Application of Geographic Information System (GIS) In Internal Security Operations, A Case Study Of Jos Metropolis, Plateau State, Nigeria

Colonel M. A. ADENIRAN, Ekpo EFFIONG, Adedayo O. ALAGBE and Captain V. J. IBEKWE, Nigeria

Key words: Spatial Planning , Database design, Spatial Analysis, GIS and Entity

SUMMARY

In view of the frequency of the activities of insurgency, terrorism, and other violent crimes in Jos metropolis, it became necessary to employ GIS tools in understanding the trend and pattern of operations so as to plan, strategize and, enhance response time and evacuation of victims in the event of attacks. In this paper, efforts have been made to illustrate the use of GIS as a decision support system with emphasis on ability to be readily accessed and used for security response operations. The Google Earth imagery of the study area was clipped out from Google Earth. The coordinates of selected facilities were acquired using Handheld GPS (Garmin CP76). Ethno-religion crisis information was obtained from International Crisis Group. Spatial database and a digital road network were created for the generated entities. The Spatial database created was tested with spatial queries for information. Analyses carried out also include best route, closest and service area analysis. The products generated are an indication of how the spatial analytical capabilities of GIS can help in internal security operations in Jos metropolis. It was recommended that GIS should be introduced or adopted in collaboration with other forms of security management systems. Effective training should also be giving to security personnel on how to apply the technology.

ABSTRACT

In the present digital era, GIS is an excellent tool for Military commanders in the operations. The use of GIS applications by defence forces has revolutionized the way in which these forces operate and function. Military forces use GIS in a variety of applications including intelligence, battlefield management, terrain analysis, remote sensing, cartography, military installation management, and monitoring of possible terrorist activity. Database was designed for the study area. The Google Earth imagery of the study area was clipped out from Google Earth. The coordinates of selected facilities were acquired using Handheld GPS (Garmin CP76). Ethno-religion crisis information was obtained from International Crisis Group. Spatial database and a digital road network were created for the generated entities. The analysis of this work was carried out using ArcGIS 10. Various spatial operations such as Overlay Analysis, Buffering Analysis, Spatial query, best or shortest route, closest facilities and service area analysis were performed and results were presented . In this paper, the use of satellite imagery combined with GIS tools have been demonstrated as pivotal in planning and coordinating internal security operations, hence this can serve as a decision support for ameliorating Ethno-Religious conflict in Jos metropolis.

Application of Geographic Information System (GIS) In Internal Security Operations, A Case Study Of Jos Metropolis, Plateau State, Nigeria

Colonel M. A. ADENIRAN, Ekpo EFFIONG, Adedayo O. ALAGBE and Captain V. J. IBEKWE, Nigeria

1. INTRODUCTION

Since the beginning of civilization on the planet earth, military forces have played a dominant role. Mankind has since time immemorial had a thirst for warfare and this still continues today. Methods used in warfare have changed with technology but technological revolution, which has not only changed the way wars are fought has become key factors in attaining dominance in military power. The victory in battle is complete only after ground forces occupy the enemy land and take control of the area. To hold and maintain the control of occupied land, armed forces need to know the spatial extent upon which they have control (Satyanarayana, P. and Yogendran, S., 2009). The military command, which acquires such information fast and uses it fast will be at advantageous position in a future war. Major General Gurbaksh Singh VSM, states: "The lessons gained from military history indicates that the key to military victory lies (regardless of the size of the opposing forces) in remaining ahead of the enemy in time sensitive process" Electronic Today (November, 1996). A defending force or weaponry with sufficient intelligence to locate with accuracy where an attacker is or what will be his future course of action, will make it easier to defeat him by occupying position of advantage or by massing a superior force at the point of battle. This statement would amply demonstrate how important spatial information is to a field commander or his superiors at command headquarters ta aid in taking appropriate decision for response to military operations. This paper deploys the power of the spatial analytical capabilities of GIS combined with Remote Sensing technology for solving internal security operations in Jos LGA.

2. STATEMENT OF PROBLEM

In view of the frequency of the activities of insurgency, terrorism, and other violent crimes in Jos metropolis, it became necessary to employ GIS tools in understanding the trend and pattern of operations so as to plan, strategize and, enhance response time and evacuation of victims in the event of attacks.

