Mapping and Modeling of Frequency and Location of Road Accident along Onitsha – Awka Expressway-Anambra State Nigeria Using GIS Techniques

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ABSTRACT

A Road traffic accident is one of the major disasters that cause untold hardship to both the citizens and government at large. Onitsha- Awka express road is a very busy road supporting equally very high economic activities. It is known to have recorded the highest number of ghastly road mishaps. Road Traffic Crash (RTC) data obtained from the policy, research and statistics department of the Federal Road Safety Commission (FRSC) Amawbia headquarter revealed that from 2010 to 2014, there has been a geometric increase in the rate of traffic crash.
Recently, a road accident which killed about four people in a family of six including the parents occurred along Ikenga junction Awka-Onitsha expressway. The junction is notorious for incessant road accidents. This study seeks to map and model accident victims and their locations along Onitsha-Awka expressway using Geographic Information System (GIS). RTC data for a period of 2010 to 2014 was collected from the FRSC and used to create the database. Locations of accident hotspots, police stations, Fire service station, market and other facilities which may contribute to occurrence or prevention of road accidents along the study area were obtained using handheld Global Positioning System (GPS). The result of the study shows that 2013 has the highest number of road accidents while the month of December recorded the highest number of road accidents. The study recommends that more hospitals should be located especially at Onitsha Head Bridge that has the highest number of accident occurrence.

Keywords: Road accident, GIS, Mapping and Victims

1. INTRODUCTION

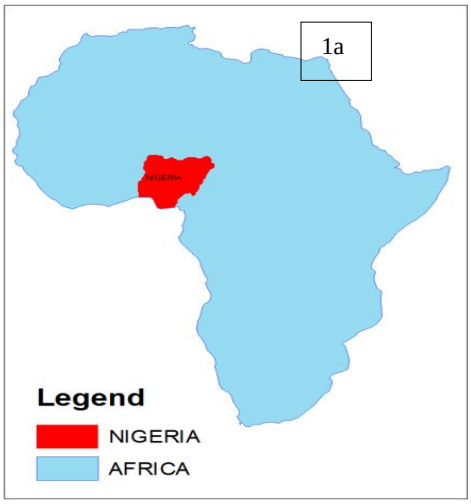
Road transportation is by far the commonest means of transportation in Nigeria compared to other means; air, rail and water. The technology has made life easy compared to the hitherto means of transportation such as animals. Nigerian economy despite its harshness, has afforded millions of its populace the means to own cars making road traffic a major problem.

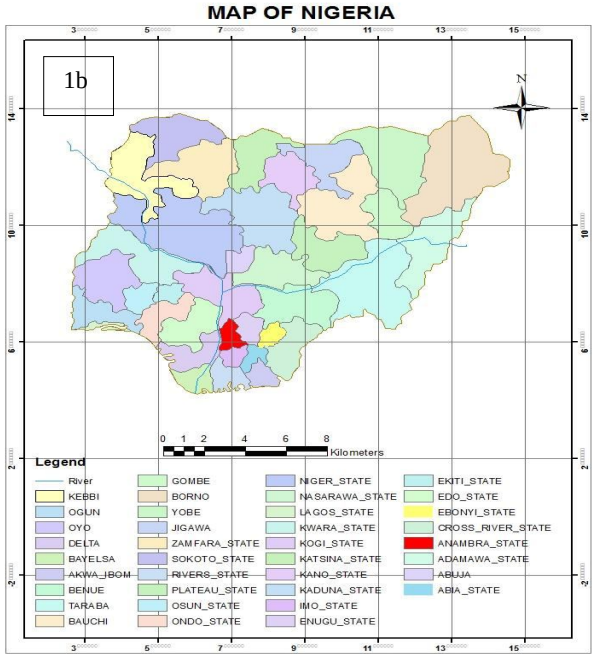
Road accidents are a global tragedy with ever raising trend. They are common fare in our daily news as we see these accidents happen almost every day. Road accidents are generally classified as single vehicle either colliding with fixed objects or multiple vehicle accidents in which two or more vehicle can collide head-on. Most people continue to be negligent and ignore the dangers involved in their driving and so, these accidents happen.
Nigerian roads despite the current effort of Road Maintenance Agency are still in very bad states especially those leading to rural areas. According to FRSC report (2015), not less than 87,320 road users lost their lives between 1990 and 2001 alone, most victims being between 20-40 years of age bracket. It was estimated that the number of registered vehicles in Nigeria rose from 600,000 in 1988 to 6,000,000 in 2004. Despite the happiness and change of quality of family lives associated with owning a vehicle, its possession has made so many families bereaved of their breadwinners or lovely ones due to unprecedented rate of road traffic accidents (RTAs).
According to [1] [2] [3] [4], the probable causes of road accident includes Speed violation (SPV), Loss of control (LOC), Dangerous driving (DGD), Tyre burst (TBT), Break failure (BFC), Wrongful overtaking (WOT), Route violation (RTV), Mechanically deficient vehicles (MDV), Bad roads (BRD), Road obstruction violation (OBS), Dangerous overtaking (DOT), Overloading (OVL), Sleeping on steering (SOS), Driving under alcohol / drug influence (DAD), Use of phone while driving (UPWD), Fatigue (FTQ), Poor weather (PWR)and Sign light violation (SLV).
It has been recognized that the most effective means towards accident reduction lies in a systematic and scientific approach based on the use of accurate and reliable traffic accident data. The conventional accident analysis as used by some researchers has not been successful in reducing the occurrence of traffic related accidents [5]. There is a need for better information on the circumstances of collisions, especially with regard to location in order to come up with a general picture of the data. More precise location data could help provide facts to guide programs including enforcement, education, maintenance, vehicle inspection, emergency medical services, and engineering to improve streets and highways and that is the reason GIS is best employed in this research.

