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Spatial Distribution of Terrorists Attacks in Selected Local Governments in Borno State, Nigeria

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ABSTRACT

Nigeria has witnessed an unprecedented increase in terrorist attacks in the last five years especially in the North eastern part by the Boko haram sect. This has culminated into thousands of deaths and displacement of hundreds of thousands from their towns and villages. However, despite the military efforts to curtail the insurgency, the terrorist attacks still occur abated in the region. Hence there is need to study the spatial distribution of the attacks and generate spatial information that would be useful in implementing effective counter insurgency strategies. Spatial data of terrorist attacks obtained from national emergency management agency (NEMA) and global terrorism database (GTD) in addition other ancillary data were analysed using geospatial techniques. These data were integrated into a geodatabase and spatial analysis carried out to determine the spatial characteristics of the terrorist attacks. The result shows that the pattern of the terrorist attacks is clustered and its orientation towards the north east of the study area. The hotspot of the terrorist attacks are Gwoza and Bama while central feature of attacks is Baga town; Maiduguri has the highest number of IDPS of 14,000 while Konduga has the lowest number of IDPS; Kalga has the highest number of fatalities. The attack hotspots is close to the border indicating transborder movement of the terrorists. Hence, more military force should be deployed to the Gwoza and Bama to counter the insurgent attacks.

Keywords: Terrorist Attacks, GIS, Hotspots, Spatial Analysis, Insurgency.

I. INTRODUCTION

The term "Terrorism" is any form of violence or threat meant to coerce an individual, group or entity to act in a manner in which the individual, group or entity could not otherwise lawfully force them to act (1). This means that these acts are intended to intimidate individuals or group of people collectively to coerce change in government conduct through the use of mass destruction, assassination or kidnapping.. The psychological impacts generated in the mind of people matter more to the terrorist than the physical attack on the victims. Some activities of the terrorists include aircraft hijacking, suicide attacks, mass murder and insurgency with transmit national borders. Consequently, terrorism has attracted global interest and is subject of international discourse. The thinking of policy formulators and law enforcement agents is increasingly shaped by the need to respond appropriately to the threats or terrorism. Terrorism threatens fundamental nation's law and order, human rights and it is the enemy of mankind. It has been around for a long time, and there is no realistic prospect of its becoming extinct in the foreseeable future. Therefore, all of those concerned with the effective combat of terrorism must be prepared for a long haul.

The causes of terrorism range from socio-economic and political conditions to theories based on the personality and environment of the terrorists. Terrorism is motivated by a variety of inner drives such as financial gains, revenge, fundamentalism, deprivation, political frustration, regional disparities, marginalisation of sub-national groups, extremism, despair, injustice, discrimination, resentment against

regime, feeling of insignificance, weak government, separation, oppression and inequality (1). Terrorism is fuelled by various factors. These include the openness of free societies, the easy access to technologies by means of violence and a radical and global ideology.

Conflicts in some countries particularly in the Middle East have inevitably formed a global issue and solidarity among terrorists. This global issue has become a unifying factor to share the suffering and establish a sense of togetherness based on religious brotherhood among the believers to resist against the oppressor. Nigeria has witnessed an unprecedented increase in terrorist attacks in the last five years especially in the North eastern part by the Boko haram sect culminating into thousands of deaths in both civilian population and military force and displacement of thousands from their towns and villages (2-4). Boko Haram has intensified its operation in the North-East of Nigeria despite the state of emergency that was declared by the federal government in the three states in the northern region where Boko Haram activities are concentrated. The activities of the sect have been of concern to scholars who have written various academic papers on the modus operandi of Boko Haram. Studies by (6) analyzed the origin and ideology of the sect, from their analysis they posit that Jama'atu Ahlis Sunna Lidda'awati Wal-Jihad better known as Boko Haram is an Islamic terrorist group that has a strong operational based in the northeast of Nigeria. The ideology of the sect according them is to bring to an end the secular system of government and introduce sharia law in Nigeria. However, (2) did not subscribe to the notion that the Boko Haram aim is to Islamize Nigeria through the introduction of sharia law. He argued that the foot soldiers of the sect are unemployed and disgruntled youths who have been paid by unscrupulous politicians to cause mayhem in the country because of their selfish ambitions.

The high rate of poverty, unemployment and political corruption has been blamed on the elongation of the conflict. Most of the foot soldiers of Boko Haram are youths that are frustrated because the lack employment, income and they have been disdained by politicians after being used by these politicians for their elections victory. Studies by (7-9) assert that the youths enlisted into Boko Haram because of the prevalence of poverty in the North. The poverty profile of Nigeria that was released in 2011 by the National Bureau of Statistics (NBS) indicated that the northern region has more poor people than people in the south. Aside the killings, kidnapping and bombing of the sect, their activities constitute a hindrance to the socioeconomic development of the northeast where their operation is focused and Nigeria as a whole. Similarly, most researches on the Boko Haram insurgency agree that the sect heinous crimes hinder socio-economic development in Nigeria (6,10,11). In combating terrorism in the study area, it will be worthwhile to explore geospatial technology in minimizing the activities of the terrorists.

Geospatial techniques provide the means to collect and use geographic data which are spatially referenced to the earth. Geographic Information System (GIS) is capable of integrating, storing, editing, analysing, sharing and displaying geographically referenced data. It has been commonly said that whereas information is power, geographic information implies its might and speed" (5). This information provides a base for all intelligence operations, tactical decisions and operations, planning and execution of most battlefield activities. In order to successfully support current and future military operations in the study area, geospatial information must be rapidly integrated and analysed to meet on going force structure evolution and new mission directives.

1.1 Statement of the Problem

The frequency of insurgency, terrorism and other violent crimes by the militant Islamist group known as Boko Haram, has caused severe havoc in North-eastern Nigeria through suicide bombing, assassination and abductions claiming over and destruction of properties worth billions of naira (12). The internal displace monitoring center (IDMC) estimates that there are almost 2,000,000 internally displaced people (IDPs) in Nigeria as of 31 December 2015 as result of boko haram attacks (13).

Most of the researches carried out on the terrorist attacks focused mainly on the socio-economic effects (10-12). However, there is no study on understanding the spatial distribution of the terrorist attacks with a view of providing spatial information for effective counter terrorism measures and provision of adequate relief for the victims in the study area.

1.2 Aim and Objectives of the study

This study is aimed at assessing the spatial distribution of terrorist attacks in selected local government areas in Borno State, Nigeria with the view of providing vivid description of attacks and its attendant effects to provide policy makers with information required for making decision.The specific objectives are to:

a. analyze the terrorist attacks in the study area;
b. determine the distribution pattern of the terrorist attacks in the study area and
c. identify the hotspot of the terrorist attacks in the study area.