3. AIM OF THE STUDY

The aim of this paper is to demonstrate the use of GIS as an effective Decision Support System (DSS) for internal security operations in Jos metropolis

4. OBJECTIVES OF THE STUDY

The objectives of this research are to plan, coordinate and effectively command an Internal Security operation in order to prevent or defeat insurgency, maintain law and order using GIS as a decision support system. This is done through the following steps

1. Database Design for the study area
2. Acquisition of Geometric and Attribute data of the study area.
3. Database creation and linking attribute tables to geometric data.
4. Design a digital road network map.
5. Identify crime incident areas in the study area.
6. Performing spatial analysis

5. STUDY AREA

Jos metropolis is the capital of Plateau state, Nigeria. It lies between latitudes $9^0$51'30''N to $10^0$02'00''N and longitudes $8^0$48'00''E to $9^0$59'00''E. Its headquarters lies in the city centre of Jos. It has an area of 291km^2 and a population of 821,718 as at the 2006 census.

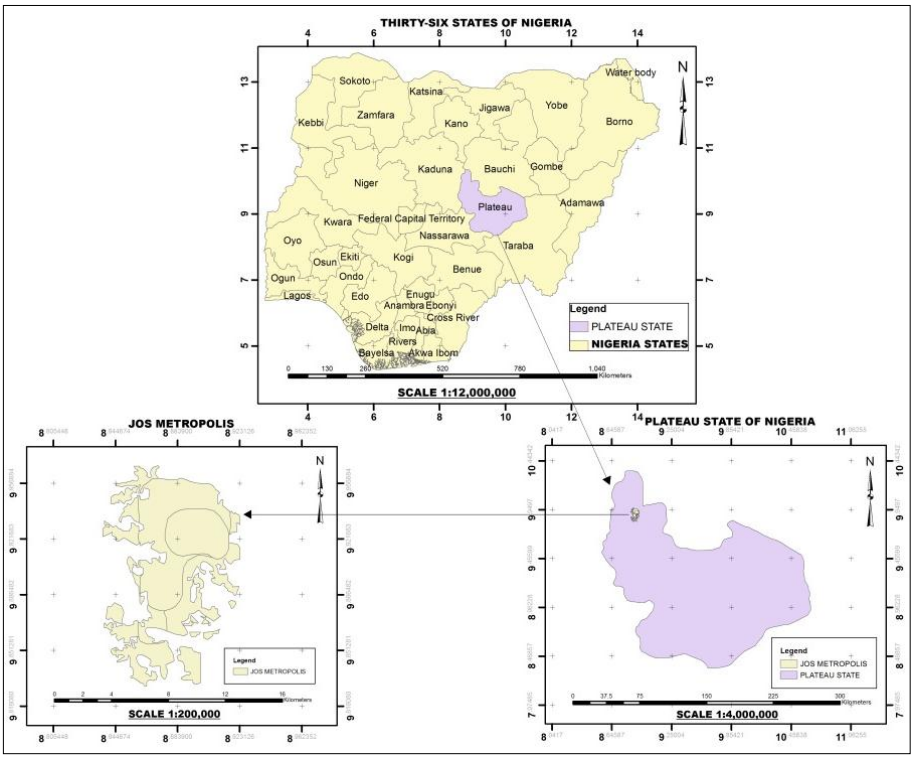

Figure 1. Location of the study area

6. METHODOLOGY

This section deals with database design, collection of geometric and attribute data and database creation.

6.1 Database Design

The effective implementation of any GIS research lies on the proper planning and design of the database is known as the heart of GIS. The process of designing a database is known as data modeling, here real world entities and their relationships are analyzed and modeled to conform to the syntax of the software of choice (kufoniyi,1998) The design of database involves the following phases; Conceptual design, Logical design, Physical design

Conceptual Design: This involved the representation of reality in a format that is simple and still satisfies the information requirement. In this context, the vector model was employed where entities perceived were represented as points, lines and polygons. Roads were represented as lines and other features as point features.

