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Spatio-Temporal Analysis of Boko Haram Attacks and its Effects on Education in Northern Nigeria (2009-2020)

Adewale O. Akingbade[1]
https://orcid.org/0000-0003-4588-4949
Afolabi E. Olabamiji[2]
https://orcid.org/0000-0002-8542-3154
Olayinka A. Ajala[3]
https://orcid.org/0000-0001-5089-096X

[1 2 3] *African Regional Institute for Geospatial Information Science and Technology, Ile Ife, Nigeria*

CORRESPONDENCE
Afolabi Olabamiji
Email: olabamijiafolabiemmanuel@gmail.com

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Abstract: *The persistent attacks from Boko Haram have been issues of concern to the Nigerian government and its citizens. The study assessed spatio-temporal pattern of attacks by Boko-Haram insurgents and its effects on education in the Northern Region of Nigeria between 2009 and 2020 with specific objectives of ascertaining the pattern of the attacks, and appraising the trend of attacks' fatalities over time, and reviewing the effects of the attacks on education. The study covered all three geopolitical zones (19 States with FCT) in the Northern Region of Nigeria. Data on Boko-Haram attacks were obtained from the Armed Conflict Location and Event Data Project (ACLED) database. Nearest Neighbourhood Analysis and Geographically Weighted Regression on ArcGIS 10.8 were analytical techniques adopted in this study. Results with a negative Z-value of -88.62 indicated the clustered pattern of Boko-Haram at an observed mean distance of 1213 metres from one attack to another. There were 28 792 reported fatalities due to Boko-Haram attacks from 2009 and 2020. Boko Haram has affected the education system of the Northern Region of Nigeria through attacks and abduction of students. The study revealed that geospatial technology has the potential to analyse and monitor insecurity issues, and it is thus recommended that geospatial technology need to be integrated into security surveillance and operation to curb the challenges of insecurity on education, not only in the northern region but the entire space of Nigeria, so that Sustainable Development Goal Four (quality education for all) can be achieved.*

Keywords: Boko-Haram, Fatalities, Attack, SDGs, Education, Geospatial technology.

1. Introduction

Insecurity has been a threat to different countries of the world, which has manifested in the form of terrorism, militancy, armed robbery, political thuggery, gun and drug trafficking (Mbagwu and Obileye, 2019; Ozoigbo, 2019). Terrorists have become great antagonists to different levels of government and their security forces in developing countries. Different nomenclatures are given to different groups of terrorists depending on their regions of operation, such as Taliban in Afghanistan; Al Shabaab in Somalia; Al Qaeda in the Islamic Maghreb (AQIM) in Algeria; Boko Haram in Nigeria; Kurdistan Workers Party and Hayat Tahrir Al-Sham in Syria; Khorasan Chapter of Islamic State and Tehrik-i-Taliban Pakistan in Pakistan; Communist Party of India Maoist, Hizbul Mujahideen, Jaish-e-Mohammad (JeM), Lashkar-e-Taiba (LeT) in India; the New People's Army (NPA) and Bangsamoro Islamic Freedom Movement in Phillipines (Forbes, 2019). As of 2018, most terrorised countries were Afghanistan, Iraq, Nigeria, Syria, Pakistan, Somalia, India, Yemen, Philippines, DR Congo (Forbes, 2019).

Terrorism as one of the factors that undermine regional security has hindered the meaningful development in Africa, especially in the Sub-Sahara region, through killing, kidnapping, and displacement of people, thereby violating human rights and threatening both local and national economy and education (Akinyetun, 2017). The roots of terrorism have been traced to illiteracy, unemployment, poor leadership, the porosity of national boundaries, the illegal proliferation of arms, and political interference (Ozoigbo, 2019). Egunjobi (2021) observed that the increased level of unemployment had been momentum for the high level of poverty and insecurity in Nigeria. Ozdeser, Cavusoglu and James (2019) found out that terrorism, especially Boko Haram, is one of the dangerous factors to Nigeria's Gross Domestic Product (GDP), income, and economic

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development. The attacks from terrorists have denied some pupils to participate in basic education in Nigeria (Bakwai, Yisa & Jega, 2014).

Boko Haram, which was believed to be founded by Mohammed Yusuf, has been a major terrorist in Nigeria as far back as 2009. According to Stoddard (2019), the group, in 2016, was divided into two main militant factions: Islamic State West Africa Province (ISWAP) and Jama'at Ahl as- Sunnah lid-Da'wah wa'l-Jihad. Islamic State West Africa Province (ISWAP) led by Abu Musab al Barnawi (also known as Habib Yusuf), the son of Boko Haram's founder. The second faction, Jama'at Ahl as- Sunnah lid-Da'wah wa'l-Jihad, was led by Abu Bakar al Shekau, who was the former deputy to Mohammed Yusuf (Stoddard, 2019). Nigeria's security challenges have manifested in the increased rate of abduction and kidnapping, which was attached to the high rate of unemployment in Nigeria and affected different sectors, including education (Bakwai et al., 2014; Osarense & Lawrence, 2020).

Since 2009, Boko Haram has declared war against western education. This reflected in their nomenclature, Boko Haram, which literally connotes "Western education is forbidden". This is absolutely against the global goal of education as it has specified in Sustainable Development Goals (SDGs). Achieving quality education for all has been specified as the fourth goal of the seventeen Sustainable Development Goals (SDGs), which every country is expected to achieve by 2030 (United Nations, 2015). There are many targets under the Goal Four of Sustainable Development Goals (SDG 4) "*ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*". And targets of SDG 4 are as follows:

> "*Target 4.1 is to ensure that every boy and girl has access to a free and quality basic education that brings effective learning outcomes. Target 4.2 is the preparation of every boy and girl for primary education through quality early childhood development, care and pre-education. Target 4.3 is to enable every woman and man equal accessibility to affordable and quality technical, vocational and tertiary education, including university. Target 4.4 is to ensure an increased number of youths and adults that have acquired the relevant skills, including technical and vocational skills. Target 4.5 is to eradicate the gender disparities in education and ensure equal access to all levels of education and vocational training for all people, including the vulnerable and disabled. Target 4.6 is to ensure the inculcation of literacy and numeracy in all youth and a substantial proportion of adults, both men and women. Target 4.7 is to ensure that all learners acquire the knowledge and skills needed to promote sustainable development. Target 4a is to build and upgrade education facilities that provide safe, non-violent, inclusive and effective learning environments for all. Target 4b is to increase the number of scholarships available to developing countries for enrolment in higher education by 2020. And Target 4c is to substantially increase the supply of qualified teachers especially through international cooperation for teacher training in developing countries*" (United Nations, 2015).

Attacks from Boko Haram have caused a tremendous setback towards achieving these targets of SDG 4 in Nigeria, especially in the Northern Region of Nigeria. Despite the fact that primary education is free and compulsory in Nigeria, almost 10.5 million children from the age of 5 to 14 are out of school (UNICEF, 2021). The picture is even bleaker in the North of the country, with a net attendance rate of 53 per cent (UNICEF, 2021). UNICEF (2021) reported that the level of female primary school net attendance is very low as 47.7% and 47.3% female school attendance have been recorded in the north-east and north-west, respectively, an indication that less than half of females are not in schools. Moreover, 2.8 million children are in need of emergency education support in three conflicted-affected states of the north-eastern part of Nigeria-Adamawa, Borno and Yobe. In these states, not less than 802 schools have been shut down, 497 classrooms have been completely destroyed, and another 1,392 classrooms have been irreparably damaged (UNICEF, 2021). In the face of persistent attacks from Boko Haram, bringing back the students to schools is very difficult, and this poses a great challenge on education, especially in Northern Nigeria.

In an attempt to create enabling and non-conflict learning environment, different mitigating strategies of Boko Haram's activities have been suggested by different scholars. Wonah (2018)

suggested that insecurity could be curbed, and sustainable development could be achieved through the practice of real federalism in Nigeria. All levels of Nigeria's government must make resources available to refurbish the inefficiencies of the security agencies through advanced training and development to achieve the safety of life, especially students in the country (Mbagwu & Obileye, 2019). Reliable information from the public to the government is vital, and the safety of the informants should be certain (Ozoigbo, 2019). Curbing terrorism and its menace should be the key agenda of the Nigerian government (Akintetun, 2017).

