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SPATIAL ANALYSIS OF BUILDINGS ON THE MEDIUM VOLTAGE OVERHEAD POWERLINE SETBACKS IN PORT HARCOURT, NIGERIA.

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Abstract
This study spatially analyzed of Buildings on The Medium Voltage Overhead Powerline Right-Of-Way in Port Harcourt, Rivers State, Nigeria. To map medium voltage powerlines across the study area, ArcGIS 10.7.1. was used. The coordinates of each pole were acquired using the Global Positioning System (GPS). This was imported into the ArcGIS environment and enabled the mapping of medium voltage overhead powerlines across the study area. The overhead powerline right-of-way was obtained by buffering the powerlines with a distance of 11m to represent the stipulated setback. The lines were buffered to enabled the capturing of the buildings within the 11m setback from the powerlines. The result showed that about twenty-nine thousand and thirty (29,030) structures in the study area were under the menace of medium voltage powerline hazards. It is therefore recommended that, demolition of encroached buildings, landscaping and planting of trees and shrubs on powerline rights-of-ways should be encouraged as another way of greening the cities and improving urban ecology. This study therefore showcased the importance of Geographic Information System (GIS) in environmental monitoring and planning.

Keywords: Buildings, Right-of-way, Encroachment, Medium Voltage, Overhead Powerline, Regulatory, Setbacks.

INTRODUCTION

The rate at which city populations develop and countries urbanize reflects the rate of social and economic change (Vocht, Philips, O'Carrol, & Henshaw, 2013). In the year 1800, London was the only city in the world with a million residents, with the population of the world's 100 largest cities totaling only 20 million. By 1990, the world's top 100 cities had a combined population of 540 million people, with 220 million of them living in

the world's top twenty cities (Olsen, 2018). In 2006, the global urbanization figure surpassed 3.3 billion people, accounting for roughly half of the world's population. By 2050, the target year for the Millennium Development Goals (MDGs), cities are expected to grow to two-thirds (6 billion people), with the majority of this growth occurring in developing countries (United Nations, 2014). With these trend, land rights, housing and sustainable habitats become economic issues which are not only important for individuals' survival but also future development of cities (Olasunkanmi, 2015). According to United Nations Human Settlements Programme - UNHABITAT (2008), though Africa still had only 39.15% of its total population in cities, its urbanization rate from 2005 - 2010 was 3.31%. The projected urbanization rate for Nigeria between 2010 and 2020 is 3.39%. The recently reviewed population statistics of Nigeria by National Population Census 2010 puts Nigeria's population at 167,000,000 people (Oketola, 2012). Notwithstanding the constantly increasing population, and total land area is still fixed at 923,700 square kilometers. Hence population density, in the face of competing uses of land or land use will continually soar. 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 will 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 as well as rights-of-ways are then filled up with various developmental activities without considering environmental impacts.

Right-of-way, otherwise known as clearance zone/ powerline (buffer) corridor is the distance of any structure from the middle conductors of overhead powerlines of any voltage level (Nigerian Electricity Supply and Installation Standards Regulations, 2015). It can also be defined as an area of land that shows the safe distance between the electricity source and where structures/building can be instituted. It sets the boundaries of where construction can safely occur in relation to powerlines and cables. Building inside the clearance zone is hazardous and also put future workers at risk by forcing them to work within the danger zone. As a result, Nigerian Electricity Supply and Installation Standards Regulations (2015) has stipulated a minimum horizontal distance (right-of-way) of 11-meters between a building and 11kv cable, and minimum horizontal distances of 11 meters, 30 meters, and 50 meters are recommended for a building between 33kv cable, 132kv cable, and 330kv cable respectively.

This research is concerned with the level of property encroachment or compliance to

regulations governing distribution lines rights-of-way and safety of people living near, working on or in close proximity to such lines. Therefore, for the purpose of this research work, 11kv and 33kv which are medium voltage powerlines with 11-meter setbacks was considered. This is because, medium voltage powerlines are more rampant in urban areas, lining across streets, expressways, major and minor roads; and 11-meter setback is the minimum clearance distance or right-of-way to be observed.

