SPATIO- TEMPORAL ANALYSIS OF MOTOR VEHICLE- RELATED ACCIDENTS IN ABUJA NIGERIA

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Ph. D /SSSE/99/43

THIS THESIS IS SUBMITTED TO THE POSTGRADUATE SCHOOL IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN REMOTE SENSING APPLICATIONS, IN THE DEPARTMENT OF GEOGRAPHY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, NIGERIA.

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CERTIFICATION

This thesis titled "Spatio-Temporal Analysis Motor-vehicle Related Accidents in Abuja Nigeria" by SIKIRU ADEYEMI BALOGUN (Ph. D Reg. No /SSSE / 99 / 43) meets the regulation governing the award of the Degree of Doctor of Philosophy (Ph.D) of the Federal University of Technology, Minna and is approved for its contribution to scientific knowledge and literary presentation.

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GLOSSARY

1. Accident – Sad, unfortunate loss of human, material (vehicle) resource
2. Accident cause – weighted index of all contributing factors to accident
3. Accident type – weighted index of all fatal, serious, and minor accidents
4. Black spot – Accident Prone Areas, place with accident record above the mean value
5. B.I.D – Brought in Dead
6. Bunching – Degree of constraint
7. By standers- sympathizers at accident scene
8. Casualty- number of people dead and injured in an accident
9. CBD – Central Business District
10. Coordinate – Longitude/Latitude
11. ERS – Earth Resources Satellite
12. Fatal accident- accident in which the victim died within 30 days of accident occurrence
13. Fatality index-death per accident
14. FCC – Federal Capital City
15. FCDA – Federal Capital Development Authority
16. FCT – Federal Capital Territory
17. FRSC – Federal Road Safety Commission
18. First Aider
19. Georeference: To ensure that two images of different source are brought to the same coordinate
20. GIS – Geographic Information System: Advance method of data Analysis
21. GPS – Global Positioning System
22. Headways – Distance (i.e Gap) between two vehicles in the traffic
23. Inter Urban – Movement within cities
24. Intra Urban – Movement within cities. It includes Public (Transit) and Private transportation
25. I.P.O- Investigating Police Officer
26. JERS
27. LANDSAT

28. Level of motorization-vehicle per 1,000 population
29. LRT – Light Rail Transit
30. Minor accident – accident in which none of the victim sustain injury
31. Mosaic – To join many picture fragments of an object together
32. NASRDA-National Space Research Development Agency
33. Passenger safety-death per 100,000 populations
34. Platoon- Queue of vehicles
35. Primary Distributor - Transit spine, four lane bus way, with space for future LRT RRT
36. RADAR – Radio Detection and Ranging
37. RAIDS – Road Accident Immune Delusion Syndrome
38. Rasterised – To scan a document
39. Remote Sensing – Data collection method from a distance
40. ROAS – Reprobate Offenders Alert Series
41. RRT – Rapid Rail Transit
42. RTA- Road Traffic Accident
43. SAR – Synthetic Aperture Radar
44. Serious accident – Accident in which the victim did not die as a result of the injury sustained
45. Severity index-fatal per casualty cases
46. Spatial data – data of each location
47. SPOT – System Pour's Observation de la Terre
48. Temporal Data – Dale at each time, i.e. day, date, hour, month, and year
49. Traffic safety-death per 10,000vehicles
50. Transit – Urban Public Transportation
51. Urban Sprawl – The drive to relocate from urban area to the fringes. The opposite of Urbanization
52. UTM – Universal Transverse Mercator
53. Vectorised –to digitize a document
54. Vehicle safety – accident per 1,000 vehicles

ABSTRACT

In this thesis titled "Spatio temporal analysis of motor vehicle related accidents in Abuja Nigeria" an attempt was made to identify the variables relevant for testing the road traffic accidents in Abuja, analyze the Spatio temporal characteristics of road traffic accidents in Abuja, use GIS to identify the black spot location in FCC and outline the implication of the study for road traffic accident management and policy. The data input comprise both the spatial and attribute data. The spatial data (i.e maps) was scanned, digitized, and georeferenced to UTM with the chosen ground control points to form the geographic street database of Abuja. The attribute data include traffic count and accident record obtained by the author and from FRSC FCT Command between 1999 and 2003. The independent variables are Traffic volume, spatial and land use while the dependent variables are the number of casualty, cases reported, vehicles involved, causes of accident and types of accident. The data were analysed using the EXEL, SPSS and spatial analysis explained in vector presentation in georelational map model of Arc view GIS using coverages, overlays and queries. The trend in accident variable between Monday and Sunday, January to December, across the dates and hours of each day is similar. Ho_1 was not significant for all variables when dry and rainy season as well as early month and month end was compared. But it is significant for some variable and insignificant for other variables when weekday and weekend, and day and night were compared. The statistics also show that Ho_2, Ho_3, and Ho_4 are significant and rejected. These relates to data on different years (1999-2003), road and junction and district in FCC respectively. The points on point overlay confirm disproportionate effect of land use on accident variable while city outlets are more predisposed to accident variables. The study submits that since most of the accidents in FCT were associated with areas of intense business activities such accidents would be reduced if FRSC should increase their presence at city outlets at night, busies routes on weekdays, adverse weather and month –end respectively. The FRSC should be proactive in accident prevention, responsive to the dynamics of accident causative factors and reactive to rescue accident victims. There is also need for FRSC, Police road maintenance agencies and Hospitals to form a strategic alliance or network in data acquisition and exchange and capacity building and exchange respectively.

CHAPTER ONE

INTRODUCTION

1.0 Background information

Road traffic accident (RTA) at first seems relatively unimportant in Nigeria and most developing countries when compared to hunger, educational, financial and economic resources problems. But an analysis of the causes of death in a number of countries throughout the developing countries has shown that deaths and fatalities from road traffic accident in Nigeria rank among the highest in the world and second behind those by hunger and gastroenteritis (Adebisi, 1988).

The contribution of death resulting from RTA to total death rose from 38.9% in 1967 to 60.2% in 1974 (Adebisi 1988) and this trend has been increasing up till 1982 after which it became erratic. The worst hit decade was between 1974 and 1983, the number of accidents increased by 10.4%, injured cases increased by 43%, fatalities by 110.6%, total casualties by 57.1% and human population by 27.2%. (Adebisi, 1988).

Other studies (FRSC, 2005) have shown that Lagos, Kano, Ogun, Oyo, Kaduna, Niger, Edo and Delta States have individual fatality average exceeding the national average of 11 per 100,000 populations. For instance somebody was killed every 47 minutes and an accident occurred every 10 minutes in Lagos State between 1990 and 2004. All these and other available data, albeit inadequate, show that RTA has become a serious national malaise and the cost is colossal.

The grim RTA statistics shown above is as a result of sudden increase in movement of people by road, without a commensurate increase in infrastructure development in terms of traffic management tools, good roads and road complementary facilities. Even though the fatality rate in Abuja is still very low, the mass influx and circulation of people and vehicles in FCT after relocation of federal capital to Abuja gives cause for concern.

The relocation of the Federal capital of Nigeria from Lagos to Abuja brought a lot of changes to the pattern and organization of settlements in Abuja. Modern methods of farming and in other areas industries, replaced the traditional farming practice of the people. The extensive vegetal cover is gradually being replaced with housing units. The exposed parcels of land that could not bear this witness increased erosion. The restriction of manufacturing sectors to the fringes of Gwagwalada and the dependence on the neighboring states for food supplies have also eroded the self-sustenance nature of the area.

At first, these changes caused outer fringe to inner core movement but the high rent in the Federal Capital City (FCC) has for some time now driven the low and medium income earners back to the satellite towns and fringes of FCC and FCT respectively. Right now there is inflow of people and vehicles into FCC in the morning and outflow to satellite towns in the evenings.

The above scenario has far reaching effect on the accident rate along the transit corridors, and on the internal circulation in FCC during the work period. The resulting traffic congestion along Wuse New Market, Area 10, federal secretariat and so on deteriorates the environment, increases

the accident rate involving pedestrians, cause driver stress, frustration, delay, time losses at the same time making the door-to-door advantage of motor vehicle unachievable.

Since accidents are caused by multifaceted factors comprising the road, vehicle, driver, environment and other factor arising from these four, the approach towards solving accident problems have also been multifaceted comprising enforcement, enlightenment, engineering, and environmental approaches. These approaches have been appropriately coined the 4 E's. Following these approaches traffic management problems have been solved in the past by continuously widening the road, optimizing the existing road network with various traffic management measures, encouraging the use of public transport, and the introduction of traffic pricing.

Traffic management measures such as these are good but adequate information is hardly available. Traffic information should be adequate, timely, frequent, and spatial before one can model the accident situation of an area. The information should be capable of telling why, when, and where to locate command post. The information should show how to deploy patrol vehicles to accident scene, how to locate a black spot, how to determine the shortest route to locations and the closeness of spatial feature. The information should show the nearest help area, the intersection at which most traffic accidents occur, how close the accident spots are to the freeway exit, which social facility attracts more traffic, and which hospital lies at 5 minute walk among others.

Linking geographic location to accident information and socio-economic characteristic of accident victim is vital to decision making. The diverse forms of data generated from traffic (spatial, and aspatial) can best be combined and analyzed with Geographic Information System (GIS). Unfortunately, this technology is yet to be fully embraced in this part of the world as aid to our planning and decision making process. This study highlights this empirically with a view to ensuring the relevance of this geographic tool to accident investigations.

1.1 Statement of the problem of study

A review of accident trends in Nigeria (Adebisi, 1988) presents a disturbing spectacle of an increase in accident casualty unparalleled elsewhere in Africa. The road becomes unsafe at any speed. The traffic situation in most cities is nothing less than chaotic. When accident finally occurs, huge hospital bills are incurred, there is loss of productivity while the victim is often bedridden. Human and material resources are lost, the salvage value of the car is also reduced.

Some of the victims often die either due to improper handling after accident or outright lack of care. The RTA statistics compiled by the FRSC or Police are aggregate in nature, as they do not specify location or type of accident. Nevertheless, these data are used for finding disaggregate information. Consequently, what we see is a peak and valley reduction rather than the consistent reduction observed in the developed world.

It is unfortunate that for too long, the attention of road safety policies has been focused on rate of accident, forgetting what caused the accident. The blames of RTA have been placed on the

driver, vehicle, and traffic law enforcement Agencies etc and not on the transport system that gives rise to them, such as the poorly designed traffic facilities, inadequate control devices, poor traffic operation, dense population activities and more importantly the misguided and or poor dissemination of traffic information. Driving involves a lot of human judgment and like any type of conflict; accident becomes inevitable when there is breakdown in communication between driver – driver, vehicle – driver, vehicle – road etc. If one is therefore to mention one single cause of RTA then it is breakdown in communication.

Hazards do not recognize political boundaries, yet data that are generated in order to effectively mitigate disaster are usually administered within politically defined boundaries (ESRI, 2000). But the geographical information system (GIS) has the modeling and analytical capability which transcend political boundaries while providing the necessary structure for assisting the implementation of policy within administrative areas. The non-consideration of the above in road safety planning partly contributes to the inconsistent reduction that we see in RTA statistics generated in Nigeria. Such reduction is also strongly related to vehicle population.

Similarly, accident does not differentiate between land uses but the recovery and the cost and impact on society are often greatly affected by the land use differentiation (ESRI, 2000). Sometimes accident is modified and often magnified by heterogeneous landscape and land use, i.e. indiscriminate parking or location of shops along the roads. These boundary conditions are difficult to map and virtually impossible to model without the use of GIS.

The shape and often the size of roads follow the topography or the terrain of the area. That is why we find roads with low sight distance in the rocky terrain. The risk portended by such roads to human life and property can only be assessed, mitigated and responded effectively to, if the predictive and operational models embedded in GIS software are used.

The above reveal why traffic crimes and the emergency response is a problem and why solution to them would help humanity. It is not a new problem hence the data needed for their solutions are relatively accessible. Most of the agencies involved in the transportation sector today also have traffic engineering responsibilities of increasing the traffic carrying capacity of the road since it is not only costly to build more roads but in fact irrational at times. Unfortunately, most of these agencies often have a small department for this data collection responsibility.

The challenges in accident preparedness and response demand an accurate, timely and appropriate dissemination of information to all the parties involved in accident prevention. Linking geographic location to information is vital to national decision-making (Remigton, 1998). Such linkage provides answer to who is involved in accident?, at what time did the accident occur? It also provides answers to the kind of problems that arise while integrating the sources of spatial information within various levels of accuracy and the detail to meet the unique needs of each party at various points in the disaster cycle. It also provides the amount of uncertainty that the various parties tolerate when receiving information provided to them at various stages in the disaster cycle.

Based on the above the following research question become apparent:

1. To what extent can GIS be used to determine black spots, safest path and monitor RTA?
2. Can GIS be used as a decision support system in road safety decision-making?
3. What are the variables required in the analysis?
4. Can the result obtained in this study be applicable to similar areas or discipline in Nigeria?

1.2 Aim and Objectives:

The aim of this study is to describe the pattern of road traffic accident in Abuja using GIS. Consequently effort would be made to:

i Identify the variables relevant for testing the road traffic accident in Abuja

ii Analyze the spatio-temporal characteristic of road traffic accident in Abuja

iii Use GIS to identify the black spot location in FCC.

iv Outline the implication of the study for road traffic accident management and policy.

1.3 Hypotheses

In order to achieve the above objectives it is hypothesized that:

Ho_1 There is no statistically significant difference in the temporal characteristics of accident (weekdays /weekends, rainy/dry seasons, day/night, and month end (early month).

Ho_2 There is no statistically significant difference in accident potentials during different years in FCT

Ho_3 There is no statistically significant difference between accident potentials at junctions and road sections.

Ho_4 There is no statistically significant difference in accident potentials at various districts in Abuja

1.4 Justification of study

The research would open a new vista in road safety database management Vis data acquisition, presentation and analysis. The use of GIS capability in Arc view would present the spatial representation of accident situation in Abuja with GIS. This study can be applied to cities with similar transportation – settlement characteristics. Relating accident time and effect to black spot and relating black spot to each other is a critical factor in decision on industrial location, physical distribution, rescue, and road maintenance.

The interaction between man and his environment often occur under conditions that can be hazardous either to human life or natural/habitat. This includes earthquakes, wild fire, RTA etc for which a quick response is mandatory. One common statement after an accident is "had I known", and such knowledge today is kept in the Geographic Information System (GIS). Preparing a model for mitigating accident is critical to the survival of accident victims and can mean the difference between life and death. The GIS will reveal the trends, pattern, and relationship between data quickly and accurately.

1.5 Scope of Study

The study rely on the accident statistic obtained from the Federal Road Safety Commission between 1999 and 2003.The data was tabulated into hours, days of the week, dates of the month and months in the years. The data was further grouped into night and day, early week and weekend, early month and month end and rainy and dry season respectively.

All places where accident occurred consistently during the study period were regarded as black spots. Places with accident occurrence more than the mean value for a particular variable was also regarded as black spot location. The number of vehicles involved in each accident, number of casualty recorded, weighted index of accident type and weighted index of accident cause were regarded as dependent variables.

The study focuses on the five districts of Federal Capital City (FCC), namely Maiitama, Wuse, Central area, Asokoro, and Garki. However effort was also made to investigate situation in the fringes of FCC such as Kado, Kubwa, Karu, Airport road and Giri roads respectively.

1.6 Limitation of study

One major limitation to the use of a model is the limitation imposed by the availability of data. Even the simplest model can have a vast appetite for data and the more realistic a model becomes the more versatile the data needed (Lea, 1973). It is particularly so here because the accident data has to be disaggregated into location of accident, time, day, and date of accident as

well as the characteristics of the victims involved. The accident data have not been occurring in this spatio-temporal format.

Consequently, all accident that resulted into death within 30 days of accident was recorded as fatal and the time of accident occurrence was approximated to the nearest hour. All accident location was associated with the nearest junction or road section and digitized as point and link respectively.

1.7 Conclusion

This chapter appraises the contributions of road traffic accident to loss of human and material resources with particular reference to the developmental changes in Abuja and the role that GIS can play in finding solution to the ugly accident trend. Consequently the study highlights the various objectives to be pursued, justify the need for the study and gave the length, breadth and depth of coverage in the study.

CHAPTER TWO

TRANSPORTATION SYSTEM IN ABUJA

2.0 The making of Abuja.

After the amalgamation of Eastern and Western protectorates in 1904, Lagos was made the capital of Nigeria among others due to the fact that Lagos is a port city. Lagos was also made a state in 1967 following the creation of 12 states by the Military regime of General Yakubu Gowon. These developments made Lagos to be the Political, Industrial, Financial and Commercial Nerve center of Nigeria. In fact, Lagos was doubling as a state and Federal capital. The population of Lagos in 1991 was estimated at 5,685,781 million and this is compounded by in-migration estimated at 0.3 million per year.

The expansion of Lagos is due to assimilation and expansion of land filled lagoon fondly remembered by Reclamation Street in Lagos Island. But the underground water level is high and is of almost equal salinity with the sea. The soil is compressible, climate not clement the water drains away quickly and the highest point on the state lies below 6.5 meters above the sea level, a fact that explains the sudden damage to roads and collapse of buildings in the state. Apart from the chaotic traffic congestion, the various offices of Federal Government located in any National capital require fast service and expanse of land for development. Lagos State was envisaged as not capable of meeting the above conditions. In fact at the inauguration of Committee on Housing and Urban Development, President O. Obasanjo described Lagos as an 'Urban Jungle'.

It therefore became imperative for the government to look for a suitable site for the country's Capital. (Obasanjo, 2000)

Abuja, Nigeria's new capital was excised from Niger, Kwara and Plateau States to be the center of unity and progress through the enabling Decree No. 6 of 1979. It is ethnically and climatically comfortable and accessible to all parts of the federation. The Federal Capital Development Authority, (FCDA) was created and entrusted with the responsibility to design, build and manage the New Capital Territory. But the seat of government was finally moved from Lagos to Abuja on December 12, 1991.

The name Abuja was coined from two words Abu and Ja, which in Hausa means red and light complexion. The two words came from the names of Makau's two sons Abu and Abukwakwa. The man known as Makau migrated from Zaria to a place called Zuba (from where he later moved to Suleja) in 1804 as a result of frequent attacks by the Fulani slave traders (Abuja Street Map, 1998).

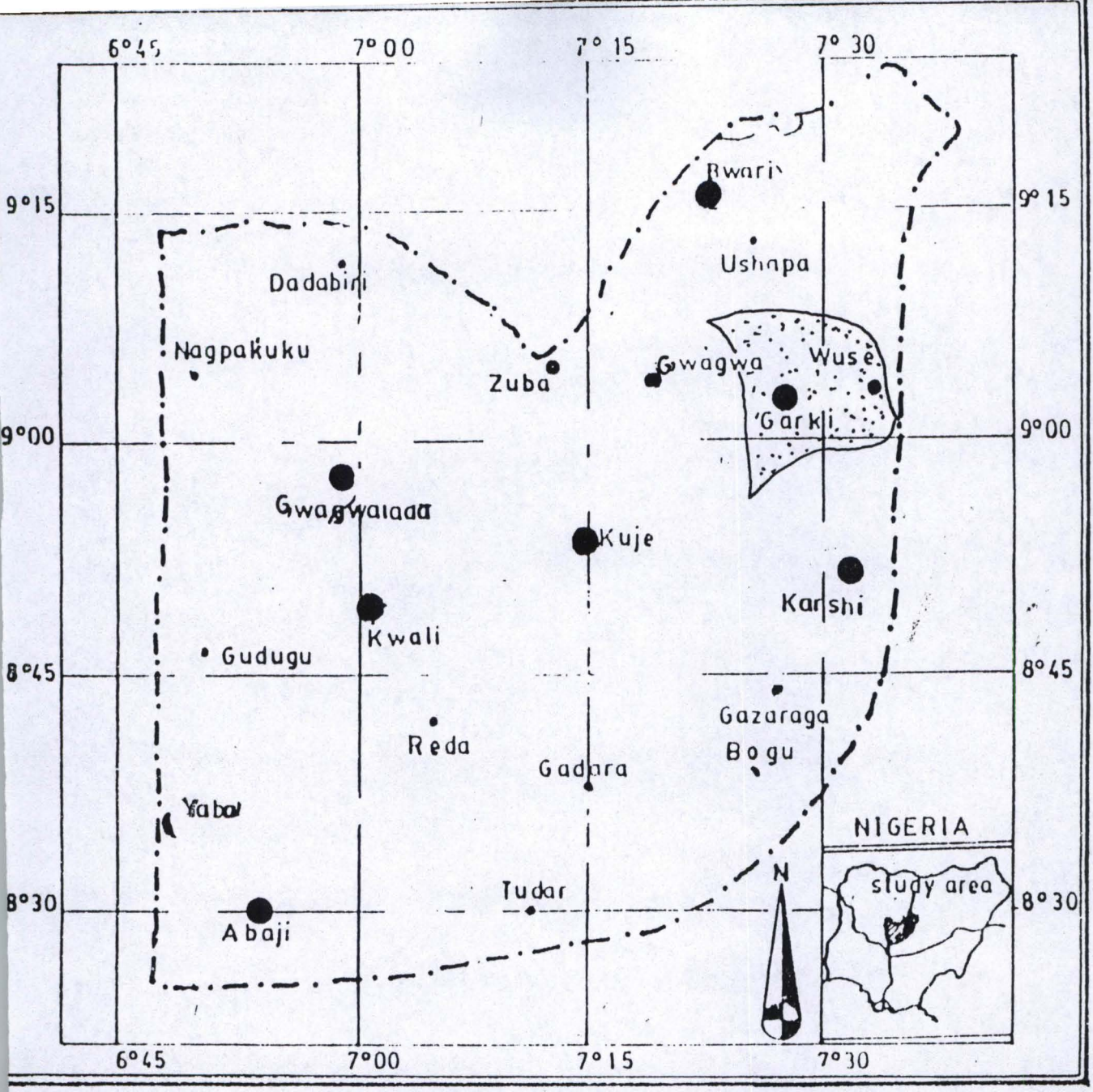
Onibokun, (1990) noted that the Master Plan presents Abuja to be linear in form and crescent in shape. It has one elongated city center. It presents a city of neighborhoods, districts and sectors with each having its own center and facilities in magnitude expected of its grade. Each neighborhood has a center, which provides facilities and services such as primary schools, corner shops, dispensary, or clinic, postal agency, community hall etc. The neighborhood is supposed to accommodate between 4000 and 5000 people while the FCC would accommodate only the middle and high-income groups.

2.1 **Locations and Physical Setting of Abuja.**

Abuja is located in the center of the country. It is located in the Guinea Savanna belt of the middle belt within latitude 8°25'N and 9°20'N of the equator, and longitude 6°45'E and 7°39'E. It is bounded to the North by Kaduna State, to the East by Nassarawa State, to the South West by Kogi State and to the West by Niger State. It occupies a land area of about 7315 sq km, which is about 0.84% of Nigeria total land area. (Abuja street map, 1998)

It has landscape of rolling hills, isolated highlands and gaps with low dissected plains. The South West Area has the lowest elevation where the flood plain of Gurara River is at an elevation of about 70m above sea level. The land rises irregularly from there; eastward we have Bwari, Aso range in the North East and the Idonkasa Range North West of Gwagwalada. There are other isolated inselbergs dotting many parts of the Federal Capital Territory.

Abuja experiences an average daily minimum and maximum temperature of 20.5°C and 30.8°C respectively. This has its minimum in August and September and the highest in January – March. It has a mean rainfall and humidity of about 119.2mm and 58.4% respectively with the highest in August and lowest between November and March respectively.



SCALE:- 1 : 250,000

LEGEND

Boundaries of the Federal Capital Territory . . . .

The study area . . . . . .

Major Towns . . . . . Garki

Minor Towns and Villages . . . . . Kandu

ig.1: MAP OF THE FEDERAL CAPITAL TERRITORY (F.C.T.) SHOWING THE STUDY AREA

Source Author's Survey (2002)

2.2 Population.

The population projections and estimates by Doxiades (1983) put FCT at 124,678 people in 1977 and rising to about 132,816 at the onset of physical developments in 1980.This means that FCT had an average density of 16 persons per square km. The 1991 census also put the population of the FCT at 378,671 thousand. The population level of the FCT was therefore low. This was one of the parameters, which gave the area an initial advantage over other rival areas in the selection process of a new capital territory (Baba, 1990). This population was disaggregated into a large number of minority tribes located in three states of the Federation (Niger, Plateau and Kwara).

Phases	Target population	Cumulative Population
1	50,000	50,000
2	92,000	142,000
3	230,000	372,000
4	610,000	982,000
5	1,050,000	2,032,000
6	1,600,000	3,632,000

Table 1. Targeted Populations for Phases 1 to 6 in FCT

Source: IPA, 1978

2.2.1 People and Culture

The original inhabitants of Abuja are the Gwari, and the Fulani. The Gwari are expert potters, craftsmen and farmers. Some of the Fulanis in Abuja are sedentary being predominantly traders

and others nomadic being herdsmen. The cultures of nomadic Fulani present a complex system involving age groups and initiations, the most important being the sahre or shedi (flogging meetings). A sahre gathering often lasts for five to seven days and is usually staged twice a year during the guinea corn harvest or Muslim holidays, marriages, honoring or installation of chiefs and settling scores between small villages. (Abuja street map, 1998)

Dispersed rural dwellings dominated the settlement pattern. A large number of the dwellings were located in accessible areas. A few large settlements however also occurred and were noted as potential and economic growth centers (Doxiadis, 1983).

Several attempts have been made to resettle the indigenes of FCT after the movement of Federal Capital from Lagos to Abuja. They were first settled at Bwari and some others were recently taken from Garki II to Zuba. But the culture, occupations etc of these people do not prevent them from settling down in a particular community. Virtually all-Nigerian tribes today inhabit Abuja.

2.3 **Land Use**

The Federal Capital Territory today has six Area Councils. These are known as FCC (Municipal), Gwagwalada, Kuje, Abaji, Kwali and Bwari area councils. The last two Area Councils were caved out of Gwagwalada and FCC respectively. The Federal Capital Territory was conceived to be developing in phases. Each phase is divided into districts. The phases are fashioned in such a way as to accommodate a population between 100,000-250,000 each while

districts are to accommodate a population between 40,000-60,000 each and city maximum of 1.6 million by year 2000 and 3.1 million ultimately (Onibokun 1990).

The Phase 1 of the development comprises Garki I and II, Wuse I and II, Maitama, Asokoro, Central Area, Three Arms zone, and Guzape districts. The phase II comprises of Wuye, Kado, Mabuchi, Durumi, Utakpo, Katape, Gudu, Kaura, Dubayi, Gaduwa, Dutse, Kukwaba, National park and Jabi. The Garki I is subdivided into Areas one, to eleven. The Wuse part of the council is also divided into I and II and while Wuse I is subdivided into zones, one to seven. The phase 3 consist of Bunkoro, Gwarinpa I, Gwarinpa II, Nboro, Galadimawa, Dakwo, Dakwo, Lokogoma, Wumba saraji, Kabusa, Okanje, Pykasa, Karmo, Dape, Kafe, Wupa district and Idu industrial areas. The detail land use plan for phase IV is yet to be prepared.

The Master Plan involves extending urbanization from a central area along two wings. Each development wing of the city has two adjacent development corridors. These corridors consist of the phases and the district within them. The limit of the phases are measured by radial expressways called ring roads with public transit spines called transit ways passing through their centers to the central area and to each other.

Every district has its land use plan, which is expected to be followed. A target of 150,000 inhabitants, was expected to be in FCT by 1986 and 30,000 (20%) of them would be the labor force who are to live in nearby village until adequate low cost housing were constructed for them. Another 11% would be the construction workers who were to live in 2 or 3 family houses with occupancy of 3 persons per room. A total of 25,000 housing units with occupancy of six

persons per household were expected but only 7851 houses were built (Onibokun, 1990). These shortfalls outstretched the achievements in transport infrastructure provision particularly with the Ad-hoc amendments that have now amounted to distortion (Onibokun, 1990) of the plan.

For instance Parastatals were supposed to be sited close to their Ministry. But there were so many Parastatals, that the employment zone of Maitama was given to parastatals. Jabi dam was also hastily located on the city land in 1982 to facilitate movement to Abuja. For the same reason, houses were built at Asokoro and Maitama even when their infrastructure was yet to be awarded. The idea of boys' quarters was also incorporated into housing plan to accommodate drivers etc. The hilly areas reserved for National Park were given to soldiers instead of their cantonment. These land use distortions have implication on the traffic movement in FCC.

2.4 **Transportation Planning in Abuja**

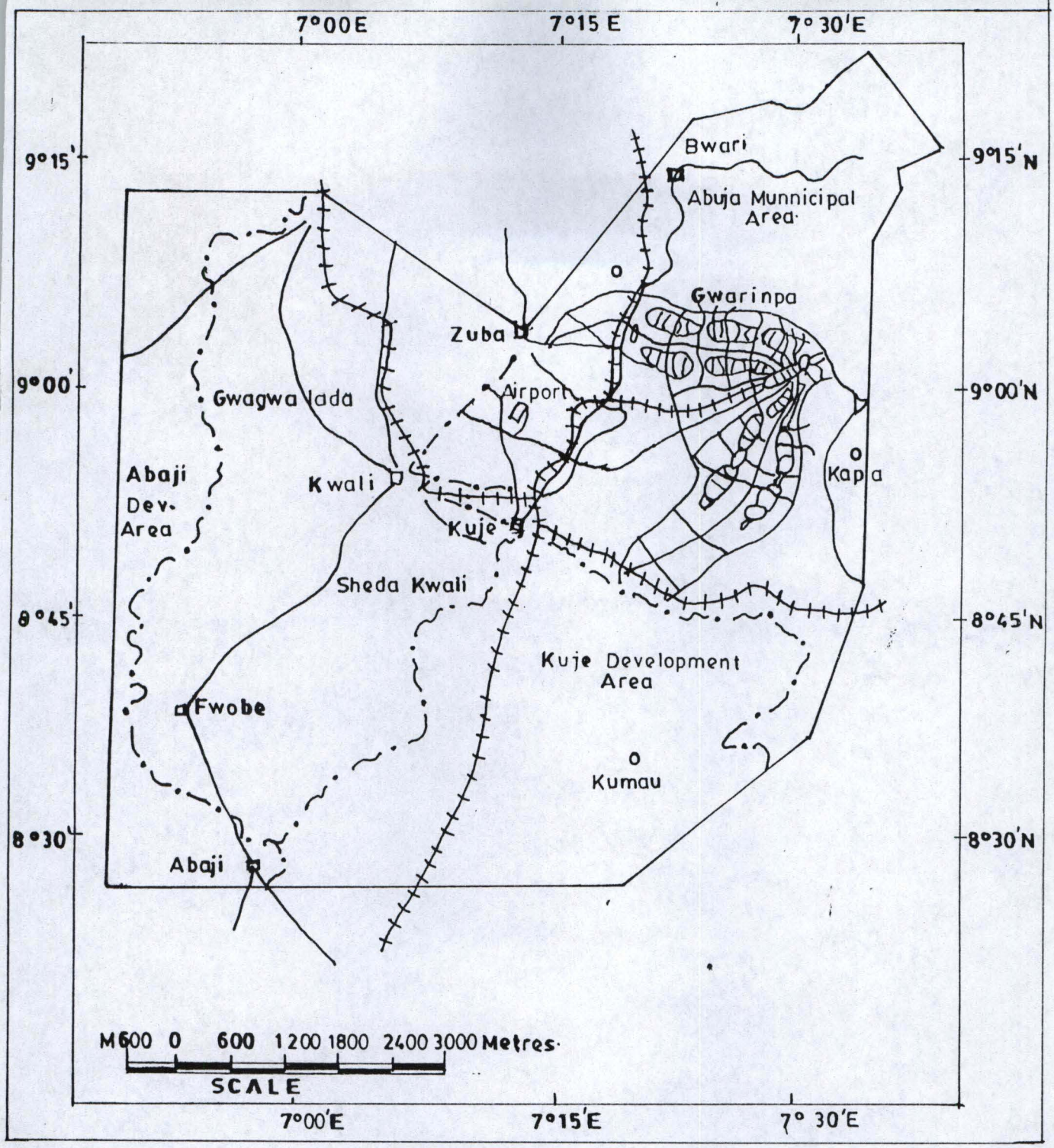
Before the creation of the Federal Capital Territory in 1976, the means of transportation in this predominantly agrarian and unsophisticated economy was trekking on short distances often on narrow and unplanned track paths. The traffic was light, a long travel time and accident was unheard off. Such movement was largely by human porterage, pack animals or by canoes.

Some of the paved roads recorded in Abuja before it was made the Federal Capital in 1976 include Nyanya - Jos road, Abaji – Jos road, Suleja – Minna road etc, but all were transit routes. With movement of the seat of the Federal Government into Abuja in 1991, the transportation system witnessed a boom. Road terminals sprang up here and there. Prominent among these are

LAND USE INDEX AND ITS SAATY'S WEIGHT	Maitama	Yan/ maraba	Karimu	Apo/ gudu	Garki	Wuse	Asokoro	C/ area	G/ lada	Kuj/ A-por	Kwali	Kubwa	Bwar
Hospital (3)	2	4	8	3	11	19	1	1	10			2	
Other Medical Facility (2)													
Nursery School (2)	4	1	8	1	6	14	9		7			9	
Post Pry School (3)	3	1	3	1	2	3	2		5			2	
Tertiary Institutio (1)						-			1				1
Other Sch & Equip (3)	1	1			9	11	3	2	7			1	1
Religious Insitution (3)	5	1	32	34	17	32	2	1	11			22	
Banks (3)	6		5	34	41		26	4	2				
/InsurancAllie institution (1)	4			6	19	23		8				2	
Book Shops (1)	1		1		21	8	1	1	8				
Building Materials (3)	4	6	221	36	81	66	6	3	4			5	
Urban Planners (1)	11		1		72	129	25	4	5			1	
Business Centers (4)	20	2	8	2	171	165	11	21	10			35	
Fashion & Others (1)	13	12	5		95	117	8	10	15			33	
Agric & Allied (1)			5		8	8	2	3	2	1			1
Engr. Coy& Allied (1)	27	1	95	3	114	136	3	18	14	3	2	22	
Food & Allied (4)	4	1	2		179	32		3	12			5	
Hotel & Restaurants (2)	20	5	22	2		108	12	9	34			37	
Block industries (1)	1		62									4	
Filling Station (4)	2		6		4	15	4	5	3	1		1	
Telecom & Others (2)	10	2	5		53	78	2	8	9	1			
Publishing & Allied (1)	6	1	2	1	57	62	6	9	14			4	
Embassies &NGO (1)	37	1			15	29	12	9					
Legal & Security (1)	5		4		55	113	3	13	11			3	
TOTAL	185	39	495	123	1030	1168	138	132	184	6	2	188	3

Table 2: Distribution of infrastructure in FCT (Source: Abuja yellow pages, 2001)

Area 1 and Berger terminals. The latter was later moved to Zuba and the movement encouraged the development of private coach terminals such as Chisco, ABC etc.



