

THE NIGERIAN GEOGRAPHICAL JOURNAL

New Series Volume 11 No. 1 (2016)



**PUBLISHED BY THE ASSOCIATION OF NIGERIAN GEOGRAPHERS
FORMERLY NIGERIAN GEOGRAPHICAL ASSOCIATION FOUNDED IN 1957**

IMPACT OF CLIMATE VARIABILITY ON ROAD ACCIDENT ALONG LAGOS-IBADAN EXPRESS WAY, NIGERIA

Elisha Ademola Adeleke, Nurudeen Adesola Malik and Senadheera Lionel Tilakasiri

Department of Geography & Environmental Management, University of Ilorin, Ilorin, Nigeria

Email: adelekeelisha@yahoo.com

ABSTRACT

This study tries to appraise extreme weather events on road accidents over a period of 10 years (2004- 2013) and also examines the frequency of fatal, major and minor accidents in relation to weather conditions along the Lagos-Ibadan expressway. The data collected include the yearly occurrence of road traffic accidents along the Lagos - Ibadan expressway (2004 – 2013), weather elements such as minimum and maximum Temperature, Rainfall amount, Wind speed, Relative Humidity and Sunshine hours. Data on road accidents (Reported cases, casualties and vehicles involved) were collected from the Federal Road Safety Commission, Moniya, Ibadan and Nigeria Police Force Headquarters Eleyele, Ibadan while weather variables were collected from Nigerian Meteorological Agency Oshodi, Lagos state. Both descriptive and inferential statistics were used for the analysis. Descriptive and inferential statistics including tables, charts, Trend analysis, Analysis of Variance, Regression and Correlation analysis were used to analyze the data. The results revealed that some climatic factors examined work together to cause road accidents. Hence, weather conditions have a pronounced impact on road accidents because fog, slippery roads, flood, erosion, visibility, smoke, dew, heat and radiation one way or the other affect the easy movement of vehicles thereby resulting in different forms of accident. The study recommends that Federal Road Safety Commission and other relevant agencies should organize workshops and seminars for the drivers on the etiquette of being safety conscious on the highways.

Keywords: *Climate Variability, Road Accidents, Fatal injuries, Lagos-Ibadan Expressway, Nigeria*

INTRODUCTION

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes with the climate system (internal variability) or to variations in natural or anthropogenic

external forcing (external variability) (IPCC, 2011). Scientists think of climate variability as the way climate fluctuates yearly above or below a long-term average value (Keely, 2010).

One of the major problems facing most countries of the world is the increase in road accidents in which weather plays an important role due to slippery roads, bad

visibility and other adverse weather conditions. Several studies indicated adverse weather conditions as important factors in the causation of road traffic accidents. Road traffic accidents along Nigerian federal highways are the number one killer of travelers and the major cause of fatal injuries which lead to the death of its victim, amputation of parts of the body or a lifelong handicap. The findings by Ipingbemi (2006) revealed that fatalities and injuries increase by 630% and 120% respectively in the 41 years period of review (1960-2001).

Transport and Urban geography are closely intertwined. Cities are very much shaped, indeed created, by the types of exchange and interaction facilitated by movement. Increasingly since the 19th century, transportation has been seen as way cities, countries or firms compete with each other in a variety of spaces and contexts.

The idea surrounding road traffic accidents on expressways was expressed thus by King, (1970) "the multiplication and increasing use of motor vehicles has led to many accidents". This is true in developed countries, the tendency is that, car ownership will increase the risk of accidents compared to the rural areas where reverse is the case. Vehicles as one of the means of road transport are also dangerous to some extent. On roads, accidents constitute one of the major social problems of this time, and this is usually blamed on drivers, on the road, or the vehicle, and this is why road accident is

the greatest source of criticism of motor vehicle transportation.

This was shown in a study conducted by Zaal (1994) where he views accidents as the major cause of death in many countries. Estimates indicate that approximately 400,000 people die every year in road accidents around the world. Deaths and injuries caused by road accidents result in significant social and economic costs especially in developing countries. Charman et al, (1997) were of the view that before an effective road safety measure could be employed, a particular visual requirement must be met by those applying for and holding current driving licenses for private motor vehicles. Although, Graham (2008), postulated that the occurrence of accidents depends mainly on the level of interaction between the vehicle and the driver. He further explored the relationship that drivers have with their vehicles, the manner in which car owners/drivers view their vehicles as 'territory' and the implications of this for drivers' behavior.