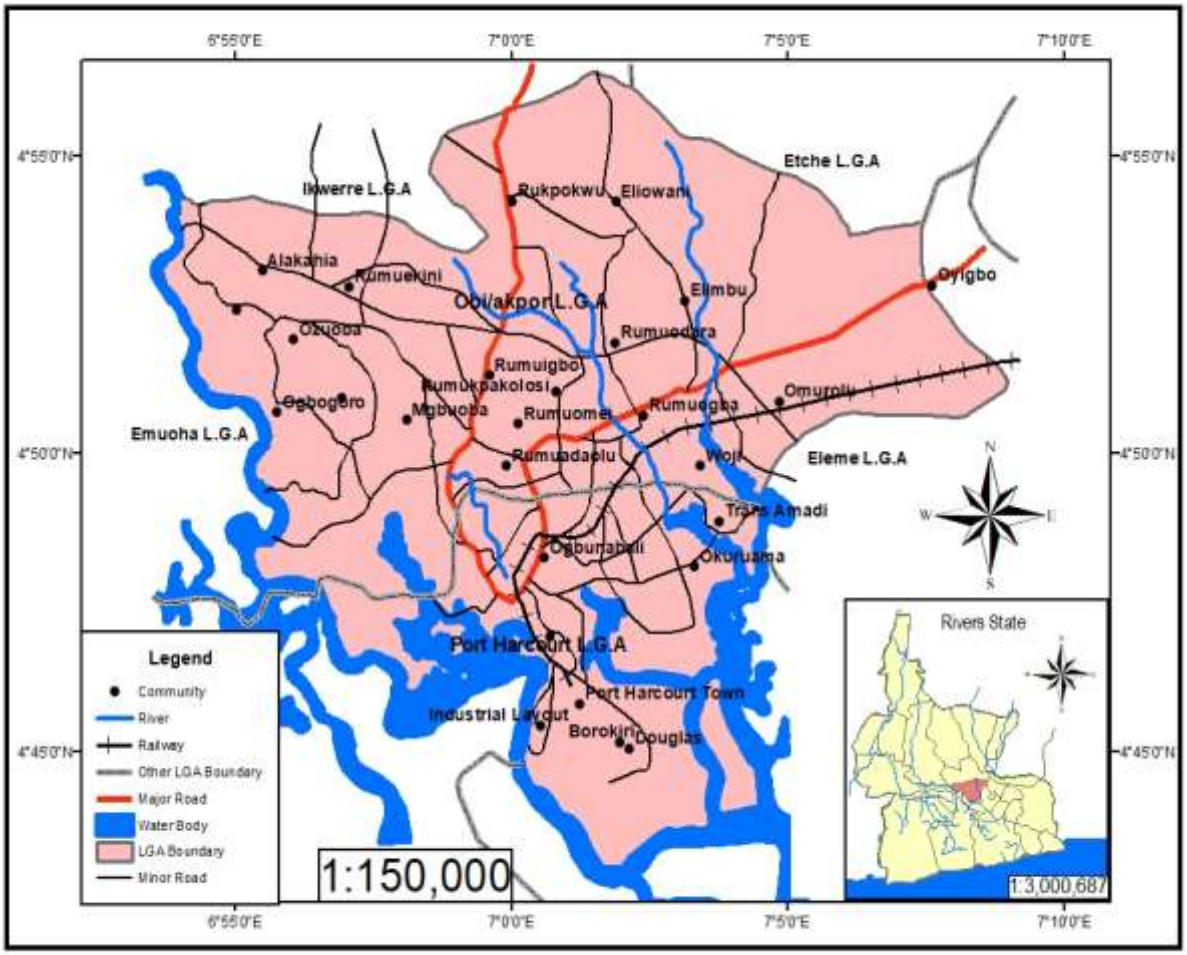
Aim and Objectives

The aim of this study is to analyze the buildings on the medium voltage overhead powerline right-of-way in port Harcourt, Rivers State. The objectives of the study are to:

1. Map medium voltage power transmission lines across the study area
2. Identify and examine buildings encroaching on the stipulated 11-meter setback from medium voltage overhead powerline
3. Examine the demographic characteristics of households occupying the buildings on the powerline right-of-way
4. Examine the characteristics of buildings within the powerline right-of-way
5. Investigate the factors responsible for locating the buildings on the powerline right-of-way.