LEGEND

Proposed Rail Route, Airport, Area Council Capital, Major Towns,
Area Council Boundary, Major Roads, Minor Roads.

Fig.2: THE MAJOR TRANSPORTATION NETWORKS IN FEDERAL CAPITAL TERRITORY (F C T) ABUJA.

Source:- Author's Survey (2002).

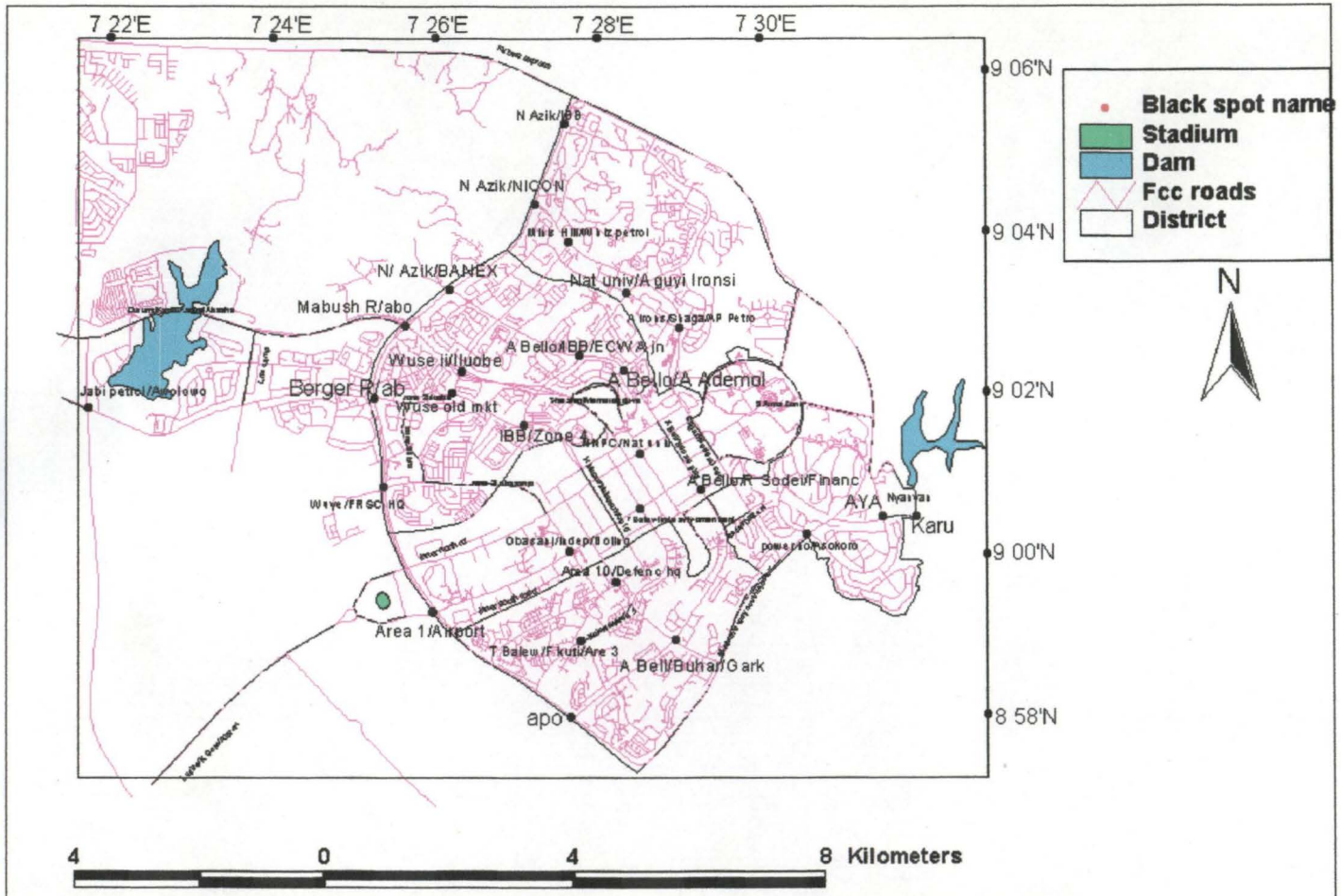


Fig 2: Black spot junctions and roads in FCC (1999-2003)

Source: Authors field work, 2005

The streets in Maitama are named after major waterways or rivers in the world, Wuse streets are named after African state capitals, Garki streets are named after major towns in Nigeria while the Asokoro streets are named after important people in the world. The naming of the streets reflects the size, influence, political power, etc, of individuals, rivers, tourist centers, etc, that the streets are named after. There are good networks of roads (Fig 2 and 3) such as express way, parkway, arterials, collectors, pedestrian ways and regional roads that connect the city center to satellite towns such as Bwari, Abaji etc. Most of the roads bear traffic signals controlled and maintained by FCDA.

Illegal structures are dismantled as frequently as they are built in the satellite towns to give way to more costly buildings and this along with other factors make the traffic of low income earners often on motorcycles to increase tremendously. The commercial motorcyclists (2.9%) have almost displaced the taxis (9.7%) and other cars by forming formidable unions in areas like Gwagwalada, Kuje, Bwari and the like where settlements are linear (not network) and unprofitable for taxis. (FRSC, 2000).

The Messrs International Planning Association (IPA) commissioned by the FCDA to draw the Abuja Master Plan recognized that for the city to be a successful living environment as well as an expression of Nigeria's unity, the form and organization must be responsive to Nigerian urban tradition and life style. The goals itemized below (MFCT, 2000) are important.

(a). Image ability which means the perception by the observer of the city's purpose, organization and symbolism.

(b) Efficiency of the ease with which the purpose of government business and individuals can be carried out.

(c). Flexibility or the ease with which growth and change can be accommodated. Such phased development allows room for future modification of the plan as changes occur in economic growth, technology, society and institutions. Within the above goal is the transportation objective for Abuja. These include:

i To maximize public transport mobility for those residents who own cars. The road would be made for the use of buses mixed with other traffic or general use street. Latter only the buses would have exclusive right of way. Thereafter, light rail transit (LRT) and rapid Rail Transit (RRT) would be introduced as the city develops.

ii To minimize traffic movements passing through the various development sectors, it is important to develop transit spines for each corridor. This would be designed to accommodate four lane bus ways with space reserved to accommodate the future LRT and RRT. As planned, the principal traffic generators are located along transit spine (fig 2). The decision is informed by the desire to ensure that residents need not walk more than 5 minutes before getting to the transit way station.

iii To provide multiple highway paths between development sectors, thereby avoiding network bottlenecks. A closer look at the road network in fig 2 shows that it originates from the Aso rock.

Air travel is achieved through the Nnamdi Azikiwe International Airport, which is connected to the city through the Airport Express way and planned Rapid Rail Transit line. In the Rail corridors, (fig 2), Abuja is connected to the North by the Kaduna line, to the South by the Ajaokuta line and to the East and West by the Lafia – Abuja – Minna line.

The Transportation Center or Railway Station as conceived is comparable to Union station, Washington, Frankfurt – Hauptbahahoff, Germany and London Victoria station. The size is 200m by 1000m. The station building is planned to house the National Headquarters of Railways and the FCT Urban Rapid Rail Administration. There are to be Goods station at Idu and Gwagwalada and Idu container Terminal (IPA, 1978).

There is to be extensive rail- air traffic in Abuja. For this reason, a well-integrated airport/rail station has been planned to handle traffic at the high peak of 15 minutes interval. The rail station will be housed under the terminal building of the Airport such that travelers can easily move from the city center to the Airport. Other Rail stations are at Izom, Kuje, Karshi and Kubwa. The sea link to Abuja is through the Warri - Ajaokuta – Abuja rail line. Idu will eventually serve as an inland dock (IPA, 1978).

The Master Plan of Abuja intends to achieve a functional integration between FCC and its surrounding Territory through various programmes of resource development and creation of an interactional space. It is to undergo spatial recognition and economic transformation that would enable it meet the needs of the FCC, as well as positively respond to the opportunities offered by the New City. Consequently, villages within five kilometers of FCC site, reserve, water sheds

and major access points were relocated in order to protect the periphery of the city from developmental encroachment or unplanned expansion. Settlements were regrouped to form absorption centers like Gwagwalada, Bwari, Karu, Abaji, Lafia, and Dangara. This is envisaged to cause hierarchy of settlements ranging from FCC, Satellite population centers (i.e. Gwagwaglada), regrouped villages and then, isolated undisturbed settlements. The master plan made provision for Agriculture and Forestry, Extractive industries, Regional Recreation Centers and sites for training, research and Military purposes.

An initial plan to resettle all residents within the FCT in their states of origin at 2.2% per annum and to leave the entire territory vacant for fresh development was abandoned early because of the sheer cost of compensation and administrative complications. This was after the government had relocated Wuse to the new site. This comprises Ushafa or Usuma, Tsobo, Garki, Jabi, Kukwaba Communities while Kubwa comprises Maitama, Sabo and Tsobo. Baba (1990) views the implication of this relocation on the emerging regional landscape in two perspectives. First, on the apparently positive side, there is the emergence of a rational and more efficient settlement structure and ease of access to basic services and utilities, But, from the economic point of view, the strategy of integration raises the problem of increasing difficulty of access to the means of production particularly land. Rural communities that are to be resettled within the developed area are faced with the difficulty of having enough land for their farming activities. The alternative of looking for more land in other communities also imply greater distances and travel time between residence and working place.

2.5 Road Safety situation in Abuja.

Before the establishment of Federal Road Safety Corps in 1988, efforts were made by the motor traffic division (MTD) of Nigerian Police, the Federal Government by establishing the National Road Safety Commission in 1974 and by Oyo State Government in 1977 among others. All these conscious efforts are manifestations that the need to set up a body to be responsible for safety on our roads had always existed and recognized (as such). But unfortunately, these efforts did not pay off handsomely as accident rate and the resultant fatalities continued to rise steeply in spite of them.

The Federal Road Safety Corps (FRSC) was therefore established as a paramilitary organization via Road Traffic Act CAP 141 of 1990. In order to ensure the safe use of the highways, the Commission was empowered to detect and arrest traffic offenders, impound the vehicle, penalize the offenders, rescue accident victims and conduct research into ways to improve safety on the road. This is done with a Command structure (Vis HQ, 12 Zones, 37 Sectors, 50 Units and Beats). All the Commands except the last are having the departments of Operation, Administration and supplies, Motor Vehicle Administration, Planning Research and Statistics, Logistics, public education, Special marshals and Training.

Even though, the task of accident rescue has been the priority of FRSC, hospitals and first aiders, the task of accident reduction and traffic management in FCT have received the concerted effort of the Police including the FRSC, the Traffic Wardens, Highway Patrol and others doing Police duties such as the Road Traffic Officers (VIO), the Customs and the Army. In Abuja alone, the

STATE	FATAL CASES	SERIOUS CASES	MINOR CASES	TOTAL CASES	PERSON / KILLED	PERSON INJURED	TIME / Killed(min)	TIME/ RTA (min)	
Abuja	1181	1905	1202	4293	1993	7185	264		122
Adamawa	1633	2571	1242	5127	3380	8353	156		103
Abia	1248	1427	580	3259	1594	3223	330		161
A/Ibom	2059	2875	1664	5804	2411	5670	218		91
Anambra	2060	3355	2332	7733	2878	6717	183		68
Bayelsa	108	240	107	455	131	446	4012		1155
Bauchi	2495	2105	1115	5569	3532	10322	149		93
Benue	2837	4264	1772	5596	4051	12323	130		94
Borno	1719	2026	1693	5349	2094	6168	251		98
C/Rivers	2070	6585	1503	7009	3338	7405	158		75
Delta	3126	6701	3240	12274	4569	10859	115		43
Ebonyi	183	180	133	454	211	613	2491		1158
Edo	3415	6364	5532	15477	4437	13327	119		34
Ekiti	289	529	156	675	397	1060	1324		779
Enugu	1568	2020	1465	5053	2006	4264	262		104
Gombe	543	541	184	1319	795	5130	661		399
Imo	1622	2676	958	5309	2209	5856	238		99
Jigawa	1552	986	311	2849	2375	5940	221		185
Kaduna	3218	3394	2918	9527	4846	9662	109		55
Kano	6077	8194	5564	19879	7772	17559	68		26
Katsina	2444	2044	1319	5901	3719	5430	141		89
Kebbi	357	649	345	1351	454	1730	1158		389
Kwara	1455	1654	1196	4095	2570	5409	205		128
Kogi	1391	1186	721	3368	2827	7683	186		156
Lagos	9376	23719	19472	52488	11369	31391	46		16
Nasarawa	873	495	116	1398	1491	3547	353		376
Niger	3219	2249	1396	6884	5319	11765	99		76
Ondo	2363	3846	2498	8704	3684	9444	143		60
Ogun	5971	8218	5599	20488	9041	21337	58		20
Oyo	4181	5698	3505	13420	6031	2968	87		39
Osun	1386	1748	2254	4104	2300	5555	229		128
Plateau	2350	1974	1207	5336	4045	11002	130		90
Rivers	1577	3649	2348	7608	2070	7593	254		60
Sokoto	1543	1399	626	3575	2703	6313	195		14
Taraba	543	473	145	1159	688	1941	764		45
Yobe	881	950	397	2222	1433	4383	367		23
Zamfara	149	165	92	410	236	635	2227		128

Table 3:SUMMARY OF ROAD TRAFFIC ACCIDENT DATA ON STATE BASIS (1990-2004)
Source: Authors compilation from FRSC (2005)

FRSC, in addition to the presence of the National Headquarters, Zonal Headquarters and the Sector Command has five Unit Commands. The Unit Commands are located at the CBD (Federal Secretariat), Garki, Gwagwalada, Abaji and Nyanya Units.

	Cases reported	Person killed	Person injured	National population (3.45%)	Total casualty	Vehicle licensed (2.2%)	Acc/ 1000 veh	death/ 100,000 pop (persona l safety	Death/ acc(fatality index	Casualt y / ac cd	Fatal /casualt y (severit y index	Time /killed (1/xdays)	Time/ RTA case(1/x days)	Death /10,00 veh 0(traffic safety)	Veh/1,0 popu(m zation l
990	177	68	306	362956	374	117286	2	22	0.4	2	0.2	5	2	6	387
991	156	105	341	378671	446	119866	1	33	1	3	0.2	4	3	9	376
992	256	127	501	394386	728	122505	2	32	0.5	3	0.2	3	1	10	310
993	258	113	599	410993	712	125198	2	28	0.4	3	0.2	3	1	9	305
994	29	15	53	428555	68	127952	0	4	0.5	2	0.2	24	13	1	299
995	193	49	163	447139	212	130767	2	11	0.3	1	0.2	8	2	4	293
996	59	19	108	466818	127	133644	0	4	0.3	2	0.2	19	6	1	286
997	486	100	554	487669	654	136584	4	21	0.2	1	0.2	4	1	7	280
998	503	127	423	508776	550	139589	4	25	0.3	1	0.2	3	1	9	274
999	511	211	394	533228	605	142660	4	40	0.4	1	0.4	2	1	15	268
2000	276	173	367	558123	540	145799	2	31	1	2	0.3	2	1	12	261
2001	31	5	28	584566	32	149007	0	1	0.2	1	0.2	73	12	0	255
2002	459	263	1248	612669	1511	152285	3	43	0.6	3	0.2	1	1	17	249
2003	435	369	1073	642554	1442	153635	3	57	1	3	0.3	1	1	24	242
2004	464	249	1027	674342	1276	159059	3	37	0.5	3	0.2	2	1	16	236

TABLE 4: AGGREGATE DATA ON ROAD TRAFFIC ACCIDENT IN ABUJA (1990-2004)
Source: Authors compilation 2005

Table 3 shows further that the accident is more prevalent in Abuja, Edo, Kano, Lagos and Ogun States and low at Bayelsa, Ebonyi, Gombe Kebbi Taraba and Zamfara States respectively. Details from Table 2 have shown that the Federal Road Safety Commission has contributed very well to the vehicle safety. However, the effect might not be very significant in the face of increased motorization. Consequently while the statistics on accident per 1000 vehicle was reducing the statistics on death per 1000 population was fairly stable. The implication of this is that while fewer vehicles (Compared to vehicle population) were involved in accident, more people die. This situation has been found to be true nationally, particularly during the study period.

2.5 Conclusion

The chapter recounts the factor that lead to the movement of Federal Capital from Lagos to Abuja. It also appraises the geographical and socio-economic factors available in Abuja as well

as Land use intensity in the Area. The chapter shows that transportation plays a leading role in the planning and acts as a catalyst for economic development of the area. Since road safety is an important subject in the road sub-sector the chapter gives an overview of the activities of FCT sector Command of Federal Road Safety Commission.

CHAPTER THREE

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

3.0 Introduction:

It would be practically impossible to conduct any research or take any decision if the variables involved are unknown. The data for traffic analysis is however accessible but costly to obtain. To make a valid judgment of the relationship of each black spot in the network, a synoptic view of the entire network is not only necessary but the data also require advanced analytical tool such as GIS.

The human experience needs to be complemented with computers in order to bring out valid decision of the relationship between the spatial and temporal data to be used. The Geographic information system is very good in this aspect since it allows the analysis of geographical data acquired through the use of Global Positioning System (GPS), Remote Sensing (R/S) and fieldwork etc. The GIS, R/S and GPS are technologies, which have revolutionized the act of mapping in terms of their accuracy and cost-effectiveness. This literature would see how various authors have used the above in order to achieve their aims in the past with a view to applying such relevant methods to this research.

3.1 The Road traffic accident

Road traffic accident is a sad and unfortunate event. It is sad because of the human and material loses and unfortunate because it is preventable. It is a fact of life that accident will occur so far movement takes place and that the road is unsafe at any speed (Onakomaiya, 1978), but the safety record in the developing countries particularly Nigeria gives cause for concern. The more developed countries have higher level of personnel safety (death/100,000 pop.) and that the lower the level of motorization (veh/1000 pop.) the lower the level of traffic safety (death/10,000 veh) respectively (Ogunsanya, 1997).

The traffic safety increased proportionately with the vehicle ownership between 1940 and 1950, the traffic safety decline more than vehicle ownership between 1950-1970 and the traffic safety decline in spite of the growth in level of motorization from 1970 to date (Trincta et al 1988). In Nigeria, virtually all the states have the unenviable record of increase in severity index between 1970-1974 and 1977 and 1986 (Akpogomeh, 1992). The fatality index was lowest in the Urban areas of the country even though they have more RTA cases, the 'Ember' moths were not as dangerous as mid-year moths, more accident were recorded when salaries are paid, highest on Friday and lowest on Saturday and highest between 10am and 6pm and lowest between 1am and 5am respectively (Akpogomeh 1992, Olagunju 1995)

Sudden death following road traffic accidents is increasingly becoming a most important source of grief in a number of homes in Nigeria. There is scarcely a week that passes without an account of a ghastly road accident with many deaths being reported in the Nigerian press. In Nigeria the

young adult male aged 20-29 years is most frequently the victim of an auto crash (Asogwa, 1978).

The financial loss following death or injury of the Nigerian youth is difficult to quantify in monetary terms but must run into millions of Naira annually. It is this sort of loss that no nation least of all a developing country, can afford especially when it is remembered that it is on this group of people that national growth and prosperity depend. When compared with such other conditions as communicable diseases, it can be seen (Asogwa, ibid) that deaths from road crashes outweigh recorded deaths of these other conditions. Notwithstanding the staggering effect of accident on the population and the concern expressed by the public, the government effort to stem the tide have not matched the magnitude of the problem.

The problem of RTA in Nigeria cannot be fully appreciated by looking at Nigeria's trend alone. Yet International comparison can be misleading if not treated with caution. This is because the difference could arise from such factors as difference in traffic composition, in the proportion of vehicle travels which occurs in areas of urban development, in the definition of mobility and mortality statistics, in the quality of roads, street lighting, vehicle legislation, standard of driving etc.

For instance, if one compares the number of accident per year, month, day, and hour, it seems that safety decreases as one progress from Uganda through Sweden and Nigeria to Britain. But the reality is that Britain has more vehicles on its road. Figures from total killed appear to show that those killed in Nigeria is half that of Britain. But when the number killed is compared to the

total fatal accident the Nigerian roads appear deadlier (WHO, 1968). Since the best way to show this grim reality is difficult to get, its nearest parameter is killed per 100,000 vehicle or population. With this, Nigeria now appears to have twenty times (20) more mortality than UK. This is with the assumption that as the vehicles are registered, roadworthy, not out of road anytime in the year due to un-roadworthiness, not re-registered at every change of ownership, all roads are known and all accident data are reported. By and large, these are not so.

A better comparison known as death/100 accident shows that Nigerian is twice as predisposed to death as Briton (WHO, 1968; 12:298). Statistics from death/100 million vehicle mile (vehicle mile is the product of number of vehicle and the kilometer traveled) shows that Nigeria has up to (five times predisposed) 150 death per 100 million compared to 13 death per 100 million in UK (Scham, 1970)

Even then, the indices (i.e fuel consumption) that could have given the vehicle mile are not obtainable (due to fuel diversions, sabotage etc) hence one has to still rely on the number of death, which is mandatory reported to the Police. Comparing the percentage of fatal to serious to minor accidents in Nigeria and Britain shows that Nigerians are likely to die more, while comparing the ratio of fatal to serious to minor shows that minor accident are twice prevalent as fatal accident.

Perhaps another more instructive perspective is comparing percentage change over a period among the countries. While countries like Britain and Sweden recorded negative or decrease,

travel models require traffic flow of any iterative variations in traffic flow in a user-friendly manner.

Second, the topological data model used by vector GIS's cannot adequately account for the "virtual" relationships between unconnected map features essential to calculating and predicting urban travel demand. Shaw (1993) surmises that a GIS is not presently suitable for any of the four steps in the urban travel demand model. He concludes that most GISs are insufficient for present traffic demand modeling requirements because the strengths of a GIS lie in its spatial analytic capabilities rather than its spatial modeling capacities. Researchers have therefore questioned the validity of GIS model outputs (Hartgen et al., 1993). Many of the studies cited above had to transfer data back and forth between the GIS and other statistical software are complicating the use of GIS for transport and salty-related studies. Many software developers have recognized these limitations and have begun to produce GIS package oriented towards the transportation modeler (e.g., TransCAD, GIS-Trans)

3.3 Theoretical Framework

Some of the dilemmas faced during traffic studies include how best to predict the result, what are the likely situations of future estimate and what are the impacts of policy objective on the evaluation of alternative measures. These problems require detail analysis and it is for this reason that modeling is important. Therefore, in order to better understand this study it is important to immerse it in relevant theories. The two theories considered here are shown below:

distances between pairs of objects represented by a distance matrix. The spatial information can provide data on nearest distance between objects and the objects may be point polygon or aerial features. The distance information between object pair is stored in C matrix or D matrix. In the D matrix, for point features, all off-diagonal elements are non-zero, representing the distance between pairs of points. But in the D matrix from the polygon features, zero values at the off-diagonal elements reflect that the object pairs are adjacent to each other. The applicable formula is shown below.

Relationship of object	Relationship between object pair (Fotheringam and Okelly)	Topology, adjacency, contiguity	Network distance
Distance matrix d_{ij} s	Centroid distance d_{ij} (t)	Distance converted to binary connectivity matrix	Distance measured D along the network
Distance between i and j and dij is zero (0)	Distance between i and j assuming i and j are polygon features	Adjacent objects have one while non adjacent have zero (0,1) connectivity matrix	If distance is to allow nodal connectivity to network then C matrix is useful. All diagonal values in the matrix are zero like distance to one self.
dij = dij (n)	dij of D is define as dij (n) > o, then dij = dij (t), else dij = 0		

Table 8: Condition for Spatial relationships

3.3 Conclusion

During the three era of road safety (before 1940, between 1940 and 1970, and after 1970) the Road Traffic Accident increased, declined and declined further in comparison with increased level of motorization respectively. The literature observed that it is in realization of the dangers on the road and the need to organize and complement previous effort on road safety that Federal Road Safety commission was established. The review of literatures on evaluation of road safety efforts in Nigeria shows that there has been 73% improvement in safety management and that while traffic safety has reduced, the personal safety increased even in the face of increased level of motorization.

Road Traffic Accident at any location is caused by the unique combination of accident predisposing factors. Not until these exposure factors come together accident will not occur. This follows that accident is site and traffic specific. Apart from the primary causes of accident (i.e. vehicle, human, road or environment) there are myriads of secondary causes such as alcohol, culture, speed, gender, self esteem, and self control, spatial factors ((or land use), gap acceptance and temporal factors. Researches have been conducted on the contribution of each of these secondary causes of road accident. This study regrouped the factors as human behavior as shown by time of accident, characteristic of the site and the traffic volume at the site and they all affect the level of road traffic accident. Incidentally, the data generated with respect to above comes in various forms and may not be amenable to common statistics available in SPSS software. This is where GIS is important.

Geographic information system (GIS) is a computer based analytical tool capable of coping with the monotony, repetitiveness, speed and accuracy required by the multistage, spatio-temporal and multitemporal data. In addition to these, the GIS are capable of handling the issue of multicolinearity, randomness or heteroscadacity associated with traffic data. For instance a two way ANOVA often hide the sample size factor by recognizing a single data point (i.e. temporal pattern of accident against the location). GIS can integrate, manage, analyze and output these data to aid decision-making process. The literature further showed that there is sufficient use of GIS in transport planning but not in traffic analysis let alone accident analysis. The use of GIS in accident analysis therefore held a promising direction for future in terms of data base generation, accident mitigation, response to distress call black spot identification and command location and these are areas of focus in this. The study is therefore immersed into relevant theories such as the Georelational map model and theory of spatial analysis.

CHAPTER FOUR

METHODOLOGY

4.0 Introduction:

The method of achieving a set objective is one vital part of any study. The methodology sets a work plan for achieving the objective. This considers the interrelationship of the variables as well as the variable and the study area. It is this kind of relationship that would determine the analytical tool to be employed.

To perform spatio temporal analysis of road traffic accident with GIS, it is important to note that accidents are caused by the primary factor as well as the numerous secondary factors arising from the primary factors. Some of these secondary causes are listed at the back of FRSC booking sheet (see Appendix IV). For this study the spatio-temporal characteristic of accident cases, casualty, number of vehicles involved, accident type and traffic volume were considered for each black spot. The GIS is capable of linking the data to their respective geo-files and made available for coverage, overlay and query analysis as done in this study.

4.1 Types of data required for the study

The independent variable for this study include:

1. Location of accident (27 at junctions and 21 on Roads). The places where accident occurred during the study period were regarded as black spot. A total of 48 black spots were identified.
2. Land use of district of accident occurrence: Maitama, Wuse central area, Asokoro, Garki, Kado, Kubwa, Karu, Airport road and Giri
3. Year of occurrence: 1999-2003
4. Time of accident
   - Date: early month (1-21), month end (22-31)
   - Day: week end (fri-sun), week day (mon-thur)
   - Hour: day (5am-6pm), night (7pm-4am)
   - Month: rain (jun-nov), dry (dec-may)
5. Traffic volume

The dependent variable for this study includes

1. Casualty recorded
2. Number of vehicles involved in each accident and the total for each black spot
3. Types of accident (F: S: M)
4. Cause of accident

4.2 Sources of the data

The figures for the first two dependent variables were obtained directly from the records of Abuja sector command of Federal Road Safety Commission (FRSC). Data of the types of accident and causes of accident was also extracted from the accident record obtained from

FRSC. But the Traffic count was conducted on each black spot location using the format in Appendix v.

The image of FCT which was obtained via Quick bird Satellite was digitized in conjunction with NASRDA staff in Abuja in 2003 and geo-referenced using some junctions identified on the map as geo-referencing units. The image has the following description.

Satellite	-Quick bird
Resolution	- 0.6 x 0.6 meters
Bands	- M S S
Projection	- Universal Transverse Mercator (UTM)
UTM Zone	- 32
Ellipsoid	- Clarke 1880
Acquisition Date	- 2002
Processed by	- NASRDA Abuja

4.3 Data collection strategy

The traffic count was conducted on all the routes for one week randomly chosen in each of the months between 1999 and 2003. The data obtained were later rearranged into Monday to Sunday and Hour of the day. When the data were multiplied by four, the traffic volume for the month was obtained. The day of the month that the traffic count was conducted was also noted. The

total traffic counted for the day was also computed to give an estimate of traffic volume for each day of the month.

However since it is impossible to add Fatal to Serious or Minor accident, an eight-item questionnaire, which address issues such as effect of accident on victims, dependants and society was sampled on road user, transport researchers and FRSC men. Two hundred and forty questionnaires earlier validated by two senior road safety officers were distributed among the respondents. The reliability of the questionnaire was achieved by administering the questionnaire twenty of the questionnaire six months before the actual test and at the end of analysis the data obtained show that Fatal: Serious: Minor is in the ratio of 10:5:1. With this, it was possible to add all the Fatal, Serious and Minor accidents together by simply multiplying them with their respective ratio (Appendix ii).

A total of nine factors were found to cause all the road traffic accident that occurred during the study period. But because it is difficult to add for instance the total number of accident caused by over speeding to the ones caused by overloading (i.e they occur at different scales), the number of accident caused by each cause of accident was used to show its Saaty's weight (Annon, 1992a). At the end of the analysis each cause of accident was given a value between 1 and 9. This value was thereafter used to multiply the number of accident caused by that factor.

A total of twenty-four (24) indices of Land use were identified in all the districts (Appendix VII). Since each index have different effect on the traffic system, it is impossible to add for instance five hospitals and five religious homes together. Therefore the survey of the number of vehicle

that stayed more than one hour around each of the Land use was obtained. This was used to show the Saaty's weight 9Annon, 1992a) of each of the Land use indices. At the end of the analysis each of the Land use was given a value between 1 and 4. This value was there after used to multiply the number of Land use indices (i.e number of hospital) in the district. It is based on the above that the preliminary analysis was done in this study.

s/n	Causes of Accident	F (10)	S (5)	M (1)	Total	Rank	Value given
1	Road obstruction	0	15	1	16	7th	3
2	Route violation	30	15	4	49	5th	5
3	Road Traffic	0	0	1	1	9th	1
4	Speed violation	200	155	23	373	1st	9
5	Overtaken violation	30	30	5	65	4th	6
6	Traffic light	10	30	5	45	6th	4
7	Dangerous driving	70	120	36	226	2nd	8
8	Alcohol / Drug offence	0	5	2	7	8th	2
9	Mechanism deficient vehicle	50	85	10	145	3rd	7

Table 9: Ratings of various causes of accident in FCT

Note: F =Fatal; S = Serious; M = Minor accidents Source: Authors survey, (2002)

4.4 Techniques of analysis

1. The Preliminary analysis was carried out outside the GIS environment using Statistical Package For Social Scientist (SPSS) and EXEL software while the detailed analysis involves

spatial operation in Arc view GIS. Consequently, the data would be categorized into weekdays and weekend, rainy season and dry season, night and day accident, as well as early month and month end accidents. See appendix VII for procedure of SPSS analysis and data input and appendix IX for summary of data used for EXEL analysis respectively.

The analysis includes:

- Analysis of trend in accident variables and;
- Analysis of seasonal variation in accident variables

2. Detailed Analysis: Incidentally this preliminary analysis provides answer to objective one and two. These are to show the relevant variables in the study and to provide the temporal characteristic of accident in FCT. But in order to use GIS to simulate RTA situation a detailed evaluation is required.

The composite of the geo-referenced image was digitized with A_0 digitizer at NASRDA to show the street map of FCT and FCC. The digitized image was stored on the drive 'C' of the computer where Arc view was installed. Nine Layers (theme) were created during digitations viz: FCT roads, FCC roads, all black spot Junctions, All black spot roads, street light, hospitals, FRSC/Police beat, river channels, dams, FCT Boundary, and Airport. The various maps produced (see Appendix for procedure), were subjected to spatial query in order to model the intensity of accident at the various black spots.

Consequently, the data obtained for each variable on the road and junction were respectively linked with the map. The black spot roads were digitized as link and the black spot junctions digitized as points. With this it was possible to query and reveal the proportional accident situation on each black spot.

The spatial analysis was done using coverage, overlays and queries. The coverage utilizes the fundamental spatial properties of a point, line or an area as well as their attributes in a relational database management system. The overlay involves the process of combining two or more coverage (point in polygon, line in polygon, point in line, polygon in polygon respectively) to create new sets of information. The analysis also involve issuance of spatial queries to search the database for specific features in a coverage using unique identifier for specific features in a coverage using unique identifier such as the name of the black spot in the black spot junction layer. The query selects a particular feature using distinct numeric expression or selecting features located within different coverage that meet specified spatial relationship (see appendix vii for procedure of spatial analysis).

4.5 Conclusion

The Foregoing has succinctly identified the variables to be considered in this study. These include number of vehicle involved in accident, number of cases, number casualty and so on, all depending on the traffic volumes and the space time effect of road accident in the study Area. The Arc view software of GIS is considered useful here. The analysis would entail spatial query on the spatial and attribute data that are imported into GIS environment.

CHAPTER FIVE

TEMPORAL VARIATIONS OF ROAD TRAFFIC ACCIDENT

5.0: Introduction

In this section attempt was made to explain how the accident variables vary during each day of the week, month of the year, dates of the month, and during each hour of the day respectively. The data on temporal pattern of road traffic accident and the temporal data on rescue capability of hospitals to cases within their catchments areas have been individually analyzed with the SPSS and EXEL software.

5.1: Trends in road traffic accident data

Fig 4 shows that all the accident variables have similar trend during the week in FCC. The variables were high between Monday and Thursday, reduced from Thursday and reach its lowest on Saturday, and then increase from Saturday to the next Monday. However the traffic volume increases progressively between Monday and Friday followed by a downward trend on Saturday only to increase again on Sunday as shown in Fig 5.

