



## THE ENCROACHMENT OF BUILDINGS ON THE MEDIUM VOLTAGE OVERHEAD POWERLINE RIGHT-OF-WAY IN YENAGOA, BAYELSA STATE, NIGERIA

Olerum, Vivian Akunna

[vivian.nwokocha@uniport.edu.ng](mailto:vivian.nwokocha@uniport.edu.ng)

Department of Geography and Environmental Management, Faculty of Social Sciences,  
University of Port Harcourt, Rivers State, Nigeria.

### Abstract

This study used longitudinal research design, with GIS analysis and remotely sensed data, to assess the encroachment of buildings on the medium voltage overhead powerline right-of-way in Yenagoa. The Global Positioning System was used to acquire the coordinate of each pole holding the medium voltage (11kv and 33kv) powerlines. These coordinates were imported into ArcGIS environment and this aided the production of the medium voltage overhead powerline map of the study area. This map shows the route of lining of the powerline as it runs across the study area. The ArcGIS software was used to create 11m buffer on the powerline (which is the stipulated setback by the Nigerian Electricity Supply and Installation Standard Regulation, 2015), and 4% of the buildings in the study area was captured as encroaching on the powerline right-of-way. The empirical analysis showed that 69% of the respondents are married with household size of 3-4 (37%). Also, 56% of the respondents are indigenes who are mostly secondary school graduates (50%) and hence ignorant of the possible powerline hazards. About 81% are traders and artisans, whose average monthly income is less than 30,000. Furthermore, 73% of these buildings are rooming/face-to-face and 47% are used for commercial purposes. Also, 91% of these buildings are made of concrete while 49% are worth more than one million naira. About 61% of the property owners built on the powerline rights-of-way because they wanted to make more money in other to improve their living standards. Based on these findings, this paper recommended demolition of the encroached buildings while relocating the inhabitants and sensitizing them on the hazards associated with powerlines. It also suggested passing rights-of-way into law and ensuring its compliance. This paper has showcased the usefulness of GIS in developmental planning, monitoring and regulation.

**Key words:** Encroachment, GIS, Medium voltage powerline, Right-of-way, Regulations and Setbacks.

### Introduction

The increase in population has caused both land and demographic pressure, thereby leading to the development of the suburbs.

This invasion usually leads to uncontrolled and unorganized development and the encroaching communities suffer from the lack of basic infrastructures coupled with chaotic development. This trend, according

to Fahria (2009), is attributed to the absence of sound institutional arrangement to manage urban fringe growth. It is however observed that lands encroached upon are not under rigorous development controls because, they are mostly excised from planning areas of main cities. This gives rise to haphazard developmental activities that pays no attention to stipulated planning regulations as a result of pressure on land demand from city dwellers. The available marginal lands such as powerline rights-of-way are then filled up from various development purposes without considering environmental impacts. Also, these haphazardly developed fringe areas are not provided with adequate facilities (Fahria, 2009).

The need for energy is steadily increasing with the increase in population, particularly in metropolitan areas. Electricity powers everything from our gadgets to our home appliances, complicated computers, and even the traffic system. Power stations are where electricity is created. This electricity is delivered across the country via a network of power distribution and/or transmission lines. This line is a collection of conductors, such as wires and coaxial cables, designed to transport electric power or communications between two or more terminals.

Overhead powerlines are designed in such a way that suitable clearance distances or rights-of-way are ensured between the ground or nearby structures and energized conductors so as to avert unsafe contact with the line. But because of the teeming population and the need to survive, the populace engages in the development of the rights-of-way thereby making themselves vulnerable to powerline hazards. For instance, the report released by Nigeria Electricity Regulation Company (NERC) in the second quarter of 2019 underpinned the systemic rot in the power sector, alleging that at least three (3) persons were electrocuted every week between April and June 2019 across the land (Punch online Newspaper, 2020). Another survey conducted by Punch in 2017 revealed that over 51 persons have been electrocuted within the first five months of 2017 by high tension power cables taking advantage of proximity to neighborhood or residential building (Punch online Newspaper, 2017). Also, Abuja Electricity Distribution Company (AEDC) disclosed that it has recorded a total of 101 fatalities from 2013 – 2018 (THISDAY online Newspaper, 2018). Furthermore, working within 10 feet of overhead powerlines, in particular, increases the risk of electrical shock from inadvertent

contact. Workers are at danger of electrocution-related death or serious and debilitating injuries. For instance, in December, 2020, two Benin Electricity Distribution (BED) company staff in Asaba, got electrocuted when power suddenly got restored while working on the medium voltage powerline (Ochei, 2020). Being mounted at a considerable height, even at about several hundred meters, there is need to establish the effects on residents and occupational exposure to the powerlines right-of-way.

