



## Articles

### Using Casualty Assessment and Weighted Hit Rates to Calibrate Spatial Patterns of Boko Haram Insurgency for Emergency Response Preparedness

by Adegbola Ojo and Patrick Oseloka Ezepue



This work is licensed under a [Creative Commons Attribution 3.0 License](https://creativecommons.org/licenses/by/3.0/).

#### Abstract

*Since the beginning of the current millennium, Boko Haram has terrorised the residents of Northern Nigeria with devastating and high profile campaigns resuming in 2010. First responders struggle to cope with planning for and responding to the aftermath of these attacks. This paper describes analysis that can help emergency services pre-empt the geography and magnitude of susceptibility to attacks and the potential of the terrorists to generate severe attacks. The data used for the study were five years of terrorist activities. Results suggest that the efficiency of Boko Haram is not necessarily random and that attacks are generally well calculated to hit communities with disproportionate concentrations of vulnerable residents. The analysis is the first attempt to examine how a spatial segmentation framework might offer insight and intelligence towards understanding the configuration of terrorism for operational response.*

**Keywords:** Nigeria; Insurgency; Terrorism; Boko Haram; Geodemographics, Spatial Analysis; Emergency Response.

#### Introduction

The global terrorism and counter-terrorism landscape have been transformed in a number of fundamental ways since the Islamic terrorist group al-Qaeda launched coordinated attacks on the United States on September 11, 2001. There is a noticeable spike in terror incidents driven by blurred lines of command and control (Tucker, 2008; Githens-Mazer and Lambert, 2010). Similarly, some of the motivations for terror remain politically vague. Others are characterised by various forms of religious or mystical impetus (Rausch, 2015). Additionally, terrorists have become highly skilled in the use of cyber-space and manipulative media platforms (Chuiipka, 2016).

Whilst a lot of lessons have been learned about the origins, motivations and evolution of terrorist groups, new terror cell units continue to spring up (Englund and Stohl, 2016; Benedikter and Ouedraogo, 2017) and the foot soldiers of these groups are burgeoning. The capability of terrorist groups to recruit locally and across borders continues to present a challenge for efficient and effective counter-terrorism strategies. Several authors (Romagnoli, 2016; Falk, 2016; Gillombardo, 2016; Jenkins, 2017) agree that almost two decades since 9/11, not only do the perpetrators still exhibit the intent and capability to launch similar attacks, they have succeeded in motivating the emergence of other groups operating in new geographical enclaves.

Since 2002, Boko Haram has operated primarily in the North East Geopolitical Zone of Nigeria, killing and



maiming thousands of innocent victims. The ideological orientation of Boko Haram is underpinned by Salafi jihadism which is based on a belief in “physical” jihadism and the Salafi movement of returning to what adherents believe to be true Sunni Islam (Cook, 2011).

In 2009, Boko Haram was violently suppressed by the Nigerian Army (Aghedo and Osumah, 2014) under the order of late President Umaru Musa Yar'Adua. However, members of the terrorist organisation regrouped and re-surfaced in 2010 with high-profile attacks across the three geopolitical zones in Northern Nigeria. The global periscope focused on Boko Haram after the acclaimed kidnapping of 276 school girls from their dormitory in the town of Chibok in 2014 (Attah, 2016; Chiluwa and Ifukor, 2015). Some authors and stakeholders suggest that the 276 figure over-estimates the number of girls kidnapped from Chibok (Abubakar, 2015; Alter, 2015).

Since its re-emergence in 2010, Boko Haram has consistently featured amongst the deadliest terrorist organisations on the globe (Ligon et al., 2017). There are multiple dynamics which contribute towards shaping Nigeria's socio-political landscape in ways that have facilitated the rise of a group like Boko Haram. Persisting inequalities have contributed towards the polarisation of Nigeria, creating a north-south socio-economic divide. Northern Nigeria consistently lags behind the south on virtually all core development indices like educational attainment and social mobility (Cook, 2011; Aghedo and Osumah, 2014). There are many interlocking factors responsible for this yawning gap, ranging from political and leadership deficit to cultural and religious issues. Additional Nigerian dynamics which facilitate the rise of a group like Boko Haram include pervasive public sector corruption, recurring ethnic and sectarian conflicts, porous international borders, and a depleted intelligence and national security skeleton (Cook, 2011). These dynamics combine to erode national ambition and social capital and often result in disillusionment amongst the citizenry (Kieghe, 2016). Disillusioned population groups serve as easy prey for a group like Boko Haram which is constantly in search for potential recruits (Onuoha, 2014).

The remainder of this article details the examination of spatial structure and some contextual correlates of Boko Haram attacks in Nigeria from 2010 to 2015. A spatial segmentation framework is used to exhume patterns which may be operationally beneficial for first responders or the security personnel combating the terrorists. This analysis makes a modest contribution towards a better understanding of the insurgency problem facing Northern Nigerians. Additionally, the methodological framework of the analysis has the potential to serve as a basis for intelligent forecasting of future attacks.

### ***Some Challenges Confronting Emergency Response Management in Nigeria***

Nigeria's emergency response framework mirrors the administrative geography of the country. The National Emergency Management Authority (NEMA) has lead responsibility for coordinating emergencies and disasters at the federal level (Fagbemi, 2011). Each of Nigeria's 36 states have also been mandated by Nigeria's central government to establish State Emergency Management Agencies (SEMAs) and Local Emergency Management Agencies (LEMAs) (NEMA, 2010). The core rationale behind this hierarchical structure is the need to avoid duplication of efforts. The three emergency management authorities are responsible for developing capabilities to prepare, prevent, respond to, and recover citizens from emergencies and disasters (NEMA, 2010). In addition to the three levels of emergency management authorities, the military, police and para-military forces are also key players within Nigeria's emergency management system.

A range of multi-faceted factors contribute towards Nigeria's challenges to readily and rapidly respond to the insurgency in the northern part of the country, particularly at the local level. Some of these factors include



military funding inadequacies (Ajayi and Nwogwugwu, 2014), incompatibility of emergency management structures at the local, state and federal levels of government (Pichette, 2015), weakness in data infrastructure and analytical competences (Pérouse de Montclos, 2016), inadequacy of public education mechanisms (Awofeso et al., 2003), lack of collaboration amongst relevant agencies (Agbibo and Maiangwa, 2014) and corruption (Kiege, 2016).

Nigeria comprises 774 Local Government Areas (LGAs). Due to inconsistent funding and technical weaknesses, Vulnerability and Capability Analysis (VCA) have only been implemented in 21 of these LGAs (Fagbemi, 2011). Furthermore, the refusal of some Nigerian states to comply with the directive of the federal government to establish SEMAs remains lamentable. Whilst the NEMA Act stipulates that NEMA should liaise with State Emergency Management Committees, to assess and monitor the distribution of relief materials to disaster victims, only 25 out of 36 states have functional SEMAs (Nnodim, 2016). Some of the states without functional SEMAs are situated in northern Nigeria where Boko Haram insurgency is currently concentrated.

