SPATIO-TEMPORAL ANALYSIS OF ROAD TRAFFIC ACCIDENT BLACK SPOTS IN KADUNA STATE, NIGERIA

BY

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DECLARATION

I hereby declare that the work in this dissertationentitled "**Spatio-Temporal Analysis of Road Traffic Accident Black Spots in Kaduna State, Nigeria**" has been carried out by the researcher Onyikwu Victoria, ABAH in the Department of Geography under the supervision of Professor I.J. Musa and Professor J.A. Ariyo. All information obtained from literature has been acknowledged in the text as well as the list of all references. No part of this dissertation was previously presented for another degree at this or any other institution.

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CERTIFICATION

This dissertationentitled "**Spatio-Temporal Analysis of Road Traffic Accident Black Spots in Kaduna State, Nigeria**" by OnyikwuVictoria, ABAH meets the regulations governing the award of the degree of Masters in Science Transport Management of Ahmadu Bello University, Zaria andis also approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to God Almighty for His loving kindness towards me.

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All praise, worship and glory to the Almighty God, the Creator of all things, whose mercy and grace saw me through all the challenges during the period of my study. To Him alone, is all adoration. My gratitude goes to my supervisors: Professor I.J. Musa and Professor J.A. Ariyo, who out of their tight schedules, devoted time, energy, and as well encouraged me to this level of success. To all Lecturers and Staff of Geography Department, I appreciate them all.

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ABSTRACT

This study analyzed the spatio-temporal pattern of road traffic accident black spots in Kaduna. Among the objectives were to determine the spatial pattern of road traffic accident black spot, examine its temporal variation, characterize road traffic accidents as well as assess the road way nature at the black spots. Road traffic accident data were collected from Federal Road Safety Commission (FRSC) from year 2006-2014. Also field survey was carried out through which the geographic coordinates of road traffic accident locations were taken as well as on the spot field observation. Data were analyzed using the Kernel Density Estimation method in ArcGIS 10.1 environment to determine the road accidents black spots and frequency distribution tables and charts in Statistical Package for Social Science (SPSS) and Microsoft Excel.The findings show that the black spots along Zaria-Kano road includes, Yan Karfe, Dogarawa, Zabi and Anur Mosque while Polo Field, MTD, Palladan and Zango account for those along Zaria-Sokoto road of which about 66% of the total road traffic accidents took place in the black spots identified along Zaria-Kano road with Dogarawa (23.8%) recording the highest while Palladan (11.3%) recorded the highest among those along Zaria-Sokoto road. The temporal variation reveals that year 2012-2014 has the highest number of road traffic accidents black spots of 10 locations accounting for about 63% of the total number of accidents recorded, while the least was between years 2009-2011 with 5 black spots representing only 23% of the total number of accidents. It was also observed that 75% and 60% of the road traffic accident black spots identified between years 2006-2008 and 2012-2014 respectively were along the Zaria-Kano road as against 25% and 40% along Zaria-Sokoto road during the same period. The study reveals that about 85% of the death cases as a result of road traffic accidents at the black spots were recorded along Zaria-Kano road with Anur Mosque (33%) having the highest, while only 3% represents the least recorded

at MTD along Zaria-Sokoto road whereas Dogarawa has the highest number of injured persons as a result of road traffic accidents.Regarding the road designs, most black spot locations were characterized by sharp bends, U-turn and intersections. Also, other road conditions like presence of potholes, eroded road shoulder and stationary vehicles were found at the various black spot locations. The study recommended among others, emergency healthcare services to be provided at the various black spots locations on the highways, road safety strategies like compulsory use of seat belts, legislation on speed limits should be strictly enforced by the FRSC, construction of road traffic signs especially at the black spot locations and education of the drivers on meaning of such signs.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The growth and development of a nation depends largely upon the capacity of its transport system to move persons and goods to desired locations safely (Abdul and Ansa, 2012). The provision of roads and transportation facilities are fundamentally important to the development of a country as well as the well-being of its inhabitants. Road transport is the most common used mode of transportation in Nigeria and accounts for more than 90% of the sub-sector and 3% contribution to the Gross Domestic Product (GDP). In developing countries like Nigeria, the performance of road sector has not been satisfactory despite its enormous potentials for growth and development (New Nigeria, 2009). Despite the undisputed roles and impact of road transport in the efficient functioning of a society, one of the unavoidable negative consequences is accident occurrence. The high incidence of road accident tends to easily erode the positive effects of road transport in the nation's economy (Bolade, 1991).

Road traffic accident as any vehicle accident occurring on a public highway which includes collisions between vehicles and vehicles, vehicles and animals, vehicles and pedestrians or vehicle and fixed obstacles (Rune and Truls, 2004). Road accidents are among the leading causes of death in many countries, partly as an inherent consequence of the increasing mobility of today's society (Iulian, 2013). Among all accidents, road traffic accidents claim the largest toll of human life and tend to be the most serious problem world over (Kual*et al.*, 2005). Worldwide, the number of people killed in road traffic accidents each year is estimated at almost 1.2 million while the number of people injured could be as high as 50 million (WHO,2004).

The number of reported cases of fatal road traffic accidents in Nigeria has shown an increasing trend from 12,212 accidents in 1995 to 13,913 in 1996 and 15,418 in 2004 indicating an increase of 13.9% in fatal road accidents from 1995 to 1996 (Central Bank of Nigeria, 1997). According to the Annual Abstract of Statistics (2008) between 2003 and 2007,a total of 225.891 accident cases were reported by the Nigeria Police Force, out of which 29,490 were fatal, 39065 were serious cases and 23,380 were minor cases.

Road accidents appear to occur regularly at some flash points such as where there are sharp bends, potholes and at bad sections of the highways (Atubi, 2009a). The locations that have abnormal high number of crashes are described as crash concentrated, high hazard, hazardous, hot spot or black spot (Reshina and Sheikh, 2012). Hotspot or a 'high risk site' is the number of personal injury accidents occurring in a 100m grid square or 100m length in a three year period on a particular class of road. Therefore if 12 accidents are recorded over a period of three years on a 100m length of road, then the area is deemed a high-risk site. Accident black spots denote those places or spots that are prone to road accidents or where road accidents are more concentrated on a road network. This often contributes to worsen the severity of a road accident (Gregory and Jarrett, 1994).

The road system, human and vehicular factors are the three elements that are inter-linked through geo-referenced traffic events which provide the basis for road safety analyzes as well as attempts to reduce the number of road traffic accidents and improve road safety (Centre for Advanced Spatial Analysis, 2013). Black spot safety is the task of improving road safety through alterations of the geometrical and environmental characteristics of the problematic sites in the existing road network. More specifically this task involves targeting and treating intersections and road sections with an unusual high number of accidents, the so-called black spots (Geurts and Wets, 2003). Black spotssafety

work may be divided into three phases which include; targeting black spots on the road network, prioritising the black spots to treat with safety improving measures and before and after studies of the effect of treatment (Vistisen, 2002).

Kaduna is known to be one of the cities associated with high traffic volume given that it serves as a link to other cities of the North and Southern parts of the country, as a result, much use of various automobile by its residents to meet their transportation needs. This might have resulted to increased road traffic accidents in recent times especially at certain locations along major roads in the state. The situation has become more worrisome and a source of concern to everyone especially its negative effects on the socio-economic activities.Hencethe need for efficient movement of people and goods is for sustainable economic development in the state.

1.2 Statement of the Research Problem

The nature of transportation provides enhanced opportunities, but it is also a risk to travellers, drivers and pedestrians (Tesfalem, 2010). In this regard, Mekete (2000) cited in Tesfalem (2010) indicated that despite the important positive role urban transport plays in economic, social and political activities of cities and towns, it also generates major social and economic problems through traffic accident. World Health Organization (1998) ranked road accidents as the 9^{th} leading cause of mortality in the world. It estimated that 1.17million death occur each year worldwide due to road traffic accident. According to Atubi (2012), a breakdown of the figure indicates however that about 70 per cent of the death occurs in developing countries like Nigeria.

Road traffic accidents' statistics in Nigeria reveal a serious and growing problem with absolute fatality rate and casualty figure rising rapidly. In majority of developing countries, including Nigeria, accident occurrence and related deaths are with increase in population and number of vehicles. In Nigeria, studies have indicated that better facilities

in terms of good quality and standardized roads have been accompanied by increasing number of accidents (Atubi and Onokala, 2009). In 1976 there were 53,897 road traffic accidents resulting in 7,717 deaths. Although in 1981, the magnitude reduced to 5,114 accidents, but the fatality increased to 10,236 whichmean that there was an average of 96 accidents and 28 deaths for everyday of that year (Ogunsanya, 1991) as cited in Atubi (2012). The situation in subsequent years has not been any better. The number of people killed in road accidents between 1990 and 2005 rose from 28,253 and the fatality rate remains consistently high (Atubi, 2009b).

Federal Road Safety Commission (FRSC) disclosed that Nigeria contributes about 700,000 deaths out of the 1.5 million people killed on road accidents all over the world annually (Business World, 2012). The pattern of road accidents in Nigeria seems to suggest that the better the road, the higher the accident and fatality rate as well as the severity and non-survival indices because of drivers' non-compliance with speed limits (Filani and Gbadamosi, 2007). Studies have also shown that most accidents in Nigeria today occur in federal roads, and the roads topping the list include Benin-Ore, Lagos-Ibadan Expressway, Abuja-Lokoja-Okene Kaduna-Zaria-Kano, Okigwe-Umuahia, Kaduna-Abuja, Enugu-Awka-Onitsha and Otukpo-Otukpa among others (Godwin, 2012).

Before now, several studies have been done on road traffic accidents like Atubi (2012) studied determinants of road traffic accident occurrences in Lagos State: Some Lessons for Nigeria. It was clear from the study that the human factor is the most potent contributor to motor vehicle accidents in Nigeria. This is not surprising because people pervade all aspects of traffic accident causation: from poor road construction, corrupt traffic law enforcement, to poor road user. Similarly, statistics indicate that over 90% of traffic accident situations in Nigeria can be attributed to driver errors (Aworemi and Alawode, 2009).

Similarly, Aworemi and Abdul-Azeez (2010) examined the causal factors of road traffic crashes in some selected states in South Western part of Nigeria. He used regression analysis to establish the relationship between human characteristics, vehicular characteristics, roadway characteristics, environmental characteristics, and road traffic crashes in the study areas. The findings of the study revealed that human, vehicle, roadway and environment had significant contributions of about 79.4% on the road traffic crashes in the study area.

Aderamo (2012) examined the spatial variation of road traffic accident casualties in Nigeria for the period 2004 to 2007. The author used multiple regressions to model the spatial pattern of road accident casualties in Nigeria for the study period. The results of the analyzed data depict a spatial variation of road traffic accident casualties across the 36 states and the Federal Capital Territory. The results revealed that Kaduna State was the only state with relatively very high level of motor vehicle deaths in the country.

However, the findings of the above studies only determined the rate of road traffic accidents as well as its causes with little or no attention to the identification of road traffic accident black spots and its treatment which helps to reduce the rate of accidents and the fatality. In the same view, Robertson (1992) opined that causes of motor vehicle crashes are multi-factorial and involve the interaction of a number of pre-crash factors that include people, vehicles and the road environment. The combined effect of these factors in a particular location has led to the development of accident black spots of which fatalities of road accidents at these spots are usually high.

In Kaduna State, there are roads that facilitate the movement of people and goods for different reasons to meet up their needs. In doing this, often it results into road traffic accidents which among the causes are; careless driving (human factor), vehicular condition and sometimes road way factor. Recently the road factors consisting of

potholes, poor culvert and sharp bends among others have resulted in the development of road traffic accidents black spotsi.e. locations/segments along the road with high occurrence of road traffic accidents. The development of these road traffic accident black spotshas further worsened the fatalities of road traffic accidents hence, the need to examine road traffic accident black spots in Kaduna State. It is this gap in knowledge that this research work intends to fill. This research provided answers to the following questions:

i. Where are the road traffic accident black spots in the study area?

ii. Are there temporal changes in the occurrence of road traffic accidents black spots?

iii. What is the nature of road traffic accidents at the black spots?

iv. What are the road characteristics at the road traffic accidents black spots?

1.3 Aim and Objectives of the Study

This study analyzed the spatio-temporal pattern of road traffic accident black spots in Kaduna with the view of treatment aimed at improving the road safety. The objectives of the study were to:

i. determine the spatial pattern of road traffic accident black spot in the study area

ii. examine the temporal variation of road traffic accidents black spots

iii. characterize road traffic accidents at the black spots; and

iv. assess the road way nature of the road traffic accidents at the black spots.

1.4 Significance of the Study

According to World Health Organization (WHO) and World Bank report on "The Global Burden of Disease" (1999), deaths from non-communicable diseases is expected to climb from 28.1million a year in 1990 to 49.7million by 2020 (an increase in absolute

numbers of 77%). Road traffic crashes will contribute significantly to this rise. According to the report, road traffic injuries are expected to move from ninth place to take third place in the rank order of disease burden by the year 2020.

Similarly, traffic crashes also impact on the economy of developing countries at an estimated cost 1-2% of a country's GNP per annum, as a result of mortality, morbidity and property-related costs (Fouracre and Jacobs, 1976; Jacobs and Sayer, 1983; WHO, 1989; Jabaan, 1989b and 1990; Downing, 1991). The socio-economic costs of road traffic accidents in Nigeria are immense. It has been estimated that person injured in accidents on Nigerian highways and streets no longer participate in the economic mainstream and this amounts to loss of labour of millions persons years to the nation (Pratte,1998). Moreover, Iulian (2013) identifying and analysing the road black spots (black spot) and black zones would help to improve road safety by acting against the common causes that create the spatial clustering of crash accidents.

1.5 Scope of the Study

The spatial scope of this research work covered Zaria-Sokoto road from PZ to Giwa village and Zaria-Kano from Zaria to Makarfiin Kaduna State while the content scope covered road accidents along these roads, their specific location, nature of the accident (number of fatal, serious, death and injured) as well as the road characteristics at the road traffic accidents black spots. The temporal scope of the study covered recorded road traffic accident cases between 2006 till2014with Federal Road Safety Commission (FRSC). This period was chosen based on data availability.

CHAPTER TWO

THEORETICAL/CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Introduction

This chapter applies various bodies of theories in social and behavioural science, predominantly emphasizing on system theory, risk theory, political ecology approach, including literature review. The geographical approach concerning time factor, spatial variation and regional distribution are also used in the study.

2.2 Theoretical Framework

Road traffic accident may also be defined as anything which happens by chance, anything occurring unexpectedly and un-designed (Agbonkhese *et al*., 2013). Road traffic accident is the collusion between two or more vehicles, a vehicle and cyclist, a vehicle and a pedestrian, a vehicle and a fixed object such as a bridge, building, tree, post, or single vehicles that overturned on or near a public road (Faturoti, 2014). Several theories have been used to explain road traffic accidents and road safety management. The relevant ones to this study are discussed below.

2.2.1 System Theory

The first theoretical approach of the study is the system approach. Explanations of the systems theory are based on man-environment adjustments and maladjustments (Muhlrad *et al*., 2005). The components of the theory are the environment, the means of transport (vehicles) and the behaviour of man (Krug *et al*., 2000). The environment component comprises of the natural and the built environments and transport networks. The means of transport component comprises of the volume and quality of vehicles on the modes of transport. The behaviour of man component comprises of demographic characteristic of road users (age, sex, education, socio-economic status, stage in life cycle), people's perceptions of risk and people's general behaviour on the streets.

Integrated in the systems theory is a system of highway codes and enforcement mechanisms designed to ensure that road users adhere to the controls and regulations of traffic flow for maintaining road traffic safety. Comprehensive traffic management should be sufficient to maintain road traffic safety (Haur, 1995 and Button, 1993).

Thus, the relevance of systems theory in understanding the accident black spotcan be seen at three different levels**.** First, the theory helps to identify the system of traffic laws, regulations and mode of enforcement designed to ensure traffic safety in Zaria. Second the model help to identify the multiple causes' interplay of risk factors and prevention of traffic accidents that occur in the study area. Third, the model assist in identifying/understanding the three major contributory factors of road traffic accident including human, mechanical (vehicle) and road environment factors.

2.2.2 Risk Theory

Risk theory has also been used in the description of accident causation. A common agreed upon definition of risk is yet to be articulated. Risk can for instance be defined as subjective assessment of probability for a specific occurrence of a negative event, and how concerned individual is with the consequences of this event (Sjorberg 1983, Rundmo 2004; Moen 2005), thus the combination of perceived probability and severity of consequences , relate to how the individual perceive risk.

According to Dejoy (1989) in road traffic, risk is the function of four elements. The first is the exposure-the amount of movement or travel, within the system by different users or a given population density. The second is the underlying probability of crash, given a particular exposure. The third is the probability of injury given a crash. The fourth element is the outcome of injury. Risk can also be explained by human error (Reason, 2000; Rasmussen, 1999); kinetic energy, tolerance of human body and post-crash care (Bustide*et al*., 1989). Lupton (1999) also asserts that risks can be seen from

four perspectives. These are the rationalist, realist, constructionist and middle positions. The rationalist sees risks as real world phenomena to be measured and estimated by statistics, prioritized by normative decision theory and controlled by scientific management. The realist sees risks as objective hazards or threats that exist and can be estimated independently of social and cultural processes but that may be distorted or biased through social and cultural frameworks of interpretation. The constructionist sees nothing as a risk in itself. Rather, what is understood to be a risk, the constructionist sees as the product of historically, socially and politically contingent ways of seeing. Proponents of the middle positions between realist and constructionist theory see risk as an objective hazard or threats that is inevitably mediated through social and cultural processes and can never be known in isolation from these processes (Jaeger *et al*., 2001; Horden, 2004).