For these reasons, Nigeria Electricity Regulation Company (NERC) has a mandatory "no-obstruction" policy in place for its overhead powerline rights-of-ways. It is vital to keep the areas beneath them clear for the residents' and NERC staff' safety. Minimum clearance distances between powerlines and any form of developmental activity on ground according to Nigerian Electricity Supply and Installation Standards Regulations - NESISR (2015) are 11m, 11m, 30m, and 50m for 11kv, 33kv, 132kv, and 330kv, respectively. Furthermore, the federal government has high overhead powerline reliability regulations, taking into account the rate of urban expansion as a result of rural-urban migration.

The paper is set to delineate the 11kv and 33kv overhead powerline corridor in Yenagoa, using GIS method; Identify and examine buildings encroaching on the stipulated 11-meter setback from the powerline as stipulated by NESISR (2015), investigate the characteristics of buildings and residents within the right-of-way, with the aim of protecting the health and well-being of the inhabitants and ensuring suitable urban development in the study area.

## **2. Data and Methods**

### **Study Area**

The study area is the urban areas in Yenagoa, the capital of Bayelsa state, Southern Nigeria consisting of Akaba, Amarata, Swali, Yeneka, Bumoundigbene, Bumoundi, tombia, Yenegwe, Nedugo Agbia, and Ogboloma.. It is located at the southern part of the country at coordinates 4°55'29''N and 6°15'51''E (Fig 1). It has an area of 706km<sup>2</sup> and a population of 352,285 at the 2006 census (Yenagoa, 2022). The ijaw form the majority of the state.

The Global Positioning system (GPS) was used to acquire the coordinates of each pole holding the powerlines. The powerlines run across the study area (Fig. 1).

In order to obtain the sample size for questionnaire administration, the google image of the study area was acquired, georeferenced and mosaiced to enable the acquisition of buildings that encroached into the powerline right-of-way. The powerline right-of-way was obtained by buffering 11m distance from the powerline as stipulated by Nigerian Electricity Supply and Installation Standard Regulation (2005). The 11m right-of-way was overlaid on the google image and the buildings that encroached into the powerline right-of-way were captured.

However, a total number of 1,692 buildings encroached into the powerline right-of-way. These encroached buildings were numbered. The Taro Yamane formula was applied to the total number of houses to determine the sample size. The sample size of 324 was obtained. But, 400 questionnaires were distributed using the simple random sampling and 397 were retrieved. Out of this numbers, 102 property owners responded to the research instrument. This happened by chance as there were questions in the questionnaire that were meant for property owners alone.

### 3. Literature Review

Recent changes in energy policy and infrastructure have continued to encourage research on the impact of high voltage overhead transmission lines (HVOTLs) on property values (Anderson, Williamson & Wohl, 2017). Kinnard (1967) was one of the first to undertake a comprehensive study concerning the effects of electric transmission lines on the value of residential property. Kinnard conducted a year-long survey of seventeen (17) subdivisions located in nine suburban towns in Metropolitan Hartford, Connecticut. Most home owners reported that they did not mind living near a tower line. Over 85% said that they would purchase again in the same location. Screening a tower or line from view through landscaping, at least partially, did tend to considerably reduce any negative reactions by adjacent home owners. The owners of higher priced or custom homes had a slightly more negative reaction to the proximity of the tower line than the owners of lower-end homes. In general, the attitudes of those who influence residential sales were more negative about the effects of a powerline than the attitudes of the home owners.