1.3 The Study Area

The general study area is bounded by latitudes 10^0 $30^{'}$ and 13^0 $00^{'}$ N and longitudes 11^0 30' and 14^0 40' E in Borno State, North -eastern Nigeria. It has an area of about 12,100 square kilometres. The area is located in the semi-arid region and is made up of ten local government areas that are mostly affected by insurgency: Michika, Hong, Mubi South and North, Girei, Madagali, Damboa, Konduga, Maiduguri, Biu, Kaga, Bama, Dikwa, Jere, Mafa, Chibok, Magumeri, Hawul, Gwoza, Askira/Uba, Geidam, Damaturu, Gujba, Tarmua and Gulani.(Figure 1). The Southern and Eastern part of the study area is predominantly hilly, the geology which is underlying by the basement complex. The areas is characterized by mountains, plateau, ridges, escarpment and related features (14). The landscape developed on the young sedimentary rock on the Chad formation. The area features a variety of fluvial and Aeolian like fossil sand dunes, beach ridges, and interdunes ridges depression (15). The study area is drained by two rivers; one is towards the south draining to river Benue while the other is towards Lake Chad. The soil types are predominantly sandy at the surface and also low in organic matter content and low weatherable minerals, rapid oxidation of organic residue and frequent exposure of soil due to seasonal bush burning characterize these soils. The climate of the study area is semi-arid type with distinct seasonal and diurnal temperature ranges, a long dry season followed by a short wet season. The vegetation types falls within the transition zones of the Sudan and Sahel savannah type of vegetation. The distribution and character of the vegetation result from the interplay of climate, edaphic and biotic factors. Generally the natural vegetation consists of shrubs, short grasses and scattered trees. The study area is agrarian with people engaged in farming, cattle rearing and fishing, important grown include millet, groundnut and beans.

II. METHODS AND MATERIAL

This methodology adopted by this research was divided into three stages namely: data acquisition, processing and analysis as depicted in figure 2.

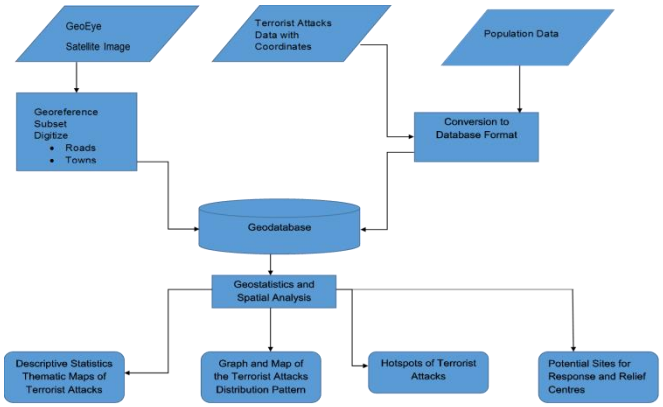

Figure 2 : Flow Chart

2.1 Description of Data/Sources

Various forms of data from both primary and secondary sources were used for this study. The primary data used were direct field observations carried out in affirming the insurgent activities and GPS coordinates of some geographic features recorded in the study area. The secondary data consists of Geo-Eye satellite image, boundary feature from OSGOF, population data from NPC, NEMA and GTD terrorist attacks data (Table 1).

Table 1: Data Characteristics and their Sources

SN	DATA	YEAR	FOR MAT	SOURCE
1.	GPS coordinates of geographic features	2016	Digital	Field Work
2.	Terrorist Attacks	2010-2015	Digital	National Emergency Management Agency and Global Terrorist Database
3.	Administrative Boundary	2012	Digital	Office of the Surveyor General of the

				Federation (OSGOF).
4	Population Data	2006	Digital	National Population Commission
5	Geo-Eye Satellite Image	2015	Digital	Geo-Eye Inc, USA

2.2 Data Processing

The population density and current population was determined from the population data. The road network was extracted from the Geo-Eye satellite images. The terrorist attacks was imported as point feature while the population data was imported as polygon feature. The administrative boundary was used to delineate the study area. All data were converted to geodatabase format and organized in different thematic layers.

2.3 Assessment of the Spatial Pattern of Terrorist Attacks

The modelling of the spatial pattern provides the distribution and pattern of the terrorist attacks in the study area. The spatial patterns are geo-statistical operations that identify the mean centre, median centre, mean central feature, directional distribution, density, standard distance and pattern of attacks in the study area. The coordinates of terrorist attack data obtained from NEMA was used to determine the spatial pattern. Attribute information on the spatial distribution of other features include the total number of people, number of internally displaced people, number of lives loss, frequency of attacks, number of houses, shops, schools, churches and vehicles destroyed in the study area. The road network in the study area was also used to evaluate the proximity of the terrorist attacks.

This identifies the most centrally located feature within a set of features in a geographic boundary. The central feature tool identifies the most centrally located feature in a point, line, or polygon feature class. Distances from each feature centroid to every other feature centroid in the dataset are calculated and summed. Then the feature associated with the shortest accumulative distance to all other features (weighted if a weight is specified) is selected and copied to a newly created output feature class. The Central Feature tool is useful for finding the center when you want to minimize distance (Euclidean or Manhattan distance) for all features to the center. The central feature of the terrorist attacks in the study area was calculated to identify the area that is most prone to the attacks in the region and recommend fortifying the town defenses.

2.3.1 Mean Centre of the Terrorist Attacks

The mean centre is the average x- and y-coordinate of all the features in the study area. It's useful for tracking changes in the distribution or for comparing the distributions of different types of features. The mean centre was calculated using formula 1 in the in spatial analyst of ArcGis. The mean centre of the terrorist attacks in the study area was calculated to suggest a central place for sitting a military command that can deploy troops and machineries to counter terrorist attacks within a reasonable time frame.

$$\bar{X}_{Coord} = \frac{\sum_{i=1}^{n} X_i}{n} \qquad \bar{Y}_{Coord} = \frac{\sum_{i=1}^{n} Y_i}{n}$$

where xi and yi are the coordinate for features i and n equal to the number of features.

2.3.2 Density of Attacks

The kernel density tool calculates the density of features in a neighbourhood around those features. It can be calculated for both point and line features. Kernel Density calculates the density of point features around each output raster cell. Conceptually, a smoothly curved surface is fitted over each point. The surface value is highest at the location of the point and diminishes with increasing distance from the point, reaching zero at the Search radius distance from the point. Only a circular neighbourhood is possible. The density map created is sometimes called heat map or dot density map. The density map of the terrorist attacks was created to show areas where the attacks were more intense in the study area.

2.3.3 Standard Distance of Terrorist Attacks

The standard distance measures the compactness of a distribution and provides a single value representing the dispersion of features around the centre. The value is a distance, so the compactness of a set of features can be represented on a map by drawing a circle with

the radius equal to the standard distance value. The Standard Distance tool creates a circle polygon. The standard distance was calculated to determine the dispersion of the terrorist attacks around the mean centre in the study area.