With the help of GIS, the road user can identify high accident location, obtain the accident location's ranking, visualize the road accident and location information, input and retrieve the accident database, perform statistical analysis on the selected accident location and so on within a short period. GIS provides relational link between different streams of accident Data, Inventory Data, etc. GIS enables the safety experts to compare accidents along a road way segment with land use and zoning- data or population and other demographic data to gain a better understanding of the relationship of crash incidents or the zone-data could be integrated with accidents records to provide a true picture.

1.1 Study Area

The study area lies in Anambra, South-Eastern States of Nigeria (See figure 1a and 1b). Anambra state is one of the South Eastern states of Nigeria. The road selected for the study is the Awka/Onitsha dual-carriage express road which passes along the following towns; Awka, Amawbia, Umuokpu, Enugwu-Agidi, Abba, Igbariam, Awkuzu, Nteje, Umunya, Ogbunike, Ogidi, Nkpor and Onitsha. Onitsha/Awka road is located at latitude 6˚ 00'N and 6˚ 30'N and longitude 6° 45'E and 7˚ 30'E in WGS84 coordinate reference system (see Figure 1c)





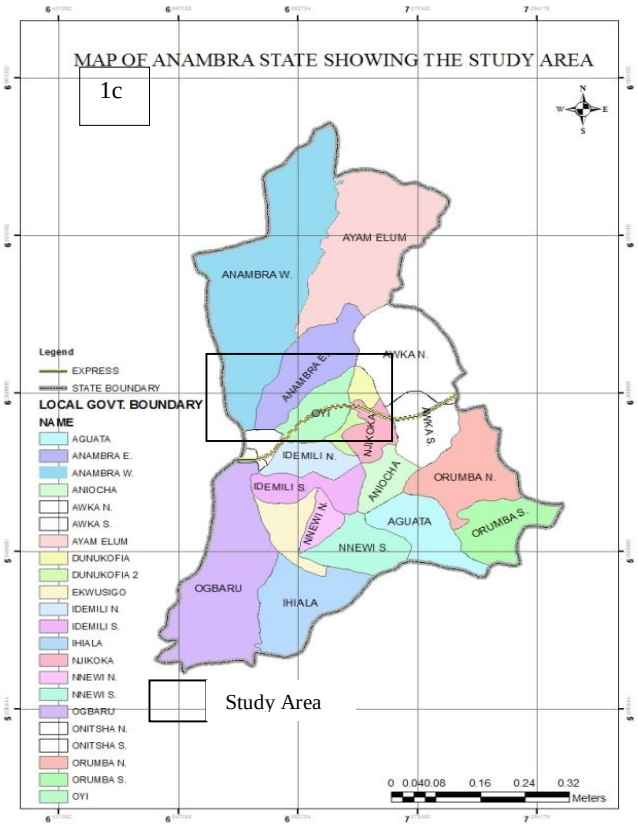


Figure 1a: Map of Africa showing Nigeria; Figure 1b: Map of Nigeria showing Anambra State and Figure 1c: Map of Anambra State Showing the Study Area

2. METHODOLOGY

The coordinates of accident hotspots obtained from the 2010-2014 records of the FRSC, hospital, markets, schools, police station, fire services, and Road Safety offices along the study area were collected using GPS. Also, pictures of accident hotspot were obtained with camera for hyper linking. Coordinates of land use/ land cover classes such as vegetations, water bodies, built up areas and open space were acquired for land use and land cover supervised classification.