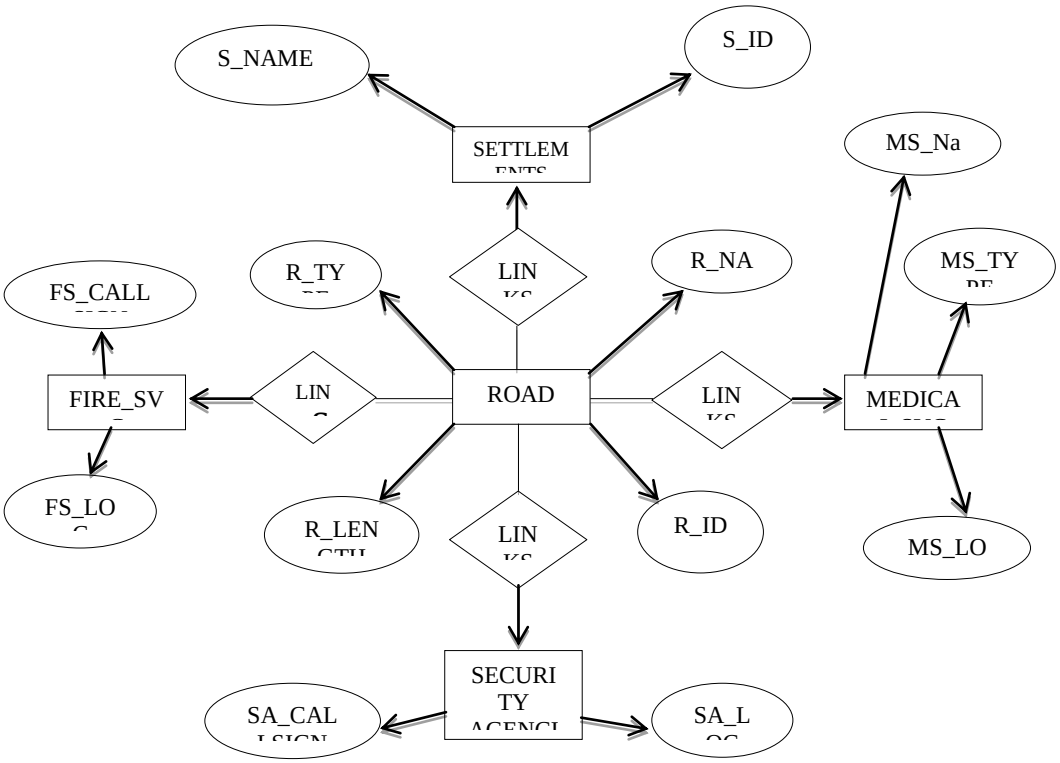

Figure 2 Entity – Relationship diagram

Logical Design: This phase translate the conceptual design into data structure. Data can be structured using the Tabular, Hierarchical, Network, Object Oriented or Relational approach. For the purpose of this paper the relational data model was adopted

Table 1 Road table and its attributes

ATTRIBUTE	DESCRIPTION
R_ID	Road identification
R_Name	Road name
R_Type	Road type
R_Length	Road length

Table 2 Settlement table and its attributes

ATTRIBUTE	DESCRIPTION
MS_Name	Medical service name
MS_Loc	Medical service Location
MS_Type	Medical service Type

Table 3 Medical Centre table and its attributes

ATTRIBUTE	DESCRIPTION
S_Name	Settlement name
S_ID	Settlement number

ATTRIBUTE	DESCRIPTION
FS_Callsign	Fire Service Callsign
FS_ID	Fire Service Identification
FS_Loc	Fire Service Location

Table 4 Security Agency table and its attributes

ATTRIBUTE	DESCRIPTION
SA_name	Security agency's name
SA_loc	Security agency location
SA_callsign	Security agencies callsign

Table 5 Fire Service station table and its attributes

5.1 Dataset Required

The process carried out involved the collection of primary data, that is, location data of facilities through field observation using the Garmin handheld Global Position System

(Garmin CP76). While the secondary data source include Google earth imagery updated in the the month of October, 2012 and documentations from International crisis group

Physical Design

This stage is referred to as the implementation stage. It involves the representation of the data structure in a format of the implementation software

Table 6 Road table and its data declaration

ATTRIBUTE	DESCRIPTION	DATA TYPE	FIELD LENGTH
R_ID	Road identification	Short integer	
R_Name	Road name	Text	15
R_Type	Road type	Text	20
R_Length	Road length	Short integer	

Table 2 Fire Station and its attributes

Table 7 Settlement table and its data declaration

ATTRIBUTE	DESCRIPTION	DATA TYPE	FIELD LENGTH
S_Name	Settlement name	Text	15
S_id	Settlement number	Short Integer	

ATTRIBUTE	DESCRIPTION	DATA TYPE	FIELD LENGTH
FS_Call sign	Fire Service Call sign	Text	20
FS_ID	Fire Service Identification	Text	20
FS_Loc	Fire Service Location	Text	20

Table 10 Fire Fervice station tableand its data declaration

ATTRIBUTE	DESCRIPTION	DATA TYPE	FIELD LENGTH
MS_Name	Medical service name	Text	15
MS_Loc	Medical service Location	Text	20
MS_Type	Medical service Type	Text	20

Table 9 Security Agency table and its data declaration

6.3

ATTRIBUTE	DESCRIPTION	DATA TYPE	FIELD LENGTH
SA_name	Security agency's name	Text	15
SA_loc	Security agency location	Text	20
SA_call sign	Security agencies call sign	Text	20

Database Creation

Following the design phase, the database was created and populated in ARCGIS 9.3 environment. Polygon, Line and Point layers were created respectively for the identified entities. These form individual relations which were then populated with their attribute values.

