areas that are fully or inadequately served (see figures 4).

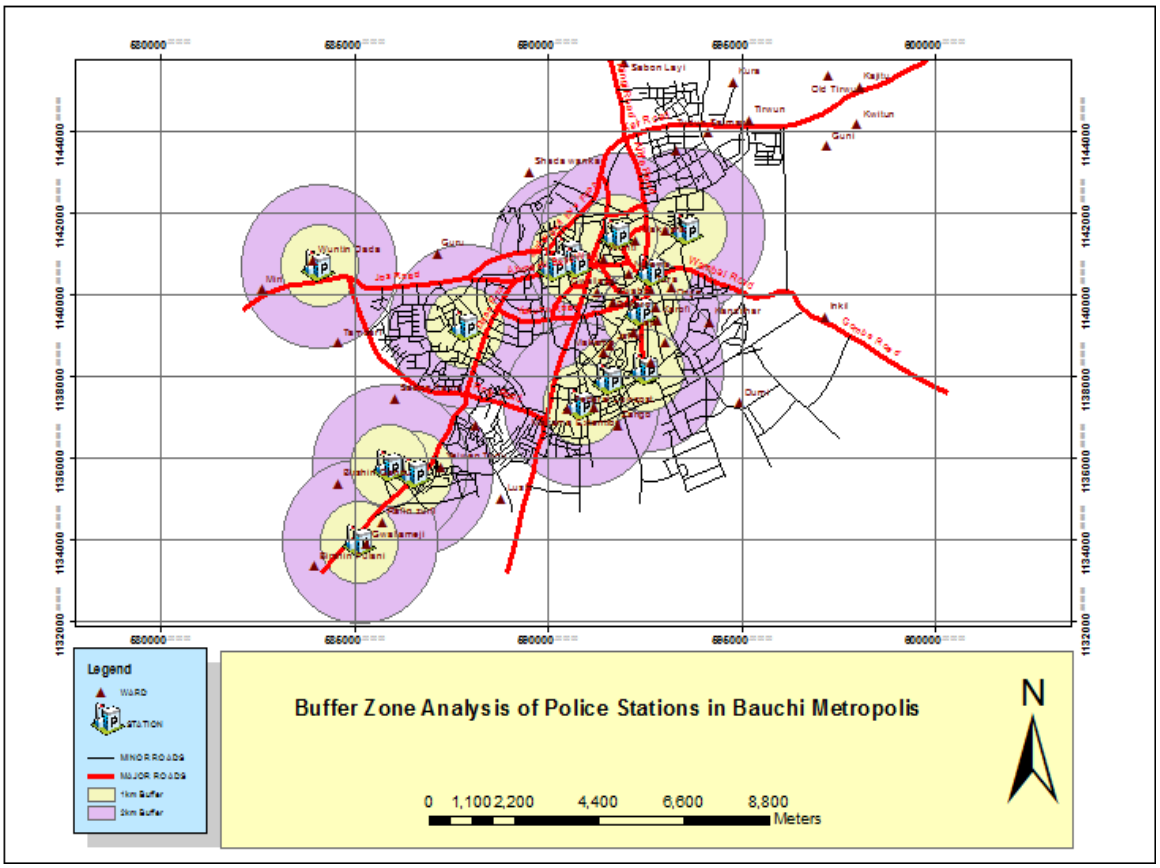


Figure 4. Map Showing 1km and 2kmBuffer Zones Analysis of Police Stations in Bauchi Metropolis

This has shown that the areas inside the city are fully served, considering both 1 and 2 km buffer. Areas in the east of metropolis are under served and in most of the area people have to travel more than a km or two to the nearest police station. Results of database queries were presented inform of digital maps, graphic displays, or animated graphics, photographs, reports, and tables. The maps can also be thematic in nature.

These presentations can be in hardcopy, softcopy and onscreen.

The map generated from the integration of the geographic location of the police stations, schools, hotels, markets, religious centers and Bauchi State Street map is shown in figure 5. The map below is the digital map produced on the course of this project. While figure 6 shows only the police stations and the wards which were superimposed on the Bauchi State street map, figure 7 shows other points of interest such as schools, hotels, markets and religious centers which are liable to insecurity.