The street guide maps of Onitsha and Awka, 20m Digital Elevation Model (DEM) and Spot 5 image covering the study area were georeferenced to a common coordinate system and used to update the map of the study area. The DEM was used to obtain elevation information of the area for topographic analysis. Accident locations were digitized as point features while the road networks of the study area were digitized as line features. The X and Y coordinate of all the points collected with handheld GPS during the field operation were typed into Microsoft word excel and saved as a DBF Excel document. The data were imported into Arc Map and used to create the database.

The following data were used in creating the accident location attribute database:

i. Year of accident.
ii. Month of accident.
iii. Location name of the accident.
iv. Geodetic coordinate of the accident location points
v. Accident casualties.
vi. Accident type.
vii. Probable cause of the accident.
viii. Number of male injured.
ix. Number of female injured.
x. Number killed.

Supervised classification of the land use/ land cover types was carried out using Erdas Imagine software. The land use/ land cover map was overlay with the accident hotspot to ascertain if land cover classes contribute to the causes of accident in that location. Proximity, visibility and network analysis were carried out in order to test the effectiveness of the database. Some sample queries were also carried out.

3. RESULTS AND DISCUSSIONS

The following results were obtained. Figure 3.1 to 3.5 shows the bar chart representing the month with the highest number of accident occurrence for the year 2010, 2011, 2012, 2013 and 2014. Figure 3.6 shows the total number of accident that occurred in each month from 2010 to 2014.

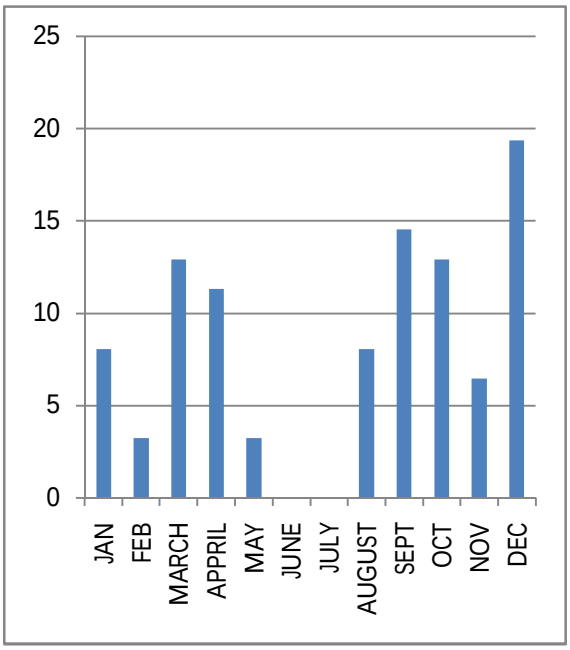


Figure 3.1: shows the result of the month with the highest number of occurrence in 2010

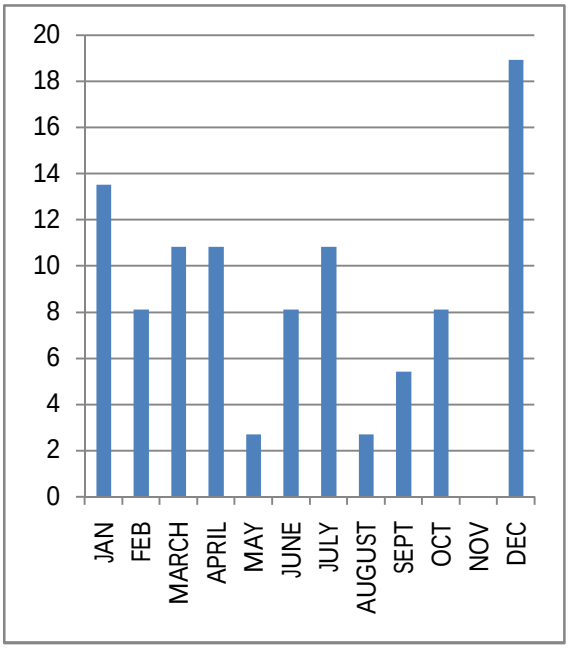


Figure 3.2: shows the result of the month with the highest number of occurrence in 2011