The second main theoretical approach this study is related to risk perception and the relation between risk judgments and decision under uncertainty. A variety of factors have been suggested to predict risk perception. Rundmo (2004) identified that poverty and poor countries exhibit a higher risk tolerance culture are the relevant approach in understanding why people neglects risk because of being influenced by other existing risks, in a high risk society people are experiencing several severe risks. Furthermore, risk is associated with personality traits and attitudes. Some people prefer a higher risk level, so called sensation-seekers, most likely in all types of society or cultures (Zuckerman, 1979). Existing literature on traffic accidents have noted the fact that whiles rates of accidents have fallen in industrialized countries, it is rather on the increase in developing countries. As the developing countries are characterized by poverty, majority of the people living in these countries are exposed to various risk situations every day. Risk can

be assessed as an “objective” phenomenon or a social cultural or subjective “phenomenon” which could be socially construction (Lupton, 1999).

Several variables are thought to influence risk perceptions among the public. Information about risk from various social relations and the media are for example thought to shape how individuals and societies approach potential risks (Slovic, 1987). A consequence is that the public do not always associate objectively more dangerous activities (Olterdal, Moen, Klempe and Rundmo, 2004). For instance, in Egypt the statistical probability of being injured in traffic is larger than being struck by a terrorist attack. Still many western tourists tend to worry more about terrorism than traffic accident. During their stay in this country, this example indicates that risk should be regarded as the multi-dimensional concept, which is not always congruent with objective statistical calculations.

When people perceive risk several aspects have to be taken into consideration. The first is the probability of a negative event and the severity of consequences of such an event. In addition, processing theories and appraisal theories account for how affect influences such judgments. The result of several researches carried out previously on road traffic accidents have shown that greater the consequences of the negative event, the more affect will be present when thinking about the risk source and the more precautionary action to avoid an accident is expected (Rundmo and Iversen, 2004). According to Thompson *et al*. (2002), risk compensation is the name given to a theory which states that an individual provided with a protective device such as automobile seatbelts will act or behave in a riskier manner because of the increase sense of protection from the seatbelt and thereby nullify the protection afforded by the seatbelt.

Wilde (2002) stated that individual’s risk-taking decisions represent a balancing act in which perceptions of risk are weighed against propensity to take risk. The

propensity to take risk is influenced by expected rewards and as a perceived threats or danger increase, people respond by being more careful. There is therefore a balancing behaviour influenced by perceived danger and propensity to take the risk which in turn influences accidents and rewards. If the perceived risk of a situation exceeds our target level, we will act to reduce it and if the perceived risk is lower than the target level, we will attempt to increase our risk back to our target level (risk optimization) through more dangerous actions. Wilde's name for this process is risk compensation. The author viewed risk homeostasis as therefore an extreme form of behavioural adaptation, not only do we modify our behaviour in response to external changes design to make us more or less safe but we seek to counteract these changes completely and return to our desired risk level.

The target level of accident risk is determined by four categories of motivating factors. First is the expected advantage of comparatively risks behaviour alternatives: for instance gaining time by speeding or over speeding when roads are good (risk compensation). Second is the expected cost of comparatively risks behaviour alternatives: for instance automobile repair expenses and insurance surcharges for being at fault in an accident (Wilde, 2002). Three is the expected benefits of comparatively safe behaviour alternatives. For instance the psychology of insurance discount for accident-free driving, and fourth are the expected costs of comparatively safe behaviour alternatives: for instance, using an uncomfortable seatbelt (Wilde, 2002).

2.2.3 Jørgensen and Abane Model for Traffic Accidents

Traffic accidents bear strong elements of man-environment adjustments and maladjustment a well-known approach in geography (Muhlrad *et al.*, 2005). Based on the logic of a modified human ecological model of a disease the approach can be transferred to studies of road traffic accident. A model for traffic accident as inspired by the ecological model of a disease was developed by Jørgensen and Abane (1999) who made a

heuristic adjustment of this basic model to suit road traffic accident analysis. The model is characterized by three main components:

i. The vehicle (corresponding to the vector in disease ecology) which describes vehicles into its composition, age, technical conditions and safety equipment like seat belts in a car.

ii. The environment, comprising the road system and the wider physical and built up environment. The physical environment splits further into different aspects such as; Daylight and climate (weather conditions and road conditions), Spatial conditions (arrangements and Macro structures), Settlement pattern (Urban or rural/sparse or populated area), situation of areas of residence and working areas, Principle of traffic separation, topography and road constructions qualities.

iii. The behaviour of the population; including its characteristics such as age and sex ratio as well as attitudes and general traffic behaviour. And it goes further into driving behaviour, driving experience, driving style, risk compensation and risk driving (influence of alcohol and drugs)

Superimposed on this model is a system of traffic laws, regulations and mode of enforcement designed to ensure that the population adheres to the controls and regulations so as to maintain some level of road safety i.e. traffic rules (speed restrictions, road signs), speed controls and convictions for various road traffic offences (ibid). The model is used as a framework for understanding the multiple causes and prevention of traffic accidents that occur in cities developing countries. Available literature identifies traffic accidents in a place as been caused either by physical factors in the road system (environment), the vehicle or behaviour factors, and how they interact with enforcement regulations in unique settings.

2.3 Conceptual Framework

2.3.1 Road Traffic Accident Black Spot

There is very little information in the literature as to what is an accident ‘black spot’ and how it is defined spatially and numerically e.g. the absolute and relative incidence of events. This lack of a readily available definition highlights the high margin for error when analyzing road traffic ‘black spot’. For example, a study by Gregory and Jarrett (1994) into the long term analysis of accident remedial measures at high risk sites in Essex delenede a black spot or in their words a ‘high risk site’ by the number of personal injury accidents occurring in a 100m grid square or 100m length in a three year, one year or six month period on a particular class of road. Therefore, if 12 accidents are recorded over a period of three years on a 100m length of road, then the area is deemed a high-risk site (Gregory and Jarrett, 1994).

At a practical level because there is no standardization of what constitutes as a black spot, it is very challenging to undertake any sort comparative analysis of all the results would be open to interpretation (Anderson, 2003). It is the police forces and local authorities, whichare deeply affected by this lack of guidelines and standardization. In order to reduce the hotspots and ‘high-levels’ of accidents in one specific area, the exact cause of the black spots must be established. In other words, the black spot is there because of a high number of accidents but the cause of the accidents may differ. For example; some incidents could be caused by weather conditions, others by a blind bend and others because it is near a public house, and all of these factors put together can cause a ‘hotspot’, but take the accident rate on their own (i.e. the independent causation factor) and the area may not be a hotspot (i.e. the problem of equifinality of outcome).

2.3.2 Road Traffic Accident Black Spot Analysis

Black spots, which are defined as relatively high-risk locations, are commonly identified on the basis of some specific selection criteria. Many different methodologies and criteria have been developed for improving the accuracy of the black spot identification process, thus the cost-effectiveness of a safety improvement program (Highway Safety Manual [HSM], 2010). One of the most commonly used selection criteria is defined by the expected collision frequencies at the sites of interest. According to Tarko and Kanodia (2003), this particular criterion emphasizes on maximizing the system-wide benefits of safety intervention targeted to the black spots, whereas another commonly implemented criterion is considering the expected collision rate (i.e., expected collision frequency normalized by traffic exposure) which emphasizes on individual road user's equity perspective.

The expected collision frequency at a site is commonlyestimated using a collision model-based approach, in which collision frequency is statistically modeled as a function of some relevant features such as road characteristics, traffic exposure, and weather factors (Cheng and Washington, 2008).The expected crash frequency could also be estimatedusing a geo-statistical technique by considering the effects of unmeasured confounding variables through the concept of spatial autocorrelation between the crash events over a geographical space (Pulugurtha, Krishnakumar and Nambisan, 2007). Kernel Density Estimation (KDE) is an example which has been used in road safety to study the spatial pattern of crash and identify the black spots (Blazquez and Celis, 2013). Similarly, there are othergeo-statistical methods such as clustering methods that evaluate relative risk based on their degree of association with its surroundings. Examples of these methods used in road safety studies are K-mean clustering (Kim and Yamashita, 2004), nearest neighborhood hierarchical (NNH) clustering (Kundakci and Tuydes-Yaman,

2014), Moran's I Index, and Getis-OrdGi statistics (Prasannakumar, Vijith, Charutha and Geetha, 2011). Anderson (2009) applied KDE method in the City of Afyonkarahisar, Turkey. In this study, the authors were able to detect highly crash risk sections which were highly concentrated in road intersections. Similarly, Keskin, Yenilmez¸ Olak, Yavuzer and Du¨zgu¨n (2011) and Blazquez and Celis (2013) used KDE and Moran's Index method to observe temporal variation of hotspots across the road network.

Furthermore, Lu (2000) compared kernel density to other spatial analysis techniques and found out that Kernel density is more reliable and desirable for hot spot analysis. Lu has the following observations: "First, kernel density uses more information about point distribution than virtually all distance view cluster algorithms. A continuous density surface is generated over all locations to let data pattern show itself. Users can visually inspect the variability of density over the whole surface and identify black spot depending on his/her observation point of view. Second, since density is a measurement of magnitude, in addition to showing spatial clustering, black spots are comparable over space as well as between studies. Algorithms based on spatial separation of observations are shy to support the quantitative comparison of black spots. Third, kernel density technique is more arbitrariness free and provides relatively stable analysis results to user." It is for this reason that Kernel density was adopted in this study.

2.4 Literature Review

Urban transport problems remain one of the most nagging problems in urban transportations today. All over the world, attempts have been made to tackle the problems, yet the situation seems to get worse. Cities are centres of economic, social, cultural and intellectual activities. Among the most notable urban transport problems are traffic congestion and parking difficulties; longer commuting; public transport inadequacy; difficulties for non-motorised transport, less of public space, environmental

impacts and energy consumption, accident and safety, land consumption and freight distribution (Aderamo, 2012). With the rapid development of economy, road transportation system is playing an increasingly role in comprehensive transportation system. However, the occurrence of traffic accident shows a rising tendency as a result of the quick growing of motor vehicles (Ali, Ieyla, Ahmad and Abdolreza, 2011).

Road Traffic accident (RTA) can be said to be an unplanned occurrence of auto crash that may result in injuries, loss of lives and properties. RTA is having a worsening effect on our society and economy. RTA claims the largest toll of human life and tends to be the most serious problem all over the world (Kual*et al.,* 2005). Worldwide, the number of people killed in RTA each year is estimated at almost 1.2 million while the number of people injured could be as high as 50 million (WHO, 2004). Currently, motor vehicle accidents rank 9th in order of disease burden and are projected to be ranked 3rd in the year 2020. Nearly three-quarters of deaths resulting from motor vehicle crashes occur in developing countries (Odero, 1998) and this problem appears to be increasing rapidly in these countries (Jacobs *et al.,* 2000).

The World Bank (1990)study, calculated that, worldwide, there are around 500,000 fatalities and 15 million injuries per annum as a result of road accidents. Earlier estimates also suggest that about sixty percent of these deaths and injuries take place in those countries of Africa and Asia which are classified by the World Bank as low or middle income (World Bank, 1990 and Yerrell, 1992).

2.4.1 Road Traffic Accident Fatality

Fatalities as a result of road accidents have become more significant in Less Developed Countries in recent years. For example, in Africa, road accident fatalities have risen by over 300 percent since 1968, while over the same time period road accident fatalities in industrialized countries have fallen. There were some 500,000 road accident

fatalities per annum, worldwide, of which around 70% occur in the developing world. While for example developed countries have experienced a decreasing trend since the 1960s, the fatality rate in African countries ranges from 10-fold to more than 100-fold of those in the United States (Chen, 2010; Jacobs, Aeron-Thomas and Astrop, 2000; Peltzer and Renner, 2004). Lagarde (2007) also reported that while South-East Asia has the highest proportion of global road fatalities (one-third of the 1.4million occurring each year in the world), the road traffic injury mortality rate is highest in Africa (28.3 per 100,000 population) compared with 11.0 in Europe. Indeed, if major efforts are not made to reverse the trend, it is feared that road traffic crash fatality rate in Africa as a whole is anticipated to increase by 80 per cent between 2000 and 2020 (Peden*et al.,* 2004).

Nigeria has the highest rate of fatalities from motor accidents in Africa according to statistics compiled by the Federal Road Safety Commission (FRSC). Nigeria leads 43 other nations with 230 deaths Per 10,000 vehicle crashes followed by Ethiopia, Malawi and Ghana with 219, 183 and 178 deaths per 10,000 vehicles respectively (Daramola, 2004). International comparison indicates that the chance of a vehicle killing someone in Nigeria is 47 times higher than in Britain. The proportion of fatalities to injuries reported is also very high. For example, while Czech Republic has only one death in 197 accidents, France, one death in 175, South Africa, one death in 47 accidents, Nigeria has one death in 2.65 accidents (Atubi, 2010). Accidents may be fatal, resulting in deaths of the road users (passengers, drivers or pedestrians), or minor when it is not severe enough as to cause substantial hardship (Agbonkhese*et al.,* 2013). Road accidents are usually classified as being fatal if a victim dies within 30 days of the accident occurring.

2.4.2 Causes of Road Traffic Accident

Agbonkhese*et al*. (2013) opined that causes of road traffic accidents depend on a list of factors which can be broadly divided into:

i. Vehicle operator or driver factors

ii. Vehicle factors

iii. Road pavement condition factors

iv. Environmental factors.

2.4.2.1 Driver Factors

Driver factors in road traffic accidents are all factors related to drivers and other road users. However, unlike the findings ofTraffic Accident Causation inEurope (TRACE) cited in Agbonkhese *et al*. (2013), Nigerian studies and road traffic accident records have clearly shown that the attitude of the Nigerian driver to driving code and etiquette is the single most important contributing factor as driver factors solely contributes to about 57% of road traffic accidents and 93% either alone or in combination with other factors.Driver-related issues include:

Speed and Indiscriminate Use of Sirens: An increase in average speed is directly related both to the likelihood of a crash occurring and to the severity of the consequences of the crash. Travelling too fast for prevailing conditions or above the speed limit contributes to road traffic accidents. The risk of being injured increases exponentially with speed much faster than the average speed. The severity of accident depends on the vehicle speed change at impact and transfer of kinetic energy. Though vehicles travelling slower than average speed are also at increased risk of road traffic accidents, most involved speed too fast for the conditions.

Drink-driving and Use of Drugs: Drinking and driving increases both the risk of a traffic accident and the likelihood that death or serious injury will result. The risk of being involved in a traffic accident increases significantly above a Blood Alcohol Concentration (BAC) of 0.04 g/dl. Doctors often advise patients to abstain from driving vehicles or

operation of machineries while under certain drugs as these drugs are known to cause side effects of sleepiness and fatigue thus leading to possible occurrence of accident.

Distracted Driving: There are many types of distractions that can lead to impaired driving, but recently there has been a marked increase around the world in the use of mobile phones by drivers that is becoming a growing concern for road safety. The distraction caused by mobile phones can impair driving performance in a number of ways, e.g. longer reaction times (notably braking reaction time, but also reaction to traffic signals), impaired ability to keep in the correct lane, and shorter following distances. Text messaging also results in considerably reduced driving performance, with young drivers at particular risk of the effects of distraction resulting from this use. Drivers using a mobile phone are approximately four times more likely to be involved in a traffic accident than when a driver does not use a phone. Hands-free phones are not much safer than hand-held phone sets as they too have been recorded to result in traffic accidents when shocking news is received while driving.

Inexperience and Unqualified Drivers: Majority of Nigerian drivers do not possess the right authorization from government authorized agencies like the Federal Road Safety Commission, FRSC and are unqualified before driving cars on road pavements. This is the major reason most Nigerian drivers are ignorant of highway codes or traffic orders. They put their lives and those of other road users at the risk of traffic accidents. As a result of their inexperience, since they were never given any tutorial or taught how to use their vehicles on highways by government accredited driving schools, their decision making ability and reaction speed to traffic is bad.

Non-use of safety device and negligence of duty by government established agencies: Seat belts are safety device provided to safeguard a driver in the course of an accident. The use of vehicle seat belts also helps to ensure that the driver is in an upright and

comfortable position thus enabling him/her to proper operate the vehicle. However, this provided safety device has been grossly abused thus increasing the risk of fatality among front-seat and of rear-seat passengers. Also majority of motorcyclists or their passenger do not wear helmets while plying the road thus exposing themselves and indeed other road users to road traffic accident.

2.4.2.2 Vehicle Factors

The vehicle itself is a key factor when analyzing the remote causes of a traffic accident and it is incorporated with gadgets like, the horn, side mirrors, wipers, braking system, trafficators, headlights and break-lights (to mention just a few) so as to avoid road accident. Malfunction of any vehicle parts such as tyres, engines, braking systems, light systems can cause road traffic accidents. The reliability of the vehicle is itself a function of the condition of vehicle at every given time. Vehicle components and vehicle maintenance are the two main conditions which affect vehicle factors as it relates to causes of road traffic accidents. The assembled components of a vehicle working effectively uniformly or abnormally as a unit will determine the occurrence of a traffic accident.

Vehicle Design: The specific maximum load designed for a vehicle in its entire ramification goes a long way towards determining its stability on the road surface. When vehicles are subjected to stress over and above the provisions of the design specifications as is the case of a lot of vehicles plying the Nigerian roads, deterioration for the condition of the vehicle in accelerated wear and tear sets in. Design defects affect the subsequent condition of the vehicle once it is put on the road and operated either normally or otherwise which may result to possible road traffic accidents.

Vehicle Brake System: Brakes are generally applied to rotating axles or wheels. Vehicles use a combination of braking mechanisms which works jointly with the accelerator as the

main synchronizer of the speeds of vehicles. Any malfunctioning of the brake sub-system should be taken very seriously as a potential source of unavoidable accident.

