USING GIS AND GPS TECHNIQUES IN MAPPING ROAD ACCIDENT PRONE AREAS IN JALINGO TOWN TARABA STATE, NIGERIA

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ABSTRACT

In this paper, effort has been made to map out road accident prone areas in Jalingo metropolis using Geographic Information System (GIS) and Global Positioning System (GPS). Street guide map of Jalingo metropolis and road accident data for the year 2009, 2010 and 2011 were used in identifying and mapping of the accident prone areas. GPS coordinates were taken and used for geo-referencing and digitization using AutoCAD Land Development and Arc GIS 9.2 which give the digital map of accident prone areas. In addition, accident particulars for the year 2009, 2010 and 2011 such as, location, type of vehicle involved, and number of persons injured or dead were also collect and included in a GIS database. It was revealed that year 2011 had the highest number of accidents due to the growing population and increase in number of vehicles. The result revealed that the distribution of accident varies depending on the types of road surface at the time of accident, the type and number of vehicles involved in the collision. It is recommended that Police, Road Safety, VIO official and other transport workers will find this study useful in identifying remedial measures for the improvement of safety.

Keywords: Accident, GIS, GPS, Safety and Casualties

INTRODUCTION

The transportation problems faced by various nations have increased manifold, necessitation search for methods or alternatives that ensure efficient, safe, feasible and faster means of transport. Road accidents particularly in Jalingo, the capital of Taraba state constitute a problem which cause vast number of injuries and death.
The severity of road traffic accident is influenced by a number of variables; prominent among these are population and vehicle densities which could be used to assess fatality rate (Magnasoft, 2003). In general, the various factors that can cause accidents can be broadly categorized into road related, vehicle related and driver related (World Bank Group, 2002).

However, traffic safety has become a major area of concern for the authorities. The development of urban transport has not kept pace with the traffic demand both in terms of quality and quantity (Musa, 2012). As a result, the use of personalized transport mainly two wheelers and intermediate public transport is growing at a rapid speed. The disproportionate growth in traffic vis-à-vis growth in road length along with unauthorized encroachment on road is a societal menace. Lack of traffic and lane discipline and deficiency in traffic control have contributed to the increasing problems of congestion in urban areas.

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The advancement of GIS and GPS can be put to effective use to map analyse accident. Although GIS has been used for over thirty (30) years, however, it has only recently being used in the field of transportation. In addition to promoting linkages between various types of data and maps, GIS is able to manipulate and visually display numerous types of data for easy comprehension (Kufoniyi, 1998). GIS is a technology for managing and processing location and related information. It visually displays the results of analysis thus enabling sophisticated analysis and quick decision making. Development of a system that uses GIS in mapping traffic accidents has been pursued towards improving the efficiency and effectiveness of traffic accident counter measures (Bassey, 2010). Thus, GIS offers a platform to maintain and update accident record database and use it for further analysis.

The objective of this paper is to identify accident prone areas in Jalingo, to determine factors that constitute to accident, and to produce a digital map of accident prone areas in the study area.

The Area of Study

Jalingo is the capital of Taraba state and is one of the 16 local government areas that make up the state. It is located on latitudes 08^0 $50^{'}$ and 09^0 $10^{'}$ North of the equator and longitudes 10^0 80^1 and 11^0 $50^{'}$ East of the Greenwich meridian.

Apart from being the state capital, the local government secretariat is located inside the heart of Jalingo. It also serves as the traditional seat of Muri Emirate Council of Taraba state. Jalingo local government is bounded on the east by Yoro local government area, on the north by Lau local government area and on the south by Ardo-kola local government area and south-west by Karim Lamido local government area.

METHODOLOGY

Data

- GPS coordinates of road junctions in Jalingo metropolis
- Police station accident report
- Road Safety accident report
- Topographical Map of Jalingo

Software

- Corel draw 12; used for map processing after scanning.
- AutoCAD Land Development GIS software.
- Arc GIS 9.2 package.

Hardware

- Laptop computer (specification 40 GB HDD, Pentium IV Processor and 516 MB RAM). Scanner; used for scanning the map into the computer.
- Hewlett Packard DeskJet 9600 series.
- Garmin 12, Global Positioning System (GIS).

Data Acquisition

In order to determine the accident prone locations in Jalingo metropolis, the following data were collected and used.

i. Police station accident report obtained from the office of the superintendent of police, Jalingo.
ii. Accident report for the year 2009, 2010 and 2011 (Road Safety Jalingo).
iii. Street guide map of Jalingo metropolis.