Study Area

The study area is Port Harcourt city, in Rivers state, consisting of two local governments: Port Harcourt and Obio/akpo Local Government Area (Fig 1). It falls within latitude 4.8156° N and Longitude 7.0498° E.



Source: Adapted from NASRDA, 2010 and Digitized by the Researcher
Figure 1: Port Harcourt City

2.0 Literature Review:

Olasunkanmi (2005) explores the planning and health effects of land use encroachment on setback from high-tension powerlines in Agbado, Ogun state, Nigeria, based on an empirical examination of relevant literatures. The goal of this study is to determine the impact of land use encroachment on the setback of high-tension powerlines in Agbado, Ifo Local Government Region, Ogun State, in order to propose measures for managing development in the study area.

A 50-meter buffer was established on both sides of the high-tension powerline passing the affected region using remote sensing technology, while random systematic sampling based on an interval of four buildings was used for household evaluation. Households were the data gathering units. The survey included household heads in 150 buildings, accounting for 25% of the total, and 7% of the total households in the research region. The findings show that there are 602 land uses identified in the research region, with 427 (71%) of them being residential, and none of the buildings assessed have an approved plan.

Furthermore, the majority of respondents (52.7%) are unaware of the harmful health impacts of

electromagnetic fields released by high-tension powerlines. This is followed by 24% who are aware of the potential detrimental health effects of electromagnetic fields released by High-tension Powerlines and 23.3 percent who are unconcerned; 96 percent of respondents claim not to have been diagnosed with leukaemia, and 4% are unconcerned. Meanwhile, the vast majority of leukemia patients (91.7 percent) interviewed at the Lagos State University Teaching Hospital (which specializes in leukemia treatment in the Ogun-Lagos Region) claim they have never lived near a high-tension powerline, while 8.3 percent admit they have.

In a similar vein, Usikalu, Olawole, and Ikeh (2004) evaluated the level of extremely low frequency radiation from powerlines in order to identify safe distances for human activities and homes. Between February and May 2013, while the lines were supplying energy in all areas with powerlines in Ota, Ogun State, Nigeria, the measurement was carried out during regular everyday human activity from 8:00 a.m. to 4:00 p.m. An ELF Detection meter developed by Action Electronics, USA was used to monitor Extremely Low Frequency (ELF) related with transmission powerlines in various areas in Ota, Nigeria.

The lowest average ELF detected was 1.15 mG at 200 feet (61 meters) distant from the transmission lines, while the maximum was 50 mG at the power transmission line's base. The ELF field appears to diminish rapidly with distance from the source or hot areas. The study concludes that building dwellings or engaging in other human activities within 200 feet (61 meters) of power transmission wires is not safe.

Similarly, Nkeki (2013) highlights the capability of Geographic Information System (GIS) methodologies in identifying populations in the Benin region of Nigeria who are both exposed to EMFs and at risk of electrocution since they live inside the zone of possible risk near powerlines. GIS buffering, overlay, and address geo-coding are utilized to create a database that contains both geographical and non-spatial data, allowing for a holistic visualization of the population at risk. Zones of double danger and single risk are used to categorize potential risk locations. Double-risk zones account for 51% of the 20 percent of the built-up area that is exposed to electromagnetic radiation, while single-risk zones account for 49%. Furthermore, the bulk of exposed zones are concentrated in high-density residential areas on the region's outskirts. This research also shows that a GIS-assisted database will improve future epidemiologic research and act as a platform for better decision-making.

Olamiju and Oyinloye (2015) used GIS to investigate the features and vulnerability of houses in Akure, Nigeria, that are subjected to overhead high-tension powerlines. He examined the characteristics of people and the vulnerability of dwellings beneath the 330KV overhead powerline in Akure, Nigeria. This study combined the social survey research method with GIS analysis utilizing remotely sensed data. The powerline goes from the north-east to the south-east over Akure, covering a distance of around 10 kilometers. The ArcView GIS software was used to generate 30m

and 60m buffers on both sides of the facility, resulting in the identification of 126 buildings that were infringing on the setback.

According to empirical analysis, 68 and 58 buildings in the corridor are vulnerable to electromagnetic radiation health hazards, respectively; more than 60% of buildings in the corridor are of the face-to-face/roomy type, which is typically associated with low-income earners; respondents' average age is 37, and their average household size is 5. Over 60% of individuals polled work as dealers or artisans, with only 16.0 percent possessing a formal education.