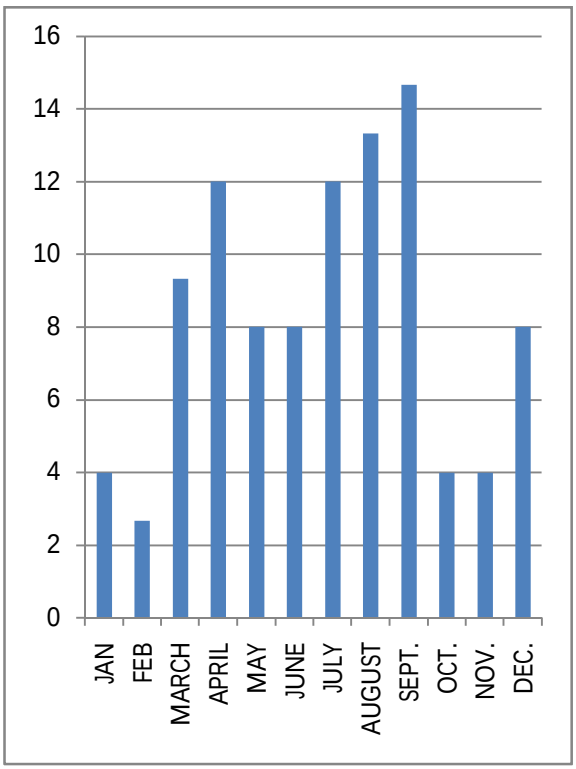


Figure 3.3: shows the result of the month with the highest number of occurrence in 2012

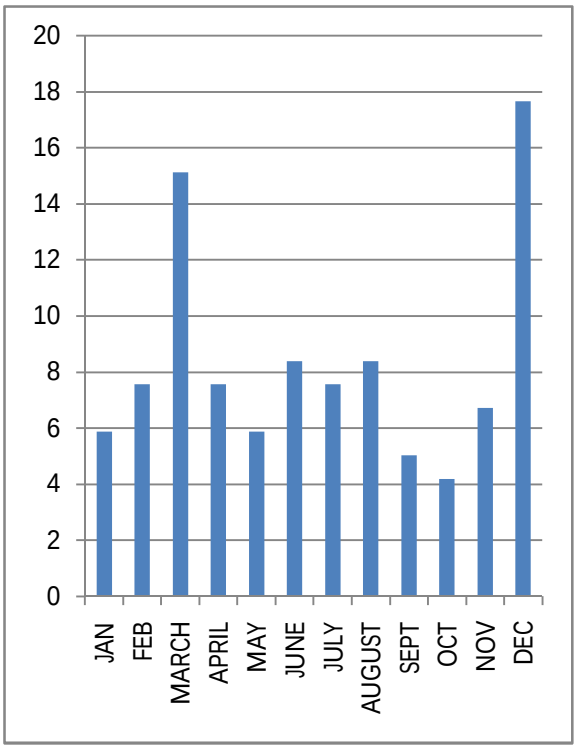


Figure 3.4: shows the result of the month with the highest number of occurrence in 2013

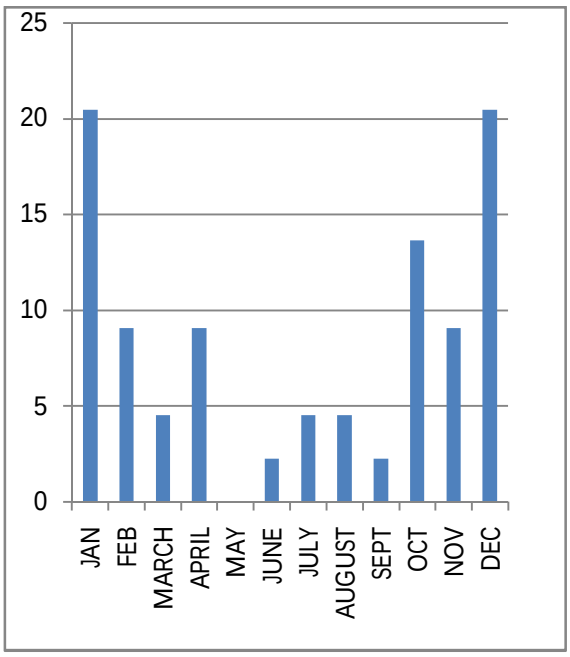


Figure 3.5: shows the result of the month with the highest number of occurrence in 2014