Geo-referencing

The street guide map of Jalingo was acquired from Taraba State Ministry of Lands and Survey and scanned into the computer. The map was scanned in bits as the raster input using scanner and merged Corel Draw 12 for further processing. Geo-referencing was done by the used of tie-points. Three features were sought for, and used as tie-points because of their ease of identification. The features include road junctions, river confluence and cross points of roads and rivers (i.e. bridges). The geo-referenced map portrayed information as to where the area represented on the map fit on the surface of the earth.

Digitization

Digitization was carried out to create spatial data from existing hard copy maps and documents. The geo-referenced raster image of street guide map of Jalingo metropolis was digitized using Arc GIS 9.2 by the process of on-screen digitization. Road network of the study area was digitized as line features, while accident locations were digitized as point features. The exact locations of accident areas were identified by using tool in AutoCAD Land Development (Figure 1). By using the measure tool, the spatial location of a particular accident was marked by knowing its distance from a particular station to where it occurred. The accident locations for 2009, 2010 and 2011 are presented as shown in tables 3, 4 and 5 respectively.

RESULTS

Geographic Location of the Accident Prone Areas

Using Garmin 12 GPS unit, coordinates of points (particularly the road junctions) were determined to give the spatial locations of the accident prone areas. It is worthy of note that Nigeria is covered by three UTM Zones namely 31, 32 and 33. The coordinates were therefore obtained using UTM Zone 33 projection system. These coordinates are presented in table 1.

Table 1: The Coordinates of Accident Prone Areas

S/No	Accident Prone Areas	Easting X(M)	Northing Y(m)
1	F.G.G.C. Junction	757491	987731
2	State Sec. Junction	757644	987150
3	Mayo Gwai Bus Stop	758286	986017
4	Jankada Junction	758892	985558
5	First Bank/Key Stone Bank (U Turn)	759211	985211
6	Hospital Junction	760107	984092
7	Market	759679	983885

