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Thematic Mapping of the Trend of Road Traffic Crashes in Nigeria: A Tool for Advancing Sustainable Safety of Lives

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Abstract. The problem of Road Traffic Accidents (RTAs) in the Nigerian context cannot be overemphasized. The paper will map the trend of road traffic crashes in Nigeria using Geographic Information System (GIS) techniques for a decade (2010-2020). Findings from such mapping will inform policy formulation and program implementation at tactical and operational levels to curb the menace of RTA in Nigeria. Data used for this study is extracted from the Federal Road Safety Commission (FRSC) Statistical Digest. The methods of analysis adopted for the study are Descriptive Statistic and Geographic Information System (GIS) with results presented in tables, graphs and maps. The results shows that the highest rate of road traffic crashes is in year 2011(10.8%), 2012(10.5%), 2013(11.1%) and 2021(10.6%) respectively with Kaduna state, Ogun state, Oyo state and the Federal Capital Territory, Abuja classified as black or hot spots over a decade now. This study therefore recommends that geo-visualization as the creation and use of visual representations that facilitate thinking, understanding, and knowledge construction of geospatial data should be encourage among agencies and parastatals responsible for safety of lives and properties most especially on the roads.

Keywords: Road Traffic Crashes, Trend, Thematic Mapping, Geographic Information System, Nigeria.

1. Introduction

Road traffic crashes have become a global phenomenon. Its frequency is higher in developing countries when compared to the developed countries (Obafemi & Obafemi, 2021). According to global estimates, road traffic crashes claim the lives of approximately 1.35 million people each year, with an additional 20 to 50 million people suffering non-fatal injuries with many resulting in various forms of disability (International Transport Forum, 2020). Injuries sustained from road traffic crashes are one of the leading causes of death in Africa with 20% of the World's Road deaths (World Health Organization, 2015). Recent studies also show that Africa has the higher cases of road traffic crashes when compared with Europe and Asia. Furthermore, low- and middle-income countries over the World have less than half of the world's vehicle, yet contributing to 80% of the total number of road traffic deaths; this could be due to the poorly maintained roads and lack of enough resources to enforce laws (FRSC, 2020).

In Nigeria, available statistics put the casualty figure at about 1.2 million deaths yearly, and between 20 to 50 million people are injured annually (Atubi & Gbadamosi, 2015). Nigeria is among the countries with the highest rate of accident in the world, with a figure of 1042 deaths for every 100,000 vehicles and about ₦80billion is lost yearly on road accidents (Labinjo *et al*, 2010, Atubi, 2012). According to the Federal Road Safety Commission (FRSC, 2017), 5053 people were killed in 9694 road crashes in 2016, a decrease of 387 people when compared to the death toll of 5440 in 2015, when 9734 crashes occurred.

According to Ukoji (2014), unsafe driving behaviours account for up to 90% of crashes in Nigeria, including inappropriate speeding and speed-related factors, a lack of understanding of traffic regulations, including road signs and markings, drink driving, dangerous driving, driver fatigue, and inappropriate overtaking. Individuals' quality of life, social and

economic activities and the nation's overall economic activity are all affected by crashes (Gudaji & Dankishiya, 2016). Road traffic crashes in Nigeria have also been attributed to human, mechanical, and environmental elements (Odufuwa et al., 2017). However, recent studies have revealed man as the central factor responsible for most of the road traffic crashes in developing countries like Nigeria, as the decisions to either put the roads or vehicles in good condition nor careful driving for safety purposes solely depend on him (Afolabi & Gbadamosi,2017).

Road traffic accident in Nigeria is increasing at an alarming rate and with the high number of lives lost to road traffic accidents as the highest in African continent is a serious concern that deserves urgent action from various stakeholders involve in transportation and disaster management (Emmanuel et al.,2021). Nigeria has the highest rate of mortality from road accidents in the world according to statistics compiled by the Federal Road Safety Commission (FRSC). The country leads 43 other nations with highest number of deaths in 10,000 vehicle crashes followed by Ethiopia with 219 killed per 10,000 vehicles while Malawi and Ghana are with 183 and 178 killed per 10,000 respectively (Adebayo, 2015). This study is therefore necessary, considering the importance of roads, and the increasing level of road traffic accidents over the years along Nigeria motorways and with its huge effect on the economy and healthcare services, everyone will like to see a reduction in it. Despite measures taken by the law enforcement agencies to curb this menace, it is still a growing problem. Hence, if this is not checked, there is every tendency of increase in the cases of road traffic accidents in Nigeria due to increase in the number of vehicles on the roads without commensurate increase in the number of roads as well as improvement in the available road conditions and other facilities (Emmanuel et al., 2021).

This research paper is however important to pursue the course of curbing road traffic crashes in achieving the Sustainable Development Goal (SDGs 3) on Good Health and well being in Nigeria by 2030 using thematic mapping techniques and classifying the states in Nigeria based on their rate of crashes occurrence. What is the current trend of road traffic crashes in Nigeria? Where are the black pots? How thematic maps can give better understanding of the trends and events leading up to a crash in order to prevent it? These and others will form the specific objectives of the study.

2. Literature Review and Theoretical Framework

The peculiarity of road has made it to be epicenter of Road Traffic Crashes (RTC) globally, and it is even more disturbing when it is considered that global annual deaths attributed to road traffic crashes were 1.24million in 2013, 1.25million in 2014 and 1.35million in 2018 respectively with strong indications that about 90% of these fatalities are accounted for by low and middle income countries that have only about 48% of registered vehicles (FRSC, 2020). More than half of global fatalities are attributed to road users; while RTC has crashes, injuries and fatalities has remained the leading cause of death among the young people within the age bracket of 5-29 years.

The pathetic situation in low and middle income countries were linked to the absence of Sustainable City Structures and Safe System Approach. There are sufficient indications that the alarming projection of 1.9 million annual fatalities by the United Nations (UN) could become a reality in the near future. The official RTC data of Nigeria as published by the FRSC and the Nigeria Bureau of Statistics indicates that there were 5,181 deaths and 32,220 injuries in 2018. The rate of crashes, injuries and fatalities has been trending downwards in the last ten years. The figures however still remain high and require more efforts to curtail the menace (FRSC, 2020).

The trend of road accidents varies all around the world and also differs in its causative factor from one country to another. In the United States of America for example, studies have shown that the main causative factor of road accident is driving under the influence of alcohol, which accounts for 82% of road accidents in the country while in India, lack of knowledge regarding prevention of road accidents is among the major causative factors (Sanjay, 2017). A lot of road traffic accidents in Nigeria are attributed to reckless driving, brake failure, burst tyres, engine failure, undulated terrain, bad weather and heavy shower that resulted to poor road conditions and other road facilities (Afolabi & Gbadamosi, 2017; Emmanuel et al.,2021).

Like in many parts of the world, road traffic accidents are very high in Nigeria and have become progressively important because of its heavy health and financial burden (Osayomi & Areola, 2015). Developing countries generally suffer most losses from road traffic accident when compare to developed countries due to the current trend of urban growth, poor state of road infrastructures, and

defective political economy system (Osayomi, 2013). Due to the consequences of this hazard in Nigeria, it has drawn keen attention from both academic and policy makers who have tried to come up with road traffic accidents prevention and reduction strategies. These strategies include the country's recent National Action Plan on Road Safety, the Safe Road initiative, which was largely derived from the United Nations' Decade of Action for Road Safety (2011-2020) to "reduce road traffic crashes and injuries by 50 percent in 2020" (FRSC, 2020), despite this, road traffic crashes still remain major causes of anxiety (Emmanuel et al.,2021).

Despite the huge attention given to road traffic accidents, little studies are done on its geographic distribution and severity especially in the developing countries such as Nigeria (Iyanda, 2018; Osoro et al., 2011). However, the area of thematic mapping which is the focus of this study has not been explored in details in explaining the trend of road traffic crashes and its consequences in Nigeria.

Thematic mapping is the process of producing a type of map that portrays the geographic pattern of a particular subject matter (theme) in a geographic area. This usually involves the use of map symbols to visualize selected properties of geographic features that are not naturally visible, such as temperature, language, or population (Nelson, 2020; Bartz, 1979). In this, they contrast with general reference maps, which focus on the location (more than the properties) of a diverse set of physical features, such as rivers, roads, and buildings. Thematic mapping is closely allied with the field of Geovisualization.

Several types of thematic maps have been invented, starting in the 18th and 19th centuries, as large amounts of statistical data began to be collected and published, such as national censuses. These types include; choropleth maps, isarithmic maps, and chorochromatic maps, that use different strategies for representing the location and attributes of geographic phenomena.

One of the earliest thematic maps was one entitled *Designatio orbis christiani* (1607) by Jodocus Hondius, showing the dispersion of major religions using map symbols, in the French edition of his *Atlas Minor* (1607). This was followed by a thematic globe (in the form of a six-gore map) showing the same subject, using Hondius' symbols, by Franciscus Haraeus, entitled *Novus typus orbis ipsus globus, ex Analemmate Ptolomaei diductus* (1614). An early contributor to thematic mapping in England was the English astronomer Edmond Halley (1656–1742), who introduced the Enlightenment conception of the thematic map as a tool for scientific thinking. Early chorochromatic (nominal area-class) maps also appeared in the late 18th century as scientific instruments for exploring geographic phenomena such as geology and language.