7. SPATIAL OPERATIONS

In land based Military operations, it is important for the commander on ground to be acquainted with the terrain conditions, elevations for maneuvering armour carriers, tanks and for use of various weapons. In addition, they need vegetation cover, road networks, and communication lines with pin-point accuracy for optimizing the resource utilization. A detailed land map with information on the land use, terrain model and proximity of habitats are essential for military operations.

There is a wide range of function for data analysis in most GIS packages; this is what distinguishes GIS from all other information system. These capabilities use the spatial and non-spatial data in the spatial database to answer questions and solve problems that will be used as a decision support system. Having acquired all the necessary data, the Geographic information system operation performed within the study area are: Buffering, Classification, and 3D Analysis, Network Analysis

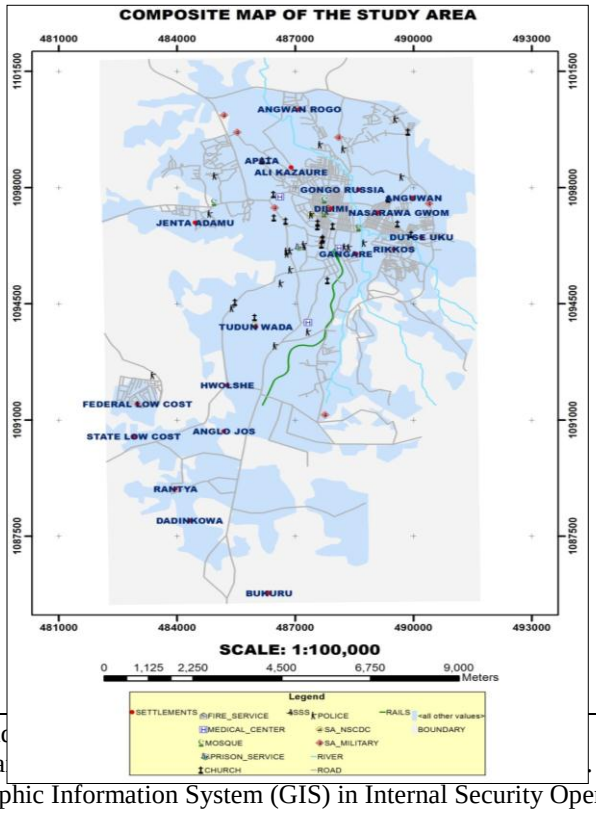

Figure 3 Composite map of the study area

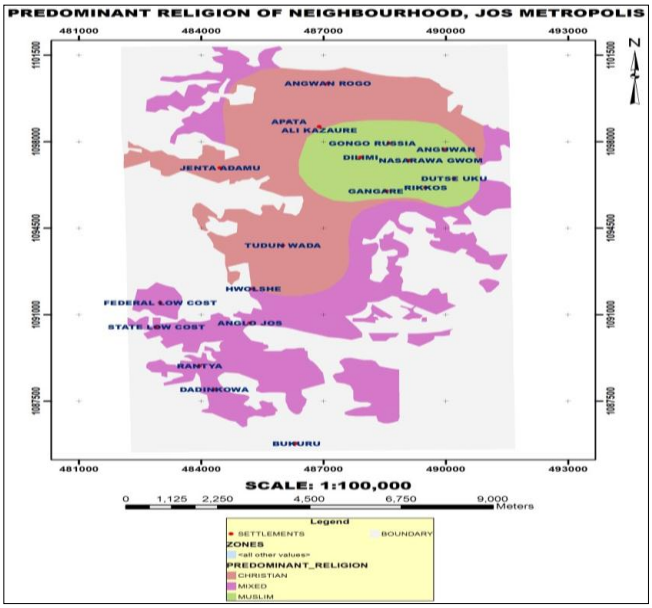

Figure 4 Spread of violence map of the study area

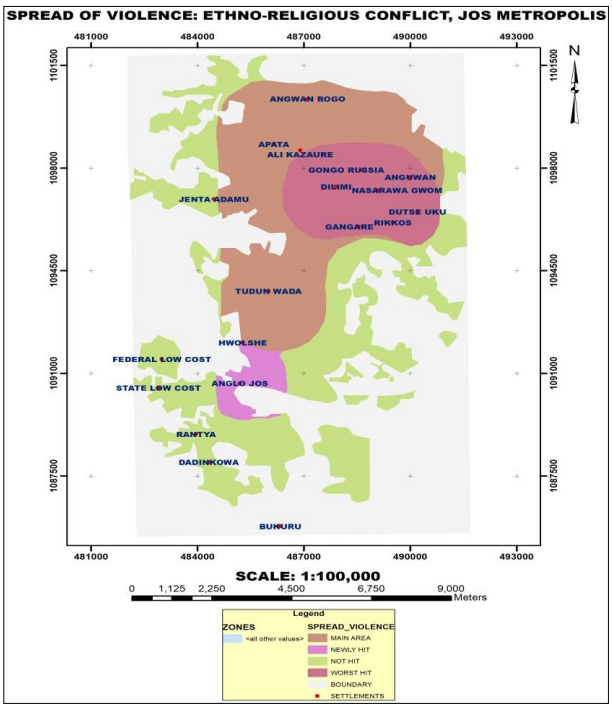

Figure 5 Predominant religion map of the study area

7.1 Spatial Search

Database are central to GIS, they give "intelligence" to maps by attaching information to make geographic data useful. GIS performs much of its work at database, and understanding what the database offers and how it functions is important (Davis B.E 1996). The following queries were performed in this research.