Weather and climate are other important factors that increase the rate of accidents on roads. Extreme weather conditions like haze, fog and cloudiness reduce visibility immensely, thereby causing motorist especially those with poor eyesight to unknowingly run headlong into incoming vehicles or losing track. In the same vein, the climate condition, whether dry season as in harmattan period or rainy season also contributes to fatal accidents on the road. For example, during the rainy season the surfaces of carriage ways may be slippery

to vehicle tyres, even if the surfaces tend to be coarse causing them to skid out of control. Also, during heavy downpour, visibility could be reduced especially for drivers with malfunctioning screen wipers. Transportation geography measures the result of human activity between and within locations. It focuses on things such as travel time, routes chosen, and modes of transport, cost and resource use. Other topics of interest include topography, safety of vehicles, and energy use within an individual's or group's journey. The purpose of transportation is to move through space, which is shaped by both cultural and physical constraints such as distance, political boundaries, time, and topography (Rodriguez, 2013).

A striking feature of the data on the age-dependence of accidents and visual performance is that although visual performance by most tests steadily declines after early middle age, older drivers have less accident than their younger counterparts, whose visual performance is superior to the older ones. It is concluded that, although correlations between poor vision as by some tests and accidents rates can be shown in large sample of drivers, as yet, no single test or combination of tests has been shown to be able to effectively screen out those at risks of accidents without also leading to the disqualification of a substantial number of potentially safe drivers. Thus no change in the present visual requirements is recommended at the present time. Skuli Thordarson and Bjorn Olafsson (2008) findings in examining the impact of weather on road transport put it forward

that both sites investigated for wind induced accidents are adjacent to mountains that during specific weather conditions are prone to magnifying the wind effects, causing extremely hazardous conditions on the road. The highest wind gust can be as high as 2.5 times higher than the mean wind speed, frequently catching drivers off-guard, despite amiable message signs indicating the wind speed on the site. On exposed sites, cross winds acting laterally on the side of the vehicle are commonly as strong as the vehicle velocity induced air-speed, the air pressure acting sideways can thus be high as the drag force in the driving direction.

Guohua Li, (2006) view accidents from the public health perspective that the public health approach consists of four steps: Surveillance, Risk factor, Intervention and Evaluation. As a foundation of the public health approach, surveillance involves systematically collecting, analyzing, interpreting and disseminating data pertaining to injury occurrence and outcome principle guiding the public health approach to road safety.

Researches of scholars have revealed the pattern, causes and costs of road accidents in Nigeria (Onakomaiya, 1981 and Oyeyemi, 2002 cited in Ipingbemi, 2008). Nigerians have been deluded into thinking that road accidents is a possible incident that occur during long trips and rainy seasons, and as such, many people accept as fate what could have been forestalled if precautionary measures have been taken. In Nigeria, the issue of accidents has not been given the appropriate treatment it deserves, and this explains why policies

made to ensure safety on roads are not aggressively implemented. This also explains why there are many unlicensed road users, unworthy vehicles, reckless drivers among others increase geometrically on federal highways. It is generally accepted that road accidents worldwide have reached an endemic stage and Lagos-Ibadan expressway is not an exception. This is attributed to the fact that since man started inventing vehicles and automobiles road accidents have become inevitable for him. This is particularly against the background that this problem is caused by circumstances which are mostly avoidable in all countries of the world (Irelewuyi, 1992).

As a result of the setback caused by the problem, the federal government decided to embark on a series of safety programs aimed at reducing road traffic accidents. For example, the Nigerian Army introduced the annual road safety program in 1972 and the defunct National Road Safety Commission (NRSC) in 1974 (Sunday sketch of 22nd May, 1994). All the above mentioned strategies have achieved little or nothing in ensuring safety on Nigerian roads. In spite of the efforts by the federal government to ensure safety on our roads, the expressway is still faced with a high number of deaths through road accidents. Road accidents are causing a lot of problems not only in the transport and health sector of the economy. The loss of lives and destruction of properties through road accidents have to some extent retarded the economic development of both Lagos and Oyo state even Nigeria at large.

On the other hand there are atmospheric related problems or events which are related to road accident on the Lagos - Ibadan expressway. These include visibility impairments, precipitation, high and whirl winds and extreme temperature which affect the driver's capabilities, vehicle performance (i.e., traction, stability and maneuverability).