The early to middle 19th century could be considered, as Robinson called it, a "golden age" of thematic mapping, when many of the current techniques were invented or further developed. For example, the earliest known choropleth map was created in 1826 by Charles Dupin. Based on this work Louis-Léger Vauthier (1815–1901) developed the population contour map, a map that shows the population density of Paris in 1874 by isolines. One of the most influential early works of thematic cartography was a small booklet of five maps produced in 1837 by Henry Drury Harness as part of a government report on the potential for construction of railroads in Ireland. Included were early chorochromatic and flow maps, and possibly the first proportional point symbol and dasymetric maps.

Another example of early thematic mapping comes from London physician John Snow. Though disease had been mapped thematically, Snow's cholera map in 1854 is the best-known example of using thematic maps for analysis. Essentially, his technique and methodology anticipated the principles of a geographic information system (GIS). Starting with an accurate base map of a London neighborhood which included streets and water pump locations, Snow mapped out the incidence of cholera deaths. The emerging pattern centered around one particular pump in Broad Street. At Snow's request, the handle of the pump was removed, and new cholera cases ceased almost at once. Further investigation of the area revealed that the Broad Street pump was near a cesspit under the home of the outbreak's first cholera victim.

By the early 20th century, established methods were in place for manually drafting a variety of thematic maps, but they were still produced in far fewer numbers than general reference maps, and occupied a relatively small portion of cartographic education. Their popularity vastly increased in the second half of the century, due to several influences: first, the Quantitative revolution in geography and the rise of cartography as an academic discipline, both of which increased the role of thematic maps as tools for scientific analysis and communication; second,

technology that facilitates map design and production, especially the personal computer, the geographic information system (GIS), graphics software, and the Internet; and third, the widespread availability of large volumes of data, notably the first digital releases of national censuses in the 1990s.

3. Materials and Methods

3.1 Study Area

Nigeria is located between 4° to 14°N of the equator and between 2° to 15°E of Greenwich Meridian in West Africa along the Atlantic Ocean Gulf of Guinea. It has the total land area of 923,768 square kilometers and 853km coastline. Nigeria shares boundary with Benin Republic to the west, Cameroun and Chad to the east and Niger Republic to the North. The country has 36 states with the Federal capital territory in Abuja. The terrain of Nigeria includes lowlands that ascend up into the hills in the south, plateaus in the central, mountainous in the southeast and plains in the north. It has an estimated population of about 200 million people (NBS, 2015).

Nigeria has the largest road network in West Africa with about 195,000 km of road network of which about 60,000 km are paved (World Bank, 2022). Most of the major road networks in the country were constructed in the 80s and early 90s, of which most, as a result of poor maintenance and low-quality materials used for repairs are deteriorating in conditions (World- ometer, 2022). The country most important highways run from the South to the North, designed to bring produce from the hinterlands to the coast for export and to link the economies of old Northern and Southern Nigeria. These highways are labelled the A1, A2, A3 and A4. All other major roads in the country originate from these four (World Bank, 2022). The country as at today has evolved into a political structure that consist of 36 states and a new Federal Capital Territory (Abuja), all constitutionally summarized into six Geopolitical zones. There are also, 774 Local Government Areas (LGAs) in the country, each with its own administrative headquarters (Ademiluyi, 2020).

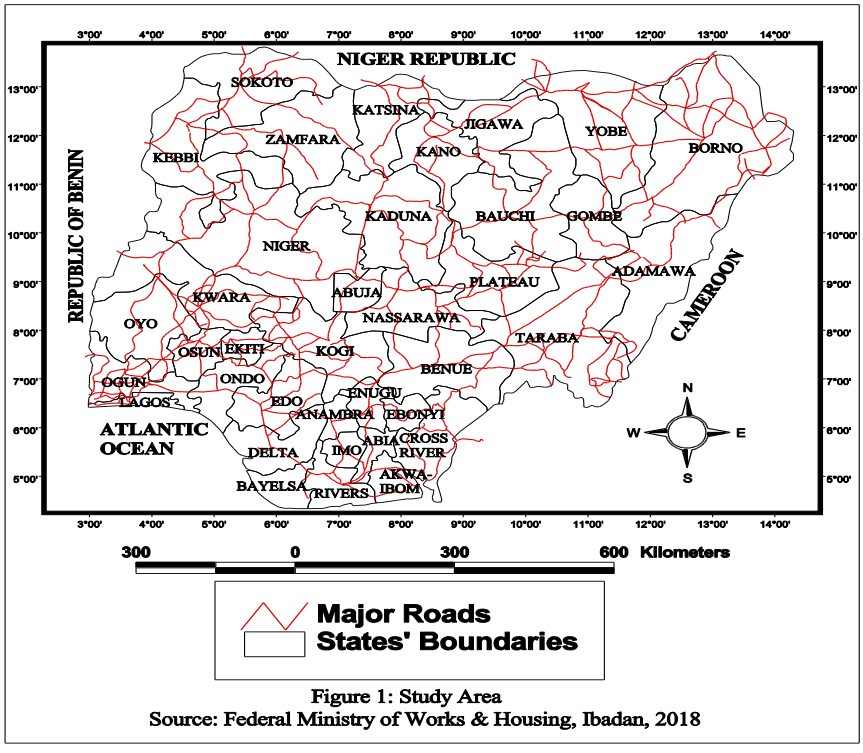


Figure 1: Study Area
Source: Federal Ministry of Works & Housing, Ibadan, 2018

3.2 Data Source and Types

This research made use of secondary data, accessed from the National Bureau of Statistics (NBS) data bank for the compiled reported cases of road traffic accident in Nigeria for a decade. Additional data were also collected from the data bank of the Federal Road Safety Commission (FRSC) as well as their quarterly road traffic data

publication called "Digest". The data provided include year, state of occurrence, number of accidents, number of injuries and number of deaths.

3.3 Method of Data Analysis

The methodology employed for the data analysis include preparation of thematic maps showing the rate of road traffic crashes in each state of Nigeria as well as classification of the states based on the fatality rate of road accident that occurred in them for better visualization. Descriptive and inferential statistical methods were also used in presenting the current trend of recorded road traffic crashes in Nigeria. ArcGIS 10.0 software was used to design the thematic maps indicating the rate of road traffic accidents and their fatality across the 36 States of the federation and Abuja, the federal capital territory.

4. Results and Discussions

Trend of the Reported Cases of Road Traffic Crashes in Nigeria for Year 2011-2021

Table 1: Reported Cases of Road Traffic Crashes in Nigeria between year 2011 and 2021

Year	Fatal Cases	Serious Cases	Minor Cases	Total Cases	Number Killed	Number Injured	Total Casualty
2011	2840	8357	1999	13196	6054	41165	47219
2012	2935	8277	2050	13262	6092	39348	45440
2013	3294	8589	1700	13583	6544	40057	46601
2014	3117	6356	907	10380	5996	32063	38059
2015	2854	6039	841	9734	5440	30478	35918
2016	2638	5633	1423	9694	5053	30105	35158
2017	2587	5456	1340	9383	5121	31094	36215
2018	2739	5849	1153	9741	5181	32220	37401
2019	2896	6911	1265	11072	5483	35981	41464
2020	2809	4124	2490	9424	4382	26159	30541
2021	1712	3027	1393	13027	6205	38073	44278
Total	**30421**	**68618**	**16561**	**122496**	**61551**	**376743**	**438294**

Source: *Federal Road Safety Commission (FRSC) Statistical Digest, 2022.*

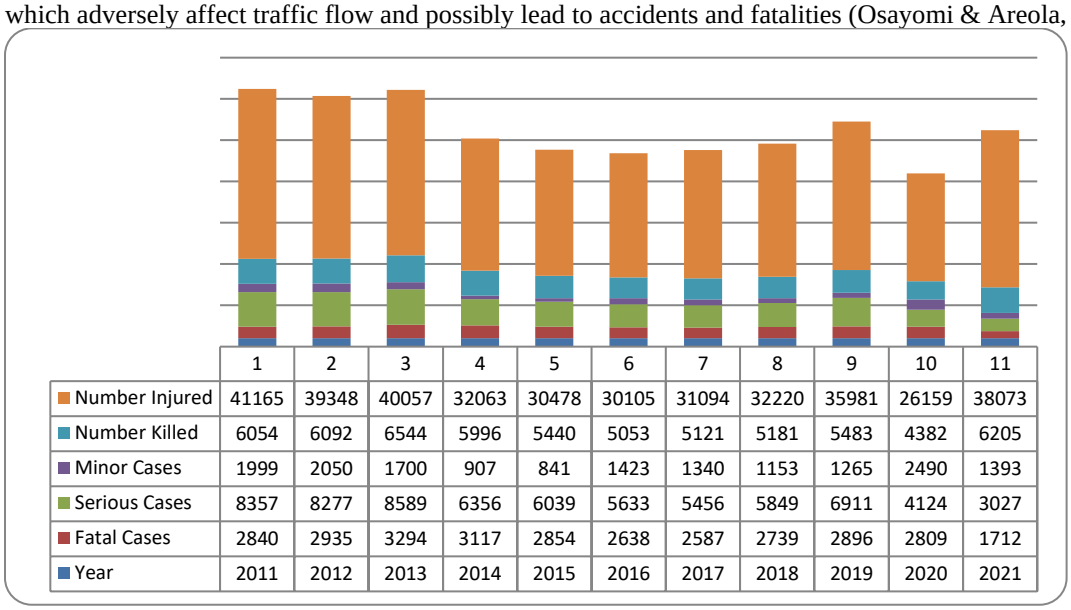
The trend of road traffic crashes cases for the past ten years (2011-2021) is presented in Table 1 and Figure 2 respectively. A total number of 122,496 different types of road traffic accidents cases were reported for the year of study. Of which 25% are fatal cases with 56% classified as serious and 14% minor in nature. Table 1 and Figure 2 further revealed the degree of casualty involved in the reported cases of road crashes between 2011 and 2021 with a total of 438,294 casualties out of which 14% of the victims died while 86% sustained various form of injuries. On year bases, year 2011 recorded the highest number of casualties (47,219) as a result of road crashes followed by year 2013 (46,601), 2012 (45,440), 2021(44,278), 2019 (41,464) with year 2020 having the least casualties (30,541) (see Table 1 and Figure 2).