Query 1: Select churches within the study area
Syntax: "F_Type" = 'Church'

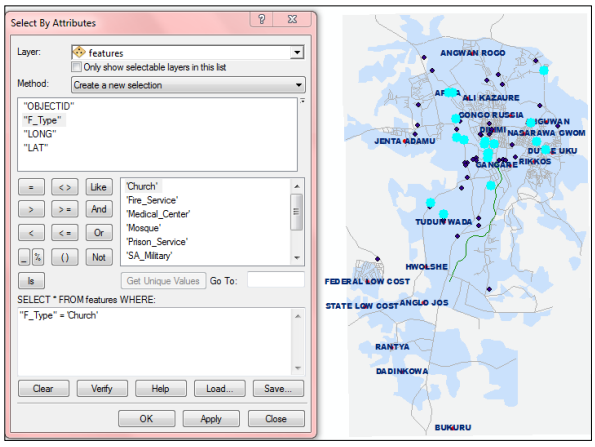

Figure 6 Query for major church locations within the study area

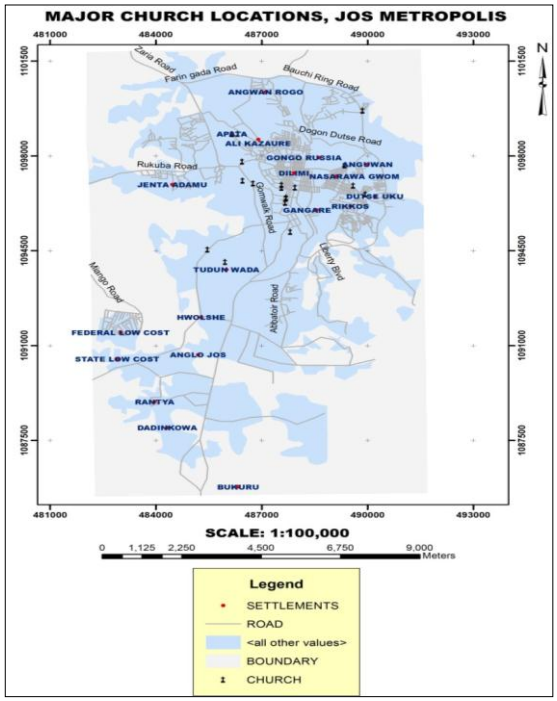

Figure 7 Map of major church locations within the study area

7.2 Network Analysis

7.2.1 Best route analysis

Basically, network GIS operates on these lines features, but it also includes the surrounding area and associated attributes. Distance along roads or other line networks is fundamental information in many applications. A simple assignment is to find the shortest path between two (2) points. Additional information is required, such as directions and distances. The network analysis operation asks for the starting and ending points to be connected.

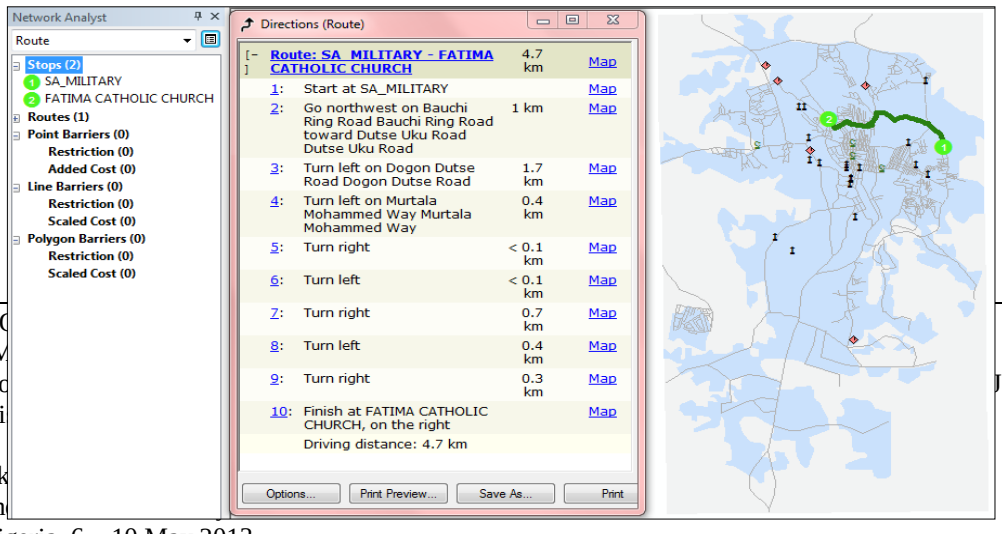

Figure 8 Best route analysis from a military post to Fatima Catholic Church

Figure 9 Alternative route analysis from a military post to Fatima Catholic Church