Solum (1985) conducted an opinion study of the impacts of transmission line easements on rural land in northwest Wisconsin. He presented a questionnaire to landowners whose properties had been encumbered by a transmission line ranging from 69 kV to 161 kV. The 180 respondents owned encumbered property that fell into three categories: agricultural, recreational, and residential. When asked how the transmission line had affected their property, most agricultural property owners responded that the line had no effect. The most frequently cited effect for agricultural property was the inconvenience of working around transmission structures in areas that were being actively farmed. Recreational property owners were primarily concerned with the loss of future timber value from clearing the easement area, while residential landowners named the loss of aesthetic beauty as the predominant effect. Some landowners were also concerned that the transmission line would have a negative impact on future sales price. To examine this further, Solum conducted personal interviews with buyers and sellers of encumbered properties. According to these interviews, all but one of the encumbered properties sold at a market price comparable to non-encumbered properties, and none of

the buyers reduced their offer to purchase the property due to the presence of the powerline. Solum concluded that despite some concerns and inconveniences, the resale price of all three property types was not reduced due to the transmission line easement.

Delaney and Timmons (1992) found that the value of a property near a high voltage overhead transmission line (HVOETL) is, on average, 10% lower than the market value for comparable properties not subject to the influence of these lines.

Kung and Seagle (1992) analyzed perceptions regarding the spatial relationships between power transmission lines and property values in Memphis and Shelby Counties, Tennessee. In this study, neighborhoods with overhead powerlines were identified, and homes under or adjacent to these lines were surveyed to determine the real or perceived influences on the value and marketability of these properties. None of the home owners surveyed saw the lines as a potential health hazard. However, 87% claimed that if they had known of potential health risks, they would have paid less for their home or looked elsewhere.

Priestley and Evans (1996) conducted a survey based on a large sample of people

living near a powerline about 28 miles north of San Francisco who were surveyed using psychometrically developed scales. The line had recently been rebuilt to carry more power and consisted of three high-voltage circuits ranging from 120 to 160 feet in height. The survey results indicated that many of the nearby residents feel this line is a negative element in their neighborhood and that it has moderately negative impacts on health and safety, property values, and aesthetics; 87% of respondents indicated that the lines have an adverse effect on the attractiveness of their neighborhood. Negative perceptions were greater for older people and those with higher status jobs, and less for those who use the right-of-way for recreational purposes. Those who lived in the neighborhood prior to the line upgrade had the most strongly negative views about the lines. Physical factors such as distance from the line and visibility did not appear to affect perceptions.

One of the two studies not focusing on residential properties is provided by Brown (1976), who uses regression analysis to analyze sales of farm land in south-eastern Saskatchewan, Canada that occurred between 1965 and 1970. The study included sales of “quarter section” (136–199 acre) and “half section” (200–350 acre) parcels.

Parcels with significant improvements were excluded from the analysis. The relationship of land value to the number of powerline structures was not found to be statistically significant. To further examine the effects of powerlines and easements, very similar parcels, with the main difference being that one had a powerline and one did not, were paired and analyzed. Overall, the properties with powerlines sold for higher prices than their pairs without powerlines. It is unreasonable to conclude that this higher price was due to the powerlines and easements, but it appears that the lines did not negatively affect land value. Brown (1976) concluded that powerlines do not have an effect on market value as a whole. However, the easement required to build the line does reduce the rights of the property owner, and powerline structures normally have an adverse impact on the efficiency of farming operations.

Rigdon (1991) analyzes the impact of a 138kV transmission line on vacant recreational land in Marquette County, Michigan using multiple regression techniques. Forty-six sold properties ranging from 10 to 160 acres were selected in two large “neighborhoods” during the study period of January 31, 1986 to January 30, 1991. Results indicated no statistically

significant relationship between sales price and proximity to a powerline easement. The author found only a few previous studies that pointed to any negative property value effects from powerline proximity.

Others like Des Rosiers (1998), Wolverton and Bottemiller (2003), Cowger, Bottemiller, and Cahill (1996), Chalmers and Voorvaart (2009) etc has also studied extensively on the Impact of High Voltage Overhead Transmission Lines (HVOTLs) on Property Values.

Furthermore, the issue of health effects of transmission lines on human has received attention due to the market's purported "fear" of harmful exposure to electromagnetic fields (EMFs). Numerous studies have been conducted around the world to determine what health effects, if any, are caused by EMF exposure. This research has employed numerous methodologies, and the findings are largely inconclusive. In 1992, the U.S. Congress authorized the Electric and Magnetic Fields Research and Public Information Dissemination Program (EMF-RAPID), a six-year "program of research and analysis with the purpose of providing scientific evidence to clarify the potential for health risks from exposure to extremely low

frequency electric and magnetic fields (Jackson & Pitts, 2010).