Whilst a substantial number of scholarly contributions have been made towards aspects of the dynamics of the insurgency in the northern part of Nigeria, these have focused largely on theoretical and policy debates. There is significant paucity in the use of empirical techniques for understanding patterns and dimensions of the conflict for operational decision-making. Currently, NEMA and SEMA find it challenging to optimise the speed and volume of critical assistance delivery immediately after the onset of insurgency attacks. This is partly due to methodological constraints in systematically pre-empting where insurgents might strike and estimating the probable scale of humanitarian assistance that different types of communities might require (Valenti, 2015). Additionally, international humanitarian organisations have called for improvement in modelling and visualisation of at-risk communities. Christian Aid<sup>1</sup> recommends the development of early warning and early response systems with predictive capabilities alongside training provision (Christian Aid, 2016). It is believed that some methodological aspects of the research study summarised in this article may prove useful for such early warning response systems.

### ***Potential of Utilising Spatial Segmentation Profiling for Emergency Response Preparedness***

Geographical Information Systems (GIS) add considerable context to spatial decision making. Geodemographic classifications are spatial segmentations that use multi-criteria and geo-statistical techniques to group places and people into clusters of similarity (Harris et al., 2005). There is a significant amount of interest in the development and adaptation of geodemographic problem-solving approaches across much of the developed world (Vickers and Rees, 2006; Willis et al., 2010; Kimura et al., 2011; Singleton and Spielman, 2014) with minimal application in developing countries (Ojo and Ezepe, 2011; Ojo et al., 2012; Ojo et al., 2013).

Geodemographic modelling of the social, economic and demographic conditions of small areas within the framework of GIS has been used successfully for a wide range of human development sectors such as education and health (Brown, et al., 1999; Webber, 2005; Farr and Evans, 2005; Shelton et al., 2006, Abbas et al., 2009; Singleton, 2010; Singleton et al., 2012; Goodwin and Sykes, 2012; Sabater, 2015; Leventhal, 2016). Applications to the profiling of traditional criminogenic activities is also common (Ashby and Longley, 2005; Breetzke and Horn, 2009). However, the potential of geodemographic profiling remains under-exploited in studying insurgency and terrorism. It has been suggested that geodemographic segmentations may be used

<sup>1</sup> Christian Aid is a UK registered charity that provides urgent practical and effective assistance where need is great, tackling the effects of poverty as well as its root causes.



to offer a strategic review of neighbourhoods and to identify potential terrorist cells (Ashby et al., 2008). To the best of our knowledge there is no evidence in academic and policy literature, of the application of geodemographic segmentation for profiling and mapping terrorism.

Geodemographic segmentations are generally developed by adapting clustering algorithms to relatively big multivariate spatial datasets (Ojo et al., 2012). This allows small areas to be grouped on the basis of their similarity in taxonomic space. A key reason for doing this is that there may be links identified with the classification of these small areas and other processes such as insurgency and terrorism. For example, spatial segmentations have been found useful in predicting educational behaviour (Brundson et al., 2011) as well as health dynamics (Kimura et al., 2011). In a similar vein, it is presumed that spatial segmentations could be used as a basis for identifying those community groups that may be more exposed to terrorists' activities or where terrorist attacks are likely to yield disproportionately higher degrees of casualties. Such detailed level of insight can be particularly powerful for first responders.

Geodemographic segmentations serve as useful analytical tools for drilling down to local analytical scales of geography. This helps to eliminate bias in the geographical disbursement of national operational resources and responses to conflict and chaos zones. There is strong evidence of the potent power of social sorting tools for targeting and monitoring the impact of security interventions (Lyon, 2007). Additionally, spatial segmentations have been used by Regional, State and Local Authorities to drive national social marketing agendas (Powell, et al., 2007). This can be particularly useful when trying to educate local populations about the drivers of tensions in fragile communities.

Detailed pen-portraits of characteristics of local residents often accompany geodemographic segmentations. Therefore, linking terrorism data with spatial segmentation yields more powerful insight beyond pointing out the locations of these terror incidents. Such data linkage helps to elucidate (in qualitative terms) some of the information underlying complex quantitative detail. Due to their multivariate quality, geodemographic segmentations offer the opportunity to develop new hypothesis about dynamic activities (Abbas et al., 2009).

Although the availability of geodemographics is not yet widespread across Africa (Ojo and Ezepue, 2011), relevant statutory emergency response agencies in Nigeria can access an open-source geodemographic system (Ojo et al., 2012). Similarly, rapid global digital revolution has led to the development of several open-source Geographical Information Systems (GIS) (Travis, 2015). These non-commercial software packages are freely accessible to first responders in Nigeria. However, these statutory agencies often lack the requisite methodological and technical know-how required to effectively utilise some of these systems (Ojo and Ezepue, 2011).

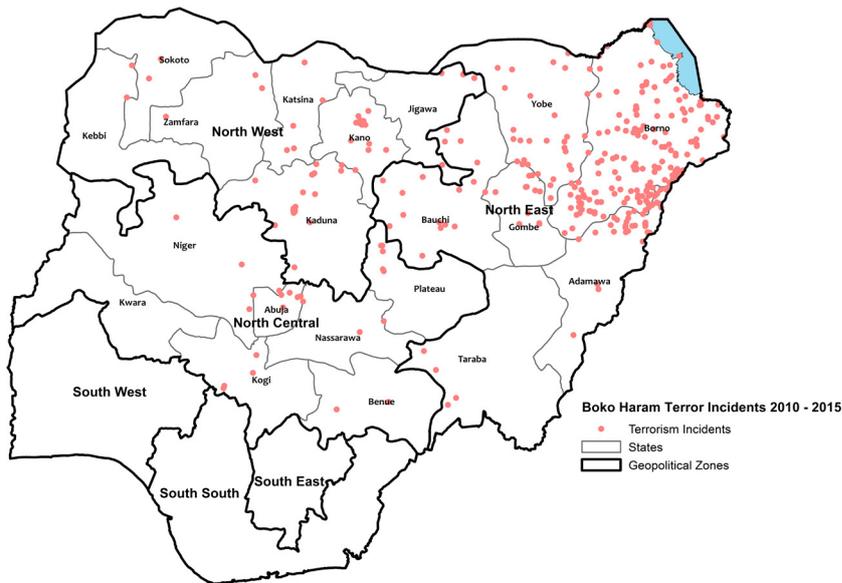
## **Datasets**

Two datasets were used in synergy for the study reported in this article. The first is the Armed Conflict Location and Event Data (ACLED). The ACLED is one of the most comprehensive public collection of political violence and protest data for developing countries including Nigeria. The dataset contains variables which capture information on the specific dates and locations of political violence and protest, the types of event, the groups involved, fatalities, and changes in territorial control (Raleigh et al., 2010). Additional variables within the dataset record the battles, killings, riots, and recruitment activities of rebels, governments, militias, armed groups, protesters and civilians.