Abidoye and Oyedeji (2014), on the other hand, investigate "The Impact of High Voltage Powerlines on Residential Property Values in Selected Areas of Lagos State." This research aims to add to the body of information on the issue and, more crucially, to fill a vacuum in knowledge about Nigeria, specifically the Lagos Metropolitan Area. The study is focused on the Lagos Metropolitan regions of Ejigbo and Isolo. It uses a stratified random sample method to deliver oral interviews and questionnaires to people residing within 0-200m, 201-400m, and 401-600m of high voltage powerlines. The findings demonstrated that being close to high-voltage powerlines raises the annual rental value by 6.8% as the distance between the powerlines grows by 200 meters from its center.

Abdulkareem (2016) conducted study on "Evaluation and Mitigation of Technical Losses on Powerlines: A Case Study of the Nigerian 330-Kv Network." A novel technique is being developed to simulate unbalanced short-circuit faults (SLG, LL, DLG) on each line of the three-phase network in order to precisely assess these transmission losses. At each bus, different features of these asymmetrical failures are simulated to see how they affect the voltage magnitude, line current, and maximum fault current in the test system. The test system is Nigeria's current 28-bus, 330-kV power system.

A MATLAB software was created to execute the numerous computations required for the analysis of all 28 faulty buses considered quickly and accurately. This method captures peak technical losses in three categories of maximum line current, namely low, medium, and high currents, which are analogous to steady-state, subtransient, and transient currents. As a result, the transmission line losses were calculated using these. For low, medium, and high current levels, the equivalent powerline losses were 146.73MW, 322.24MW, and 738.28MW, respectively. The yearly energy (MWH) losses owing to low, medium, and high-power losses in 2013 were 443.45GWH, 976.895GWH, and 2231.230GWH, respectively, totaling N8.4 billion, N18.6 billion, and N42.4 billion. The load-flow result obtained using MATLAB and Power Word Simulator (PWS) validates the low-power loss (steady-state) result of this work, while the annual MWH for the high-power loss level compares favorably with the normal practice of utility operators' monthly energy balance, closing the gap between practical and theoretical information. A total of 335 and 25 violations are recorded in the single line contingency analysis for the uncompensated and

compensated system networks, respectively. These findings reveal a significant improvement in the voltage profiles of all impacted buses, as well as an 18.35 percent reduction in power loss. The other section of loss mitigation measure determines the fault current magnitudes for three phase short-circuit simulated in 28 sites using Matlab which is utilized to calculate the lines" circuit breaker ratings. The research work has analyzed network losses with optimal network efficiency that promotes higher dependability and security for sustainable electric energy supplies.

In Abakaliki, Ebonyi State, Nwofe (2016) explores the risks linked with electrical equipment in households and powerlines. The likely reasons, and implications, are x-rayed utilizing a literature based conceptual approach; hence the author studies the literature on electrical and powerlines dangers in Abakaliki Metropolis, Ebonyi State, Nigeria. The study finds that high level of illiteracy, lack of Government attention in implementing regulations that could prevent future occurrences, bribery and corruption, and criminality are the key causes of the electrical risks. After that, the author offers recommendations for remedies that can improve reduced cases, sustainable urban planning, and feasible routes to a hazard-free sustainable green city.

However, the perceived environmental costs of high voltage powerlines, including health risks and property value losses, are frequently limited to the powerlines' immediate zone of influence, which is only a few meters wide (Haider & Haroun, 2001). Health-related risks (such as a greater incidence of cancer) and property value loss in adjacent property occupants remain a contentious topic till date, with researchers on both sides failing to provide conclusive evidence in support of their claims. Furthermore, the majority of these research were conducted in developed countries, with very little information on emerging countries, particularly Nigeria.