This research was led by the National Institute of Environmental Health Sciences (NIEHS). At the conclusion of this project in 1999, the NIEHS reported that scientific evidence linking EMF exposure to health risks is weak. Overall, epidemiological EMF studies show a pattern of small, increased risk of two types of cancers: childhood leukemia and chronic lymphocytic leukemia in adults with occupational EMF exposure. However, laboratory research fails to provide any consistent evidence of this connection. The NIEHS determined that while EMF exposure cannot be ruled as entirely safe, the scientific evidence of health risks is "insufficient to warrant aggressive regulatory concern" (Jackson & Pitts, 2010).

In other to determine whether there is an association between distance of home address at birth from high voltage powerlines and the incidence of leukemia and other cancers in children; Draper, Vincent, Kroll and Swanson (2005) carried out research titled "Childhood cancer in relation to distance from high voltage powerlines in England and Wales: a case-control study".

Children within the age of 0-14 years with cancer (malignant neoplasms and tumors of the central nervous system and brain) in England, Scotland, and Wales, was examined through several sources including the National Cancer Registration System and the UK Children's Cancer Study Group, and the National Registry of Childhood Tumors at the Childhood Cancer Research Group. Nearly 33,000 cases of childhood cancer in children born in England and Wales, 1962-95, and diagnosed in England, Wales, or Scotland over the same period are identified. Birth information for just over 31,000 cases, are obtained while about 1,700 cases are excluded because either the child was adopted or the birth record could not be traced.

In order to calculate distance from powerlines, 275- and 400-kv overhead lines and a small fraction of 132kv lines, was considered and this amounts to a distance of about 7000km altogether. The grid references of all 21,800 pylons concerned is obtained from the records of National Grid Transco. Conditional logistic regression on the matched case-control pairs is used to calculate relative risks and Chi-square ( $X^2$ ) values. The results show that there were no clear patterns of excess risk with distance from powerlines. After adjustment for

confounders (age, sex [except breast cancer], deprivation, rurality), for distances closest to the powerlines (0-49 m) compared with distances 600-1000 m, odds ratios (ORs) ranged from 0.82 (95% confidence interval = 0.61-1.11; 66 cases) for malignant melanoma to 1.22 (0.88-1.69) for brain/central nervous system cancer; no meaningful excess risks and no trends of risk with magnetic field strength for the four cancers examined is observed. In adjusted analyses at the highest estimated field strength,  $\geq 1000$  nanotesla (nT), compared with  $< 100$  nT, ORs ranged from 0.68 (0.39-1.17) for malignant melanoma to 1.08 (0.77-1.51) for female breast cancer. It was therefore concluded that there is an association between childhood leukemia and proximity of home address at birth to high voltage powerlines, and the apparent risk extends to a greater distance than would have been expected from previous studies.

Similarly, Elliott et.al (2013) conducted a case-control study to investigate risks of adult cancers in relation to distance and extremely low-frequency magnetic fields from high-voltage overhead powerlines using National Cancer Registry Data in England and Wales, 1974-2008. The study included 7,823 leukemia, 6,781 brain/central nervous system cancers, 9,153 malignant



melanoma, 29,202 female breast cancer cases, and 79,507 controls frequency-matched on year and region (three controls per case except for female breast cancer, one control per case) 15–74 years of age living within 1000 m of a high-voltage overhead powerline. It was therefore concluded that adult cancers have no epidemiological association with residential magnetic fields in proximity to high-voltage overhead powerlines.

Since there has been scant evidence of any actual health effects from EMFs, any measured effects on property values would, then, likely be due to other factors such as visual encumbrance or the physical encumbrance of the easement area through which the transmission lines pass. This point is generally borne out in the studies reviewed above.

While the findings of these studies may provide some general insights, the conclusions are unlikely to have direct application to the Nigerian scenario in all circumstances due to significant disparities in legislation and socioeconomic context.