STUDY AREA

The Lagos-Ibadan expressway is an important federal and trunk (A) road. This is because of its socio-economic values in Nigeria as a whole in the movement of freights, information, humans and other items from the north to south west and within the south west. The Lagos-Ibadan expressway was commissioned in the year 1977. The road is made up of the surfacing layer which is the topmost surface, the base layer which is about 150-200mm thick. All these layers are called the pavement structure and the road has thirteen bridges constructed across it with spurs, which is extension of roads or the area through which the highway extends into a city e.g. Oworonsoki is a spur of the Lagos-Ibadan expressway, and some other roads like Oyo among others. (Federal Ministry of Works and Housing highway unit, 2007). The Lagos - Ibadan expressway lies within the tropical rainforest belt of Nigeria. The Climate is characterized by hot average temperature all year round and high monthly precipitation, typically no less than 60mm a month with annual precipitation tending to be over 2000mm. The diurnal temperature range is greater than the

annual temperature range. The reason for this regular climate is due to a feedback between low pressure convectional processes that result from the high altitude of the sun (ITCZ) and the high levels of soil moisture and interception of rainfall from the dense vegetation cover leading to transpiration. Lagos – Ibadan expressway has a more humid climate experiencing rainfall in all months of the year, with a maximum monthly rainfall of 16.3 inches in June (Wikipedia, 2013)

The soil in this area is highly humus and bleached alkaline soils. The population of micro organisms is very high because of the high alkalinity; hence there is a very high mixing of soil materials between one horizon and another. This is why the horizon of the podzol profile has very sharp and distinct boundaries. (Leong et al; 1999)

The vegetation of the Lagos-Ibadan expressway is made up of mainly trees, although there is a small proportion of woody shrubs and herbaceous plants (Leong et al; 1999). The expressway throughout its length passes through some predominantly rural areas. These villages include: Ibafo, Mowe, Asese, Alapako and others. The few towns linked to the expressway are Ogere, Ode-remo, Ipara and Shagamu among others. Also along the expressway are religious camps like Mountain of fire prayer city, the Redemption camp, Cherubim and Seraphim, Guru Maraji camp, Deeper Life camp and Nasfat camp among the rest. The road runs within the Lagos, Ogun and Oyo states axis and road starts from the

defunct toll gate in Lagos and ends at the last toll gate in Ibadan. The road is about 140km dual carriage expressway. Its capacity is about an hundred and twenty vehicles per kilometer and it is designed for a speed of one twenty kilometers per hour 120 km/hr (Fieldwork, 2015).

Materials and Methods

The data required for this research consist of the yearly occurrence of road traffic accident along the Lagos - Ibadan expressway between 2004 and 2013 and also weather elements such as minimum and maximum Temperature, Rainfall, Wind speed and Sunshine. These data were collected majorly through secondary sources and also little observation and facts gathered by the researcher. Data on road accidents such as reported cases of accident, casualties and condition of vehicles involved were sourced from Federal Road Safety Commission, Moniya, Ibadan and the Nigeria Police Force Headquarters Eleyele, Ibadan, while Weather variables such as Minimum and Maximum Temperature, Rainfall, Wind speed, Relative Humidity and Sunshine hours were collected from Nigerian Meteorological Agency Oshodi, Lagos state.

Both descriptive and inferential statistics were used for analysis of the collected data. Descriptive statistics include the use of charts and tables while inferential statistics include trend analysis to examine the trend pattern of accident occurrence from year 2004 to 2013. Regression analysis was used to examine the precise relationship between the weather variables

and reported cases of accident occurrences. Climatic variables (minimum and maximum Temperature, Rainfall, Wind speed, Relative Humidity and Sunshine) were regressed against the rate

of accidents in the study area between 2004 and 2013. However, 250 respondents were interview at specific period (during traffic holdup) along the expressway at interval of 9km.