Vehicle Body and Tyres: The firmness of the structure of a vehicle though less prominent attributes to some measure in causing road traffic accidents. One of the dominant factor in determining the stability and safety of vehicles on the road is the tyres. Tyres designed and specified for cold regions are not those specified for temperate regions like Nigeria. However, this is not the case of most tyres used in Nigeria as vehicle owners do not take the specification of tyres into consideration when buying and fixing tyres onto their vehicles and this has been known to cause tyre raptures thus leading to traffic accidents. Some other tyre related causes of road accidents could be due to one or a combination of overinflated tyres, underinflated tyres, thread of tyres are thoroughly worn out.

Vehicle Lights: The failure of vehicle light is a major factor in road traffic accident. Failure of vehicle lights has a tendency to misinform and mislead other road users thereby providing a good opportunity for an accident to occur. Vehicle lights are very useful at all times during the daylight, in darkness and in poor/bad weather. For example, a failed trafficators light of a vehicle ahead will not normally provide the usual warning to other vehicles behind that it is about to undertake a turning manoeuvre and if for instance the driver of the vehicle behind has not allowed for a sufficient stopping sight distance or the vehicle has a faulty brake sub-system, this could result in an accident occurring.

Vehicle Engine: The power house and heart of the vehicle is the engine sub-system which is responsible for bringing other parts of the vehicle into motion and one whose sudden failure on a highway is more likely to cause an accident if the volume of traffic is sufficiently high at that point in time. Even when the traffic is reasonably low, mismanagement of the failure by an experienced driver could cause road traffic accident.

Acquiring a well-designed vehicle and putting it onto road use is not enough to prevent the vehicle from causing road traffic accident. Actually not performing routine maintenance and checks on the vehicle can lead to deterioration of the vehicle sub-systems and thus expose the vehicle to causing road traffic accident as a well maintained vehicle is less likely to be involved in accidents. For example, if the brakes and tires are good and the suspension well-adjusted, the vehicle is more controllable in an emergency and thus, better equipped to avoid accidents.

2.4.2.3 Road Pavement Condition Factors

Nigerian highways are arguably one of the worst and most dangerous in the world as they are often poorly designed, necessary important road facilities like drains are not adequately provided for and to top it up, they are rarely rehabilitated and are in dilapidated states. The deplorable states of the Nigerian highways create a scenario that makes vehicles and other road users susceptible to road traffic accidents. This further confirms that road traffic accidents are not just caused by human error or drivers' negligence.

2.4.2.4 Environmental Factors

Environmental related conditions such as fog, sunrays, mist and rain in no small measure contributes greatly to the rate of road traffic accident in Nigeria today. Having stated earlier that most vehicles on Nigerian roads are poorly maintained, a poorly maintained vehicle for example on a rainy day is most likely to cause road traffic accident if the wipers are faulty and not functioning as the driver will be unable to see ahead.

2.4.3 Cost of Road Traffic Accident

The socio-economic costs of RTA in Nigeria are immense and the direct cost of traffic casualties can perhaps, at best be understood in terms of the labour lost to the nation’s economy (Adekunle, 2010). It has been estimated that persons injured in

accidents on Nigerian highways and streets no longer participate in the economic mainstream and this amounts to a loss of labour of millions of person's years to the nation (Pratte, 1998). Adekunle (2010) opined that the cost to society such as loss of able bodied men and women who hitherto, would have been involved in productive economic activities, loss of intellectuals in our schools, loss of resources to government and families, to insurance companies and damage to properties, etc. are inestimable. Again, valuing the psychosocial impact on victims is another difficult task. Issues like suffering and loss of life injuries associated with road traffic accidents is difficult to assign monetary value.

According to Onakonaiya (1992), with injuries, people often suffer physical pain and emotional anguish that is beyond any economic compensation. Permanent disability such as paraplegia, (paralysis of the lower half of the body), Quadriplegia (paralysis of all four limbs), loss of ability to achieve even minor goals and result in dependence on other people for economic support and routine physical care which may although not in all cases for the rest of the victim's life (Jacob, 1990). According to Nnadede (1997), "Equal protection to all road users should be aimed at, since non-motor vehicle users bear the disproportionate share of road injuries and risk. The traffic system should help users to cope with increasingly demanding condition".

2.4.4 Trend of Road Traffic Accident in Nigeria

The world road accident problem dates back to 1863 when Lenoir built the first car in Paris, France. But, it was not until after 1896 that the first motoring facility was experienced. Indeed the first recorded death due to mechanical vehicle in the United States of America was in 1899 (Haddon, 1968). Nigeria recorded her first traffic accident in Lagos in 1906 (Oluduro, 1999). For more than half a century thereafter, accident rates in the country remained low due largely to low vehicular population (Ogunsanya, 2004).

But from the 1970s following remarkable improvements in the economic prosperity in the country arising from the oil boom, the magnitude of the accident problem increased.

According to Ogunsanya (2002), the period witnessed a substantial increase in private vehicle ownership (motor car fleet was reported to have increased by 183% between 1978 and 1987). This was followed by the economic recession of 1980s characterized by increasingly inadequate and poorly maintained road infrastructure. The situation today has been exacerbated by the near absence of alternative modes of transportation as an estimated 90% of passengers and freight in Nigeria rely on the road network with the attendant challenge of increased number and incidence of road traffic crashes.

As in other developing countries, a road traffic accident in Nigeria is one of the most serious problems in need of pragmatic solution. Yet this problem has been difficult to address probably because of the country's level of development. Nigeria is said to have the highest road traffic accident rates in Africa and the second in the world (Obinna, 2007). In Nigeria, road traffic accident situation over the last three decades has been particularly disturbing. In 1976, there were 53,897 road traffic accidents resulting in 7,717 deaths (Atubi, 2010). Although in 1981, the magnitude reduced to 5,114 accidents but the fatality increased to 10,236 which mean that there was an average of 96 accidents and the situation in subsequent years has not been any better. The number of people killed in road accident between 1990 and 2005 rose to 28,253 and the fatality rate remains consistently high (Atubi, 2009).

In 1976, there were 53, 997 road traffic accidents resulting in 7,717 deaths. In 1981 the magnitude reduced to 35,114 accidents but the deaths increased to 10,236, while in 1984 Nigeria was said to have the highest rate of road traffic deaths in Africa and indeed the world over with the chances of a vehicle killing someone in Nigeria was 47

times higher than Britain (Bolade and Ogunsanya, 1990). In 1988 there were 25,292 road traffic accidents with as high as 9,077 deaths. From these statistics, it can be induced that as the number of accidents reduced, the number of deaths increased. Secondly using the 1988 accident data alone,it was observed that on the average there was an embarrassing rate of 69 accidents and 24 deaths every day of that year.

Sadly, the character of Road Traffic Accidents in terms of frequency of occurrence and fatality rate has not changed over the years in Nigeria. Within the period, an annual average of 8,153 crashes was recorded with 5,084 annual deaths and an average fatality rate of 5 per 100,000 populations (FRSC, 2012). The highest number of 11,341 cases was recorded in 2008 as against the figure of 8,477 cases in the preceding year. Since 2008 however the trend has been a declining one. Perhaps one can safely conclude that this may be attributed to the activities of the Federal Road Safety Corps which assumed full road safety responsibilities in 2007. In terms of spatial spread, the FRSC has shown that about 50% of the total accidents and fatalities were recorded in most of the states that constitute the North Central and North-Western zones. They are therefore ranked respectively as the first and second high risk zones in the country in which Zaria, Kano and Sokoto are among the states in the North-West zone.

2.4.5 Empirical Studies on Road Traffic Accidents

Rankavat and Tiwari (2013) used Geographic Information Systems (GIS) in identifying pedestrian accident-prone locations. The crash data were geocoded in ArcGIS over the digitized road map of Delhi. Their results highlighted four pedestrian fatal hotspot locations in Delhi. Fatal pedestrian accidents were significantly clustered ($p<0.05$) over the Ring Road of Delhi at intersections. The analysis showed that the pedestrian fatalities at arterial road intersections involving cars and buses were 27% and 14% respectively.

Korter, Olubusoye and Salisu (2014)examined the characteristics, spatial pattern and concentrations of RTC in Nigeria, Oyo state and acrossLocal Government Areas (LGA). Data on RTC were obtained from Federal Road Safety Commission (FRSC).The longitudes and latitudes of RTC locations were collected based on landmarks provided by FRSC. RTC cases were found to pose a greater risk of deaths than most of the diseases that is the focus of individuals, government, non-governmental organizations and international bodies in Nigeria. The analysis showed that there was less than 1% likelihood that the observed clustering pattern in RTC could be a result of random chance. The Unique RTC center was found to be Akinyele LGA. The standard deviational ellipse was found to be a more elegant measure of spatial concentration than the standard distance deviation. The black spots include Oyo West, Oyo East, Afijio, Akinyele, Lagelu, Egbeda, OnaAra, Oluyole, Ido, Ibadan North, Ibadan North East, Ibadan North West, Ibadan South East and Ibadan South West LGA.

Umar (2009) mapped Road Traffic Crashes (RTC) along Kano-Zaria Road using Remote Sensing and GIS. The top five black-spots in the study area were highlighted. The results of the study showed that over speeding was the factor most responsible for Road Traffic Crashes along the road with 37.5%. Also, Jibril and Wabundani (2014) examined the spatial distribution of RTA frequencies along Kaduna-Zaria Expressway. The study segmented into three namely; Kaduna-Katabu (18.41 km), Katabu-Jaji (17.02 km) and Jaji-Zaria (38.51 km). Spatial data were generated from the field, satellite imagery and road accidentsdata from the Federal Road Safety Corps (FRSC) and Nigeria Police Force (NPF) along Kaduna–Zaria expressway of Kaduna State. The result partly revealed that Rigachuku, National Teachers Institute (NTI), Tollgate and Maraban Jos (Katabu) recorded high frequency of Road Traffic Accidents (RTA) along Kaduna-Katabu especially in 2009 and 2010.

Jobin (2015) applied Remote Sensing and Geographic Information Systems (GIS) to analyze road traffic accident black spot along Zaria-Kaduna Expressway, Kaduna State, Nigeria using accident data obtained from Federal Road Safety Commission of Nigeria. The accident data were evaluated in ArcGIS version 10.1 environment. Queries and Kernel Density Estimation (KDE) were used to determine the accident black spot, Analytical Hierarchy Process (AHP) and Accident Point Weightage (APW) formula was used to the rank the accident black spot. Image interpretation was also carried out to identify the characteristics of the road. The results of the study showed that over-speeding (27.7%), tyre burst (17.6%), loss of control (15.5%) and dangerous driving (13.6%) were the major causes of accidents along the route. The study also discovered that Jaji, BirninYero, Foundation and KonarFarakwai are the most dangerous locations along the study route. Finally, characteristics of the road such as Bridges (24.9%), built-up areas (24.9%) were the cause of accident while sharp bend (21.9%), U-turn/intersection (13.8%), stationary vehicles (6.2%), slope (4.2%), market (2.7%), potholes (1.4%) also contributes significantly to accidents along Zaria-Kaduna Expressway.

Many literature have discussed the variety of factors affecting traffic accidents including road geometry, layout and traffic control factors. However, there is divergence of opinion on what factors have more influence on safety. Also, there are regional differences in the importance of factors which influence safety. This research was built upon past research and evidence from other literature to apply Geographic Information System (GIS) of analyzing road traffic accidents black spots along Zaria-Kaduna (dual carriage way) and Zaria-Sokoto (single carriage way).

CHAPTER THREE

STUDY AREA AND METHODOLOGY

3.1 The Study Area

3.1.1 Location and Size

Kaduna State is located between latitudes 9º 2' N 11° 33' N and longitudes 6° 10' E and 8° 50' E of the Greenwich meridian. Kaduna State is bounded in the north by Kano, Katsina, Zamfara States in the west by Niger State, to the east by Bauchi State and in the south by Nasarawa and Plateau State (OSGOF, 2011). The state occupied a land mass of about 48, 473.2km^2 (See Figure 3.1).

3.1.2 Geology and Soil

The geology of the study area is part of the basement complex geology of central Nigeria. It is composed of older high grade metamorphosed gnesis interspersed by belt of young metasediment of mainly quartzites and schist. The region is underlain by older granitic crystalline, metamorphic rocks of precambrain to low Paleozoic age (Oguntoyinbo, 1983). It is also consists of gneisses which has suffered intense weathering and have remained stable for millions of years. The prolonged weathering under tropical bioclimatic condition has produced rolling plains dotted with residuals of different origin. Kaduna lies on the high plains of Hausa land, of height ranging from 550 to 750meters showing a general regional slope to the south.

The soils in most parts of Kaduna State fall under the ferruginous tropical soils. Most of the soils contain between 30-40% clay at a reasonable depth, because of intensive leaching. Experts have noted that the nutrients holding capacity of this soil is not known to support intensive agriculture for long periods without the application of fertilizers and or manure. Some areas have permanently waterlogged soils (FADAMA).The Kafanchan area is studded with series of swampy areas that almost dry up between January and

March. The plains in Kaduna State have undergone considerable changes over the years due to combined actions of both physical and chemical weathering (Laah, 2003).

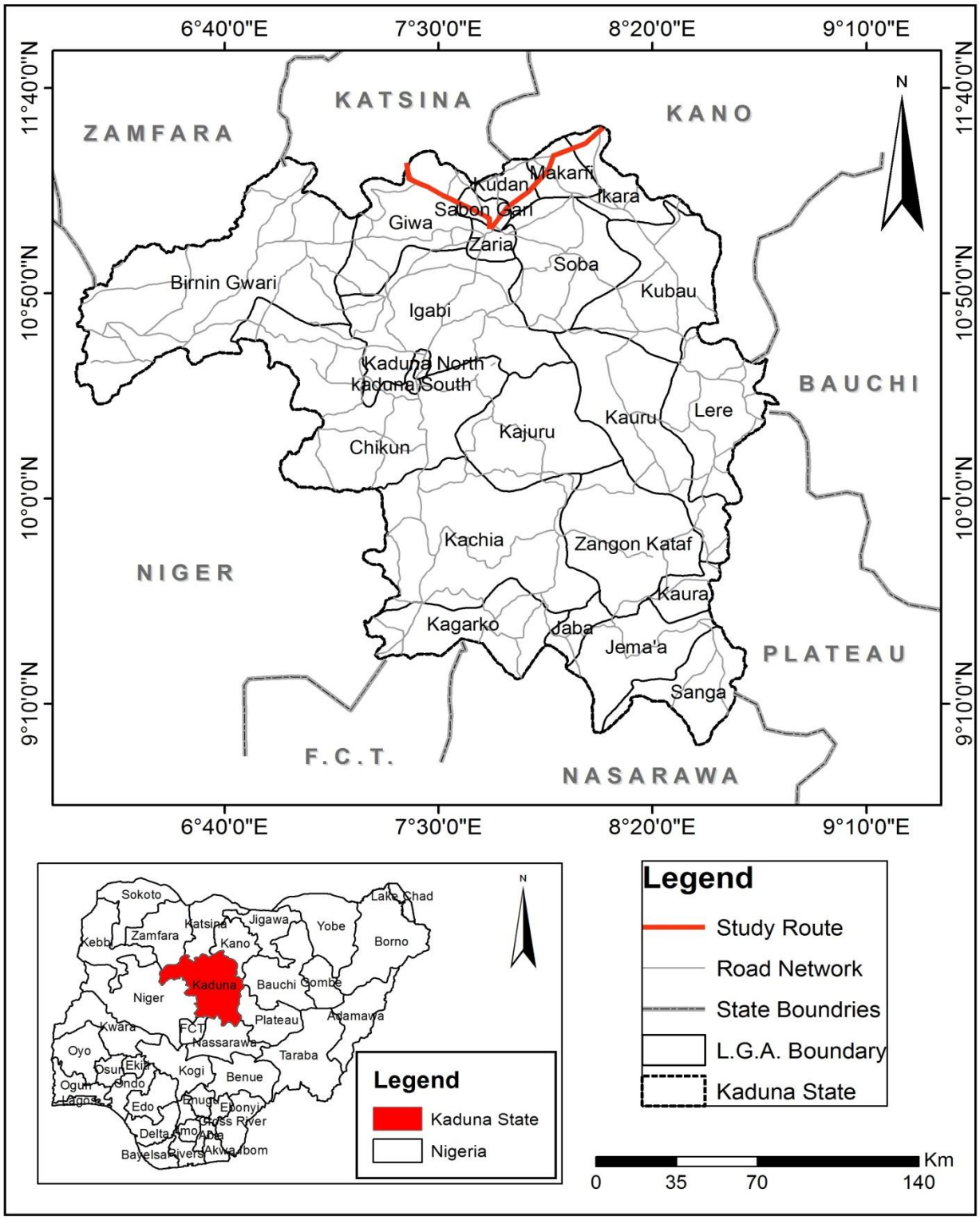


Figure 3.1: The Study Area

Source: Adapted from Administrative Map of Kaduna State

3.1.3 Climate and Vegetation

According to Ayoade (1988), Kaduna has a tropical continental climate type characterized by wet and dry season. The tropical continental is more pronounced in the dry season particularly in December and January. The dry season is dominated by the north-east trade wind called harmattan which prevails between November and February. The dry season is also rainless from October to April. The wet season is dominated by the tropical maritime trade wind which starts around May to October. The area has a mean daily temperature showing a major peak in April. As such, temperatures are hot all year round except for the dry cool and dusty months of harmattan in November to February. The maximum temperature seldom falls from about 36°C as in April to about 27°C in the heart of rain season (August-October). The annual rainfall is about 1000mm (Ayoade, 1988). The first rain of the year is usually experienced in the state in March/April and usually falls in thunderstorm showers. The rain reaches its peak in August (Mamman, 1992).