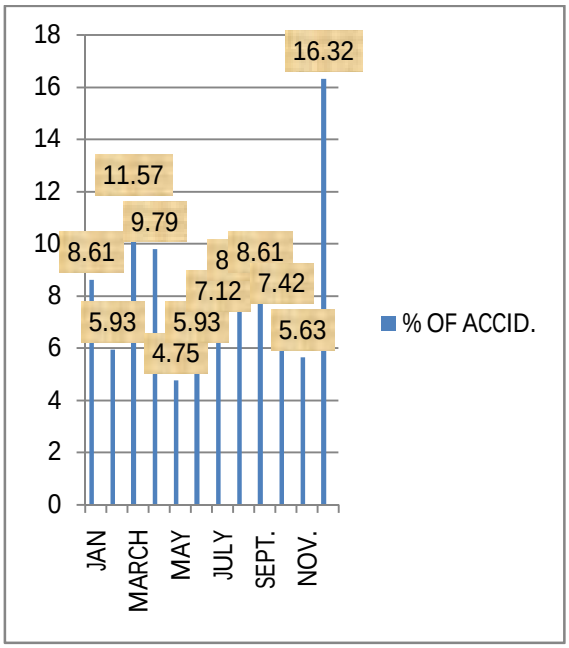


Figure 3.6: shows the result of the month with the highest number of occurrence from 2010 to 2014

From the figure 3.6, we can conclude that the month of December has the highest number of accident occurrence from 2010 to 2014. This show that accidents occur more in the month of December. This can be attributed to high business and festive activities associated with the month of December.

The numbers of accident that occur in each month were summed together to obtained the total number of accidents that occurred for the year. Table 1 shows the result of the total number of accidents that occurred for the years under study. This was further represented in figure 3.7 as percentage in a bar chart for better pictorial understanding.

Table 1: The result of the year with the highest number of accident occurrence and their percentage from 2010 to 2014

YEAR	NO. OF ACCID. OCCURRED	PERCENTAGE OF ACCID. OCCURED
2010	62	18.40
2011	37	10.98
2012	75	22.26
2013	119	35.31
2014	44	13.05
TOTAL	337	100

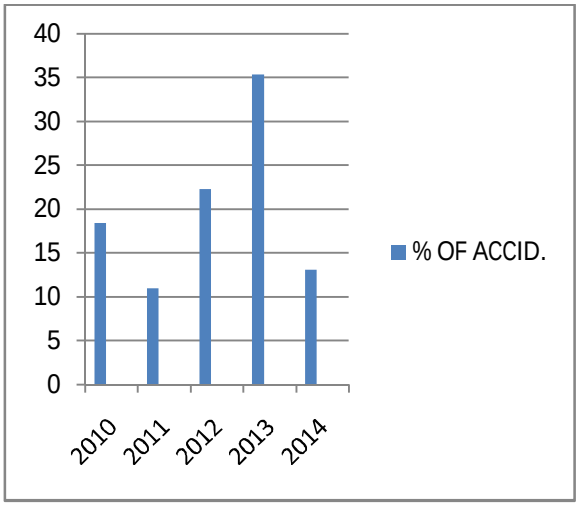


Figure 3.7: The result of the year with the highest number of occurrence

From the table 1 and Figure 3.7, we can conclude that the year of 2013 has the highest number of accident occurrence. This shows that accidents occurred more in the year of 2013. The bar chart shows that there was a sharp decline from 2013 to 2014. This means that there was a reduction in the number of accident that occurred in year 2014. This can be attributed to some of the stringent measures adopted by the FRSC to minimize road accidents.

Sample query was performed to identify the locations of the accidents. This is shown in figure 3.8.