Efforts of the Nigerian security force to curb terrorism have forced some of the Boko Haram's members to surrender their arms. According to Punch (2021), the Director of Defence Media Operations, Bernard Onyeuko, on Thursday said over 5,890 suspected terrorists have surrendered to troops in the North East in the past weeks. A cumulative total of 52 assorted arms and 1,977 rounds of 7.62mm assorted calibre ammunition, including AK-47 and FN rifles with magazines, hand grenades, commando mortar guns, locally fabricated rifles, Dushka anti-aircraft guns, Dane guns and Nigerian Police rifles, among other items were recovered from surrendered terrorists and operations within the period. This is not tantamount to the total elimination of Boko Haram, and the complete safety of schools from being attacked as many attacks have thereafter been made by Boko Haram, for example, the attack of Nigerian Defence Academy by Boko Haram (Vanguard, 2021). The approach applied to combat the increasing attacks on schools by Boko Haram relied heavily on the analogue system of intelligent information gathering, which is usually too late for response counter security operation. The application of geospatial application within the security formation for such terrorist attacks is still very low. This is traceable to inadequate necessary geospatial techniques and equipment for such a purpose.

The security forces require all forms of support from stakeholders to combat the rising insecurity, which has rendered the education system handicapped in Nigeria. Geospatial information technology, as a tool that answers the questions of what, where and how, becomes important to secure the schools in the Northern part of Nigeria. The adoption is already taking firm root in the developed countries, while sub-Sahara Africa is lagging (Nte, Abdulaziz and Uzorka, 2020). Understanding the locational pattern of Boko Haram attacks is imperative for decision making in planning for counter operation and surveillance to combat terrorists' activities that are affecting education in the Northern Region of Nigeria. Thus, this paper aims to analyse spatio-temporal pattern of Boko-Haram attacks and their effects on education in the Northern Region of Nigeria with specific objectives to ascertain the pattern of the attacks, and appraise the trend of attacks' fatalities, appraisal the implication of Boko Haram attacks on education in the Northern part of Nigeria, and proffer the solution.

2. Study Area

The study area covers all the nineteen states (out of the thirty-six states in Nigeria) with Federal Capital Territory. Northern Region of Nigeria is located between Latitude $6^0 24'$ N and $13^0 53'$ N of the Equator and Longitude $2^0 45'$ E and $14^0 41'$ E of the Greenwich Meridian. It shares a boundary with the Republic of Niger in the North, Chad in the North-East, the Republic of Benin in the West, Cameroon in the East, and the Southern Region of Nigeria in the South. It comprises three geopolitical zones (North-Central, North-East and North-West). North-Central geopolitical zone covers six-states (Benue, Kogi, Kwara, Nassarawa, Niger and Plateau) with FCT; North-East geopolitical zone is made up of six states (Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe), and North-West geopolitical zone consists of seven states (Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara) as shown in Figure 1. The Northern region covers about 719, 435 Km^2 of 923, 769 Km^2 (909 890 Km^2 of land area, and 13, 879 Km^2 of water area) area of Nigeria. The region is mainly dominated by Hausa/Fulani ethnic group with about 53.59% (75, 269, 722): North West- 35, 915, 467; North Central- 20, 369, 956; North East- 18, 984, 299), out of 140, 431, 790 total population of Nigeria as 2006 (National Bureau of Statistics, 2010). With annual population growth of 2.6% (World Bank, 2019), the 2020 estimated population of the region was 107, 816, 036, out of 201, 153, 912 estimated population of Nigeria.

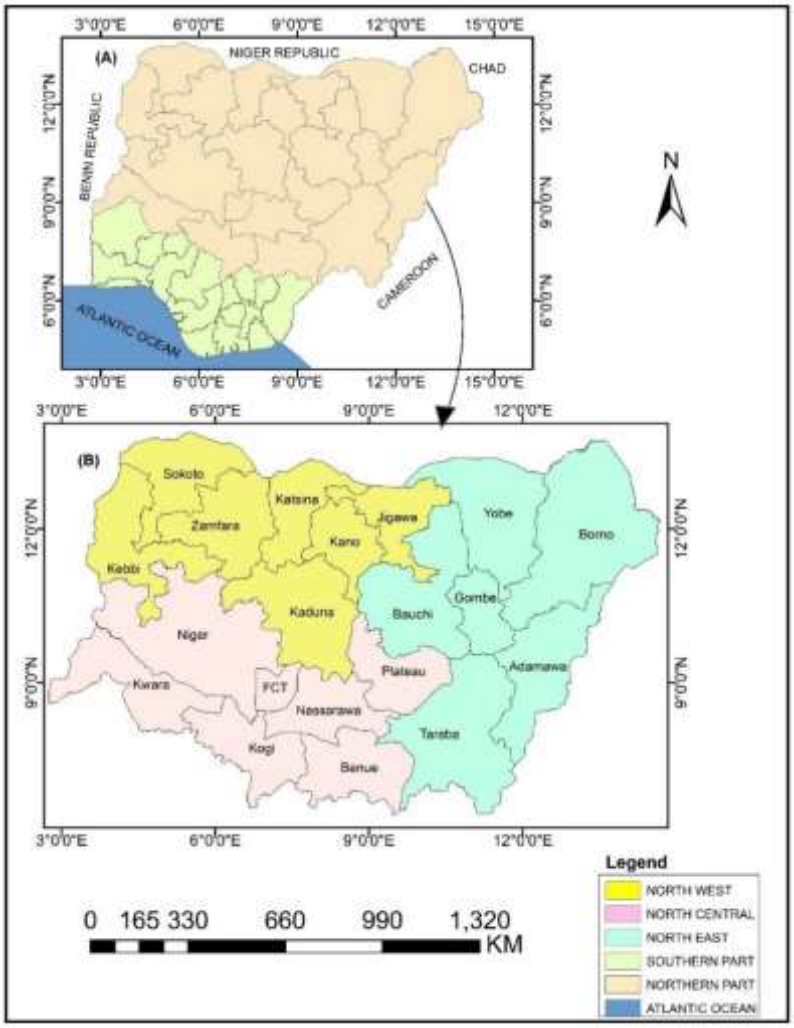


Figure 1: *(A) Nigeria Shows Northern Region and Southern Region; and (B) Northern Region shows Geopolitical zones and States.*

3. Methodology

Data for this study were sourced from the Armed Conflict Location and Event Data Project (ACLED) database, Some Nigeria's daily newspaper, and Geo-Referenced Infrastructure and Demographic Data for Development *(GRID*[3]). Data on Boko Haram's attacks in the Northern States and the fatality caused on Nigerians from 2009 to 2020 were sourced on 11th March 2021 from the database of ACLED. These were the complete years with the recorded activities of Boko Haram in the Northern Region of Nigeria. Data on the abduction of students by Boko Haram were sourced and reviewed from Premium Times, Vanguard and Punch newspapers dated from 2014 to mid of 2021 (years of major abduction). Shapefiles of the states were downloaded from the database of GRID[3]. Microsoft Excel and ArcGIS 10.8 were used for data analysis. Microsoft Excel was used for data sorting and line graph. Shapefiles and data on Boko Haram were loaded to ArcGIS 10.8 Environment for spatial analysis. Symbology, nearest neighbourhood analysis and geographically weighted regression were spatial analysis tools used in ArcGIS 10.8 Environment. Geographically Weighted Regression (GWR) is used to analyse spatial non-stationarity and the relationship between the attacks and fatalities. For instance, Weber (2018) applied mapping technique in studying exploring local influences on Zika Virus rates in Puerto Rico, using geographically weighted regression. The conventional interpretation of R^2 is that a larger value has greater explanatory power. Symbology was applied to reveal the spatial pattern of Boko Haram's attacks and the fatalities caused by them. The nearest neighbourhood analysis was adopted to determine the pattern of the attacks by Boko Haram in the Northern Region of Nigeria during the periods under review. Geographically weighted regression was performed to establish the statistically significant spatial relationship between the fatalities and attacks. Line graphs and maps were used to show the number of students abducted from 2014 to mid of 2021.

4. Results and Discussion

The results of the analysis are discussed under four subsections for easy discussion. These are the spatial pattern of Boko Haram attacks, the spatial pattern of Fatality due to attacks, the trend of attacks and fatality, geographically weighted regression between attacks and fatality, and effects of Boko Haram attacks on education in the Northern Region of Nigeria.

4.1 Spatial Pattern of Boko Haram Attacks

Boko Haram, as the crucial terrorist group in Nigeria, has attacked sixteen out of nineteen states with FCT in the Northern region of Nigeria. Kogi and Kwara in the North-Central Geopolitical Zone and Kebbi in the North -West Geopolitical Zone were the only three states in which there was no evidence of an attack from Boko Haram from 2009 to 2020, as revealed in Figure 2. This was a result of being the most distant states to Boko Haram's major base (Borno State) and the major entrance and exit points (Chad) of Boko Haram to Nigeria. Further analysis showed that ten states (including FCT) recorded less than twenty-five incidences of attacks over the period, while seven other states recorded more. For instance, Benue recorded two attacks (2), Nassarawa (2), Niger (4), FCT (11), and Plateau (18) in the North-Central Geopolitical Zone, Katsina (4); Zamfara (4), Jigawa (6) and Sokoto (7) in the North-West Geopolitical Zones; and Taraba (8) in the North-East Geopolitical Zone were states which Boko Haram has not attacked up to twenty-five times each. Another three states have been attacked several times as thirty-seven times in Kaduna (in the North-West), thirty-seven times in Bauchi (in the North-East) and thirty-one times in Gombe (in the North-East), as shown in Figure 2. Kano (in the North-East), as the most populous and economic hub of the North, has been attacked eighty (80) times, making it the fourth most attacked state by Boko Haram in Nigeria.