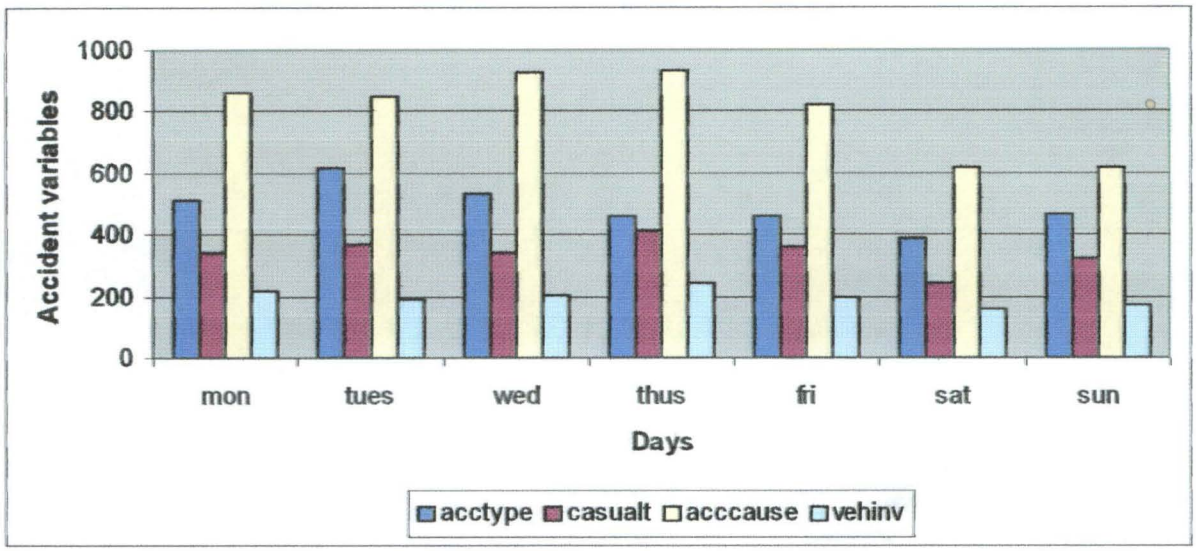


Fig 4: Daily frequency in accident variables (1999-2003)

Source: Authors field work (2004)

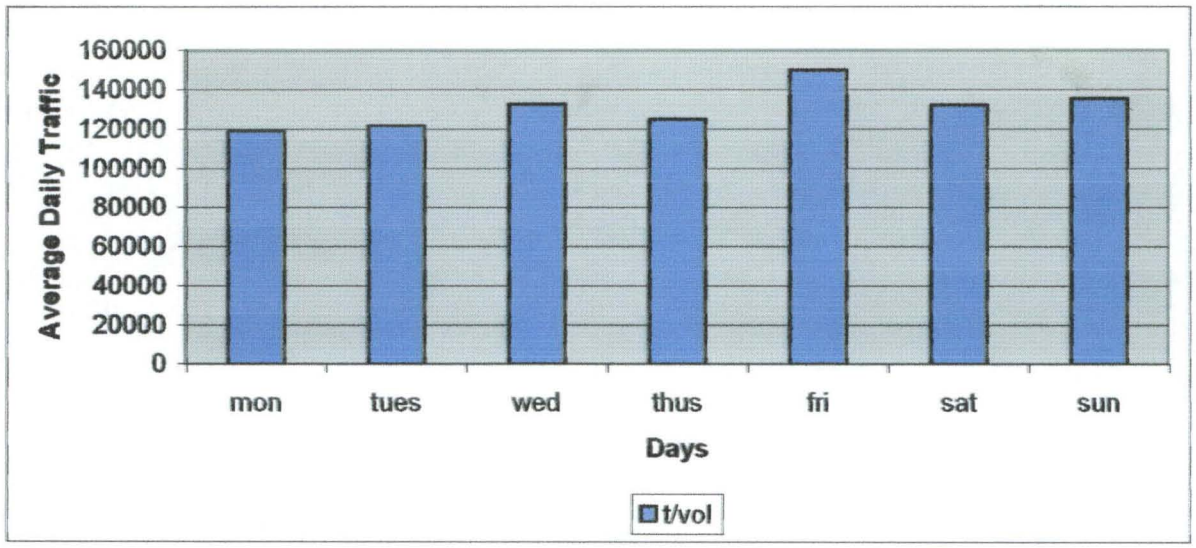


Fig 5: Average Daily Traffic (1999-2003)

Source: Authors field work (2004)

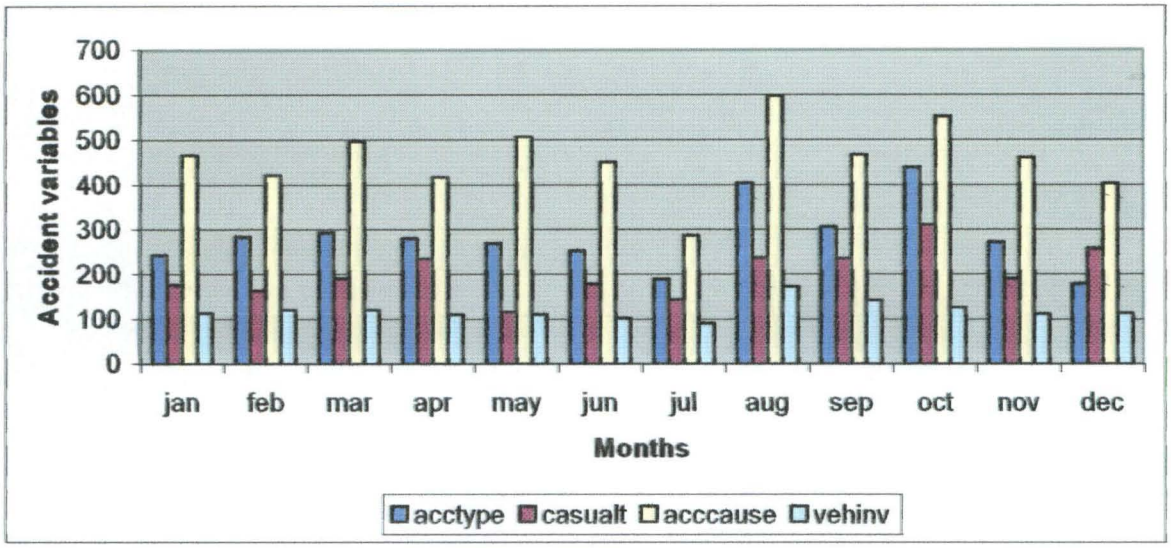


Fig 6: Monthly frequency in accident variables (1999-2003)

Source: Authors field work (2004)

The trend in all the accident variables was similar between January and June (Fig 6). These accident variables witnessed a decline in July only to increase sharply in August and thereafter fluctuate at this height till December. The trend in traffic volume (Fig 7) was harmonic in shape. The traffic volume makes a complete circle every four months with the peaks at January, May, June, July, and November respectively. This is in response to the quarterly release of fund by government.

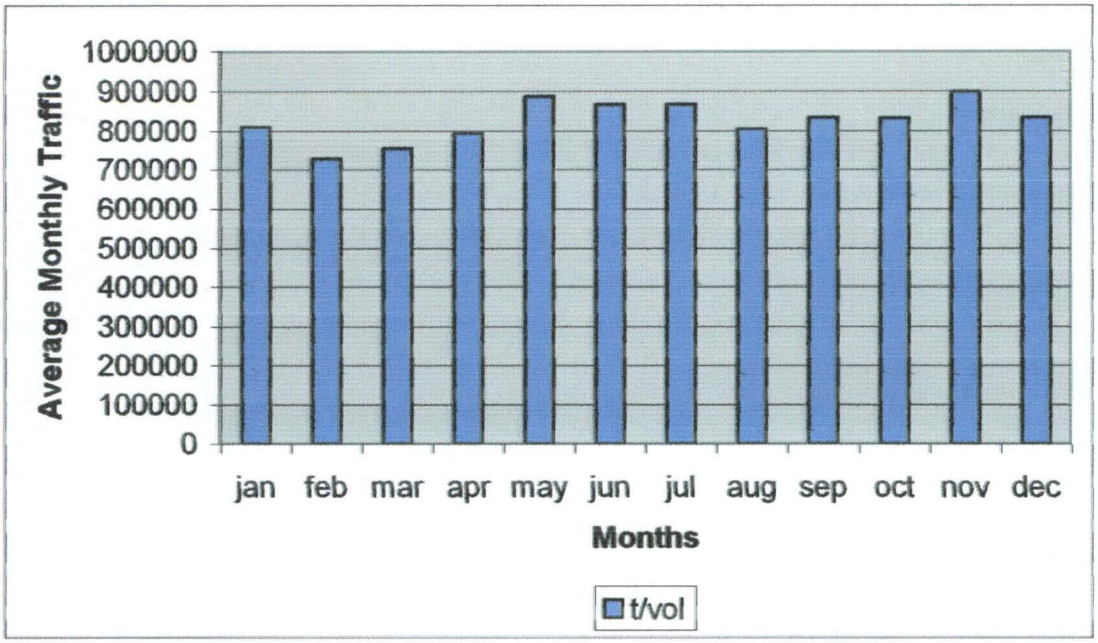


Fig 7: Average Monthly Traffic (1999-2003)

Source: Authors field work (2004)

The number of accident variables recorded increased progressively between 6am and reached its peak by 6pm in FCC. The accident variables remained at this height till 9pm thereafter declined to its lowest by 1am the following day (Fig 8). The traffic volume witnessed a cyclical trend every six hours with the peak at 1am, 5am, 11am-2pm, and 8pm respectively (Fig 9).

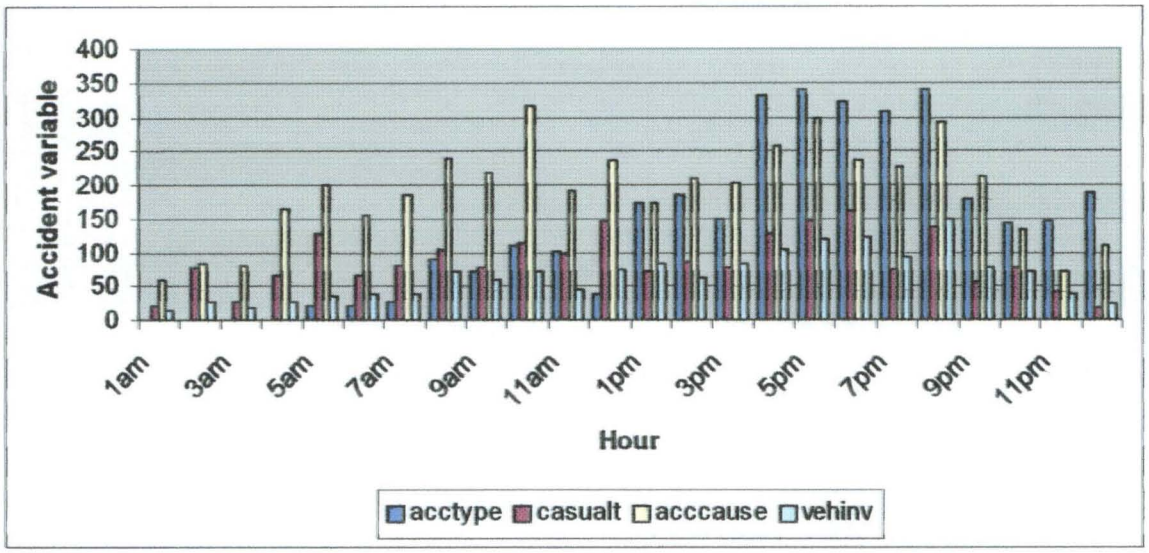


Fig 8: Hourly frequency in accident variables (1999-2003)

Source: Authors field work (2004)

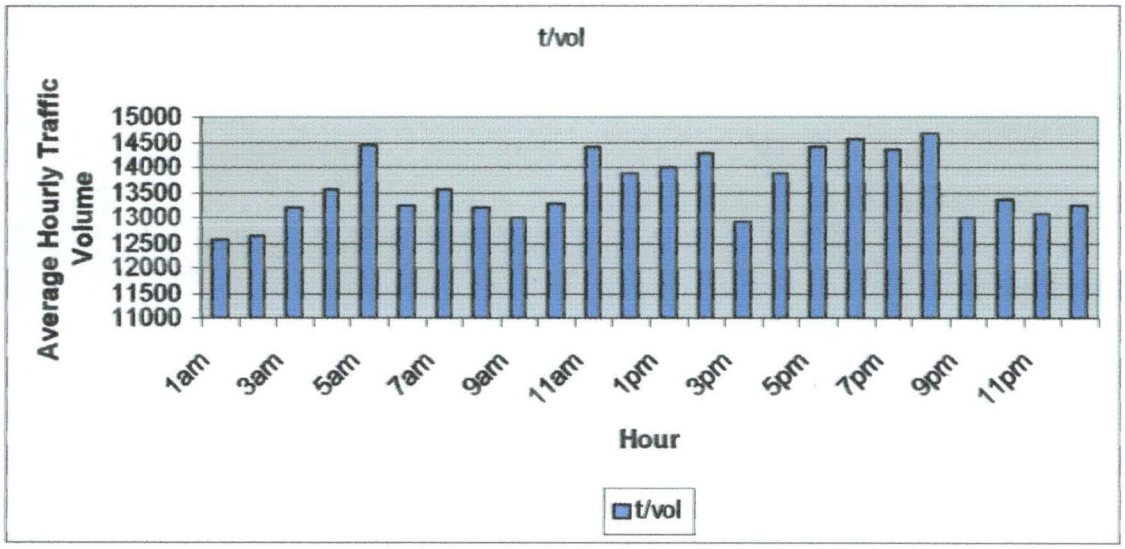


Fig 9: Variation in Hourly volume (1999-2003)

Source: Authors field work (2004)

There is great variation in the entire accident variable including the traffic volume across the dates of the months. The fluctuation comes on every other day in the months as shown in fig 10 and 11 respectively.

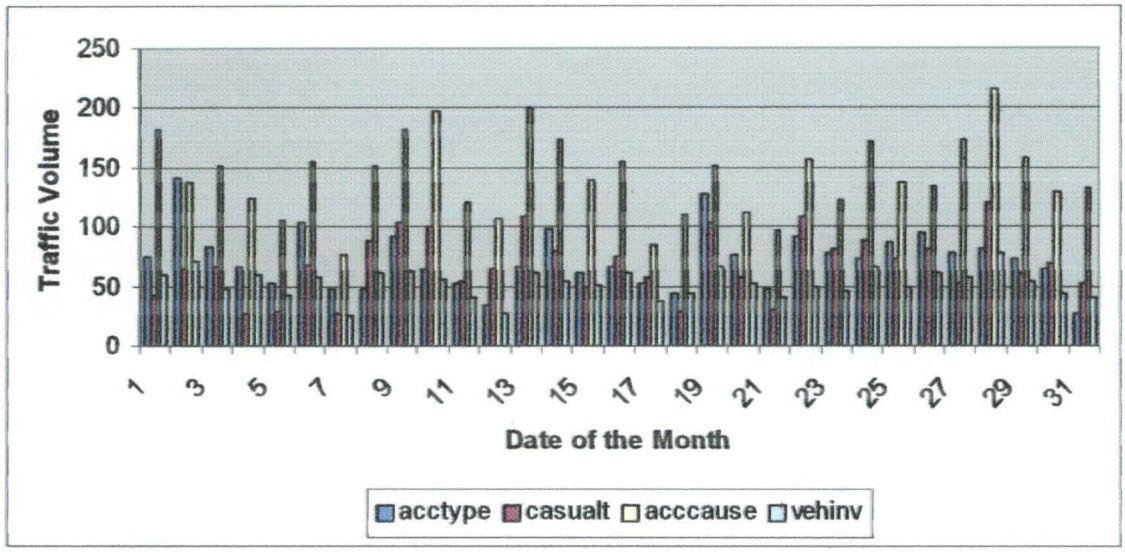


Fig 10: Frequency of variables by dates (1999-2003)

Source: Authors field work (2004)

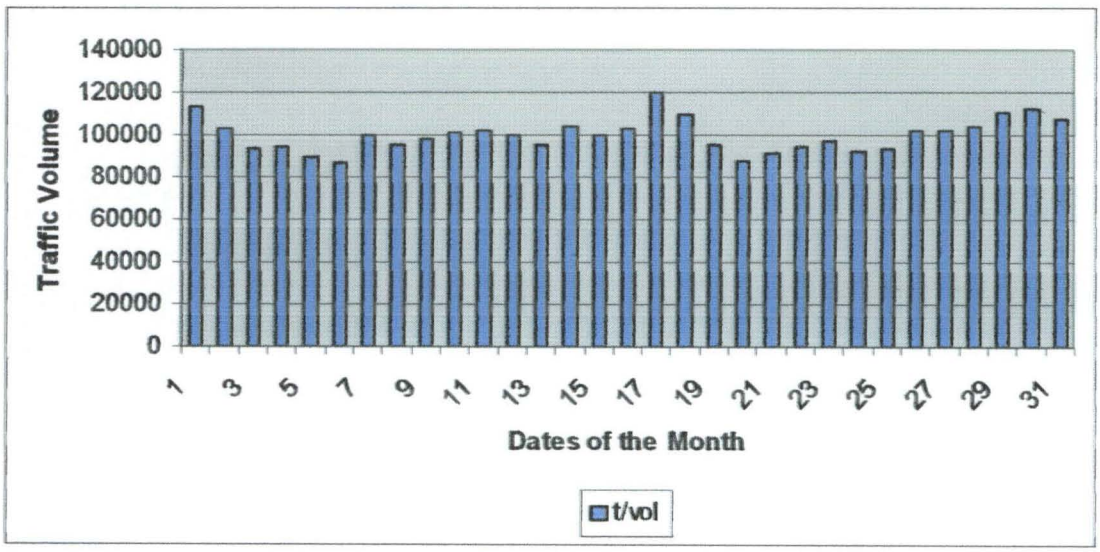


Fig 11:Traffic volume trend during the month (1999-2003)

Source: Authors field work (2004)

5.2: Seasonal variation of Accident variables

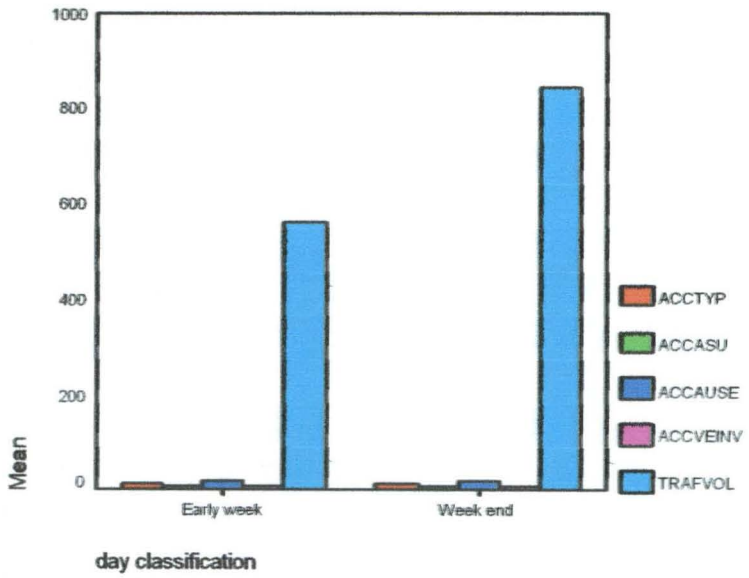
To find if more accident occurred, during weekend or weekdays, rainy or dry season, night or day, month end or midmonth, the time of accident occurrence was classified and the mean occurrence of the variables plotted using SPSS software to determine Ho_1 which state that there is no significant difference between the seasonal characteristic of accident shown in table 10

Variables	Day		Month		Hour		Date	
	Week end (fri-su)	Week day (mo-th)	Rainy (Jun-Nov)	Dry (Dec-may)	Night time (7pm-4am)	Day (5am-6pm)	Early month (1-21)	Month end (22-31)
Accident type	1318	2133	1865	1549	1303	1919	1505	751
casualty	930	1467	1298	1141	597	1493	1331	790
Accident causes	2061	3569	2812	2710	1439	3117	2918	1535
No. vehicle Involved	527	852	746	688	541	1014	1082	548
Traffic volume	41792	48185	5107748	4809780	137780	192961	2080996	1013988

Table 10 Temporal characteristics of accident variables in FCT (1999-2003)

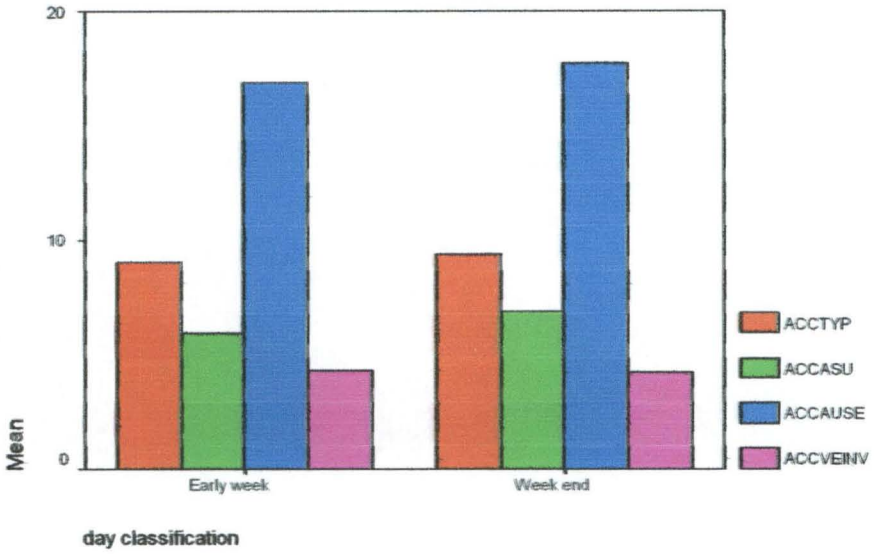
Source: Authors field work, 2004

All figures in this study show cluster of separate variables under study. Specifically Fig 12 and 14 show that the number of vehicle that got involved in accidents during the week is insignificant compared to the number of vehicles that move on the road. In order to see the effect of this small proportion of vehicle that was involved in accident the traffic volume was removed from the chart as shown in Fig 13. Fig 12 show that more vehicles move during the weekend but Fig 12 show that weekends was more predisposed to accident than the early week.



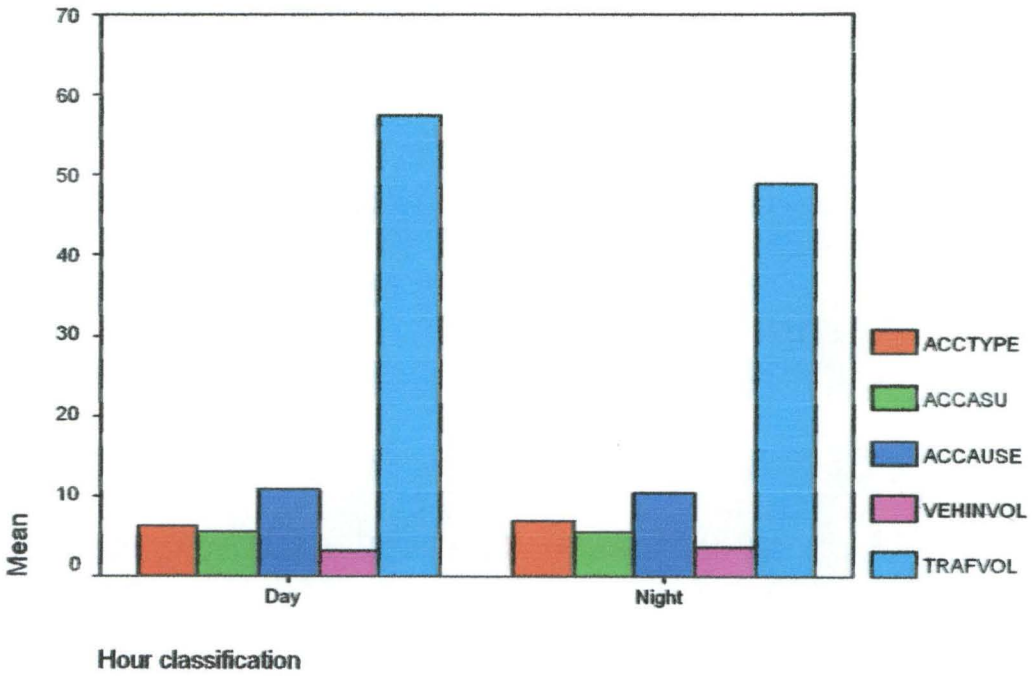
Source: Authors field work, 2004

FIG 12 Accident situations during the week in FCT (1999-2003)



Source: Author fieldwork, 2004

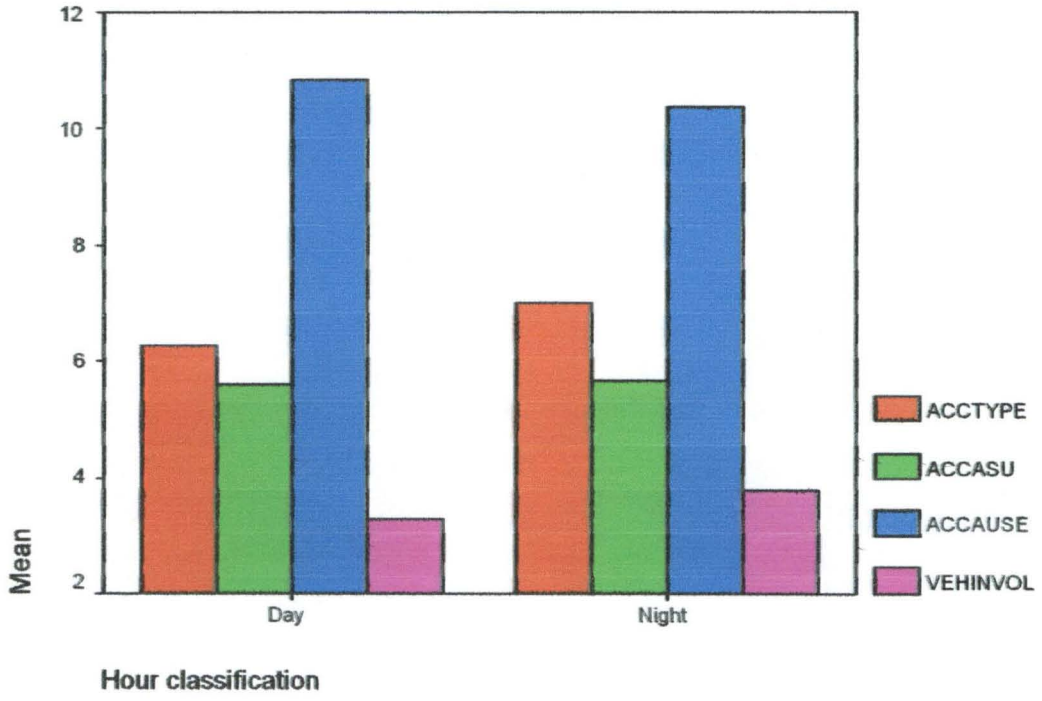
FIG 13 RTA during Early week and Week end in FCT (1999-2003)



Source: Authors field work, 2004

FIG 14: Accident situations during the day and Night in FCT

At 95% level of confidence the difference in accident variables recorded during the weekends and weekdays was significant for traffic volume (0.016) hence values obtained is not due to chance therefore Ho_1 is rejected. However values is not significant for the types of accident (0.611), casualty (0.1), accident causes (0.610) and the number of vehicle involved (0.836) respectively hence the values obtained is due to chance and Ho_1, cannot be rejected. (Appendix IX).

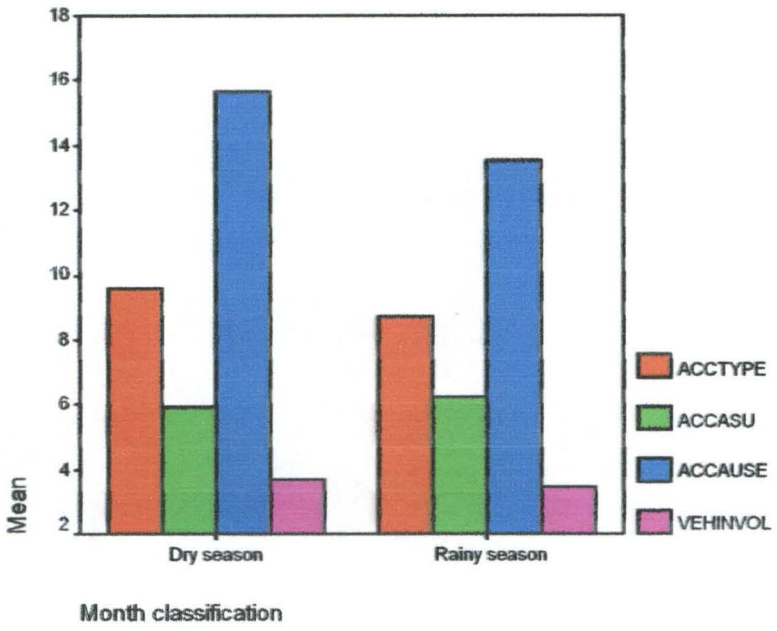


Source: Authors field work, 2004

FIG 15 RTA for day and night in FCT (1999-2003)

Similarly, Fig 15 shows at 95% level of confidence there is no significant difference in the casualty, accident cause, accident types and the number of vehicles involved in accident during the day and night consequently values obtained for these variables are

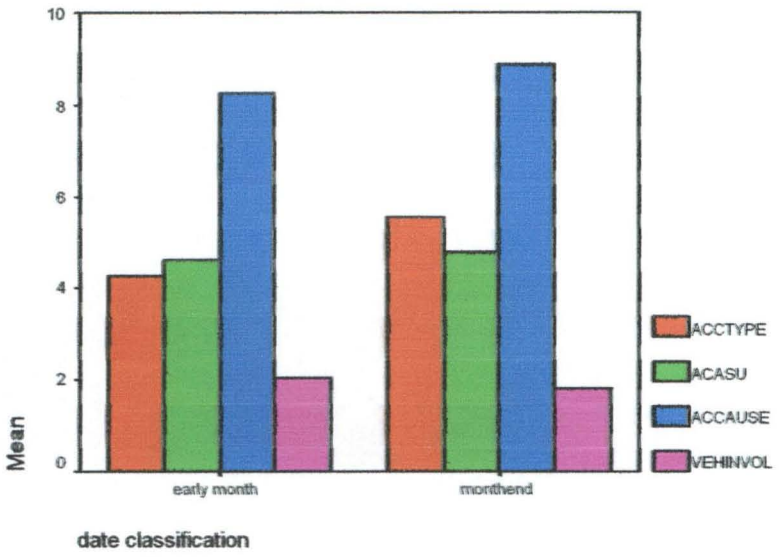
due to chance and Ho_1 cannot be rejected for these accident indices. Furthermore for or this hypothesis there were fewer than two groups for the traffic volume hence the value cannot be computed. (Appendix IX).



Source: Authors field work, 2004

FIG 16 RTA during dry and rainy season in FCT (1999- 2003)

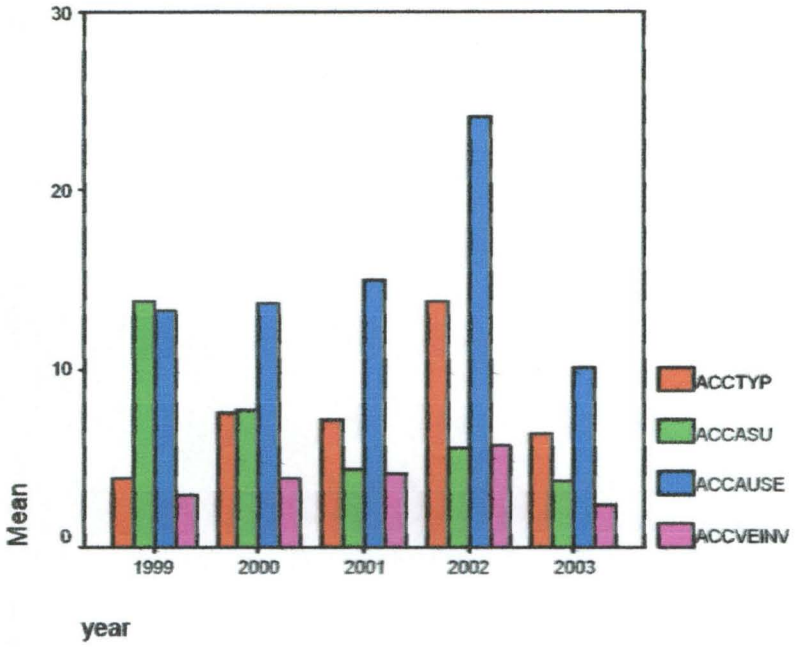
Furthermore, Fig 16 show that dry season was slightly more predisposed to accident than rainy season. But the difference observed during dry and rainy season was insignificant for all the accident potentials (Appendix IX). This implies that the value obtained for road accident potentials as categorized by dry and rainy season was due to chance hence Ho_1 cannot be rejected.



Source: Authors field work, 2004

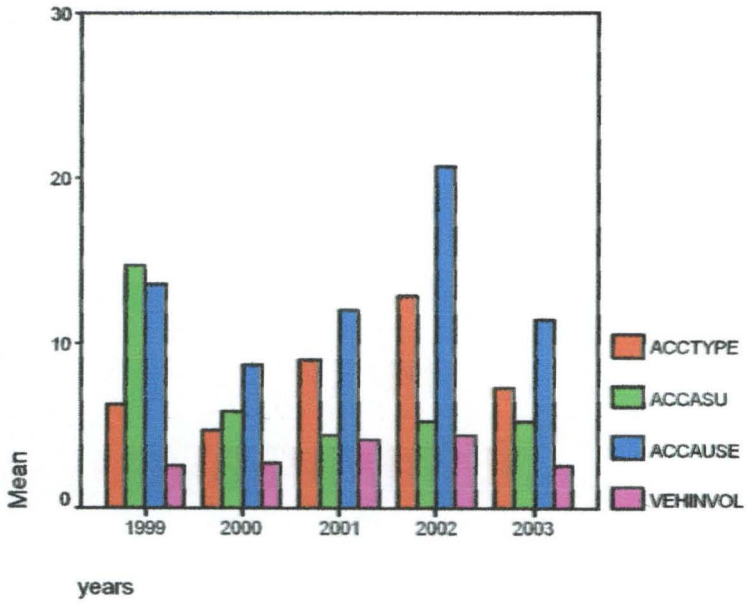
FIG 17 RTA for the month end and early month in FCT (1999-2003)

Figure 17 show that month ends are more predisposed to road accident than early month. However at 95% level of confidence none of the difference in accident potential was statistically significant. Therefore the value obtained for road accident potential was due to chance and the Ho_1 is not rejected. The implication is that the difference between the month ends and early month is not much.