The natural vegetation of the study area is that of the Northern Guinea Savanah with grass dominating and scattered trees hardly higher than 15ft with broad leaves. Meanwhile, the seasonal character of rainfall in the study area has influenced the vegetation which turns evergreen during the wet season and pale brown in the dry season respectively. Thus, the dominant true species are *IsoberlinaDoka*, *Dodoneaspp*, and grass communities consist of *Hyperhenia* and *Andropogon* species. In the city proper the vegetation is characterized by Silk cotton, Baobab and other protected trees. However, man have greatly affected the vegetation formation in the area, through his activities like; bush burning, cultivation of crops, grazing, lumbering, urbanization and industrial activities among others. The vegetation formation varies and associated with distinct ecological site with particular regard to the nature of the soil (Oguntoyinbo, 1983).

3.1.4 Historical Development

Kaduna state is one of the oldest states in Nigeria. Formerly known as North Central state during the 12 states structure, made up of Katsina and Zaria provinces, the present state came into being in 1987 when the state was split to create Katsina state. Before the establishment of Kaduna as the capital of the northern regional government by Lord Luggard, Kaduna state had widely scattered and sparse population. Apart from Zaria, there was hardly any major area of high population concentration. The settlements in Kaduna metropolis were just along the banks of the river Kaduna. However, the establishment of a base for the West African Frontier Forces (WAFF) in Kaduna town and the transfer of the regional capital from Zungeru to Kaduna were very important landmarks that led to migration into the state. Then the making of Kaduna as the seat of regional government attracted migrants from all other parts of the country in search of greener pastures and job opportunities. This contributed to the growth of the town in particular and Kaduna State in general. The administrative divisions known as Local Government Areas have grown from 7 in 1987 to 13 in 1989, 19 in 1991 and to 23 in 1996 (Laah, 2003).

3.1.5 Population and People

The population of Kaduna State is about 6,066,562 million (NPC, 2006) and with a growth rate of 3.8 per annum. The age distribution shows that more than half of the population is in the age group 0-19 year's (over 65 percent is in the age group 0-24). The state has high birth rate with total fertility rate at of 6.8. Although studies have shown that the total fertility rate (TFR) is declining in Kaduna State (Mamman, 1992), population is still expected to increase. The pattern of age distribution in the state is consistent with past surveys and census.

The population of Kaduna State comprises the following major ethnic groups; Atyab (Kataf), Bajju (Kaje), Hausa, Fulani, Gbagyi, Ikulu, Kadara, Kagoro, Kuturmi, Jaba, Moroa and Ninzam. There are other ethnic minorities such as Yoruba and Igbo among others, who have come as immigrants from western, eastern and other parts of the country. Islam and Christianity are the major religion with other traditional forming the minority group. The religion and culture of the Hausas are intertwined as a result, a thin line between Islam and the Hausa/Fulani tradition.

3.1.6 Economic Activities

About 80% of the state's population is engaged in peasant farming for food and commercial purposes. Some of the main crops grown in Kaduna state include yam, cassava, cocoyam, maize, cowpeas, guinea corn and millet. Cash crops such as ginger, cotton, tobacco, groundnut and soyabeans are grown in commercial quantities. With the introduction of the FADAMA project, Kaduna State is really making giant strides in food production. The FADAMA project essentially entails the utilization of the wetland areas for dry season farming. Agriculture is the dominant occupation of rural populace which is mainly rain-fed and characterized by low land labour productivity. Yet, Kaduna has a potential comparative advantage in the production of a variety of fresh and processed high value crops especially vegetables during the dry season and livestock products (meat and milk) and fisheries throughout the year. This is because Kadunais endowed with underground and surface water, rich pastures and favourable agro-ecological conditions. During the dry season, a considerable number of peasants in the state engage in irrigation farming along some major river banks and on vast FADAMA farm lands. There are over 7500 hectares of potential FADAMA lands in the state, out of which only about 55,000 hectares is under cultivation. The other important aspect of agriculture engaged by the

people is animal husbandry through the rearing of cattle, sheep, goats, pigs and poultry (Kasai, 2001).

There are many industries that contribute greatly to the economy of the State. Some of these industries include; the food confectionaries and breweries, petrochemicals, agro allied, banking, vehicle assembly plant, and textiles. Kaduna State is ranked among the states in Nigeria with the highest concentration of industries. There are a dozen of textile industries that contributed to the historical growth and development of the state, however, the textile manufacturing sector over the years have witnessed significant decline in recent years. The location of industries in Kaduna State is lopsided in favour of Kaduna metropolis. Over 90% of all the industries in the state are sited in Kaduna metropolis. According to the Kaduna State Ministry of Economic Planning (1996), the composition of industries in Kaduna State is 22.8% for manufacturing, 21% for private professional services and 14% for whole sale/retail trade.

3.2 Methodology

This section discussed the various methods employed in generating data for the study; it also explained the type of data, source of data, and the methods of data analysis.

3.2.1 Reconnaissance Survey

A reconnaissance survey was carried out to get acquainted with the study area and Federal Road Safety Commission officers who assisted in identifying the road traffic accident black spots.

3.2.2 Types of Data Used

In accordance with the stated objectives, the data types used in this work were;

(i) Accident location

(ii) Accident type

(iii) Time of the accident

(iv) Number of accident

(v) Cause of accident

(vi) Condition of the road at road traffic accidents black spots

3.2.3 Sources of Data

In an effort to achieve better and meaningful results for this study, the researcher made use of both primary and secondary sourced data.

3.2.3.1 Primary Sources of Data

Primary data on the coordinates of the location of road traffic accident black spots along the study area was acquired using handheld GPS, which was used to create map showing the road traffic accidents black spots accident locations. Field Observation was also carried out by the researcher to get relevant data on the road characteristics at the road traffic accident black spots.

3.2.3.2 Secondary Sources of Data

This involved the sourcing of information through the use of documented materials such as road accident report collected from Federal Road Safety Commission. Journals, textbooks, proceedings of seminar on road accident black spots and its management which gave a background to the literature review in the study.

3.2.4 Data Analysis and Presentation

Both descriptive and inferential statistics test was used in analyzing the data for this study. All statistical analysis was carried out using SPSS version 20 statistical programme and Microsoft Excel 2007. The statistics used in achieving the objectives of the study was as follows:

Objective i was achieved through the use Kernel Density Estimation (KDE) in ArcGIS 10.1 to determine the road traffic accident black spots along the route. KDE provided an

estimate of the proportion of total accidents that can be expected to occur in any given map location. It works by first overlaying an area of interest with a fine rectangular grid. It then calculates an estimate of the density of accident in each grid cell which is based on a weight function - the kernel. The kernel is a function of specified shape and bandwidth (or search radius). The KDE is given by the equation below (Deepthi and Ganeshkumar, 2010):

$$f(x,y) = \frac{1}{nh^2}\sum_{i=1} K\begin{pmatrix} d_i \\ h \end{pmatrix} \quad \text{..... (i)}$$

Where (x,) is the density estimate at location *(x,y), h* is the search radius (bandwidth or kernel size), *n* is numbers of observations (total number of accidents), *K* is the kernel function and *di*, is the distance between the location (event point) *(x,y)* and location of the ith observation. The mean and standard deviation of the Kernel Density Estimation was used to determine the blackspotand also a raster map was generated, where the intensity of traffic accidents is represented by continuous surfaces. Lighter shades were used to represent locations with a lower traffic accident density, while darker shades represent locations characterized by the highest traffic accident density.

Objective iiwas achieved through the use of simple descriptive statistics like mean, and standard deviation to analyse the changes in the road traffic accident black spots development over the sampled period.

Objective iii and ivwere achieved through the use of frequency tables and charts where necessary to summarize the time of road traffic accidents at the various black spots, the type of the accidents, number of accidents and number of persons involved as well as the road way characteristics at the black spots.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter determined the Road Traffic Accidents (RTA) black spots along Zaria-Kano and Zaria-Sokoto Expressways and mapping of the black spots using the Kernel Density Estimation (KDE). Finally road traffic accidents at the black spots were characterized as well as the roadway nature at black spots was examined.

4.2 Spatial Pattern of Road Traffic Accident Black Spot

4.2.1 Spatial Distribution of Road Accident Black Spots

This section presents the spatial distribution of road traffic accident black spots in the study area. Kernel Density Estimation method in ArcGIS 10.1 environment was used to determine the road accident black spots with a search radius of 500m which was based on the black spots identification criteria for highways given by Xie and Yan (2008). The Hot-spot analysis was done for route to see the sections of road or locations where there is concentration of accidents. Figure 4.1 presents the black spots map generated by Kernel Density Estimation from the FRSC data and coordinates obtained during the field observation from 2006-2014 whereas Table 4.1 shows the frequency of road traffic accidents at the various black spots during the period.

The result of the density estimation identified four (4) different black spot locations each along the two study routes. The black spots along Zaria-Kano route include, Yan Karfe, Dogarawa, Zabi and Anur Mosque while Polo Field, MTD, Palladan and Zango accounts for those along Zaria-Sokoto route. This implies that there is no difference in the number of road traffic accident black spots in Zaria-Kano (dual carriage way) and Zaria-Sokoto (single carriage way) during the period.

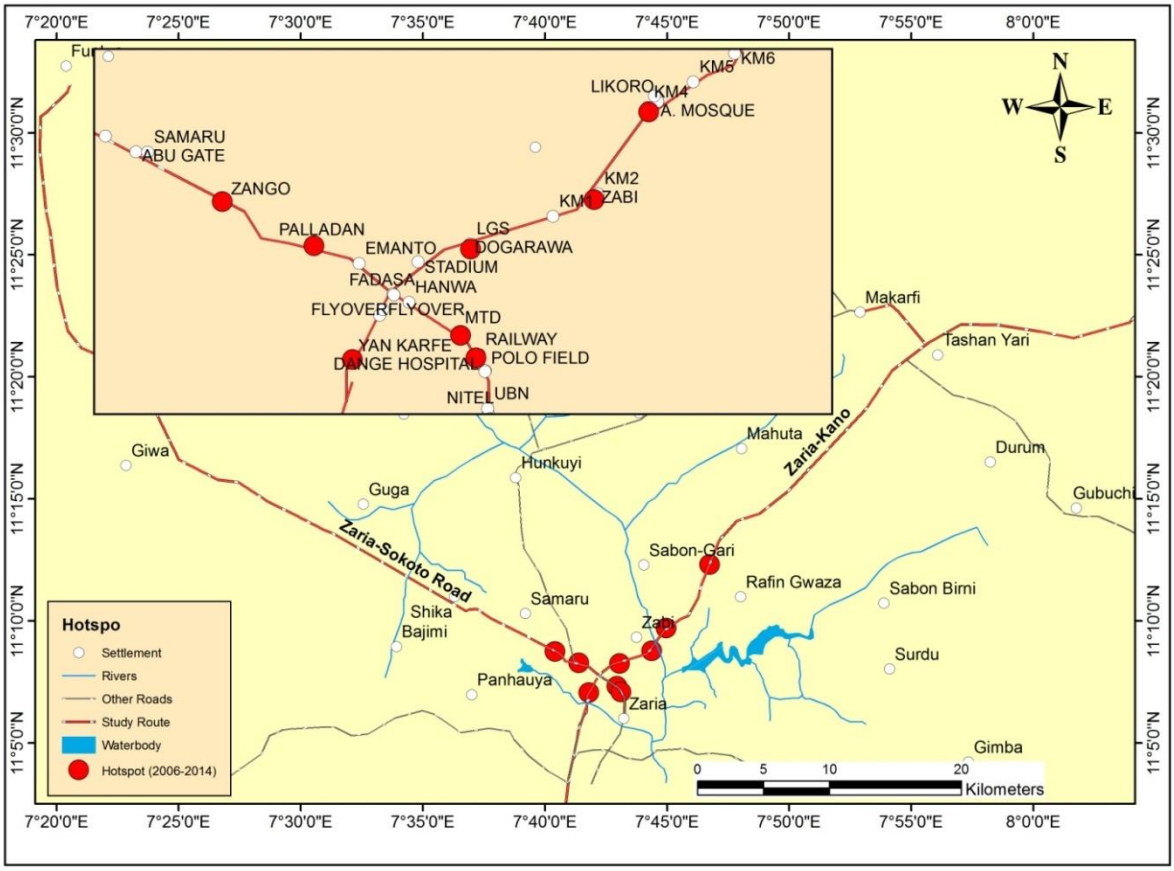


Figure 4.1: Road Traffic Accident Black spot by Kernel Density Estimation from 2006-2014.

Source: Author Analysis, 2016

Table 4.1 shows that about 66% of the road traffic accidents that occurred during this period took place in the black spots identified along Zaria-Kano road with Dogarawa (23.8%) recording the highest number of accidents. Palladan (11.3%) recorded the highest number of accidents that took place along Zaria-Sokoto road. This indicates that although the number of road traffic accident black spots during this period for the two routes were the same, more road traffic accidents were recorded along Zaria-Kano road than Zaria-Sokoto road. This corroborates the finding of Rukewe, Taiwo, Fatiregun, Afuwape and Alonge (2014) that road traffic crashes on dual carriage roads accounted for54.3% while 45.7% occurred on non-dual carriage roads.

Table 4.1: Frequency of Road Traffic Accidents at the Black Spot (2006-2014)

Route	Location	No. of Accidents	Percentage (%)
Zaria-Kano	Anur Mosque	34	20.2
	Zabi	21	12.5
	Dogarawa	40	23.8
	Yan Karfe	16	9.5
Zaria-Sokoto	Polo Field/Railway	18	10.7
	MTD	12	7.1
	Palladan	19	11.3
	Zango	8	4.8
Total		168	100.0

Source: Author Analysis, 2016

This shows that most road traffic accident black spots were located at road intersections and sharp bend. This is inconsistent with the finding of Oulha, Brahimi, Boumediene, Dali and Madouche (2013) that most of road traffic accidents hotspot points were located at intersections between N6 and N4 with villages and small cities like khessibia, Hassine, Oggaz and Sig.Also the recording of higher number of road traffic accidents recorded along Zaria-Kano road than Zaria-Sokoto road could be attributed to difference in the volume of traffic handled by each of these routes.

4.3 Temporal Variation of Road Traffic Accident Black Spots

4.3.1 Road Traffic Accident Black Spots (2006-2008)

The distribution and frequency of the road traffic accidents vary across the years as a result of the development of black spots. Figure 4.2 and Table 4.2 shows the road traffic accident black spots along the routes between years 2006-2008 and the frequency of accidents respectively.

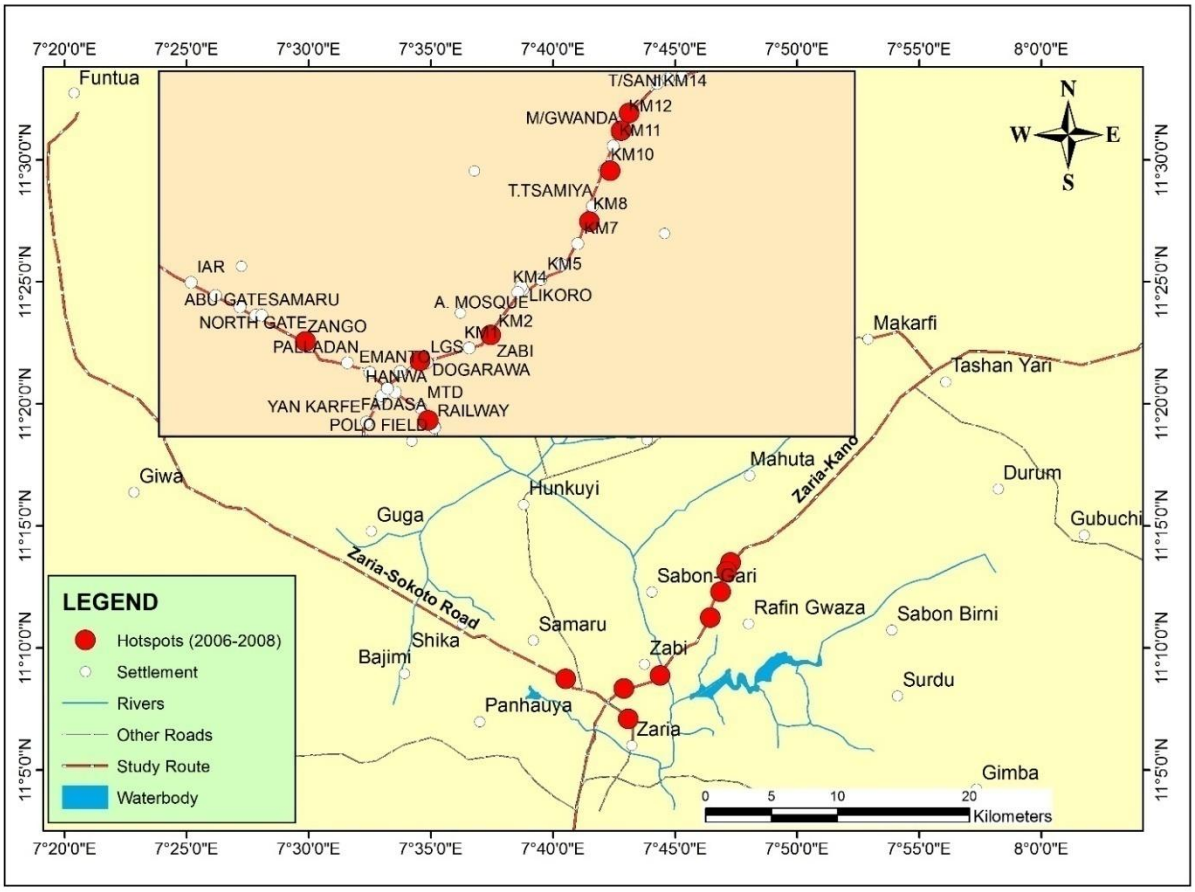


Figure 4.2: Road Traffic Accident Black spots by Kernel Density Estimation from 2006-2008.