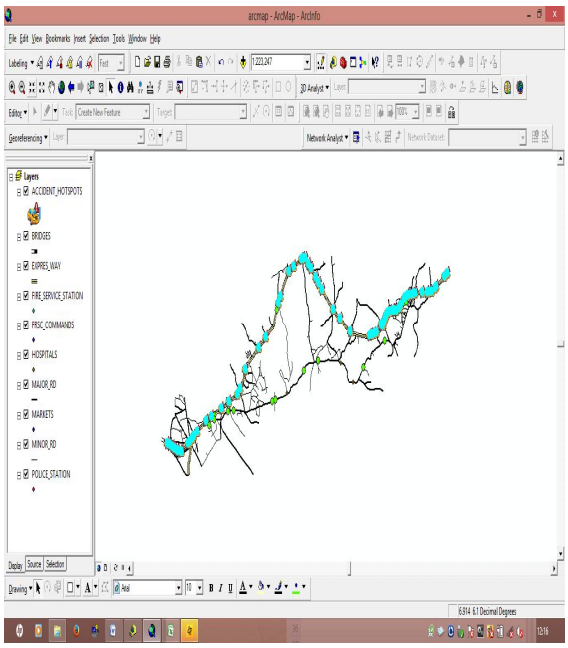


Figure 3.8: Query result of the accident hotspots

Another query was performed to identify the location of accidents that occurred in the month of December. The month of December was chosen since it recorded the highest number of accident occurrence. The result is shown in figure 3.9.

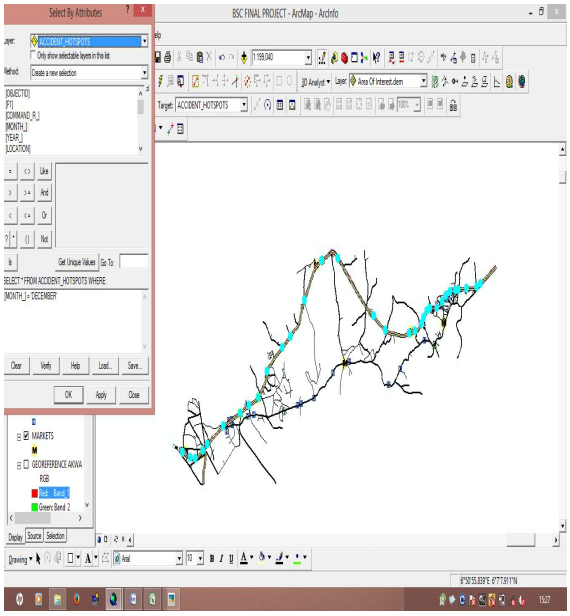


Figure 3.9: Query result of all the accidents that occurred in the month of December from 2010 to 2014

Figure 3.10 shows the query locations of accidents that were caused by tire burst (TBT). In our quest to identify the locations with frequent accident occurrence, sample query was carried out to identify locations where accidents occurred more than five times within the period of study. This is shown in figure 3.11.

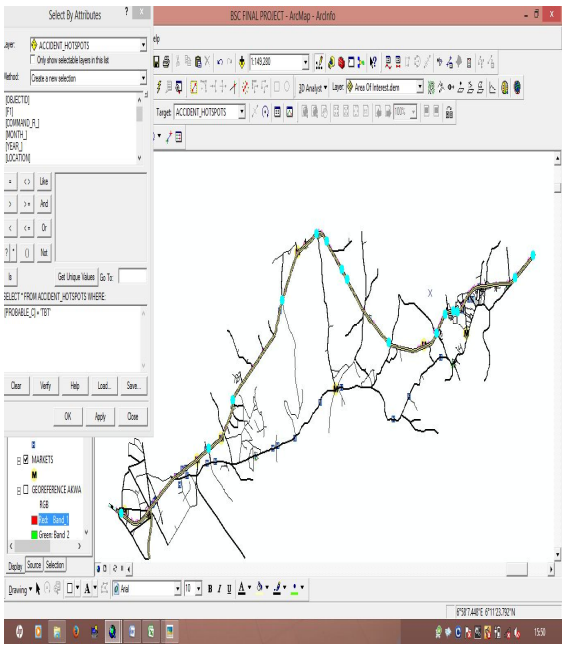


Figure 3.10: shows the result of the query performed for all the accident caused by tire burst (TBT)