However, some scholars such as Olasunkanmi (2005); Usikalu, Olawole, and Ikeh (2004); Nkeki (2013); Olamiju and Oyinloye (2015); Abidoye and Oyedeji

(2014); Abdulkareem (2016); and Nwofe (2016) are known to have looked into transmission powerlines, their influence on land ownership, rental structure, health, industry, and a variety of other things.

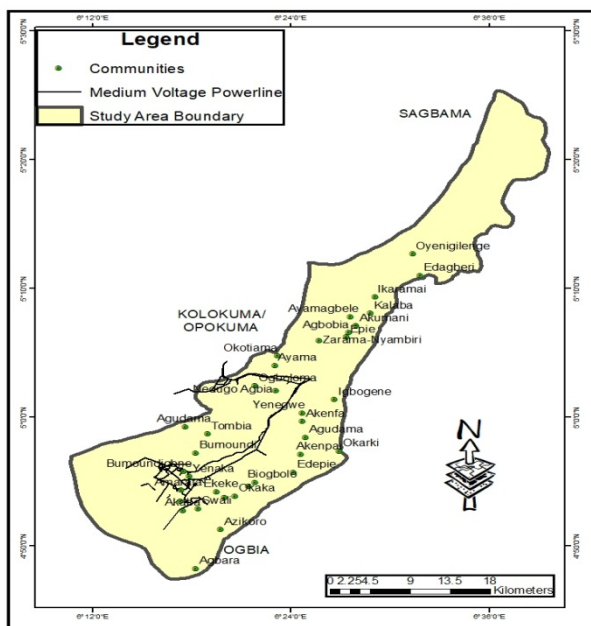
However, no study has been done on distribution lines with emphasis on 11kv and 33kv in Yenagoa the capital of Bayelsa state. The level of property encroachment into the power distribution line right-of-way or setbacks has neither been recognized nor measured in this study area. Furthermore, the demographic characteristics of the inhabitants and the factors responsible for building on such reserved lands has not been examined.

This research used qualitative statistics and questionnaires as data collection strategies. Some researchers used geographic information system tools, but not to the level of detecting urban dwellers' exposure to overhead electricity distribution lines and evaluating regulatory compliance. This study therefore seeks to employ geo-spatial tools in mapping, identifying and evaluating populations' susceptibility to risks as a result of violation of stipulated setbacks from overhead power distribution line right-of-way.

## 4. Findings

### 4.1 Map of the Medium Voltage Overhead Powerline in the Study Area:

To map medium voltage power distribution lines across the study area, Arc GIS was used. The coordinate of each pole was acquired using the Global Positioning System (GPS) and was imported into the ArcGIS environment to enable the mapping of the overhead powerline routes (Fig. 1). This exercise was carried out in order to ascertain and understand the route of lining of the medium voltage distribution lines across the study area.



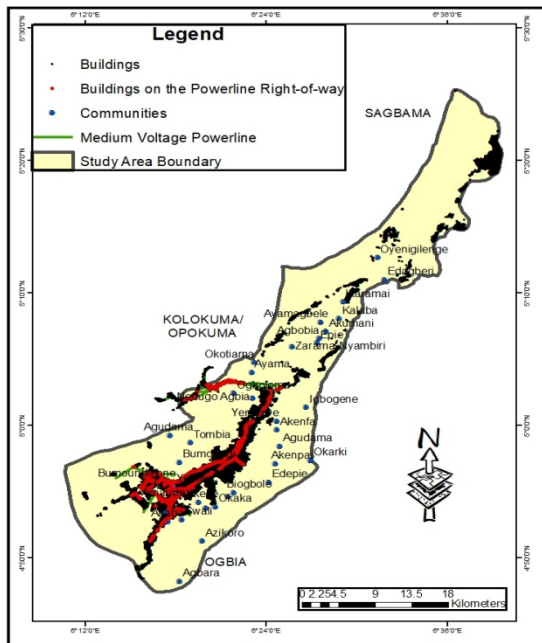
*Source: Researcher's field work, 2020.*

Fig. 1: Medium Voltage Overhead Powerline Map (Yenagoa).