The hot spots of Boko Haram's attacks have been three states (Borno, Yobe and Adamawa), all in North-East Geopolitical Zone. Borno State, which shared a major boundary with Chad, recorded the highest of 2, 321 Boko Haram attacks, while Yobe and Adamawa had 228 and 201 attacks respectively as the second and third most attacked states in the Northern region of Nigeria (Figure 2). It could be deduced that Borno was the Boko Haram major base, and Chad served as their entry and escape routes as Borno State alone has been attacked more than other eighteen states with FCT in the Northern Region of Nigeria, with the two thousand three hundred and twenty-one (2, 321) attacks, out of the total attacks of three thousand and three (3, 003). This could be as a result of the porosity of the boundary shared with neighbouring countries in North-eastern Nigeria. It could be summarised from Figure 2 that all six states (Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe) in the North-East Geopolitical zone accounted for 94% (2, 826) of total attacks; followed by North West Geopolitical Zone (Jigawa, Kaduna, Katsina, Kano, Sokoto and Zamfara) with 138 attacks; and North Central Geopolitical Zone (Benue, FCT, Nassarawa, Niger and Plateau) accounted for 39 attacks. This reveals that the attacks decrease with an increased distance of geopolitical zones to Chad.

Considering the temporality of the attacks in each of the states, Figure 3 presents the magnitude of the attacks across the three epochs of four-year intervals (2009-2012 as early years; 2013-2016 as middle years; and 2017-2020 as latest years). In the early years of Boko Haram, the attacks were carried out in fifteen states with FCT (Adamawa, Bauchi, Borno, Gombe, Yobe, Taraba, Jigawa, Plateau, Benue, Nassarawa, FCT, Kaduna, Kano, Katsina, Niger, Sokoto) excluded Kebbi, Kwara, Kogi and Zamfara. In the middle years, Niger and Benue escaped being attacked during the period, while Zamfara State was attacked alongside other states in the North except Kebbi, Kwara and Kogi, which have never been attacked by Boko Haram from 2009 to 2020. In the latest epoch of years, Sokoto, Kaduna, Katsina, Nasarawa and FCT are devoid of attacks from Boko Haram. It is obvious that Nine States (Borno, Adamawa, Yobe, Gombe, Jigawa, Bauchi, and Plateau, Taraba and Kano) have been persistently attacked throughout the three epochs of time. All these nine states are the closest states to the North-East boundary of Nigeria. Furthermore, seven states (Sokoto, Niger, Kaduna, Benue, Plateau, Bauchi, and Kano), recorded at least fifty per cent of its attacks during the early period (2009-2012) of the attacks. Jigawa, Zamfara, FCT, Adamawa and Gombe experienced at least fifty per cent of its attacks in the middle epoch (2013-2016). While Nassarawa and Katsina were attacked fifty per cent by fifty per cent in the early and middle epochs;

Benue was attacked fifty per cent by fifty per cent in the early and the latest epoch. At least fifty per cent of attacks in Borno and Taraba occurred in the latest epoch (2017-2020). The rate of attacks was closely similar in Yobe across the three epochs of time. It could be succinctly stated that the rate of attacks changed and differed from state to state over time.