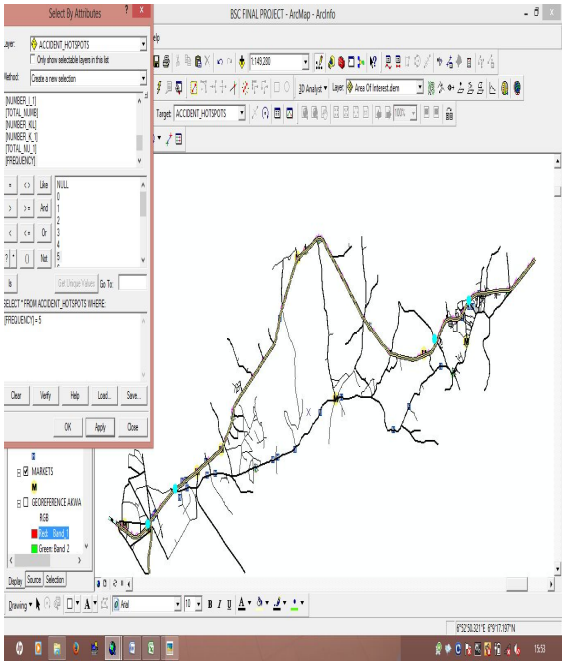


Figure 3.11: Query result of locations where accidents occurred five times within the 5-year research

The accident hotspots were overlaid with the classified image of the study area. This was done to determine if landuse/ landcover types contributed to the occurrence of accidents in the locations. Figure 3.12 shows the result of this overlay.

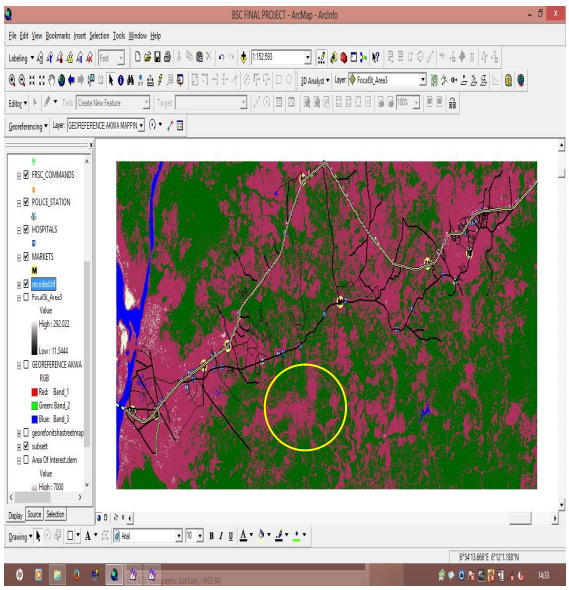


Figure 3.12: Overlay of land use/ land covers classification with the accident hotspots

It can be deduced from the result that the hotspots with the highest accident occurrence fell within the densely built up areas of Onitsha and Awka precisely along Head Bridge Upper Iweka Onitsha and UNIZIK temporary site at Awka.

Network analysis was also carried out to test the effectiveness of the database created. Figure 3.13 shows the result of the shortest route analysis from an accident location to the nearest hospital. Figure 3.14 shows the result of shortest route analysis from an accident hotspot at Head Bridge Onitsha to Boromeo hospital. Figure 3.15 is the result of the shortest route analysis from an accident hotspot at Udoka Housig Estate at Awka to Fire Service Headquarter. The essence of these analyses was to determine the distance from accident hotspots to emergency response facilities such as hospitals and fire service unit.

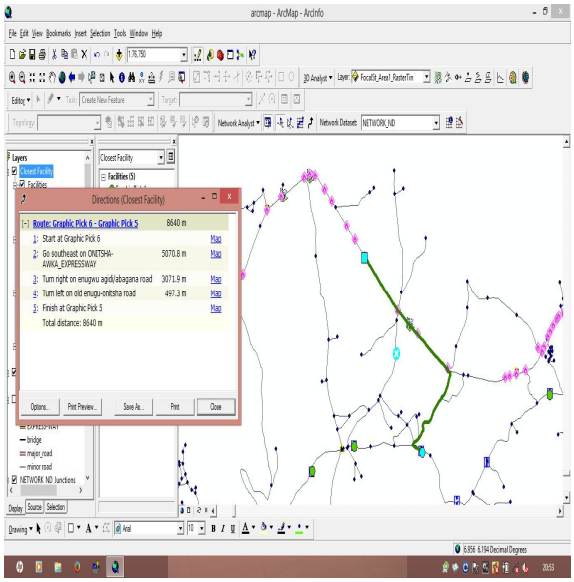


Figure 3.13: Shortest route analysis from a specified accident hotspot to its nearest hospital