Source: Field Observation 2011

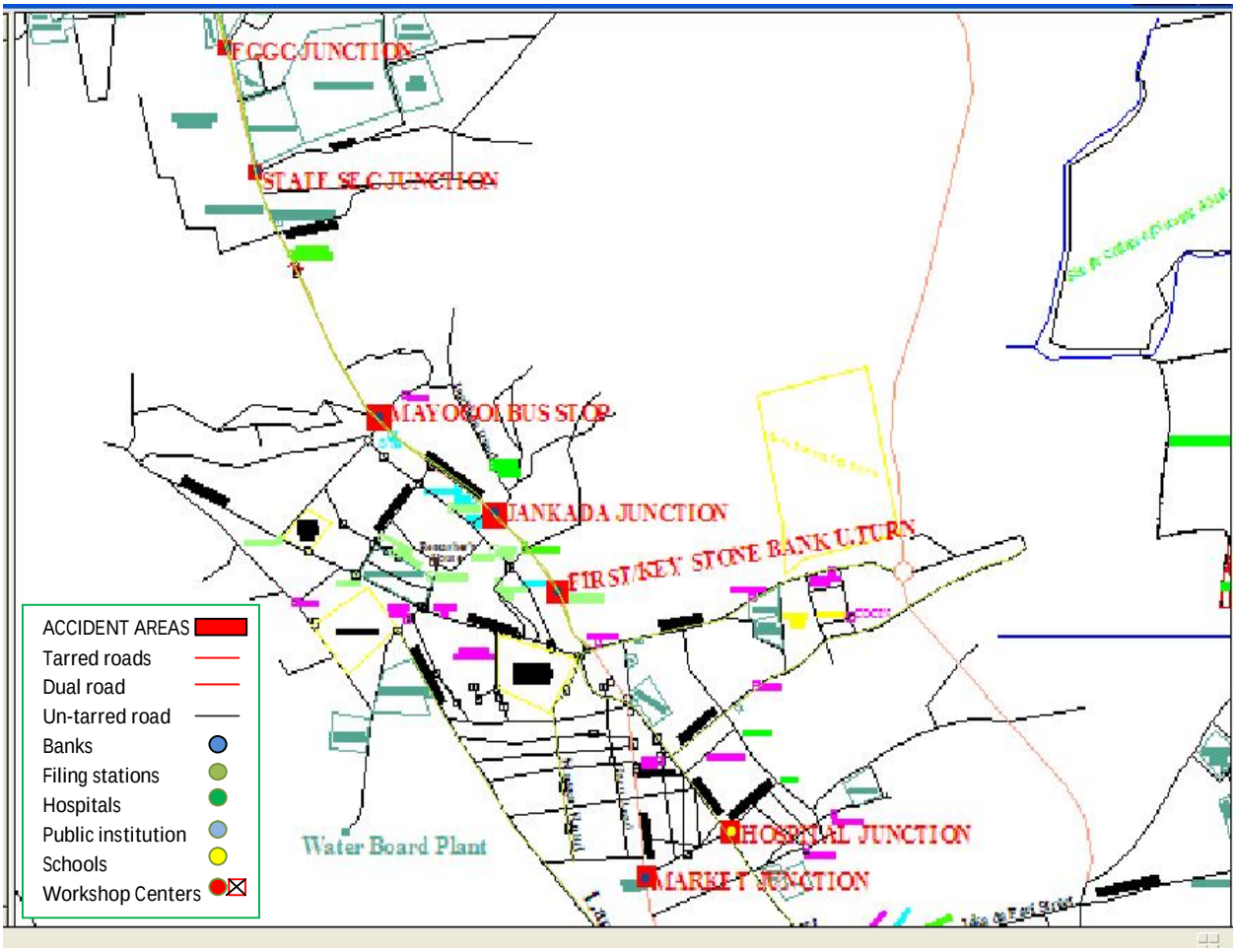

Figure 1: A Digital Map of Jalingo Metropolis Showing the Accident Prone Areas

Table 2: Summary of Road Accidents in Jalingo Metropolis from 2009-2011

S/N	Year	No. of Accident	Casualties		Non- Casualties	Total Casualties
			Killed	Injured		
1	2009	128	50	47	173	467
2	2010	170	50	436	158	486
3	2011	203	52	444	176	496