2.3.4 Distribution Pattern of Terrorist Attacks

This distribution pattern describes the pattern of the clusters of the terrorist attacks and shows whether the occurrence of the attacks are clustered, random or dispersed in the study area. The spatial autocorrelation tool in ArcGis spatial analyst tool was used to determine the distribution pattern of the terrorist attacks. This measure spatial autocorrelation for a series of distances and optionally creates a line graph of those distances and their corresponding z-scores. When values for neighbouring features are either both larger than the mean or both smaller than the mean, the cross-product will be positive. When one value is smaller than the mean and the other is larger than the mean, the cross-product will be negative. In all cases, the larger the deviation from the mean, the larger the cross-product result. If the values in the dataset tend to cluster spatially (high values cluster near other high values; low values cluster near other low values), the Moran's Index will be positive. When high values repel other high values, and tend to be near low values, the Index will be negative. If positive cross-product values balance negative cross-product values, the Index will be near zero. The numerator is normalized by the variance so that Index values fall between -1.0 and +1.0. Z-scores reflect the intensity of spatial clustering, and statistically significant peak z-scores indicate distances where spatial processes promoting clustering are most pronounced. These peak distances are often appropriate values to use for tools with a distance band or distance radius parameter.

2.3.4 Directional Distribution of Terrorist Attacks

Directional distribution measures the trend for a set of points or areas by calculating the standard distance separately in the x- and y-directions. These two measures define the axes of an ellipse encompassing the distribution of features. The ellipse is referred to as the standard deviational ellipse, since the method calculates the standard deviation of the x-coordinates and y-coordinates from the mean centre to define the axes of the ellipse. The ellipse allows you to see if the distribution of features is elongated and hence has a particular orientation. The directional distribution was determined using directional distribution tool in spatial analyst of ArcGis and shows the direction which the terrorist attacks are occurring in the study area.

$$SDE_x = \sqrt{\frac{\sum_{i=0}^{n}(x_i - \bar{X})^2}{n}}$$

$$SDE_y = \sqrt{\frac{\sum_{i=0}^{n}(y_i - \bar{Y})^2}{n}}$$

Where $\bar{x}_i$ and $\bar{y}_i$ are the deviation of the xy –coordinate from the mean center

2.3.5 Density of Attacks

The kernel density tool calculates the density of features in a neighbourhood around those features. It can be calculated for both point and line features. Kernel Density calculates the density of point features around each output raster cell. Conceptually, a smoothly curved surface is fitted over each point. The surface value is highest at the location of the point and diminishes with increasing distance from the point, reaching zero at the Search radius distance from the point. Only a circular neighbourhood is possible. The density map created is sometimes called heat map or dot density map. The density map of the terrorist attacks was created to show areas where the attacks were more intense in the study area.

2.4: Hotspot Analysis

The Hot Spot Analysis calculates the Getis-OrdGi* statistic (pronounced G-i-star) for each feature in a dataset. The resultant z-scores and p-values tell you where features with either high or low values cluster spatially. This analysis examines each feature within the context of neighbouring features. A feature with a high value is interesting but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values as well. The local sum for a feature and its neighbours is compared proportionally to the sum of all features;

when the local sum is very different from the expected local sum, and that difference is too large to be the result of random chance, a statistically significant z-score results. In determining the hotspot of the terrorist attacks, data on terrorist attacks obtained from the National Emergency Management Agency, Abuja containing information on the coordinates of attacks areas, total number of persons affected by the attacks, number of internally displaced people, number of death recorded, frequency of attacks, number of schools, churches, shops, houses and vehicles affected the terrorist attacks in the North East, Nigeria. The hotspot of the terrorist attacks was determined using the hotspot analysis tool in ArcGis software and hotspot areas identified using the frequency of attacks.

III. RESULTS AND DISCUSSION

3.1 Spatial Analysis of Terrorist Attacks

The terrorist attacks were analysed and spatial characteristics determined include the mean centre, median centre, central feature, directional distance and standard distance of the terrorist attacks in the study area. The population density, internally displaced people, fatalities and frequency of attack was also determined. The mean centre and median attacks are located the Goneri, north-eastern part of Damboa local government area between Yamtaji and Bullaulm but with different geographic coordinates (fig 3). The close proximity of both the mean and median centre indicate minimal presence of outliers and almost binomial distribution of the data. The central feature of attack is also located at Goneri in between Damboa and mulgwe Mayirirna along the highway road network towards the north-eastern part of the study area. The central feature is surrounded by the most frequently attacked areas and equidistant to all other places of the attacks. However, this does not imply that the central feature of attack is the most frequently attacked. The close proximity of the central feature, median centre to mean centre of attacks validates the selection of Goneri as potential site for establishing a response centre to rapidly deploy resources against insurgent attacks.