Table 1 and Figure 2 also shows that more cases of road traffic accidents were recorded in year 2013 (13,583), 2012 (13,262) and 2011 (13,196) with a downward trend for the rest of the years before picking up again in year 2021. The trend of fatality involved as a result of this menace also varies over the period of study with virtually all the years recording a great number of deaths (Table 1 and Figure 2). These findings corroborate the fact that road traffic crashes in Nigeria is still very high and this can be largely attributed to various causative factors such as human, natural and mechanical factors (Emmanuel et al., 2021).

Gbadamosi (1997) stressed that more than half of all the road traffic accidents and casualties in Nigeria were due to drivers' error which include recklessness, over speeding, improper overtaking, in attention or confusion, inexperience, carelessness at junctions and intoxication. Furthermore, according to him nearly six (6) percent of the accidents were due to mechanical vehicular factors while another six (6) percent was due to road construction problems. As for mechanical causes, the incidence is traced to owners' or drivers' refusal to take adequate care of the defects in their vehicles until they degenerate into disastrous conditions.

Generally, Nigerian roads are in dreadful conditions because of "…continued lack of maintenance, poor design and construction, excessive use and inadequate financing of road projects by the federal, state and local governments"

(Akinyemi, 2012). Given these challenges, these roads repeatedly develop potholes and, in some cases, gullies which adversely affect traffic flow and possibly lead to accidents and fatalities (Osayomi & Areola, 2015).



	1	2	3	4	5	6	7	8	9	10	11
Number Injured	41165	39348	40057	32063	30478	30105	31094	32220	35981	26159	38073
Number Killed	6054	6092	6544	5996	5440	5053	5121	5181	5483	4382	6205
Minor Cases	1999	2050	1700	907	841	1423	1340	1153	1265	2490	1393
Serious Cases	8357	8277	8589	6356	6039	5633	5456	5849	6911	4124	3027
Fatal Cases	2840	2935	3294	3117	2854	2638	2587	2739	2896	2809	1712
Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021

Figure 2: The Trend of Road Traffic Crashes Cases in Nigeria for year 2011-2021

Thematic Mapping of the Trend of Road Traffic Crashes Cases, Injuries, Deaths and Number of People Involved in Nigeria by States for year 2018-2021

Reported Cases of Road Traffic Crashes Cases

Table 2: Reported Cases of Road Traffic Crashes by States for year 2018-2021

State	Cases (2018)	Cases (2019)	Cases (2020)	Cases (2021)
Abia	77	90	87	106
Adamawa	130	143	235	330
Akwa-Ibom	81	80	77	73
Anambra	165	160	190	267
Bauchi	356	318	352	583
Bayelsa	53	18	14	48
Benue	268	234	279	227
Borno	46	57	51	86
Cross-River	56	79	90	145
Delta	124	168	172	215
Ebonyi	133	90	74	124
Edo	208	209	215	243
Ekiti	71	76	73	143
Enugu	175	150	93	285
Abuja,FCT	1051	972	908	1117
Gombe	217	292	205	328
Imo	128	117	76	103
Jigawa	361	227	237	353
Kaduna	830	756	759	829
Kano	356	302	304	279
Katsina	283	295	253	138
Kebbi	139	186	259	213
Kogi	332	288	300	472
Kwara	268	231	290	394
Lagos	356	452	425	596
Nasarawa	485	420	455	893
Niger	475	405	384	655
Ogun	539	611	702	1221
Ondo	449	330	290	459
Osun	233	193	271	404
Oyo	401	405	487	628
Plateau	246	163	201	298
Rivers	134	110	44	105
Sokoto	114	137	129	122

Taraba	126	170	166	238
Yobe	147	149	148	174
Zamfara	128	135	129	133
Total	**9741**	**9218**	**9424**	**13027**

Source: *Federal Road Safety Commission (FRSC) Statistical Digest, 2020*

Table 2 and Figures 3 to 6 shows the spatial pattern of reported cases of road traffic crashes in Nigeria by states for year 2018-2021. In 2018, a total number of 9,741 cases of road traffic accidents were reported with Abuja, the Federal Capital Territory having the highest number of cases (1051) followed by Kaduna (830) and Ogun (539) states respectively (see Table 2). Likewise in the years 2019, 2020 and 2021, the Federal Capital Territory, Abuja still recorded the highest number of cases of road traffic accidents closely followed by Kaduna and Ogun states, making them the blackspot or hotspot when it comes to road traffic crashes in Nigeria (see Figure 3 to 6).

The manifestation of these black spots suggests that there may be some prevalent conditions in the region which are responsible for the occurrence of these events such as the presence of Nigeria's busiest highway, the 121.8 kilometre Ibadan-Lagos expressway which begins at Ibadan in Oyo state; traverses Ogun state and ends at Ikeja, Lagos state) could be one of the reasons for this hotspot (Osayomi & Areola, 2015). This highway among others has been described by some as a death trap (Okwuofu, 2011) because many lives have been lost and many people injured.

Another explanatory factor might be the relatively high vehicle ownership level in most of the identified hotspot states which could translate to high accident severity and fatality rates in these states (FRSC, 2020; Vasconcellos, 1996; Jones et al., 2008; Kanchan et al., 2012). Another reason could be the level of economic development as it has been revealed that accidents follow the pathways of economic development. Areas with high degree of economic activities such as Abuja, Kaduna, Kano, Ogun, Oyo and Lagos states are particularly known to draw people, goods and services from near and distant locations, thereby generating a high volume of vehicular traffic. In such circumstances, accidents are more likely to occur (Osayomi & Areola, 2015).

