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Application of Participatory GIS in Crime Mapping of Ibadan North, Nigeria

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ABSTRACT

This paper demonstrates the application of Participatory Geographic Information System (PGIS) as a tool to present people's local spatial knowledge of crime in the form of 2-dimensional maps. This study adopted a survey research design employing both primary and secondary data sources. Primary data were collected through the administration of 96 copies of questionnaires, and a Web-based PGIS map served as a data collection instrument to collect spatial information on crime occurrences in the study area. Secondary data were sourced from journals, reports and the Nigerian Police Force. Results show that Mokola is a poor residential neighborhood occupied mainly by self-employed and low-income business merchants. It also reveals that Mokola experiences 689 percent more crime than would be expected, given the distribution of crime in the study area. Also, crime hotspots such as Roundabout junction, Dandaru hill, Darlington street were identified by participants aiding knowledge of the crime pattern in the study area. This study recommends natural surveillance as a concept of Crime Prevention through Environmental Design (CPTED) to keep potential offenders under easy observation. In conclusion, this study offers a vital link between the police and the general populace, one that has been absent in times past.

KEYWORDS

Crime; participatory GIS; urban growth; urban planning; urban surveillance

Introduction

Urbanization, urban growth and migration are related terms that explain the process of change in urban centers (Basorun 2006). Drawing from the description by Jrank (2010), urbanization is a multi-dimensional process- social, economic and territorial- which transforms social organizations including the role of the family, the demographic structures, nature of work and choices in human interaction. Social change is unavoidable and sometimes degenerates into disharmony, conflict and cultural dichotomy and other forms of crime (Chiabi 2009). Crime is one of the human security problems confronting humanity across the world (Aduloju, Adeniran, and Ageh 2018). By definition, Balogun, Okeke, and Chukwukere (2014, 1), defines crime as "an act or conduct that causes harm to the community, the commission which, by law, renders the person responsible to punishment by a fine, imprisonment or other penalties." Richard (2009), defines crime as a violation of the law and therefore, an act of deviance (*i.e.*, a rule-violation). From the viewpoints of Soh (2012), crime contributes to damage of property, a general increase in

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insurance claims on properties; health and life; higher workers compensation as well as private legal costs, among others. Increase in crime concentration in urban centers means that the level of exposure of urban dwellers to various property crimes and human assaults is higher hence they tend to consider the safety of life and properties as a critical determinant in choosing a dwelling. A crime-prone community disincentivizes both local and foreign investment as evident in various parts of Nigeria today.

Ibadan metropolis is one of the major cities in Nigeria under the siege of increasing crime. Also, the Nigerian police have not demonstrated sufficient intelligence in crime detection and prediction. Balogun, Okeke, and Chukwukere (2014, 2), explains that "Crime (what) is a spatial entity which has a geographical location (where) and a time (when) it was committed." Relevant information on crime such as "what" is "where," "where" is "what" and "when" can be acquired and stored using the Geographic Information System (Balogun, Okeke, and Chukwukere 2014), hence the role of Participatory Geographic Information System (PGIS). Fajemirokun *et al.* (2006) in a crime mapping study in Victoria Island, Lagos – one of the wealthiest neighborhoods in Nigeria, revealed that the Nigerian Police still employs the old and inefficient method of keeping and retrieving crime data.

Consequently, Fajemirokun *et al.* (2006) explained in the case of Victoria Island that with geospatial data, crime trends could be reliably represented for proper analysis. The forgoing shows the ineptitude of law enforcement officers in handling crime. This scenario is, however, not different from how crime is being controlled in Ibadan North LGA.

However, there exists a clear departure in approach to identifying various crime hotspots as PGIS is a new paradigm shift in crime mapping, which is reliant on the community's knowledge in ensuring safe urban centers. A deep understanding of the nature of crime in Mokola, Ibadan North LGA, Nigeria, using the participatory GIS technique will help in developing and recommending solutions that either serve as a proactive or a responsive measure to combat crime in the study area and Nigeria as a whole.

Study area

Covering a total area of 0.77 km^2, Mokola is located in Ibadan North Local Government Area between Latitude 3.89°N and 3.90°N and Longitude 7.40°E and 7.41°E (Figure 1). Ibadan North Local Government Area which is one of the eleven Local Government Areas (LGAs) making up the Ibadan metropolis is bounded on the west, east and north by Ibadan North West LGA, Ibadan North East LGA and, Lagelu L.G.A. and Akinyele LGA., respectively. Ibadan metropolis is the largest city in sub-Saharan Africa and the capital of Oyo State. Located in the core commercial area of Ibadan, Mokola is occupied by merchants that engage in business activities such as trading and printing. Mokola is occupied by agrarian Yoruba ethnic groups originating from Oyo, Oke-Ogun, Ibadan and Ibarapa areas all living in the core urban area of the town.

Conceptual framework

Over the years, the field of urban planning has joined the spheres of criminology, social work, urban anthropology or psychology who are traditionally and most associated with crime as an issue of an individual. By description, one can see crime from the perspective of Moser and McIlwaine (2004), as "an act (usually a grave offence) punishable by law." In other words, crime includes many illegal forms of violence. However, a spate of research has presented crime mapping as a way of geographically identifying areas under the influence of crime. According to Aydin (2006), maps are an abstraction of reality. Except with geospatial references, crime data are limited to information on incident type, address, offender and victim status. Crime mapping involves a systematic process used to identify crime hotspots spatially by various means of data