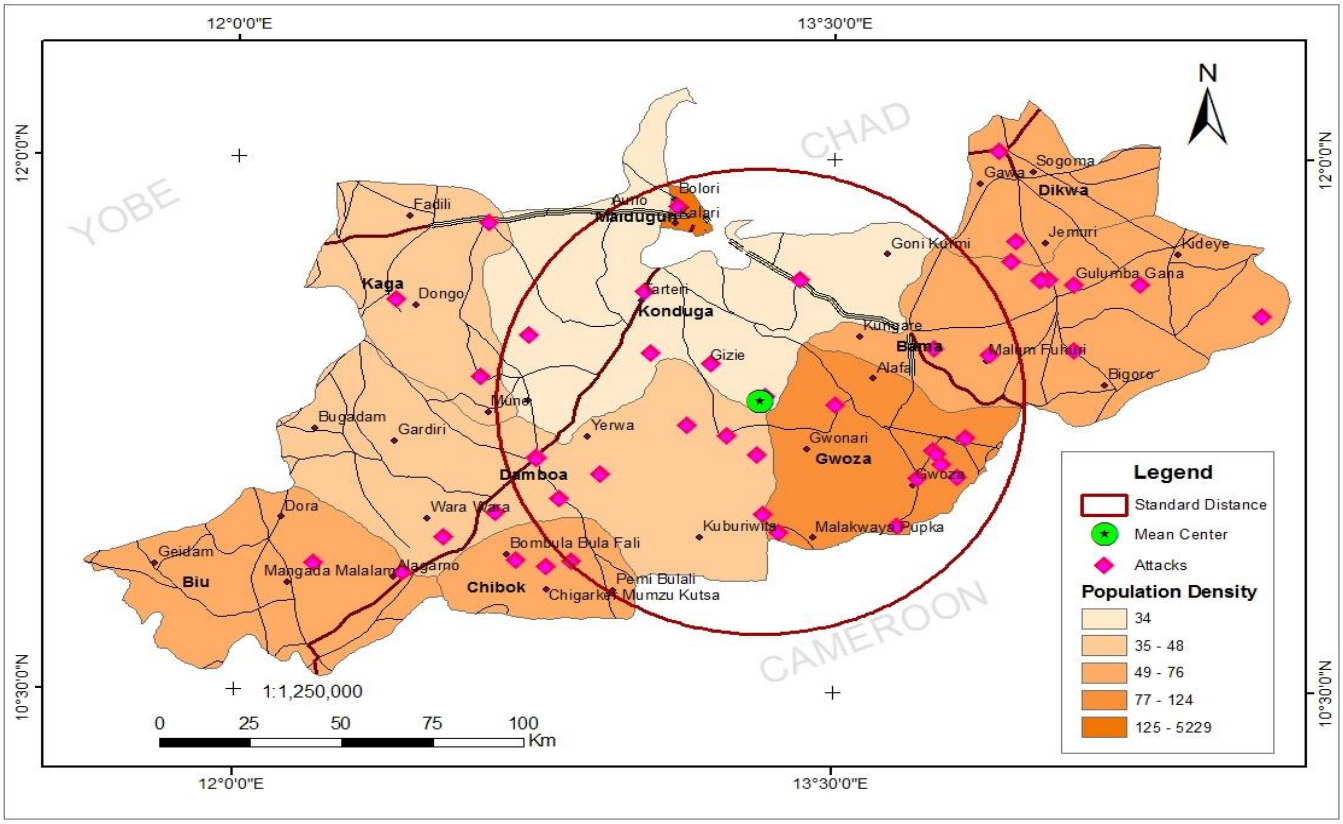

Figure 3. Mean Centre and Standard Distance of Attacks in the Study Area

The standard distance is represented by a circle with the mean centre of attack as its centre. The radius of the circle is equal to the standard distance from the mean centre. The standard distance of attacks

encompassed other places of attacks and covers Gwoza, Maiduguri and part of Chibook, Damboa, Konduga, Kaga and Bama local government areas. The area coverage of the standard distance is 424km^2.

The estimated population calculated using the NPC 2006 census growth rate of 3.4% in the study area is 549,180. The UNPFA 2015 population estimate for Borno state is 345,169 (16). The estimated population density of the different local government area varied from 55 to 341. However, the activities of the insurgents have created high number of IDPS and lead to thousands of fatalities. Hence, the estimated population was recalculated taking into account the number of IDPS and fatalities recorded in the region. An estimated population of 452,231 was derived with the population density ranging from 45 to 452 in the different local government areas (Fig 5). Maiduguri, Gwoza, Bama and Dikwa were the most densely populated areas.

The total number of IDPs generated from both the NEMA and GTD data is 1,345,345 and ranged from 34,000 to 123,000 in the different local government areas (Table 2 and Fig 4). IDMC reported that there are 1,434,149 IDPs in Borno state as at December, 2015 (13). However, according to (17), the actual number of IDPS remains unknown due to ineffective monitoring of displaced persons. Hence, the figure of IDPs obtained from NEMA though not actual give us a close estimate of the actual number and can serve baseline data for planning purpose. The spatial distribution of the IDPs show that there are more IDPs in high density areas than those low density areas. This indicate a positive correlation with IDPs and population confirming that the terrorist target areas with high population for maximum damage as reported by (18).

Table 2 : Terrorist Attacks Data

Table

Attacks

X	Y	Date_of_Oc	Date_Repor	Community	LGA	State	Type_of_At	Total_No_o	No_of_IDPs	No_of_Live	No_of_Peop	Frequency	No_of_Hous	No_of_Shop	No_of_Scho	No_of_Cl
13.753	11.1816	07/01/2014	08/01/2014	Wala_warabe	Gwoza	Borno	Insurgency	9231	4239	0	0	6	10	15	0	
12.75787	11.15387	08/01/2014	08/01/2014	Damboa	Damboa	Borno	Insurgency	1200	0	4	0	10	5	0	0	
14.0201	11.6621	08/01/2014	11/01/2014	Banki	Bama	Borno	Insurgency	12555	5250	6	0	10	23	18	0	
12.61667	11.38333	17/01/2014	20/01/2014	Gashigar	Bama	Borno	Insurgency	6442	2350	20	0	3	63	26	0	
12.8145	11.0414	22/01/2014	25/01/2014	Jawa	Damboa	Borno	Insurgency	479	209	8	0	1	30	0	0	
12.918	11.11	22/01/2014	25/01/2014	Kaya	Damboa	Borno	Insurgency	509	269	8	0	1	40	0	0	
13.13334	11.25	22/01/2014	25/01/2014	kwaljeri	Damboa	Borno	Insurgency	748	748	0	0	1	67	0	0	
13.947	11.713	29/01/2014	30/01/2014	Kawuri	Konduga	Borno	Insurgency	9900	2111	85	0	10	45	32	0	
14.104506	11.650119	07/02/2014	10/02/2014	Gulumba	Bama	Borno	Insurgency	16700	3121	15	0	5	55	0	3	
13.83334	11.21666	09/02/2014	10/02/2014	Hambagda	Gwoza	Borno	Insurgency	9331	3743	0	0	0	25	40	0	
13.41705	11.66199	11/02/2014	12/02/2014	Konduga	Konduga	Borno	Insurgency	15911	5478	36	0	0	12	0	0	
12.526	10.9323	11/02/2014	14/02/2014	Wajiriko	Damboa	Borno	Insurgency	320	162	4	0	0	245	0	0	
13.36678	10.95	15/02/2014	19/02/2014	Izge	Gwoza	Borno	Insurgency	10321	8135	106	0	3	0	0	0	
14.104506	11.4629	19/02/2014	20/02/2014	Bama	Bama	Borno	Insurgency	20000	5113	109	0	13	78	0	0	
13.3278	11.0007	22/02/2014	23/02/2014	Izge	Gwoza	Borno	Insurgency	0	0	0	0	5	156	0	0	
12.63153	11.81854	01/03/2014	02/03/2014	Mainok	Kaga	Borno	Insurgency	4911	2086	39	0	2	160	70	0	
14.041	11.6651	03/03/2014	04/03/2014	Jakana	Konduga	Borno	Insurgency	4559	2729	35	0	2	1	0	1	
12.75787	11.15396	15/03/2014	16/03/2014	Damboa	Damboa	Borno	Insurgency	0	0	20	0	10	0	0	0	
13.027012	11.624823	20/03/2014	21/03/2014	Dalwa	Konduga	Borno	Insurgency	1200	0	5	0	10	0	28	0	
14.58	11.56	21/03/2014	22/03/2014	Ngelzarma	Bama	Borno	Insurgency	0	0	0	0	3	0	0	0	
13.7552	11.4679	23/03/2014	25/03/2014	Nguro_soye	Bama	Borno	Insurgency	1000	0	32	0	7	65	0	0	
12.919	11.411	23/03/2014	25/03/2014	Dalwa	Konduga	Borno	Insurgency	300	0	0	0	10	0	0	0	
13.23334	11.22	28/03/2014	30/03/2014	Azir	Damboa	Borno	Insurgency	330	0	4	0	2	55	0	0	
12.656	11.0002	12/04/2014	14/04/2014	Bulum	Damboa	Borno	Insurgency	1759	753	18	0	1	89	0	0	
12.4	11.6	12/04/2014	13/04/2014	Bainshek	Kaga	Borno	Insurgency	874	174	0	0	0	56	1	0	
13.8559	11.9653	13/04/2014	15/04/2014	Baga	Bama	Borno	Insurgency	390	390	0	0	10	0	0	0	
12.847	10.8658	14/04/2014	15/04/2014	Chibok	Chibok	Borno	Insurgency	3000	1107	2	0	3	0	1	0	
13.9165	12.024	15/04/2014	16/04/2014	Dikwa town	Dikwa	Borno	Insurgency	2000	0	8	0	3	0	0	0	
13.775	11.1416	30/04/2014	02/05/2014	Ngoshe	Gwoza	Borno	Insurgency	2500	0	1	0	10	0	0	0	
13.7611	11.172552	04/05/2014	07/05/2014	Wala_warabe	Gwoza	Borno	Insurgency	90	0	0	0	5	0	0	0	
13.506	11.31	05/05/2014	06/05/2014	Gamboru	Gwoza	Borno	Insurgency	20000	2231	100	0	2	0	0	0	
13.042	11.452	10/05/2014	11/05/2014	Kawuri	Konduga	Borno	Insurgency	11	0	0	0	10	0	0	0	
13.6631	10.9697	10/05/2014	12/05/2014	Liman_Kara	Gwoza	Borno	Insurgency	0	0	0	0	10	0	0	0	
12.2005	10.8583	20/05/2014	21/05/2014	Alagarno	Askira_Uba	Borno	Insurgency	6000	5003	17	0	1	0	0	0	
12.4242	10.8319	22/05/2014	24/05/2014	Kimba	Biu	Borno	Insurgency	1500	517	0	0	1	0	0	0	
13.3305	11.3305	26/05/2014	27/05/2014	Maiduguri	Maiduguri	Borno	Rain storm	15000	0	7	0	3	0	0	0	