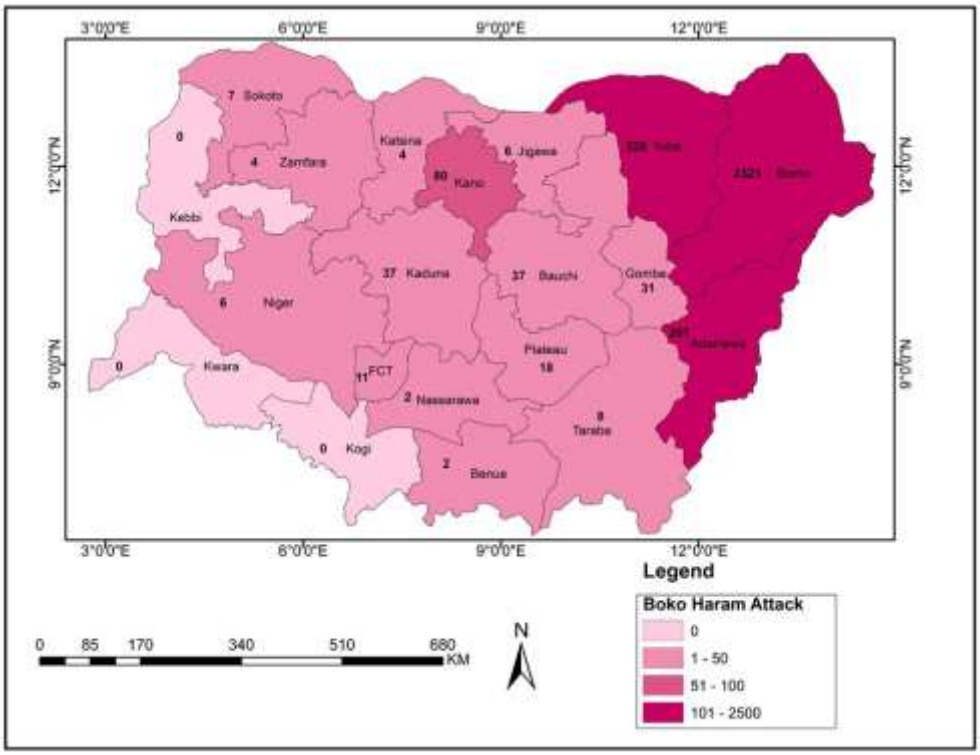


Figure 2: *Boko Haram Attacks in the Northern Region of Nigeria (2009-2020)*

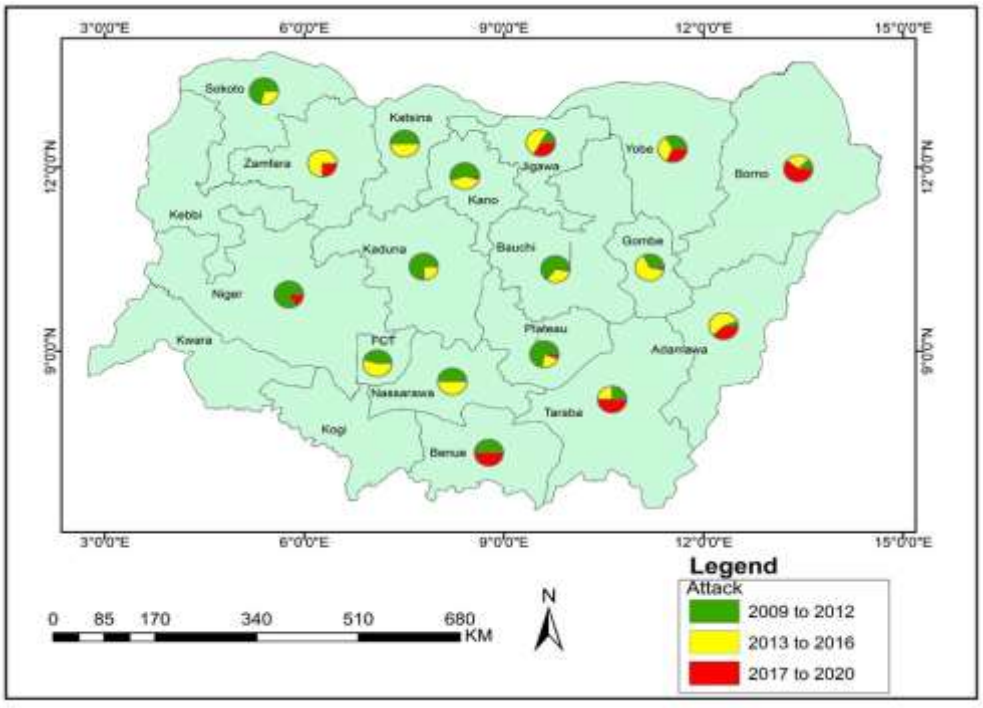
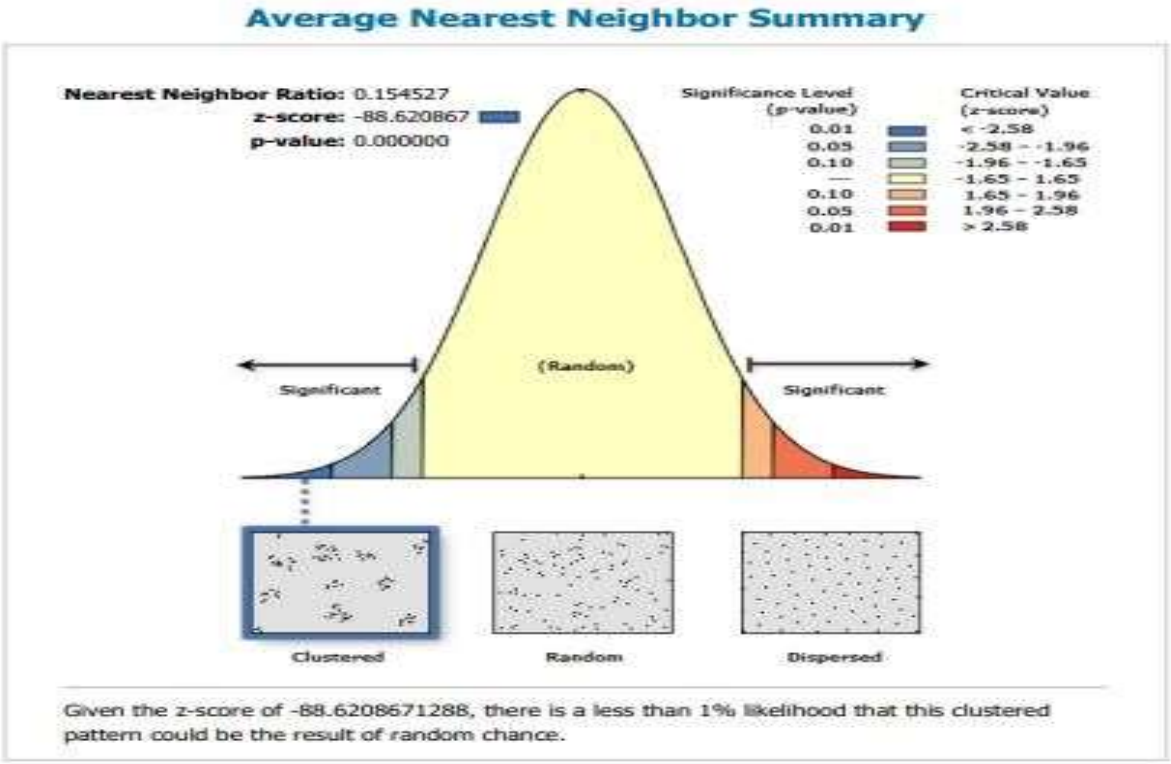


Figure 3: *Boko Haram Attacks at three Epochs in the Northern Region of Nigeria*

The spatial pattern of the attacks in the area was clustered (Figure 4). The clustered spatial pattern was significant at a p-value of 0.00 and a negative Z-value of -88.6208 with the nearest ratio of 0.1545 and an observed mean value of 1213.4317 metres (see Figure 4). The significance of the clustered spatial pattern of attacks was corroborated with the results shown in Figure 2, where Borno State alone accounted for 2 321 (77%) attacks out of 3,003 attacks recorded from 2009 to 2020. Figure 5 also presents that the attacks were carried out at an approximate distance of 1213 metres from an attacked point to the nearest attacked point by Boko Haram. This is an indication that the activity of Boko Haram was more concentrated within an area, especially the North-East Geopolitical zone, precisely Borno State. If Boko Haram could be conquered in Borno State, the effectiveness of Boko Haram would be at bay, if not eradicated. This could be possible if the remote sensing (both airborne and space-borne platforms) for monitoring surveillance and GIS technologies for analysis could be applied and improved upon to get first hand and accurate information before Boko Haram attacks any place, especially schools so that the lives of the Nigerian army, residents and students would not be at risk.



Average Nearest Neighbor Summary

Observed Mean Distance:	1213.4317 Meters
Expected Mean Distance:	7852.5573 Meters
Nearest Neighbor Ratio:	0.154527
z-score:	-88.620867
p-value:	0.000000

Figure 4: *Spatial Pattern of Attacks in the In the Northern Region of Nigeria (2009-2020)*

4.2 Spatial Pattern of Fatality Due to Attacks

Irrespective of the epoch, not all attacks by Boko Haram resulted in the death of people. At times it might involve only the abduction of people, especially students (see Figure 5 and Figure 12). Figure 5 presents that all attempted attacks by Boko Haram in Benue were without killings during the period under study. Notwithstanding, the attacks in Zamfara, Nassarawa and Taraba were always accompanied by fatalities. Except in Jigawa State, where the attacks that involved killing was 50%; all other states (Borno, Yobe, Adamawa, Gombe, Bauchi, Plateau, Kano, Kaduna, Katsina

Niger, Sokoto and FCT) recorded the higher percentage (more than 50%) of attacks with fatality (Figure 5). This reveals that more operations of Boko Haram involved killings than abductions as sixteen states, including FCT in the Northern Region of Nigeria, have experienced more attacks that led to fatality than otherwise. This has hindered the achievement of SDG 4.b that focuses on building and upgrading education facilities that provide safe, non-violent, inclusive and effective learning environments for all.

It has already been discussed that many attacks by Boko Haram claimed the lives of people. Out of 3, 003 attacks; 2, 248 (75%) attacks have led to the death of people (see Figure 2 and Figure 5). It is thus imperative to depict the spatial pattern of these fatalities across the states in the Northern region of Nigeria. Figure 6 reveals that a total of 28 792 people have lost their lives to the attacks of Boko Haram between 2009 and 2020. This has made some students lose their parents and become orphans. For instance, a 21-year-old female reported that "*I lost my parents, pregnant sister, other siblings to Boko Haram in one day*" (The Nation, 2021). This could affect the emotion of the students towards learning. The spatial pattern of fatality shows that 79% (22, 707) of fatalities occurred in Borno State followed by Adamawa State with 7.1% (2, 053) and Yobe State with 6.1% (1, 743), all in North-East Geopolitical Zone, and Kano 2.6% (760) in North-West Geopolitical Zone were the states with more than 500 fatalities each.

In some states, the count of fatalities was more than 100 and less than 500. These states were Gombe (373), Kaduna (274), Plateau (266), FCT (241) Bauchi (199) and Zamfara (112). Taraba (47), Sokoto (17), Katsina (13), Jigawa (12), Niger (12) and Nassarawa (9) were the states with fatalities of less than a hundred. Benue was the only state that Boko Haram has attacked without a recorded fatality. Kebbi, Kogi and Kwara States have not recorded any attack from 2009 to 2020. Based on geopolitical zones, North-East Geopolitical Zones recorded 27, 076 (94%); North-Central Geopolitical Zone recorded 1, 188 (4.2%); and North-West recorded 528 (1.8%) fatality (Figure 6).