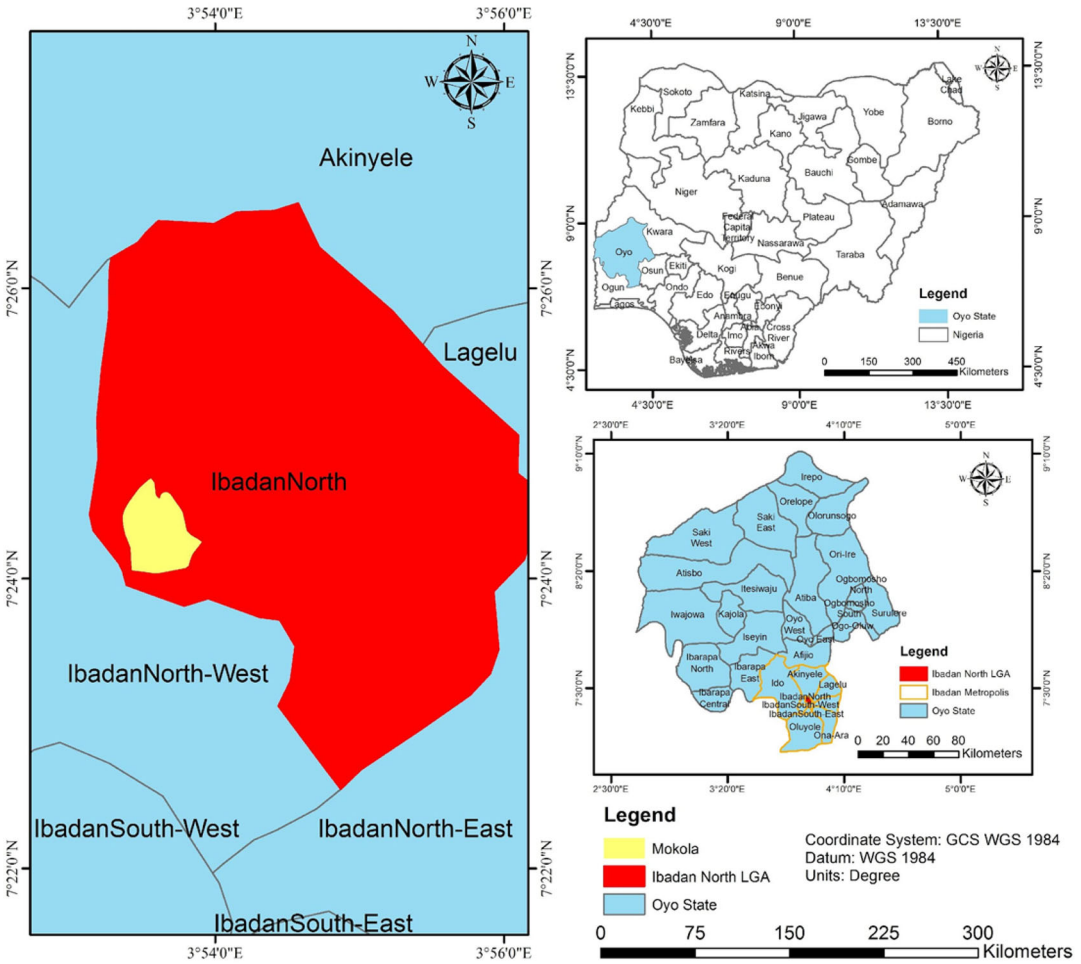


Figure 1. Study area.
Source: DIVA GIS (2017); Authors' Mapping, 2018.

collection. The Participatory Geographical Information Systems (PGIS) emerged during the 1990s as a result of the merger of the Participatory Rural Appraisal (PRA) and Geographical Information Systems (GIS). The emergence is rooted in the inability of the traditional GIS to answer emerging social and societal challenges such as crime (Weiner *et al.* 1995). PGIS uses geospatial information management tools to present people's local spatial knowledge in the form of 2- or 3-dimensional maps (International Institute for Environment and Development 2009). The application of participatory methods in crime mapping is anchored on the principle that people have a perfect understanding of where they reside, and valuable information can be gathered at the community level about crime-prone areas and various measures to address crime in these areas.

Residents have expertise in recognition of certain places which are prone to a specific type of crime, and the dissemination of this information to relevant policing agencies can be crucial in providing various solutions to crime problems. In essence, the application of PGIS in crime mapping presents an opportunity for communities to identify crime-prone areas in their neighborhood and to prioritize the places most in need of attention to developing various measures to serve as a response by identifying key players and responsibilities (Liebermann and Coulson

2004). However, the advent of PGIS offers a paradigm shift from the traditional crime mapping (mapping based on state data) to mapping based on perception (mapping based on data from local knowledge) of the people in the study area as crime generally has been duly noted by Aduloju, Adeniran, and Ageh (2018) as an issue of man rather than that of state.

The PGIS concept has been applied to many crime mapping studies. According to Musungu (2014), in a crime mapping exercise in Freedom Park, Cape Town, community leaders and residents used aerial photographs from 2004 and 2013 to identify crime hotspots as well as the types of crimes that occurred there. In another study reported by Liebermann and Coulson (2004), the Participatory GIS method was applied to crime prevention in Pretoria, South Africa with three practical objectives to identify hotspots at neighborhood scale; prioritize the places in order of intervention, and investigate interventions toward developing responses with role assignment to crucial players.

According to Liebermann and Coulson (2004), participants drew maps depicting their residence in relationship with various places where they feel threatened. By merging individual maps into large scale maps, 20 crime hotspots were identified, which is approximately five-fold of identified locations by the police in their workshops confirming the effectiveness of the participatory GIS method in crime mapping.

Web-based Participatory mapping involves the movement of participatory processes from a computer/mobile device that is either standalone or isolated to interconnected networks of individual computers/mobile devices that are connected to a shared server. Besides, the Web-based method opens up a new prospect of access to spatial data based on locally sourced resources. The Web-based process provides the capability to integrate data from different sources while ensuring storage and easy retrieval of data before, during and after the Participatory GIS project (Kyem and Saku 2009).

Methodology

This study adopted three (3) methods (Figure 4). For the first method, 96 copies of questionnaires were administered to the residents of the building in the study area – which is 10 percent of the total number of buildings in the study area (Figure 2) to describe the social and economic composition of residents as it affects crime in the area. In the second method, the current crime concentration index (CCI) for the study area was analyzed using police reports to determine how much Mokola contributes to crime in Ibadan North LGA.

For this research, a Web-based PGIS shown in Figure 3 was developed (PlanShare Crime Map). The Web-based PGIS provided the platform for the third method, as crime hotspots in the study area were mapped during the process of questionnaire administration. The hotspots were identified using the Planshare Crime Map application. After providing answers to the questionnaires, respondents were handed a tablet device with the application to share their spatial knowledge of crime by picking specific points on the map. This principle is very similar to the earlier PGIS approaches where participants contributed by marking precise points on a physical map, whereas the Planshare application aided digital collection, recording and analysis in the course of this project. The Web-based PGIS platform is available at http://plansharemap.herokuapp.com/

The results of the web-based participatory mapping were imported from the Django Representational State Transfer (REST) back-end of the Web-based PGIS map server into the ArcGIS environment for data cleaning and analysis to produce crime risk maps for the various types of crime recorded in the study area. The Mapbox API was used as the framework to present the crime risk maps on the Web-based PGIS map to the community and police to enable them to have full spatial knowledge of crime-prone areas in Ibadan North LGA.

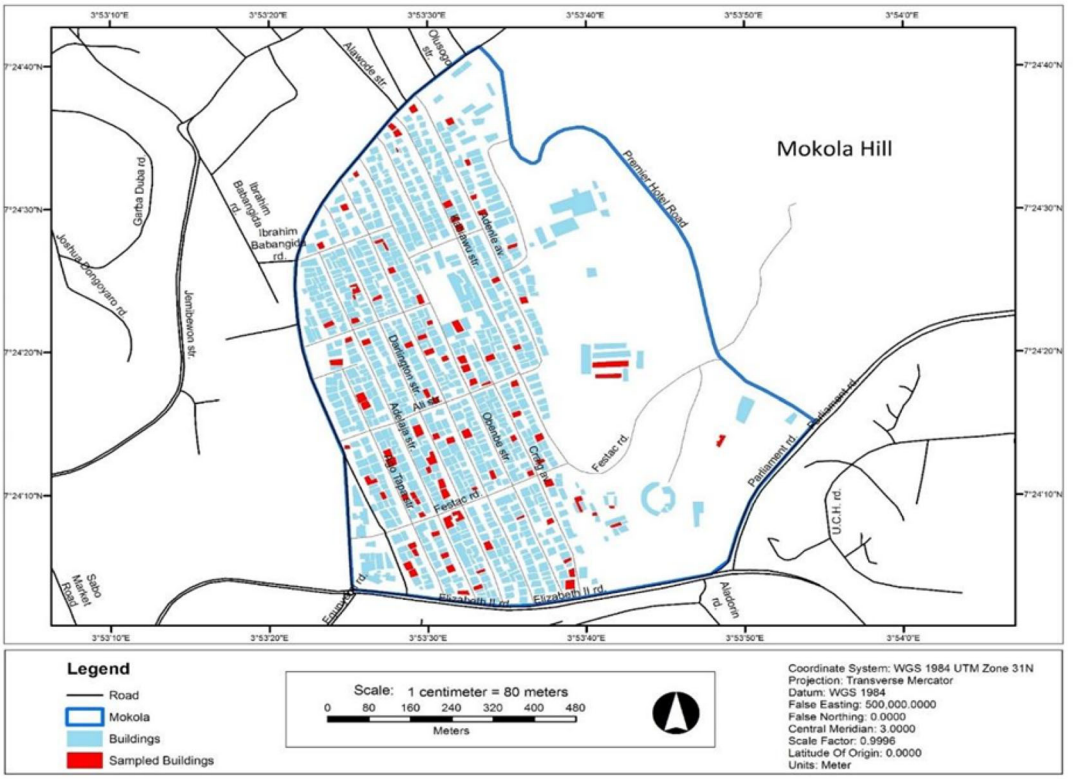


Figure 2. Map of the study area showing the sampled buildings.
Source: Source: Authors' Fieldwork, 2018.