Source: Authors field work, 2004

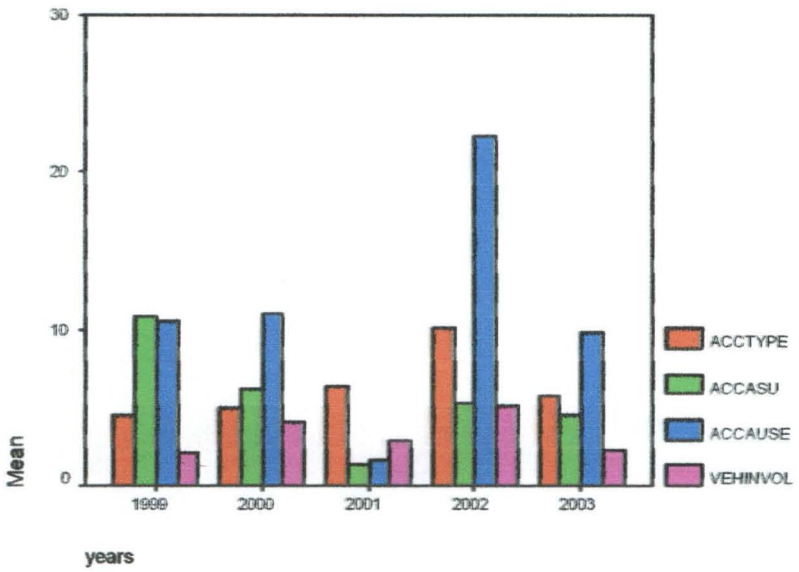
FIG 18 Weekly RTA data (1999-2003)



Source: Authors field work, 2004

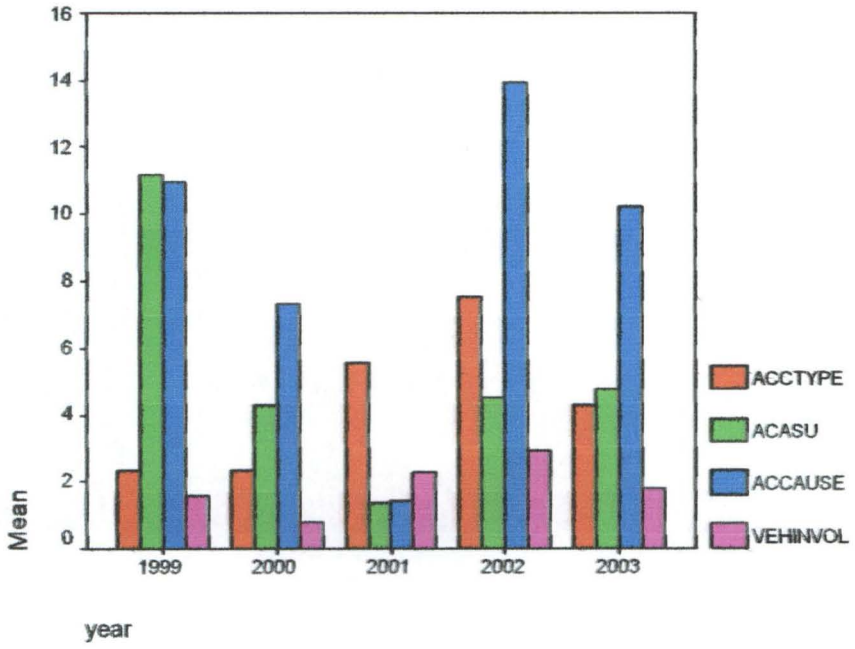
FIG 19 Monthly RTA DATA (1999-2003

Figures 18 to 21 show the result of a test, which states that there is no significant difference in accident, potential from 1999 to 2003 in FCT (Ho_2). Both the accident type and accident cause are significant, the result not due to chance and Ho_2 is rejected when the data was considered during the dates 1-31 of the month. But the variables are in significant at 95% level of confidence for all the years when the data was considered for each day of the week, month of the year, and hour of the day respectively (Fig 18 to 21). This implies that the values were due to chance and the Ho_2 cannot be rejected.



Source: Authors field work, 2004

FIG 20 Hourly RTA data (1999-2003)



Source: Authors field work, 2004

FIG 21 RTA data by date of the month (1999-2003)

5.3: Conclusion

The study therefore seeks to find the difference in RTA at different times of the day (day and Night, weekend and weekday, month end and early month, rainy and dry season respectively), different land uses and at different years (Appendix viii).

The study found that only few of the commuting vehicles got involved in accident. Nighttime and rainy season are similarly predisposed to accident like the day and dry season respectively. Similarly the month end and early month are equally predisposed. But the cause of accident and the number of vehicles involved are significantly different on weekdays than weekends. Though there is no difference in dates, the data vary significantly daily, monthly, and Hourly respectively

CHAPTER SIX

SPATIAL ANALYSIS OF ROAD TRAFFIC ACCIDENT

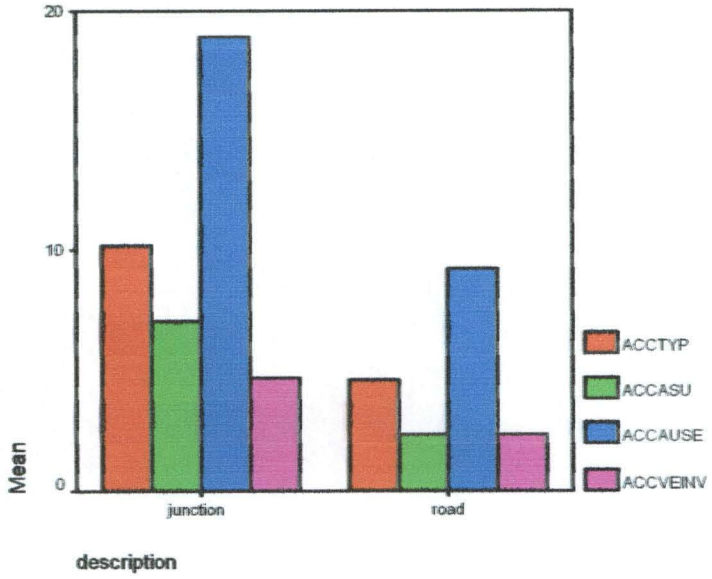
6.0: Introduction

This research demonstrates the capability of GIS for road accident monitoring and as a decision support system in road safety decision-making. Consequently, this chapter will show the capability of GIS in black spot location in order to determine and to point to road users the safest path on the road. The relationships of spatial pattern of road traffic accident and rescue capabilities were displayed with a color coded GIS map of Abuja showing all the zones. The relationship of these data sources created the ground for examining the various hypotheses put forward in this study.

6.1 Analysis of accident location outside GIS environment

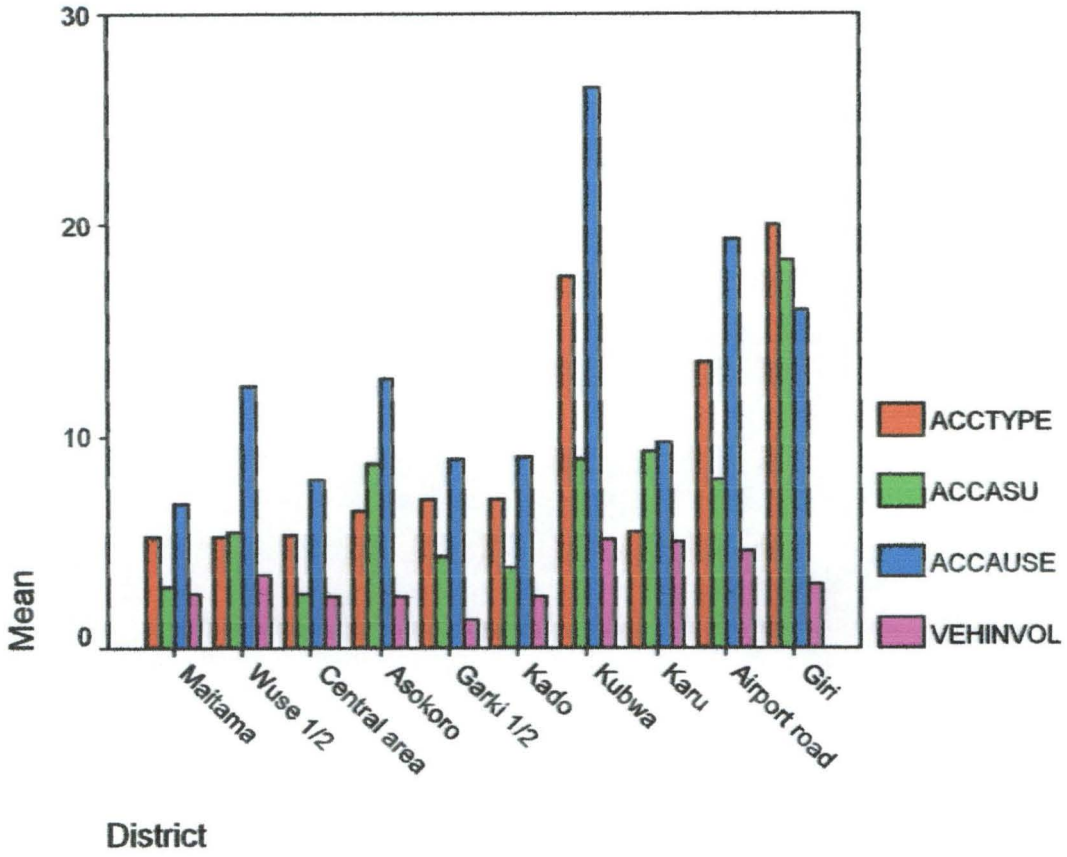
This section explains the test of hypothesis, which states that there is no significant difference between the accident potential at the junction and on the road (Ho_3). Fig 12 and 14 already confirm that an insignificant proportion of the vehicles moving on the road get involved in accident. Fig 22 shows that, more accident happens along the road (link) than the junction (nodes) in FCT. Statistics further confirm that the result was not likely to be wrong at 95% level

of confidence for the entire accident predisposing factor (Appendix IX). Therefore the result was not due to chance hence Ho_3 is rejected.



Source: Authors field work, 2004

FIG 22 RTA that occurred at Junctions and on the Roads in FCT (1999-2003)



Source: Authors field work, 2004

FIG 23 RTA at different districts in FCT (1999-2003)

Fig 23 show the result of test which states that there is no significant difference in the accident potential at various district in FCC (Ho_4) The figure show that more accidents happen along Kubwa express road than other places in FCT. This record is closely followed by Airport road. The Wuse district is most predisposed to road traffic accident in the FCC. Kado and Karu districts closely follow this. Even though there are more causes of accident at Asokoro than the Central area, the accident was more deadly in the latter. Garki district has a lower accident index than Maitama in spite of the high traffic volume in the former. At 95% level of confidence it was

confirmed that the result was not likely to be wrong for all the accident predisposing factors. Consequently Ho_4 is rejected, as the value obtained was not due to chance.

6.2 Spatial Analysis of data in GIS environment

6.2.1 Number of black spots and hospitals in each district.

Figures 24 and 25 describe the distribution of Rescue facilities in Federal Capital City. The figure shows that Central Area district has the highest police FRSC presence. This is followed by Garki,Wwuse, Asokoro and Maitama in that order. Similarly, Wuse also has the highest distribution of hospitals. Garki, Asokoro, and Central Area, and Maitama follow this in that order. The figure further shows the consistent high and low rescue capabilities at Garki and Maitama Districts respectively. Even though Wuse has a high presence of hospitals the number of police/ FRSC is not so high.

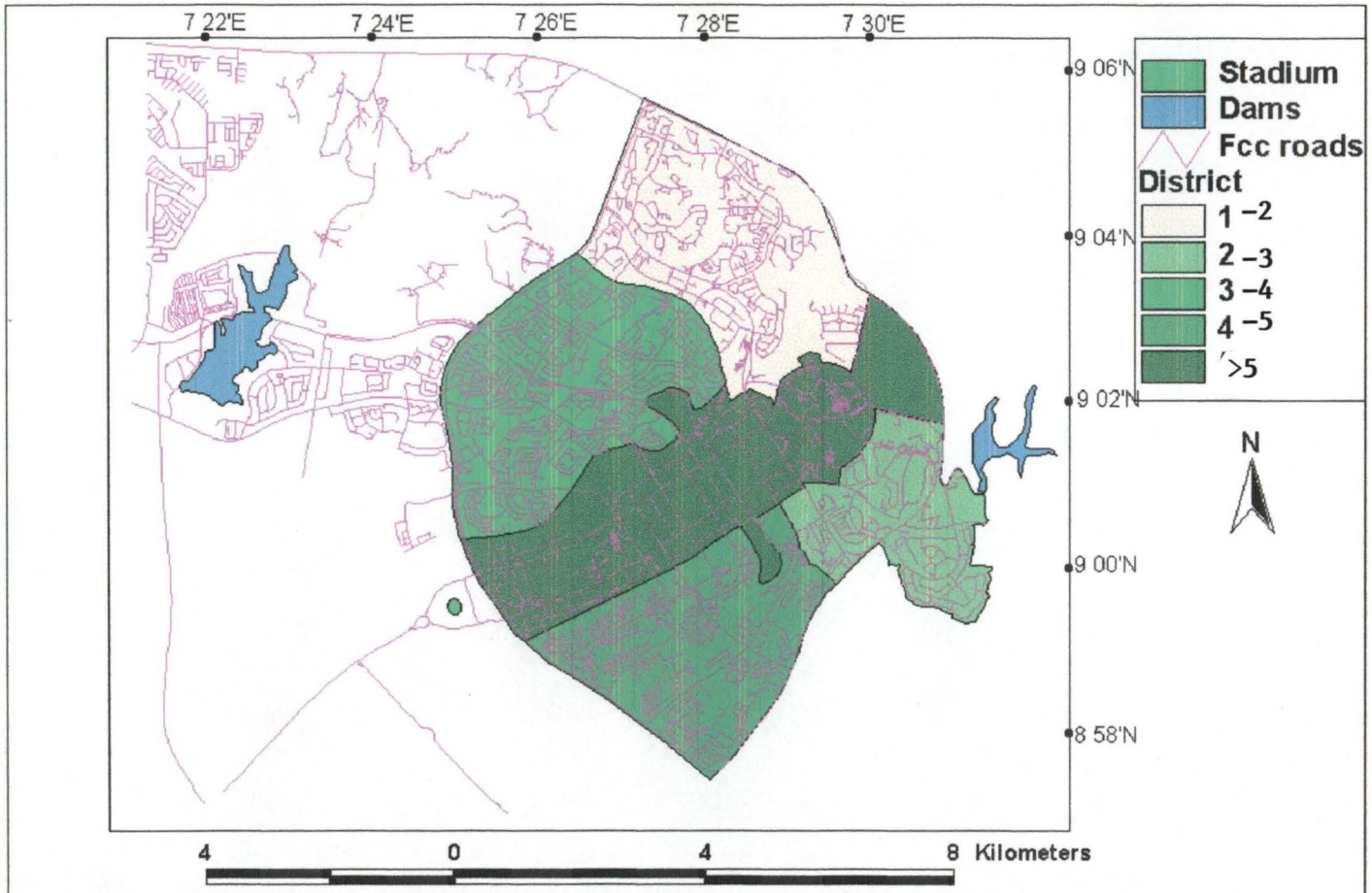


Fig 24 : Distribution of Police/FRSC post in each district of FCC

Source: Authors field work, 2005

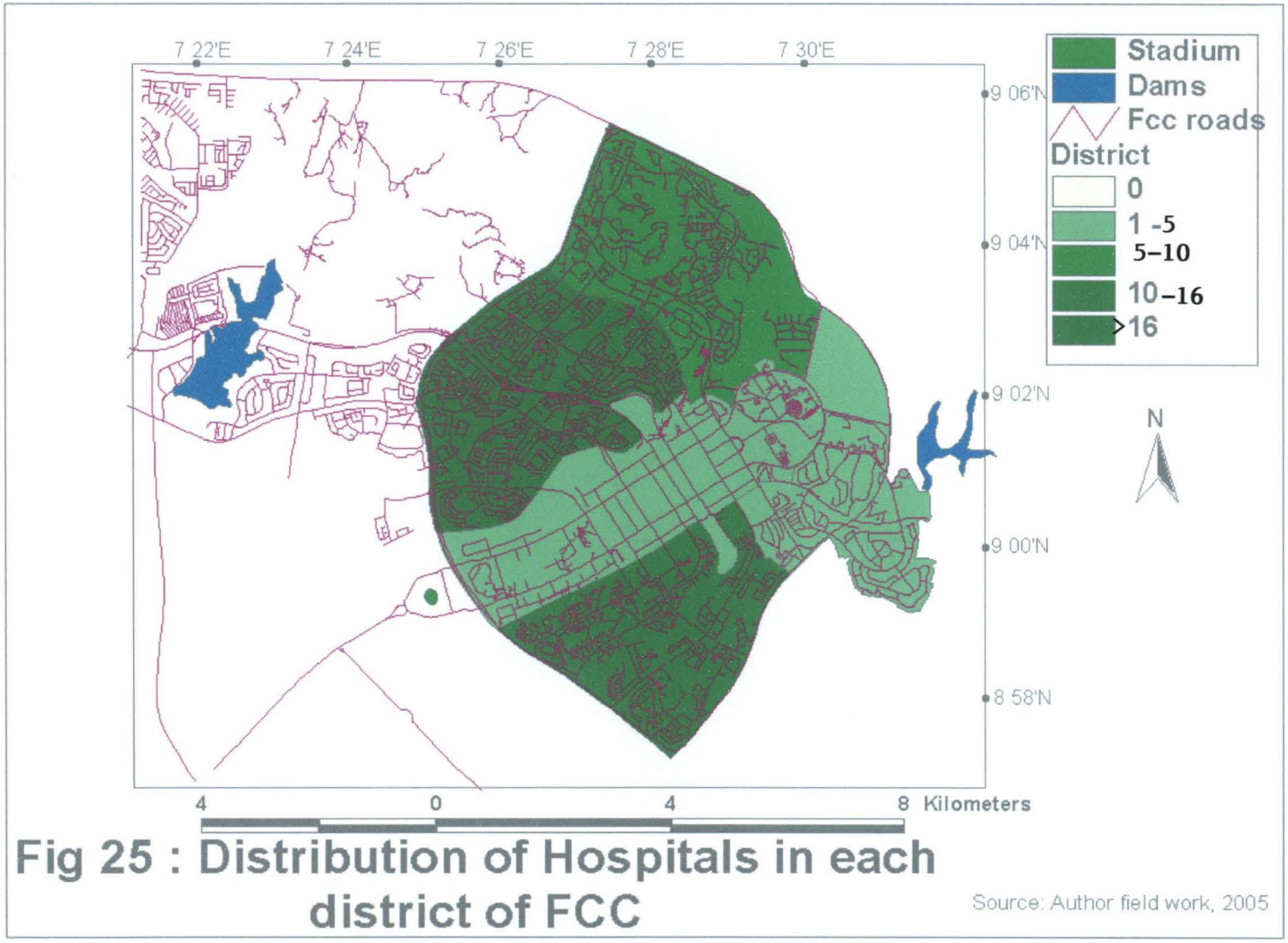


Fig 25 : Distribution of Hospitals in each district of FCC

Source: Author field work, 2005

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6.2 2 Accident-prone areas

The mean values for casualty road and junction are 64 and 39, for weighed index of accident type 128 and 53, for number of vehicle involved in accident 34 and 24, while for the weighed index of accident cause 140 and 100 respectively. Consequently, spatial query was issued too find places where the variable value is less than mean. The accident-prone road and junction are categorized as places, which has values higher than the mean value of the variable and these were shown in red color (the thicker the higher the intensity) while the places shown in yellow has low mean value.

Figures 26 to 29 show areas that are prone to road traffic accident variables. Specifically, Fig 26 reveals that 3 Arms Zone, Abattoir /Muritala Muhamed way North, Before City Gate, Herbert Maculy/ Mailamari/Area 10 and Nyanyan road are the casualty prone roads. The casualty prone junctions are airport junction, Shagari/ AP, BANEX, Mabushi, Old market, Apo junction and AYA junctions. None of the casualty prone black spot junction is located in the Central Area.

The weighted index of accident was calculated from the addition of all fatal, serious, and minor accident together. This kind of addition show the degree of seriousness of morbidity or and mortality of accident at the location concerned. Therefore, Fig 27 show that locations such as M Muhamed/Abatoir, Mailamari/Area 10, Nyanyan, and the 3 Arms Zone are the black spots roads prone to high morbidity and mortality. Furthermore, places such as IBB/Zik, BANEX, Berger, Wuye/FRSC, and Apo junctions all along the Nnamdi Azikiway road are accident type blacks

pot. Other accident type black spot are Min hill, Shagari/ Ap petrol, Old market, Zone 4 AYA, and Karu junctions.

Accident involving a lone vehicle is regarded as lone vehicle accident, and when two or more vehicles are involved in the accident then it is a multiple accident. Fig 28 show that multiple accident are more prevalent at places such as Airport road, M Muhamed/Abatoir, Nyanyan, Herbert Macauly/Mailamari/Area 10 and 3 Arms Zone roads. The black spot junctions where multiple accidents are prevalent include Min hill, A Ironsi, AYA, and Apo junctions. All the black spot junctions in Wuse witness multiple accidents except Old market, A Ademola /A Bello, and ECWA church junctions.

Fig 29 shows the weighted average of various causes of accident in FCC. The figure shows that M Muhamed/Abator, 3 Arms Zone, Mailamari/Area 10, Nyanyan, and Airport roads are black spots for various kinds of accident causes. Junctions such as IBB/Zik, Ministers hill, A Ironsi, AP petrol, BANEX, Mabushi, Berger, Wuye/FRSC, Iluobe, Apo, and AYA are noted for various causes of accident. However none of the junctions in the central area is noted for the accident causes.

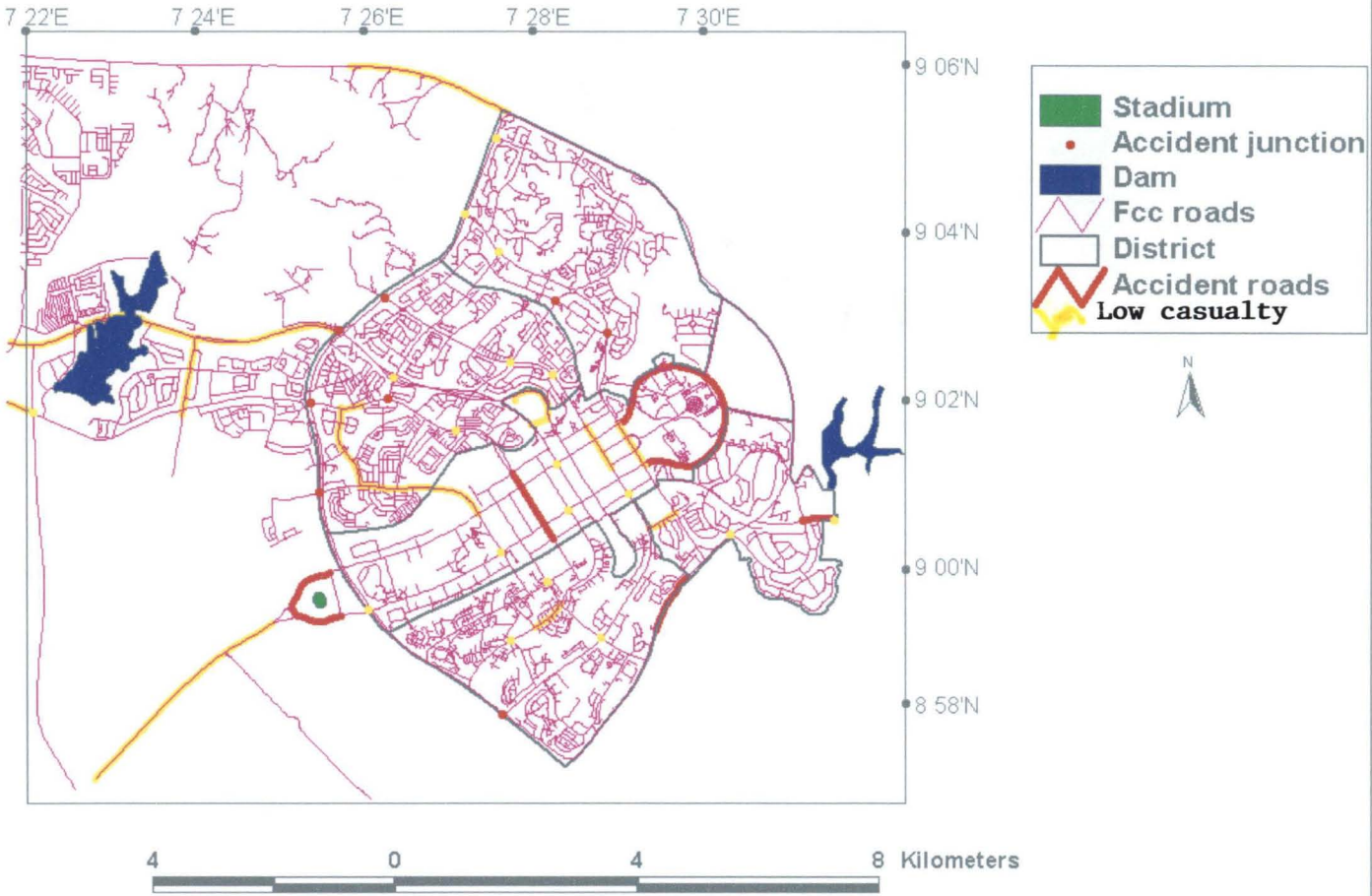


Fig 26: Casualty black spots in each district of FCC (1999-2003)

Source: Authors field work, 2005

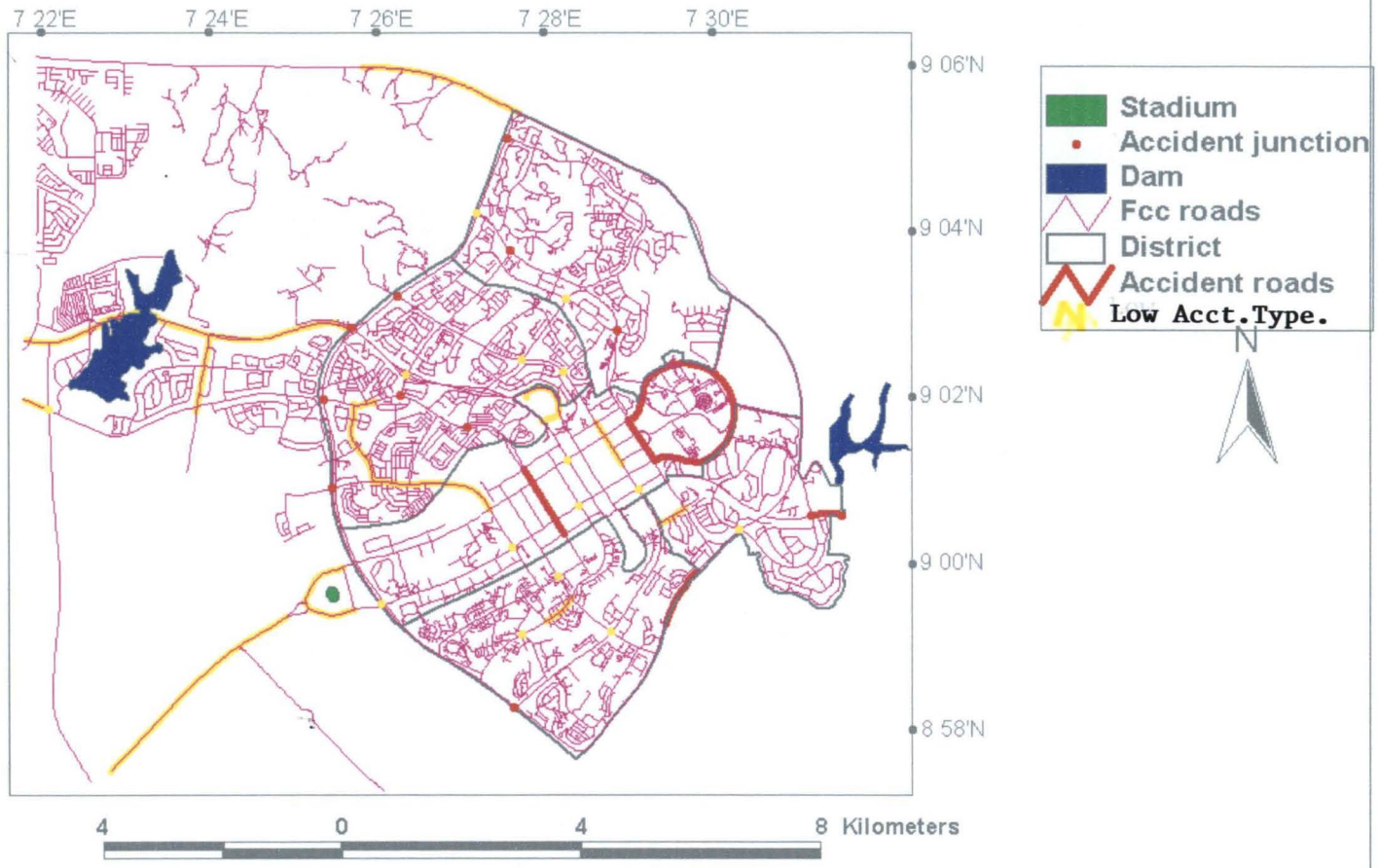


Fig 27: Weighted average of accident types at the black spots in each district of FCC (1999-2003)

Source: Authors field work, 2005

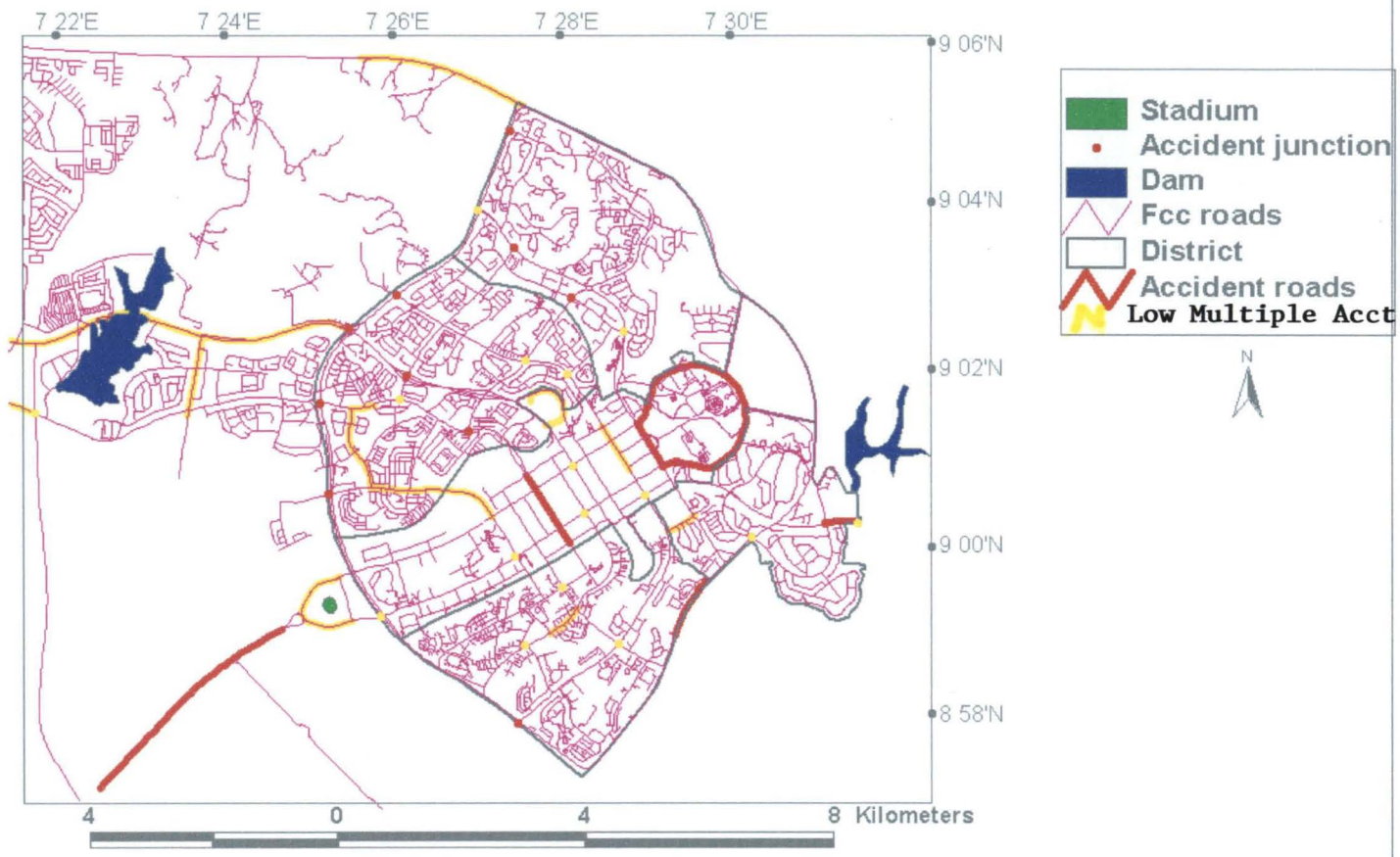


Fig 28: Multiple accident black spots in each district of FCC (1999-2003)

Source: Authors field work, 2005

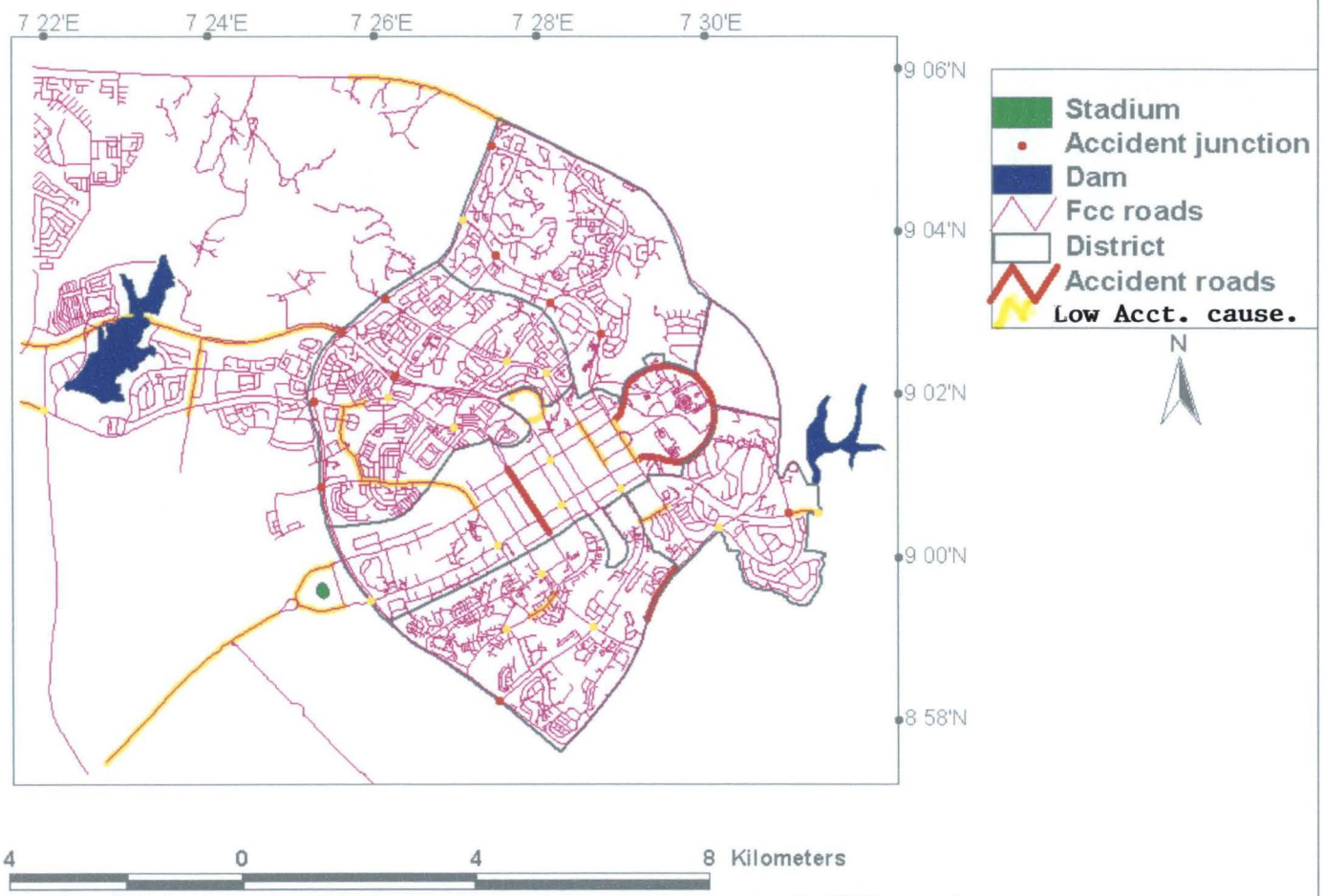


Fig 29: Weighted average of accident causes at different black spots of FCC (1999-2003)

Source: Authors field work, 2005

6.2 3 Relationship between traffic volume and accident variables

Fig 30 shows a point on point overlay of traffic volume on accident variables in FCC (1999-2003). Junctions and roads with thick dots and lines are where traffic volume affect number of vehicle involved most. The figure show that for between 121 and 242 vehicles one is involved in accident at Mailamari/Area 10, 3 Arm zone and Airport roads and one out of between 1256 1894 vehicle along Kado and Kubwa roads respectively. One out of between 44 and 114 vehicles that pass through Nine (9) junctions in Wuse, five (5) in Maitama, three in Central Area, two (2) in Garki and two (2) in Asokoro respectively. Fig 31 show that one casualty was recorded for between 18 and 69 vehicles that pass through junctions such as Berger R/About, Wuye/FRSC HQ, Mabuchi, Bannex, Wuse OLD market, Zone 4, AP Petrol, National University Commission, AYA and Apo junction respectively.