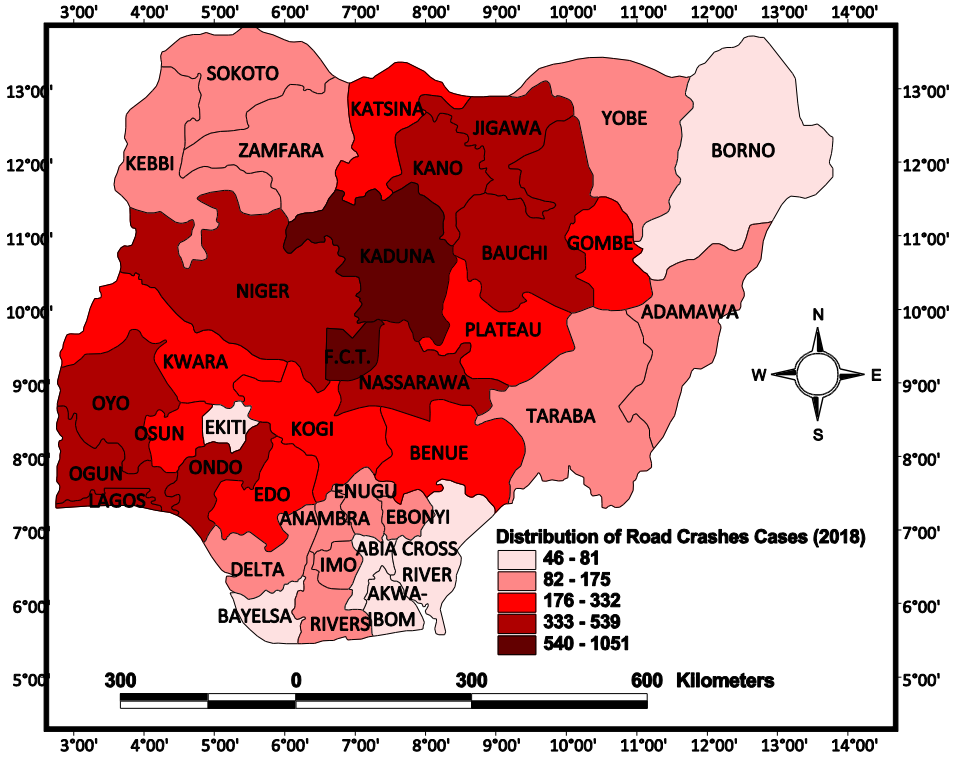


Figure 3: Road Traffic Crashes in 2018

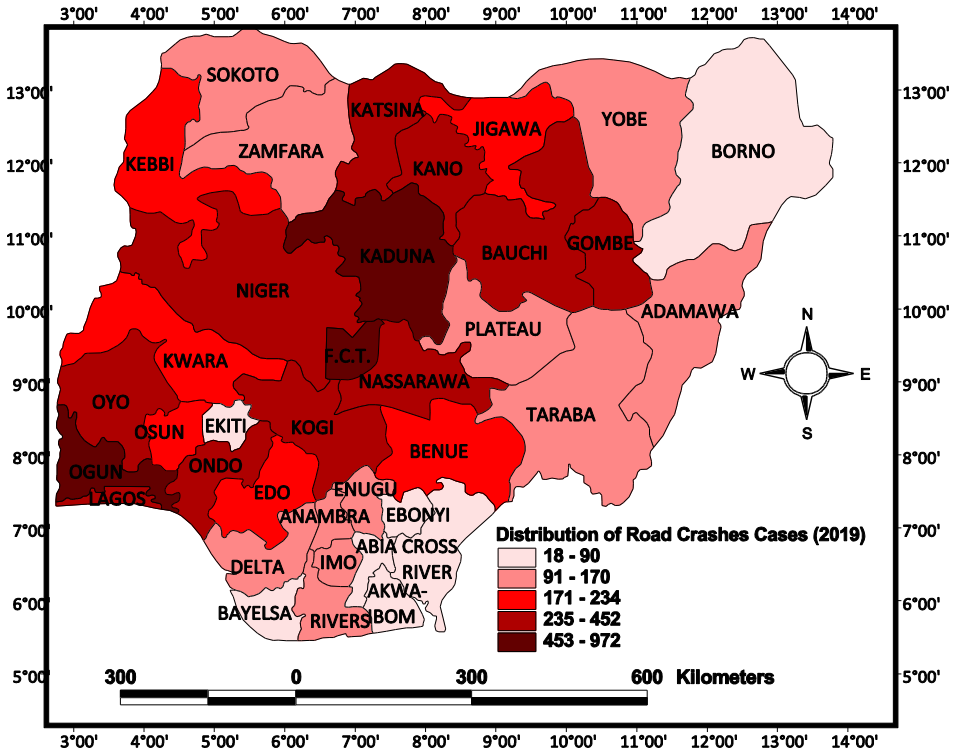


Figure 4: Road Traffic Crashes in 2019

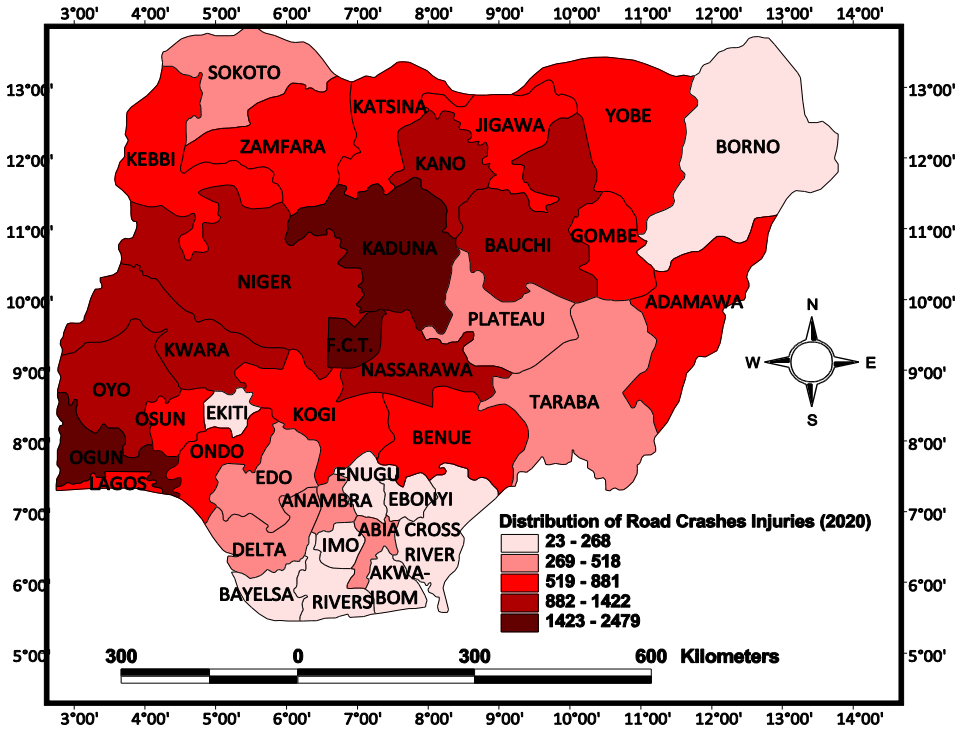


Figure 5: Road Traffic Crashes in 2020

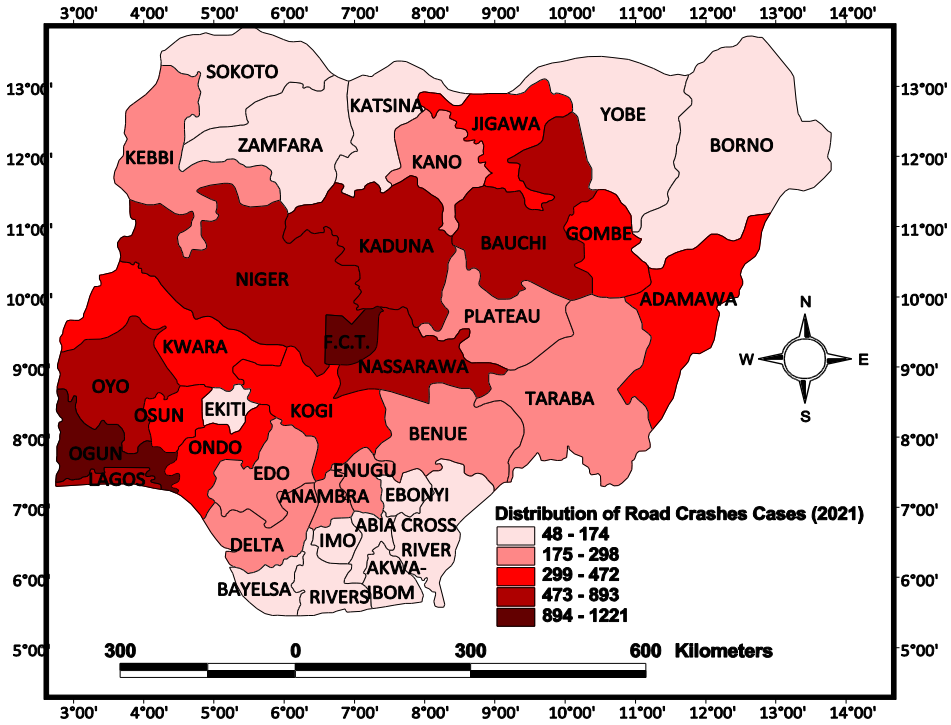


Figure 6: Road Traffic Crashes in 2021

Reported Cases of Injuries sustained during Road Traffic Crashes

Table 3: Reported Injuries of Road Traffic Crashes by States for year 2018-2021

State	Injuries (2018)	Injuries (2019)	Injuries (2020)	Injuries (2021)
Abia	316	317	325	307
Adamawa	392	462	642	930
Akwa-Ibom	149	219	118	124
Anambra	532	397	378	583
Bauchi	1580	1558	1422	2561
Bayelsa	92	50	23	94
Benue	797	735	681	575
Borno	215	202	212	323
Cross-River	157	176	219	401
Delta	476	470	384	626
Ebonyi	383	276	203	390
Edo	811	700	518	577
Ekiti	234	238	156	388
Enugu	576	532	268	783
Abuja,FCT	2347	2035	1623	2184
Gombe	658	965	587	945
Imo	423	365	184	350
Jigawa	921	766	825	1456
Kaduna	3300	3053	2479	3361
Kano	1382	1177	1105	1211
Katsina	1256	1131	833	571
Kebbi	399	594	815	676
Kogi	1059	982	881	1379
Kwara	942	883	1019	1357
Lagos	772	778	599	1004
Nasarawa	1613	1311	1115	2273
Niger	1505	1478	1344	2344
Ogun	1886	1900	1645	2558
Ondo	1199	1025	851	1087
Osun	1053	866	709	1193

Oyo	1323	1263	1194	1637
Plateau	860	546	510	923
Rivers	322	245	93	342
Sokoto	383	498	417	430
Taraba	343	470	470	690
Yobe	964	838	701	883
Zamfara	600	687	611	557
Total	**32220**	**30242**	**26159**	**38073**

Source: *Federal Road Safety Commission (FRSC) Statistical Digest, 2022*

Table 3 and Figures 7 to 11 depict the spatial distribution of road traffic injuries across Nigeria for year 2018, 2019, 2020 and 2021. A total number of 32,220 people sustained various degree of injuries in year 2018 as a result of road traffic crashes with Kaduna state (3,300) leading the chart, followed by Abuja (2,347), Ogun (1,886), Nasarawa (1,613), Bauchi (1,580), Niger (1,505), Kano (1,382), Oyo (1,323), Katsina (1,256), Ondo (1,199), Kogi (1059) and Osun states (1053) and Bayelsa state (92) recording the least (see Table 3). The thematic map (Figure 7) further confirmed these findings.