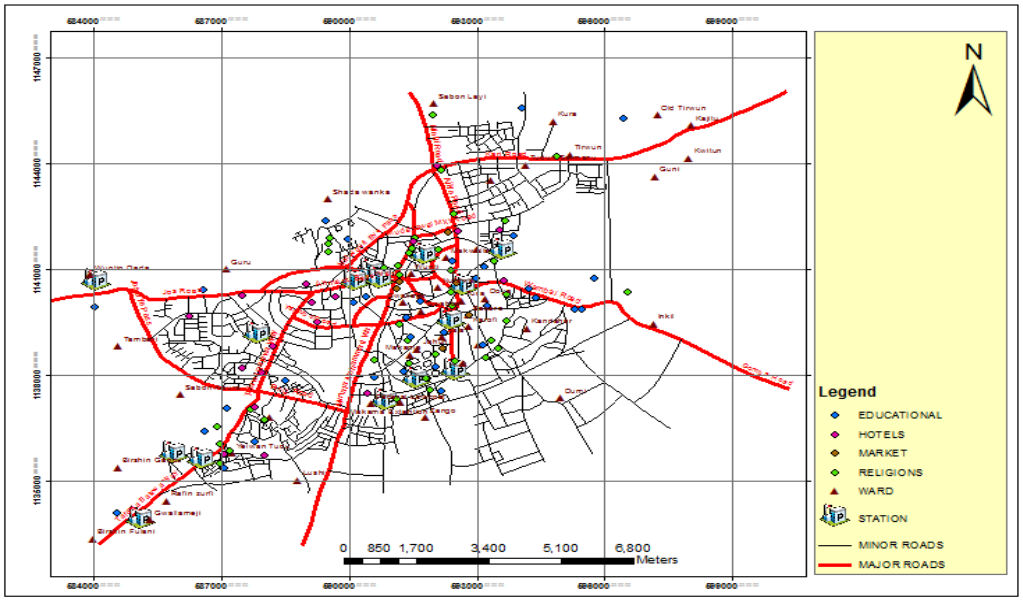


Figure 5.Digital Map of Bauchi Metropolis

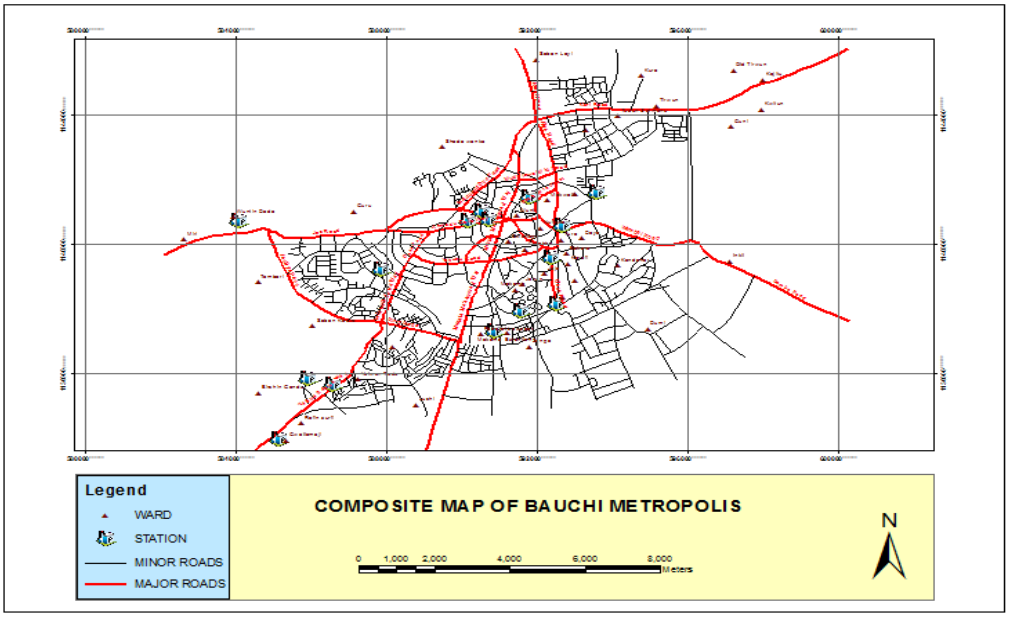


Figure 6.Map Showing the Positions of the Stations (Headquarters, Zone 12Headquarters, Divisional Police Station Headquarters and Police Outpost)