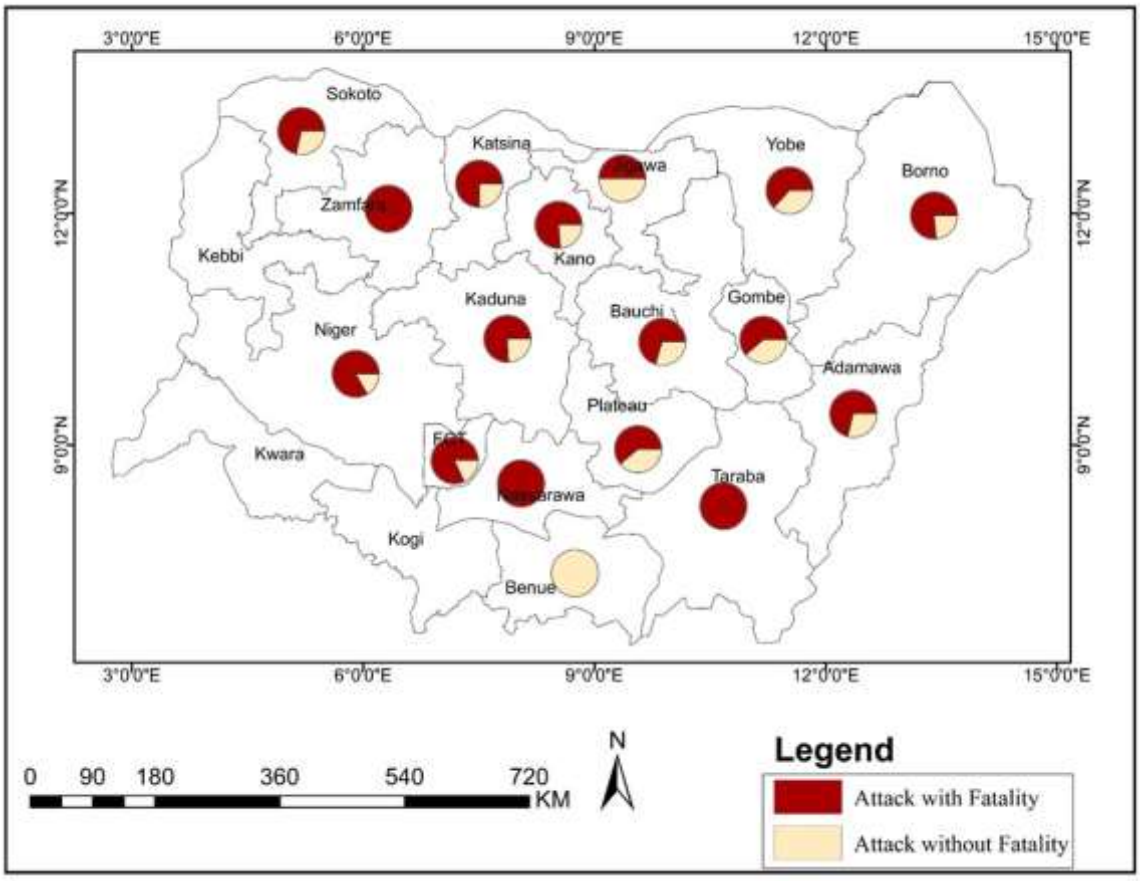


Figure 5: *Attacks with and without Fatality in the Northern Region of Nigeria 2009-2020*

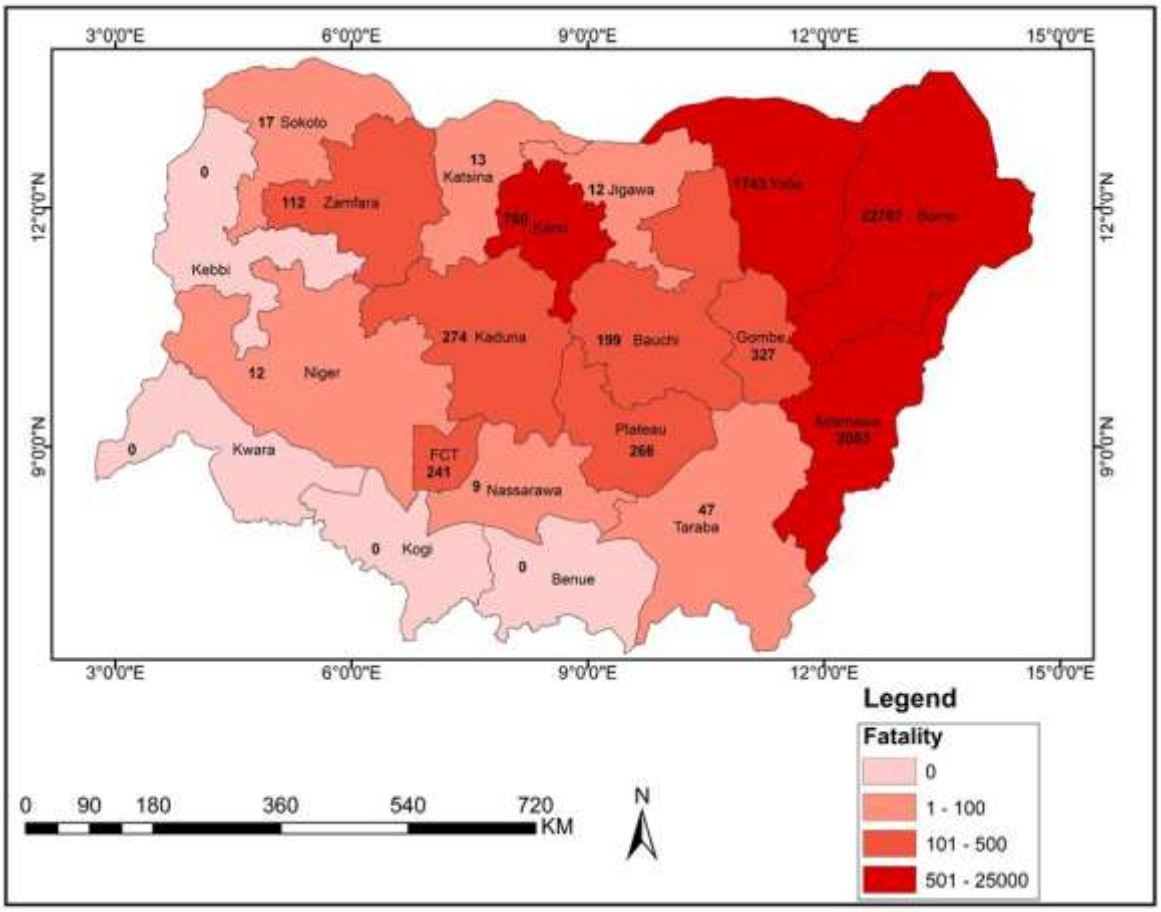


Figure 6: *Fatality Caused by Boko Haram in the Northern Region of Nigeria 2009-2020*

Looking at the temporal aspect, in the early time (2009-2012) of Boko Haram in the North, people were killed in fourteen states (Sokoto, Katsina, Kano, Jigawa, Yobe, Borno, Adamawa, Taraba, Plateau, Bauchi, Kaduna, Niger, Nassarawa, Gombe) and FCT. Among these states, Sokoto, Katsina, Kaduna, Niger, and FCT recorded their higher percentage of fatality during this time. Zamfara and Benue were the only two states that did not have any record of fatality despite the Boko Haram attacks during the period. From 2013 to 2016, the mid-period of Boko Haram activity, fourteen states (Sokoto, Katsina, Kano, Jigawa, Yobe, Borno, Adamawa, Taraba, Plateau, Bauchi, Kaduna, Zamfara, Nassarawa, Gombe) and FCT were the states where Boko Haram killed people. During this time, Niger, Benue, Kebbi, Kwara, and Kogi were the state without fatality caused Boko Haram's attacks. In six states (Borno, Yobe, Adamawa, Taraba, Niger and Zamfara), killings of people by Boko Haram were recorded in the latest epoch (2017-2020), Figure 7. This is as a result of shifting from their initial target of killing people to the abduction of people, especially students with the aim of collecting ransoms in exchange for the release of abducted students.