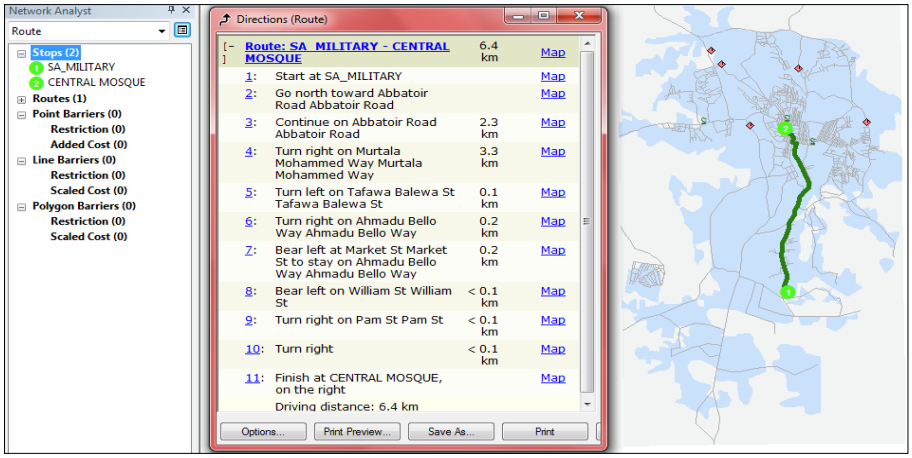

Figure 10 Best route analysis from a military post to central mosque

Figure 11 Alternative route analysis from a military post to central mosque

Table 6 Comparison between best and alternative route

LOCATION	BEST ROUTE	ALTERNATIVE ROUTE	DIFFERENCE
Military post to Fatima catholic church	4.7km	5.4km	39.0m
Military post to Fatima central mosque	6.4km	6.5km	

7.2.2 Network Closest facility

A closest facility analysis is useful in determining the closest facility or facilities to an incident based on a specified network cost.

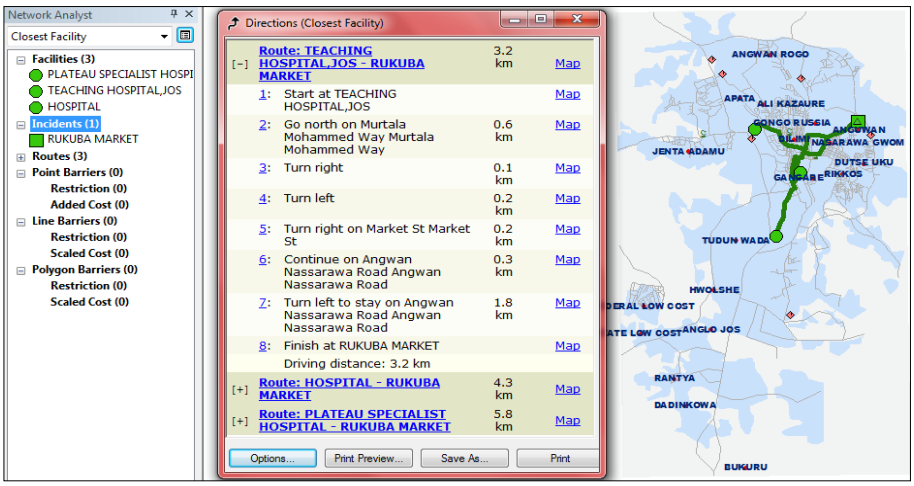

Figure 12. Closest facility operation to determine the closest Medical center from a bomb incident at Rukuba market

7.2.3 Network Service Area

A network service area is a region that encompasses all accessible streets (that is, streets that are within specified impedance). Service areas created by Network Analyst also help evaluate accessibility. Concentric service areas show how accessibility varies with impedance. Once service areas are created, one can use them to identify how much quantities of anything else are within the neighborhood or region.