One casualty was recorded for as many as between 505 and 861 vehicles at Women Center. Between 56 and 159 vehicles would have passed along 3 Arms zone, Kado and Nyanyan roads respectively before one casualty was recorded. Fifure 32 show how the traffic volume has affected the weighted average of accident types at junction and roads in FCC. But the trend is similar to what was recoded in Figure 31 except in places like Kubwa road and T Balewa/Area 7 where casualty was as low as one for between 1423 and 2080 vehicles while the accident type (fatality) was as high as one in between 328 and 625 and between 26 and 117 vehicles respectively. Similarly, one accident occurred for between 8 and 15 vehicles that pass the Berger, Mabuchi, Wuye and AYA junction while one out of between 27 and 68 vehicles pass Mailamari, Ibro Hotel and so on get involved in accident during the study period as shown in the point on point overlay in Fig 33.

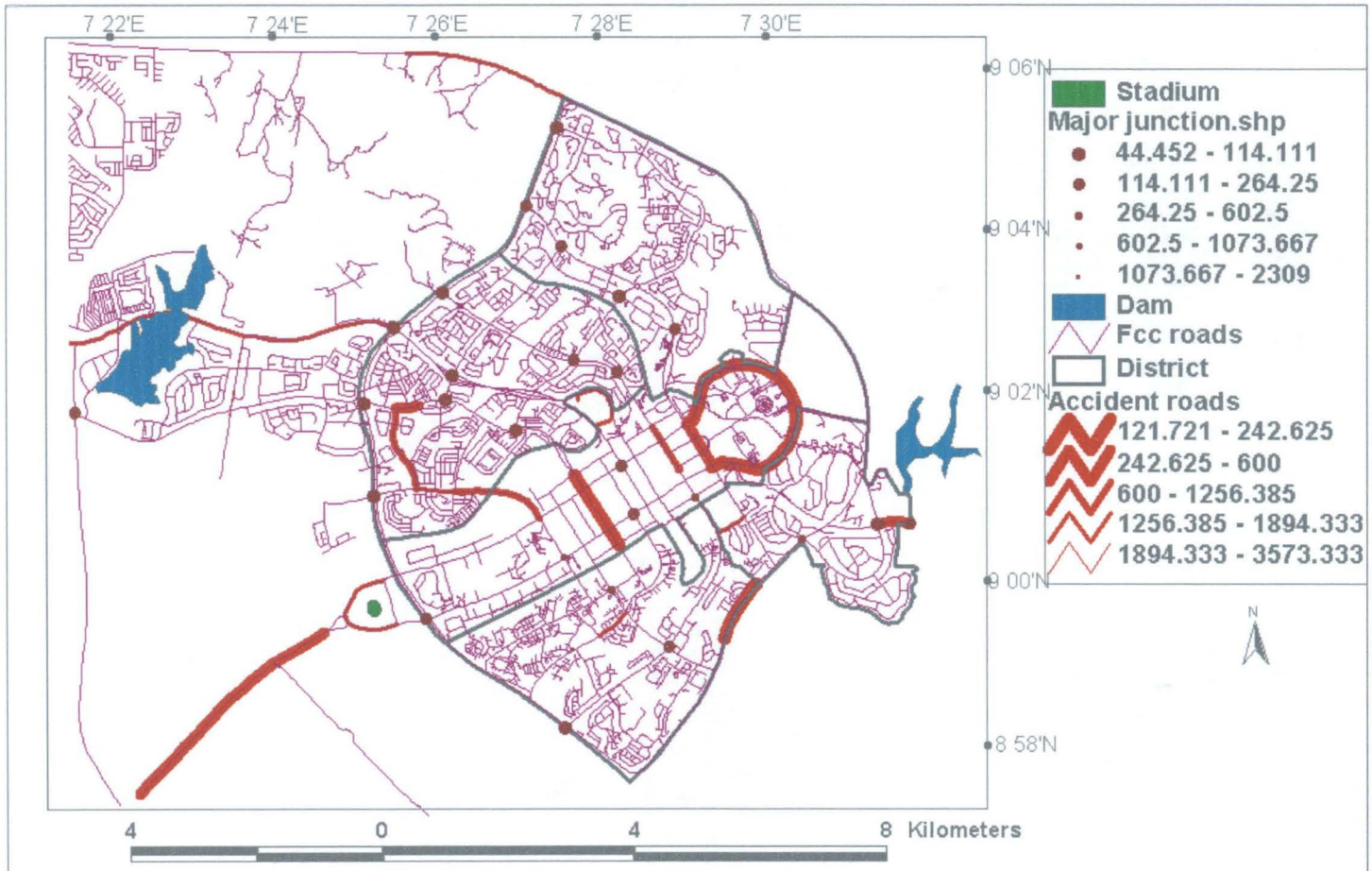


Fig : 30 Effect of traffic volume on the number vehicle that got involved in road accident in FCC (1999-2003)

Source : Authors field work, 2005

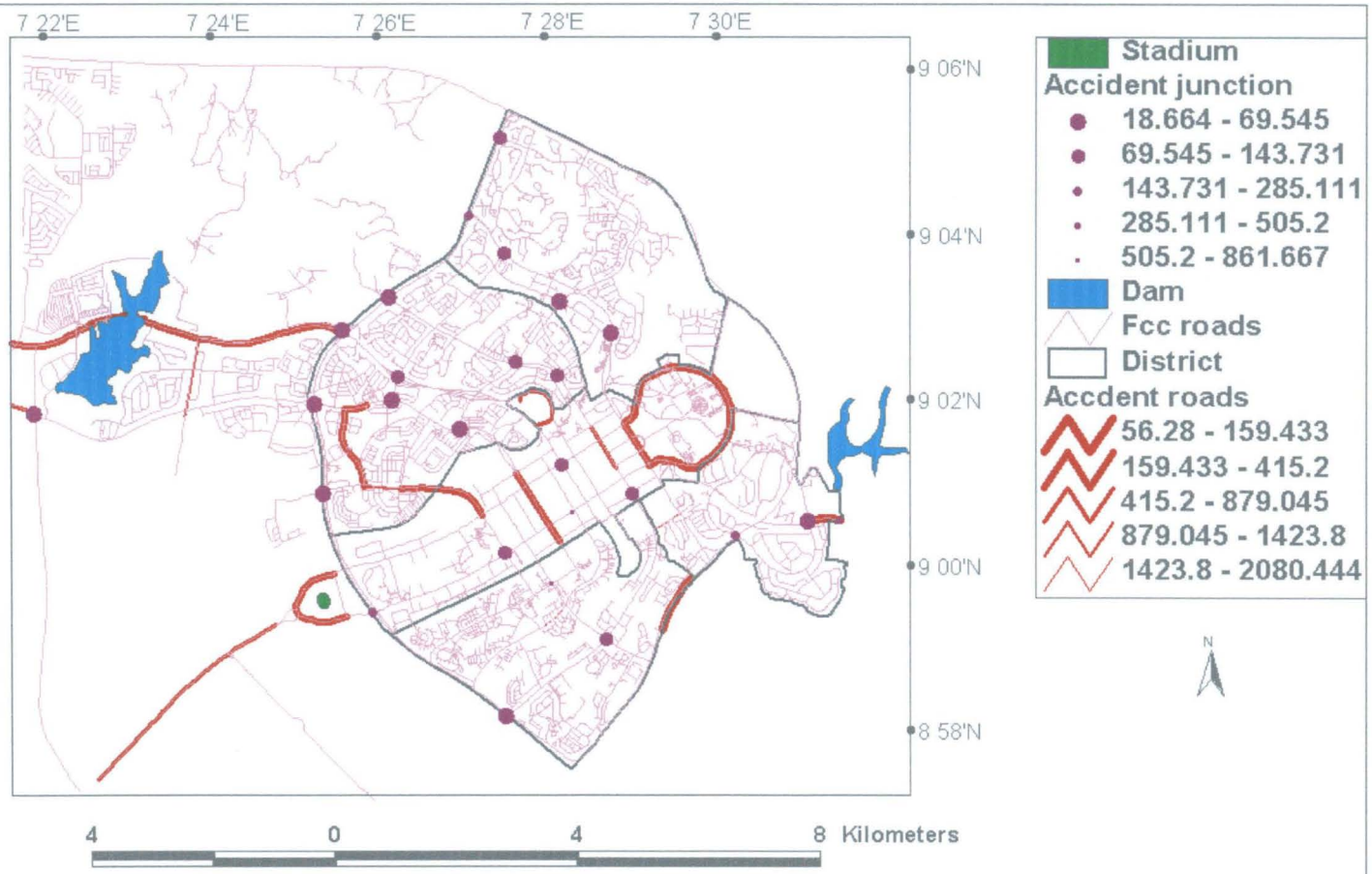
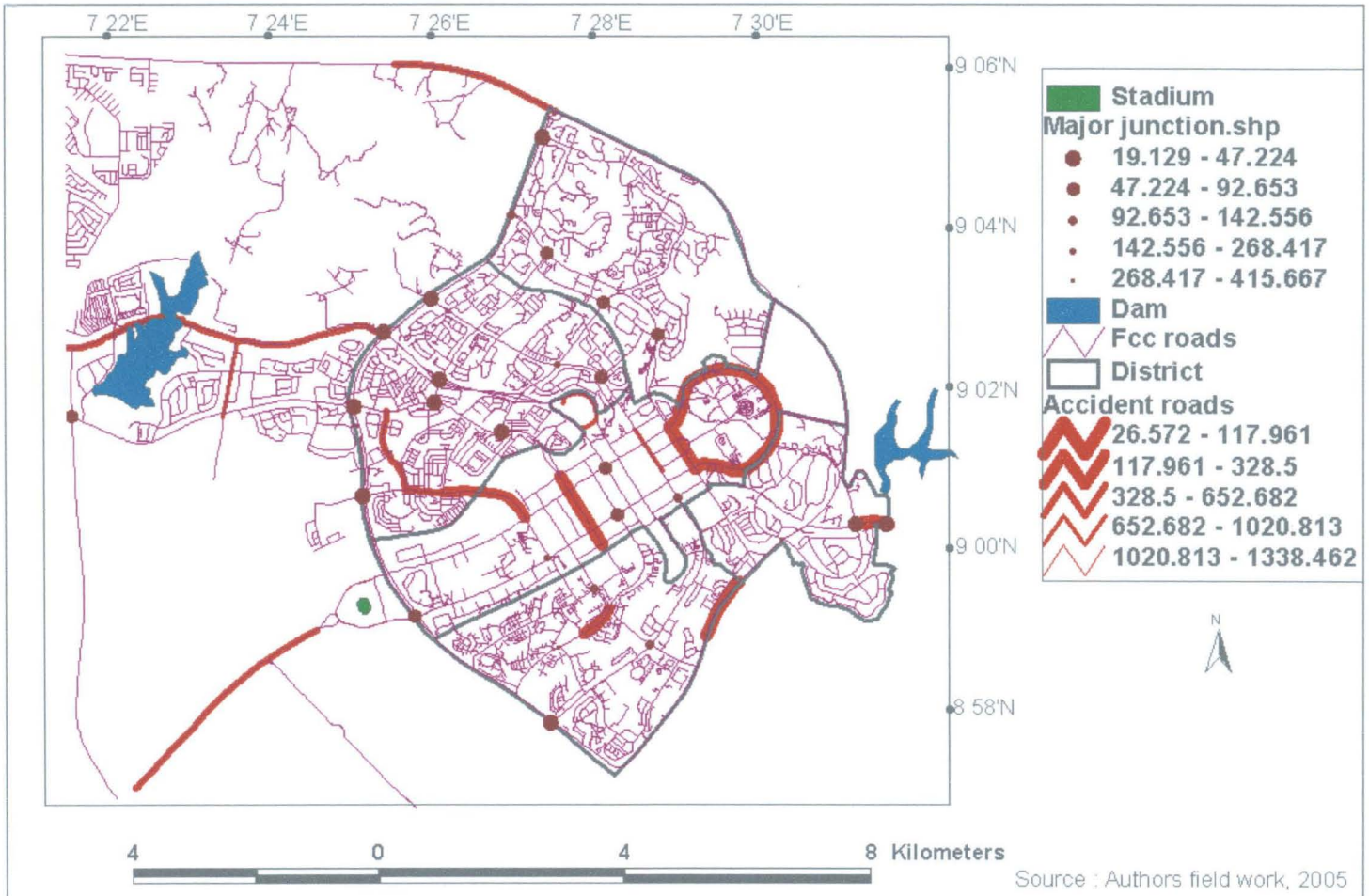


Fig 31: Effect of traffic volume on the number of casualty recorded during accident in FCC (1999-2003)

Source: Authors field work, 2005



Source : Authors field work, 2005

Fig : 32 Effect of traffic volume on the weighted average of accident types at each black spot in FCC (1999-2003)

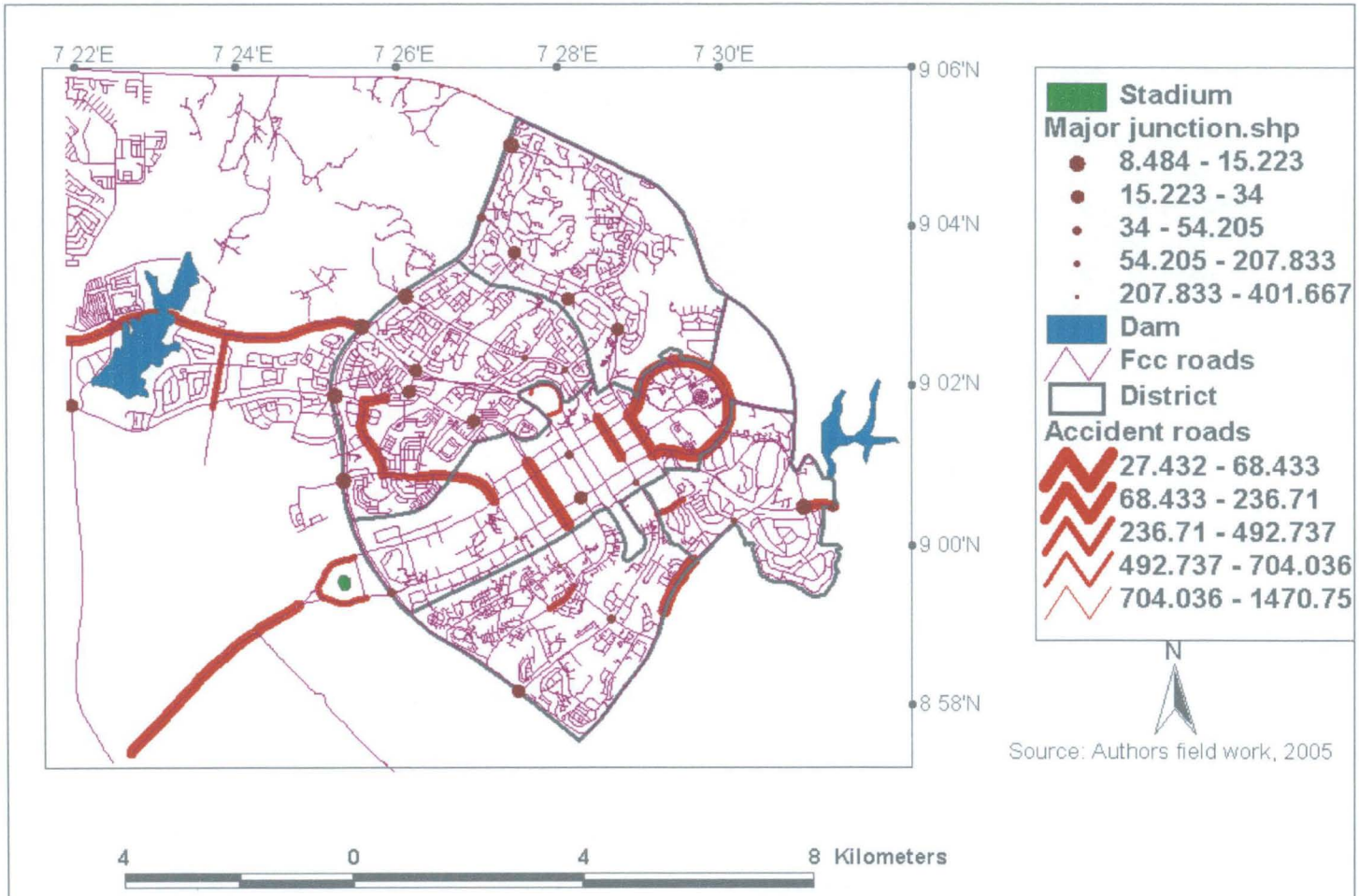


Fig : 33 Effect of traffic volume on the weighted average of accident causes at each black spot in FCC (1999-2003)

6.2 4 Relationship between Land use and accident variables

Fig 34 Table 2 and Appendix (VIII) show that the land use has equal effect at Wuse and Garki districts amounting to weighted average between 2257 and 2434. Maitama follows these districts with weighted average between 305 and 2253. Fig 35 show a point-to-point overlay of land use and number of casualty recorded in FCC between 1999 and 2003. Land use has high effect on the number of casualty recorded in Garki where between 3 and 4 casualty is caused by each weighted value of land use while almost no casualty is recorded with each weighted value of land use. The Land use has equal effect on the casualty recorded in Maitama and Asokoro.

Fig 36 show a point on point overlay of Land use and number of vehicles that got involved in accident in FCC between 1999 and 2003. Land use has a high effect on the number of vehicle that got involved in accident at Garki with between 13 and 18 vehicles getting involved in accident as a result of land use factor. The number of vehicles that got involved in accident as a result of a land use factor decrease from between 4 and 7 vehicle in Wuse 3 vehicles in Maitama and one in Asokoro while land use factor rarely predispose any vehicle to road accident in the Central Area of FCC from 1999 to 2003.

Fig 37 shows a point on point overlay of land use and weighted average of various types of accident that occurred in FCC. Where as land use has high effect on the weighted average of types of accident that occurred in Garki with one factor of land use causing the indexof accident type was between 3 and 6, Land use barely affect the weighted average of accident in the Central Area. Fig 38 show a point on point overlay of Land use and the weighted average of different causes of accident in FCC. The Land use has high effect on the weighted average of different causes of accident at Garki with one factor of land use causing between 1 and 18 weighted average of accident causes. There is barely a relationship between Land use and the weighted average of accident type at the Central Area.

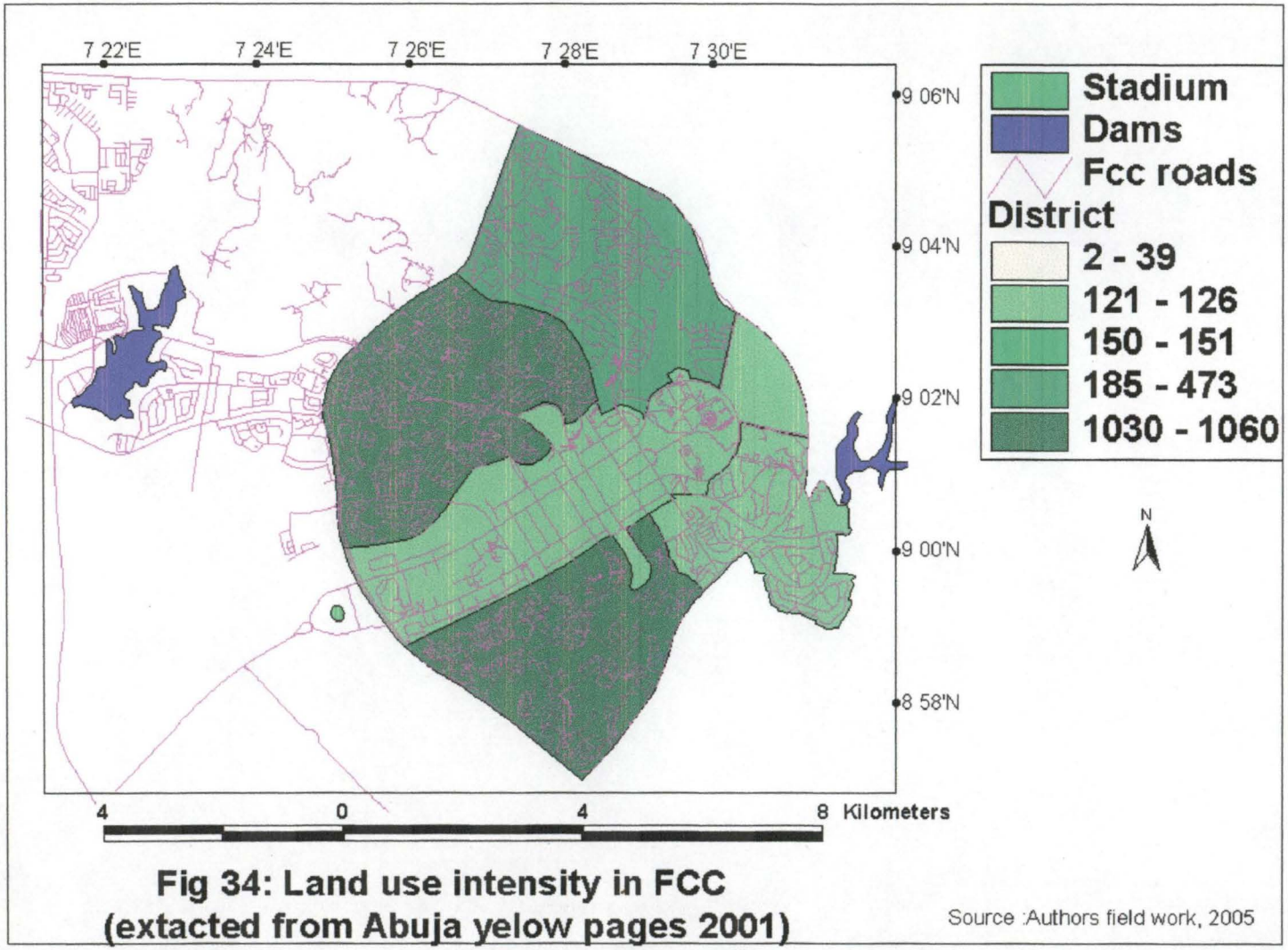


Fig 34: Land use intensity in FCC (extacted from Abuja yelow pages 2001)

Source :Authors field work, 2005

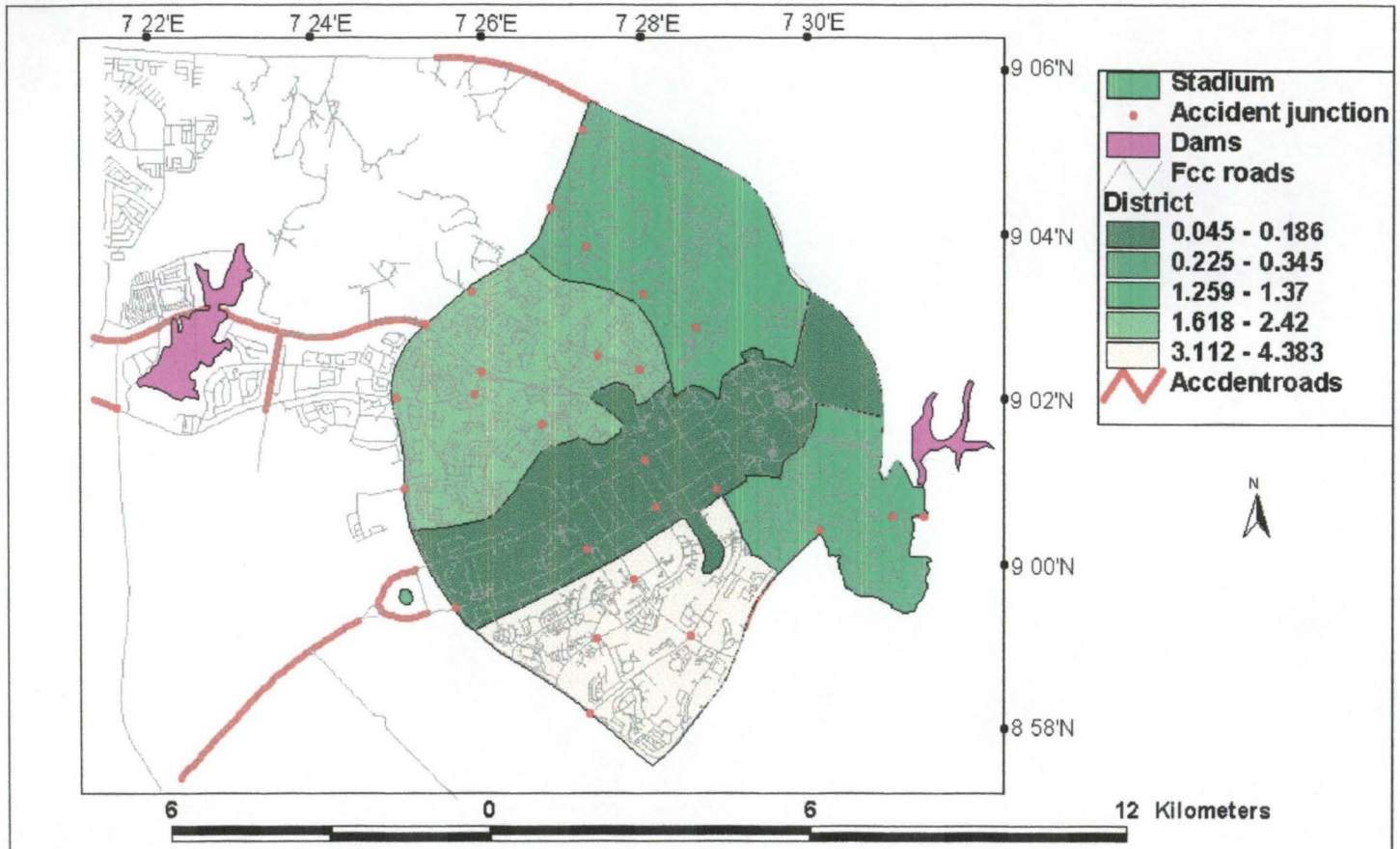


Fig 35: Effect of Land use on the number of casualty recorded in FCC (1999-2003)

Source: Authors field work, 2005

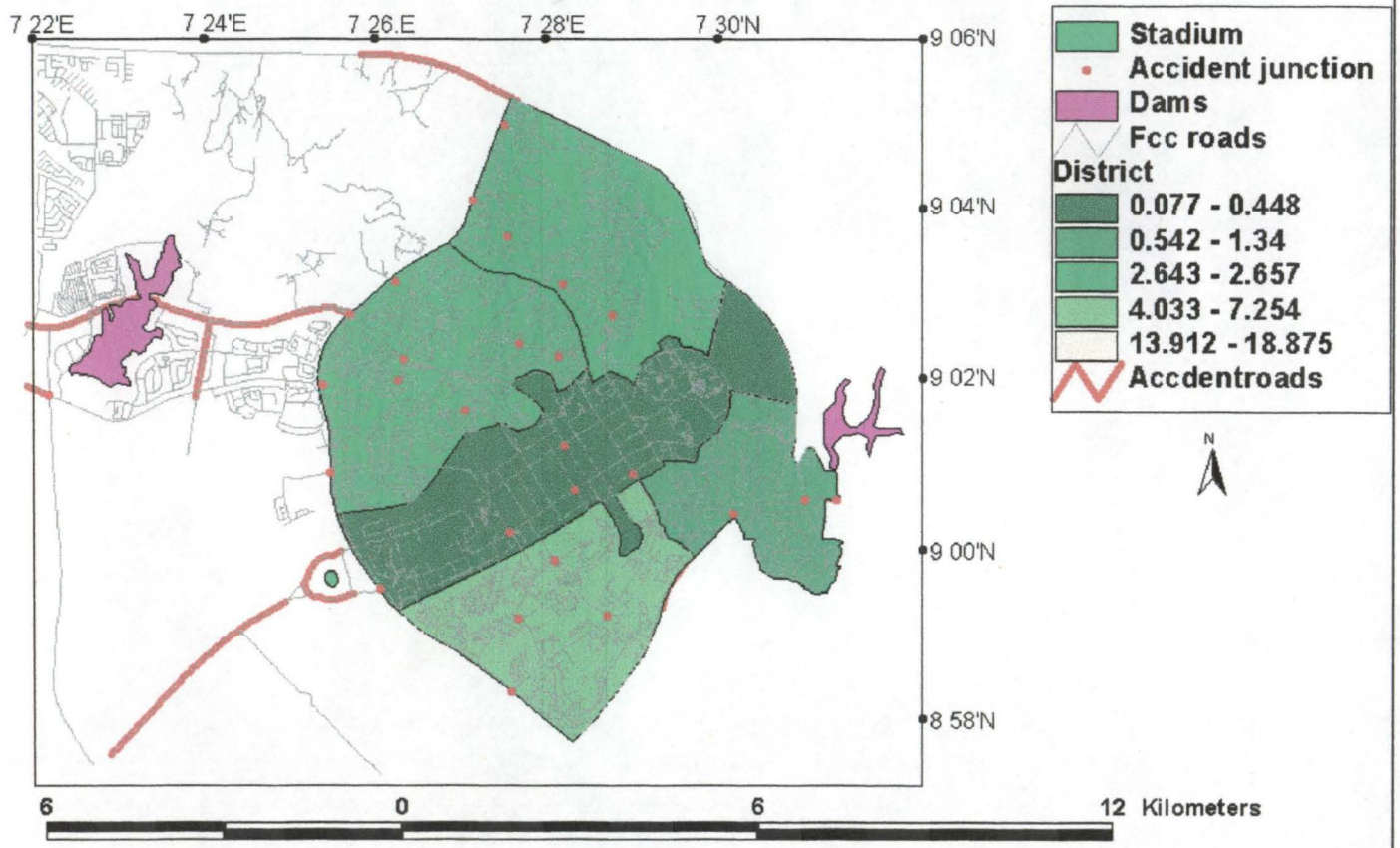


Fig 36: Effect of Land use on the number of vehicles that got involved in accident in FCC (1999-2003)