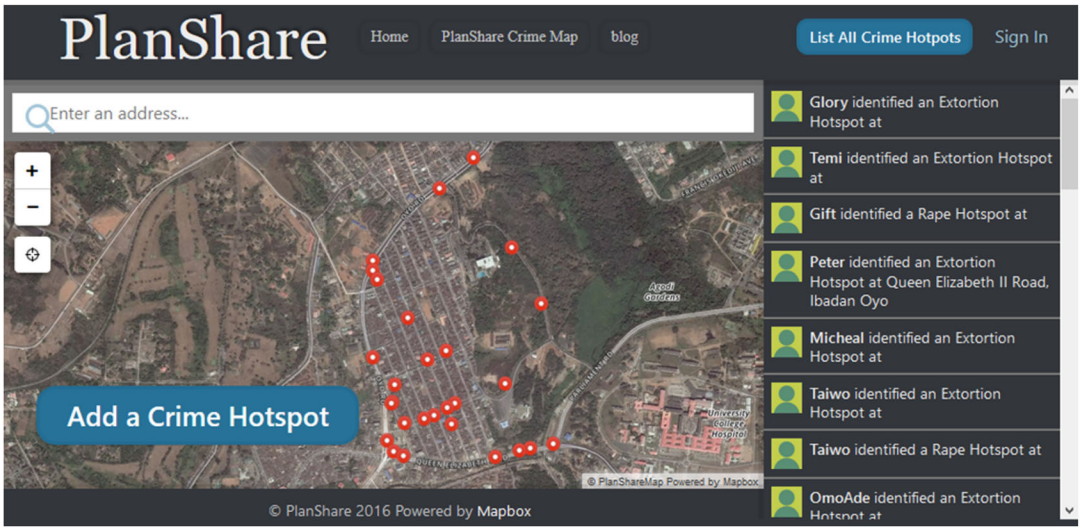


Figure 3. The web-based PGIS platform for this study (PlanShare Crime Map).
Source: Authors' Fieldwork, 2018.

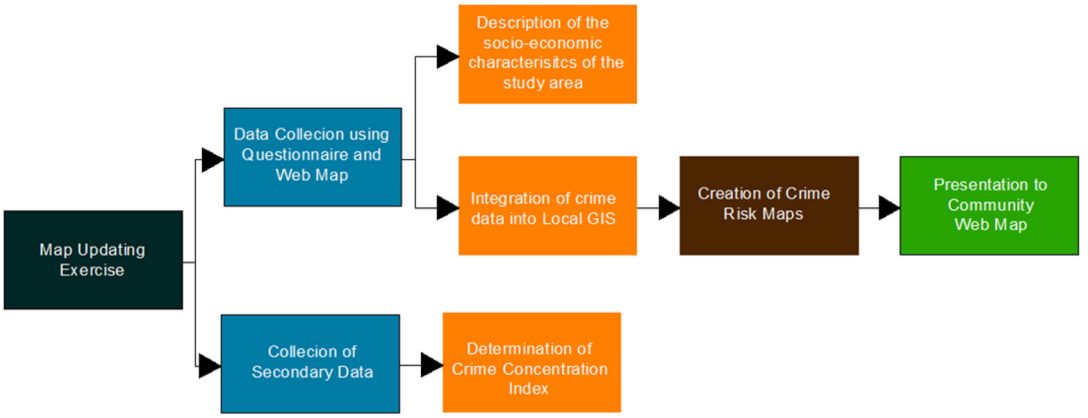


Figure 4. Steps in crime mapping of core urban areas using participatory GIS.
Source: Authors' Fieldwork, 2018.

Discussion of findings

Socio-demography

Field study, as revealed in Table 1 shows the age distribution of respondents. The economic age bracket between the ages of 18 and 45 years accounted for 61.0 percent of the total respondents. While those between 46 and 65 years were 27.0 percent. The independent age bracket represents 88.0 percent of respondents of the agile workforce that is fit enough to perpetrate crime-related vises. In terms of marital status, the survey shows that 71.9 percent of the respondents were married, 26.0 percent were single and 2.1 percent were separated. Furthermore, being a commercial area, dominated by printing companies and traders, a larger proportion of the respondents in the study were self-employed and private employees representing 78.1 percent and 13.5 percent of the total occupation. Majority of the respondents (53.1 percent) earned between N5, 000 and N20, 000 per month. Further, those who earned between N20, 001 and N50, 000 were 44.8 percent, while only 2.1 percent respondents earned above N50, 000. A critical analysis of the household income trend shows that the majority of the respondents accrue income below 35,000 per month.

Crime concentration analysis

Crime concentration analysis (CCA) (Table 2) conducted for the study area using crime data from police stations in Ibadan North resulted in a Loop Quantum Cosmology (LQC) value of 7.39 for Mokola. From the preceding, it shows that Mokola experiences 639 percent more crime than would be expected, given the distribution of crime in Ibadan North. This finding can be linked to the commercial activities dominating the area while a significant number of housing stocks were affirmed to be in poor condition.

Based on this analysis, Mokola can be said to be both a "crime attractor" and "crime generator." Brantingham and Brantingham (1998) described crime attractor as cynosure to criminals while crime generator is viewed as one which induces crime. Human agglomeration thus encourages potential perpetrators of crime to carry out their pre-established evil intention of committing a specific crime.

Crime generation in Mokola can be linked to its strategic position in accessing notable landmarks in adjoining areas such as the University of Ibadan, Agodi Secretariat and the University College Hospital, among others.Reason for this is evident in the recently constructed overhead bridge at Mokola Junction by the Oyo State Government aimed at easing traffic flows in the area.

Table 1. Socio-demographic characteristics.

Character	Percentage (%)
Age distribution	
Below 18 years	0.7
18–25 years	36.0
26–45 years	25.0
46–65 years	27.0
Above 65 years	11.3
Total	100
Marital status	
Married	71.9
Single	26.0
Separated	2.1
Total	100
Occupation	
Student/apprentice	6.3
Private Employee	13.5
Self-employed	78.1
Civil servant	2.1
Total	100
Monthly income	
5,000–20,000	53.1
20,001–35,000	35.4
35,001 and 50,000	9.4
Above 50, 000	2.1
Total	100

Source: Authors' Fieldwork, 2018.

Table 2. Crime concentration analysis of Mokola.

Variables	Mokola	Ibadan North	
Crime Count (C)	767	3131	0.24
Area (Sq.M) (A)	0.77	26.33	0.0292
LQC	7.39		

Source: Authors' Computation, 2018.

Intrinsically, Mokola possesses notable activity centers such as the Premier Hotel, Cultural Center and various shopping and relaxation centers. These activities draw the population from far and near increasing the opportunity for crime. These activity centers are targets of criminally-minded visitors to the locality.