In 2019, a total number of 30,242 road traffic injuries were reported with Kaduna state (10.1% of the total cases of injuries) recording the highest followed by Abuja, the Federal Capital Territory (7%), Ogun (6.3%), Bauchi (5.2%), Niger (4.9%), Nasarawa (4.3%), Oyo (4.2%), Kano (3.9%), Katsina (3.7%) states respectively and Bayelsa state (0.2%) still with the least number of road traffic injuries (Table 3). Table 3 further revealed that the same states including Abuja with the highest number of injuries in the year 2018 and 2019 are still the blackspot for year 2020 and 2021 with Bayelsa state still the cold spot. Figures 7 to 11 further visualized the spread of cases of road traffic injuries with virtually all the states in Nigeria recording various levels of injuries.

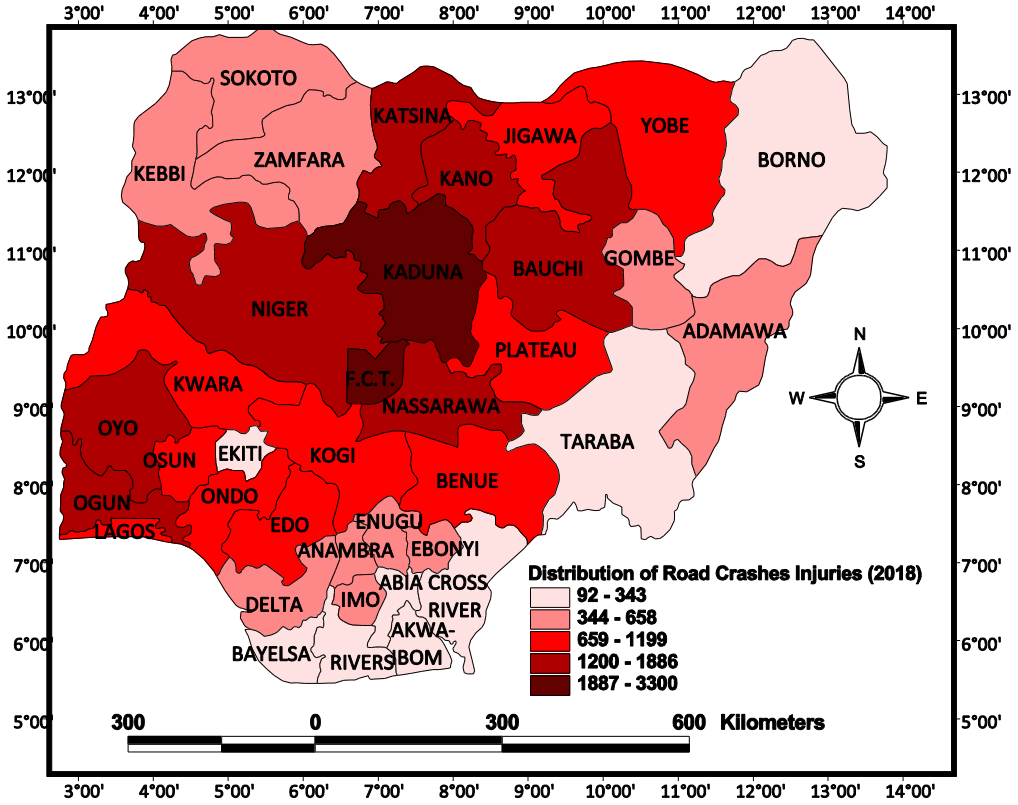


Figure 7: Road Traffic Injuries in 2018

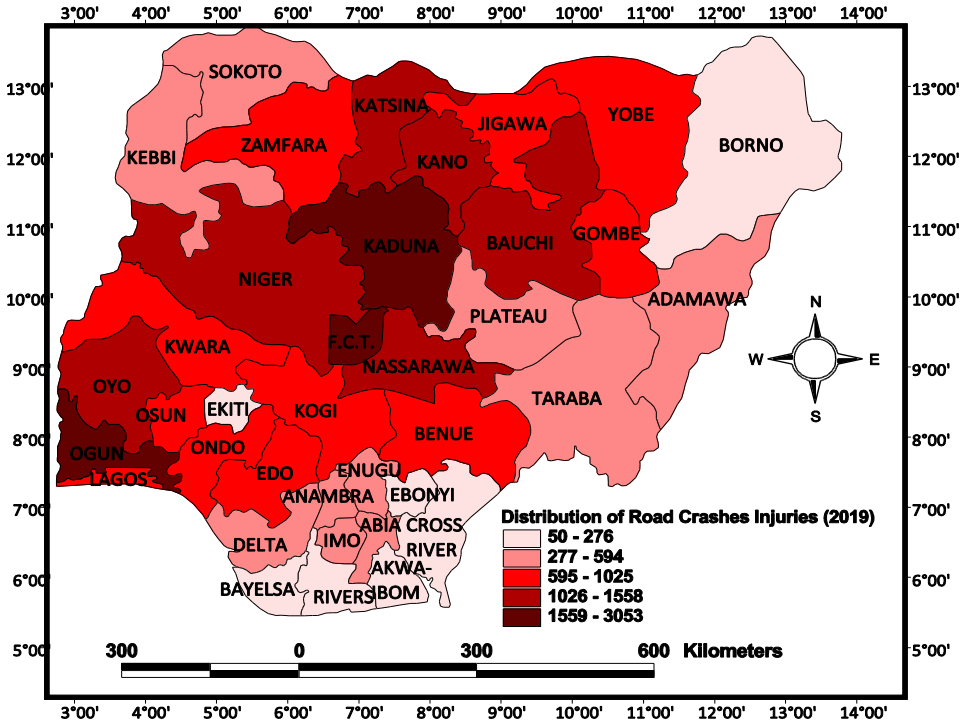


Figure 8: Road Traffic Injuries in 2019

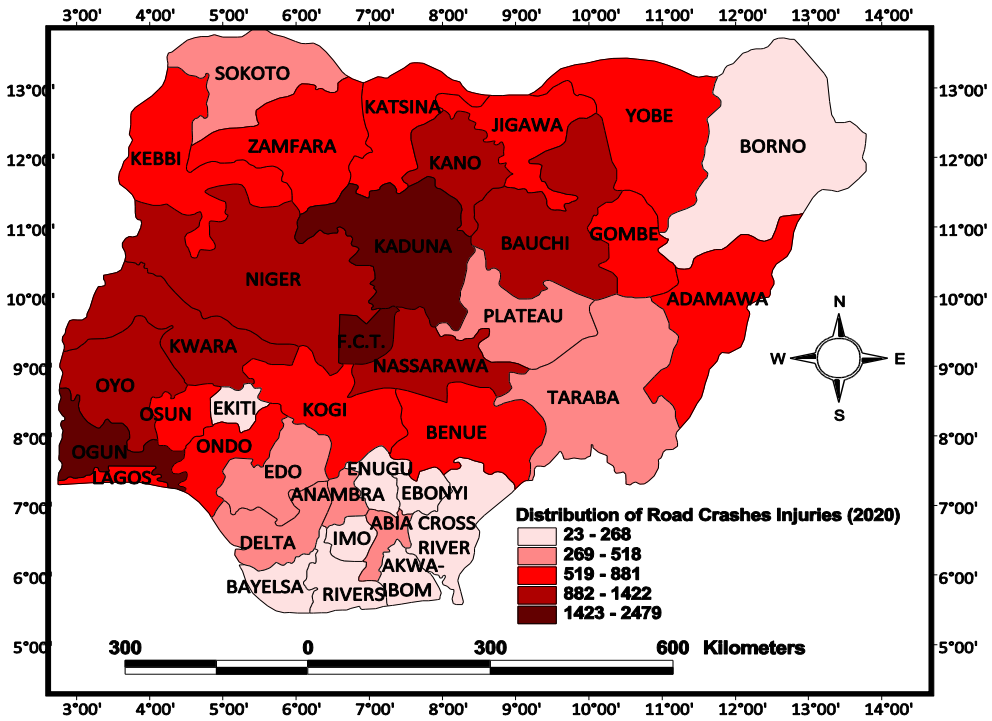


Figure 10: Road Traffic Injuries in 2020

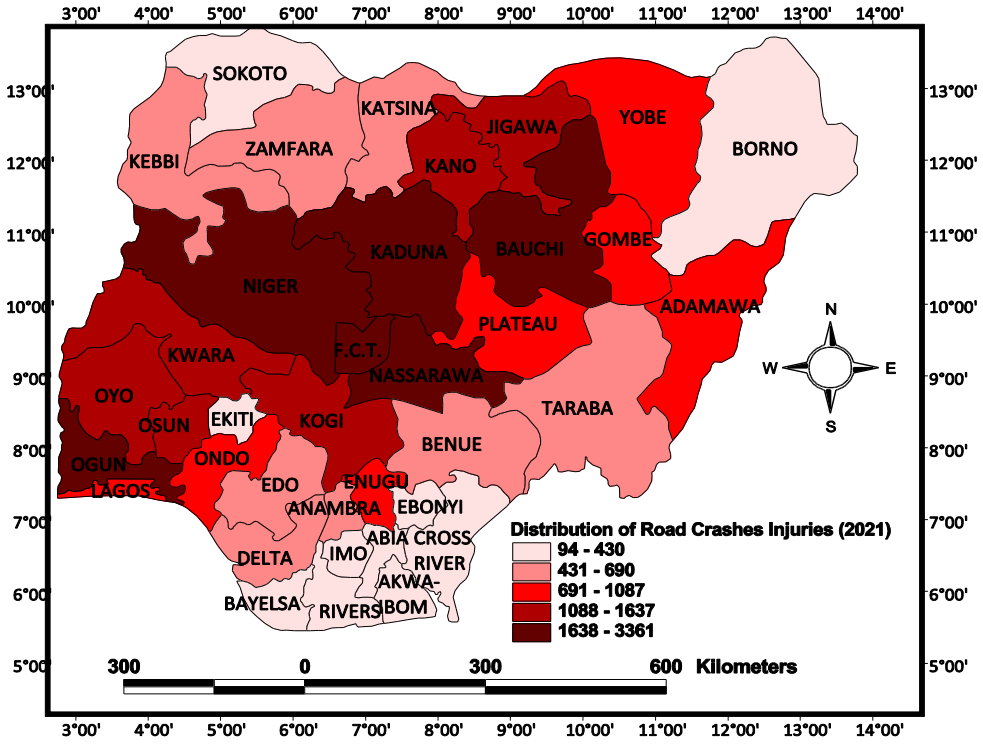


Figure 11: Road Traffic Injuries in 2021

Reported cases of Deaths as a result of Road Traffic Crashes

Table 4: Reported cases of Deaths as a result of Road Traffic Crashes by States for year 2011-2018

State	Deaths(2018)	Deaths (2019)	Deaths (2020)	Deaths (2021)
Abia	39	46	60	68
Adamawa	44	73	71	93
Akwa-Ibom	49	36	12	33
Anambra	70	94	67	89
Bauchi	245	306	238	396
Bayelsa	14	3	21	35
Benue	101	145	55	61
Borno	55	24	29	36
Cross-River	39	44	72	70
Delta	123	83	91	120
Ebonyi	81	55	54	89
Edo	142	152	159	158
Ekiti	31	32	19	48
Enugu	100	71	65	108
Abuja,FCT	281	209	174	216
Gombe	65	144	63	102
Imo	72	56	37	69