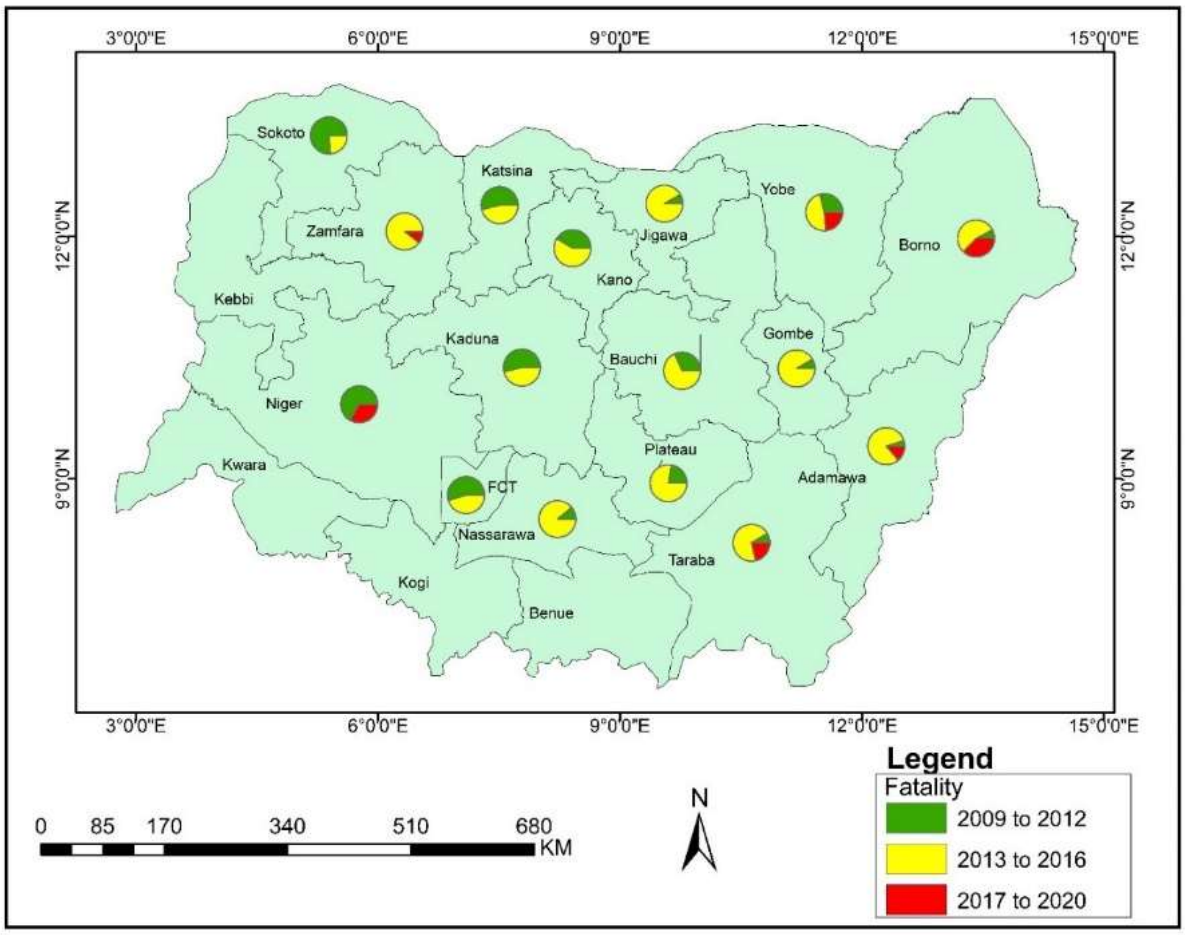


Figure 7: *Fatality at different Epochs in the Northern Region of Nigeria 2009-2020*

4.3 The Trend of attacks and fatality from 2009 to 2020

Considering the attacks and fatalities together, Figure 8 shows that the rate of attacks increased from 22 in 2009 to 34 in 2010, to 115 in 2011 and 339 in 2012 before the decline set in to put the attacks at 278 in 2013 and rise in 2014 to 404. During this period, apart from 2009 with 817 fatalities, the rate of fatalities has been in a persistent increase from 75 in 2010 to 593 in 2011, to 1603 in 2012, and to 2974 in 2013. The highest fatalities of 7,529 were recorded in 2014, which preceded General Election, characterised by political alliances and manoeuvres towards presidential and national assembly elections. It was observed that after the election in 2015, both the attacks and fatalities declined to 147 and 5079, respectively. The declination also continued in 2016 as attacks and fatalities declined to 89 and 991, respectively. This could be attributed to the posture of government depicting seriousness to combat terrorism as one of the campaign promises of All Progressive Congress (APC), the party that won the general election. However, in 2017 Boko Haram attack incidence increased again with 398 attacks and 2587 fatalities. Since then, attacks have consistently been on the trend of above 350 incidences and fatalities above 2000. The result revealed a persistent increase in the attacks and fatalities from 350 in 2018 to 368 in 2019 and 461 in 2020 for attacks, and from 2046 in 2018 to 2091 in 2019 and 2407 in 2020 for fatalities (Figure 8). This finding is corroborated with Ozdeser *et al.* (2019) that persistent attacks from Boko Haram have brought a great loss of lives.

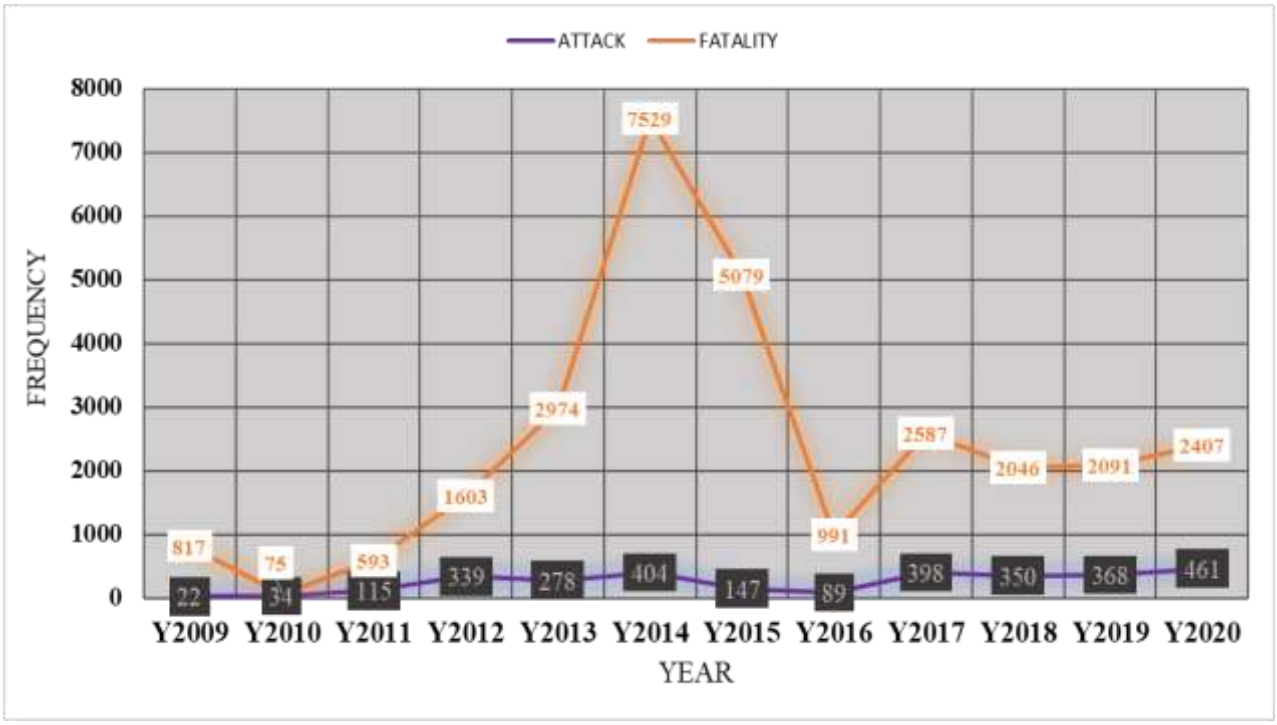


Figure 8: *The Trend of Attack and Fatality from 2009 to 2020*

4.4 Geographical weighted Regression (GWR) between Attacks and Fatality

To ascertain the significant relationship between attacks and fatalities, this study applied GWR. The result of geographically weighted regression (GWR) in Figure 9 reveals Local R^2 of not less than 0.99, which indicates that at least 99% of the fatalities in the northern region of Nigeria could be traced to the attacks by Boko Haram in the Northern Region of Nigeria. Despite the area having at least 0.99 of Local R^2, there was still a slight decrease from the North-East to North-West of the study area. This also reflected in Figure 10 that without attack from Boko Haram, fatalities from other factors can be minimised as low as 18 to 22 in Sokoto, Zamfara and Niger; as low as 23 to 28 in Katsina, Kano, Jigawa, Kaduna, Plateau, FCT and Nassarawa; and as low as 29 to 36 in Borno, Yobe, Gombe, Bauchi and Taraba. This is an indication that there is a need to eliminate the attacks from Boko Haram, which could be attainable with an increased application of geospatial technology as a complementary tool for security surveillance, monitoring and decision in Nigeria. These would reduce unforeseen attacks and curb the activities of Boko Haram in the area, especially in schools.