Source: Author Analysis, 2016

The result reveals that the black spots location along Zaria-Sokoto route were at Railway/Polo Field and Palladan while Dogarawa, Zabi, Km 8, Km 10, Km 12 and Km 14 accounted for those along Zaria-Kano route. This implies that there is more road traffic accident black spots along Zaria-Kano (dual carriage way) when compared with Zaria-Sokoto (single carriage way) especially during a short period of time.

Table 4.2: Frequency of Road Traffic Accidents at the Black Spot (2006-2008)

Route	Location	No. of Accidents	Percentage (%)
Zaria-Kano	Km 14	3	10.7
	Km 12	3	10.7
	Km 10	3	10.7
	Km 8	5	17.9
	Zabi	3	10.7
	Dogarawa	4	14.3
Zaria-Sokoto	Polo Field/Railway	3	10.7
	Palladan	4	14.3
Total		28	100.0

Source: Author Analysis, 2016

Table 4.2 indicates that more than half of the road traffic accidents recorded during this period took place at the black spots identified along Zaria-Kano of which most recorded equal number of accidents. Zaria-Sokoto road has only two road traffic accident black spots which accounted for 25% of the total accidents recorded during the period. This is inconsistent with the finding of Obaidat and Ramadan (2012) that discovered twenty-eight road traffic accidents hazardous locations at Amman-Jordan roads with each having at least twenty accidents and two fatality records per year.

4.3.2 Road Traffic Accident Black Spot (2009-2011)

Figure 4.3 and Table 4.3 reveal various locations of road traffic accident black spots along the routes between year 2009-2011 and number of accidents that occurred at the black spots.

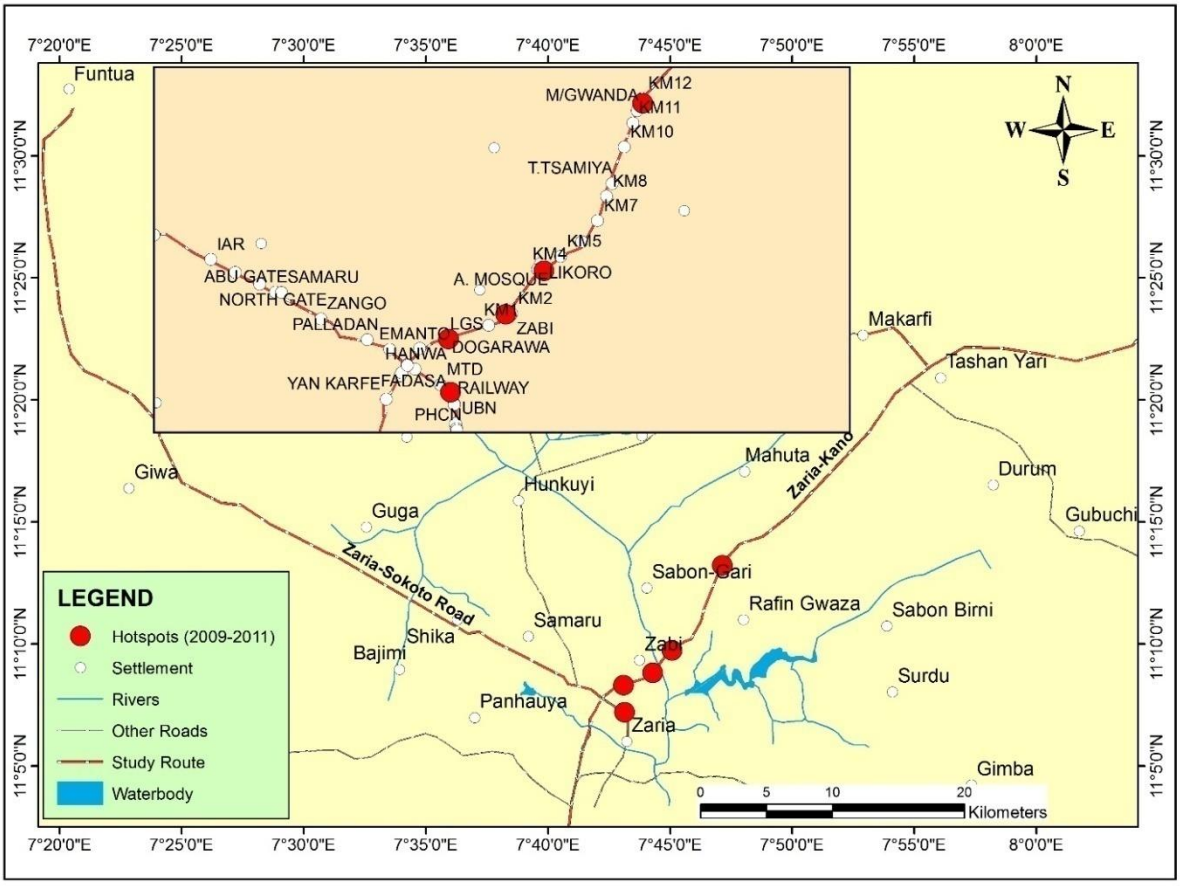


Figure 4.3: Road Traffic Accident Black Spotsby Kernel Density Estimation from 2009-2011.

Source: Author Analysis, 2016

The result reveals that the black spot location along Zaria-Sokoto route was only at Railway/Polo Field while Dogarawa, Likoro, Anur Mosque and Km 10 accounted for those along Zaria-Kano route (Figure 4.3).

Table 4.3: Frequency of Road Traffic Accidents at the Black Spot (2009-2011)

Route	Location	No. of Accidents	Percentage (%)
Zaria-Kano	Km 10	4	8.3
	Anur Mosque	7	14.9
	Likoro	14	29.2
	Dogarawa	11	22.9
Zaria-Sokoto	Polo Field/Railway	12	25.0
Total		48	100.0

Source: Author Analysis, 2016

The four (4) road traffic accidents black spots identified along Zaria-Kano road accounted for 75% of the accidents that was recorded during this period of which most occurred at Likoro (29.2%) with Km 10 representing the least (8.3%) whereas Polo Field/Railway the only black spot along Zaria-Sokoto road had about 25% of the total number of road traffic accidents (Table 4.3).

4.3.3 Road Traffic Accident Black Spot (2012-2014)

Figure 4.4 and Table 4.4 indicated the various locations of road traffic accident black spots and the number of accidents along the routes between years 2012-2014.

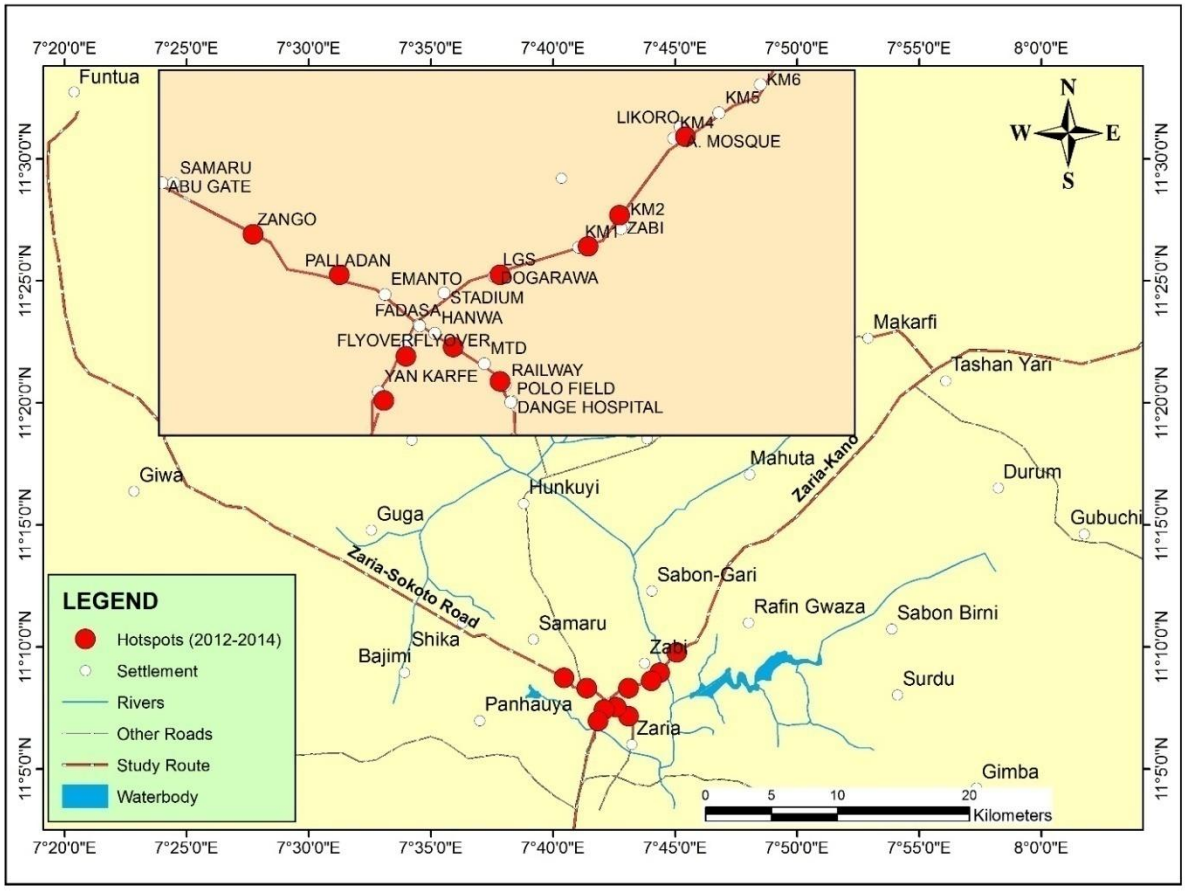


Figure 4.4: Road Traffic Accident Black Spot by Kernel Density Estimation from 2012-2014.

Source: Author Analysis, 2016

The black spot along Zaria-Sokoto route includes Railway/Polo Field, MTD, Palladan and Zango while Anur Mosque, Zabi, Marke, Dogarawa, Jim Harrison and Yan Karfe account for those along Zaria-Kano route.

Table 4.4: Frequency of Road Traffic Accidents at the Black Spot (2012-2014)

Route	Location	No. of Accidents	Percentage (%)
Zaria-Kano	Anur Mosque	22	16.9
	Zabi	16	12.3
	Marke	5	3.8
	Dogarawa	23	17.7
	Jim Harrison	9	6.9
	Yan Karfe	15	11.5
Zaria-Sokoto	Polo Field/Railway	12	9.2
	MTD	10	7.7
	Palladan	11	8.5
	Zango	7	5.4
Total		130	100.0

Source: Author Analysis, 2016

Table 4.4 shows that about 70% of the road traffic accidents recorded during this period occurred at the six (6) black spots identified along Zaria-Kano with Dogarawa (17.7%) having the highest number of road traffic accidents, followed by Anur Mosque (16.9%) and Marke (3.8%) accounting for the least. On the other hand, four (4) road traffic accidents black spots were identified along Zaria-Sokoto road which accounted for 30% of the total accidents of which Polo Field/Railway (9.2%) and Palladan (8.5%) represented the highest. This result indicates that despite the efforts of Federal Road Safety Commission and other safety agencies, the number of road traffic accidents has been on the increase especially along these study routes.This agrees with Mamman and Jediel (2014) that out of a total 490 road traffic crashes thatoccurred within the study period 35, 145, 115 and 195 occurred in 2007, 2008, 2009 and 2010respectively depicting a steady increase.

4.4 Characterization of Road Traffic Accidents at the Black Spots

The distribution of road traffic accidents by the number of persons involved for fatal, serious, death and injured cases in all the black spots identified during the period of 2006-2014 Nigeria is as shown in Figure 4.5.

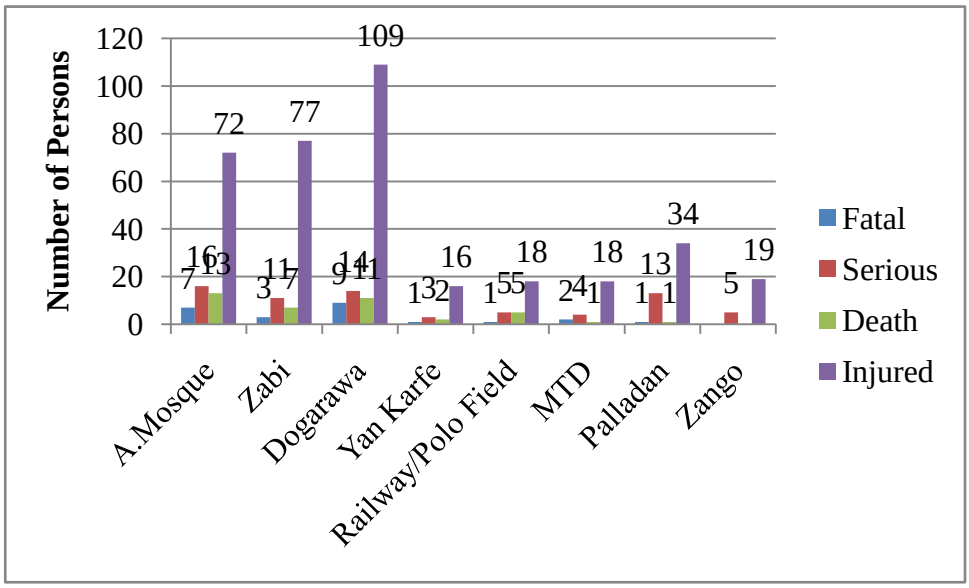


Figure 4.5: Nature of Accidents at the Black Spots during 2006-2014

Source: Author Analysis, 2016

Figure 4.5 shows that number of persons injured as a result of road traffic accidents was much in the hot spots along Zaria-Kano road with Dogarawa (30%) accounting for the highest while Railway/Polo Field and MTD along Zaria-Sokoto road has 18 persons injured each (Appendix A). Of the 40 RTA deaths, 33 (83%) were recorded in the road traffic accidents black spots along Zaria-Kano road with Anur Mosque having the highest number of death whereas none was recorded in Zango location along Zaria-Sokoto road. This is similar to assertion of (Atubi, 2012) thatthe number of reported cases of fatal road traffic accidents in Nigeria shown an increasing trend from 12,212cases of accidents in 1995 to 13,913 in 1996 and 15,418 in 2004 and Annual Abstract of Statistics (2008 in Atubi, 2012), between2003 and 2007, a total of 225,891 accident cases were reported by the Nigeria Police Force, out of which 29,490

werefatal, 39,065 were service cases, 23,380 were minor cases.Moreover,this high rate of road traffic accident fatality could be mainly due to poor provision of emergency services in the event of road traffic accidents which eventually results in the death of accident victims at the location of accidents or before the receiving of first aid and conveyance to hospitals for treatment.Plate 4.1 shows Anur Mosque hotspot location along Zaria-Kano road.



Plate I:Black Spot Location Close to Anur Mosque
Source: Author Field Survey, 2016

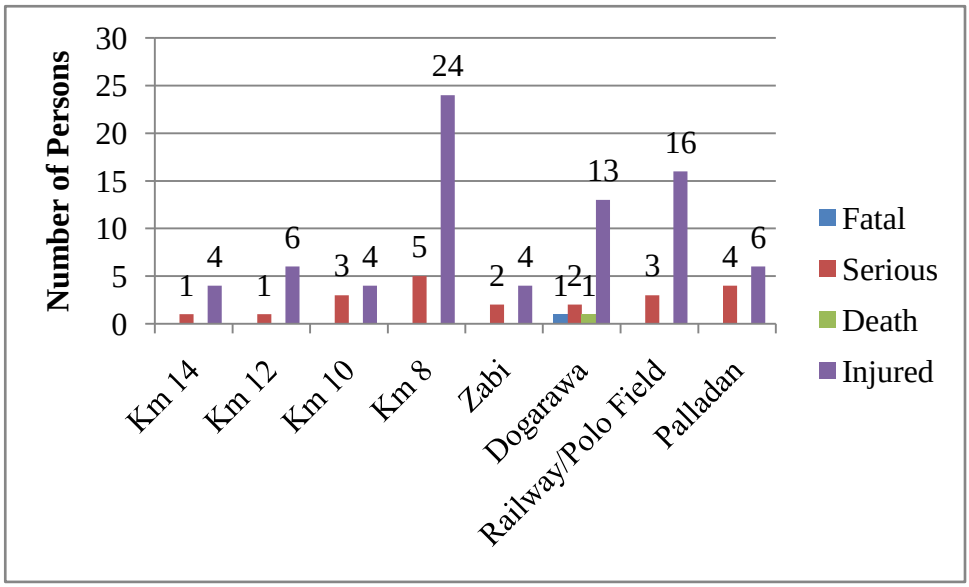


Figure 4.6: Nature of Accidents at the Black Spots during 2006-2008

Source: Author Analysis, 2016

Figure 4.6 shows that of the 77 number of persons injured as a result of road traffic accidents, 24 (31%) occurred at Km 8 (Zaria-Kano road) black spot while nearly 21% represented those recorded at Railway/Polo Field (Appendix A). During this period, neither death nor fatal case was recorded in all the road traffic accidents black spot locations across the two routes except as Dogarawa. This result indicates that there was drastic reduction in the number of road traffic accidents as well as the death and fatality rate.