For the purpose of the analysis reported in this article, 1,664 unique terrorist events linked to Boko Haram



between 2010 and 2015 were extracted from the ACLED repository after consulting the relevant codebook (Raleigh and Dowd, 2017). The spatial distribution of the extracted data is shown Figure 1. A large number of terror strikes were concentrated in the North East Geopolitical Zone.



*Figure 1: Distribution of Boko Haram Terror Incidents (2010 – 2015)*

The second dataset – The Nigerian LGA Geodemographic Classification System (NIGECS) serves as the framework for capturing the contextual characteristics of the areal targets of the terrorists. The geodemographic segmentation encapsulates variables derived from the Nigerian Census and other national surveys (Ojo et al., 2012).

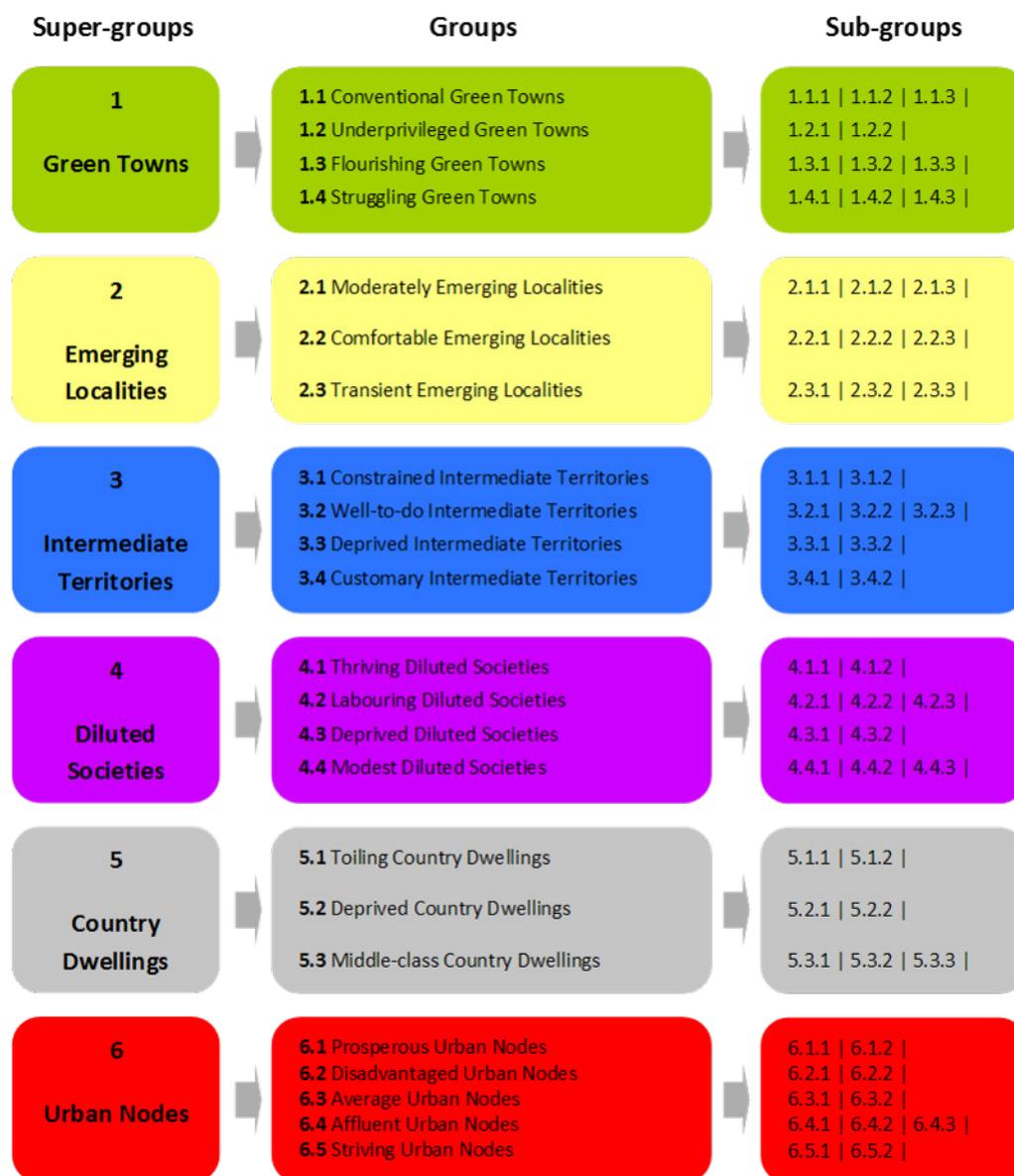


Figure 2: Hierarchical Structure of the Nigerian Geodemographic Classification System

Almost 35,000 data points spread across 10 thematic domains were fused together using a multicriteria clustering procedure (Ojo et al., 2012; Ojo, 2010). The data domains include Agriculture, Demographics, Education, Employment, Health, Household Composition, Household Infrastructure, Housing, Socio-economics and Women and Children. The clustering procedure generated six clusters called Super-groups. Two further hierarchies – Groups (23 clusters) and Sub-groups (57 clusters) were also created using the same clustering criterion. All 774 Local Government Areas (LGAs) in Nigeria were assigned to a corresponding Super-group, Group and Sub-group cluster based on the prevailing characteristics of the resident population. Figure 2 shows the hierarchical structure of the entire system whilst Figure 3 showcases the spatial distribution of the geodemographic clusters at the Group level. It is noteworthy that three area types do not exist in northern Nigeria. These include Underprivileged Green Towns, Deprived Intermediate Territories and Customary Intermediate Territories.

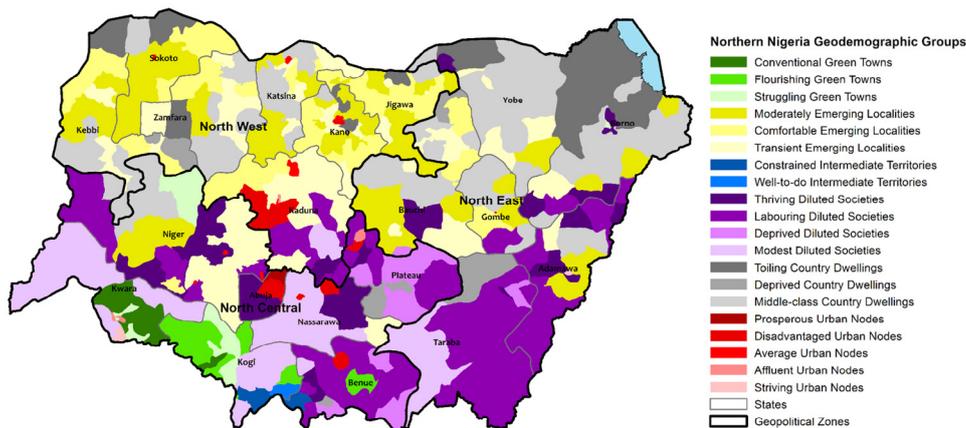


Figure 3: Geodemographic Segments of Northern Nigeria

Green Towns concentrate mostly in the South Western corner of Nigeria and can also be found in the North Central, South South, South East and North East Geopolitical Zones. Other variables such as desertification however affects the spatial spread of Green town concentration in the North East (Ojo, 2010). Unlike the southern geopolitical zones, these areas do not have huge spatial availability of Green towns due to the fast encroaching Saharan desert.