1 (0 out of 48 Selected)

STATES | Boundary | LGAS | STATES | Attacks

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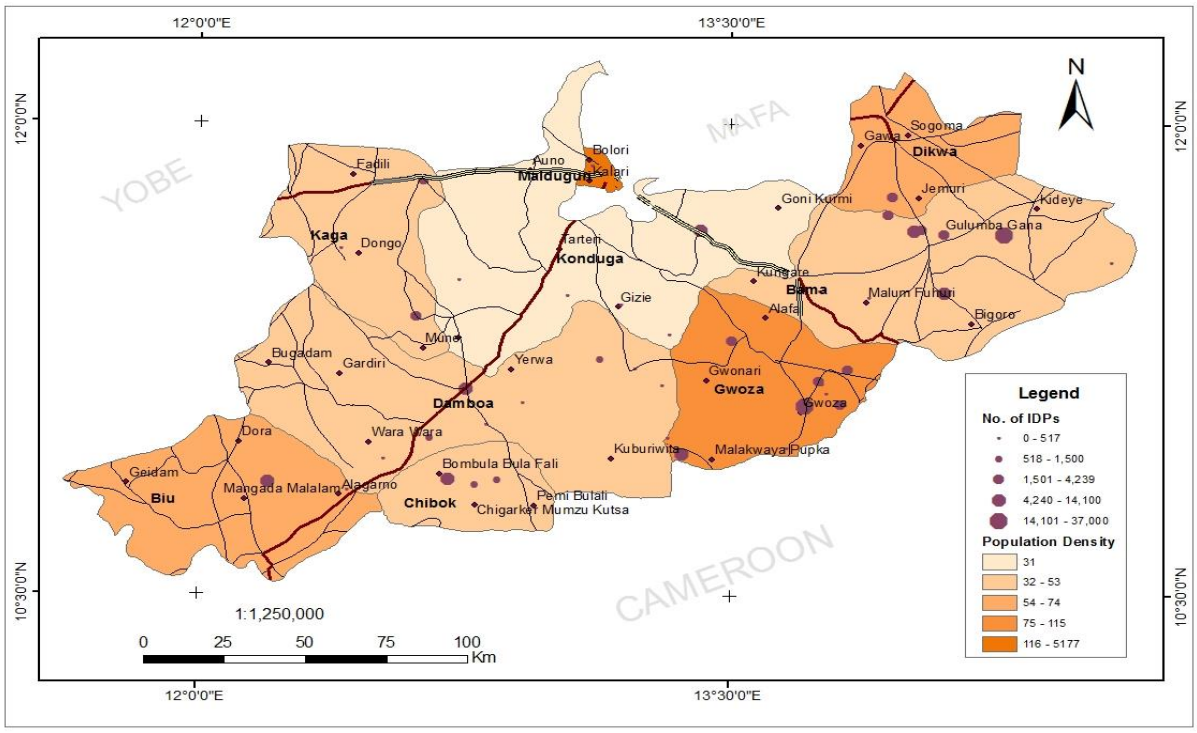

Figure 4. Number of IDPs in the Study Area

Similarly, fatalities data obtained from both NEMA and GTD reveal a total of 23,456 fatalities and ranged from 456 to 15,600 across the local government areas (fig 5). According to IDMC, over 20,000 lives have been lost due to terrorist attacks in Borno state (13). Though the actual figure of fatalities is not known, the figure determined is a close estimate of the number of fatalities recorded in the study area.