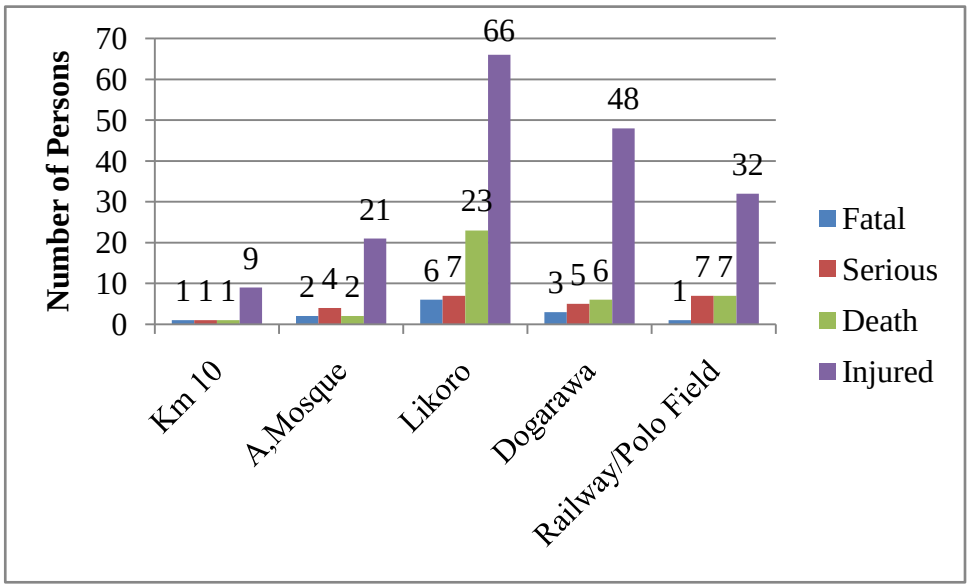


Figure 4.7: Nature of Accidents at the Black Spots during 2009-2011

Source: Author Analysis, 2016

Figure 4.7 reveals that cases of death caused by RTAs were recorded in all the road traffic accidents black spot during this period which shows that of the 39 deaths, nearly 60% occurred at Likoro hotspot while the least Km 10 accounted for only 3% of the deaths of which both black spots were along the Zaria-Kano road (Appendix A). Similarly, Likoro (37.5%) represented the hotspot location with the highest number of injured persons, followed by Dogarawa (27.3%) whereas Km 10 recorded the least of 0.5%.

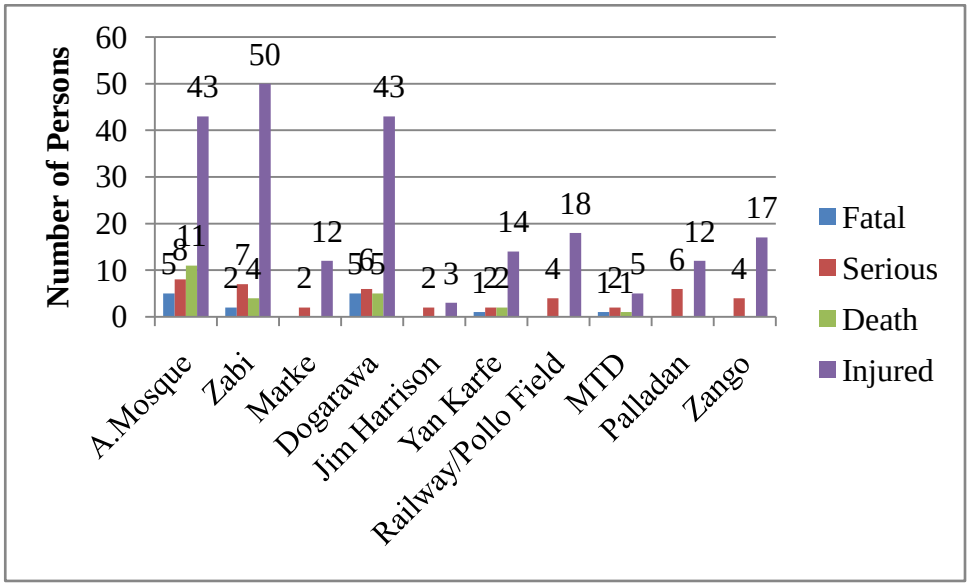


Figure 4.8: Nature of Accidents at the Black Spots during 2012-2014

Source: Author Analysis, 2016

Figure 4.8 reveals that among the black spot locations where cases of death as a result of RTAs were Anur mosque, Zabi, Dogarawa and Yan Karfe (Zarai-Kano road) with only MTD along the Zaria-Sokoto road. Anur mosque accounts for about 48% of the total death cases recorded along the two roads whereas only 4.3% occurred at MTD which was the least (Appendix A). It further shows that out of 14 fatal cases, 35.7% each represent those recorded at Anur mosque and Dogarawa hot spot locations respectively.Noticeable is the steady increase in the number of fatal cases across the study period. This rising increase in the annual number of fatal cases indicates increasing trends in the severity of road traffic accidents occurring over the years.

4.5 Nature of Roadway at Road Traffic Accidents the Black Spots

Road accident black spots as identified by this study had different roadway design and conditions which possible has a contributive role in the frequency of the occurrence of road traffic accidents as shown in Table 4.5.

Table 4.5: Roadway Characteristics at Black Spots

Location	Characteristics
Mararabar/Gwanda	Potholes
Likoro	Intersection, eroded shoulder
Anur Mosque	Sharp bend, potholes
Zabi	Bridge, sharp bend
MTD	Intersection
Palladan	U-turn at sharp bend
Zango	Eroded shoulder
Railway/Polo Field	Sharp bend
Dogarawa	T-junction, stationary vehicles
Jim Harrizon	U-turn at sharp bend
Yan Karfe	Sharp bend

Source: Author Analysis, 2016

This study revealed that the road design of most black spot locations were characterized by sharp bends, U-turn and intersections of which at such locations, over speeding drivers usually find it difficult to control their vehicles, which may eventually result to road traffic accident (Plate 4.2). This corroborates the assertion of Soltani and Askari (2014) that road traffic accidents occur more frequent in main arteries where more urban activities take's place and cluster in the areas of urban that have high traffic volume and provide more accessibility to other roads.



Plate II:Bridge after sharp bend at Zabi

Source: Author Field Survey, 2016



Plate III:Potholes at MarabanGwanda

Source: Author Field Survey, 2016



Plate IV:Eroded Road Shoulderat Jim Harrizon

Source: Author Field Survey, 2016

Similarly, other road conditions like presence of potholes, eroded road shoulder and stationary vehicles were observed at the various black spot locations as shown in Plates 4.3-4.4. This study revealed that the concentration of accidents are not evenly distributed along the roads as more of the occurrences appear to be regular at some black spots such as where there are sharp bends, slopes, U-turns, intersections, bridges and potholes along the roads. This agrees with the findings of Jobin (2015) that bridges (24.9%), built-up areas (24.9%) were the cause of accidents while sharp bend (21.9%), U-turn/intersection (13.8%), stationary vehicles (6.2%), slope (4.2%), market (2.7%), potholes (1.4%) contributed significantly to accidents along Zaria-Kaduna Expressway.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the discussion of the major findings in relation with the background and literature review. The researcher views are also included arising from observation and interpretation of situations encountered during the study. The conclusions are given based on the findings and consequently recommendations were made based on the conclusion.

5.2 Summary

The general objective of the study was to analyze the spatio-temporal pattern of road traffic accident black spots in Kaduna. The study made a number of findings from the results which includes;

i. The density estimation identified four (4) different hotspot locations each along the two study routes. The black spots along Zaria-Kano route include, Yan Karfe, Dogarawa, Zabi and Anur Mosque while black spots along Zaria-Sokoto route include Polo Field, MTD, Palladan and Zango. The study shows no difference in the number of road traffic accidents black spots in Zaria-Kano (dual carriage way) and Zaria-Sokoto (single carriage way) during the period. Although, 66% of the road traffic accidents took place in the black spots identified along Zaria-Kano road with Dogarawa (23.8%) recording the highest number of accidents.

ii. The study reveals that more than half of the road traffic accidents recorded between 2006 and 2008 occurred at the black spots identified along Zaria-Kano off which most recorded equal number of accidents. For 2009-2011, four (4) black spots were identified along Zaria-Kano road whereas Polo Field/Railway was the only black spot along Zaria-Sokoto road. About 70% of the road traffic accidents

recorded from 2012-2014, occurred at the six (6) black spots identified along Zaria-Kano, four (4) were identified along Zaria-Sokoto road.

iii. The study reveals that road traffic accidents at the black spots along the routes were characterized by both deaths and injury. It was found that number of persons death and injured as a result of road traffic accidents were much in the hot spots along Zaria-Kano road.

iv. This study revealed that the road designs of most hotspot locations were characterized by sharp bends, U-turn and intersections. Similarly, other road conditions like presence of potholes, eroded road shoulder and stationary vehicles were found at the various black spot locations.

5.3 Conclusion

Road Traffic accidents tend to occur more at dangerous locations. Its concentration in occurrences suggests spatial dependence between accidents and other causes. These locations often termed black spots can be detected by several geo-statistical techniques of which among are kernel density estimation. This identification and analysis is an important step in traffic accident prevention. It can be concluded that both the dual and single carriage ways have the same number of road traffic accident black spots across the years although, on the temporal basis slight difference were recorded. Also road way characteristics were discovered to be one of the contributing factors to the fatality of road traffic accidents at the various black spot locations.

5.4 Recommendations

Based on the outcome of this research on the spatio-temporal analysis of road traffic accident black spots, the following are recommended:

i. Emergency healthcare services should be available at various black spots locations on the highways. This will ensure that adequate first aid treatment is given to accidents victims as a result, reduction in fatality rate;

ii. Road rehabilitation should be carried out by Federal Emergence Road Maintenance Agency (FERMA) at the potholes and eroded shoulder portion of the various black spots;

iii. Sharp bends and road intersection points at the black spots should be realigned by FERMA. Also construction of road traffic signs along the highways especially at the black spot locations; and

iv. Finally, road traffic police should also be used to control traffic especially the black spots with intersections which assist in road traffic accident reduction.

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APPENDIX A

S_N	Year	TIME	ROUTE	LOC	LAT	LONG	FATAL	SERIOUS	DEAD	INJURED	Total	CAUSE
1	2014	0815HRS	ZAR-KN	FLYOVER	11.1294	7.70383					0	
2	2014	0945hrs	ZAR-KN	MARKE	11.2611	7.83812					0	
3	2014		ZAR-SKK	1KM	11.2097	7.55077					0	
4	2014	0620HRS	ZAR-SKK	3 KM	11.2205	7.53162					0	
5	2014	0620HRS	ZAR-SKK	3 KM	11.2205	7.53162					0	
6	2010	0800HRS	ZAR-KN	A. MOSQUE	11.1646	7.75028	-	1	-	2	3	TBT
7	2010	1830HRS	ZAR-KN	A. MOSQUE	11.1646	7.75028	-	1	-	3	4	HITS
8	2010	1606HRS	ZAR-KN	A. MOSQUE	11.1646	7.75028	-	1	-	5	6	RTV
9	2010	1606HRS	ZAR-KN	A. MOSQUE	11.1646	7.75028	-	1	-	1	2	TBT
10	2011	1800HRS	ZAR-KN	A. MOSQUE	11.1646	7.75028	1	1	-	3	5	TBT
11	2011	1700HRS	ZAR-KN	A. MOSQUE	11.1646	7.75028	-	-	-	2	2	SPV
12	2011	1540HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-	1	-	2	3	TBT
13	2011	0930HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-	1	-	1	2	MDV
14	2011	1910HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-	1	1	2	4	TBT
15	2011	1400HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-	-	-	3	3	SPV
16	2011	1547HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	1	-	1	8	10	DGD
17	2012	1140HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-	1	-	1	2	DGD
18	2012	1230HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	1	-	1	1	3	LOC
19	2012	1545HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-	1	-	4	5	DGD
20	2012	0955HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	1	-	2	4	7	SPV, TBT
21	2012	1055HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-	-	-	-	0	LOC
22	2012	1700HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-	1	-	1	2	DGD
23	2012	1000HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-	1	-	6	7	LOC
24	2012	1300HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	1	-	3	3	7	DGD

25	2012	1355HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-		-		-			2	2	TBT, LOC
26	2012	0941HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-			1	-			2	3	MDV
27	2012	1530HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-		-		-		-		0	LOC
28	2012	1715HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577		1	-			4		8	13	BFL
29	2012	1507HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-			1	-			2	3	SPV
30	2012	1505HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577		1	-			1		2	4	HIT
31	2013	1145HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-			1	-			4	5	TBT
32	2013	1300HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577	-			1	-			3	4	TBT
33	2014	1430HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577									0	
34	2014	1120HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577									0	
35	2014	1600HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577									0	
36	2014	1430HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577									0	
37	2014	1125 HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577									0	
38	2014	0657HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577									0	
39	2014	0845HRS	ZAR-KN	A. MOSQUE	11.1602	7.74577									0	
40	2011	1030HRS	ZAR-SK	ABU FARM	11.1745	7.61591	-			1	-			2	3	WOT
41	2009	0820HRS	ZAR-SKK	ABU GATE	11.1547	7.65815		1	-			1		11	13	OVS
42	2009	0645HRS	ZAR-SKK	ABU GATE	11.1547	7.65815	-			1	-			1	2	DGD
43	2012	2000HRS	ZAR-SKK	ABU GATE	11.1547	7.65815	-			1	-			10	11	DGD
44	2012	1025HRS	ZAR-SKK	ABU GATE	11.1547	7.65815	-			1	-			2	3	DGD
45	2012	0903HRS	ZAR-SKK	ABU GATE	11.1547	7.65815	-			1	-			1	2	HOC
46	2014	1240HRS	ZAR-SKK	ABU GATE	11.1547	7.65815									0	
47	2014	1020HRS	ZAR-SKK	ABU GATE	11.1547	7.65815									0	
48	2014	1640HRS	ZAR-	ABU GATE	11.1547	7.65815									0	

49	2008	1000HRS	SKK ZAR-SKK	ABUTH	11.1731	7.6129	-			1	-			1	2	OVS
50	2009	0930HRS	T/SHIP	ABUTH	11.1731	7.6129	-			1	-			1	2	DGD
51	2010	0700HRS	ZAR-SKK	ABUTH	11.1731	7.6129	-			1	-			1	2	DGD
52	2014	1130HRS	ZAR-KN	ANNUR MSQ	11.1602	7.74577									0	
53	2007	0600HRS	ZAR-SKK	DANGE HOSPITAL	11.1158	7.72028	-			1	-			2	3	DGD & OLV
54	2007	2200HRS	ZAR-SKK	DANGE HOSPITAL	11.1158	7.72028	-			1	-			1	2	DGD
55	2007	1520HRS	ZAR-SKK	DANGE HOSPITAL	11.1158	7.72028	-			1	-			12	13	DGD, OLV
56	2007	1130HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-			1	-			11	12	SPV, OLV
57	2008	0845HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-			1	-			2	3	LOC
58	2008	1015HRS	ZAR-KN	DOGARAWA	11.138	7.71725		1	-			1	-		2	SPV
59	2008	1000HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-		-		-		-		0	MDV
60	2009	1534HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-			1	-			2	3	OVS
61	2009	1025HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-		-		-		-		0	PEDESTRIAN
62	2009	1600HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-			1	-			1	2	LOC
63	2010	-	ZAR-KD	DOGARAWA	11.138	7.71725	-			1	-			2	3	DGD
64	2010	1213HRS	ZAR-KN	DOGARAWA	11.138	7.71725		1	-			2		6	9	LOC
65	2010	1445HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-			1	-			6	7	TBT
66	2010	1900HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-			1	-			2	3	LOC
67	2010	1650HRS	ZAR-KN	DOGARAWA	11.138	7.71725		1	-			3		14	18	HITS
68	2010	1500HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-			1	-			7	8	RTV
69	2010	1100HRS	ZAR-KN	DOGARAWA	11.138	7.71725		1	-			1		4	6	DGD
70	2011	1500HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-		-		-			4	4	DGD & BFL
71	2012	1745HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-			1	-			1	2	MDV
72	2012	1145HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-			1	-			1	2	TBT

73	2012	1700HRS	ZAR-KN	DOGARAWA	11.138	7.71725	1	-		1		17	19	DGD
74	2012	1250HRS	ZAR-KN	DOGARAWA	11.138	7.71725	1	-		1		1	3	HIT
75	2012	1430HRS	ZAR-KN	DOGARAWA	11.138	7.71725	1	-		1		7	9	SPV
76	2012	1900HRS	ZAR-KN	DOGARAWA	11.138	7.71725	1	-		1	-		2	DGD
77	2013	1325HRS	ZAR-KN	DOGARAWA	11.138	7.71725	1	-		1		5	7	LOC
78	2013	1800HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-		1	-		3	4	RTV
79	2013	0900HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-		1	-	-		1	DGD
80	2013	0820HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-		1	-		3	4	RTV
81	2013	1530HRS	ZAR-KN	DOGARAWA	11.138	7.71725	-		1	-		1	2	TYV
82	2014	1410HRS	ZAR-KN	DOGARAWA	11.138	7.71725							0	
83	2014	1230HRS	ZAR-KN	DOGARAWA	11.138	7.71725							0	
84	2014	0850HRS	ZAR-KN	DOGARAWA	11.138	7.71725							0	
85	2014	0820HRS	ZAR-KN	DOGARAWA	11.138	7.71725							0	
86	2014	1705HRS	ZAR-KN	DOGARAWA	11.138	7.71725							0	
87	2014	0820HRS	ZAR-KN	DOGARAWA	11.138	7.71725							0	
88	2014	1210HRS	ZAR-KN	DOGARAWA	11.138	7.71725							0	
89	2014	1500HRS	ZAR-KN	DOGARAWA	11.138	7.71725							0	
90	2014	1340HRS	ZAR-KN	DOGARAWA	11.138	7.71725							0	
91	2014	1640HRS	ZAR-KN	DOGARAWA JNC	11.138	7.71725							0	
92	2014	0937HRS	ZAR-KN	DOGARWA	11.138	7.71725							0	
93	2014	1510HRS	ZAR-KN	DOGARWA	11.138	7.71725							0	
94	2014	1029HRS	ZAR-KN	DOGARWA	11.138	7.71725							0	
95	2014	1063HRS	ZAR-KN	DOGORAWA	11.138	7.71725							0	
96	2011	0900HRS	ZAR-SKK	EMANTO	11.1348	7.69781	-		1	-		8	9	BFL
97	2014	1159HRS	ZAR-SKK	EMANTO JNCT	11.1348	7.69781							0	
98	2010	1400HRS	ZAR-KN	FADASA	11.1292	7.704	1	-		2		6	9	SPV