Source: Bureau of Statistics, 2011

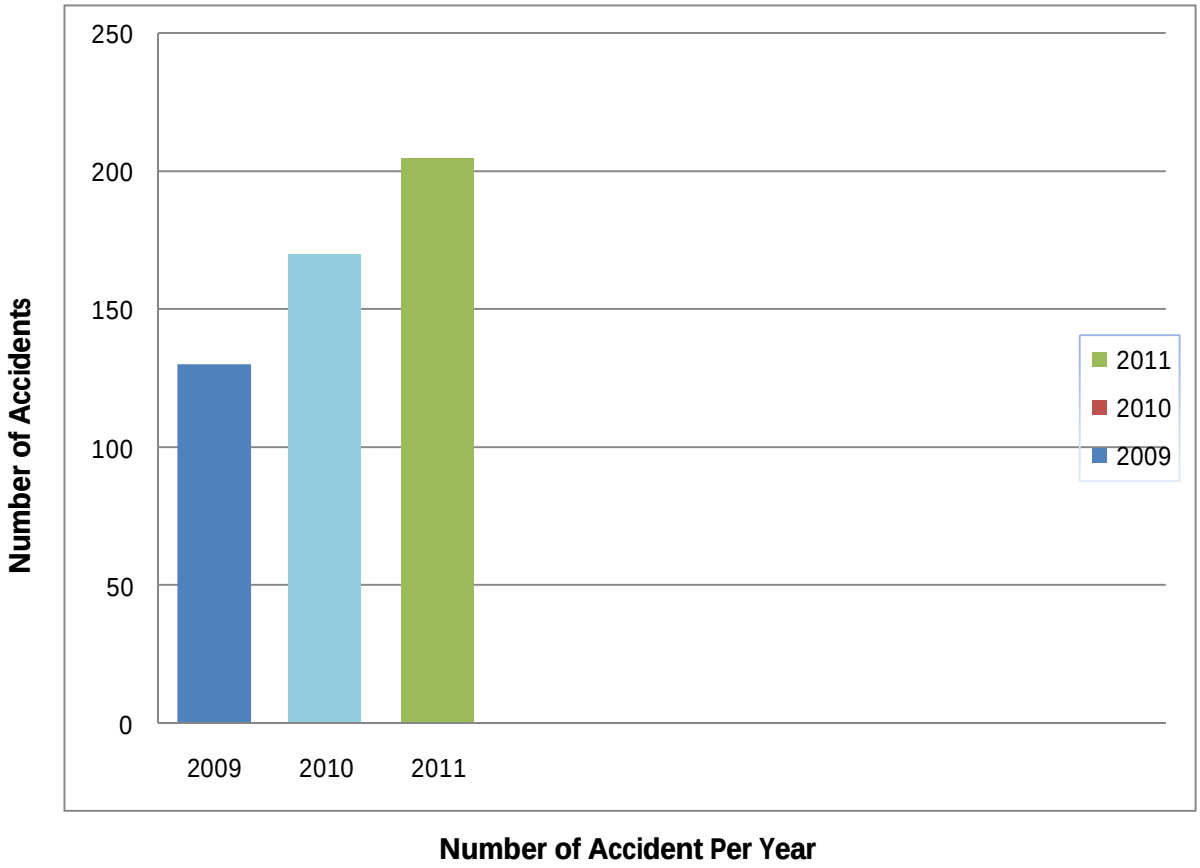

Figure 2: Bar Chart Showing Distribution of Accidents for the Three Years Under Study

DISCUSSION

Based on the available attributes of the accident data obtained from the road safety office, it has been observed that the distribution of accidents varies depending on the location (market junction, secretariat junction and bank junction etc), types of road surface (wet surface, un-tarred road, narrow, sharp bend and pavement surface) and types and numbers of vehicle and motor cycles involved in the collision (trailer, Boxer, Buses).

The study revealed some factors that contributed to the cause of accidents to include cross junctions, road congestions, and absence of traffic signals to the guide road users, riders and drivers not complying with road safety and vehicle inspector officers (VIO) guidelines and over speed. Also, the frequency of road traffic accidents was manifested by a number of variables, prominent among these are increase in population and vehicles. All these factors that cause accidents are categorized into three namely; road related, vehicle related and driver related. The study also revealed that year 2011 recorded the highest number of accidents. The number of accidents was on increase from 2009 to 2011 as shown in table 2 and figure 2 above. Tables 3, 4 and 5 give further details of the finding.

CONCLUSION

This paper demonstrated some techniques in digital mapping. It has shown that digital technology can be used in monitoring road accidents and its efficiency in terms of speed, efficient accuracy, reliability and economy of the work.

The paper has shown the process of converting analogue map to digital form through scanning the raster map (analogue map), which was imported into Arch GIS 9.2 for geo-referencing and on screen digitization was performed. Point features were used in designing and creating the spatial location of the accident prone areas. The outcome of this research is a digital map of accident prone areas which can serve as a based map for other researchers in future for the purpose of mapping out some other important features within Jalingo metropolis by digital means. The study has also shown the benefit of digital mapping. This research work contains the information which is relevant for decision making and planning in the state. It is hoped that the Police, Road Safety, VIO official and other transport workers will find this study useful in identifying remedial measures for the improvement of safety.

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Appendix

Table 3: Summary of Accident Distribution for the Year 2009

S/N	Months	No of Accident	No of People Involve	No. Of People Injured	No. of People Killed	Cause of Accident	Types of Vehicle		No. of People Non Injured	Accident Prone Areas						
							Motor Cycle	Car		FGGC Junction	State Sec Junction	Mayo Junction	Jankada	First Keystone Bank	Hospital	Market
1	Jan.	15	70	37	6	Bad Weather	Boxer	Toyota	27	1	3	3	1	1	1	5
2	Feb.	11	50	40	3	High Speed/ Bad road	Jincheg	Si. Bus	7	2	2	1	1	1	1	4
3	Mar.	10	30	16	5	High Speed/ Bad road	Boxer	Peugeot pick up	9	1	2	1	2	1	1	2
4	April	12	75	44	6	Driver fault/Bad road	Boxer	Peugeot 504	25	1	3	1	1	1	2	3
5	May	7	33	8	1	Bad weather/High speed	Jincheg	Golf	24	1	1	1	1	0	1	2
6	June	6	30	18	5	Bad weather	Honda	Station Wagon	7	0	1	1	1	1	0	2
7	July	10	60	50	3	Passenger fault/ Bad Road	Jincheg	Bus	7	1	2	2	0	1	1	3
8	Aug.	8	42	30	2	Passenger fault	TVS	Golf	10	0	1	1	2	1	1	2
9	Sept.	10	63	45	4	Bad road/ rain fall	Boxer	Bus	14	1	3	2	1	1	0	2
10	Oct.	12	65	33	4	Bad road/ rain fall	Boxer	Bus	28	1	4	2	1	1	1	2
11	Nov.	9	40	33	2	Driver fault	Jincheg	Bus	5	0	2	1	0	0	0	5
12	Dec.	18	82	63	9	Bad road/ mechanical fault	Boxer	Bus	10	1	1	5		4	3	5