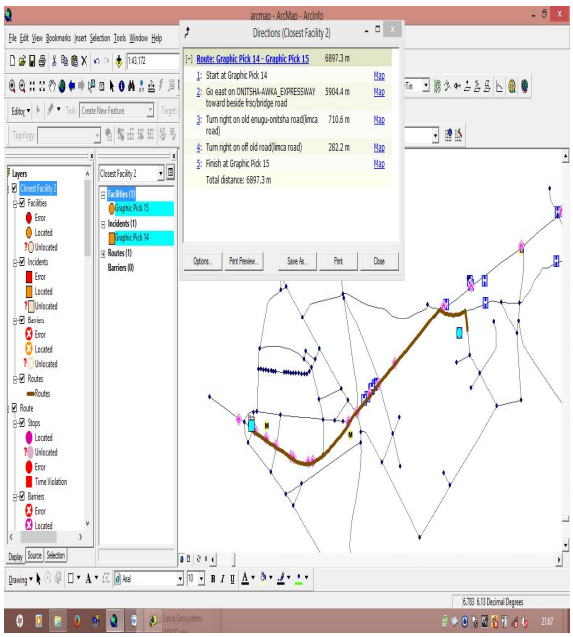


Figure 3.14: Shortest route from a head bridge accident hotspot to Boromeo hospital

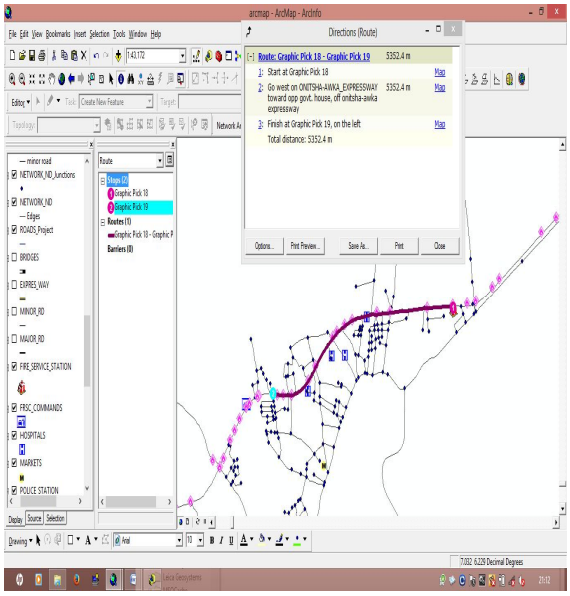


Figure 3.15: Shortest route from the fire Service Headquarter at Awka to accident hotspot at Udoka Estate

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

This study has demonstrated the effectiveness of GIS as a veritable tool for solving environmental and social problems. Accident hotspots are spatial in nature. In other words, they have locations. GIS provides the linkage between spatial and attribute data. The attribute data of accident hotspot obtained over some years was combined with the spatial location of the accidents hotspot in order to model or analyze the frequency of occurrence of accident at a particular location.

Several causes of road accidents were identified and used to model the frequency of accident occurrence. The information obtained from such analysis can assist road users to identify the accidents hotspots and possibly use the alternative routes. Maps can also be created to model the accidents of several target groups such as Pedestrian, cyclist as well as various categories of accident victims. By so doing, we can be able to determine if there is a pattern to the accident occurrence and possibly proffer solution.

4.2 Recommendations

Based on the findings of this research, the followings are recommended:

1. More FRSC offices should be established closer to the accident hot spots.
2. The market located close to the Onitsha head bridge accident hotspot which recorded the highest number of accident occurrence should be relocated to another safer place.
3. More hospital should be established along the Expressway especially along the Onitsha head bridge.
4. Fly over should be constructed across the accident hotspots junctions to ease the flow of traffic.
5. Warning signs should be placed at strategic accident locations such as Head Bridge Onitsha and UNIZIK temporary site to warn drivers to slow down because of the busy activities at these locations.

5. ACKNOWLEDGMENTS

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