With large concentrations in the North West and pockets of the North East and North Central zones, Emerging Localities encapsulate 166 LGAs. While population density is below the national average (452 persons per Km<sup>2</sup>), the mean household size of these areas is quite high at 6.1 persons.

A majority of Intermediate Territories can be found within the South East. They are also scattered across the South South and some areas of the North Central Geopolitical Zones. With a mean household size of 4.6 persons, they make up 114 LGAs and have an above average mean population density of 709 persons per square kilometre (Ojo, 2010).

While Diluted Societies concentrate in the North Central Area of Nigeria, they can also be found in every other geopolitical zone. They make up 126 LGAs and have the highest mean household size of 5.4 persons. Their average population density is 643 persons per square kilometre.

Country Dwellings spread across the North East and North Western parts of Nigeria. They can also be found in the North Central Geopolitical Zone and they make up a total of 82 LGAs. These area types have a mean household size of 5.1 persons and an average population density of 144 persons per square kilometre.

With a mean household size of 4.6 persons and a very high population density of 5117 persons per square kilometre, Urban Nodes are scattered across the country and do not necessarily concentrate in any geopolitical zone. However, the North East has the lowest share of Urban Nodes (Ojo, 2010).

### **Operational Question and Methodology**

The study reported in this article sought to arouse some possible hypotheses about the rationale for the patterns of Boko Haram attacks. More importantly, the analysis generates some explanations for the following prominent operational question which continues to puzzle first responders and similar law enforcement agencies in Nigeria's northern region.



**Research Question:** What is the spatial configuration and contextual descriptors of communities that are likely to suffer severe attacks and those that are expected to be susceptible to insurgency activities?

The theoretical foundation of this study is the rational choice theory (Cornish and Clarke, 1986). Terrorism is considered a type of crime, therefore it is assumed that the decision-making protocol of terrorists and criminals are generally similar (Clarke and Newman, 2006). Terrorist attacks are not random because the perpetrators have finite resources often deployed within the boundaries of a risk-reward calculus. In general, attacks are launched when the perceived reward exceeds the perceived risk (Pape, 2003). Conversely it is arguable that they can decide to launch attacks even though perceived risks outweigh rewards like attacking a fully functional military formation/barracks. This type of assault will make the news and project them as brave and daring. The fundamental conjecture is that terrorists consider the level of attractiveness of all potential targets before they strike. This implies that not all targets are equally eye-catching to terrorists. Secondly, terrorists do not have a monopoly of personnel and resources; therefore, they plan their attacks within the boundaries of these constraints.

There is an assumption that terrorists generally have a pre-determined level of carnage which they intend causing when they launch attacks (Jackson and Frelinger, 2009). The level of carnage will also vary from one location to another.

A total of 22,429 fatalities were recorded in the dataset harvested from the ACLED repository (Raleigh and Dowd, 2017). To model aggregated severity of attacks, all unique terrorist fatalities resulting from Boko Haram activities were geo-coded and linked to their corresponding geodemographic typologies. Two metrics were initially calculated – (1) the prevalence rate of fatalities (Aggregated fatalities per 100,000 inhabitants) and (2) the incidence rate (Aggregated fatalities per terrorist attack). Casualty Assessment Matrices (CAMs) were subsequently developed by comparing the two metrics. This was achieved by standardising the prevalence and incidence rates using an inter-decile range standardisation approach. This method is a slight variation of Wallace and Denham (1996) range standardisation method. The range standardisation is calculated by comparing the minimum and maximum values of a distribution. However, the inter-decile range standardisation is calculated by relating the median, tenth and ninetieth percentiles of a distribution as shown in the notation given in Equation 1.

$$\frac{x_i - X_{med}}{X_{90th} - X_{10th}} \quad (1)$$

Where,

$x_i$  is the value of the variable to be standardised

$x_{med}$  is the median of the distribution

$x_{90th}$  is the 90<sup>th</sup> percentile

$x_{10th}$  is the 10<sup>th</sup> percentile

For an area to be deemed highly susceptible, Boko Haram must be efficient in the deployment of their activities in the area. There is no general consensus as to the most appropriate measure of geographical susceptibility in terrorism analysis. This analysis considered a measure to ascertain the efficiency of Boko Haram. The hit rate is the proportion of terrorist attacks that successfully lead to at least one fatality in each geodemographic cluster (Bowers et al., 2004). This quantity varies with the frequency of attacks. Those LGAs



with higher frequency of incidents yield lower hit rates relative to their counterparts with fewer incidents. To mitigate this drawback, a weighted hit rate (WHR) measure is used. This allows the model to factor in the relative effect of the frequency of incidents. The WHR is given by the notation in Equation 2.

$$WHR = \left(\frac{n}{N}\right) \times \frac{\left\{\frac{N_i}{\sum_{i=1}^k N_i}\right\}}{\left\{\frac{P_i}{\sum_{i=1}^k P_i}\right\}} \quad (2)$$

Where,

$n$  is the number of incidents resulting in fatalities

$N$  is the total number of incidents for the corresponding geodemographic typology

$k$  is the total number of area typologies

$P$  is the total population in each area typology

The efficiency of Boko Haram terrorists is gauged by the density of fatal incidents. The WHR is interpreted as the quotient between the efficiency rate of Boko Haram in each geodemographic typology and the relative likelihood for an attack to occur in that typology.

### ***Severity and Susceptibility to Attacks***

Results from the analysis of prevalence and incidence by geodemographic typologies are presented in Table 1. Not all 23 geodemographic groups shown in Figure 2 were used because some area typologies cannot be found in the north of Nigeria. Therefore, sixteen group level typologies with reported fatalities were chosen. With regard to the results in Table 1, fatalities are excessively widespread within two types of groups – Struggling Green Towns and Toiling Country Dwelling.