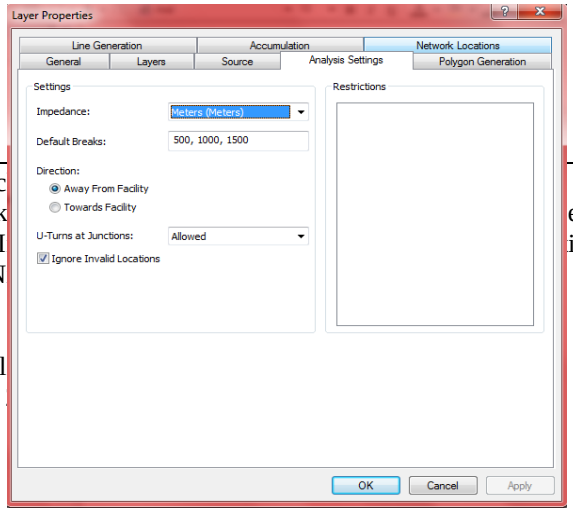

Figure 13 Analysis Settings for service area analysis of police posts at intervals of 500m, ` 1000m, 1500m

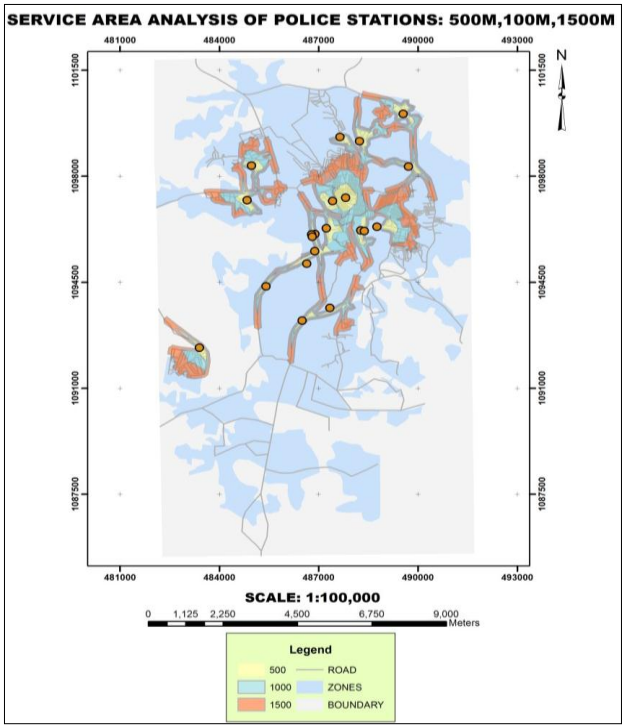

Figure 14 Service area analysis of police posts at intervals of 500m, 1000m, 1500m

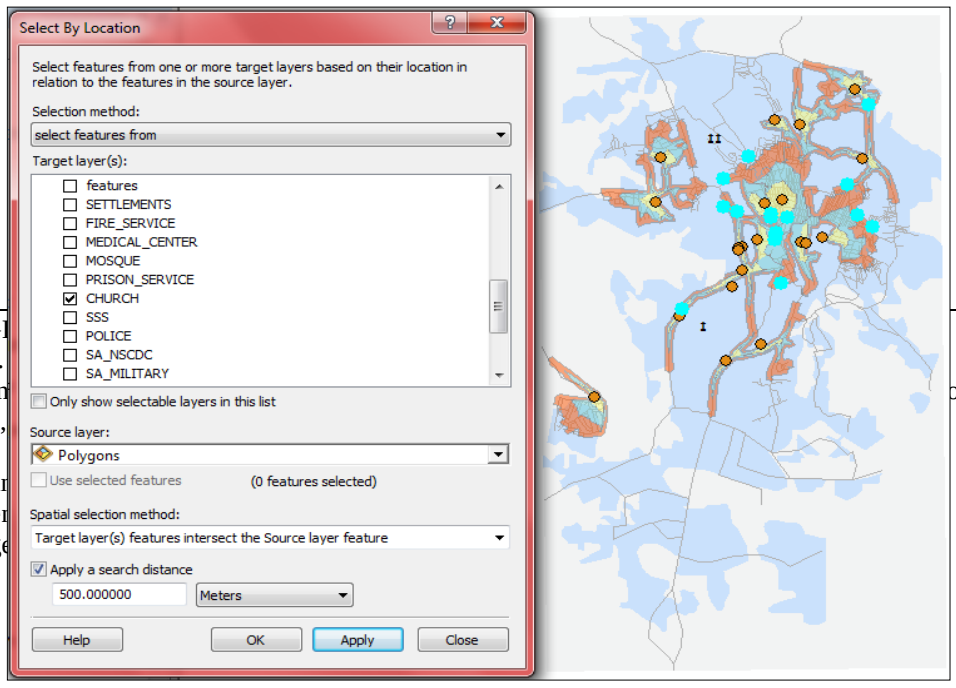

Figure 15 Select by location operation to determine churches within 500m service area analysis of police posts