Table 4: Summary of Accident Distribution for the Year 2010

S/N	Months	No of Accident	No. of People Involve	No. of People Injured	No. of People Killed	Cause of Accident	Types of Vehicle		No. of People Non Injured	Accident Prone Areas						
							Motor Cycle	Car		FGGC Junction	State Sec Junction	Mayo Junction	Jankada	First Keystone Bank	Hospital	Market
1	Jan.	20	82	65	7	High Speed/ Bad road	Boxer	Truck	10	2	4	3	2	2	1	6
2	Feb.	14	60	51	23	Driver fault/Bad road	Boxer	Toyota	6	1	3	2	1	1	2	4
3	Mar.	13	43	30	2	mechanical fault /Bad road	Jincheg	Bus	11	1	3	1	1	1	2	4
4	April	16	72	45	6	High Speed/ Bad road	Honda	Pick up Van	21	1	3	2	1	2	1	6
5	May	11	38	25	3	High Speed/ Bad road	Jincheg	Toyota	10	0	2	3	1	1	1	3
6	June	9	35	25	4	mechanical fault /Bad road	Boxer	Golf	6	1	1	1	2	1	0	3
7	July	12	37	20	1	Passenger fault/ Bad Road	Boxer/ Jincheg	Bus/ Bus	16	1	3	2	2	0	1	3
8	Aug.	9	41	29	3	Bad Weather/ Bad road	Boxer/ Boxer	Truck/ Bus	9	1	2	1	0	2	1	2
9	Sept.	17	39	15	1	rain fall/ Bad road	Jincheg	Trailer	23	2	2	3	2	2	1	5
10	Oct.	15	58	41	5	Driver fault / Bad road	Boxer	Bus	12	2	2	2	1	3	2	3
11	Nov.	10	47	38	3	High Speed/ Bad road	Jincheg	Pick up Van	6	1	3	1	0	1	1	3
12	Dec.	24	92	52	12	Driver fault/Bad road	Boxer	Bus/ Bus	28	3	4	6	1	1	1	8

Table 5: Summary of Accident Distribution for the Year 2011

S/N	Months	No of Accident	No of People Involve	No. of People Injured	No. of People Killed	Cause of Accident	Types of Vehicle		No. of People Non Injured	Accident Prone Areas						
							Motor Cycle	Car		FGGC Junction	State Sec Junction	Mayo Junction	Jankada	First Keystone Bank	Hospital	Market
1	Jan.	22	84	61	6	Driver fault/Bad road	Jincheg	Truck	17	1	5	5	2	2	1	6
2	Feb.	14	58	47	4	Driver fault/Bad road	Boxer	Trailer/ Bad Road	7	2	3	2	0	1	1	5
3	Mar.	11	45	22	1	mechanical fault /Bad road	Jincheg	Bus/ Bus	22	2	2	1	1	2	1	2
4	April	17	72	51	7	Passengers fault/ Bad Road	Boxer	Toyota/ Bus	14	1	4	2	2	1	2	5
5	May	15	41	30	3	High Speed/ Bad road	Boxer	Pick up/ Toyota	8	2	2	3	2	2	2	2
6	June	13	39	30	4	Bad Road	Jincheg	Bus	17	1	2	2	3	1	1	3
7	July	15	39	30	4	Bad Road	Boxer	Pick up Van	5	3	3	3	1	2	1	2
8	Aug.	16	50	35	3	High Speed/ Bad road	Honda	Trailer / Toyota	12	1	2	3	2	1	3	4
9	Sep.	19	33	16	5	Mechanical fault/ bad road	Boxer	Bus/ Bus	12	2	4	2	2	1	1	7
10	Oct.	22	47	34	3	High Speed/ Bad road	Boxer	Toyota	10	3	3	2	1	3	28	3
11	Nov.	13	52	29	2	Bad weather / driver fault	Jincheg	Toyota	21	2	2	1	1	1	3	3
12	Dec.	26	98	66	13	Bad weather/ Bad road	Boxer	Bus/ Bus	19	1	4	3	3	2	2	10