**Table 1: Aggregated Prevalence and Incidence Rates of Fatality by Geodemographic Groups (2010 – 2015)**

Group Codes	Geodemographic Groups	Incidents Share (%)	Fatalities Share (%)	Population Share (%)	Prevalence Rate (Fatalities per 100,000 Inhabitants)	Incidence Rate (Fatalities per Terrorist Attack)
1.1	Conventional Green Towns	0.06	0.08	0.97	2.31	19
1.3	Flourishing Green Towns	0.36	0.08	2.73	0.77	3
1.4	Struggling Green Towns	20.01	14.56	1.95	196.7	10
2.1	Moderately Emerging Localities	11.54	12.39	16.16	20.18	14
2.2	Comfortable Emerging Localities	1.44	1.72	10.92	4.15	16
2.3	Transient Emerging Localities	8.65	6.49	14.11	12.11	10
4.1	Thriving Diluted Societies	6.13	5.04	6.55	20.25	11
4.2	Labouring Diluted Societies	8.77	8.03	10.43	20.25	12
4.4	Modest Diluted Societies	0.30	0.21	5.07	1.07	9
5.1	Toiling Country Dwellings	12.56	24.89	4.64	141.08	27
5.2	Deprived Country Dwellings	0.06	0.04	1.42	0.66	8
5.3	Middle-class Country Dwellings	20.79	19.95	12.57	41.77	13
6.1	Prosperous Urban Nodes	1.32	0.71	0.43	43.56	7
6.2	Disadvantaged Urban Nodes	0.24	0.4	3.47	3.04	23
6.3	Average Urban Nodes	6.61	4.01	6.73	15.7	8
6.4	Affluent Urban Nodes	1.14	1.4	1.87	19.79	17

Struggling Green Towns are areas dominated by people in older age categories with high levels of population density. These areas are also more likely to have higher than average concentration of widowed and vulnerable population groups.

Toiling Country Dwellings are also disproportionately disadvantaged in terms of their likelihood of suffering huge numbers of casualty when Boko Haram strikes. In Northern Nigeria, Borno State has the largest number of LGAs categorised as Toiling Country Dwellings. There are average level representations of children. Single parent households are not much but there is an above average presence of separated couples (Ojo, 2010). Toiling Country Dwellings also exhibit the highest level of frequency of fatalities (incidence).

Incidence rates are also quite high within Disadvantaged Urban Nodes. These are areas with an above average representation of people aged between 15 and 59 years. Unmarried persons are substantially representative within these areas. Households with at least one pensioner are also disproportionately high. It is also not uncommon to find households of over 5 residents (Ojo, 2010).

The significantly high prevalence rates of fatality suffered by residents of Struggling Green Towns and Toiling Country Dwellings is somewhat linked to the repeated volume of attacks experienced in these areas. Together, both geodemographic clusters account for a third of all attacks. However, one of the highlights of the analysis is that it exposes high fatality rates (44 fatalities per 100,000 people) within Prosperous Urban Nodes where the frequency of attacks is quite low. The findings suggest well-calculated attacks in areas with disproportionately high representations of unmarried middle aged persons. Large numbers of pensioner households and single parents can also be found in these areas.

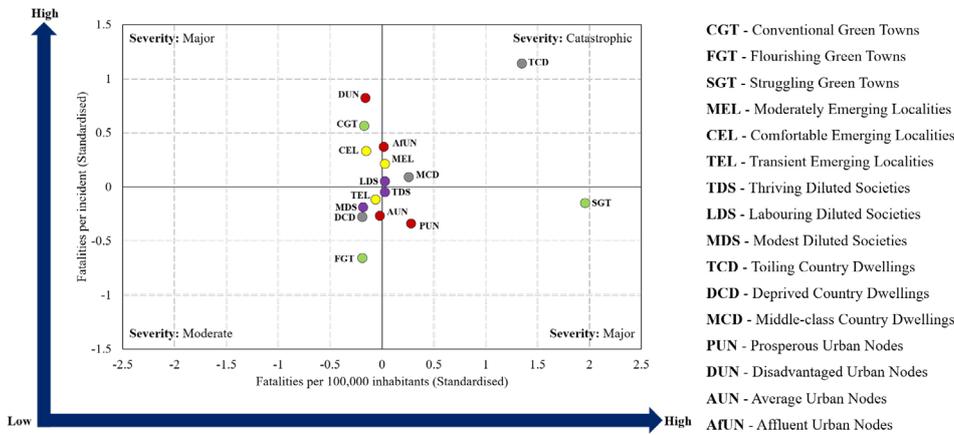


Figure 4: Casualty Assessment Matrix

The Casualty Assessment Matrix (CAM) is essentially a scatter plot of the standardised prevalence and incidence rates. Results are shown in Figure 4. For the assessment of severity, both prevalence and incidence rates are considered equally important. Therefore, neither was prioritised over the other. Prevalence is descriptive, often demonstrating need. On the other hand, incidence is useful for studying the underlying causes or examining the order in which events occur. Those geodemographic groups with higher than average levels of both prevalence and incidence of fatalities are designated catastrophic in terms of the expected levels of severity of the situation. Areas where the levels of severity are expected to be major are characterised by high prevalence with low incidence or low prevalence with high incidence. Moderate levels of severity combine low prevalence with low incidence rates.

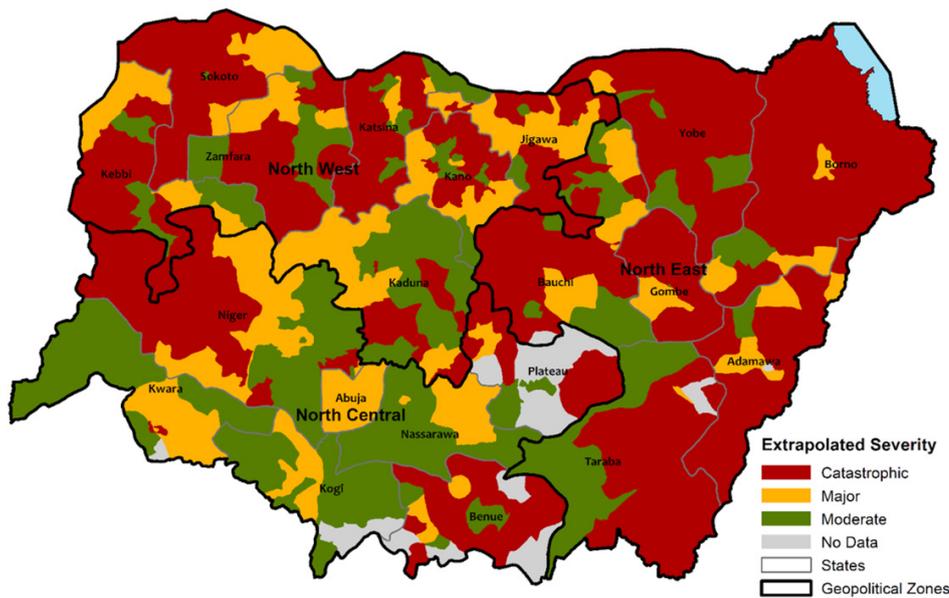


Figure 5: Potential to Generate Catastrophic, Major and Moderate Attacks

On the basis of outputs from the analysis, Figure 5 highlights those areas where insurgents have the potential to generate catastrophic, major or moderate levels of severity when they attack. These spatial divisions are an



extrapolation of the CAM analysis of the geodemographic groups. The map demonstrates the usefulness of this approach for emergency response planning for instance, in a fragile security zone. By highlighting those areas with a high predisposition for fatalities, the results could assist both policy and sensitisation efforts in these areas. Results show that Toiling Country Dwellings exhibit traits that make these area types the most vulnerable to catastrophic levels of severity.