The route of lining cut across the city center, consisting of Akaba, Amarata, Swali, Yeneka, Bumoundigbene, Bumoundi, tombia, Yenegwe, Nedugo Agbia, and Ogboloma. The rest of the settlements in Yenagoa was not considered in the course of this work. The map allowed the capturing of the buildings within the 11-meter setback of the powerlines.

### 4.2. Buffering Analysis on the Powerline Corridor

Buffering analysis on a distance of 11m was done (Fig 2). The 11m distance is the stipulated right-of-way by the Nigerian Electricity Supply and Installation Standard Regulation (2015), for both 11kv and 33kv (regarded as medium voltage powerline by Gönen, 2014) that was used in the course of this research.



*Source: Researcher's field work, 2020.*

Fig. 2: Building encroachment into the overhead powerline right-of-way in Yenagoa.

However, about 42,114 houses were in the study area, 4% (1,692) encroached, while 96% (40,422) complied. This means that, about 4% of these houses located on the powerline right-of-way, had the inhabitants exposed to hazards associated with proximity to powerline on daily bases. It was also observed that these building on the clearance zone of powerlines are mostly scattered all over the city especially along the major and minor roads.

### 4.3 Socio-economic Characteristics of Respondents

The total number of respondents were three hundred and ninety-seven (397), two hundred and two (50%) were males while one hundred and ninety-five (49%) were females making males more responsive than females. 14% (54) of the respondents were single, 69% (273) were married, 5% (21) were divorced, 11% (42) were single parent while 2% (7) of the respondents were widowed. That is to say that the majority of the respondents were married, with children/family and were 'bread-winners'. Therefore, being exposed to the hazard of overhead powerline is detrimental to the mental and financial well-being of their families.

Furthermore, 14% (57) of the respondents in the study area were aged 18-25, 13% (53) were within 26-35 years, 31% (122) were within 36-45 years, 23% (92) were within 46-55 years, and 18% (73) falls within the age bracket of 56 years and above. It can be deduced therefore that the occupants of the powerline setbacks are predominantly middle aged. 14% (56) of the respondents had no formal education, 19% (77) had primary education, 50% (198) had secondary education and 17% (66) had tertiary education. This means that, the

majority of the respondents are not well educated hence had little or no knowledge of the consequences associated with existing on the powerline right-of-way. However, 56% (210) of the respondents were indigens who left their family houses in search of greener pastures while 19% (184) were non-indigenes who migrated into the study area in other to make ends meet. 14% (54) had household size ranging between 1-2, 37% (148) between 3-4; 27% (109) between 5-6; 22% (86) had above six (6) household sizes. Agricultural source of income accounted for 33% (131) while non-agricultural contributed 67% (266). That is to say that, a good number (67%) of the respondents earn a living through non-agricultural means (such as trading, artisanship, civil service etc) hence the reason for the makeshift shops scattered all over the study area which infringed on the powerline clearance zones. This is evident in the fact that, 8% (32) of the respondents were unemployed, 6% (23) were civil servant, 5% (21) were public servant, 54% (215) were traders, whereas 27% (106) were Artisans. Yenagoa had 40% (157) of respondents with average monthly income of less than ₦30,000, 26% (104) for ₦30,000 - ₦60,000, 18% (73) for ₦61,000- ₦90,000, 7% (29) for ₦91,000 - ₦120,000, and 9% (34) for ₦120,000 and above). That

is to say that the occupants of the structures on the powerline right-of-way were predominantly low-income earners who could not afford strictures outside the powerline clearance zone and who falls below the dollar per day standard often used by the National Bureau of Statistics in measuring poverty.

#### **4.4 Characteristics of Buildings on the Powerline Right-of-way**

The characteristics of buildings on the setback of powerline was examined in order to ascertain the features and types of buildings exposed to powerline hazards. However, it was observed that 73% (291) occupied rooming/face to face, 21% (85) occupied flats, 5% (21) occupied storey buildings, while none occupied duplex. Furthermore, 46% (181) of the respondents in the study area lived in the building while 54% (216) work/trade there. Convincingly, a greater proportion are into the exchange of goods and services in order to earn a living. This means that, both the lives of the occupants and their source of livelihood were exposed to the threats of overhead powerline. 30% (118) of the structures were used for residential purposes, 47% (185) for commercial, 1% (5) for industrial, and 22% (89) for both residential and commercial purposes. This means that, these respondents