Mokola can also be regarded as a crime attractor as some offenders often travel to the area with the pre-established intention of committing a crime. Crime attractiveness in Mokola can be linked to the presence of crime breeding activity centers, especially along Festac Road characterized by pubs that attract a high number of alcohol-related crimes such as assault and rape.

Participatory GIS and crime analysis

This study employs both descriptive and analytical methods using participatory GIS to profile crime-prone areas in Mokola. The participatory mapping exercise was used to analyze the perception of people on crime hotspots in Mokola. The respondents participated in the crime mapping exercise by pinpointing the most crime-prone areas using the participatory web map. Figure 5 shows the interface of the participatory web map on the completion of the participatory mapping exercise. The mapping was aided with the use of paper maps for respondents that had issues using dedicated mobile devices.

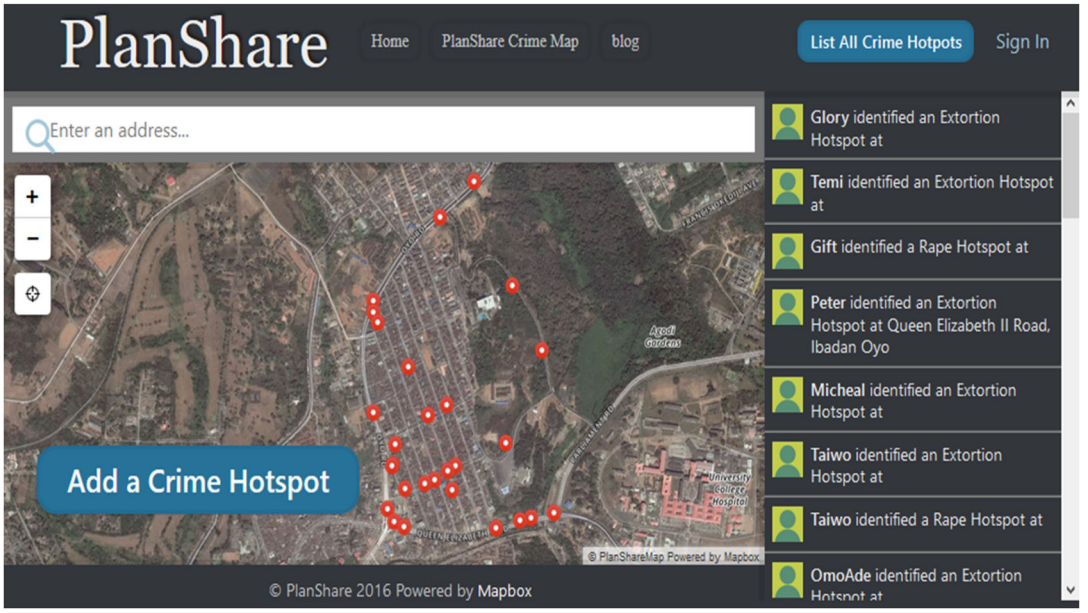


Figure 5. PlanShare web-based participatory crime map.
Source: Authors' Fieldwork, 2018.

Spatial pattern of crime in Mokola

The participatory mapping yielded positive responses from participants, as most of them were quite concerned about the crime situation in the community. Some participants were not comfortable divulging sensitive information on crime in the community as they felt this could implicate them. During the participatory mapping, 32 crime hotspots were mapped by participants mostly based on personal crime experience and information from family, friends and other sources. Figure 6 shows the spatial distribution of crime risk areas based on different types of crime as mapped by the respondents. The mapping exercise revealed that extortion is the most prevalent type of crime committed in Mokola.

The local knowledge of crime in the community further reveals an uneven spatial distribution of crime hotspots in the community. Also, certain corridors were mapped for specific types of crime based on some intrinsic characteristics that promote such crime types in these areas. To identify and profile the vulnerable areas under the siege of crime attacks and find out the contributing factors, a 50-m buffer analysis (as adopted by Newton and Hirschfield 2009) was conducted for all the types of crime in this study.

A 50 m buffer analysis (Figure 7) for extortion, theft and burglary hotspots shows the closest area of influence for these respective crime types. The study indicates that extortion often occurs in areas characterized by the presence of pubs and thick vegetation that serves as hideouts for criminals. As narrated by participants, criminals use motorcycles to take advantage of victims on the road, snatching their mobile phones or other valuables then zooming off. From Figure 7, areas vulnerable to extortion crime include Roundabout Junction, Festac road, Queen Elizabeth Road (Danadaru Hill) and Premier Hotel Road while Burglary was dominant opposite the community grammar school and inside the Mokola neighborhood. Also, Roundabout junction, Mokola market area and City center hotel have been reported to be vulnerable to forms of theft.

Figure 8 displays the hotspot information as mapped by a participant for an extortion hotspot along Queen Elizabeth road (Odo Dandaru area) which was notable for various types of crime such as extortion and rape in Mokola. The Queen Elizabeth road area shows high affinity to