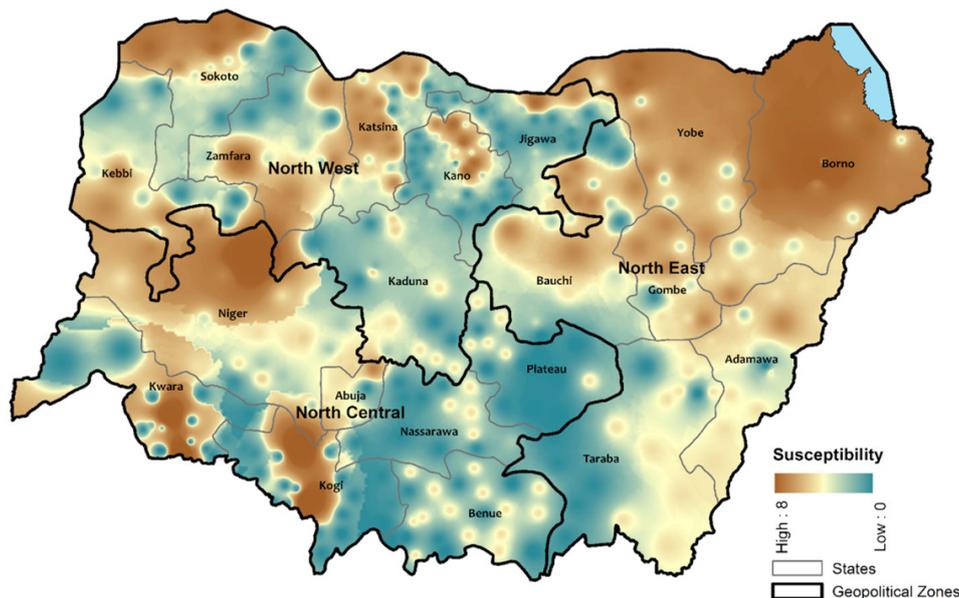


Figure 6: Geography and Magnitude of Susceptibility to Boko Haram Attacks

Figure 6 shows a heat map of the quotient between the efficiency rate of Boko Haram in each geodemographic typology and the relative likelihood for an attack to occur in that typology. The susceptibility modelling results suggest that areas that are highly susceptible to Boko Haram attacks are characterised by people in older age categories. Though households of 1 to 2 persons are very common, the population density in such areas are much higher than average. Again, these areas have a large concentration of widowed population groups. The findings from this analysis suggest that these types of communities (Struggling Green Towns), which includes the capital of Borno State, are 8 times more susceptible to Boko Haram activities. Toiling Country Dwellings which are next in the queue in terms of susceptibility are only twice as vulnerable. These areas exhibit literacy rates that are below the national average with high incidence of uneducated household heads. General access to primary school is low and there are low rates of secondary school completion. Our results reveal marked inequalities in terms of susceptibility to attacks.

### ***Some Implications for Security Evaluation and Emergency Response***

The authors clarify how the spatial patterns illustrated may be used by local, state, and federal emergency response agencies to effectively respond to Boko Haram attacks. The arguments are generally hermeneutic since the research findings should be construed in light of additional knowledge in the agencies which lie outside the scope of the paper.

The focus of the security and emergency response agencies should be to combine the evidence base detailed in this paper with additional covert information for the purpose of smarter decision-making. The weighted hit rate of the attacks modelled in Equation 2, intuitively provides a comparative measure of the relative expected levels of fatalities across different communities, normed by prevalence rates and base populations.



This information and related measures are conveyed visually in figures 1-6 in the paper. The results show how terrorist activities are differentially spatially concentrated in different Northern states, with higher activities in Yobe, Borno, Kano, Gombe, Bauchi, and North Eastern Adamawa states, compared to the sparsely-distributed occurrences in North Western states (Kebbi and Sokoto) and North Central states (Niger, Taraba, Kaduna), and the Abuja FCT. It seems that the closeness to Sokoto, which is the seat of the Islamic Caliphate in Northern Nigeria (Enwerem, 1995) may be associated with less intensity, possibly complete absence of the attacks in these geographic areas, compared to the North-Eastern states. This insight requires an understanding of the differences in containment strategies in the different states and geo-political regions, and importantly the impact of different Muslim sects on the patterns and severities of attacks.

Results from this analysis further suggest that attacks in major cities like Kano, Kaduna, and Abuja may be connected to a strategy of causing more visible impacts on the part of the terrorists. These insights again need to inform the nature of emergency response especially at the federal level.

Overall, the evidence base should be used to strengthen the awareness of the importance of geodemographic analysis in security analysis and responses on the parts of the local, state and federal emergency response agencies. Again, the insights need to be combined with what is already known by these agencies regarding the case stories of victims and their families, and how their experiences differ by their socio-economic backgrounds.

## **Conclusion**

Sadly, coping with increased terrorist activities and threats have become a part of the daily lives of Northern Nigerian. Whilst public safety and increased policing and military presence is paramount, it is integral for the decision-making process of armed forces and emergency service providers to be underpinned by properly scrutinised evidence. The overwhelming response of the Nigerian governments has been to increase security in public spaces – and rightfully so. However, the analyses reported in this paper indicate that the terrorists are quite meticulous. Zones of susceptibility and severity of attacks correlate with the presence of vulnerable residents. The combination of a geodemographic framework with open data on terrorist activities helps to organise security analysis for first responders. Furthermore, results from this analysis can be used to facilitate information sharing and integration during emergency preparation and response. Arguably, this can help to stimulate better communication, increased situational awareness and analysis including agile decision making for more effective risk management and emergency response by statutory emergency response agencies.

## **Acknowledgement**

The authors would like to thank the anonymous reviewers for their comments and suggestions. This research was supported by a British Academy Skills Innovators grant - SK150054.

## **About the authors**

**Dr Adegbola Ojo** is a Senior Lecturer in Human Geography and Director of Teaching & Learning at the School of Geography, University of Lincoln.