Jigawa	301	147	124	208
Kaduna	597	385	414	677
Kano	204	183	292	250
Katsina	161	152	187	115
Kebbi	50	40	104	112
Kogi	187	160	129	229
Kwara	200	160	232	246
Lagos	100	99	102	157
Nasarawa	202	193	130	222
Niger	289	265	205	454
Ogun	281	314	279	430
Ondo	233	141	159	203
Osun	146	128	125	240
Oyo	239	244	220	339

Plateau	85	58	53	97
Rivers	59	21	12	56
Sokoto	60	65	56	110
Taraba	26	48	27	36
Yobe	117	96	129	118
Zamfara	93	137	116	115
Total	**5181**	**4609**	**4382**	**6205**

Source: *Federal Road Safety Commission (FRSC) Statistical Digest, 2022*

Table 4 and Figures 12 to 15 present the spatial distribution of cases of deaths as a result of road traffic crashes in Nigeria. The result shows a significant variation in the reported cases of road traffic deaths among the states with Kaduna state having the highest fatalities for the year 2018, 2019, 2020 and 2021 followed by Bauchi, Niger, Oyo and Ogun states. Year 2021 happens to be the year with the highest number of deaths followed by year 2018 (5,181), 2019 (4,609) and year 2020 with 4,382. These findings confirmed a survey that was conducted on road traffic accidents involving 193 countries of the world where it was revealed that Nigeria happens to be the second highest countries (WHO,2013). Hence, three quarter of all accidents on Nigerian roads are fatal (Oladepo & Brieger., 2006). This has however prompted the World Health Organization in the recent time to conduct a survey of death rate in Nigeria as the most vulnerable country in Africa with death rate of 33.7 persons per 100,000 populations annually. This sub-set of United Nations reported that one in every four road accidents death in Africa occurred in Nigeria (FRSC, 2020).