Source: Authors field work, 2005

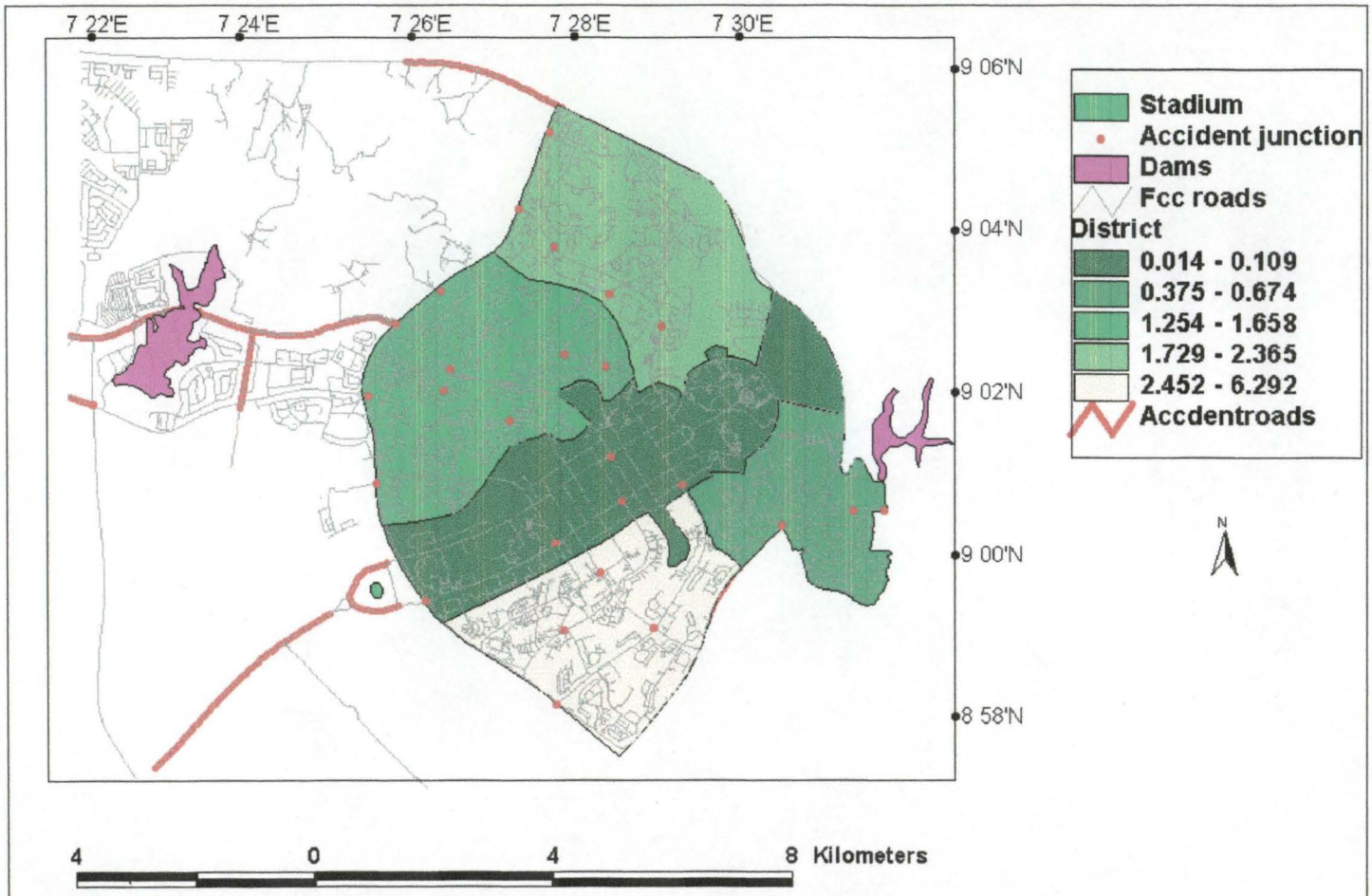


Fig 37: Effect of Land use on the various types of accident that occured in FCC (1999-2003)

Source: Authors field work, 2005

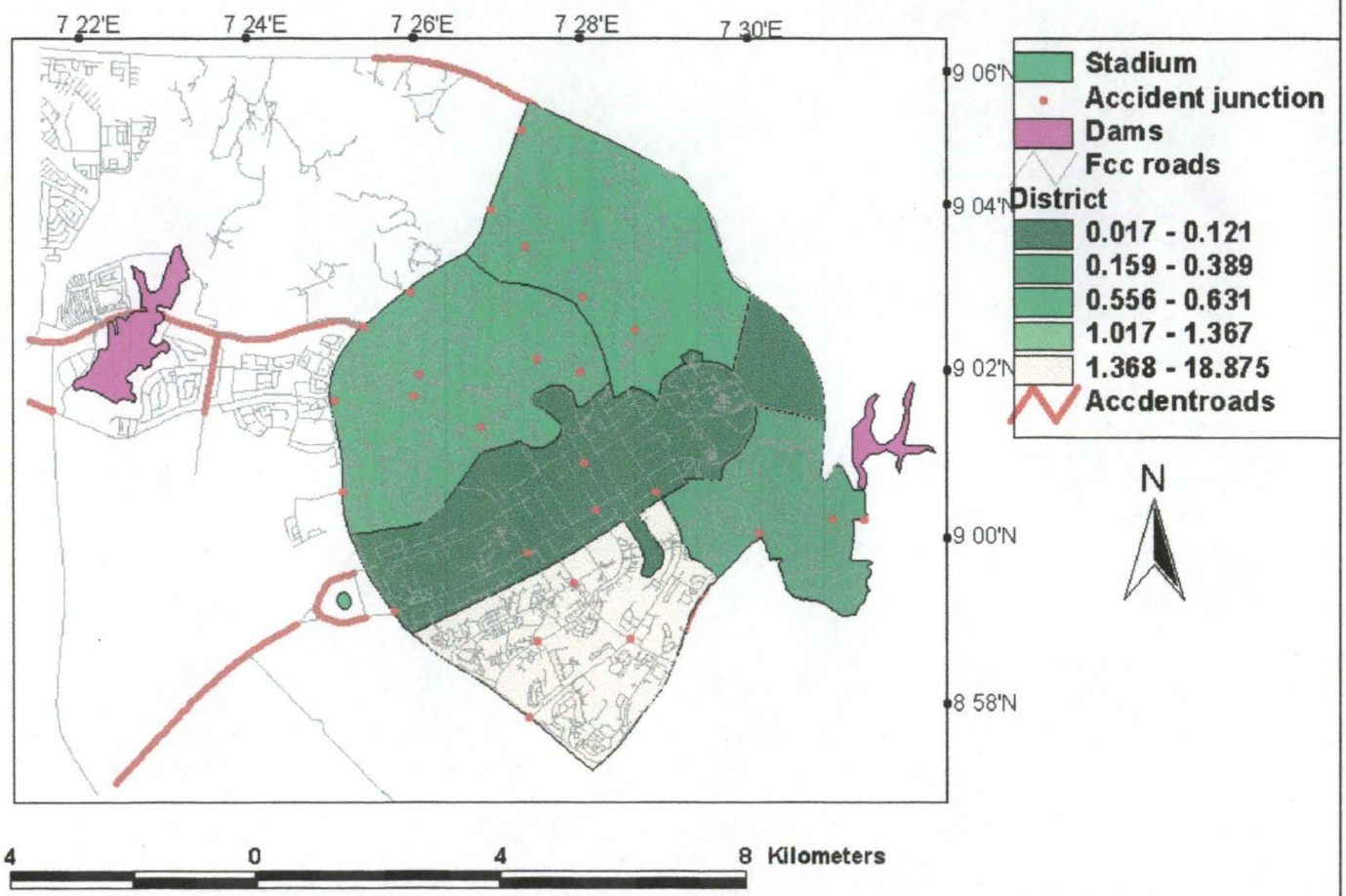


Fig 38: Effect of Land use on the weighted average of different causes of accident in FCC (1999-2003) Source: Authors field work, 2005

6.2.5 Relationship between Traffic light and accident variables

Preliminary analysis has shown that Maitama has seven (7) traffic lights in full operation and three (3) in amber operation at its junction, Asokoro has thirteen (13) amber traffic lights and five (5) full traffic lights. Wuse has nineteen (19) traffic lights in full and one in amber, Garki has twenty (20) traffic lights in full and none in Amber while Central Area has eleven (11) in full and none in Amber respectively.

Fig 39 show a point on point overlay of traffic light and the number of casualty recorded in FCC. As in Fig 35 to 38, the attribute of traffic light was stored in the district theme. The figure show that traffic light has its highest effect on the number of casualty recorded in the Asokoro district. This was closely followed by Garki and Maitama. The traffic light exerts equal effect on the number of casualty recorded at Wuse and Central Area district. Unfortunately, the value in the entire district is zero. It follow that the number of casualty at black spot was not influenced by the presence or absence of traffic light.

Fig 40 show a point on point overlay of traffic light and the number of vehicles that got involved in accident. The Figure shows that traffic light has highest influence on the number of vehicles in Maitama and the least effect at both Wuse and Central Area districts respectively. The implication is that the multiple accidents at both Wuse and Central Area occurred along the roads and not at signalized junctions. It also follow that most of the accident in Wuse and Central Area are lone accident. The frequency of lone and multiple accidents are equal at Garki district.

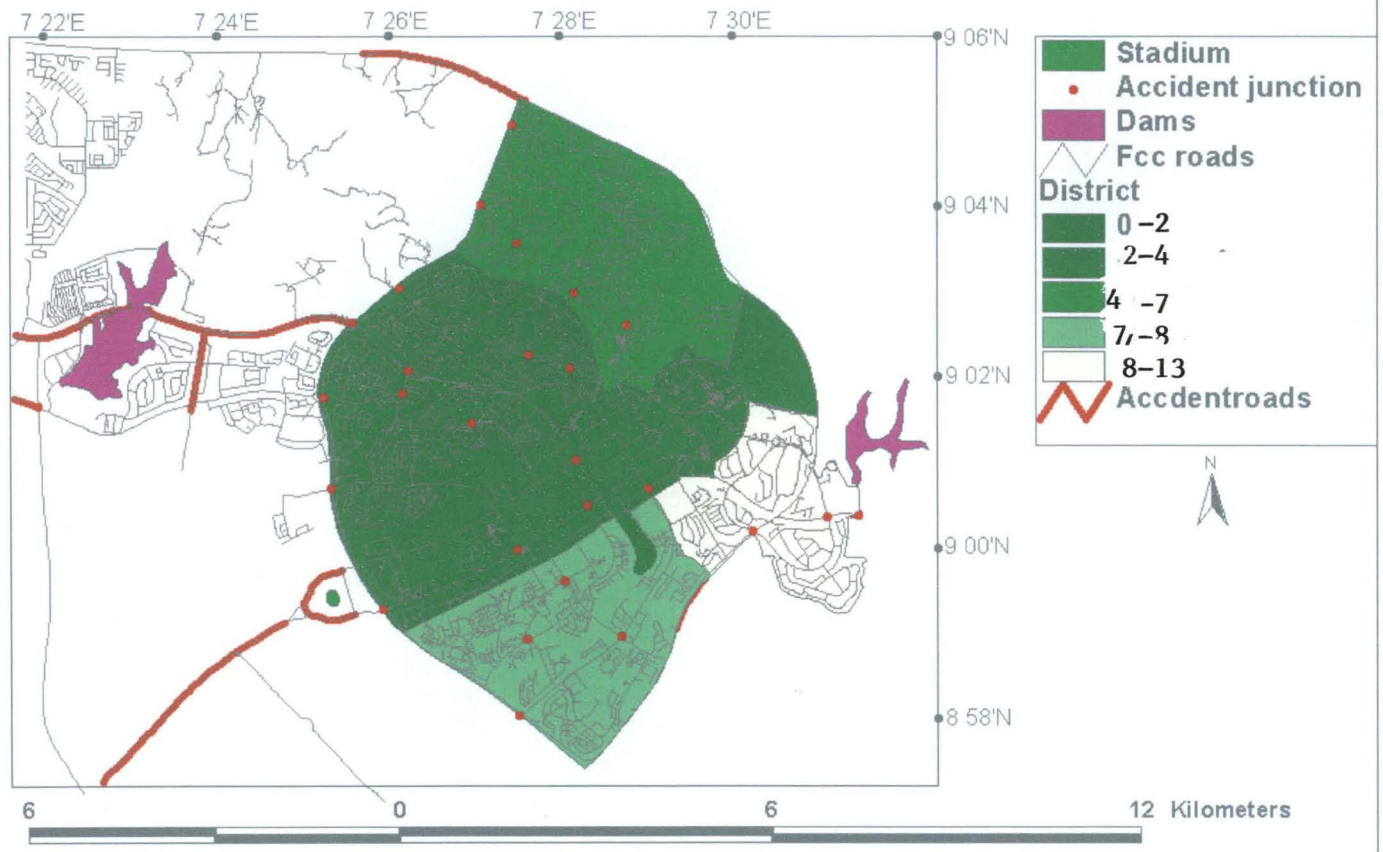


Fig 39: Effect of presence of Traffic Light on the number of casualty recorded in FCC (1999-2003)

Source: Authors field work, 2005

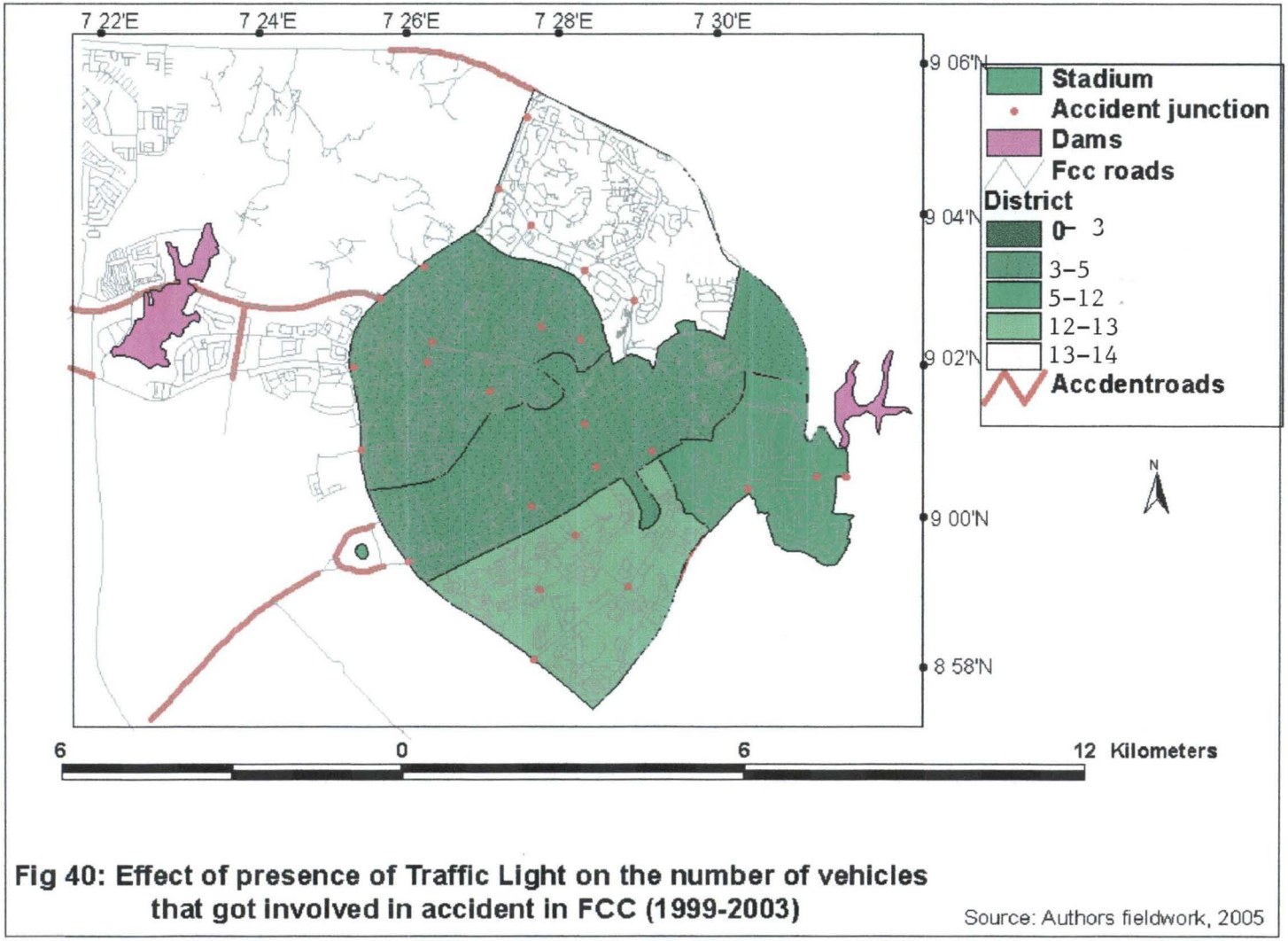


Fig 40: Effect of presence of Traffic Light on the number of vehicles that got involved in accident in FCC (1999-2003)

Source: Authors fieldwork, 2005

6.2 6 Rescue capability in FCC

Fig 40 show a theme on theme overlay and query of black spot junctions and roads respectively. The black spot junctions located less (<) than 500 meters from Police/ FRSC post in yellow color while black spot beyond 500 meters are represented with red color. All the black spot junctions in Maitama are located beyond 500 meters, only one black spot junction in Asokoro and Garki is located beyond 500 meters. However, a high number of black spot junction in Wuse and Central Area are located beyond 500 meters from Police/ FRSC posts. The theme on theme overlay of black spot road located beyond 500 meters from Police/ FRSC post (Fig 42) show that the three black spot roads in Phase 1 of FCC located beyond 500 meters from Police/ FRSC posts are H Macauly/ Mailamari/Area 10, H Macauly/ zone 6 and Sagari/Dikko/Area 11 roads respectively. The remaining black spots in this category are located beyond Phase 1 of FCC. These roads include Kado, Airport and City Gate roads respectively.

Fig 43 also shows that Maitama and Asokoro are not only denied of Police/ FRSC presence but Hospital as well. Because all the black spots there are located beyond 500 meters to both Police/ FRSC posts and Hospitals. The figure further shows that in spite of the heavy presence of Hospitals at both Garki and Wuse they are located beyond 500 meters to the black spots. Fig 44 show that even though H Macauly/ Mailamari/Area 10, H Macauly/ zone 6 are located beyond the Police/ FRSC presence they have hospital around them. But Sagari/ Dikko/ Area 11 is located beyond 500 meters from both the Hospital and the Police/ FRSC post. Even though other places such as Nyanyan, Sagari/ Federal Secretariat Benue Plaza and T Balewa roads are located beyond 500 meters from Hospitals, they are quite close to either Police/FRSC presence.

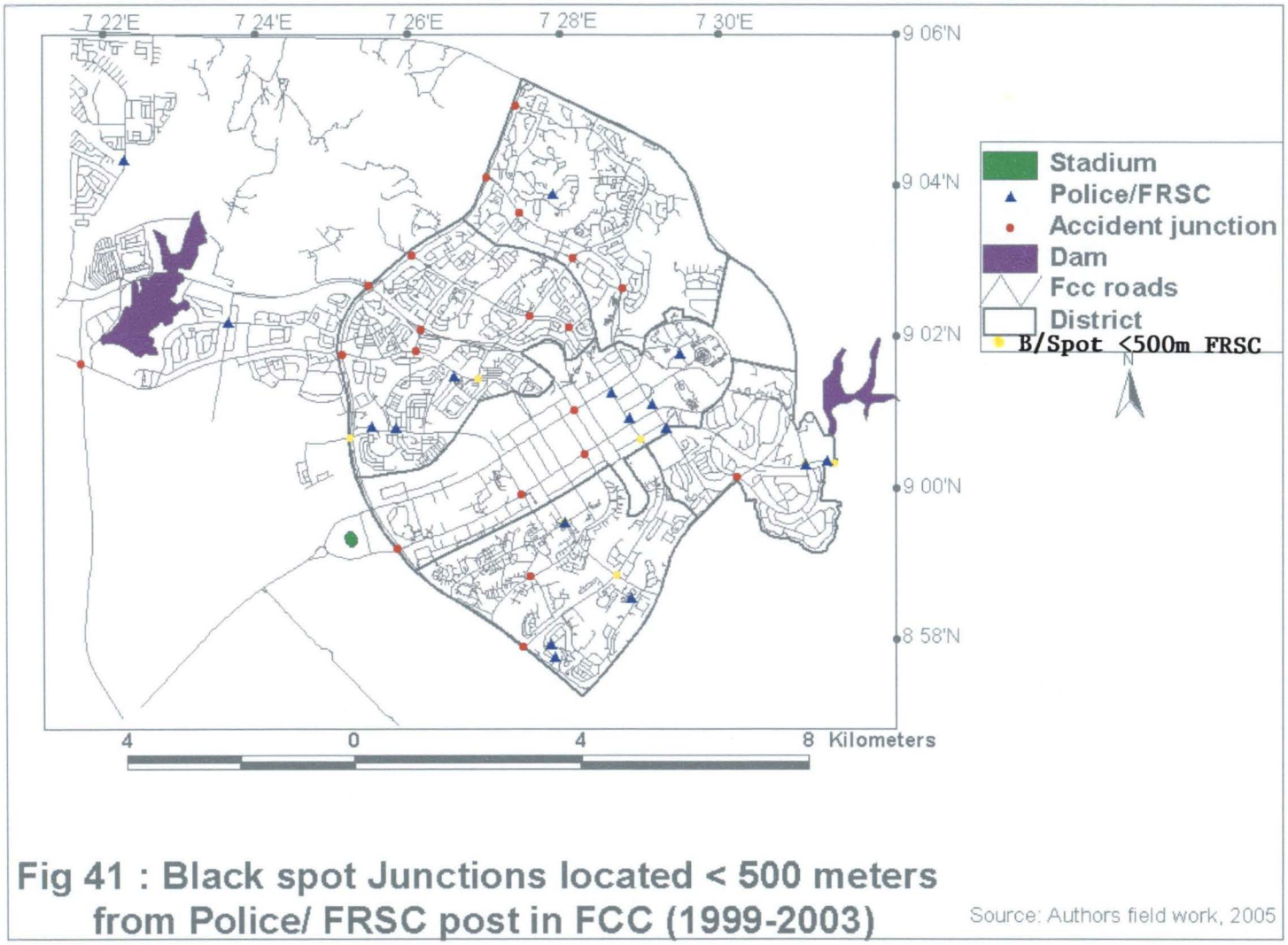


Fig 41 : Black spot Junctions located < 500 meters from Police/ FRSC post in FCC (1999-2003)

Source: Authors field work, 2005

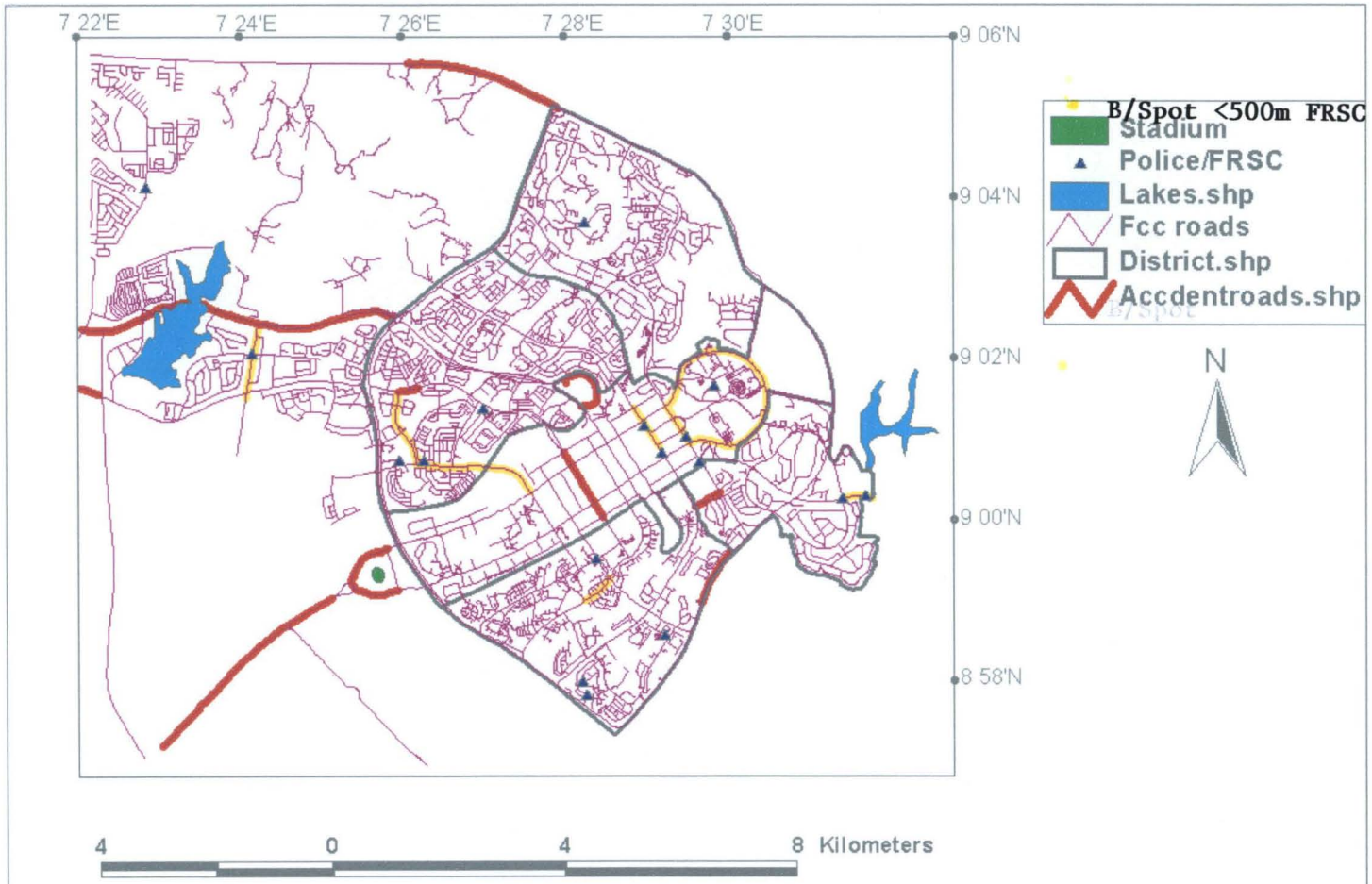


Fig 42: Black spot roads located < 500 meters from Police/ FRSC post in FCC (1999-2003)

Source : Author field work, 2005

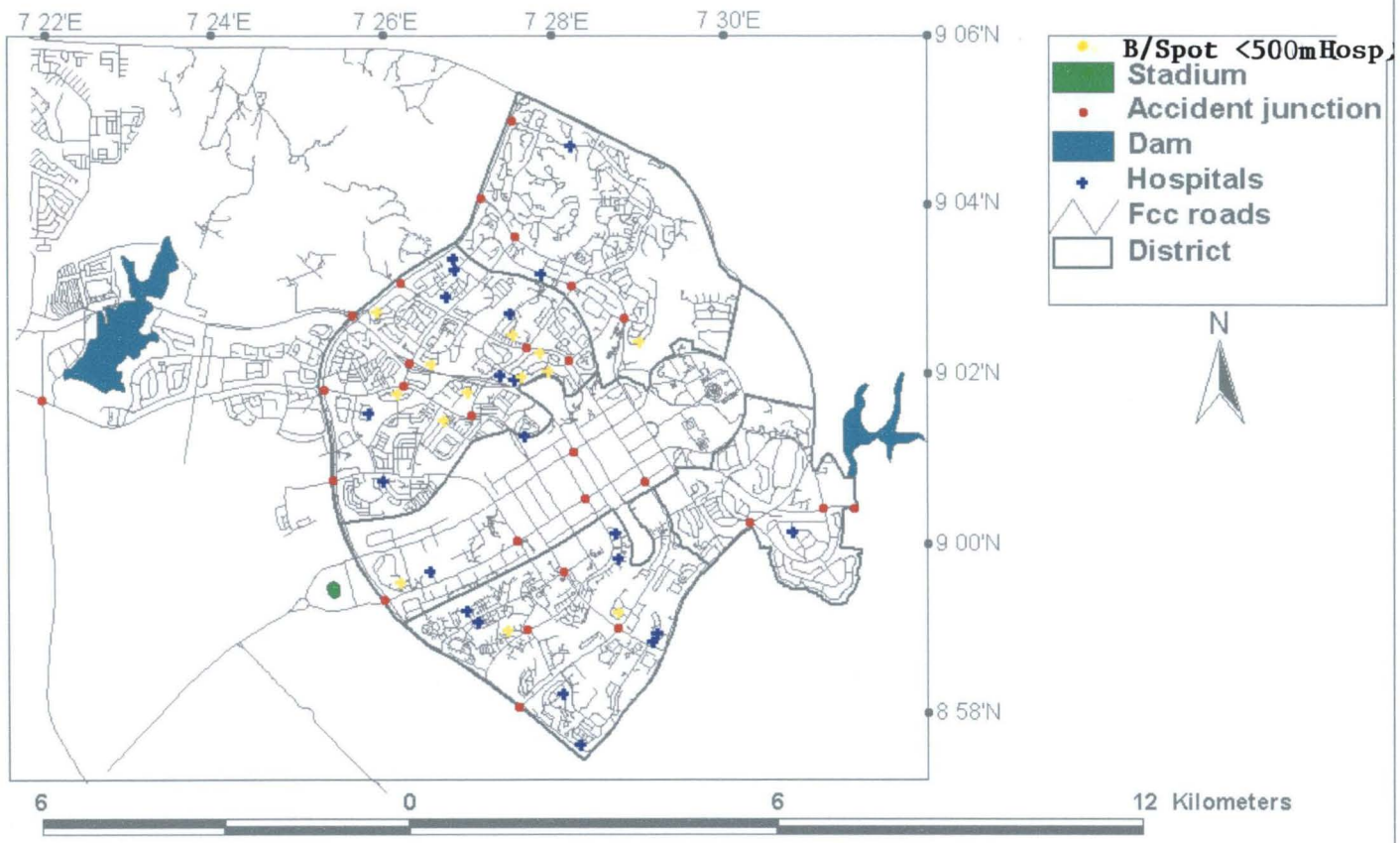


Fig 43: Black spot junctions located < 500 meters to Hospitals in FCC (1999-2003)

Source: Authors field work, 2005

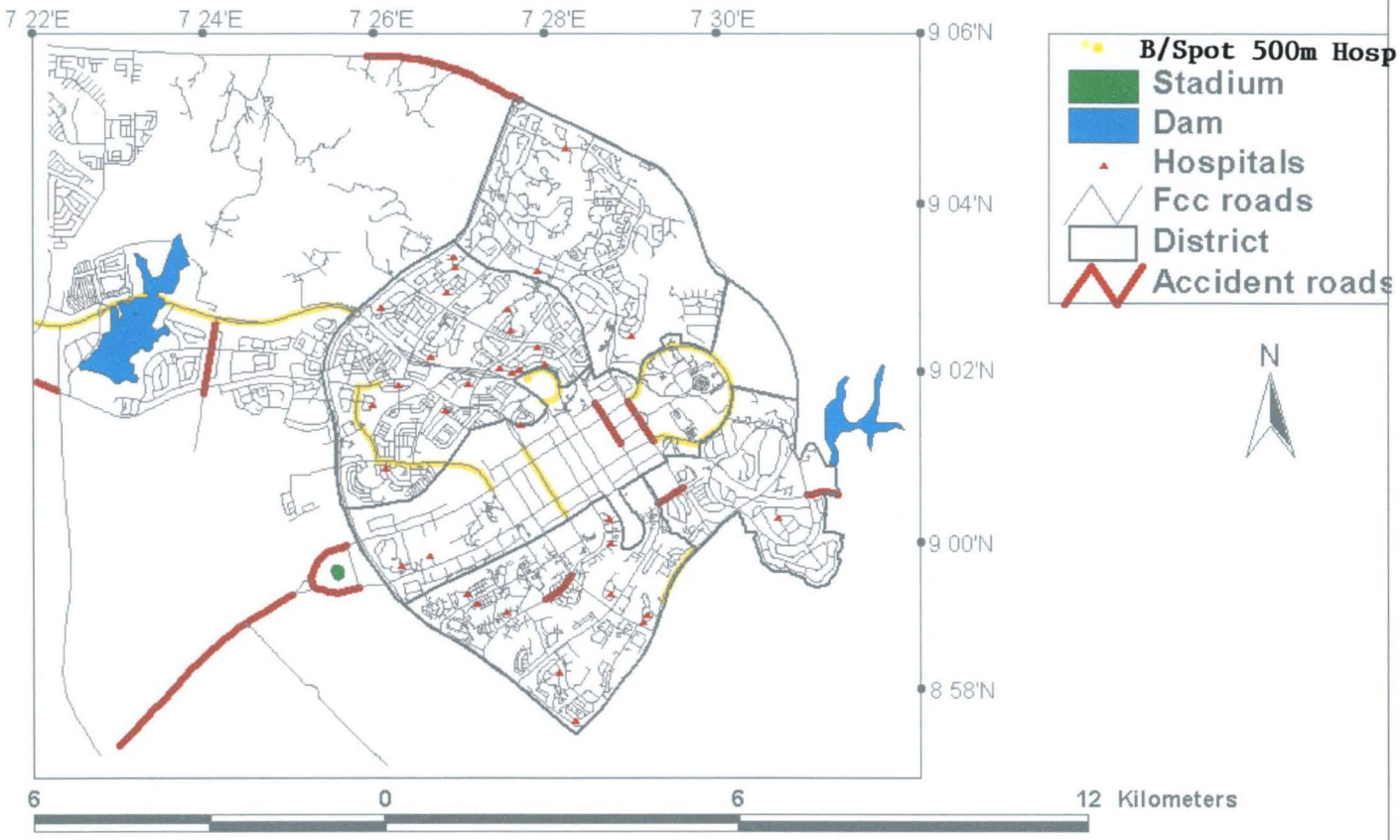


Fig 44: Black spot roads located < 500 meters from Hospitals in FCC (1999-2003)

Source: Authors field work, 2005

6.3 Conclusion

The chapter shows the output of the dynamic linkage of attribute and spatial data with the Arc view software in GIS. The study therefore seeks to find the difference in RTA on the road and junction. The study found that road recorded more accident indices than junction while Kubwa and Wuse recorded the highest accident indices in FCT and FCC respectively.

The spatial analysis of the data with GIS involves overlay and query. The analysis show that Central Area has highest Police/ FRSC where Wuse has highest Hospital, while Maitama the has least in Police/ FRSC distribution, casualty is highest along 3 Arm Zone and Airport roads (which also has high multiple accident) but victims are more likely to die more along Murtala wat/Abattoir as well as along N Azikiwe road. While the traffic volume is responsible for the multiple accidents, accident type and accident casualty along Airport, 3 Arms Zone and Abattoir, it is not responsible for the casualty there. Land use has high effect on accident variables in Gari and no effect on all variables in Central Area.

Similarly, traffic light has high effect on casualty in Asokoro and high effect on the number of vehicles involved in accident in Maitama but no effect on the two variables in both Central Area and Wuse districts. Even though Mailamari/Area 10 and Zone 6 are located beyond the Police/ FRSC posts they have Hospitals around them. But Sagari/Dikko road is located beyond 500 meters from both Hospital and Police presence.