Table1a: Cases of Accident in Lagos-Ibadan Express Way

Year	Accident reported cases	No of vehicle involved	No of person killed	No of person injured
2004	1,050	1,902	430	1,206
2005	1,564	2,379	327	861
2006	1,160	2,180	465	1,067
2007	408	732	164	356
2008	1,184	1,903	126	1,193
2009	1,666	2,901	287	1,140
2010	1,578	1,397	306	1,115
2011	1,532	1,310	157	368
2012	1,420	1,608	34	67
2013	1,330	1,450	120	80

Source: Nigeria Police Force Headquarters Eleyele, Ibadan, (2015)

Table 1b: Climatic Variables considered between 2004-2013

Year	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)	Sunshine (hrs)
2004	32.3	23	119.5	5.3
2005	31.9	23.7	100.4	5.1
2006	31.5	21.5	105	4.9
2007	31.4	21.5	107.6	5.3
2008	30.9	21.6	173.2	5.2
2009	31.4	21.4	154.2	5.1
2010	30.9	21.4	116.6	5.4
2011	32.3	22.7	159.1	5.1
2012	31.9	22.8	119.8	5.3
2013	32.6	23.2	121.5	5.5

Source: Nigeria Meteorological Agency (NIMET), Osodi, Lagos State (2015)

RESULTS AND DISCUSSION

Causes of Road Accidents

The information collected from respondents through interview revealed that weather elements have greater impact

on road accident along Lagos-Ibadan expressway. Though, there are other factors that assist the influence of weather conditions. From figure 1, 75 respondents (30%) were of the opinion that adverse

weather condition was the major causes of road failure which always resulted to road accident along the expressway while 98 respondents, about 40% agreed that road accident along the expressway was caused as a result of road heat/damage. Fog and poor visibility was the causes of road

accident as opined by 25 respondents (10%) while 50 respondents (20%) had the view that flooding and water loggings during wet seasons were the prominent factors that account for road accident in the study area.

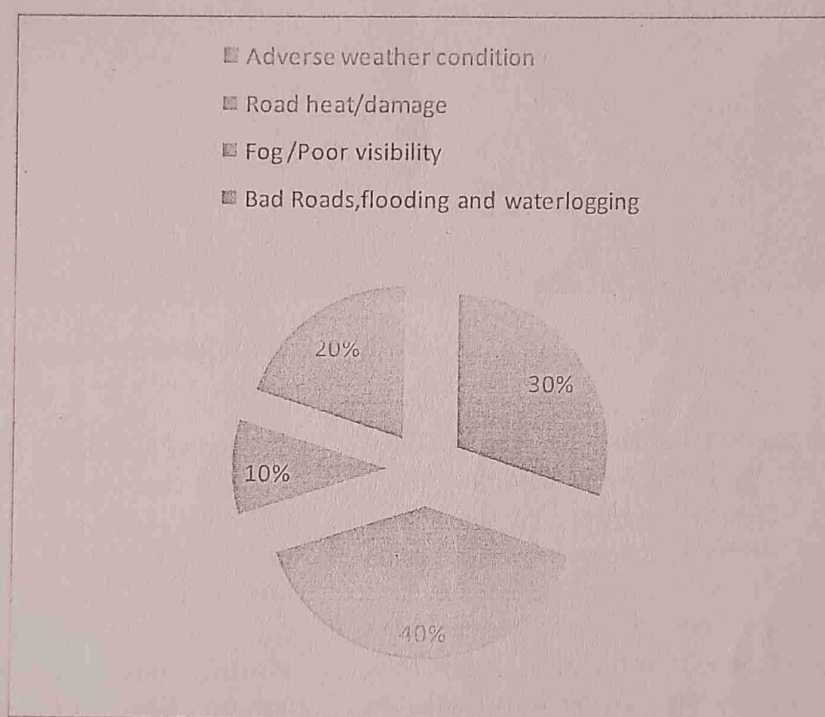


Figure 1: Causes of Road Accidents
Author's survey (2015)

Therefore it can be established from figure 1 that road heat/damage seconded by adverse weather conditions are the major causes of accidents as been viewed by both commercial and private drivers that ply this expressway route. Road heat aids bursting of vehicle tyres and general vehicle damages and this can only happen as a result of adverse weather condition.

The majority of drivers and passengers also agreed that there are other factors that explain occurrence of road accident in the study area. Fogs and poor visibility, bad roads, floods and water loggings are sub-factors of weather condition that enhance road accident if adequate attention and care are not paid to these factors especially on the Lagos-Ibadan expressway.