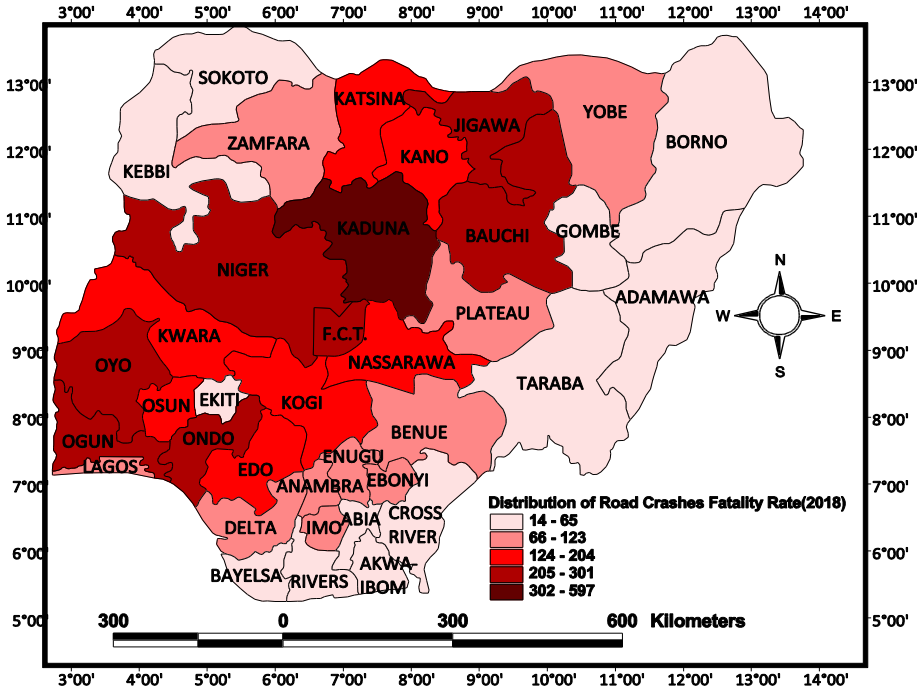


Figure 12: Road Traffic Deaths in 2018

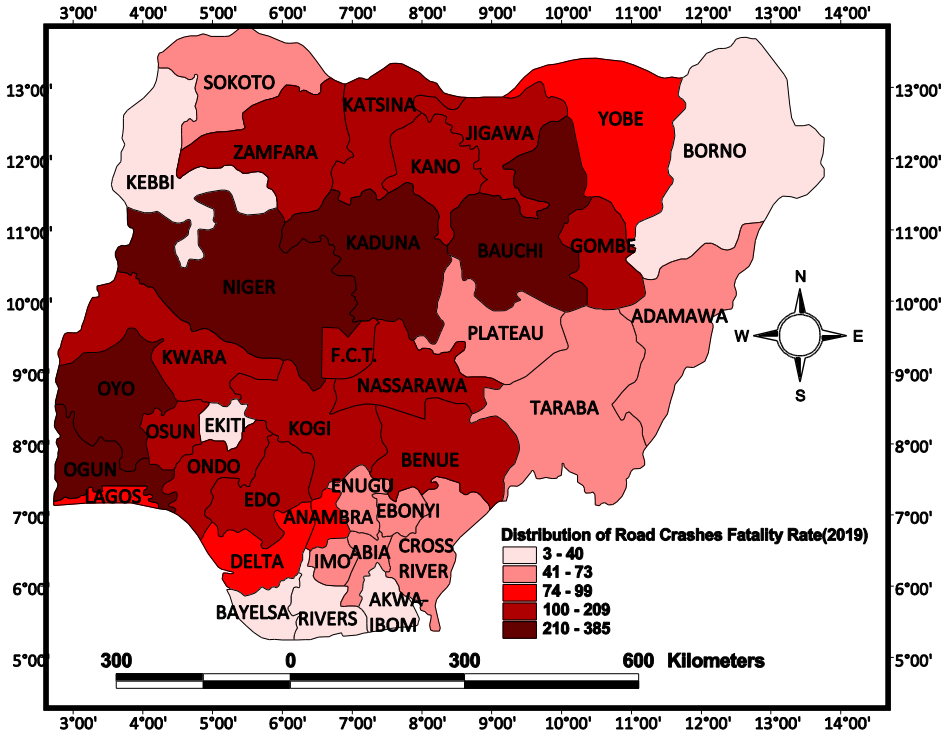


Figure 13: Road Traffic Deaths in 2019

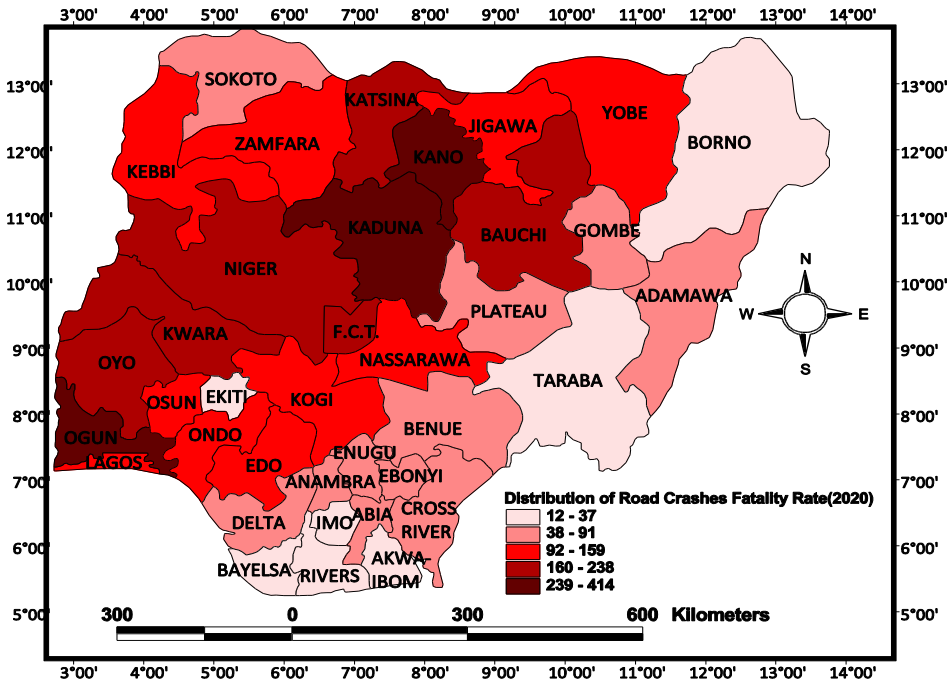


Figure 14: Road Traffic Deaths in 2020

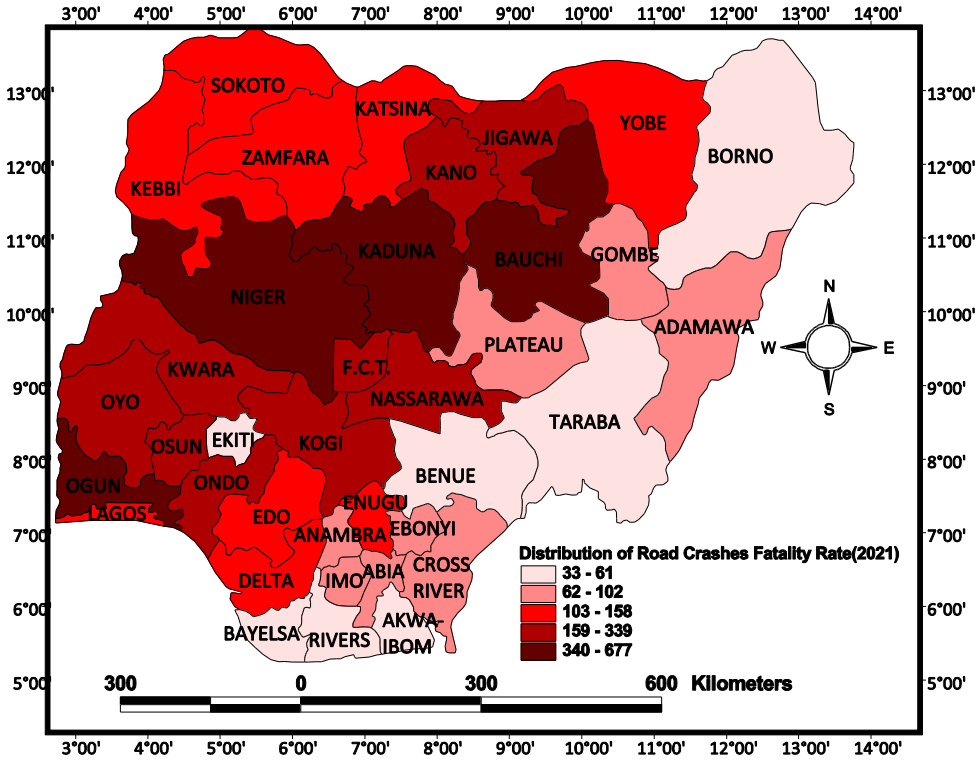


Figure 15: Road Traffic Deaths in 2021

The Number of People Involved in Road Traffic Crashes

Table 5: The Number of People Involved in Road Traffic Crashes by States for year 2011-2021

State	No. of People Involved (2018)	No. of People Involved (2019)	No. of People Involved (2020)	No. of People Involved (2021)
Abia	849	759	639	648
Adamawa	803	869	1277	1554
Akwa-Ibom	438	547	331	307
Anambra	1247	1148	1209	1562
Bauchi	2737	2566	2446	4096
Bayelsa	295	130	78	209
Benue	1423	1427	1033	784
Borno	368	339	315	545
Cross-River	316	379	540	706
Delta	948	1296	1046	1289
Ebonyi	978	836	503	776
Edo	2023	1843	1452	1377
Ekiti	499	553	321	831
Enugu	1676	1319	689	1808
Abuja,FCT	6069	5509	4101	4900
Gombe	1190	1761	1156	1495
Imo	1038	851	515	812
Jigawa	2062	1328	1529	2216
Kaduna	6804	6234	5585	6042
Kano	2641	2158	1983	1852
Katsina	2093	1827	1346	756
Kebbi	642	897	1173	1070
Kogi	2751	2760	2252	3217
Kwara	2093	1784	2170	2521
Lagos	2859	3338	2094	2426
Nasarawa	3007	2454	2067	3973
Niger	3254	2812	2616	4135
Ogun	4692	4948	4271	6541
Ondo	3367	2632	2099	2482
Osun	2242	1972	1713	2654

Oyo	3257	3072	3035	3612
Plateau	1783	1123	1012	1670
Rivers	912	717	276	647
Sokoto	547	840	655	747
Taraba	638	868	790	1010
Yobe	1431	1387	1218	1351
Zamfara	1221	1165	962	912
Total	**71193**	**66448**	**56506**	**73534**

Source: *Federal Road Safety Commission (FRSC) Statistical Digest, 2022.*

The number of people, that get involved in road traffic crashes in Nigeria annually is alarming and of a great concern. Table 5 present the number of people involved in road traffic accidents for year 2018,2019,2020 and 2021 with year 2021 recording the highest number of people involved (73,534) followed by year 2018 (71,193), 2019 (66,448) and year 2020 with 56,506.

In the year 2018, Kaduna state recorded the highest number of people involved in road traffic crashes (9.5% of the total number of peoples involved) followed by Abuja (8.5%) and Ogun (6.6%). It is the same trend for year 2019, 2020 and 2021 with Kaduna state maintaining the 1st position except for year 2021 with Ogun state recording the highest (9%). Bayelsa state happens to be the only state for the 4years of study with the lowest number of people involved in road traffic crashes in Nigeria (see Table 5). Figure 16 to 19 derived using the thematic mapping techniques in the ArcGIS environment further confirmed the above findings with Kaduna, Ogun states and Abuja being the black spots for the number of people involved for year 2018, 2019, and 2020 and then joined by Bauchi, Niger and Nasarawa for year 2021.