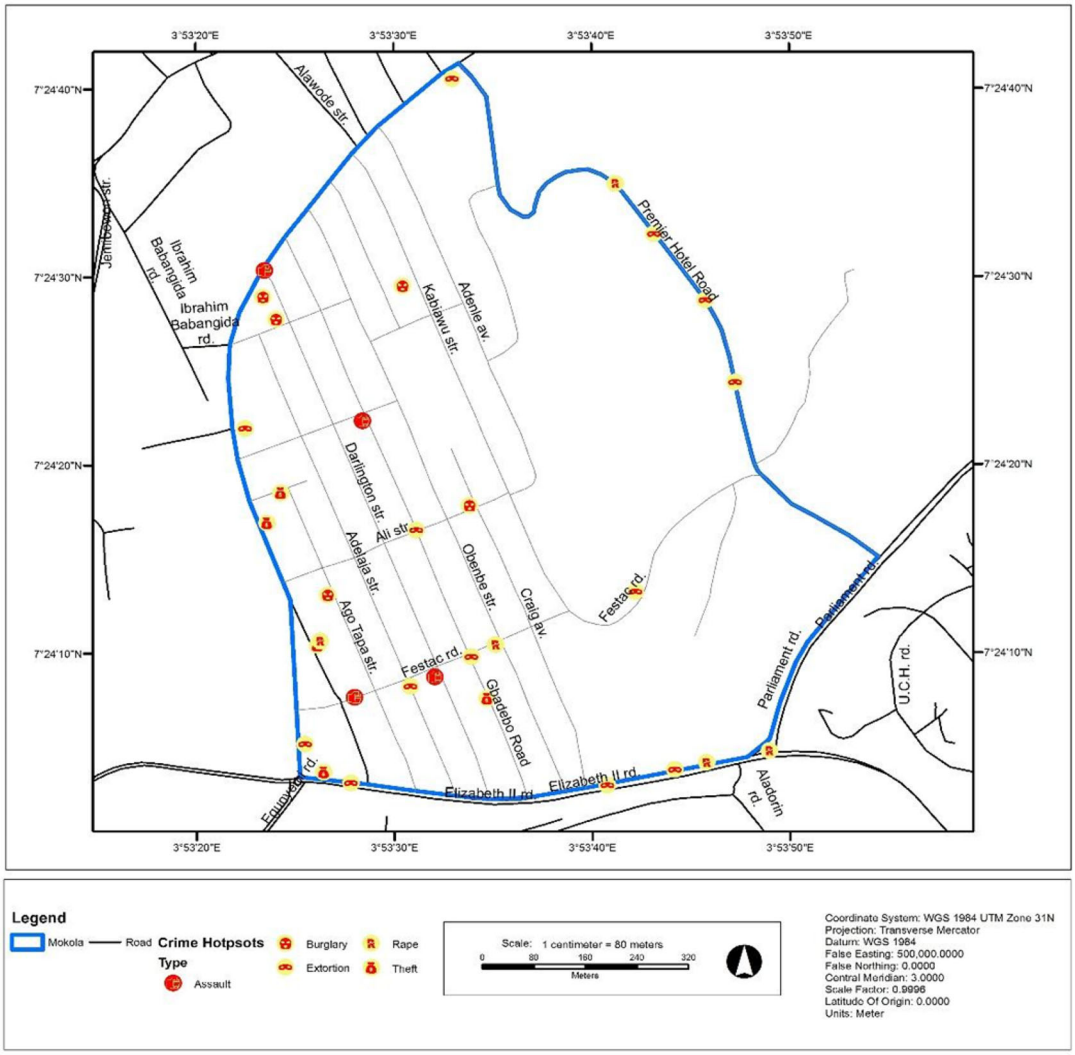


Figure 6. Crime hotspots in Mokola.
Source: Authors' Fieldwork, 2018.

criminal activities due to the presence of the thick forests on both sides of the road, which serves as a hideout for criminals.

Figure 9 also displays information for another extortion hotspot mapped by one of the participatory crime mapping participants claiming criminals disguise themselves as commercial motorcyclists to take advantage of ignorant passengers in this area. These criminals extort passengers of their valuables by stopping along this quiet and bushy corridor, asking for permission to ease themselves only to attack the passenger. The Roundabout junction is one of the busiest transport nodes in Ibadan metropolis. The Roundabout junction was identified as a hotspot for extortion and theft cases. Theft at the intersection was mostly perpetrated by criminal elements from the adjoining Sabo neighborhood occupied by Bureau de Change merchants from the Hausa ethnic group. Figure 10 illustrates the information for a theft hotspot as mapped by a participant. Furthermore, buffer analysis conducted to determine areas vulnerable to the two other types of crime in the area (Assault, Rape) Figure 11 below. Assault vulnerable areas based on the buffer analysis were common along Festac road and Queen Elizabeth road (Odo Dandaru area).

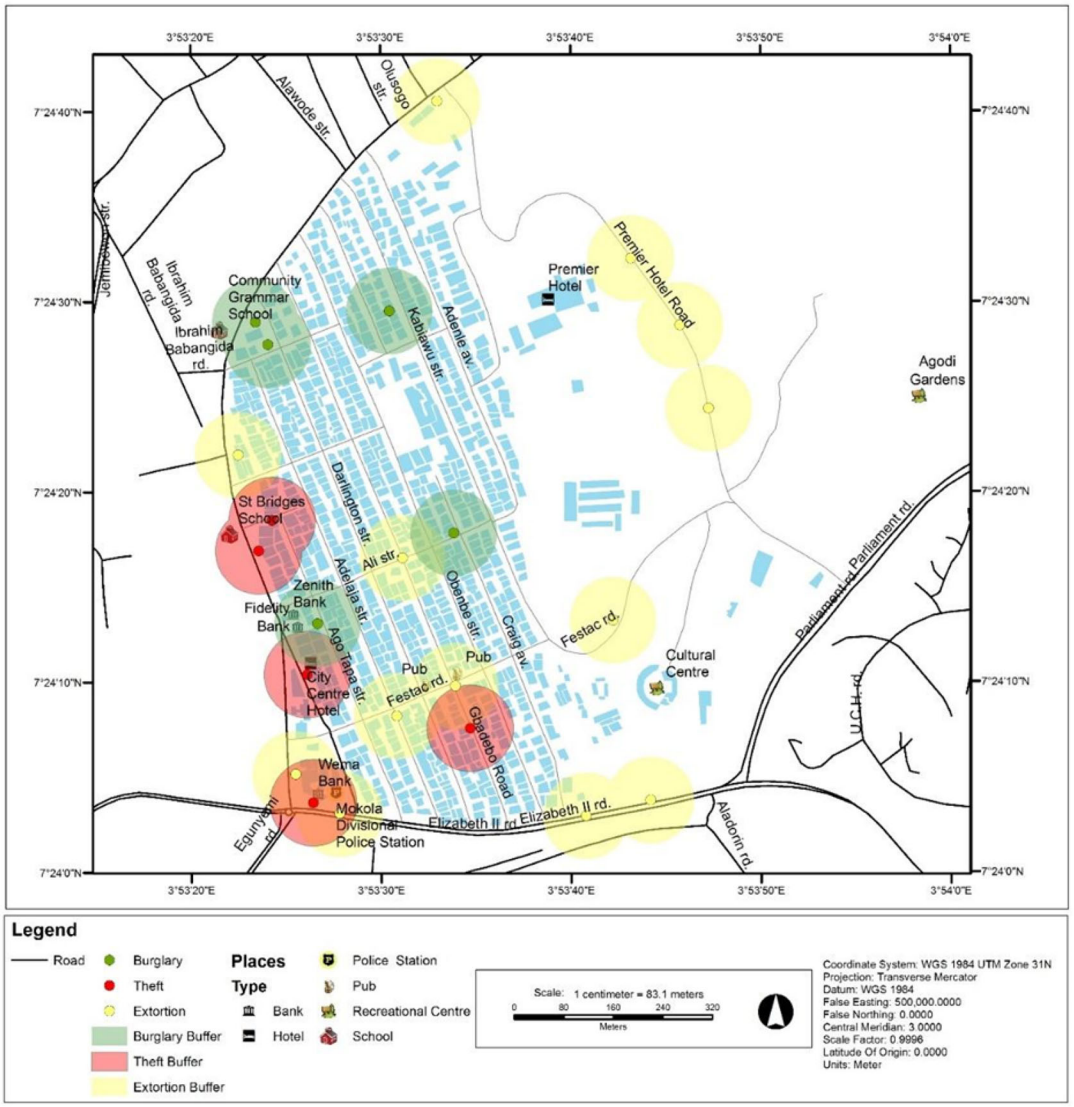


Figure 7. Buffer analysis showing areas vulnerable to extortion, theft and burglary.
Source: Authors' Fieldwork, 2018.

Mean center analysis and standard deviational ellipses

The mean center identifies the geographic center (the center of concentration or the mean x – coordinate and mean y – coordinate) for a set of features in the study area. The utility of the mean center tool is not in finding a point on the map to throw more resources at or rank prevalent crimes in this area. Instead, it is a reference point used in further analysis, such as a comparison of two different distributions like crime types (Hill and Paynich 2013).

The Mean Center Analysis for the different types of crime mapped in Mokola reveals the center of gravity of the crime types Figure 12 and as highlighted in Table 3.