7.3 Analysis of Results

Figure 3 shows the composite map of the study area and it depicts the features of interest in the study which are military posts, police posts, churches, mosques, markets, hospitals e.t.c The mapped features are hot incident areas during the ethno-religious crisis in Jos metropolis. Figure 4 shows the spread of violence in Jos metropolis and it indicates that Gangare, Dilimi, Gongo Russia and Dutse Uku are the major worst hit areas. Figure 5 shows the predominant religion in the areas within the study area. Spatial queries were performed to reveal religious locations within the study area. Such religious locations are major targets for bombs and attacks. The location of the religious centres – churches is illustrated in figure 7. In other to help military to respond and plan on time to reach crime incident areas, best route analysis was performed from a military post around Dutse Uku to Fatima Catholic Church and to the central mosque. The best route distance traveled to the church is around 4.7km while to that of the mosque is 6.4km. (See figures 8 and 10). This demonstrates the capability of GIS in responding to violence incident areas. The closest medical centres were determined to a crime incident area at Rukuba market using the network closest facility analyst. The closest of the medical centres is Teaching Hospital Jos – see figure 12. Service areas of the mapped police posts were also indicated at distances of 500m, 1000m and 1500m were traveled as illustrated in figure 14. Sixteen (16) churches were within 500m service areas of the Police posts. These analyses with the technology of GIS can help the security agencies respond, plan and manage security operations effectively.

8. CONCLUSION

Modern security operations involve combined forces and an integrated approach for evaluating conflict areas for mobilizing logistics, moving various forces and setting communication network for effective operations in real time scenario which are very necessary prerequisites for successful operations. In this paper, a map showing the location and spread of violence in Jos metropolis has been produced. Location of important security

posts were also shown on a map. The analyses performed can be used as a support for decision making processes for security agencies.

9. RECOMMENDATIONS

1. It is recommended that GIS should be introduced or adopted in collaboration with other forms of security management systems.
2. Effective training should also be giving to security personnel on how to apply the technology properly.

REFERENCES

International Crisis Group: *Curbing Violence in Nigeria (1) The Jos Crisis*, Crisis Group Africa Report No. 196 – 17 December, 2012

ArcGIS Desktop Help 9.3 version 1999-2008 ESRI Inc.

Davis B.E (1996): GIS: A Visual Approach, p. 210 onward press

Kufoniyi O. (1998) Basic concept Geographic Information Systems and Database Design and creation in Ezeigbo C.U. (Ed) Principle and Application of Geographic Information Systems, Panat press, Lagos, Nigeria.

Satyanarayana, P and Yogendran, S (2009): Military Applications of GIS www.geospatialworld.net accessed 06/09/12

BIOGRAPHICAL NOTES

Colonel M.A. Adeniran is the Deputy Director - Evaluation, Directorate of Army Real Estate at the Nigerian Army Engineers Corps Headquarters, Bonny Camp, Lagos, Lagos State. He holds the following qualifications: PGD (GIS), PGD (Surveying and Geoinformatics), PD (Surveying and Geoinformatics), HND(Surveying and Geoinformatics). He is a registered Surveyor and full member of Nigerian Institution of Surveyors (mnis).

Ekpo Effiong is a Senior Lecturer at Federal School of Surveying, Oyo, Nigeria. He is the Head of Department of Geoinformatics of the school. He holds B.Sc. Hon. (Surveying), PGD (Remote Sensing) and M.Sc. (Surveying and Geoinformatics). He is a registered Surveyor, full member of Nigerian Institution of Surveyors (mnis) and member of Nigerian Environmental Society (mnes).

Adedayo Alagbe is a Lecturer at Federal School of Surveying, Oyo, Nigeria. He holds B.Sc. Hon. (Esate Management), PGD (GIS) and M.Sc. (Information Science). He is a registered member of Nigerian Environmental Society (mnes).

Captain V. J. Ibekwe is based at Headquarters, 43 Division of Nigerian Army Engineers, Maxwell Cantonment, Jos. He holds B.Sc. Hon. (Geology) and PGD (GIS).

CONTACTS

Colonal M.A. ADENIRAN
Deputy Director, Evaluation,
Directorate of Army Real Estate,
Nigerian Army Engineer Corps Headquarters
Bonny Camp, Lagos State, Nigeria.
Mobile: +234 813 2571 026
e-mail: lekanadeniran@yahoo.com

Ekpo EFFIONG
Department of Geoinformatics
Federal School of Surveying, Oyo,
Oyo State, Nigeria.
Mobile: +234 805 2322 164
e-mail: ekpoeff@yahoo.com