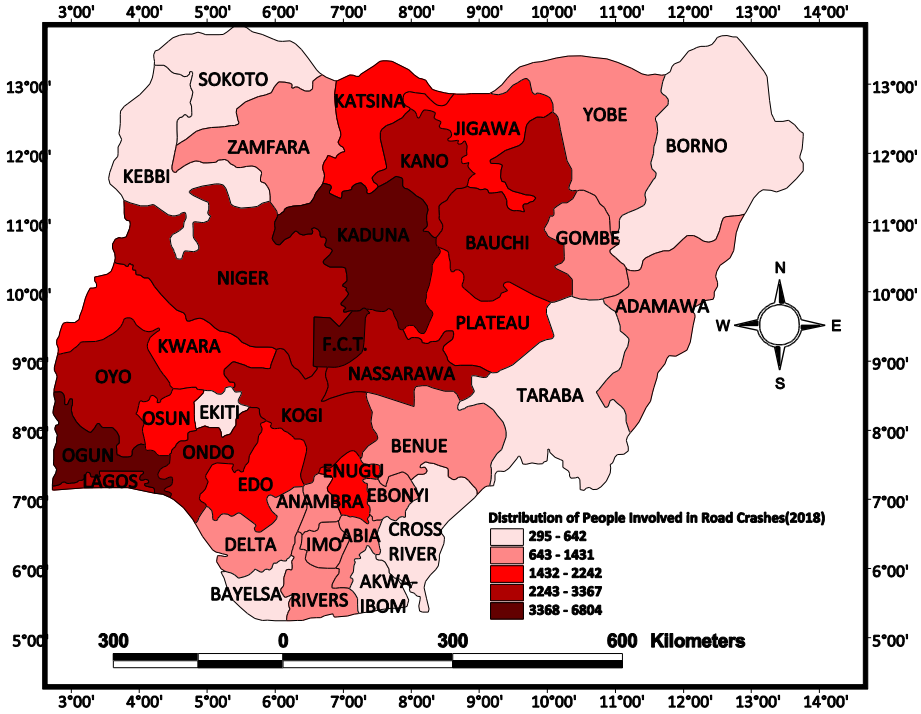


Figure 16: Number of People Involved in Road Traffic Crashes in 2018

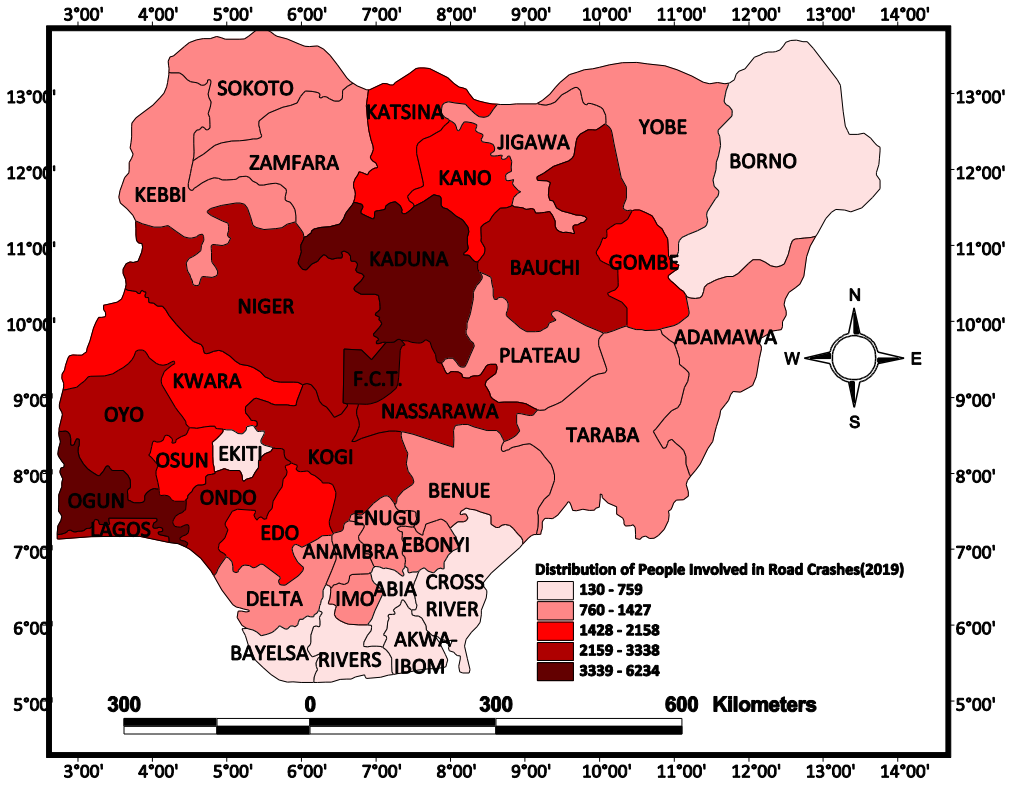


Figure 17: Number of People Involved in Road Traffic Crashes in 2019

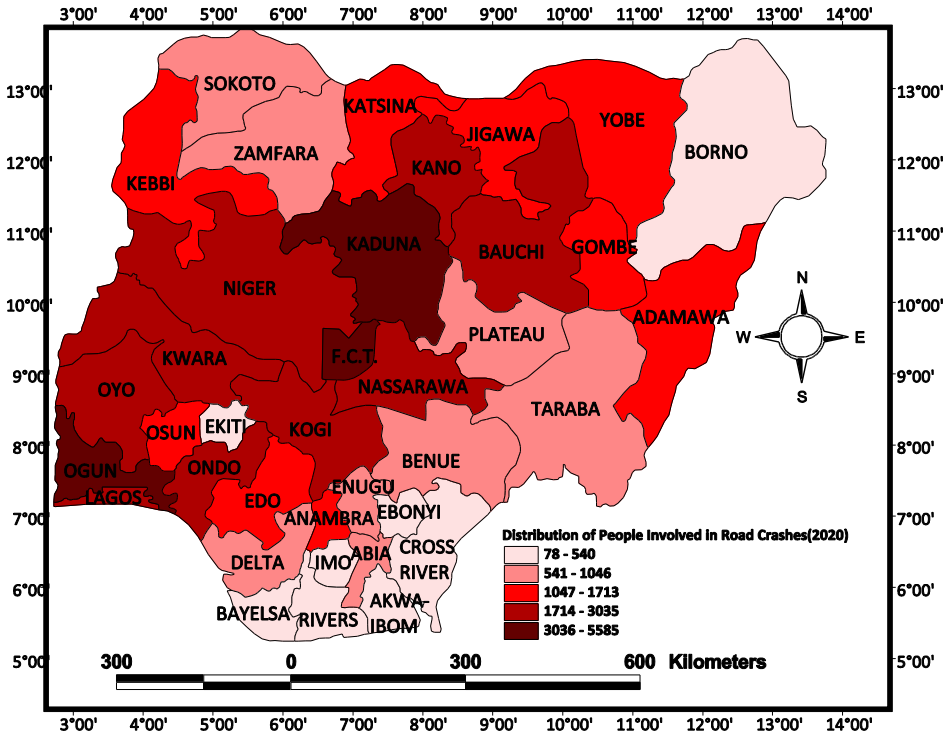


Figure 18: Number of People Involved in Road Traffic Crashes in 2020

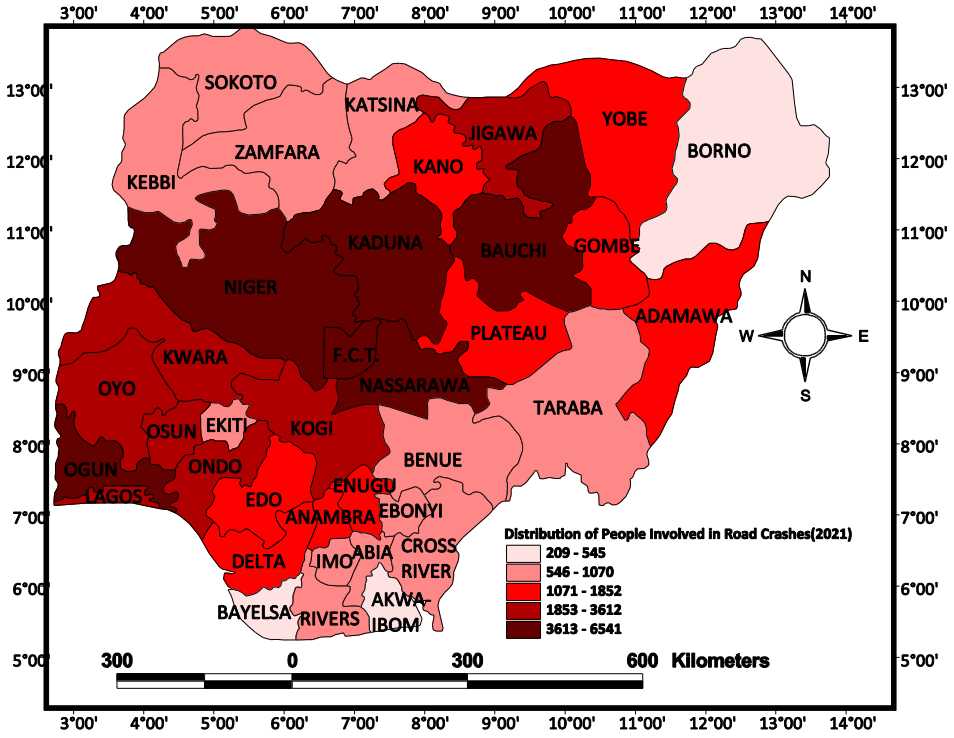


Figure 19: Number of People Involved in Road Traffic Crashes in 2021

5. Conclusion and Recommendations

This study focused on the thematic mapping of the trend of road traffic crashes in Nigeria over a decade (2011-2021); to serve as a tool for advancing sustainable safety of lives. The study makes use of reported cases of road traffic crashes in Nigeria between year 2011 and 2021, this was extracted from the Federal Road Safety Commission (FRSC) Statistical Digest. The study shows that the highest rate of road traffic accidents occurred in years 2011(10.8%), 2012(10.5%), 2013(11.1%) and 2021(10.6%) with Kaduna state, Ogun state, Oyo state and the Federal capital territory, Abuja classified as the black spots or hot spots. This was as a result of the strategic positions of these states as the economic and administrative headquarters of the country. The study further revealed a high number of casualties (438,294) over the ten years of study with 61,551 road traffic deaths.

The implementation of this research will provide detail spatial information of road traffic crashes and fatality, using map representation for the purpose of emergency management for the Federal Road Safety Commission (FRSC), National Emergency Agency (NEMA) and other stakeholders involved in road transportation management. It will also provide good map visualization platform which is the best way to enhance periodic road sensitization programme to the road users and the general public instead of the normal quoting of figures.

Therefore, this study recommends that: (i) zonal and sector commands of the Federal Road Safety Commission (FRSC) must design place-specific interventions such as deployment of more road safety officials, road safety campaigns, particularly in the black spots areas, to reduce the accident, casualty and fatality rates on Nigerian roads. (ii) Nigerian roads should be continually monitored and maintained (iii) strict enforcement of traffic regulations, use of safety belts and helmets is advised.

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