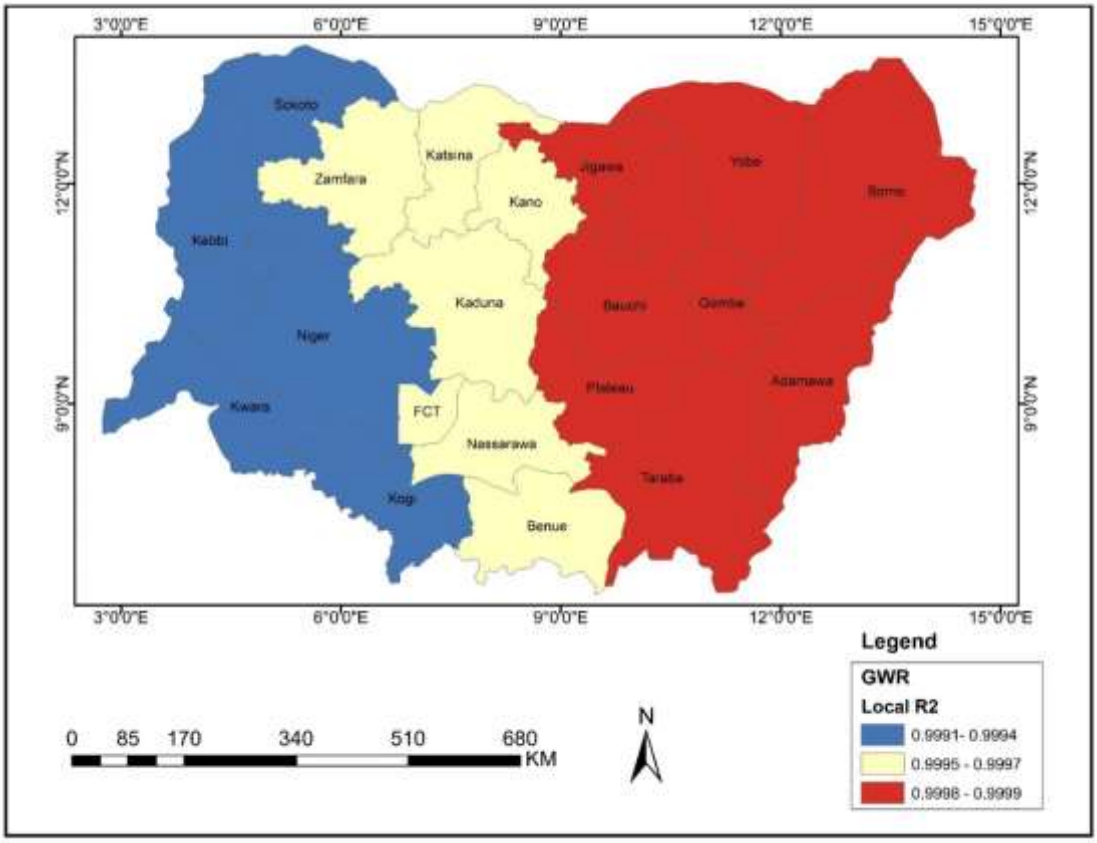


Figure 9: *Local R^2 GWR of Fatality and Attack in the Study Area*

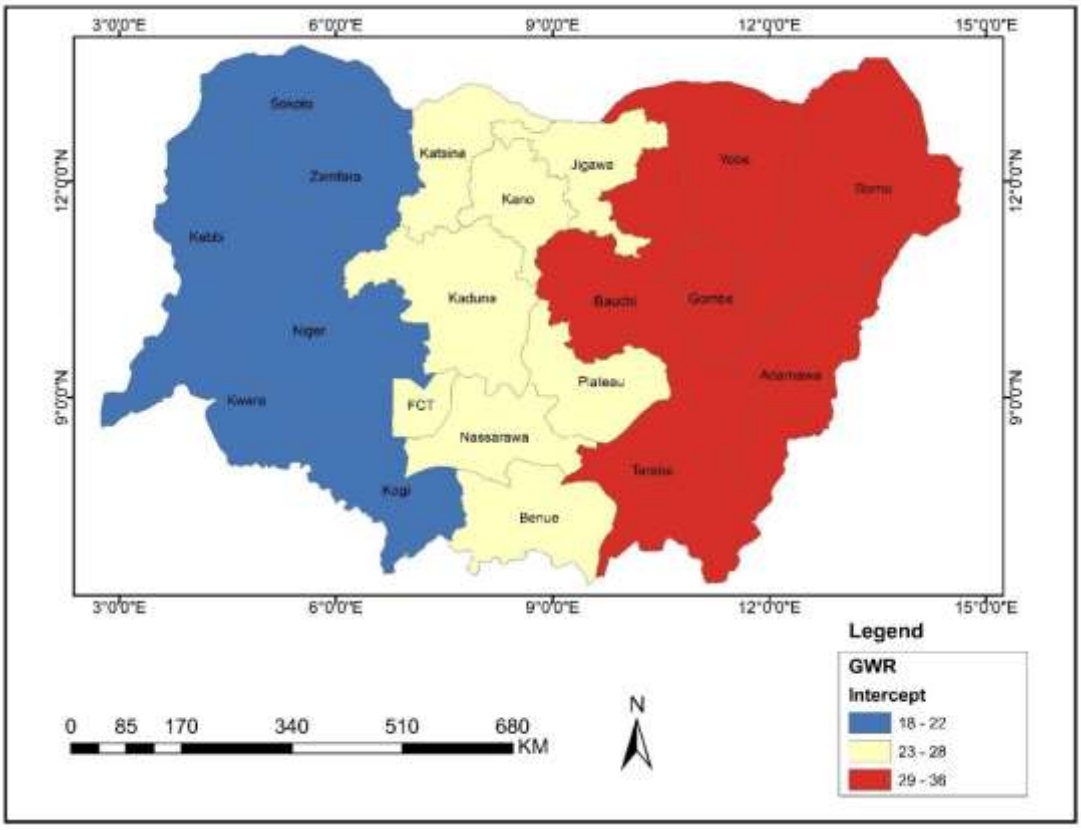


Figure 10: *Intercept of GWR of Fatality and Attack in the Study Area*

4.5 Review on Effects of Boko-Haram on Education

Boko Haram has been terrorising many states in Northern Nigeria, resulting in Kidnapping, killing, destruction of properties and cattle rustlings. They expanded their operation with the attack on schools with the first significant attack on Government Secondary School in Chibok, Borno State in May 2014 (The Guardian, 2014). This incident alone sent panic to parents and children of school age at that time till now. Thus, kidnapping of pupils become more of routing to them whenever they attack any community (The Guardian, 2014; Bakwai, Yisa & Jega, 2014; Ozdeser, *et al.*, 2019). After which, there were many reports of students' kidnappings in Nigeria. Tracing the trend of the major attacks on schools by Boko Haram, it was reported that Boko Haram abducted 276 students of Government Secondary Schools, Chibok in Borno State on 14th April 2014. On 19th February 2018, about 110 schoolgirls were kidnapped by Boko Haram terrorists in Government Girls Secondary Schools, Dapchi, Yobe State (Premium Times, 2021). In December 2020, two major attacks were made by Boko Haram in Katsina State- the first on December 11, 2020, when 344 male students were kidnapped in Government Science Secondary School, Kankara, and the second on December, 20, 2020, when 80 students of Islamiyya School, Mahuta, were kidnapped by Boko Haram (Premium Times, 2021).

After this period, Boko Haram has increased its momentum in attacking schools, as 27 students were abducted on 17th of February 2021 in Government Science College, Kagara, Niger State, and 377 students were kidnapped on February 26, 2021, in Government Girls Secondary School, Jengede, Zamfara. On 11th March 2021, thirty-nine (39) students were kidnapped in Federal College of Forestry Mechanisation, Afaka, Kaduna State; and on 21st of April 2021, another 17 students were also abducted in Greenfield University, Kaduna. Another attack led to the abduction of 169 pupils in Salihu Tanko Islamic School, Tegina, Niger State on 30th May, 2021. Boko Haram kidnapped eight (8) students on 11th of June, 2021 in Nuhu Bamali Polytechnic, Zaria, Kaduna State; and on 17th of June 2020, eighty (80) students were abducted in Federal Government College, Birnin Yauri, Kebbi State (Premium Times, 2021; and Vanguard, 2021). This gives a total of 1, 527 abducted students by Boko Haram across the primary, secondary and tertiary institution in Nigeria. Punch (2021) reported that at least 936 secondary and tertiary institutions students were abducted by suspected bandits and Boko Haram members across the country between December 2020 and 5th of June 2021. At times, teachers were kidnapped along with their students. For instance, at least 80 students and five teachers were kidnapped in Federal Government College Birnin-Yauri, Kebbi State (Premium Times, 2021). This abduction of school pupils draws the attention of the international community. Many of the girls were forced into marriage and religious conversion. There was a particular case of Leah Shaibu, who was not released because she refused to renounce her faith as a Christian girl. Up till 2021, she is yet to be released.

Figure 11 shows the temporal aspects of the students' abduction, as the number decreased from 276 abducted students in 2014 to 110 in 2018, and with a persistent increase to 424 abducted students in 2020 to 717 in the mid of 2021. During this period, Figure 12 reveals that Katsina experienced the highest number of 424 abducted students, and followed by Zamfara with 377 abducted students, Borno State with 276 abducted students, Yobe with 110 abducted students, Kebbi State with 80, and Kaduna with the lowest number of 64 abducted students. This persistent increase calls for urgent actions. Attacks from Boko Haram have caused a great setback to the education system in Nigeria, especially in the Northern region of Nigeria, as some states close their schools, and many students, especially females, abandoned schools. Some students have lost their lives, while some have become orphans and wayward due to persistent attacks of the Northern Region of Nigeria by Boko Haram. At times, members of Boko Haram married among the abducted students. Boko Haram abductees experienced forced marriage, rape, torture and abuse (The Guardians, 2014). Bakwai *et al.* (2014) observed that as a result of security challenges in the Northern States of Nigeria, many students were out of school due to sexual harassment from Boko Haram's attacks. UNICEF claimed in her portal that more than 50% of the schools in the epicentre of the Boko Haram crisis remain closed. This shows that the Nigerian government needs to put more effort through the application of remote sensing and GIS techniques in curbing the attacks of schools by Boko Haram if the Sustainable Development Goals Four, which focuses on quality education for all, is to be achieved in Nigeria.