99	2011	1750HRS	ZAR-KN	FADASA	11.1292	7.704	-		1	-		4	5	DGD
100	2011	2030HRS	ZAR-KN	FADASA	11.1292	7.704	-		1	-		2	3	SPV
101	2012	1715HRS	ZAR-KN	FADASA	11.1292	7.704	-		1	-		1	2	HIT
102	2012	0830HRS	ZAR-KN	FADASA	11.1292	7.704	-		1	-		7	8	DGD
103	2009	1200HRS	ZAR-KN	FLYOVER	11.1294	7.70383	-		1	-		8	9	ROBBERY ATTACK
104	2009	0900HRS	ZAR-KN	FLYOVER	11.1294	7.70383	-		1	-		6	7	SPV
105	2012	1730HRS	ZAR-KN	FLYOVER	11.1294	7.70383	-		1	-		3	4	RTV
106	2013	1209HRS	ZAR-SKK	FLYOVER	11.1294	7.70383	-		1	-		2	3	LOC
107	2013	1435HRS	ZAR-KN	FLYOVER	11.1294	7.70383	-		1	-		5	6	TBT
108	2011	1225HRS	ZAR-SKK	FRSC GATE	11.1072	7.72105	-		1	-		1	2	LOC
109	2012	1128HRS	ZAR-SKK	FRSC GATE	11.1072	7.72105	-		1	-		2	3	DGD
110	2014	1424HRS	ZAR-SKK	FRSC GATE	11.1072	7.72105							0	
111	2009	2300HRS	ZAR-SKK	GANGARA	11.3321	7.38797	1	-		17		3	21	OBS
112	2013	1145HRS	ZAR-SKK	GANGARA	11.3321	7.38797	1	-		4		6	11	TBT
113	2014	1615HRS	ZAR-SKK	GANGARA	11.3321	7.38797							0	
114	2014	1105HRS	ZAR-SKK	GANGARA	11.3321	7.38797							0	
115	2010	1503HRS	ZAR-SKK	HANWA	11.1279	7.70668	-		1	-		3	4	DGD
116	2011	1015HRS	ZAR-SKK	HANWA	11.1279	7.70668	-		1	-		9	10	BRD
117	2014	0850HRS	ZAR-SKK	HANWA	11.1279	7.70668							0	
118	2009	-	ZAR-	IAR	11.166	7.63568	1	-		1	-		2	OVS

119	2010	1130HRS	SKK ZAR-SKK	IAR	11.166	7.63568	-			1	-			2	3	DGD
120	2012	1445HRS	ZAR-KN	J.HARISON	11.1266	7.70203	-			1	-			1	2	LOC
121	2013	1631HRS	ZAR-KN	J.HARISON	11.1266	7.70203	-			1	-			2	3	LOC
122	2014	1255HRS	ZAR-KN	JIM HARISON	11.1266	7.70203									0	
123	2014	1730HRS	ZAR-KN	JIM HARISON	11.1266	7.70203									0	
124	2014	0900HRS	ZAR-KN	JIM HARISSON	11.1266	7.70203									0	
125	2014	1424HRS	ZAR-KN	JIM HARRISON	11.1266	7.70203									0	
126	2014	1424HRS	ZAR-KN	JIM HARRISON	11.1266	7.70203									0	
127	2014	1735HRS	ZAR-KN	JIM HARRISSON/ FLY OVER	11.1266	7.70203									0	
128	2014	0830HRS	ZAR-KN	JIMHARRISON	11.1266	7.70203									0	
129	2013	1740HRS	ZAR-SKK	KANO JUNCTION	11.1268	7.70892	-			1	-			2	3	SPV
130	2011	1715HRS	ZAR-KN	KM1	11.1432	7.73227		1	-			1		1	3	BFL
131	2006	1620HRS	ZAR-SKK	KM10	11.2051	7.77924	-			1	-		-		1	UNKNOWN
132	2006	1620HRS	ZAR-SKK	KM10	11.2051	7.77924	-			1	-			2	3	OLV & DGD
133	2007	1707HRS	ZAR-KN	KM10	11.2051	7.77924	-			1	-			2	3	TBT
134	2009	1500HRS	ZAR-SKK	KM10	11.2051	7.77924	-		-		-		-		0	DGD
135	2011	1130HRS	ZAR-KN	KM10	11.2051	7.77924	-		-		-		-		0	TBT
136	2011	1020HRS	ZAR-KN	KM10	11.2051	7.77924	-			1	-			6	7	MDV, LOC
137	2011	1725HRS	ZAR-KN	KM10	11.2051	7.77924		1	-			1		3	5	TBT
138	2012	1530HRS	ZAR-SKK	KM10	11.2051	7.77924		1	-			1		1	3	HOC

139	2013	1130hrs	ZAR-KN	KM10	11.2051	7.77924	-		1	-		3	4	TBT
140	2011	1635HRS	ZAR-KN	KM11	11.2135	7.78232	-		1	-		3	4	TBT
141	2006	0945HRS	ZAR-KN	KM12	11.222	7.78542	-		1	-		2	3	BRD
142	2006	1120HRS	ZAR-KN	KM12	11.222	7.78542	-		1	-		4	5	BRD
143	2006	1650HRS	ZAR-SKK	KM14	11.2352	7.79756	-		1	-		3	4	OLV
144	2006	1600HRS	ZAR-SKK	KM14	11.2352	7.79756	-		1	-		1	2	DGD & OLV
145	2013	1111HRS	ZAR-KN	KM14	11.2352	7.79756		1	1		1	1	4	LOC
146	2011	1620HRS	ZAR-KN	KM15	11.2378	7.80621		1	-		3	5	9	OVS
147	2011	1130HRS	ZAR-KN	KM15	11.2378	7.80621	-		1	-		2	3	RTV
148	2011	1720HRS	ZAR-KN	KM15	11.2378	7.80621		1	-		1	2	4	TBT
149	2011	0923HRS	ZAR-KN	KM18	11.2529	7.82866		1	-		2	3	6	TBT
150	2011	2011HRS	ZAR-SKK	KM2	11.1472	7.74029	-		1	-		1	2	OVS
151	2011	1615HRS	ZAR-SKK	KM2	11.1472	7.74029	-		1	-		1	2	DGD
152	2013	2210HRS	ZAR-SKK	KM2	11.1472	7.74029	-		1	-		4	5	DGD
153	2011	0730HRS	ZAR-KN	KM20	11.2649	7.84234	-	-		-	-		0	TBT
154	2011	1325HRS	ZAR-SKK	KM20	11.2649	7.84234	-		1	-		4	5	DGD
155	2011	1745HRS	ZAR-KN	KM25	11.2982	7.87323		1	-		2	5	8	SPV
156	2013	1130HRS	ZAR-KN	KM29	11.3258	7.89565	-		1	-		18	19	TYV
157	2011	1701HRS	ZAR-KN	KM3	11.1554	7.74408		1	-		1	11	13	LOC
158	2011	-	ZAR-KN	KM3	11.1554	7.74408	-		1	-		9	10	MDV
159	2011	1402HRS	ZAR-SKK	KM3	11.1554	7.74408	-		1	-		2	3	OVS
160	2011	0805HRS	ZAR-SKK	KM3	11.1554	7.74408	-		1	-		2	3	DGD
161	2011	1200HRS	ZAR-KN	KM30	11.3337	7.90009	-		1	-		1	2	OVS

162	2006	1750HRS	ZAR-KN	KM31	11.3406	7.90625	-		1	-		2	3	TBT
163	2013	2010HRS	ZAR-KN	KM32	11.3453	7.91424		1	1		2	2	6	DGD
164	2006	1000HRS	ZAR-KN	KM4	11.1626	7.74913	-		1	-		3	4	DGD &OLV
165	2011	150HRS	ZAR-KN	KM4	11.1626	7.74913	-		1	-		1	2	OVS
166	2011	1800HRS	ZAR-KN	KM4	11.1626	7.74913	-		1	-		6	7	MDV
167	2011	0735HRS	ZAR-SKK	KM4	11.1626	7.74913	-		1	-		2	3	OVS
168	2011	1000HRS	ZAR-KN	KM4	11.1626	7.74913		1	-		2	4	7	TBT
169	2006	1300HRS	ZAR-KN	KM5	11.1671	7.75717		1	1	-		4	6	BFL
170	2011	0815HRS	ZAR-KN	KM5	11.1671	7.75717	-		1	-		3	4	OVS
171	2011	0700HRS	ZAR-KN	KM5	11.1671	7.75717	-		1	-		2	3	OVS
172	2011	1400HRS	ZAR-SKK	KM5	11.1671	7.75717	-		1	-		11	12	LOC
173	2013	1804HRS	ZAR-KN	KM5	11.1671	7.75717	-		1	-		1	2	DGD
174	2011	1915HRS	ZAR-KN	KM6	11.1722	7.76454	-		1	-		7	8	RTV
175	2011	1300HRS	ZAR-KN	KM6	11.1722	7.76454	-		1	-		2	3	LOC
176	2011	1230HRS	ZAR-KN	KM6	11.1722	7.76454	-		1	-		7	8	MDV
177	2011	1345HRS	ZAR-KN	KM6	11.1722	7.76454	-		1	-		1	2	SPV
178	2011	1105HRS	ZAR-KN	KM6	11.1722	7.76454	-		1	-		1	2	RTV
179	2013	1530HRS	ZAR-SKK	KM6	11.1722	7.76454	-	-		-	-		0	OVS
180	2011	1400HRS	ZAR-KN	KM7	11.1795	7.76999	-		1	-		2	3	RTV, HOC
181	2011	2000HRS	ZAR-KN	KM7	11.1795	7.76999		1	-		1	3	5	OVS
182	2006	2130HRS	ZAR-SKK	KM8	11.188	7.77318	-		1	-		4	5	TBT
183	2006	2130HRS	ZAR-SKK	KM8	11.188	7.77318	-		1	-		9	10	TBT
184	2006	0820HRS	ZAR-KN	KM8	11.188	7.77318	-		1	-		3	4	TBT
185	2006	1030HRS	ZAR-KN	KM8	11.188	7.77318	-		1	-		8	9	TBT
186	2006	1740HRS	ZAR-KN	KM8	11.188	7.77318	-		1	-	-		1	TBT

187	2011	0838HRS	ZAR-SKK	KM8	11.188	7.77318	-			1	-			7	8	BFL
188	2011	1130HRS	ZAR-KN	KM8	11.188	7.77318		1	-			2		4	7	SPV, LOC, MDV
189	2011	0925HRS	ZAR-KN	KM8	11.188	7.77318	-			1	-			5	6	POTHOLES
190	2013	1609HRS	ZAR-SKK	KM8	11.188	7.77318	-		1-		-			1	1	DGD
191	2013	1740HRS	ZAR-SKK	KM8	11.188	7.77318	-			1	-			2	3	OBS
192	2011	0730HRS	ZAR-KN	KM9	11.1966	11.1966	-			1	-			2	3	MDV
193	2012	1430HRS	ZAR-KN	KUNKUMI	11.3616	8.03128		1	-			1		21	23	RTV
194	2006	0850HRS	ZAR-SKK	KWANGILA	11.1292	7.704	-			1	-			1	2	OLV & DGD
195	2010	1130HRS	ZAR-SKK	KWANGILA	11.1292	7.704	-		-			11		8	19	LOC
196	2010	1550HRS	ZAR-SKK	KWANGILA	11.1292	7.704	-			1	-			4	5	LOC
197	2012	0800HRS	ZAR-SKK	KWANGILA	11.1292	7.704		1	-			4		6	11	DGD
198	2014	1603HRS	ZAR-KN	KWANGILA	11.1292	7.704									0	
199	2009	1140HRS	ZAR-KN	LGS	11.1383	7.71762	-			1	-			3	4	OVS
200	2009	1155HRS	ZAR-KN	LGS	11.1383	7.71762	-			1	-			1	2	
201	2006	1730HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-		-		1	DGD
202	2006	173HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-		-		1	-
203	2009	1845HRS	ZAR-KN	LIKORO	11.1636	7.75088		1	-			7		9	17	POTHOLES
204	2009	1526HRS	ZAR-KN	LIKORO	11.1636	7.75088		1	-			4		4	9	OVS
205	2009	0650HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			4	5	POTHOLES
206	2009	1705HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1		2		2	5	DGD
207	2009	1600HRS	ZAR-KN	LIKORO	11.1636	7.75088		1	-			4		4	9	TBT
208	2010	1430HRS	ZAR-KN	LIKORO	11.1636	7.75088		1	-			1	-		2	SPV
209	2010	1920HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			1	2	TRAIL

210	2010	0650HRS	ZAR-KN	LIKORO	11.1635	7.7507	-			1	-			10	11	DGD
211	2010	0915HRS	ZAR-KN	LIKORO	11.1635	7.7507		1	-			1		2	4	DGD
212	2010	1430HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			4	5	TBT
213	2011	1730HRS	ZAR-KN	LIKORO	11.1636	7.75088	-		-		-			6	6	OLV & LOC
214	2011	1540HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			6	7	SPV
215	2011	1826HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			4	5	TBT
216	2011	1030HRS	ZAR-KN	LIKORO	11.1636	7.75088		1	-			4		10	15	DGD
217	2012	1230HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			5	6	TBT
218	2012	1300HRS	ZAR-KN	LIKORO	11.1636	7.75088		1	-			1		1	3	MDV
219	2012	1100HRS	ZAR-KN	LIKORO	11.1636	7.75088		1	-			1		2	4	TBT
220	2012	1400HRS	ZAR-KN	LIKORO	11.1635	7.7507	-			1	-			5	6	MDV
221	2012	1000HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			2	3	TBT
222	2013	1500HRS	ZAR-KN	LIKORO	11.1636	7.75088		1	-			1		5	7	DOT
223	2013	1720HRS	ZAR-KN	LIKORO	11.1636	7.75088		2	-			2	-		4	DGD
224	2013	1825HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			1	2	SPV
225	2013	1635HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			4	5	SPV
226	2013	1320HRS	ZAR-KN	LIKORO	11.1636	7.75088	-			1	-			1	2	SOS
227	2014	0830HRS	ZAR-KN	LIKORO	11.1636	7.75088									0	
228	2014	0845HRS	ZAR-KN	LIKORO	11.1636	7.75088									0	
229	2014	0946HRS	ZAR-KN	LIKORO	11.1636	7.75088									0	
230	2014	1205 HRS	ZAR-KN	LIKORO JNC	11.1636	7.75088									0	
231	2014	1658HRS	ZAR-KN	LIKORO JUCTION	11.1636	7.75088									0	
232	2014	1330HRS	ZAR-KN	LIKORO JUCTION	11.1636	7.75088									0	
233	2014	1130HRS	ZAR-KN	LIKORO JUNCTION	11.1636	7.75088									0	
234	2014	1820HRS	ZAR-KN	LIKORO JUNCTION	11.1636	7.75088									0	
235	2014	1063HRS	ZAR-	LINHAF OIL	11.1636	7.75088									0	

			SKK												
236	2014	1505HRS	ZAR-KN	LUKORO JNCT	11.1636	7.75088								0	
237	2006	1740HRS	ZAR-KN	M/GWANDA	11.2166	7.78363	-		1	-		-		1	-
238	2007	1620HRS	ZAR-KN	M/GWANDA	11.2166	7.78363	-		1	-			6	7	TBT
239	2009	1620HRS	ZAR-KN	M/GWANDA	11.2166	7.78363	-		1	-			13	14	OVS
240	2009	0500HRS	ZAR-KN	M/GWANDA	11.2166	7.78363	-		1	-			4	5	RTV
241	2010	2000HRS	ZAR-KN	M/GWANDA	11.2178	7.78385	-		1	-			6	7	OBS, LOC
242	2010	1500HRS	ZAR-KN	M/GWANDA	11.2178	7.78385	-		1	-			2	3	LOC
243	2010	1447HRS	ZAR-KN	M/GWANDA	11.2178	7.78385	-		1	-			5	6	UPWD
244	2010	1105HRS	ZAR-KN	M/GWANDA	11.2178	7.78385		1	-			3		11	15	HITS
245	2010	1447HRS	ZAR-KN	M/GWANDA	11.2178	7.78385	-		1	-			2	3	RTV
246	2010	2030HRS	ZAR-KN	M/GWANDA	11.2178	7.78385		1	-			1		2	4	LOC
247	2011	1500HRS	ZAR-KN	M/GWANDA	11.2178	7.78385	-		1	-			1	2	BFL
248	2011	1540HRS	ZAR-KN	M/GWANDA	11.2178	7.78385		1		1		5	-		7	OVL &TBT
249	2011	0730HRS	ZAR-KN	M/GWANDA	11.2178	7.78385	-		1	-			2	3	OBS
250	2011	0930HRS	ZAR-KN	M/GWANDA	11.2178	7.78385		1	-			3		4	8	OBS
251	2011	1530HRS	ZAR-KN	M/GWANDA	11.2178	7.78385	-		1	-			5	6	SPV, TBT
252	2012	1015HRS	ZAR-KN	M/GWANDA	11.2178	7.78385	-		1	-			2	3	LOC
253	2012	1349HRS	ZAR-KN	M/GWANDA	11.2178	7.78385	-		-		-			0	OVT
254	2012	1130HRS	ZAR-KN	M/GWANDA	11.2178	7.78385		1	-			1		2	4	TBT
255	2009	1615HRS	ZAR-KN	MAKARFI	11.3546	7.92518	-		1	-			1	2	TBT
256	2011	1640HRS	ZAR-KN	MAKARFI	11.3546	7.92518	-		1	-			3	4	OBS
257	2011	1240HRS	ZAR-KN	MAKARFI	11.3546	7.92518	-		1	-			1	2	DGD
258	2012	1300HRS	ZAR-KN	MAKARFI	11.3546	7.92518	-		1	-			5	6	TBT
259	2009	1815HRS	ZAR-KN	MARKE	11.2611	7.83812		1	-			1		17	19	TBT
260	2011	1500HRS	ZAR-KN	MARKE	11.2611	7.83812		1		1	-			1	3	TBT
261	2011	1330HRS	ZAR-KN	MARKE	11.2611	7.83812	-		1	-			3	4	OVT
262	2012	1417HRS	ZAR-KN	MARKE	11.2611	7.83812	-		1	-			7	8	TBT