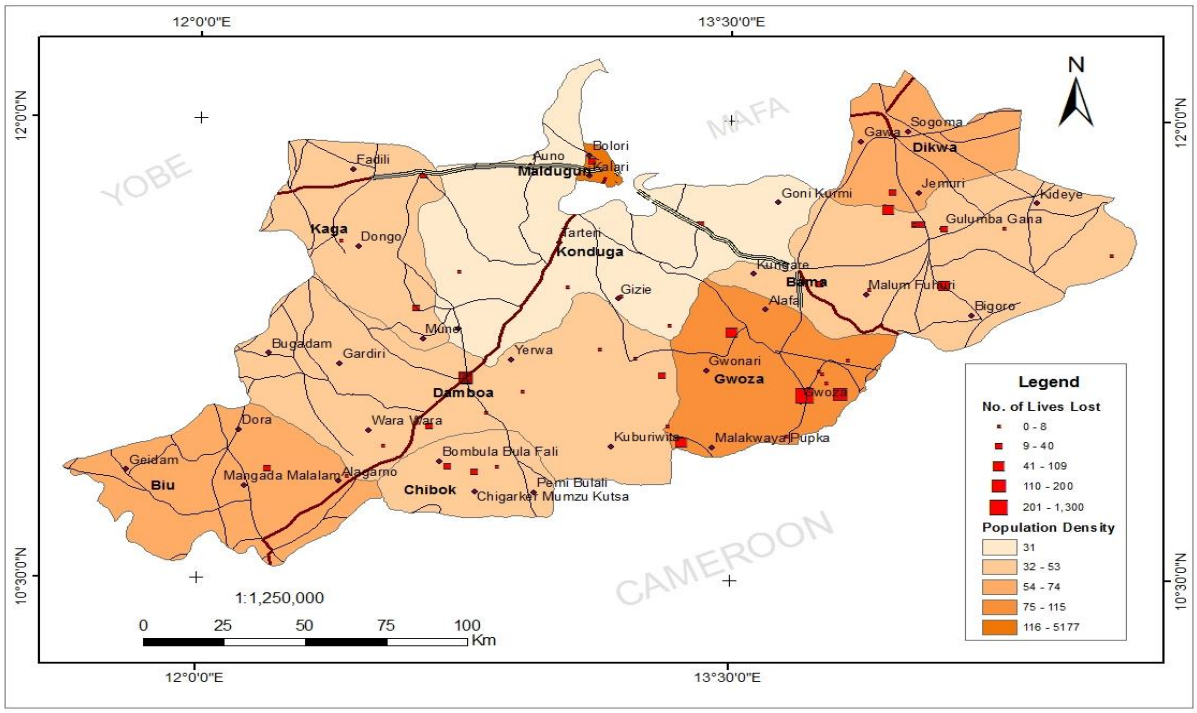

Figure 5. Number of Fatalities in the Study Area

The frequency of attacks data show that Bama, Gwoza and Maiduguri were most frequently attacked local government areas while Dikwa, Kaga and Biu were the least attacked local government areas as seen in figure 8. Bama, Gwoza and Maiduguri are densely populated and this could account for the frequent attacks in these areas.

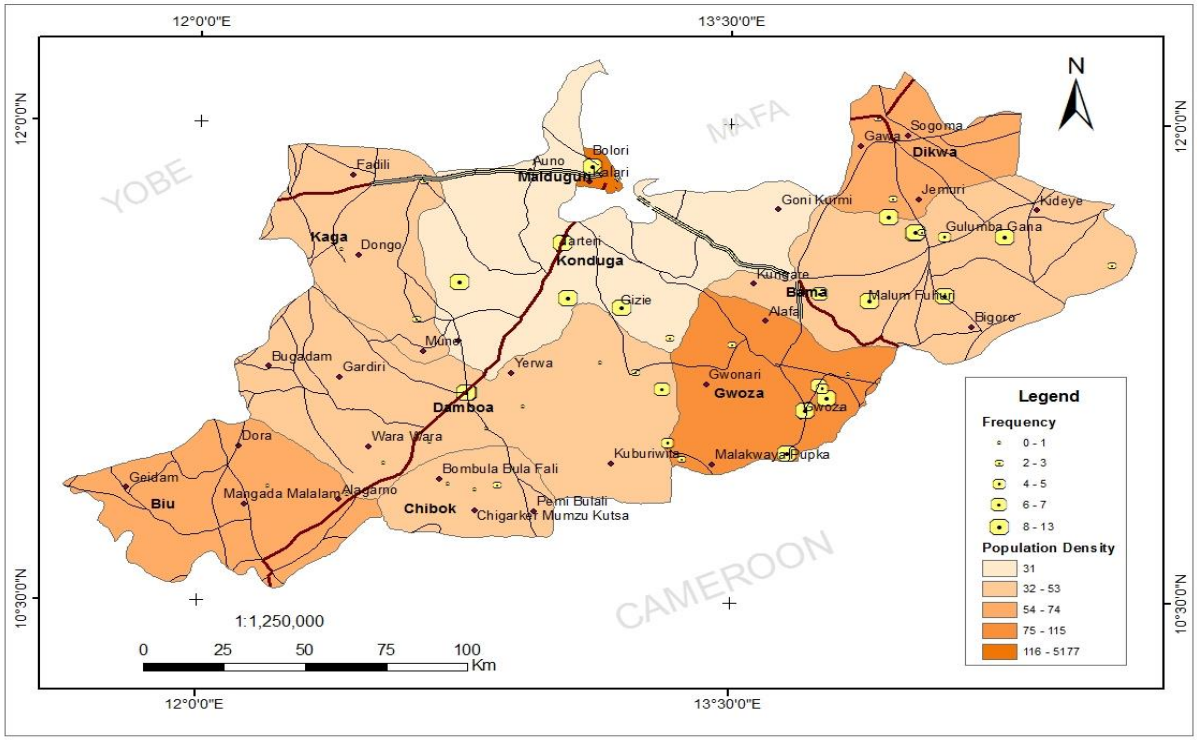

Figure 6. Frequency of Terrorist Attacks in the Study Area

3.2 Spatial Distribution of Terrorist Attacks

The spatial distribution of the attacks were determined and analysis carried out include the nearest neighbourhood analysis, directional distribution and density of attacks. Statistics generated from the nearest neighbourhood analysis that the distribution of the attacks is clustered in the study area (Figure 7). The Nearest Neighbourhood Ratio is 0.879056, Z-Score is -1.921934 with P value ranging from 1.96 to 2.58 indicating that the attacks are clustered. Given the z-score of -1.92, there is a less than 10% likelihood that this clustered pattern of attacks could be the result of a random chance. This confirms that the terrorist attacks is targeted to specific areas and not random in occurrence. Similarly, (19) argued that terrorist attacks are not randomly distributed in geographic space. The density of attacks map further reinforces the clustering pattern of the attacks as seen in figure 8. Damboa, Gwoza, Dikwa have high clustering of attacks while Konduga, Chibook recorded low attacks. Similarly, previous studies have identified areas such as Maiduguri and Gwoza has been the theater of the insurgency confirming the distribution pattern attacks (3, 17).