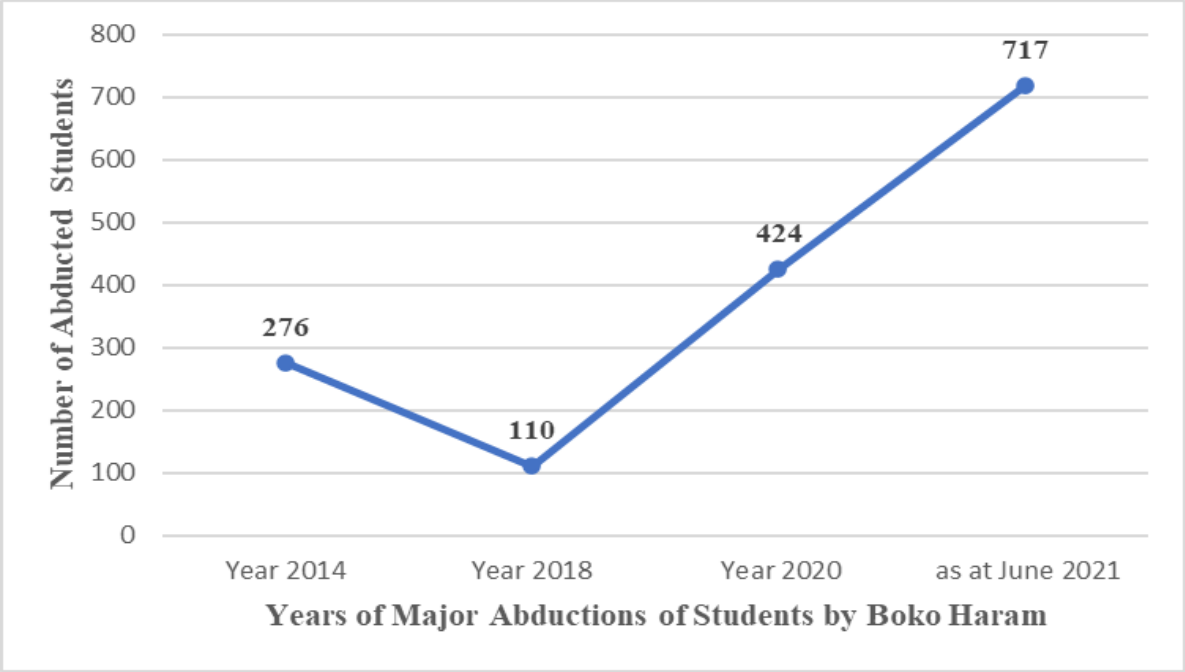


Figure 11: *Major Abduction of Students by Boko Haram*

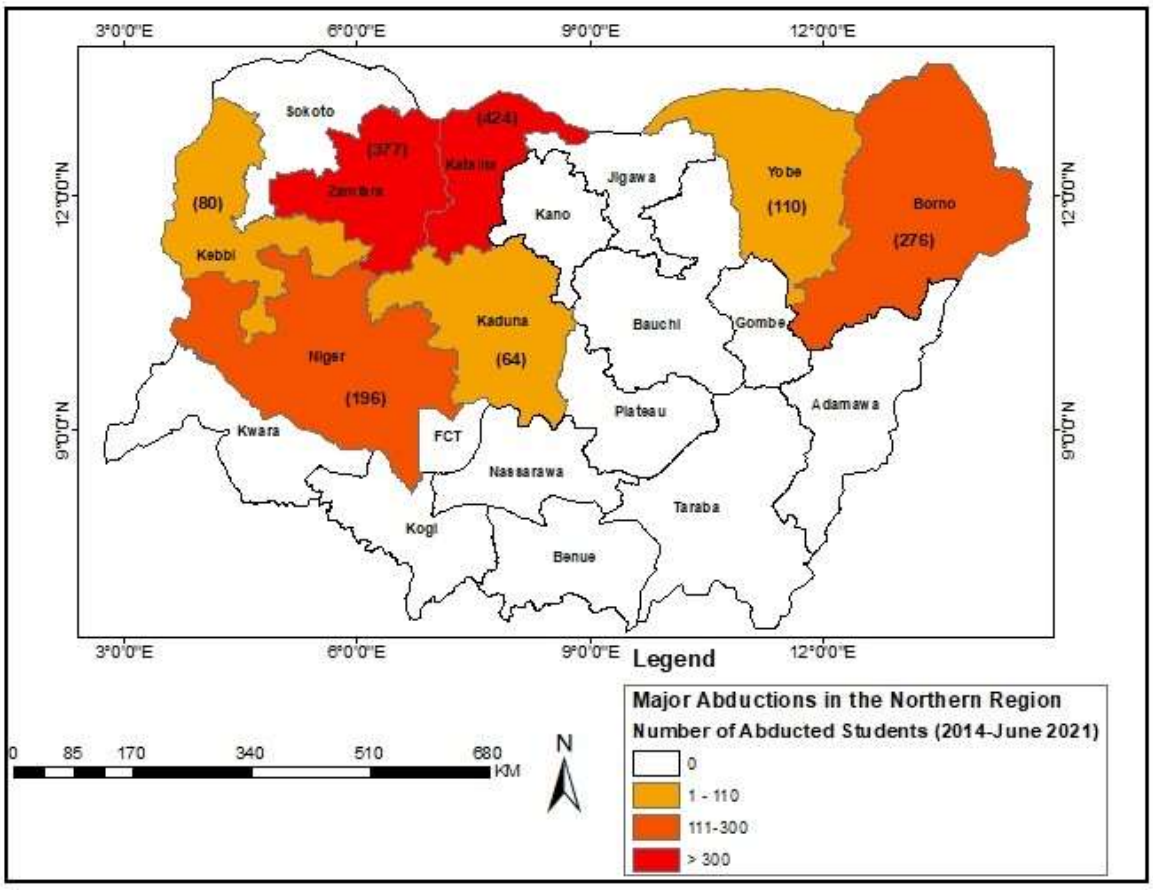


Figure 12: *Major Abduction of Students by Boko Haram in Northern Region from 2014 to June, 2021*

5. Conclusion and Recommendation

The study has shown that the attacks and fatalities caused by Boko Haram has been persistent since its inception in 2009 to 2020. The study reveals that Boko Haram has launched 3, 003 attacks and 28, 792 fatalities in which the Borno States experienced 2 321 and 22 707 respectively, the highest so far. This has led to the loss of lives and affected the region's education, especially through the abductions of students by Boko Haram. The hot spots of Boko Haram's attacks have been the three states (Borno, Yobe and Adamawa) that shared boundaries with or closed to Chad. This indicates that Nigeria's boundary seems to be porous in the North-East of Nigeria. The spatial pattern of Boko Haram was clustered, especially within the three aforementioned states. The attacks from Boko Haram were highest in 2020 while the highest fatalities were recorded in 2014, and there has been a continuous increase in the attacks and fatalities from 2018 till 2020. The study inferred that at least 99% of the fatalities could be traced to Boko Haram activities in the Northern Region of Nigeria. The study predicted that the fatalities could be reduced from as high as 22 707 in the North to as low as 18 if the attacks from Boko Haram could be eliminated. The attacks from Boko Haram have affected education as 1, 527 students were abducted by Boko Haram from 2014 to June 2021 in the Northern Region of Nigeria. This has led to the creation of fear and a violent learning environment that could not stimulate a quality education; a forceful marriage of some abducted students by Boko Haram, abandonment of schools by students, and closure of some schools by the governments. This is a great impediment to the achievement of Sustainable Development Goal Four which focuses on quality education for all.

Geospatial technology application as applied in this study showed that it has more potential in different fields, including security challenges facing Nigeria, especially her educational sector. For instance, the increased application of unmanned aerial vehicles, which is a unit of geospatial technology, is very useful in security matters. Based on this conclusion, the following recommendations were made:

- That the application of remote sensing and GIS should be incorporated and implemented most especially in esterblishing policy on security and educational matters in Nigeria.
- Remote sensing platforms with sophisticated sensors both in space-borne and airborne should be set in the Northern region of Nigeria, especially in Borno State, Yobe State, Adamawa State and at boundaries shared with Chad, Niger Republic and Cameroon; and at all government school premises. This will allow for continuous monitoring and accurate surveillance for security operations in the schools and the entire country.

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