CHAPTER SEVEN

DISCUSSION OF FINDINGS

7.0: Introduction

This chapter discuses spatio-temporal analysis of motor vehicle related accident in Abuja. Consequently, show the temporal variation of accident variables, compare the figures of accident variables obtained for the various of districts as well as roads and junctions, utilize GIS to simulate the occurrence of each accident variables at every black spot road and junction.

7.1 Issues Arising from temporal variations of accident variables

The temporal variation in the accident variables is important to know the period of the day, month, season and date of the month when the accident variable is highest. Finding from this study shows that people troop into FCT between Saturday and Tuesday and troop out from Thursday to Saturday. In effect, the best time to do business at the government offices is between Tuesday and Thursday. The inward movements consist of visitors and civil servants, residents that went to their hometowns for weekends.

The accident potential reduce at the peak of early rain in July only to increase sharply during August break. This peak corresponds to when government budget is released. But as the budget gets more implemented, business activities increase and the accident potential fluctuates.

The road traffic accidents rarely occur between 9 pm and 4 am because people rarely move during this period. This suggests that Nighttime activities in Abuja are usually done before 9 p.m. thereafter; social activities are restricted to hotels and individual homes. All the accident variables increased progressively during the day. This progressive increase completely ignores the peak and off peak period of the traffic volume.

The accident variables under study, include accident types, casualty recorded, causes, number of vehicles involved in accident, and the traffic volume at the black spots are higher during the weekdays than weekends. The higher accident rate at weekdays than weekends confirms that the victims are mostly visitors to FCC, and the accidents are caused by indiscipline, impatience, and over speeding during their business trips. This is supported by the high weighted average of accident causes mentioned above. While this was true for accident cause and traffic volume the same cannot be said of accident type, casualty and number of vehicles involved.

More traffic accidents occur during the day than night. Agunloye, (1990) already showed that more accidents happened during the day than night along inter city routes but the victims are more helpless in the latter. This study confirms that the situation is not different on intra city routes.

Though the rainy season is more predisposed to accident than the dry season. The fact that it is not statistically significant means that the cause of the accident may not be attributable to the rain itself or associated cause such as slippery road and unclear weather. However, the rainy season

coincides with farming season when city dwellers go back to the fringes to farm. Unfortunately, 60% of the months that fall under rainy season in this study are 'ember' months. The higher 'ember' month accidents disagree with similar studies by Akpogome, (1992), Olagunju, (1995) in Port Harcourt city and in Oyo State respectively. This may be an indication that the nature of accident data during the 'ember' months varies according to cities. More studies might be required to confirm this.

The month ends proves to be more predisposed to accidents than early month when the data for each month was computed on yearly basis. The month end corresponds to when salaries are collected, shopping and leisure trips are made and the congestion that often follow arouse commuters' impatience. The index of casualty is higher than the indices of accident cause at early month but the reverse is the case at month end. This trend further confirms that casualties are more fatal at month-end than early month. The analyses suggest that in tracking road accident intensity, focus should shift gradually from the dry season to the rainy period of 'ember' months. Coincidentally this is at the peak of budget implementation. In doing this, working days that fall within the month ends are to be taken as high accident potential period.

7.2 Issues Arising from the Accidents at junctions and the roads

The vehicle exposure to accident was low at all black spots on hourly and daily basis. The volume of traffic at Maitama was at variance with the road traffic accident. The study shows that Maitama has a high number of traffic light disobedience because the accidents happen at the junction. Unfortunately, all these junctions have traffic light. Tavakoli (2001) also note that

drivers tend to ignore stop lines before traffic lights and that the less the traffic light the more they are ignored. Campton and Shinar, (2001) noted that men were 2.5 times more likely to drive dangerously and the behavior decreases after 45 years of age particularly when there are passengers in the vehicles.

Previous studies (Noose, 1991) has shown that more accidents happen at intersections, have 'domino' or 'ripple' effect on other junctions and the preponderance of lane changing maneuvering was indicative of deteriorated traffic conditions and the likelihood of accident. However, this study shows that though accidents happen mostly at junctions consequently involving more vehicles, more victims are recorded along the road. This position conforms to Perkins and Haris, (1968) because the potential for an accident is a function of traffic condition and the characteristic of the site. Each site, because of its geometric and other characteristics, has certain hazards associated with it. These hazards were further intensified when the road is physically restrained.

The high accident rate at the 3 arms end of Independent Avenue can be attributed to the present design of the road that does not separate opposing traffic in spite of its low sight distance. This situation is true for all accident variables at this site. Even though Hubert-Macaulay/Area 10 road is well designed, accident of all types, particularly involving few vehicles is still possible. All the black spots located along Nnamdi Azikiwe and Sheu Shagari ways are expected to witness high casualty.

The weighted average of accident causes is high along the 3 Arms end of Independent Avenue, Muritala Muhm'd Way south, Hubert Macaulay/Area 10. The higher accident potential at these places is not only attributable to higher speed but also to low occupancy ratio of the passenger. Augustsson, (2001) show that for every 1 km/h increase in speed the chance of getting involved in accident increase by not less than 3%. Leong, (1968) drew a positive relationship between high road width, standard of alignment and high number of long distance traffic.

7.3. Issues Arising from Accident status of each district

The study shows that Police/ FRSC post are concentrated in the Central Area and least at Maitama district while Hospitals are concentrated at Wuse and least in the Central Area district respectively. There are more casualty black spots roads in Central Area while Wuse district has the highest casualty black spots junction. This is because the Land use intensity is highest in Wuse and least in Central Area. In addition to this, the City Gate is noted for high casualty while the Airport road is noted for multiple accidents. This can be attributed to over speeding and impatience on the part of motorist along Airport road and turning traffic around the City Gate respectively.

The indiscriminate parking, driving inconveniences and other acts of traffic indiscipline characteristic of Wuse and Garki districts reduce the sensitivity to gap acceptance of drivers. Ovorie, (1992) showed that a conflict of degree one would occur with every gap acceptance of 4.2 to 5.5 seconds. It should be noted that proper implementation of the design and plan of the districts in terms of parking spaces, shopping malls and leisure gardens would definitely alter the traffic statistics in these areas.

The traffic volume also has a strong influence on all the accident variables in the 3 Arms Zone and the transit corridors such as Central Area as well as junction in Wuse and Maitama. Even though Mitchell and Rapkin, 1954 showed that Urban traffic is positively related to land use and that Land use planning (rather than traffic management) is the best way to control urban traffic, it is interesting to note that in districts with high Land use intensity (such as Wuse) the effect of traffic volume on accident variable is more at the junctions while the effect is more on the road in districts with low Land use intensity such as Central Area.

The implication of this is that while speed causes more accident in the Low density Areas, indiscipline cause it in the high density areas. Of equal significance is the primary distributor roads of Kubwa and the preponderance of multiple accident and accident type along Airport roads which is not witnessed along Kubwa roads.

Even though Wuse and Garki have highest Land use intensity, its effect on the casualty and accident types is highest in Garki. Both the Land use and traffic volume has low effect on al accident variables in the Central Area district. This implies that the accident variables are influenced by other factors possibly drivers' habit such as over speeding. It is also observed that traffic light does not determine whether the number of casualty recorded or vehicles that got involved in accident at Wuse district. Where as the presence of traffic light affect the number of casualty recorded in Asokoro, it does same for number of vehicle involved in accident at Maitama.

Most of the black spot junctions are located in the FCC while the black spot roads are located in the fringes of FCC. Black spots that are not within reach of Police/ FRSC presence are closer to Hospitals. Yet, many other Hospitals are located beyond 500 meters from both the Hospitals and Police/ FRSC post particularly at Wuse and fringes of FCC respectively.

7.4 Conclusion

This chapter gives an overview of the temporal variation of accident variable, accident situation at junction and road in the FCC as well as the accident situation at each district with relevant literatures that either agree or disagree with the findings.

CHAPTER EIGHT

SUMMARY, RECOMMENDATIONS AND CONCLUSION

8.0 Summary of findings

This study analyzes the spatio temporal pattern of road traffic accident in FCC using GIS technology such as coverage maps, overlay and querying of maps. Consequently effort would be made to:

i Identify the variables relevant for testing the road traffic accident in Abuja

ii Analyze the spatio-temporal characteristic of road traffic accident in Abuja

iii Use GIS to identify the black spot location in FCC.

iv Outline the implication of the study for road traffic accident management and policy.

The study found out that:

1. GIS offers a lot of potentials in the modeling of accident spot particularly in displaying the spatial and attribute data that were dynamically linked together.

2. The accident variables were highest on all the Primary distributor roads except Kubwa.

3. The FCT is most active between Tuesday and Thursday, August and December and 4 am to 6 pm. The road traffic accident variables in FCC are more during weekday than weekends, day than night, rainy than dry season and month end than early month. These results are in conformity with those obtained by Agunloye, (1990) in his study of intercity routes.

4. Black spots are widespread in Wuse but the occurrence of accident casualties, accident type and other variables at these places is highest at 3 arms end of Independent Avenue, Bannex junction, Murtala-Muhm'd way south, Berger junction in that order. There are more black spots in Wuse and least in Asokoro. The highest concentration of Black spot is central area but junction is Wuse.

5. Few accidents occur at Memorial drive but casualty is high. Few accidents and few casualties occur at zone 4/IBB and Minister hill yet the place has high fatality. High accident casualty and fatality but few numbers of vehicles were involved at NNPC. The traffic volume is high on all primary distributor roads, moderate on secondary roads (Ibro /zone 5) and low on access roads. However, the traffic volume is low along some primary roads such as Kubwa (insufficient data), and Sheu Yaradua and high along secondary roads of Area 11/Dikko and T-Balewa/Area 3 respectively.

6. Though more accidents happen at junctions (consequently involving more vehicles) yet more casualties are recorded along the roads.

7. Most of the accidents in Maitama happen at the junctions yet Maitama has many traffic lights. This shows that the presence of traffic light in Maitama has no effect on its accident rate. This shows that the low traffic volume, social class of residents and the reduced presence of law enforcement agent in the area give room for traffic indiscipline.

8. Irrespective of traffic fluctuation the accident potential increases during the day between 1am-6pm, fluctuates between 6pm and 9pm, and thereafter decline. The accident variables fluctuate across the month, have similar trend during the week but decline during the weekend. The variables increase between January and June, decline in August but reduce between September and December.

9. The number of vehicles that got involved in accident at each black spot is statistically insignificant compared to traffic volume there.

8.1 Policy and planning implications

1.0 The traffic Management measures has not been adequate during the day. This can be attributed to the conversion of the large part of Wuse 1 and Garki 1 to a high-density area instead of its earlier design as the medium and low-density areas. This is through the inclusion of boys' quarters in the building design. The movement of diplomatic residents to Maitama also changed the place from medium/high density to low density area. These changes create traffic and traffic conflicts as well as negate the formation of an efficient Land-use or spatial relationship between the areas of FCC.

2. Most of the traffic in FCC originates from the satellite towns of FCC and outside FCT. This uncontrolled development of the fringes of FCC due to the high rent in urban area (Urban sprawl) has a lot of implication on the land use planning of the satellite towns and fringes of FCT. Apart from increasing distance to social amenities, it encourages ribbon as well as leapfrog like development along transit routes. There is uncontrolled development and poor infrastructure as well as social amenities in these areas. This mass outer fringe-inner core (urbanization) movement has implication on the life span and serviceability of the road as well as creates squatter settlements along the primary distributor roads (i.e Airport road). These settlers are seen encroaching right up to the road edge, thereby creating hazardous conditions for pedestrians and passing traffic.

3. While traffic volume determines the number of black spot junctions in an area, the traffic speed determines the number of black spot roads in the area. The high traffic volume, low occupancy and preponderance of drivers in active age without commensurate traffic management measures cause indiscriminate parking on the access roads in Wuse 1 and Garki 1 and over speeding on free roads. It also causes the conversion of lay-bys on the local distributor roads to loading points and the conversion of Green areas to building sites or recreation sites respectively.

4. The nightlife and weekend leisure activities are almost none existent in FCC. This is in spite of the fact that the streets are well lit and residents are mostly civil servant. The night life has not been significant because the FCC residents came from diverse ethnic groupings and have not really gotten over the mutual sentiments and reservation needed to build mutual trust- an ingredient that foster night life/leisure activities. The nightlife activities would be improved if

creation of neighborhood recreation centers and more efficient security presence particularly close to Green areas were encouraged

5. The general picture shows that the accidents occurring at the junctions appear to be a reflection of what is happening elsewhere and are the consequence of indiscipline, over speeding and topography. Hence, apart from traffic management better restructuring of roads and its infrastructure, enforcement of the rules and regulation of traffic laws would produce an entirely different perspective.

8.2 Recommendations

1. Many years of constant development of certain areas have caused the traffic congestion in these areas. It has also caused the population to be above projection and infrastructure provision below projection in the developmental phase of FCT respectively. Since many of the distortions are difficult to rectify (i.e conversion of low to high density areas) it is important to review the master plan to reflect the present realities and thereafter follow the plan consistently

2. More attention (i.e form of maintenance and traffic enforcement) should be paid to all primary distributor roads (such as Airport and Kubwa road) because more vehicles use them and more accidents occur there.

3. The ongoing restructuring exercise in FCT that result in the demolition of illegal structures, houses built close to government quarters, under the high tension wires and in an area

without layout is highly commended but the government should also take step to reduce the hardship faced by those affected. The Government should also control the development of squatter settlement and provide infrastructure and social amenities to the area.

4. The fringes of FCT (i.e Karu, Suleja, Madala etc) should be catered for in terms of infrastructure provision since most of the residents work in FCT.

5. Consideration should be given to the **enforcement of installation of speed limiting device in all vehicles in Nigeria**. This is already being practiced in all EEC Countries. This enforcement would go a long way to curbing the many fatal accidents arising from over speeding as shown in this study.

6. **FRSC should issue traffic alert periodically** against traffic vices such as over speeding and traffic light disobedience in FCT to sensitize residents and FCT visitors. The alert should be issued for weekend, early week, day, night, rainy season, dry season and month end

7. The FCT command of FRSC (and indeed other commands in Nigeria) should be given express permission to **network, form strategic alliance and exchange capacity** with agencies involved in road safety activities in their command. For better result, a research grant should be floated yearly for research to be conducted in conjunction with FRSC officials. This would go a long way in building the research capacity in FRSCHQ.

8 Since timely intervention can mean the difference between life and death to an accident victim, the police should not intimidate, but rather should encourage first aiders. This should be accompanied with the establishment of National Road Traffic Accident Victim Endowment Fund for short term care of victims that subscribe to it through the passenger manifest fund.

9. In order to facilitate GIS analysis of accident data, rescue agencies should as a matter of priority adopt a uniform accident reporting system that can be used as a working database and feed back mechanism of RTA data in Nigeria. Such data format should contain disaggregated information of the accident (i.e spatio temporal and socio economic characteristic of accident).

10. The formation of anti hold-up squad should be considered to reduce accident arising from increased traffic volume on the access roads.

8.3: Directions for future research

1. This study has utilized the weighted average of the various indices of accident to for the spatial and aspatial analysis of the occurrence of accident in FCC. Even though the study recognizes that quite a lot of accidents are never reported and that modeling accident rate has a large appetite for data, this research believes that future research should include the road configuration in the model. A study that gives proportionate contribution of the various causes and conditions of accident would also be helpful

2. The combination of remote images and GIS would give a more comprehensive result. This study has not used such real time data to model accident potentials of black spots.

3. It would be helpful if the accident variables were modeled with GIS. Creation of scenario (what is analysis) could be a very important area of future research. This study could not achieve this forecasting ability with GIS.

8.4 Conclusion

The Federal Capital City is a planned city, but over the years there have been several distortions in the master plan. This has resulted in increased congestion along the secondary distributor routes. The preponderance of the vehicle maneuvering that follow congestion often leads to accidents.

This study therefore analyses the motor vehicle accident data between 1999-2003 with a view to drawing a conclusion that would be used to describe the accident situation in FCT. The accident data are therefore disaggregated into variables such as types of accident, casualty recorded, accident causes, number of vehicle involved in the accident and the traffic volume in the networks. The weightages of variables that could not be added together were obtained. The data on each variable were therefore linked with the location of the accident on the route map of FCT with the GIS technology.

The temporal analysis with SPSS and EXEL software show that all the variables (indicators of accident potential) record more value during weekdays than weekends, during the day than during the night, during rainy season than dry season, at month end than early month, and on the road than at junctions. The spatial analysis of the data with GIS using coverage, overlays and query operations.

Since most of the accidents in FCT are associated with intense business activities such accident would be reduced if FRSC should increase their presence at city outlets at night, busy routes on weekdays, adverse weather and month-end respectively. The FRSC should be proactive in accident prevention, responsive to the dynamics of accident causative factors and reactive to rescue accident victims'. There is also need for FRSC, Police road maintenance agencies and Hospitals to form a strategic alliance in data acquisition, data exchange, capacity building, capacity exchange and networking.

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APPENDIX 1

FEDERAL UNIVERSITY OF TECHNOLOGY

SCHOOL OF POST GRADUATE STUDIESMINNA NIGER STATE

The.....

Abuja.

Sir,

RESEARCH ON SPATIO-TEMPORAL ANALYSIS OF MOTOR VEHICLE RELATED ACCIDENTS IN ABUJA

1. I am a Ph D student of FUT Minna. I am conducting a research on spatio-Temporal analysis of Motor vehicle related Accidents in Abuja using GIS. The study would enable me to determine the Black spots locations and injury associated with it, with a view to making proper plan for the deployment of FCT, effectiveness of my organization and a furtherance of my academic pursuit in the school.

2. The Data needed for the above projections should cover 1999 to 2003. It is however important that I determine the relative weights of fatal: serious: minor accidents. It is for this reason that you are requested to complete this questionnaire. It contains eight items such as (i.e induce fear, induce pain, incur hospital bill, stress dependants, destroy road, damage vehicle, affect productivity, and high hospital bill)

3. I therefore solicit for and would appreciate your full co-operation in providing the information requested. We hope to round off the research by December 2005.

4. Please acknowledge receipt.

5. Thank you.

SA Balogun

15 Nov. 2001

APPENDIX II

ANALYSIS OF QUESTIONNARE FOR DETERMINING PROPOTIONAL

Weight of fatal: serious: minor accidents

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
respondent category * INDUCFEA	240	97.6%	6	2.4%	246	100.0%
respondent category * INDUPAIN	240	97.6%	6	2.4%	246	100.0%
respondent category * incure hospital bill	240	97.6%	6	2.4%	246	100.0%
respondent category * stress dependant	240	97.6%	6	2.4%	246	100.0%
respondent category * destroy the road	240	97.6%	6	2.4%	246	100.0%
respondent category * damage the vehicle	240	97.6%	6	2.4%	246	100.0%
respondent category * affect productivity	240	97.6%	6	2.4%	246	100.0%
respondent category * high hospital bill	240	97.6%	6	2.4%	246	100.0%

Respondent category * INDUCFEA

Crosstab

			INDUCFEA			
			fatal	serious	minor	Total
respondent category	road user	Count	47	28	5	80
		% within respondent category	58.8%	35.0%	6.3%	100.0%
	FRSC Officials	Count	48	27	5	80
		% within respondent category	60.0%	33.8%	6.3%	100.0%
	transpot researchers	Count	60	16	4	80
		% within respondent category	75.0%	20.0%	5.0%	100.0%
Total		Count	155	71	14	240
		% within respondent category	64.6%	29.6%	5.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.915[a]	4	.206
Likelihood Ratio	6.129	4	.190
Linear-by-Linear Association	3.398	1	.065
N of Valid Cases	240		

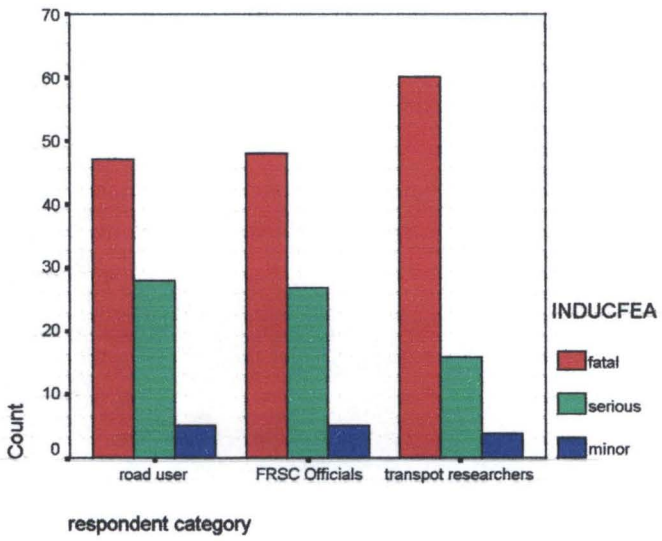
a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 4.67.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.155	.206
N of Valid Cases		240	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.



Respondent category * INDUPAIN

Crosstab

			INDUPAIN			Total
			fatal	serious	minor	
respondent category	road user	Count	58	19	3	80
		% within respondent category	72.5%	23.8%	3.8%	100.0%
	FRSC Officials	Count	49	27	4	80
		% within respondent category	61.3%	33.8%	5.0%	100.0%
	transpot researchers	Count	54	22	4	80
		% within respondent category	67.5%	27.5%	5.0%	100.0%
Total		Count	161	68	11	240
		% within respondent category	67.1%	28.3%	4.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.381[a]	4	.666
Likelihood Ratio	2.377	4	.667
Linear-by-Linear Association	.477	1	.490
N of Valid Cases	240		

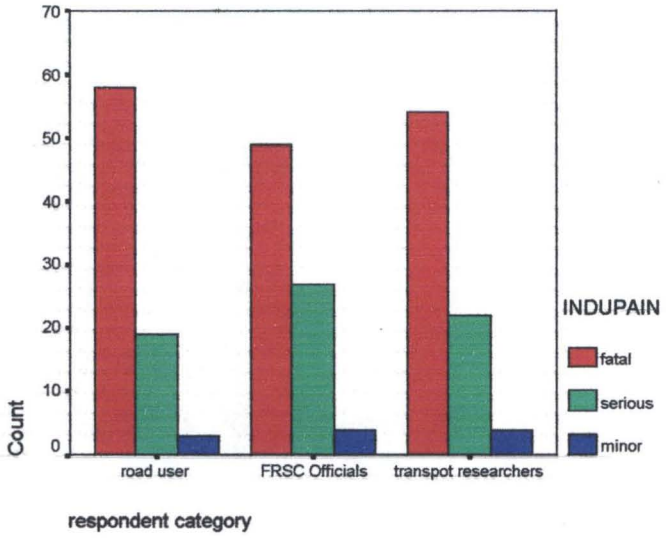
a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 3.67.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.099	.666
N of Valid Cases		240	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.



Respondent category * incur hospital bill

Crosstab

			incure hospital bill			Total
			fatal	serious	minor	
respondent category	road user	Count	53	22	5	80
		% within respondent category	66.3%	27.5%	6.3%	100.0%
	FRSC Officials	Count	58	20	2	80
		% within respondent category	72.5%	25.0%	2.5%	100.0%
	transpot researchers	Count	56	21	3	80
		% within respondent category	70.0%	26.3%	3.8%	100.0%
Total		Count	167	63	10	240
		% within respondent category	69.6%	26.3%	4.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.723[a]	4	.787
Likelihood Ratio	1.703	4	.790
Linear-by-Linear Association	.503	1	.478
N of Valid Cases	240		

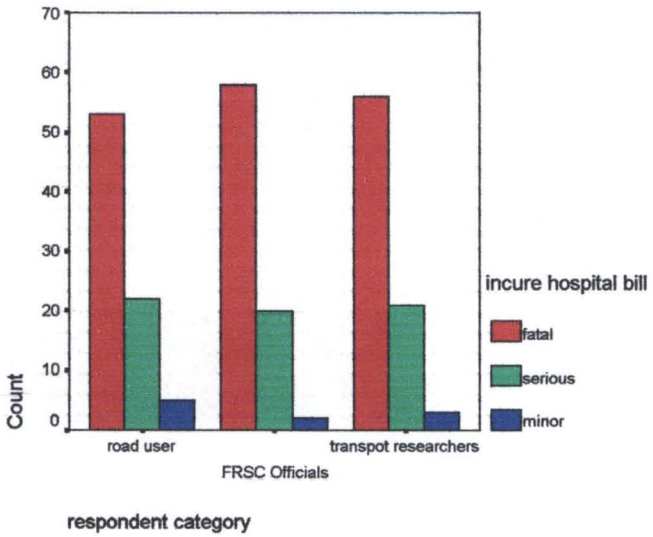
a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 3.33.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.084	.787
N of Valid Cases		240	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.



Respondent category * stress dependant

Crosstab

			stress dependant			Total
			fatal	serious	minor	
respondent category	road user	Count	55	21	4	80
		% within respondent category	68.8%	26.3%	5.0%	100.0%
	FRSC Officials	Count	52	25	3	80
		% within respondent category	65.0%	31.3%	3.8%	100.0%
	transpot researchers	Count	49	22	9	80
		% within respondent category	61.3%	27.5%	11.3%	100.0%
Total		Count	156	68	16	240
		% within respondent category	65.0%	28.3%	6.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.604[a]	4	.330
Likelihood Ratio	4.389	4	.356
Linear-by-Linear Association	2.001	1	.157
N of Valid Cases	240		

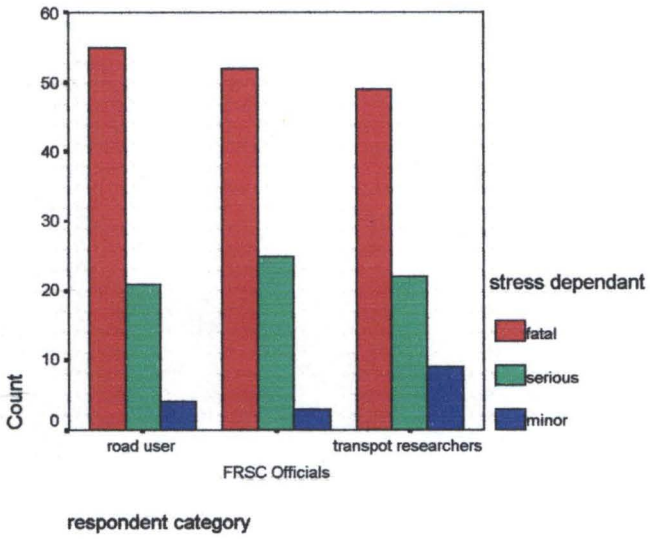
a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.33.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.137	.330
N of Valid Cases		240	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.



Respondent category * destroy the road

Crosstab

			destroy the road			
			fatal	serious	minor	Total
respondent category	road user	Count	58	21	1	80
		% within respondent category	72.5%	26.3%	1.3%	100.0%
	FRSC Officials	Count	54	24	2	80
		% within respondent category	67.5%	30.0%	2.5%	100.0%
	transpot researchers	Count	47	28	5	80
		% within respondent category	58.8%	35.0%	6.3%	100.0%
Total		Count	159	73	8	240
		% within respondent category	66.3%	30.4%	3.3%	100.0%

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.149	.246
N of Valid Cases		240	

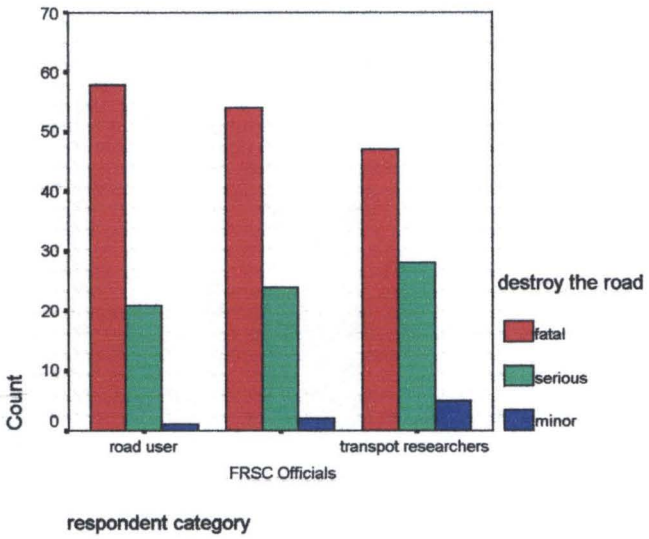
a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.434[a]	4	.246
Likelihood Ratio	5.367	4	.252
Linear-by-Linear Association	4.668	1	.031
N of Valid Cases	240		

a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 2.67.



respondent category

Respondent category * damage the vehicle

Crosstab

			damage the vehicle			
			fatal	serious	minor	Total
respondent category	road user	Count	52	24	4	80
		% within respondent category	65.0%	30.0%	5.0%	100.0%
	FRSC Officials	Count	40	26	14	80
		% within respondent category	50.0%	32.5%	17.5%	100.0%
	transpot researchers	Count	58	20	2	80
		% within respondent category	72.5%	25.0%	2.5%	100.0%
Total		Count	150	70	20	240
		% within respondent category	62.5%	29.2%	8.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.560[a]	4	.002
Likelihood Ratio	16.129	4	.003
Linear-by-Linear Association	.960	1	.327
N of Valid Cases	240		

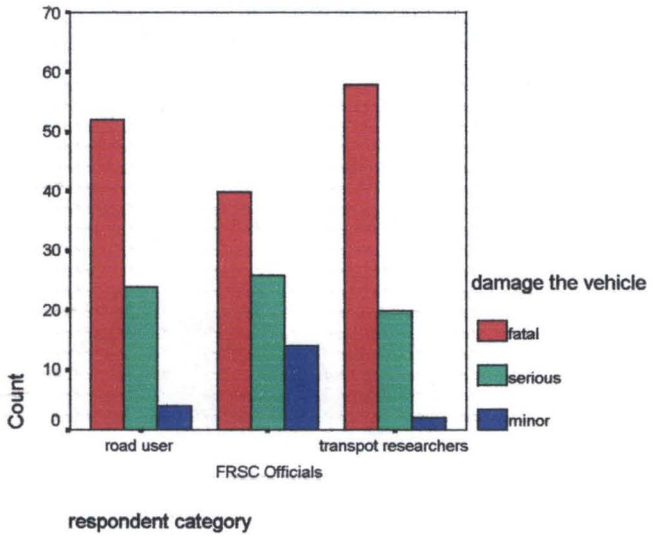
a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.67.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.254	.002
N of Valid Cases		240	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.



Respondent category * affect productivity

Crosstab

			affect productivity			Total
			fatal	serious	minor	
respondent category	road user	Count	52	23	5	80
		% within respondent category	65.0%	28.8%	6.3%	100.0%
	FRSC Officials	Count	54	19	7	80
		% within respondent category	67.5%	23.8%	8.8%	100.0%
	transpot researchers	Count	53	25	2	80
		% within respondent category	66.3%	31.3%	2.5%	100.0%
Total		Count	159	67	14	240
		% within respondent category	66.3%	27.9%	5.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.588[a]	4	.465
Likelihood Ratio	3.865	4	.425
Linear-by-Linear Association	.280	1	.597
N of Valid Cases	240		

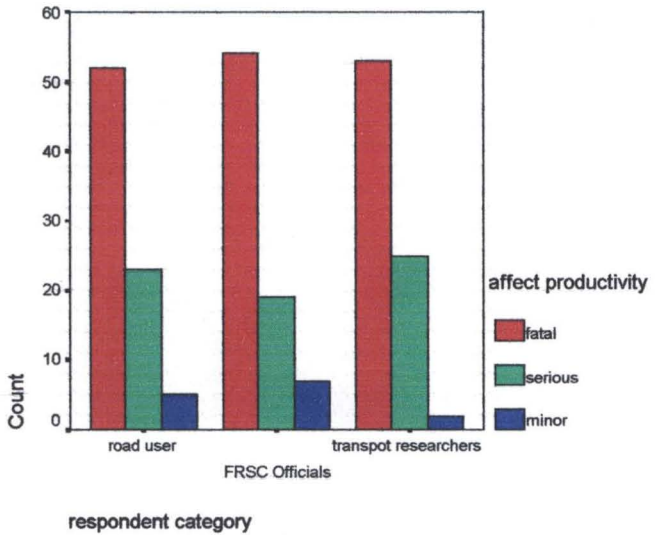
a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 4.67.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.121	.465
N of Valid Cases		240	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.



Respondent category * high hospital bill

Crosstab

			high hospital bill				
			fatal	serious	minor	11.00	Total
responder category	road user	Count	59	17	4		80
		% within respon category	73.8%	21.3%	5.0%		100.0%
	FRSC Officials	Count	46	29	5		80
		% within respon category	57.5%	36.3%	6.3%		100.0%
	transpot researc	Count	45	27	7	1	80
		% within respon category	56.3%	33.8%	8.8%	1.3%	100.0%
Total		Count	150	73	16	1	240
		% within respon category	62.5%	30.4%	6.7%	.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.712[a]	6	.190
Likelihood Ratio	9.033	6	.172
Linear-by-Linear Association	5.551	1	.018
N of Valid Cases	240		

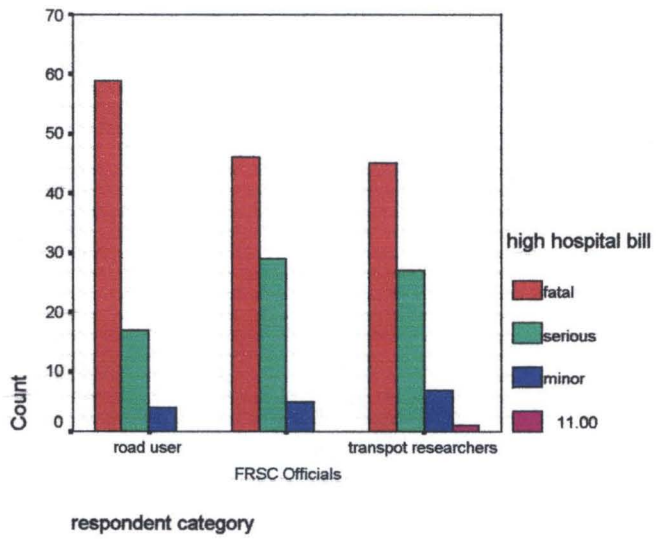
a. 3 cells (25.0%) have expected count less than 5. The minimum expected count is .33.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Contingency Coefficient	.187	.190
N of Valid Cases		240	

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.



Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
INDUCFEA	road user	80	1.4750	.6157	6.884E-02	1.3380	1.6120	1.00	3.00
	FRSC Officials	80	1.4625	.6151	6.877E-02	1.3256	1.5994	1.00	3.00
	transpot researchers	80	1.3000	.5603	6.264E-02	1.1753	1.4247	1.00	3.00
	Total	240	1.4125	.6004	3.876E-02	1.3362	1.4888	1.00	3.00
INDUPAIN	road user	80	1.3125	.5418	6.057E-02	1.1919	1.4331	1.00	3.00
	FRSC Officials	80	1.4375	.5920	6.619E-02	1.3058	1.5692	1.00	3.00
	transpot researchers	80	1.3750	.5819	6.506E-02	1.2455	1.5045	1.00	3.00
	Total	240	1.3750	.5722	3.693E-02	1.3022	1.4478	1.00	3.00
incure hospital bill	road user	80	1.4000	.6080	6.797E-02	1.2647	1.5353	1.00	3.00
	FRSC Officials	80	1.3000	.5131	5.737E-02	1.1858	1.4142	1.00	3.00
	transpot researchers	80	1.3375	.5499	6.148E-02	1.2151	1.4599	1.00	3.00
	Total	240	1.3458	.5575	3.599E-02	1.2749	1.4167	1.00	3.00
stress dependant	road user	80	1.3625	.5790	6.474E-02	1.2336	1.4914	1.00	3.00
	FRSC Officials	80	1.3875	.5624	6.288E-02	1.2623	1.5127	1.00	3.00
	transpot researchers	80	1.5000	.6936	7.754E-02	1.3457	1.6543	1.00	3.00
	Total	240	1.4167	.6148	3.968E-02	1.3385	1.4948	1.00	3.00
destroy the road	road user	80	1.2875	.4824	5.394E-02	1.1801	1.3949	1.00	3.00
	FRSC Officials	80	1.3500	.5301	5.927E-02	1.2320	1.4680	1.00	3.00
	transpot researchers	80	1.4750	.6157	6.884E-02	1.3380	1.6120	1.00	3.00
	Total	240	1.3708	.5489	3.543E-02	1.3010	1.4406	1.00	3.00
damage the vehicle	road user	80	1.4000	.5868	6.560E-02	1.2694	1.5306	1.00	3.00
	FRSC Officials	80	1.6750	.7593	8.490E-02	1.5060	1.8440	1.00	3.00
	transpot researchers	80	1.3000	.5131	5.737E-02	1.1858	1.4142	1.00	3.00
	Total	240	1.4583	.6455	4.167E-02	1.3763	1.5404	1.00	3.00
affect productivity	road user	80	1.4125	.6099	6.819E-02	1.2768	1.5482	1.00	3.00
	FRSC Officials	80	1.4125	.6501	7.268E-02	1.2678	1.5572	1.00	3.00
	transpot researchers	80	1.3625	.5335	5.965E-02	1.2438	1.4812	1.00	3.00
	Total	240	1.3958	.5977	3.858E-02	1.3198	1.4718	1.00	3.00
high hospital bill	road user	80	1.3125	.5646	6.313E-02	1.1868	1.4382	1.00	3.00
	FRSC Officials	80	1.4875	.6161	6.888E-02	1.3504	1.6246	1.00	3.00
	transpot researchers	80	1.6375	1.2452	.1392	1.3604	1.9146	1.00	11.00
	Total	240	1.4792	.8724	5.631E-02	1.3682	1.5901	1.00	11.00

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
INDUCFEA	Between Groups	1.525	2	.762	2.135	.120
	Within Groups	84.638	237	.357		
	Total	86.163	239			
INDUPAIN	Between Groups	.625	2	.313	.954	.387
	Within Groups	77.625	237	.328		
	Total	78.250	239			
incure hospital bill	Between Groups	.408	2	.204	.655	.520
	Within Groups	73.888	237	.312		
	Total	74.296	239			
stress dependant	Between Groups	.858	2	.429	1.137	.323
	Within Groups	89.475	237	.378		
	Total	90.333	239			
destroy the road	Between Groups	1.458	2	.729	2.450	.088
	Within Groups	70.538	237	.298		
	Total	71.996	239			
damage the vehicle	Between Groups	6.033	2	3.017	7.642	.001
	Within Groups	93.550	237	.395		
	Total	99.583	239			
affect productivity	Between Groups	.133	2	6.667E-02	.185	.831
	Within Groups	85.262	237	.360		
	Total	85.396	239			
high hospital bill	Between Groups	4.233	2	2.117	2.824	.061
	Within Groups	177.662	237	.750		
	Total	181.896	239			

APPENDIX III

VARIOUS CAUSES OF ACCIDENT IN FCT (1999-2004)

f		1	R_1^2	2	R_2^2	3	R_3^2	4	R_4^2	5	R_5^2	6	R_6^2	7	R_7^2	8	R_8^2	9	R_9^2
1												1	1						
2								3	529	2	49	1	1	1	1				
3								3	529	2	49								
4				2	36			3	529					2	121			2	121
5														3	400				
6				1	1			4	676	1	1	1	1	3	400			1	1
7				3	64			4	676			1	1	9	529			2	121
8		2	4					9	961	1	1	1	1	22	484			2	121
9								1	1			1	1	2	121				
10								1	1					2	121	1	1		
11								5	784			1	1	1	1				
12								1	1					1	1			2	121
13														2	121				
14								2	361	2	49			2	121			1	1
15				1	1	1	1	7	900	1	1			14	576				
16				1	1	1	1	6	841					2	121			9	256
17								2	361	3	100			2	121				
18								1	1					2	121				
19								1	1										
20								1	1										
21								1	1										
22																		1	1
23																1	1	1	1
24				1	1														
25								1	1	1	1	1	1	1	1				
26														1	1				
27								1	1									2	121
28																			
29												1	1					1	1
30				2	36			2	361										
31				3	64							1		1	1			1	1
32								1	1										
33												1	1						
34												1	1			1	1	1	1
35																		1	1
36								1	1			1	1					1	1
37								1	1									1	1
38								1	1										
39								1	1										
40								1	1										
41								2	361										
42								1	1					1	1				
43								1	1										
44								1	1										
45				1	1									1	1				
46																			
47										1	1			1	1				
48														1	1				
			5		203		2		7887		253		12		3487		3		594

H_{O-} = No difference between accident causative factors at all location H_O =was rejected, there was sig. diffe. in effect of causative factors. no due to chance .$Xr_c > Xr_t$ at 95%:38>2.73:Df =k-1 =8

APPENDIX 1V

TRAFFIC OFFENCES IN NIGERIA

LSV Failure to use headlight, rear lights between 7pm and 6.30am or when highway is dark, failure to use directional sign when required.

OBS Obstructing highways, indiscriminate parking/broken down vehicles

RTV Disobeying law guiding routes to be followed on the road,, using vehicle in unauthorized road or unauthorized person.

RDV A private car carrying passengers , using your vehicle to anger other road users.

SPV Exceeding speed limit for the vehicle on the road (on express min=45km/p, max 100km/p).

NVL Expired vehicle license and not having vehicle license while driving.

NDL Driving without possession of valid driver license, A motorcycle, B=less than 3 tone vehicle such as private car cars, C=less than 3 tone other than motorcycle, D=vehicles other than commercial but excluding articulated vehicles, E= All commercial vehicles, F= Articulated vehicle, H= Earth moving vehicle, J= physically handicap person.

OVT Unsafe overtaking: at brow of the hill, a bend etc.

TRL Disobeying traffic light or traffic warden signals

TSV Disobeying road markings and signs.

WSV Driving without reflective warning triangle, failure to display or place it properly in advent of breakdown on highway failure to report the removal of abandon vehicle by owner.

DGD Driving recklessly, posing dangers to other road user, i.e. overtaking in the face of on coming vehicle, driving at high speed in pedestrian area.

ALD Driving under influence of alcohol or drugs.

FLP Driving with forged drivers license or vehicle documents.

DAM Unauthorized removal of , tampering with road signs, driving in such a manner as to collide with and damage road barriers, electric and telephone posts, fire hydrant. The fine would be paid and the structure replace by offenders.

RHV Improper loading (overloading) or towing of other vehicle, spilling diesel oil along highways etc..

DNM Driving vehicle bearing `do not move' sticker.

CAV Disobeying warning/directional sign/speed limit at road construction site on highway.

FMO Failure of slower vehicle to move over to slow lane even when more than four car queued behind.

FPV Failure to cover securely unstable materials such as gravel, refuse etc. thereby allowing them to spill on the highway.

NPV Failure to display new number plate on any moving vehicle.

OVL Overloading with passengers/load beyond prescribed number or weigh vehicle is licensed.

ICW Failure of Construction Company to provide adequate sign at sites.

OMD unnecessary interference/willful disruption/obstruction of marshals duty.

WDV Without or severely damaged windscreen

TYV Without or with worn out thread tyres.

PLV Projected load without warning red flag (daytime) or red light (night) at end of projection.

MDV Rickety, dilapidated, bent chassis, incomplete wheels, accidented vehicle. The offence has neither point nor fine except as determined by the court after validation by VIO fro roadworthiness.

AMD Assaulting/manhandling/harming marshals on duty is an offence determine by court of law.

ATC Bribing marshals to prevent justice is another offence determine by court of law.

OVO General breach of traffic law i.e. maximum height of commercial vehicles, Procedure for carrying extra wide load, extent of projected load allowed vehicle design specification.

ROAS Compulsive/wanted/violent traffic offenders.

FEV Driving without fire extinguisher which is ABC dried chemical powder type multipurpose, portable, simple in operation, refillable, rechargeable and environmentally friendly have safety gauge, stored pressure and reflective necking. Articulated vehicles/trailers (2of 9Kg), Lorries (2 of 6Kg) Luxury buses (2 of 6Kg) Buses (1of 2Kg) Pick-up vans (1 of 2 Kg), Taxi Cab/Private cars (1 of 1Kg).

EME Using vehicle emitting dark exhaust fumes that impair vision. Fines or fine plus 6 months imprisonment determined in court after Vehicle Inspection Report of roadworthiness.

* The license would be endorsed if the total points of offences committed at a time is up to four (4) and after twenty one (21) points the holder is disqualified and license confiscated.

APPENDIX V

TRAFFIC COUNT FORMAT

Time int(hr)	Bicy le	Motor bike	Private car	Pick up	taxi	Mini bus	Luxury bus	Lorry truck	Tanker trailer	others	Total
00-01											
01-02											
02-03											
03-04											
04-05											
05-06											
06-07											
07-08											
08-09											
09-10											
10-11											
11-12 noon											
12-13											
13-14											
14-15											
15-16											
16-17											
17-18											
18-19											
19-20											
20-21											
21-22											
22-23											
23-24											
Total traffic											

APPENDIX vi
SAATY;S SCALE VALUE OF THE LAND USE INDEX

	Maitama	Yan/ maraba	Karimu	Apo/ gudu	Garki	Wuse	Asokoro	C/ area	G/ lada	Kuj/ A-por	Kwali	Kubwa	Bwar
Hospital	6	12	24	9	33	57	3	3	30			6	
Other Medical Facility													
Nursery School	8	2	16	2	12	28	18		14			18	
Post Pry School	9	3	9	3	6	9	6		15			6	
Tertiary Institutio									2				2
Other Sch & Equip	1	1			9	11	3	2	7			1	1
Religious Insitution	15	3	96	102	51	96	6	3	33			66	
Banks	18		15	102	123		78	12	9				
/InsurancAllied institutio	4			6	19	23		8				2	
Book Shops	1			1		21	8	1	1	8			
Building Materials	12	18	663	108	243	198	18	9	12			15	
Urban Planners	11		1		72	129	25	4	5			1	
Business Centers	80	8	32	8	684	660	44	84	40			140	
Fashion & Others	13	12	5		95	117	8	10	15			33	
Agric & Allied			5		8	8	2	3	2	1			1
Engr. Coy& Ali	27	1	95	3	114	136	3	18	14	3	2	22	
Food & Allied	16	4	8		716	128		12	48			20	
Hotel & Restaura	80	10	44	4		216	24	18	68			74	
Block industries	1		62									4	
Filling Station	8		24		16	60	16	20	12	4		4	
Telecom & Others	20	4	10		106	156	4	16	18	4			
Publishin & Aliied	6	1	2	1	57	62	6	9	14			4	
Embassies &NGO	37	1			15	29	12	9					
Legal & Security	5			4		55	113	13	11			3	
TOTAL	378	80	1115	350	2434	2257	287	254	370	20	2	419	4

APPENDIX VII

PROCEDURE OF GIS ANALYSIS

Linking spatial with Attribute data in Arc view GLS

1. Start Arc view from file menu, choose open Exercise and scroll down until Ex 8a is found then click ok. An empty project widow appear, light the view icon and click the menu button, A new empty view, window view I appears so drags it to the center of All view window. The gray area of views is table of content of whatever theme added later. The dialog box of Add theme is displayed if the view is selected.

2. Alternatively, with short cut, you can double click Arc view and welcome box appear click ok and add data box appear click yes and Add theme box will also appear showing its directory (C/esri/arcGis 30).

3. From the drives list (bottom right) double click the drive where you installed the data (spread sheet extension or file in case of map as we don in this study), then the different themes appear.

4. Navigate to /gt kav/data/ch 08 in the directories list. Arc view will list the geographic data source (in case of sports data) or data base source (lotus/Exel/Access if attribute) that is available in the directory. Then double click the desired theme.

5. Select feature data source from lower left drop down list and double click and you will see the entire digitized layer above (i.e. FCT roads, FCC roads, as well as their junctions, Hospital, Traffic light, Police/FRSC locations etc)

6. Select all the themes by pressing down shift key and cursor but ensure cursor stop on the last layer then click ok. The map in view 1 will appear showing the entire feature, select the needed feature then activate the theme table that the data should be linked to. Then maximize to have full view of the map.

7. Click the icon of open theme table and the table appears, click table icon and navigate to start edit. Click then select your tool and click. With this tool, type-in the field (i.e. Mon, Tue etc) then type in each record (I.e. location then its value such as value of Accident recorders) into the attribute table. Note: the nature of attribute (sales of measurement) will determine the field declaration (i.e. number, date, string, float etc) declared as day, month, date and hour respectively

8. The above was done for each junction and at the end of entering each junction, the save edit button is clicked to safe the data. Occasionally the attribute table was minimized to view the map and ensure that the attribute is properly, linked to the map.

9. By this each junction was dynamically linked with the RTA of the junction

10. The procedures 6-9 were repeated this time with the Black spots Road highlighted.

Note: The black spot Junctions and roads were digitized separately. This is because the Junction was digitized as points while the road was digitalized on links.

11 At the end of the processing, a map showing number of RTA junctions and roads was produced. Process 8-12 was repeated for the independent variables such as number of vehicle involved in RTA number of Casualty etc.

12. At the end of the exercises, different maps were produced and these were later overlaid and subjected to spatial query.

Producing a map to show intensity of variables (vehicular traffic, black spot, police post, hospitals and social amenities) in each district of FCC.

i. select layers such as FCC roads, lakes, district, and stadium from the image.

ii. The layer 'district' is later highlighted and double clicked to pop up the theme box.

iii. In the box, 'district appears in the theme window,

-select graduated color from the legend type,

-for each map produced you are to select any of the above variables in the classification field

-select normalized by none

-click classify to pop up its box in the theme layer, and set the type to quartile and number of classes to five then click ok

iv. set the color to green monochromatic

v. click apply

vi. prepare the map.

Producing a map to show the accident-prone areas in each district

i. select layers of stadium, lakes, FCC roads, district, black spot junction / road

ii. change the colors of each layer to desired by double clicking the layer

iii. Highlight black spot junction/ road

iv. Lick open theme table

v. Highlight/activate variables such as casualty, accident type, accident cause, number of vehicle involved etc

vi. From the menu, click field and then select statistic. Observe mean value of the data. (Note: that all the accident locations with values higher than the mean are categorized as black spot).

vii. Close the field and theme table

viii. click the query builder. In it's field double click the variable in question (i.e casualty)

- click less than (<) and then double click the value mean displayed
- click new set
- all the places below mean are in yellow while the accident prone areas are in red

ix. prepare the map.

Producing a map to show the chance of involvement in road accident

i. select the layers stadium, lakes, FCC roads, district, and black spot junction/ road

ii. select black spot junction/ road and double click same

iii. the legend editor appears

-the theme shows black spot road/ junction

-select 'graduated symbol' in legend type

-select denominator variable (i.e traffic vol.) in the classification field

-normalize the variable with other variables

invert the data to read like veh. inv/traffic vol.

iv. small dot means least chance of involvement

v. click apply and prepare the map.

Producing a map to show the rescue capability in FCC (i.e police post < 500meters from black spot or black spot < 1 km from hospital and so on)

i. select the layers of stadium, lakes, FCC roads, and black spot road and junction

ii. highlight the black spot road, hold down the shift key and highlight black spot road and Police/FRSC post respectively.

iii. Press open theme table button and the attribute tables of the three highlighted themes appear.

-click join button to join the tables

-After joining the tables a fields distances appear in the attribute table

-click query button. In it's field list double click distance < 500m and click new set

-the black spot with distances less than 500 would be highlighted with yellow color in the attribute table and map page

iv. prepare the map

Exporting the digitized map from Arc view to Word

1. Open Arc view; select the desired theme to be represented on the map
2. Open theme properties, activate and then delete the extension (.shp) of the theme one after the other.
3. Open view properties and fix the scale off the map unit to meters and distance Unit to Kilometers and click the OK button. From the same open view, click layout and Pick portrait.
4. Pick tools and adjust the map view as desired i.e. scale, bearing, title etc.
5. Open file, pick export, give a file name to the map, select the drive, give file name (Window Bit Map) and minimize the view.
6. Open Word document (my PhD thesis), select insert, pick picture from file, select drive Of Origin "C" and put in the file name given earlier, select the file type earlier selected (Bitmap),
7. Click the location of the map from the drive of origin and click OK.

Procedure for SPSS analysis

- Pick the tool analyse
- Open report the summary in column

- Put all accident variables in the data column
- The result show sum for junction /road etc for each of the variable
- With this you can compare Junction /road etc
- Put all acc variable in dependent variable column and put description, or year, period etc in the factor column
- Then pick compare then one-way ANOVA
- Where the value of level of significance is above 0.05 (95%) the result is insignificant.

Procedure for drawing SPSS graphs

- Pick graph
- Select type of graph
- Chose chart
- Indicate how chart should be organized (i.e Summary of cases, separate etc)
- Press define
- A box appears, the put month/ day/ hour/date in define column
- Put location/district/description, in category column
- Click Ok

APPENDIX VIII

ar =1999 =2000	Location 1-48	Description 1-junction 2=road	Districts 1=Maitam 2=wuse etc	Day, Month, Hour, Date	Day class 1=earlyweek 2=weekend 1=day 2=Night 1=Dry 2=Rain 1=Earlmonth 2=Monthend	Acctype	acasu	acause	Vehinv

PROCEDURE FOR SPSS ANALYSIS

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ACCTYP	Between Groups	20.841	1	20.841	.259	.611
	Within Groups	37676.055	469	80.333		
	Total	37696.896	470			
ACCASU	Between Groups	312.215	1	312.215	2.718	.100
	Within Groups	46870.910	408	114.880		
	Total	47183.124	409			
ACCAUSE	Between Groups	39.005	1	39.005	.260	.610
	Within Groups	67493.729	450	149.986		
	Total	67532.735	451			
ACCVEINV	Between Groups	.417	1	.417	.043	.836
	Within Groups	4125.854	427	9.662		
	Total	4126.270	428			
TRAFVOL	Between Groups	1528347.372	1	1528347.372	5.818	.016
	Within Groups	440821252.911	1678	262706.349		
	Total	442349600.283	1679			

day Classification	acctyp Sum	accasu Sum	accause Sum	accveinv Sum	trafvol Sum
	.	.	.	.	.
Early week	2142.00	1479.00	3557.00	855.00	495860.00
Week end	1319.00	1084.00	2061.00	524.00	415778.00

RTA DURING EARLY WEEK AND WEEKEND IN FCT (1999-2003)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ACCTYPE	Between Groups	.585	1	.585	.018	.894
	Within Groups	18683.792	564	33.127		
	Total	18684.376	565			
ACCASU	Between Groups	11.919	1	11.919	.566	.452
	Within Groups	11034.537	524	21.058		
	Total	11046.456	525			
ACCAUSE	Between Groups	145.822	1	145.822	2.864	.091
	Within Groups	29582.037	581	50.916		
	Total	29727.859	582			
VEHINVOL	Between Groups	13.772	1	13.772	4.143	.042
	Within Groups	5421.783	1631	3.324		
	Total	5435.555	1632			
TRAFVOL	Between Groups	241.599	1	241.599	.194	.659
	Within Groups	7120918.414	5729	1242.960		
	Total	7121160.013	5730			

Hour Classification	acctype Sum	accasu Sum	accause Sum	vehinvol Sum
Day	2002.00	1557.00	3121.00	1015.00
Night	1297.00	601.00	1404.00	543.00

RTA FOR DAY AND NIGHT IN FCT (1999-2003)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ACCTYPE	Between Groups	29.096	1	29.096	.511	.475
	Within Groups	28698.811	504	56.942		
	Total	28727.907	505			
ACCASU	Between Groups	46.296	1	46.296	.644	.423
	Within Groups	31351.595	436	71.907		
	Total	31397.890	437			
ACCAUSE	Between Groups	529.811	1	529.811	.301	.583
	Within Groups	867660.956	493	1759.961		
	Total	868190.768	494			
VEHINVOL	Between Groups	3.958	1	3.958	.746	.388
	Within Groups	2567.375	484	5.304		
	Total	2571.333	485			

Warnings

There are fewer than two groups for dependent variable TRAFVOL. No statistics are computed.

Month Classification	acctype Sum	accasu Sum	accause Sum	vehinvol Sum
.	.	.	.	.
Dry season	1541.00	1137.00	2716.00	689.00
Rainy season	1864.00	1407.00	3679.00	733.00

RTA DURING DRY AND RAINY SEASON IN FCT (1999-2003)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ACCTYPE	Between Groups	4.805	1	4.805	1.044	.307
	Within Groups	34241.104	7438	4.604		
	Total	34245.909	7439			
ACASU	Between Groups	18.294	1	18.294	.768	.381
	Within Groups	12381.292	520	23.810		
	Total	12399.586	521			
ACCAUSE	Between Groups	1.787	1	1.787	.055	.814
	Within Groups	19879.370	617	32.219		
	Total	19881.157	618			
VEHINVOL	Between Groups	.303	1	.303	.357	.550
	Within Groups	6316.587	7438	.849		
	Total	6316.890	7439			

Warnings

There are fewer than two groups for dependent variable TRAFVOL. No statistics are computed.

date classification	acctype Sum	acasu Sum	accause Sum	vehinvol Sum
.	.	.	.	.
early month	2246.00	1353.00	2933.00	1082.00
month end	1200.00	783.00	1508.00	548.00

RTA DURING EARLY MONTH AND MONTH END IN FCT (1999-2003)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ACCTYP	Between Groups	1321.622	4	330.406	4.225	.002
	Within Groups	36368.227	465	78.211		
	Total	37689.849	469			
ACCASU	Between Groups	3700.592	4	925.148	8.602	.000
	Within Groups	43449.403	404	107.548		
	Total	47149.995	408			
ACCAUSE	Between Groups	4027.283	4	1006.821	7.087	.000
	Within Groups	63505.452	447	142.070		
	Total	67532.735	451			
ACCVEINV	Between Groups	130.827	4	32.707	3.471	.008
	Within Groups	3995.443	424	9.423		
	Total	4126.270	428			

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ACCTYPE	Between Groups	446.225	4	111.556	1.976	.097
	Within Groups	28281.682	501	56.450		
	Total	28727.907	505			
ACCASU	Between Groups	3047.736	4	761.934	11.637	.000
	Within Groups	28350.155	433	65.474		
	Total	31397.890	437			
ACCAUSE	Between Groups	10538.477	4	2634.619	1.505	.199
	Within Groups	857652.290	490	1750.311		
	Total	868190.768	494			
VEHINVOL	Between Groups	59.137	4	14.784	2.831	.024
	Within Groups	2512.196	481	5.223		
	Total	2571.333	485			

Years	acctype Sum	accasu Sum	accause Sum	vehinvol Sum
.	.	.	.	.
1999	261.00	679.00	642.00	130.00
2000	559.00	604.00	945.00	273.00
2001	977.00	501.00	1174.00	383.00
2002	1137.00	455.00	1883.00	438.00
2003	471.00	305.00	1751.00	198.00

There are fewer than two groups
dependent variable TRAFVOL.
statistics are comput

RTA DATA ACCORDING TO THE YEAR OF OCCURRENCE

		Sum of Squares	df	Mean Square	F	Sig.
ACCTYPE	Between Groups	926.957	1	926.957	16.805	.000
	Within Groups	27800.950	504	55.161		
	Total	28727.907	505			
ACCASU	Between Groups	715.766	1	715.766	10.171	.002
	Within Groups	30682.125	436	70.372		
	Total	31397.890	437			
ACCAUSE	Between Groups	6635.528	1	6635.528	3.797	.052
	Within Groups	861555.239	493	1747.577		
	Total	868190.768	494			
VEHINVOL	Between Groups	31.008	1	31.008	5.908	.015
	Within Groups	2540.325	484	5.249		
	Total	2571.333	485			

Description	acctype Sum	accasu Sum	accause Sum	vehinvol Sum
.	.	.	.	.
Junction	1448.00	1151.00	2881.00	729.00
Road	1957.00	1393.00	3514.00	693.00

RTA DATA BY DESCRIPTION OF ACCIDENT SPOT

		Sum of Squares	df	Mean Square	F	Sig.
ACCTYPE	Between Groups	6502.522	9	722.502	16.124	.000
	Within Groups	22225.385	496	44.809		
	Total	28727.907	505			
ACCASU	Between Groups	1514.868	9	168.319	2.411	.011
	Within Groups	29883.022	428	69.820		
	Total	31397.890	437			
ACCAUSE	Between Groups	10579.560	9	1175.507	.665	.741
	Within Groups	857611.208	485	1768.271		
	Total	868190.768	494			
VEHINVOL	Between Groups	313.347	9	34.816	7.340	.000
	Within Groups	2257.987	476	4.744		
	Total	2571.333	485			

ACIDENT DATA IN EACH DISTRICT

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
ACCTYPE	Between Groups	7911.470	47	168.329	3.704	.000
	Within Groups	20816.437	458	45.451		
	Total	28727.907	505			
ACCASU	Between Groups	4915.914	47	104.594	1.540	.016
	Within Groups	26481.976	390	67.903		
	Total	31397.890	437			
ACCAUSE	Between Groups	64458.045	47	1371.448	.763	.874
	Within Groups	803732.723	447	1798.060		
	Total	868190.768	494			
VEHINVOL	Between Groups	521.502	47	11.096	2.371	.000
	Within Groups	2049.831	438	4.680		
	Total	2571.333	485			

There are fewer than two groups for dependent variable TRAFVOL. No statistics are computed.

Location	acctype Sum	accasu Sum	accause Sum	vehinvol Sum
Apo	64.00	39.00	111.00	39.00
Area 1airport	16.00	93.00	66.00	10.00
Wuye/FRSC	45.00	12.00	60.00	22.00
Berger R/About	134.00	73.00	157.00	44.00
Mabuchi/R/About	47.00	56.00	133.00	41.00
N Zik/IBB	85.00	71.00	183.00	83.00
N Zik/NICON	117.00	118.00	314.00	70.00
N Zik/Bannex	695.00	366.00	926.00	226.00
Min hill/Whiz pet	134.00	78.00	244.00	42.00
Nat uni/Mait/airport	17.00	18.00	59.00	32.00
AIron/AP pet	135.00	116.00	116.00	26.00
A Bello/Ademola	7.00	138.00	38.00	12.00
A Bello/IBB/ECWA	17.00	40.00	76.00	19.00
Wuse/Iluobe	77.00	31.00	171.00	36.00
Wuse old	152.00	53.00	108.00	74.00
zone 4/IBB	176.00	83.00	343.00	61.00
NNPC/Nat mosq	335.00	216.00	570.00	112.00
A Bello/Rsodind	3.00	25.00	128.00	35.00
T Balew/W Cent/indep	60.00	127.00	1102.00	53.00
Area 10/Def HQ	47.00	58.00	86.00	21.00
Obasanjo/Bolig/Indep	34.00	33.00	13.00	9.00
ABello/Buhar/Gark	16.00	19.00	15.00	14.00
T Balew/Area 3/kuti	45.00	21.00	111.00	22.00
Power ho/Asokoro	132.00	114.00	81.00	21.00
Jabi/Asokor	42.00	14.00	85.00	14.00
AYA	42.00	44.00	69.00	17.00

Location	acctype Sum	accasu Sum	accause Sum	vehinvol Sum
Karu	35.00	52.00	73.00	19.00
B/4 city gate	59.00	39.00	89.00	24.00
lugbe/k/goro/Airport	41.00	20.00	41.00	17.00
3 Arm zone	25.00	53.00	113.00	31.00
Nyanyan	33.00	31.00	20.00	13.00
Sagari/Fikko/Area II	32.00	33.00	21.00	11.00
A Bello/Benue pla	34.00	.	110.00	14.00
Shagari/Fed sec	11.00	6.00	9.00	6.00
H Macau/Mailam/war coll	24.00	26.00	9.00	5.00
Abator/M muhmd	21.00	.	5.00	9.00
T Balew/Area 7	12.00	10.00	23.00	8.00
N mkt/zon 1	23.00	15.00	31.00	11.00
Wuse zo 5/Ibro	5.00	.	4.00	3.00
H Macau/z-6/NEPA	19.00	11.00	.	6.00
Sherato/M drive	26.00	15.00	26.00	.
Kubwe exp	21.00	30.00	57.00	10.00
zone2/Obasanjo	34.00	12.00	39.00	5.00
karmo	27.00	28.00	79.00	11.00
Life camp	69.00	58.00	148.00	27.00
Durumi/Kado	51.00	36.00	72.00	9.00
Deide/Suleja	102.00	5.00	36.00	17.00
Zuba/giri/G/lada	27.00	8.00	25.00	11.00

SUMMARY OF DATA COLLECTED BY LOCATION OF ACCIDENT (1999-2003)

APPENDIX IX

day of week	acctyp Sum	accasu Sum	accause Sum	accveinv Sum	trafvol Sum
.	.	.	.	.	.
Monday	505.00	342.00	821.00	210.00	118329.00
Tuesday	607.00	379.00	879.00	197.00	119477.00
Wednesday	576.00	343.00	930.00	205.00	134085.00
Thursday	454.00	415.00	927.00	243.00	123969.00
Friday	463.00	362.00	822.00	197.00	148097.00
Saturday	371.00	246.00	602.00	163.00	134435.00
Sunday	485.00	476.00	637.00	164.00	133246.00

DAILY SUMMARY OF DATA COLLECTED (1999-2003)

Months	acctype Sum	accasu Sum	accause Sum	vehinvol Sum
.	.	.	.	.
January	263.00	179.00	450.00	112.00
February	266.00	158.00	426.00	126.00
March	294.00	189.00	509.00	121.00
April	279.00	233.00	399.00	108.00
May	260.00	119.00	516.00	107.00
June	263.00	188.00	432.00	97.00
July	185.00	140.00	310.00	91.00
August	400.00	232.00	1469.00	170.00
September	289.00	245.00	486.00	146.00
October	446.00	418.00	547.00	124.00
November	281.00	184.00	435.00	105.00
December	179.00	259.00	416.00	115.00

DAILY SUMMARY OF DATA COLLECTED (1999-2003)

Hour	acctype Sum	accasu Sum	accause Sum	vehinvol Sum
1.00	22.00	12.00	70.00	11.00
2.00	6.00	54.00	94.00	31.00
3.00	6.00	34.00	69.00	14.00
4.00	26.00	38.00	152.00	29.00
5.00	20.00	89.00	184.00	37.00
6.00	21.00	52.00	132.00	36.00
7.00	28.00	85.00	190.00	41.00
8.00	90.00	175.00	271.00	73.00
9.00	71.00	140.00	209.00	57.00
10.00	114.00	92.00	331.00	75.00
11.00	107.00	88.00	157.00	39.00
12.00	39.00	99.00	277.00	81.00
13.00	169.00	104.00	192.00	85.00
14.00	194.00	105.00	191.00	63.00
15.00	159.00	103.00	193.00	83.00
16.00	314.00	144.00	265.00	103.00
17.00	349.00	127.00	282.00	119.00
18.00	327.00	154.00	247.00	123.00
19.00	293.00	114.00	224.00	90.00
20.00	301.00	142.00	295.00	148.00
21.00	174.00	59.00	197.00	81.00
22.00	151.00	95.00	148.00	74.00
23.00	107.00	32.00	71.00	38.00
24.00	211.00	21.00	84.00	27.00

DAILY SUMMARY OF DATA COLLECTED (1999-2003)

DATE	acctype Sum	acasu Sum	accause Sum	vehinvol Sum
1.00	95.00	49.00	174.00	60.00
2.00	176.00	48.00	138.00	72.00
3.00	112.00	84.00	143.00	48.00
4.00	114.00	28.00	132.00	60.00
5.00	67.00	29.00	119.00	42.00
6.00	157.00	69.00	143.00	58.00
7.00	77.00	28.00	84.00	25.00
8.00	91.00	88.00	144.00	61.00
9.00	129.00	90.00	189.00	63.00
10.00	119.00	101.00	198.00	56.00
11.00	66.00	53.00	122.00	41.00
12.00	75.00	65.00	120.00	27.00
13.00	93.00	108.00	206.00	61.00
14.00	150.00	89.00	154.00	55.00
15.00	88.00	50.00	140.00	51.00
16.00	118.00	74.00	163.00	61.00
17.00	98.00	58.00	85.00	37.00
18.00	76.00	50.00	118.00	44.00
19.00	152.00	103.00	151.00	67.00
20.00	117.00	67.00	113.00	53.00
21.00	76.00	22.00	97.00	40.00
22.00	123.00	98.00	157.00	50.00
23.00	109.00	76.00	124.00	46.00
24.00	141.00	90.00	164.00	66.00
25.00	136.00	73.00	145.00	49.00
26.00	108.00	81.00	127.00	61.00
27.00	117.00	69.00	181.00	57.00
28.00	188.00	121.00	215.00	79.00
29.00	98.00	61.00	150.00	55.00
30.00	114.00	62.00	121.00	44.00
31.00	66.00	52.00	124.00	41.00

SUMMARY OF DATA COLLECTED BY DATES (1999-2003)