263	2013	0715HRS	ZAR-KN	MARKE	11.2611	7.83812	-		1	-			5	6	LOC
264	2014	1345HRS	ZAR-KN	MARKE	11.2611	7.83812								0	
265	2014	0715HRS	ZAR-KN	MARKE	11.2611	7.83812								0	
266	2014	1730HRS	ZAR-KN	MARKE	11.2611	7.83812								0	
267	2013	2100HRS	ZAR-KN	MKD PARK	11.1249	7.71193	-		1	-			9	10	TBT
268	2010	1730HRS	ZAR-SKK	MTD	11.1225	7.71549	-		1	-			10	11	BFL
269	2011	2015HRS	ZAR-SKK	MTD	11.1225	7.71549		1	1	-			3	5	LOC
270	2012	1451HRS	ZAR-SKK	MTD	11.1225	7.71549	-		1	-			3	4	TBT
271	2012	1930HRS	ZAR-SKK	MTD	11.1225	7.71549		1	-		1	-		2	DGD
272	2013	2130HRS	ZAR-SKK	MTD	11.1225	7.71549	-		1	-			2	3	LOC, SPV
273	2014	1112HRS	ZAR-SKK	MTD	11.1225	7.71549								0	
274	2014	1649HRS	ZAR-SKK	MTD	11.1225	7.71549								0	
275	2014	1540HRS	ZAR-KN	MTD	11.1225	7.71549								0	
276	2014	1145HRS	ZAR-KN	MTD	11.1225	7.71549								0	
277	2014	1700HRS	ZAR-KN	MTD	11.1225	7.71549								0	
278	2014	1700HRS	ZAR-SKK	MTD	11.1225	7.71549								0	
279	2014	1805HRS	ZAR-SKK	MTD	11.1225	7.71549								0	
280	2010	1230HRS	ZAR-SKK	NITEL	11.1082	7.72074	-	-		-			5	5	DGD
281	2011	0900HRS	ZAR-SKK	NORTH GATE	11.1575	7.65274		1	1	-			4	6	SPV
282	2011	1130HRS	ZAR-SKK	NUGA GATE	11.1615	7.64417	-		1	-			24	25	SPV

283	2014	1902HRS	ZAR-KN	OFFICE GATE	11.1057	7.72221									0	
284	2006	1630HRS	ZAR-SKK	PALLADAN	11.1381	7.69	-		1	-		NIL			1	TBT
285	2006	1545HRS	ZAR-SKK	PALLADAN	11.1381	7.69	-		1	-			2		3	BRD
286	2006	1430HRS	ZAR-SKK	PALLADAN	11.1381	7.69	-		1	-			2		3	DGD
287	2006	1530HRS	ZAR-SKK	PALLADAN	11.1381	7.69	-		1	-			2		3	DGD
288	2009	0935HRS	ZAR-SKK	PALLADAN	11.1383	7.68768		1	-			1		4	6	HOC
289	2010	0940HRS	ZAR-SKK	PALLADAN	11.1381	7.69	-		1	-			9		10	DGD
290	2011	1250HRS	ZAR-SKK	PALLADAN	11.1383	7.68768	-		1	-			2		3	RTV
291	2011	1749HRS	ZAR-SK	PALLADAN	11.1383	7.68768	-		1	-			1		2	DGD
292	2012	0915HRS	ZAR-SKK	PALLADAN	11.1383	7.68768	-		1	-			2		3	DGD
293	2012	1200HRS	ZAR-KN	PALLADAN	11.1383	7.68768	-		1	-			1		2	HITS
294	2012	1530HRS	ZAR-SKK	PALLADAN	11.1383	7.68768	-		1	-			1		2	LOC
295	2013	0720HRS	ZAR-SKK	PALLADAN	11.1383	7.68768	-		1	-			2		3	DGD
296	2013	1900HRS	ZAR-SKK	PALLADAN	11.1383	7.68768	-		1	-			5		6	DGD
297	2013	0910HRS	ZAR-SKK	PALLADAN	11.1381	7.69	-		1	-			1		2	SPV
298	2014	0415HRS	ZAR-SKK	PALLADAN	11.1383	7.68768									0	
299	2014	1500HRS	ZAR-SKK	PALLADAN	11.1383	7.68768									0	
300	2014	0620HRS	ZAR-SKK	PALLADAN	11.1383	7.68768									0	

301	2014	0930HRS	ZAR-SKK	PALLADAN	11.1381	7.69							0	
302	2014	1330HRS	ZAR-SKK	PALLADAN	11.1381	7.69							0	
303	2014	2327HRS	ZAR-SKK	PHCN	11.1067	7.72119							0	
304	2014	1530 HRS	ZAR-SKK	PHCN	11.1067	7.72119							0	
305	2014	1200 HRS	ZAR-SKK	PHCN	11.1067	7.72119							0	
306	2009	1320HRS	ZAR-SKK	PHCN GATE	11.1067	7.72119	-		1	-		2	3	HIT
307	2010	0933HRS	ZAR-SKK	PHCN GATE	11.1067	7.72119	-		1	-		1	2	ARMED ATTACK
308	2013	1830HRS	ZAR-SKK	POLICE GATE	11.1508	11.1508	-		1	-		3	4	DAD
309	2014	1020HRS	ZAR-SKK	POLICE GATE	11.1508	11.1508							0	
310	2010	2013HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019	-	-			2	3	5	DGD
311	2010	1645HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019	-		1	-		2	3	OVT, DGD
312	2010	1005HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019	-		1	-		6	7	DGD
313	2010	1700HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019	-		1	-		2	3	OLV, TBT
314	2011	1930HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019		1	1		5	2	9	DGD
315	2011	1745HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019	-		1	-		1	2	DGD
316	2011	2200HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019	-		1	-		2	3	SPV
317	2012	1715HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019	-		1	-		10	11	BFL

318	2012	2040HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019	-			1	-			3	4	LSV, HOC
319	2014	1140HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019									0	
320	2014	1615HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019									0	
321	2014	1430HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019									0	
322	2014	1520 HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019									0	
323	2014	1840HRS	ZAR-SKK	POLO FIELD	11.1156	7.72019									0	
324	2014	1350HRS	ZAR-KN	POLO FIELD	11.1156	7.72019									0	
325	2012	1600HRS	ZAR-KN	PPMC DEPOT	11.1256	7.70144	-			1	-			2	3	DGD
326	2012	1506HRS	ZAR-KNT	PPMC DEPOT	11.1256	7.70144	-			1	-			7	8	LOC
327	2012	1731HRS	ZAR-KN	PPMC DEPOT	11.1256	7.70144	-			1	-			2	3	DGD
328	2012	1810HRS	ZAR-KN	PPMC DEPOT	11.1256	7.70144		1	-			10		7	18	HIT & RUN
329	2014	1500HRS	ZAR-SKK	PZ	11.1034	7.72071									0	
330	2009	1835HRS	ZAR-SKK	RAILWAY	11.1186	7.71917	-		-		-			5	5	SPV, DGD
331	2009	1205HRS	ZAR-SKK	RAILWAY	11.1186	7.71917	-		-		-			1	1	BFL
332	2009	1130HRS	ZAR-SKK	RAILWAY	11.1186	7.71917	-		-		-		-		0	MDV
333	2010	0925HRS	ZAR-KN	RAILWAY	11.1186	7.71917	-			1	-			2	3	LOC
334	2011	1930HRS	ZAR-KN	RAILWAY	11.1186	7.71917	-		-		-			6	6	WOV
335	2013	1226HRS	ZAR-SKK	RAILWAY	11.1166	7.72008	-			1	-			2	3	DOT
336	2013	1636HRS	ZAR-SKK	RAILWAY	11.1166	7.72008	-			1	-			3	4	SPV

337	2014	1500HRS	ZAR-SKK	RAILWAY	11.1166	7.72008								0	
338	2014	1500HRS	ZAR-SKK	RAILWAY	11.1166	7.72008								0	
339	2006	1800HRS	ZAR-SKK	SAMARU	11.1617	7.64447	-			1	NIL		1	2	DGD &OLV
340	2007	1835HRS	ZAR-SKK	SAMARU	11.1546	7.66025		1	-			1	2	4	DPV, DGD
341	2014	1658HRS	ZAR-KN	SAMARU	11.1546	7.66025								0	
342	2014	1424HRS	ZAR-SKK	SAMARU	11.1546	7.66025								0	
343	2009	1320HRS	ZAR-SKK	SHIKKA	11.1794	7.60262	-		-		-		3	3	LOC
344	2011	1345HRS	ZAR-KN	STADIUM	11.1351	7.70832	-		-		-		3	3	TBT
345	2011	1530HRS	ZAR-KN	T.TSAMIYA	11.1925	7.77506	-		-		-		3	3	TBT
346	2012	1147HRS	ZAR-KN	T.TSAMIYA	11.1925	7.77506	-			1	-		5	6	TYV
347	2012	1350HRS	ZAR-KN	T.TSAMIYA	11.1925	7.77506		1	-			13	7	21	TBT
348	2013	1119HRS	ZAR-KN	T.TSAMIYA	11.1925	7.77506	-			1	-		5	6	TBT
349	2010	0945HRS	ZAR-KN	T/SANI	11.2368	7.80133	-			1	-		2	3	SPV
350	2011	2015HRS	ZAR-KN	T/SANI	11.2368	7.80133		1	-			1	2	4	TBT
351	2011	1633HRS	ZAR-KN	T/SANI	11.2368	7.80133	-			1	-		1	2	SPV
352	2009	1500HRS	ZAR-KN	TASHAN YARI	11.3541	7.92515	-		-		-		1	1	-
353	2011	1635HRS	ZAR-KN	TASHAN YARI	11.3541	7.92515	-		-		-		6	6	SPV
354	2011	1848HRS	ZAR-KN	TASHAN YARI	11.3541	7.92515		1	-			1	3	5	LOC, SPV
355	2011	1730HRS	ZAR-KN	TASHAN YARI	11.3541	7.92515	-		-			1	7	8	DGD
356	2011	1420HRS	ZAR-KN	TASHAN YARI	11.3541	7.92515	-			1	-		4	5	TBT
357	2012	0700HRS	ZAR-KN	TASHAN	11.3541	7.92515		1	-			5	3	9	LOC

358	2012	1707HRS	ZAR-KN	YARI TASHAN YARI	11.3541	7.92515		1	-		4		3	8	DGD
359	2006	1630HRS	ZAR-KN	TOLLGATE	11.3307	7.89869		2	-		2		6	10	DGD &SPV
360	2009	0905HRS	ZAR-KN	TOLLGATE	11.3307	7.89869	-		-		-	-		0	-
361	2009	0815HRS	ZAR-KN	TOLLGATE	11.3307	7.89869	-			1	-		1	2	TBT
362	2009	0912HRS	ZAR-KN	TOLLGATE	11.3307	7.89869		1	-		1		1	3	LOC
363	2009	1320HRS	ZAR-KN	TOLLGATE	11.3307	7.89869	-			1	-		12	13	TBT
364	2010	1603HRS	ZAR-KN	TOLLGATE	11.3307	7.89869	-			1	-		3	4	TBT
365	2010	0600HRS	ZAR-KN	TOLLGATE	11.3307	7.89869	-			1	-		1	2	LOC
366	2010	1000HRS	ZAR-KN	TOLLGATE	11.3307	7.89869	-			1	-		8	9	-
367	2010	0830HRS	ZAR-KN	TOLLGATE	11.3307	7.89869	-			1	-		6	7	TBT
368	2011	1500HRS	ZAR-SKK	UBN	11.109	7.72069	-		-		-		2	2	SPV
369	2013	1100HRS	ZAR-SKK	UBN	11.109	7.72069	-			1	-		3	4	SPV
370	2013	0800HRS	ZAR-SKK	VIO	11.1329	7.69911	-			1	-		8	9	LOC
371	2011	0915HRS	ZAR-KN	Y/KARFE	11.1175	7.69664	-			1	-		2	3	SPV
372	2012	1145HRS	ZAR-KN	Y/KARFE	11.1175	7.69664	-			1	-		9	10	DGD
373	2012	1630HRS	ZAR-KN	Y/KARFE	11.1175	7.69664	-			1	-		1	2	LOC
374	2012	1430HRS	ZAR-KN	Y/KARFE	11.1175	7.69664		1	-		2		4	7	LOC
375	2014	1640HRS	ZAR-KN	YAN KARFE	11.1175	7.69664								0	
376	2014	1140HRS	ZAR-KN	YAN KARFE	11.1175	7.69664								0	
377	2014	1115HRS	ZAR-KN	YAN KARFE	11.1175	7.69664								0	
378	2014	1550HRS	ZAR-KN	YAN KARFE	11.1175	7.69664								0	
379	2014	1820HRS	ZAR-KN	YAN KARFE	11.1175	7.69664								0	
380	2014	1640HRS	ZAR-KN	YAN KARFE	11.1175	7.69664								0	
381	2014	0850HRS	ZAR-KN	YANKAFE	11.1175	7.69664								0	
382	2014	1700HRS	ZAR-KN	YANKARFE	11.1175	7.69664								0	

383	2014	0840HRS	ZAR-KN	YANKARFE	11.1175	7.69664							0	
384	2014	1040 HRS	ZAR-KN	YANKARFE	11.1175	7.69664							0	
385	2014	1144HRS	ZAR-KN	YANKARFE	11.1175	7.69664							0	
386	2014	0910HRS	ZAR-KN	YANKARFE	11.1175	7.69664							0	
387	2008	0845HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		2	3	DGD
388	2008	1700HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		2	3	RTV
389	2009	0830HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		3	4	POTHOLES
390	2009	0630HRS	ZAR-KN	ZABI	11.1468	7.73751		1 -			3	19	23	POTHOLES
391	2011	1521HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		1	2	LOC
392	2012	2105HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		10	11	DOT
393	2012	1430HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		7	8	LOC
394	2012	1519HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		1	2	TBT
395	2012	1441HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		10	11	DGD
396	2013	1301HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		7	8	DGD
397	2013	1805HRS	ZAR-KN	ZABI	11.1468	7.73751		1 -			1	6	8	TBT
398	2013	1127HRS	ZAR-KN	ZABI	11.1468	7.73751	-		1	-		3	4	RTV
399	2013	0905HRS	ZAR-KN	ZABI	11.1465	7.73976	-		1	-		6	7	SPV, LOC
400	2013	1553HRS	ZAR-KN	ZABI	11.1465	7.73976		1 -			3 -		4	SPV, TBT
401	2014	1020HRS	ZAR-KN	ZABI	11.1465	7.73976							0	
402	2014	1021HRS	ZAR-KN	ZABI	11.1465	7.73976							0	
403	2014	1500HRS	ZAR-KN	ZABI	11.1465	7.73976							0	
404	2014	1020HRS	ZAR-KN	ZABI	11.1465	7.73976							0	
405	2014	1600 HRS	ZAR-KN	ZABI	11.1465	7.73976							0	
406	2014	1720HRS	ZAR-KN	ZABI	11.1465	7.73976							0	
407	2014	1145HRS	ZAR-KN	ZABI	11.1465	7.73976							0	
408	2011	0615HRS	ZAR-SKK	ZANGO	11.1454	7.67395	-		1	-		2	3	FATIGUE
409	2012	0806HRS	ZAR-SKK	ZANGO	11.1454	7.67395	-		1	-		2	3	DOT

410	2013	1300HRS	ZAR-SKK	ZANGO	11.1454	7.67395	-	1	-	9	10	RTV
411	2013	0730HRS	ZAR-SKK	ZANGO	11.1454	7.67395	-	1	-	2	3	DGD
412	2013	2100HRS	ZAR-SKK	ZANGO	11.1454	7.67395	-	1	-	4	5	LOC
413	2014	1615HRS	ZAR-SKK	ZANGO	11.1454	7.67395					0	
414	2014	1000HRS	ZAR-SKK	ZANGO	11.1454	7.67395					0	
415	2014	1925HRS	ZAR-KN	ZANGO	11.1454	7.67395					0	
416	2014	1740HRS	ZAR-SKK	ZARIA ACADEMY	11.1867	7.59103					0	
417	2014	1430HRS	ZAR-SKK	ZARIA HOTEL	11.1314	7.70037					0	
418	2014	1525HRS	ZAR-SKK	ZARIA HOTEL	11.1314	7.70037					0	