**Dr Patrick Oseloka Ezepe** is the Director of Research and Enterprise Development at Worldhero 3E.



## References

- Abbas, J., Ojo, A. and Orange, S. (2009). Geodemographics–A Tool for Health Intelligence. *Public Health*, 123(1), 35-39.
- Abubakar, A. (2015). *Factsheet: How Many Schoolgirls did Boko Haram Abduct and How Many are Still Missing?* Africa Check. Available at: <https://africacheck.org/factsheets/factsheet-how-many-schoolgirls-did-boko-haram-abduct-and-how-many-are-still-missing/>.
- Agbibo, D.E. and Maiangwa, B. (2014). Nigeria United in Grief; Divided in Response: Religious Terrorism, Boko Haram, and the Dynamics of State Response. *African Journal on Conflict Resolution*, 14(1), 63-97.
- Aghedo, I. and Osumah, O. (2014). Bread, Not Bullets: Boko Haram and Insecurity Management in Northern Nigeria. *African Study Monographs*, 35(3&4), 205-229.
- Ajayi, F., and Nwogwugwu, N. (2014). *Boko Haram and the Crisis of Governance in Nigeria*. Available at: [http://paperroom.ipisa.org/app/webroot/papers/paper\\_31845.pdf](http://paperroom.ipisa.org/app/webroot/papers/paper_31845.pdf).
- Alter, C. (2015). *200 Girls Rescued From Boko Haram Camps Are Not the Chibok Schoolgirls*. *Time*. Available at: <http://time.com/3839035/nigeria-boko-haram-girls-rescue/>.
- Ashby, D. I. and Longley, P. A. (2005). Geocomputation, Geodemographics and Resource Allocation for Local Policing. *Transactions in GIS*, 9 (1), 53-72.
- Ashby, D. I., Chainey, S. and Longley, P. (2008). From Crime Analysis to Homeland Security: A Role for Neighbourhood Profiling. In D. Z. Sui (ed) (2008). *Geospatial Technologies and Homeland Security: Research Frontiers and Future Challenges*. Netherlands: Springer.
- Attah, C. E. (2016). Boko Haram and Sexual Terrorism: The Conspiracy of Silence of the Nigerian Anti-Terrorism Laws. *African Human Rights Law Journal*, 16(2), 385 – 406.
- Awofeso, N., Ritchie, J. and Degeling, P. (2003). The Almajiri Heritage and the Threat of Non-State Terrorism in Northern Nigeria: Lessons from Central Asia and Pakistan. *Studies in Conflict and Terrorism*, 26(4), 311-325.
- Benedikter, R. and Ouedraogo, I. (2017). *Violent Extremism Takes Root in Burkina Faso*. Foreign Affairs. Available at: <https://www.foreignaffairs.com/articles/burkina-faso/2017-04-25/violent-extremism-takes-root-burkina-faso?cid=int-lea&pgtype=hpg>
- Brunsdon, C., Singleton, A. D., Longley, P. A. and Ashby, D. (2011). Predicting Participation in Higher Education: A Comparative Evaluation of the Performance of Geodemographic Classifications. *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 174: 17-30
- Bowers, K. J., Johnson, S. D. and Pease, K. (2004). Prospective Hot-spotting: The Future of Crime Mapping? *British Journal of Criminology*, 44(5), 641–658.
- Breetzke, G. D. and Horn, A. C. (2009). A Geodemographic Profiler for High Offender Propensity Areas in the City of Tshwane, South Africa. *Environment and Planning A* 41(1), 112-127.



- Brown, P. J. B., Hirschfield, A. F. G., Merrall, S., Bowers, K. J., and Marsden, J. (1999). *Targeting Community Safety Projects: The Use of Geodemographics and GIS in the Identification of Priority Areas for Action*. 39th Congress of the European Regional Science Association, Dublin.
- Chiluwa, I. and Ifukor, P. (2015). War against our Children: Stance and Evaluation in #BringBackOurGirls Campaign Discourse on Twitter and Facebook. *Discourse and Society*, 26 (3), 267-296.
- Christian Aid (2016). *Christian Aid Humanitarian Response in North-East Nigeria: Reaching the Unreached*. Abuja: Christian Aid. Available at: <http://programme.christianaid.org.uk/programme-policy-practice/sites/default/files/2016-11/Christian-Aid-Humanitarian-Response-report-North-East-Nigeria-Aug-2016.pdf>.
- Chuijka, A. (2016). *The Strategies of Cyberterrorism: Is Cyberterrorism an Effective Means to Achieving the Goals of Terrorists?* Ottawa: Graduate School of Public Affairs. Available at: <https://ruor.uottawa.ca/bitstream/10393/35695/1/CHUIPKA%2C%20Adam%2020169.pdf>
- Clarke, R. V. and Newman, G. R. (2006). *Outsmarting the Terrorists*. Westport, CT: Praeger Security International.
- Cook, D. (2011). *Boko Haram: A Prognosis*. James Baker III Institute of Public Policy. Available at: <https://www.bakerinstitute.org/media/files/Research/535dcd14/REL-pub-CookBokoHaram-121611.pdf>.
- Cornish, D. and Clarke, R. V. (eds) (1986). *The Reasoning Criminal: Rationale Choice Perspective on Offending*. New York: Springer-Verlag.
- Englund, S. and Stohl, M. (2016). Violent Political Movements: Comparing the Shining Path to the Islamic State. *Perspectives on Terrorism*, 10(4), 21-31.
- Enwerem, I. M. (1995). *A Dangerous Awakening: The Politicization of Religion in Nigeria*. Ibadan: French Institute for Research in Africa.
- Fagbemi, Kayode. (2011). *Nigeria: National Progress Report on the Implementation of the Hyogo Framework for Action (2009-2011)*. Prevention Web. Available at: <http://www.preventionweb.net/english/hyogo/progress/reports/v.php?id=15560&pid=223>.
- Falk, R. (2016). Failures of Militarism in Countering Mega-Terrorism. *Perspectives on Terrorism*, 10(4), 51-61.
- Farr, M. and Evans, A. (2005). Identifying 'Unknown Diabetics' Using Geodemographics and Social Marketing. *Interactive Marketing*, 7(1), 47-58.
- Githens-Mazer, J. and Lambert, R. (2010). Why Conventional Wisdom on Radicalization Fails: The Persistence of a Failed Discourse. *International Affairs*, 86 (4), 889-901.
- Gillombardo, T.C. (2016). *Bush, Obama, and Terrorism: A New Framework for Analysing Threat Response Rhetoric*. Unpublished Thesis. Available at: [http://wescholar.wesleyan.edu/cgi/viewcontent.cgi?article=2553&context=etd\\_hon\\_theses](http://wescholar.wesleyan.edu/cgi/viewcontent.cgi?article=2553&context=etd_hon_theses).
- Goodwin, S. and Dykes, J. (2012). *Visualising Variations in Household Energy Consumption*. Poster presented at the IEEE Conference on Visual Analytics Science and Technology (VAST), 14-19 Oct 2012, Seattle, Washington, US.
- Harris, R., Sleight, P. and Webber, R. (2005). *Geodemographics, GIS and Neighbourhood Targeting*. Wiley: London.