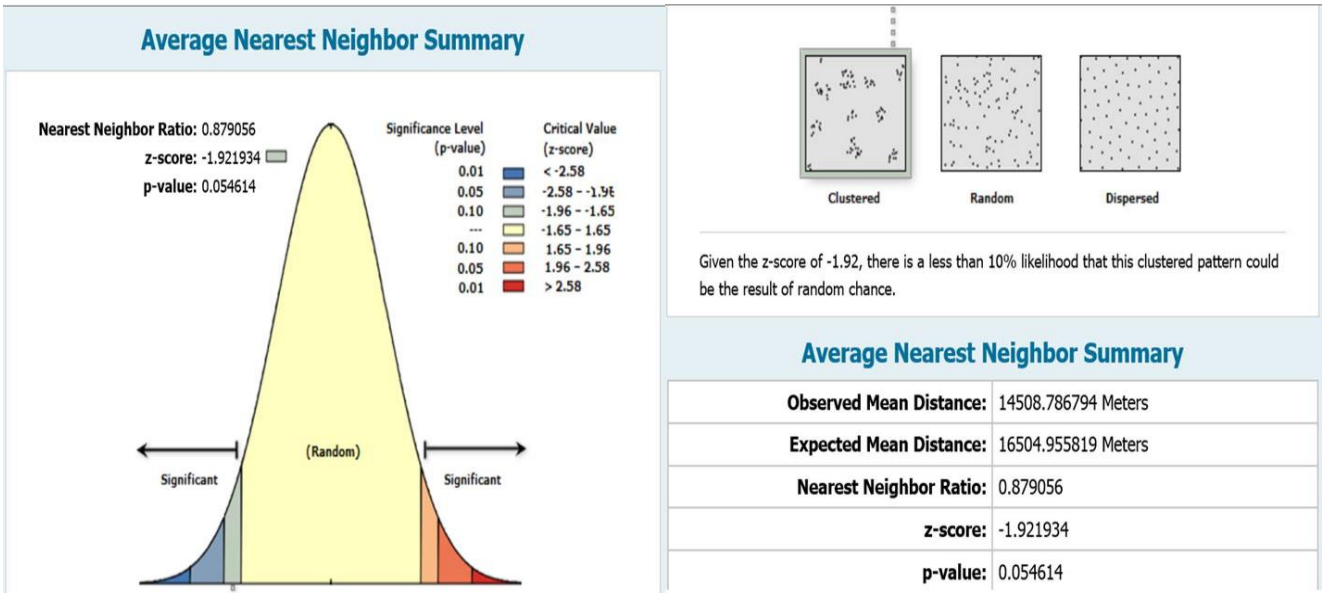

Figure 7. Nearest Neighborhood Analysis of Terrorist Attacks in the Study Area

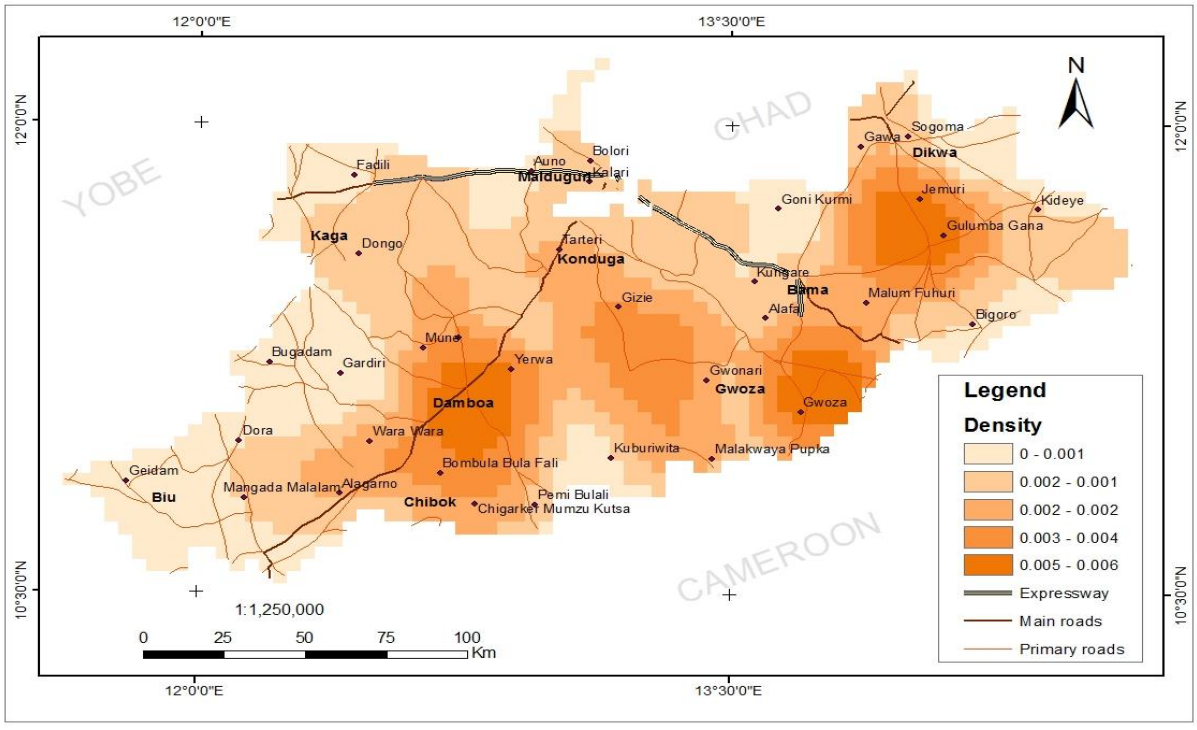

Figure 8. Density of Terrorist Attacks in the Study Area

The directional distribution of attacks show the direction in which the attacks are progressing in the study area. From the analysis, the distribution of the attacks is from north east to south west of Borno state (fig 9). Thus, most of the attacks are directed from the border areas such as Dikwa, Gwoza, Bama towards the south western areas such as Damboa, Chibook and Konduga. Furthermore, the attacks are clustered in nature and linear along the road networks in the study area. Studies by other authors noted that the terrorist base is on the fringes of the border, hence, border areas are easy targets for the attacks (3,4,17,). Maiduguri does not fall within the eclipse of terrorist attacks directional distribution. However, it has also experienced intense terrorist attacks as a result of being administrative headquarter of the Borno state, having good road network that facilitates the terrorist movement.