The Mean Center Analysis, shown in Table 3, depicts the spatial pattern for the crime type in Mokola. For this research, the Mean Center Analysis is used to track changes in the distribution of crime types in the study area. Property crime types such as theft take mean center position along Ago-Tapa street which adjoins the City Center Hotel and burglary takes mean center

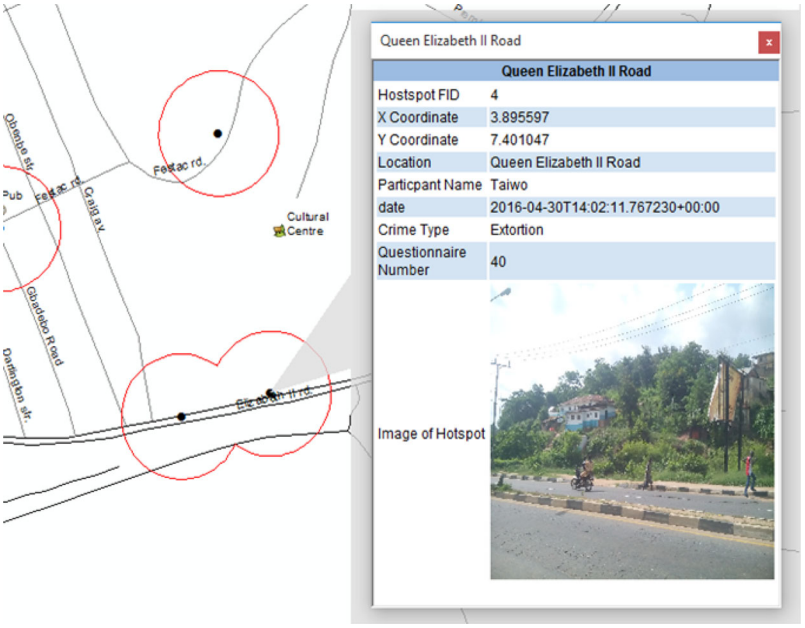


Figure 8. Extortion hotspot information at Odo Dadanru.
Source: Authors' Fieldwork, 2018.



Figure 9. Extortion hotspot information along Premier Hotel Road.
Source: Authors' Fieldwork, 2018.

position along Gbadebo street which lies adjacent to Darlington street which has been described as a significant crime hub in Mokola layout by Participatory Mapping Participants (PMP). Assault crime types (rape and assault) take mean center positions along Festac road and Adelaja Street, respectively. For this research, it was also essential to determine the dispersion of the crime point data as mapped by participants. Using the Standard Deviation Ellipses (SDEs), point

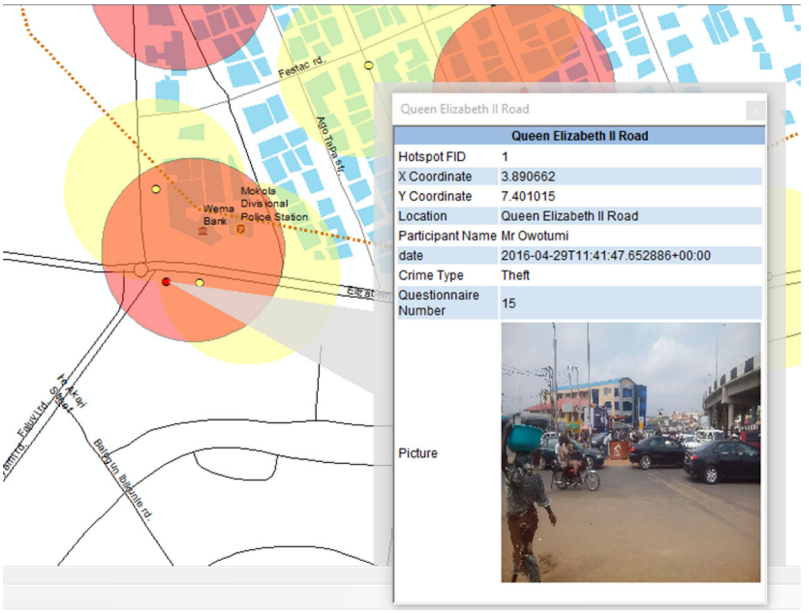


Figure 10. Theft hotspot information at roundabout junction.
Source: Authors' Fieldwork, 2018.

data dispersion can be analyzed. Statistically, this SDE is calculated using a bivariate distribution defined by:

Bivariate Distribution:
X and Y-Axis Defined:
Area of Ellipse: $A = \pi \times \times$

Figure 13 shows the dispersion of participatory mapping crime hotspots around the geometric mean center for the crime types as determined in the Mean Center Analysis conducted above. The Standard Deviation Ellipse for all crimes shows a high crime distribution in the central part of the Mokola layout. This reason is attributed to the large-scale presence of business activities, pubs and Landlord sons operating in the central part of Mokola layout.

Conclusion and recommendations

The primary aim was to determine crime-prone areas using the PGIS technique; to recommend strategies to prevent and control crime vulnerability in core urban areas. The study gave an in-depth analysis of crime in Mokola through PMP while examining the spatial distribution of crime types in the study area.

This study reveals that Mokola is a poor residential neighborhood occupied mainly by self-employed and low-income business merchants. Crime Concentration Analysis conducted in the study area using mean crime count for the past five years shows that Mokola experiences 689 percent more crime rate than Ibadan North as a whole mainly due to its strategic position in accessing notable landmarks in adjoining areas and using the PlanShare Crime Map, some crime hotspots such as Roundabout junction, Dandaru hill, Darlington Street and Festac Road were identified by participants aiding knowledge of the crime pattern in the study area.

Based on these findings, it is however recommended that areas mapped as crime hotspots should receive more attention, and this should be done in collaboration with the community