that occupied the residential houses together with their households are under the threat of powerline hazard, the percentage that used it for commercial purpose together with their sales person(s) and/or apprentice(s) and customers are also exposed; while the residential/commercial buildings expose households (if their households are occupants of the same building), businesses, sales person(s) and customers. However, 9% (36) of the respondents in the study area existed in buildings worth less than ₦100,000, 13% (53) worth ₦101,000 - ₦300,000, 8% (32) worth ₦301,000 - ₦500,000, 21% (83) worth ₦501,000 - ₦1,000,000, and above ₦1,000,000 worth, accounted for 49% (193). That is to say that a greater percentage (49%) of the structures occupied by the respondents in the study area were expensive, (worth over one million naira - ₦1,000,000) and cannot be easily replaced by either the property owners nor the government should there be a hazard outbreak. 91% (362) of the respondents occupied structures made with concrete, 5% (18) wood, and 4% (17) zinc/metal. 30% (121) of the respondents occupied building less than ten (10) years, 41% (164) between 10-20 years, 4% (16) between 21-30 years, 16% (62) occupied building 30 years and above, while 9% (34) had no idea. This

means that these buildings siting on the powerline buffer corridors are relatively recent buildings which are attached or built not more than 20 years ago.

#### **4.5 Factors Responsible for Locating the Buildings on the Powerline Right-of-way**

The factors responsible for locating the buildings on the powerline setbacks was enumerated in this section. This was to ascertain the various reasons why the respondents who are property owners chose to erect their buildings on the setbacks of powerline.

In the study area, 26% (102) of the respondents were property owners while 74% were tenants. However, when accessing the reasons for the choice of structural location by the property owners, 61% (62) of the respondents said they wanted to make money, 27% (28) said it is their community, 9% (9) said it was because of the infrastructural and social facilities, while 3% (3) gave other reasons. The major reason why the respondents who were property owners built on the powerline clearance zones was because they wanted to improve (add to) their income. They achieved this by adding shops/houses in front of their already existing buildings

(which did not encroach into the powerline right-of-way) thereby making the shops or additional rooms encroach into the setbacks of powerline. Furthermore, 87% (89) were willing to relocate if compensated by the government, while 13% (13) were not. 41% (42) of the respondents said they do not experience reduction in property value while 59% (60) said they do. 5% (3) said proximity to overhead powerline was the reason for the reduction in property value, 12% (7) said inadequacy of infrastructural facilities, 35% (48) said irregular power supply, whereas 25% (15) had other reasons. Therefore, irregular power supply is the major reason for the reduction in the value of properties on the right-of-way of overhead powerlines. Moreso, 37% (145) of the respondents in the study area said they were aware of the hazards associated with medium voltage powerline, while 63% (251) said they were not aware. That is to say that a greater percentage of the respondents in the study area were not cognizant of the fact that residing on the buffer corridor of powerlines were dangerous.

## **Conclusion**

From this study, it is clear that 4% (1,692) of the buildings in the study area encroached into the medium voltage powerline right-of-

way. This showcased the inadequacy, on the part of the government, in monitoring developmental activities in the study area. These buildings, as observed, are mostly rooming/face to face, concrete buildings not more than 20 years of age, used for commercial purposes. They are occupied by predominantly poor indigens who are not well educated and therefore ignorant of the hazards associated with proximity to powerlines.

This study also showed the usefulness of Geographic Information System (GIS) in developmental planning, monitoring and regulation compliance.

## **Recommendations**

It is therefore recommended that the base map of the medium voltage powerline produced in the course of this research should be used by the government in decision making and for future developmental planning.

Furthermore, all one thousand six hundred and ninety-two (1,692) building siting on the setbacks of powerline should be demolished and the rights-of-way landscaped or beautiful trees and shrubs planted there as this will serve as another way of improving the ecosystem. There is also need for massive public sensitization on the possible

hazards associated with living in proximity to powerline.

Also, the inhabitants should be relocation and the property owners compensated. There is need for the provision of affordable low-cost housing estates for the low-income earners in the study area.

The Bayelsa state government should pass into law and also ensure strict adherence to setbacks as stipulated by the Nigerian Electricity Supply and Installation Standard Regulation (2015).

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