- Jackson, B.A. and Frelinger, D.R. (2007). *Understanding Why Terrorist Operations Succeed or Fail*. RAND Corporation. Available at: [https://www.rand.org/content/dam/rand/pubs/occasional\\_papers/2009/RAND\\_OP257.pdf](https://www.rand.org/content/dam/rand/pubs/occasional_papers/2009/RAND_OP257.pdf).
- Jenkins, B.M. (2017). *Middle East Turmoil and the Continuing Terrorist Threat – Still No Easy Solutions*. RAND Corporation. Available at: [http://www.rand.org/content/dam/rand/pubs/testimonies/CT400/CT462/RAND\\_CT462.pdf](http://www.rand.org/content/dam/rand/pubs/testimonies/CT400/CT462/RAND_CT462.pdf).
- Kieghe, D. (2016): *National Ambition: Reconstructing Nigeria*. London: New Generation Publishing.
- Kimura, Y., Saito, R., Tsujimoto, Y., Ono, Y., Nakaya, T., Shobugawa, Y., Sasaki, A., Oguma, T. and Suzuki, H. (2011). Geodemographics Profiling of Influenza A and B Virus Infections in Community Neighborhoods in Japan. *BMC Infectious Diseases*, 11(36), 1-12.
- Leventhal, B. (2016). *Geodemographics for Marketers: Using Location Analysis for Research and Marketing*. London: Kogan Page Limited.
- Ligon, G., Logan, M., Hall, M., Derrick, D.C., Fuller, J. and Church, S. (2017). *The Jihadi Industry: Assessing the Organizational, Leadership, and Cyber Profiles*. Final report prepared for the Department of Homeland Science and Technology Directorate's Office of University Programs. College Park, MD: START.
- Lyon, D. (2007). Surveillance, Security and Social Sorting. *International Criminal Justice Review*, 17(3), 161 – 170.
- National Emergency Management Agency (NEMA). (2010). *National Disaster Management Framework (NDMF)*. Available at: [http://www.preventionweb.net/files/21708\\_nigherianationaldisastermanagementf.pdf](http://www.preventionweb.net/files/21708_nigherianationaldisastermanagementf.pdf)
- Nnodim, O. (2016). *No Emergency Management Agencies in 11 States – NEMA*. Punch Online. Available at: <<http://punchng.com/no-emergency-management-agencies-11-states-nema/>>
- Ojo, A. (2010). *Geodemographic Classification Systems for the Developing World: The Case of Nigeria and the Philippines*. PhD. University of Sheffield.
- Ojo, A. and Ezepue, P. O. (2011). How Developing Countries Can Derive Value from the Principles and Practice of Geodemographics, and Provide Fresh Solutions to Millennium Development Challenges. *Journal of Geography and Regional Planning*, 4(9), 505-512.
- Ojo, A., Vickers, D. and Ballas, D. (2012). The Segmentation of Local Government Areas: Creating a New Geography of Nigeria. *Applied Spatial Analysis and Policy*, 5(1), 25-49.
- Onuoha, F. C. (2014). *Why Do Youth Join Boko Haram?* United States Institute of Peace, Special Report 348: 6. Available at: [https://www.usip.org/sites/default/files/SR348-Why\\_do\\_Youth\\_Join\\_Boko\\_Haram.pdf](https://www.usip.org/sites/default/files/SR348-Why_do_Youth_Join_Boko_Haram.pdf)
- Pape, R. A. (2003). The Strategic Logic of Suicide Terrorism. *American Political Science Review*, 97(3), 1–19.
- Pérouse de Montclos, M. (2016). Arguments for a Qualitative and Quantitative Analysis of Violence in Nigeria. In: M. Marc-Antoine, Ed. *Violence in Nigeria: A Qualitative and Quantitative Analysis*. Leiden: African Studies Centre.
- Pichette, A. (2015). *The Rise of Boko Haram: An Analysis of Failed Governance*. Outstanding Gateway Papers. Paper 9. Available at: <http://digitalcommons.iwu.edu/gateway/9>.
- Powell, J., Tapp, A. and Sparkes, E. (2007). Social Marketing in Action: Geodemographics, Alcoholic Liver Disease and Heavy Episodic Drinking in Great Britain. *International Journal of Non-Profit & Voluntary Sector Marketing*, 12(3), 177-187.



- Raleigh, C. and Dowd, C. (2017). *Armed Conflict Location and Event Data Project (ACLED) Codebook 2017*. Available at: [http://www.acleddata.com/wp-content/uploads/2017/01/ACLED\\_Codebook\\_2017.pdf](http://www.acleddata.com/wp-content/uploads/2017/01/ACLED_Codebook_2017.pdf)
- Romagnoli, M. (2016). The Effects of Terrorism on Tourism: (Inter)relations, Motives & Risks. *Journal of Tourism, Culture and Territorial Development*, 7(5), 125-133.
- Raleigh, C., Linke, A., Hegre, H. and Karlsen, J. (2010). Introducing ACLED: An Armed Conflict Location and Event Dataset. *Journal of Peace Research*, 47(5), 651-660.
- Rausch, C.C. (2015). Fundamentalism and Terrorism. *Journal of Terrorism Research*. 6(2), 28-35.
- Sabater, A. (2015). Between Flows and Places: Using Geodemographics to Explore EU Migration Across Neighbourhoods in Britain. *European Journal of Population*, 31(2), 207-230.
- Shelton, N., Birkin, M.H., and Dorling, D. (2006). Where Not to Live: A Geo-Demographic Classification of Mortality for England and Wales, 1981-2000. *Health and Place*, 12 (4), 557-569.
- Singleton, A. D. (2010). The Geodemographics of Educational Progression and their Implications for Widening Participation in Higher Education. *Environment and Planning A*, 42(11), 2560-2580.
- Singleton, A. D., Wilson, A. G., and O'Brien, O. (2012). Geodemographics and Spatial Interaction: An Integrated Model for Higher Education. *Journal of Geographical Systems*, 14(2), 223-241.
- Singleton, A. D. and Spielman, S. E. (2014). The Past, Present and Future of Geodemographic Research in the United States and United Kingdom. *Professional Geographer*, 66(4), 558-567.
- Travis, C. B. (2015). *Abstract Machine: Humanities GIS*. Redlands: ESRI.
- Tucker, D. (2008). Terrorism, Networks, and Strategy: Why the Conventional Wisdom is Wrong. *Homeland Security Affairs* 4 (5). Available at: <https://www.hsaj.org/articles/122>.
- Valenti, A.D. (2015). *Estimating Populations at Risk in Data-Poor Environments: A Geographically Disaggregated Analysis of Boko Haram Terrorism 2009-2014*. Unpublished MSc. Thesis. University of Southern California.
- Vickers, D.W. and Rees, P.H. (2006). Introducing the National Classification of Census Output Areas. *Population Trends*, 125, 15-29.
- Wallace, M. and Denham, C. (1996). The ONS Classification of Local and Health Authorities of Great Britain. *Studies on Medical and Population Subjects*, ONS. Number 59.
- Willis, I., Gibin M., Barros J. and Webber R. J. (2010). Applying Neighbourhood Classification Systems to Natural Hazards: A Case Study of Mt. Vesuvius. *Natural Hazards*, 70(1), 1-22.
- Webber, R. (2005). *The 2005 British General Election Campaign: How Effectively did the Parties Apply Segmentation to their Direct Marketing strategies?* Paper Presented at the Joint seminar in ESRC/NERC/EPSRC Transdisciplinary Series and ESRC Research Methods Seminar Series, Centre for Advanced Spatial Analysis, London.