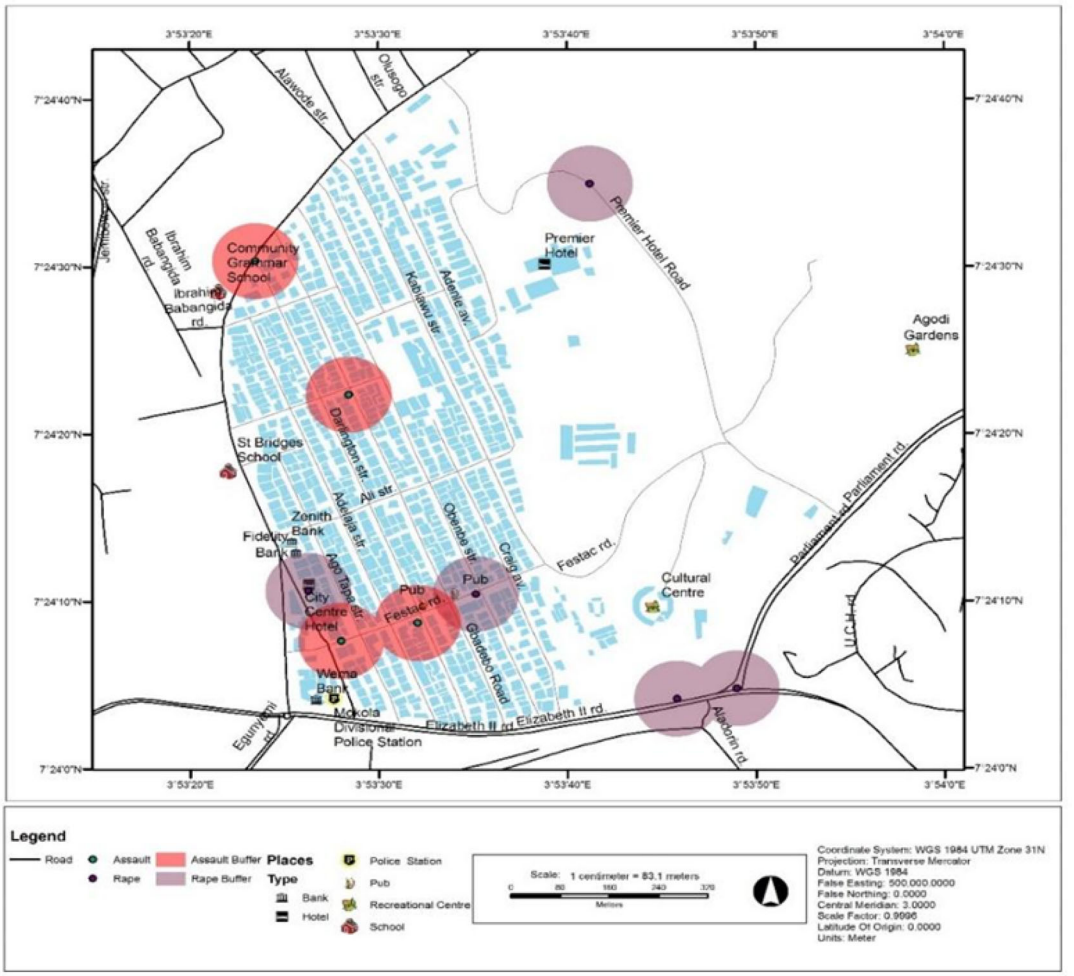


Figure 11. Buffer analysis showing areas vulnerable to assault and rape.
Source: Authors' Fieldwork, 2018.

through Natural Surveillance. Natural Surveillance as a concept of Crime Prevention Through Environmental Design (CPTED) aims at keeping potential offenders under easy observation. It is a principle that underlines the importance of guardianship in minimizing crime risk. Citizens generally render more protection in society than the formal guardians such as the police because there are comparably fewer police officers patrolling neighborhoods than the citizens themselves. Also, it is recommended that crowdsourcing public knowledge using the web participatory GIS method used in this research work be adopted in many planning issues currently experienced in urban centers. Planning problems ranging from crime, housing shortage, transportation, natural resource management are some of the pending urban planning issues in which local knowledge or ideology can be super beneficial to developing viable and feasible plans to provide lasting solutions. PGIS will provide a platform for every member of the community irrespective of age, gender or social status to have an equal say in decision making in community development. In crime mapping, the adoption of Participatory GIS will ensure the direction of resources to pressing security needs (crime-prone areas), thereby ensuring the effectiveness of police patrol. Additionally, a more vital link is built between the police and the general populace, one that has been absent in times past.

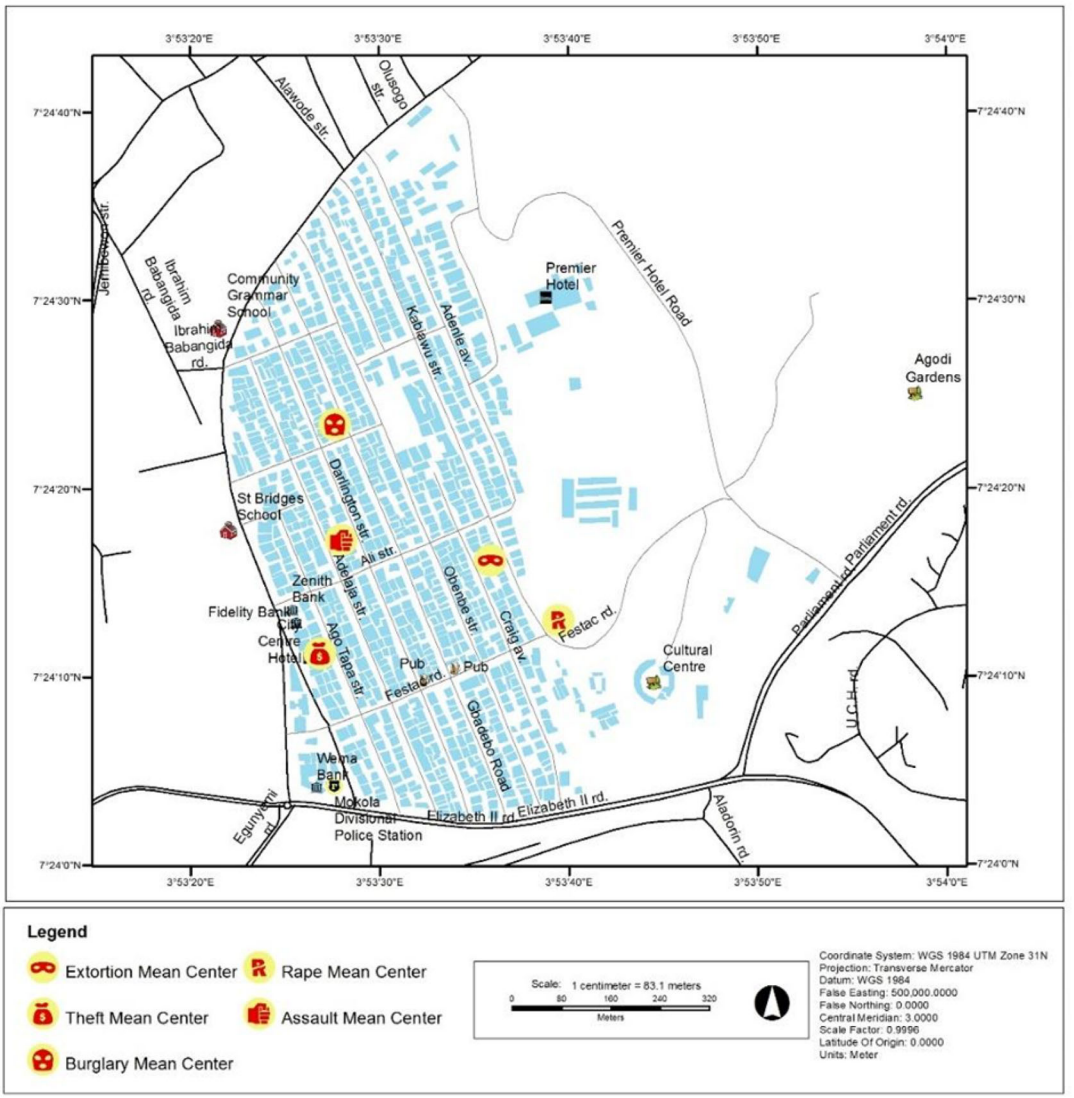


Figure 12. Distribution of crime mean centers.
Source: Author's Fieldwork, 2018.

Table 3. Mean center analysis of crime types in Mokola.

Crime type	Mean center location	Mean center coordinates (latitude, longitude)
Extortion	Craig Avenue	3.893298, 7.404494
Theft	Ago-Tapa Street	3.890789, 7.403124
Burglary	Gbadebo Street	3.890994, 7.405869
Rape	Festac Road	3.894292, 7.403607
Assault	Adelaja Street	3.891099, 7.404795

Source: Author's Fieldwork, 2018.