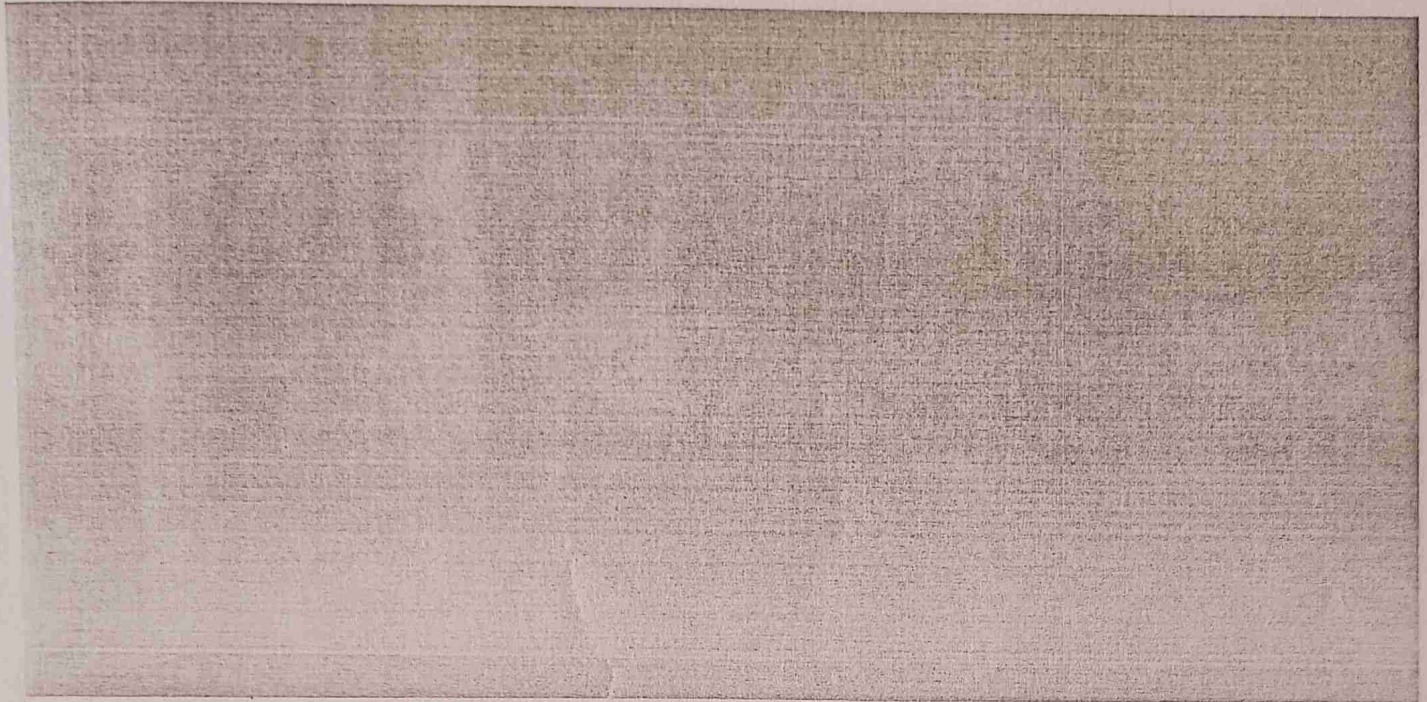


Figure 2: Trend Analysis of Accident Occurrence
Author's survey (2015)

The trend analysis for accident occurrence along the Lagos – Ibadan expressway as shown in figure 2 revealed that year 2009 records the highest number of accidents (1,666) probably as a result of high value of maximum temperature (32°C) during the dry seasons and high amount of rainfall (154.2mm) during the wet seasons recorded the same year while 2007 records the lowest reported cases of accidents and low recorded maximum temperature and low amount of rainfall (107.6mm). From 2007, the number of accidents continued to rise yearly up till 2009 and then reduced yearly from there to 2013. In 2009, highest number of vehicles (2,180) that involved in road accident was recorded and highest number of casualty (465) was recorded in 2006. In 2004, 1,050 accident cases were reported which involved 1,902 vehicles and about 1,206 people incurred fatal injury while 430 people died. In 2012,

1,420 cases of accident were reported, 1,608 vehicles were involved, 34 people died and 67 people sustained various degree of injury. Reported cases of accidents were reduced in 2013 with a reduced number of vehicles involved, number of people killed and people that sustained diverse injuries because rainfall amount (121.5mm) was reduced in the year with low rate of surface slippery on the expressway. It is however agreed that climate variables have significant impact on road failure which always cause road accident in major highways, especially Lagos-Ibadan expressway.