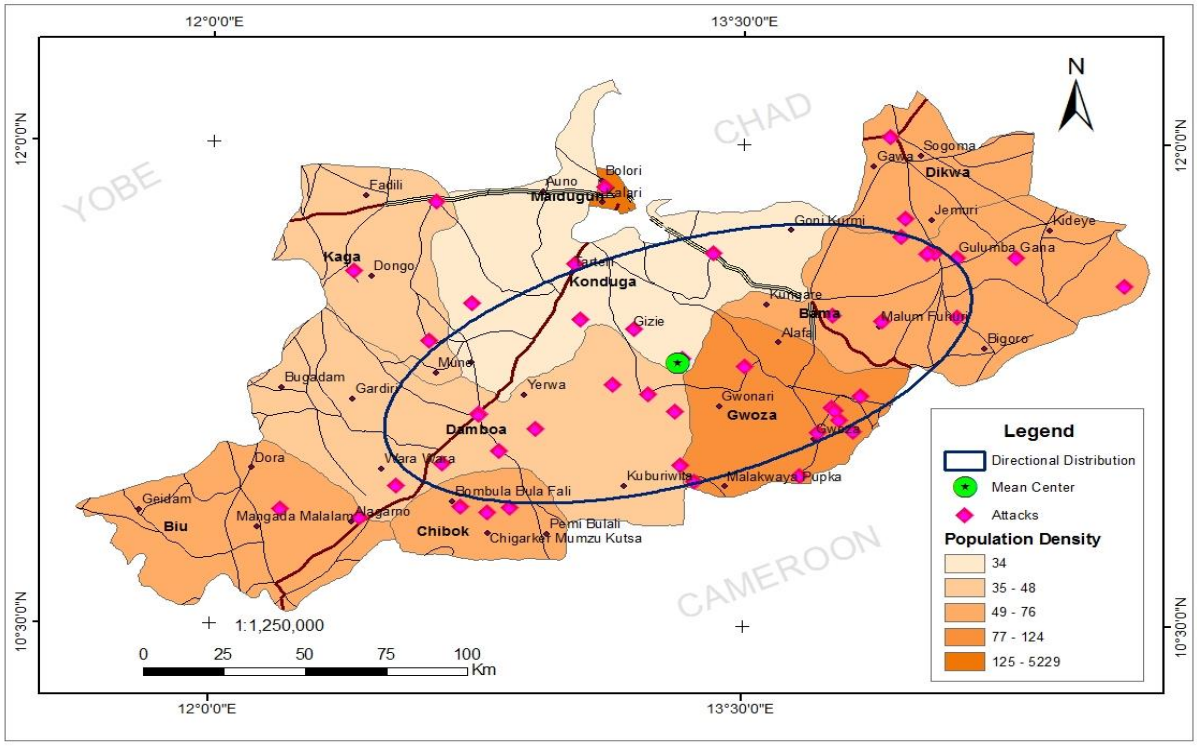

Figure 9. Directional Distribution of Terrorist Attacks in the Study Area

3.3 Hotspot of Terrorist Attacks

The hotspot analysis determines areas that statistically significant to be considered as hotspot and coldspot. Hence, Gwoza and Bama local government area was determined as the hotspot of the terrorist attacks based on the intensity of attacks (fig 10). However, Gwoza has 99 % compared to Bama 95% confidence as a terrorist hotspot. All the remaining were not significant to considered either as cold or hot spot. Gwoza is a relatively large area and densely populated while Bama is largely and less densely populated. Both area that borders Cameron in the east which may account for the intense terrorist attacks in the area. Furthermore, their neighbours Dikwa, Konduga and Damboa have also experienced intense terrorist attacks. Studies by (20) reported that terrorism hotspots are predominately occur in large metropolitan areas. With the identification of Gwoza and Bama as a terrorist hotspots, contingency strategies targeted at eliminating the activities of insurgents in the area should be deployed immediately.

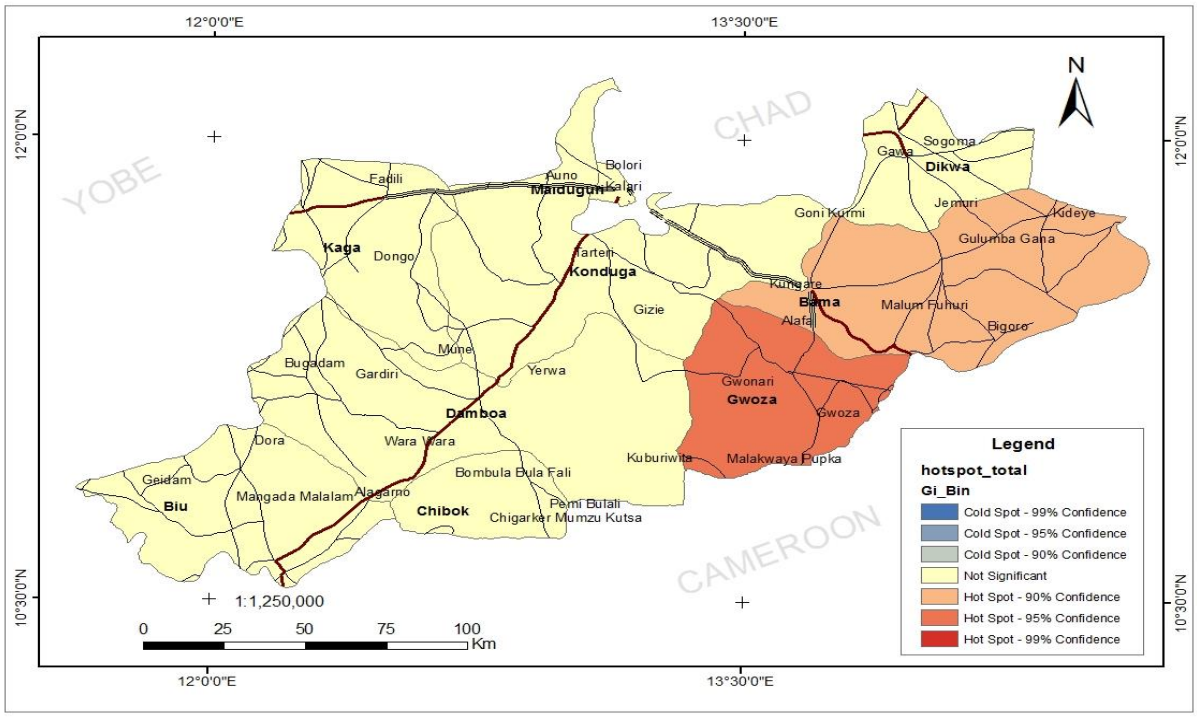

Figure 10. Hotspot of Terrorist Attacks in the Study Area

IV.CONCLUSION

This study examined the spatial distribution of terrorist attacks in selected local government areas in Borno state, Nigeria from 2010 to 2015. Geo-statistical information generated from terrorist attacks data reveal that the mean center of terrorist attacks was located in Goneri, Damboa local government area. Hence, response and relief center can be established in area to service other areas in the region. The distribution pattern of the attacks is clustered with most of the attacks concentrated in Damboa, Gwoza and Maiduguri, the administrative capital of the state. These attacks originate from the borders areas in east towards the areas in south and state capital. Consequently, a high number of fatalities and even higher number of IDPs has been recorded in the region. The geographical representation of attacks, fatalities and IDPs provide vivid information on locations which will be valuable for decision and policy makers charged with managing the terrorist menace. The location of the terrorist hotspot areas identified as Gwoza and Bama confirmed the linear and transnational movement of the terrorists. Therefore, effectively counter terrorist measures and transnational collaboration should be embarked upon to curtail the terrorist activities in the region.

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