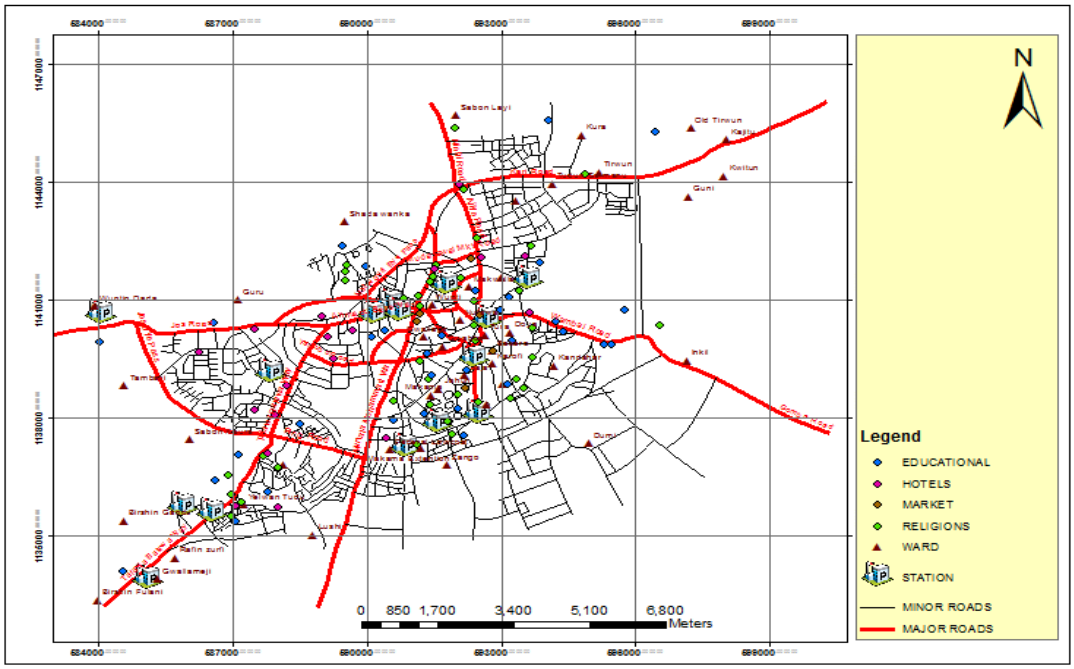


Figure 7. Map Showing Positions of other Points of Interest such as Schools, Hotels, Markets and Religious Centers

Conclusion

GIS technology provides the capability to understand how events relate to each other and their potential impacts on infrastructures. The security and safety of citizens create the necessity for GIS to be integrated in an overall Information Technology infrastructure plan as security needs of man is one of the fundamental requirements for human survival.

It was noticed that the pattern of distribution of police stations in Bauchi metropolis is clustered at the center of the city, and as one moves away from the center, the police stations are sparsely distributed. Larger numbers of police personnel are concentrated in the city of Bauchi metropolis than at the suburbs (districts). This could be attributed to the large population, presence of the police state headquarters and zonal police headquarters located within the Bauchi state capital. This study made an attempt to utilize GIS technology and software in policing and it demonstrated clearly its efficiency in accurate identification of locations of existing police stations.Owing to the findings of this study, population distribution should be a considerable factor in the distribution of police stations and police personnel. There is need for deployment of more police force and establishment of more stations in the metropolis in order to meet the UN standard and recommendations. Overall, there is need to deploy GIS as an effective tool that will ensure efficient planning for improvement of security services by the police force.

References

Ahmed, M. & Salihu, S. (2013). Spatiotemporal Pattern of Crime Using Geographic Information System (GIS) Approach in Dala L.G.A of Kano State, Nigeria. *American Journal of Engineering Research (AJER)* e-ISSN: 2320-0847 p-ISSN: 2320-0936 Volume-2, Issue-3, pp-51-58.

Akinbileje, B. F., Ibochi, A. A. & Shehu M. K. (2012). Geographical information system approach to urban reform: A case study of Makwalla area of Bauchi, Bauchi state, Nigeria. *Journal of Environmental Science and Resources Management*, Vol. 4.

Akuul, T. (2011). The role of the Nigerian police force in maintaining peace and

security in Nigeria, *Journal of Social Science and Public Policy*. Vol. 3, pp 16 - 23.

Anne, C. (2004). GIS fights crime in Chicago. Article in http://eweek.com enterprise.

Arase, S. E. & Iwouofor, I. P. O. (2007). "Policing Nigeria in the 21st century" Spectrum Books Limited, Ibadan.

Dambazau, A. B. (2007). The Nigerian police and crime prevention: Criminology and Criminal Justice, Nigerian Defense Academy Press, Kaduna. Ch 5, pp221.

Fajemirokun, F., Adewale, O., Idowu, T., Oyewusi, A. A. and Maiyegun, B. (2006). A GIS Approach to Crime Mapping and Management in Nigeria: A Case Study of Victoria Island Lagos. Shaping the Change, XXIII FIG Congress, Munich, Germany, October 8 – 13, 2006.

Henry, V. (2002). The Compstat Paradigm: Management Accountability in Policing, Business and the Public Sector, Loose-leaf Law Publications, New York, NY.

Kelling, G.L., and Sousa, W.H. (2001).Do police matter? An analysis of the impact of New York City's police reforms, Centre for Civic Innovation at the Manhattan institute, New York, NY.

Wilson, A. P., Brown, and T. & Schuster, B. (2009) .Preventing Neighborhood crime: Geography matters. *NIJ Journal,* 263: 30 – 35.