Weather Conditions and Road Accidents

The result in Table 1 indicate that there exist a positive linear relationship between road accidents and weather conditions has explained by $r^2 = 0.625$. This means that weather variables account for 63% of road

accident along the Lagos – Ibadan expressway while the remaining 37% is caused by other factors such as negligence on the part of the driver, over speeding and also faulty vehicles. This implies that as

weather conditions tend to be unfavorable, road accidents are bound to happen leading to various degrees of injuries and death.

Table 1: Extreme Weather and Road Accidents

Model	R	R Square	Adjusted R Square	Standard Error
1	.791	.625	-.124	393.58360

Author's survey (2015)

Testing of Hypothesis

H_0 : Weather condition do not have a pronounce impact on road accidents

H_1 : Weather condition do have a pronounce impact on road accidents

Decision Rule: reject H_0 if $F\text{-cal} (0.834) > F\text{-table} (0.613)$

Conclusion: since $F\text{-cal} (0.834) > F\text{-table} (0.613)$ reject H_0 and hold on to the

alternative H_1 . Hence weather condition do always have a pronounce effect/impact on road accident because fog, slippery roads, flood, erosion, visibility, smoke, dew, heat, radiation among others all in one way or the other affect the easy movement of vehicles thereby resulting in different forms of accidents (see Table 2).

Table 2: Road Accident and Weather Conditions in Ibadan

Model	Sum of Squares	df	Mean Square	F	Significance
Regression	775389.438	6	129231.573	.834	.613
Residual	464724.162	3	154908.054		
Total	1240113.600	9			

Author's survey (2015)

Table 3: Road Accidents and Weather Conditions in Ogun

Model	R	R Square	Adjusted R Square	Standard Error
1	.780	.609	-.173	402.10008

Author's survey (2015)

The regression results in table 3 showed a positive relationship between road accidents and weather conditions as explained by regression coefficient $r^2 = 0.609$. This means that weather variables account for 60% of road accident along the Lagos – Ibadan expressway while the remaining 40% may be attributed to other

factors including negligence on the part of the driver, over speeding and also faulty vehicles among others. This implies that as weather conditions tend to be unfavorable, road accidents are bound to happen leading to various degrees of injuries and death.

Table 4: Road Accident and Weather Conditions in Ibadan

Model	Sum of Squares	df	Mean Square	F	Significance
Regression	755060.166	6	125843.361	.778	.638 ^a
Residual	485053.434	3	161684.478		
Total	1240113.600	9			

Author's survey (2015)

TESTING OF HYPOTHESIS

H_0 : Weather condition do not have a pronounce impact on road accidents

H_1 : Weather condition do have a pronounce impact on road accidents

Decision Rule: reject H_0 if $F\text{-cal} (0.778) > F\text{-table} (0.638)$

It is shown in Table 4 that since $F\text{-cal} (0.778) > F\text{-table} (0.638)$ we reject H_0 and hold on to the alternative H_1 . Hence weather condition do always have a pronounce effect/impact on road accident because fog, slippery roads, flood, erosion, visibility, smoke, dew, heat, radiation etc. all the above listed in one way or the other affect the easy movement of vehicles therefore resulting in different forms of accidents leading to different degrees of injuries, burns and eventually death.

CONCLUSION AND RECOMMENDATIONS

Road traffic accidents along Nigerian federal highways are the number one killer of travelers and the major cause of fatal injuries which lead to the death of its victim, amputation of parts of the body or a lifelong handicap. Road accidents are inevitable as it claims lives without differences. Through the data collected and analyzed, the study has shown that road accident is on the increase and that accidents occur mostly during the dry

season. It has also shown that some factors (climate, human, road and vehicle) work together to cause accidents, and all these can be controlled if proper precautions are taken. There have been high accidents rates and fatality trends along the Lagos – Ibadan expressway. Although there is a decrease in the number of reported cases of accident, yet, the fatality rate is high. This study therefore suggests that Federal Road safety Commission and the Police Force in conjunction with the State and Federal government should check the incessant incidence of parking at black spots, over speeding, traffic congestion and then enforce the compliance of road users to the speed limit and observation of traffic rules and regulation. The Federal Road Safety Commission should strive towards sustaining seminars and workshops aim at educating the drivers on the essence of safety on our highways.

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