However, as ardent and integrative participatory GIS is, it has been marred with some shortcomings that future research must critically guide against when adopting it in crime mapping activities. For instance, unlike ground data, the accuracy of points collected through a participatory process relies heavily on the respondents. Furthermore, because these points are collected at

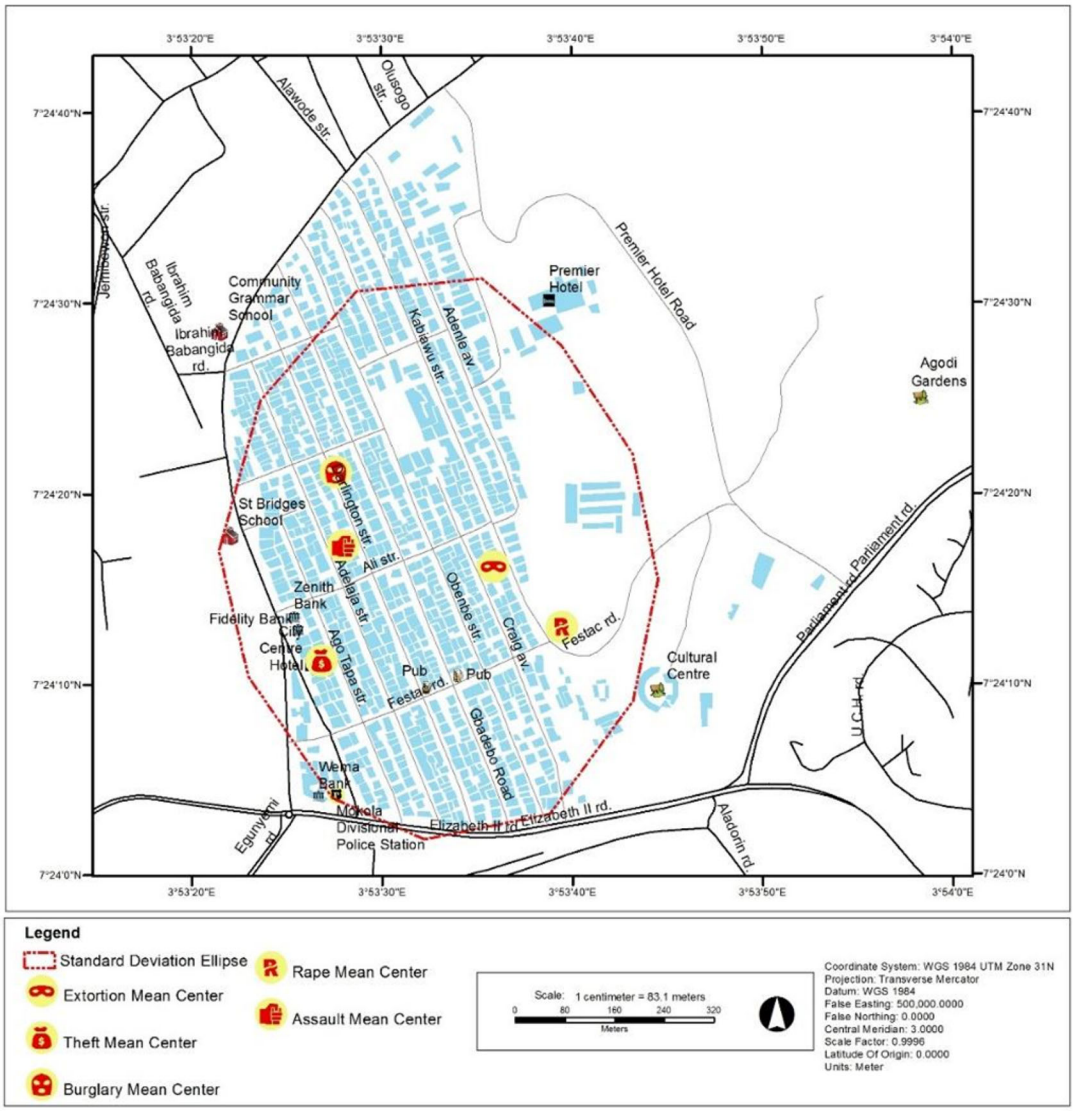


Figure 13. Standard deviation ellipse of crime.
Source: Authors' Fieldwork, 2018.

a relatively larger scale than ground data, they have relatively lower accuracy. Lack of spatial knowledge of some respondents means that they couldn't contribute to the crime mapping process. To this end, an extensive awareness of crime mapping processes must be done precisely for the respondents to arrive at accurate results.

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Disclosure statement

The authors declare no conflict of interest.

References

Aduloju, O. T. B., I. A. Adeniran, and J. A. Ageh. 2018. Urban violence and crime: A review of literature in Nigeria. In *The just city: A compendium on poverty alleviation and deprivation*, ed. D. O. Olanrewaju, F. K. Omole, E. E. Okoko, O.B. Akinbamijo, A. A. Emmanuel, and O. O. Popoola, 392–406. 1st ed. Akure: Department of urban and regional planning, FUTA.

Aydin, Y. E. 2006. *Web-based multi participant*. M.Sc Diss., Middle East Technical University, Ankara, Turkey.

Balogun, T. F., H. Okeke, and C. I. Chukwukere. 2014. Crime mapping in Nigeria using GIS. *Journal of Geographic Information System* 6 (5):453–66. doi: 10.4236/jgis.2014.65039.

Basorun, J. 2006. *Basic elements of urban and regional planning*. 3rd ed. Akure: Shalom Publishers.

Brantingham, P. J., and P. L. Brantingham. 1998. Environmental criminology: From theory to urban planning practice. *Studies on Crime and Crime Prevention*, 7(1): 31–60.

Chiabi, D. K. 2009. Urbanization and crime in Cameroon. In *Urbanization, policing and security: Global perspectives*, ed. G. Cordner, A. Cordner, and D. K. Das, 19–42. London: CRC Press, Taylor and Francis Group.

Fajemirokun, F., O. Adewale, T. Idowu, and A. Oyewusi. 2006. *A GIS approach to crime mapping and management in Nigeria: A case study of Victoria Island Lagos. Shaping the Change*. Munich: FIG.

Hill, B., and R. Paynich. 2013. *Fundamentals of crime mapping*. Massachusetts: Jones and Bartlett Learning, LLC.

International Institute for Environment and Development. 2009. *Participatory geographical information system*. London: International Institute for Environment and Development (IIED).

Jrank. 2010. *Urbanization – The social impacts of urbanization*. Jrank. Accessed November 16, 2020. http://family.jrank.org/pages/1732/Urbanization-Social-Impacts-Urbanization.html

Kyem, P., and J. Saku. 2009. Web-based GIS and the future of participatory GIS applications. *EJISDC* 38 (7):1–16.

Liebermann, S., and J. Coulson. 2004. Participatory mapping for crime prevention in South Africa-local solutions to local problems. *Environment and Urbanization* 16 (2):125–34. doi: 10.1177/095624780401600204.

Moser, C., and C. McIlwaine. 2004. *Encounters with violence in Latin America: Urban poor perceptions from Colombia and Guatemala*. London: Routledge.

Musungu, K. 2014. Participatory mapping: Methods, results and lessons from Cape Town. FIG Congress: Engaging the challenges, enhancing the relevance, Kuala Lumpur, Malaysia.

Newton, A., and A. Hirschfield. 2009. Measuring violence in and around licensed premises: The need for a better evidence base. *Crime Prevention and Community Safety*, 11(3): 171–188. doi: 10.1057/cpcs.2009.12.

Richard, B. 2009. Violence, crime, and violent crime. *International Journal of Conflict and Violence* 3 (1):23–39.

Soh, M. B. 2012. Crime and urbanization: Revisited Malaysian case. *Procedia - Social and Behavioral Sciences* 42: 291–9. doi: 10.1016/j.sbspro.2012.04.193.

Weiner, D., T. A. Warner, T. M. Harris, and M. R. Levin. 1995. Apartheid representation in a digital landscape: GIS, remote sensing and local knowledge in Kiepersol. *Cartography and Geographic Information Systems* 22 (1): 30–44. doi: 10.1559/152304095782540537.