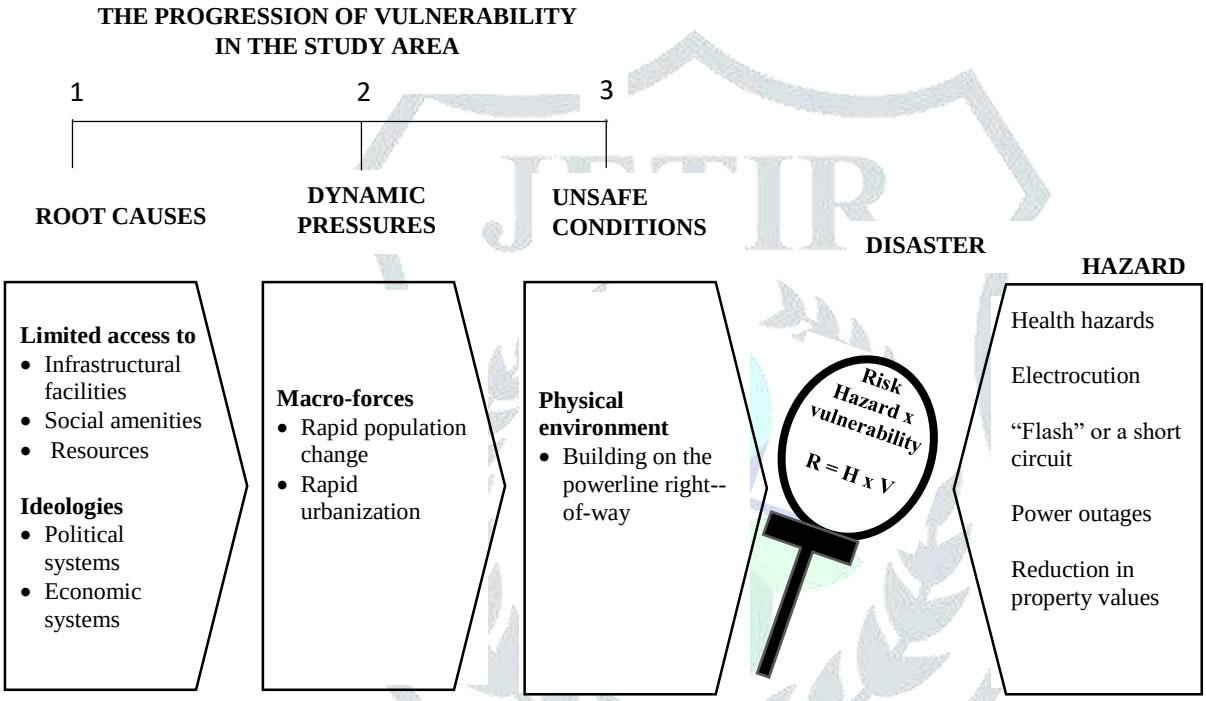
However, no study has been done on distribution lines with emphasis on 11kv and 33kv. The level of property encroachment into the power distribution line right-of-way or setbacks has neither been recognized nor measured. Furthermore, the extent to which properties complied with the required setbacks of overhead electricity distribution lines right-of-way has not been investigated.

This research used qualitative statistics and questionnaires as data collection strategies. Some 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.

Pressure and Release Model

In the study area, poor governance, inadequate infrastructural facilities, social amenities etc has pushed the rural inhabitants into the urban centers, leading to rapid urbanization/over population.

This urban populace strives on the limited available lands which most often have high value and/or cause land conflicts/disputes. Consequently, the rapid urbanization and inadequacy of land for building lead to the development of the overhead powerline right-of-way or buffer corridors. The consequence of such actions i.e., the building on the powerline right-of-way, can result to several issues such as electrocution, health hazards such as childhood leukaemia and chronic lymphocytic leukaemia in adults, "Flash" or a short circuit, power outages, reduction in property values etc.



Source: Adapted from Wisner et al., (2004)

Figure 3: The Pressure and Release Model of the Study area

However, the PAR model proved beyond doubts that it is the most suitable vulnerability framework to be adopted for this work because it went beyond the identification of vulnerability by addressing the underlying driving forces, as well as root causes. The framework was also able to explain why the urban residents of the study area found within the overhead powerline right-of-way are classified as being vulnerable to the hazards associated with powerlines (figure 3).

Materials and Methods

Sources of Data

Both primary and secondary data was utilized in the course of this study. They include questionnaire, photographs, physical observation, Global Positioning System (GPS) coordinates, satellite imageries, and Publications from books, journal articles, magazines etc.

The acquisition of overhead powerline data in the study area was done using the Global Positioning System (Etrex instrument) - GPS and applied into GIS environment.

The GPS was used to acquire the coordinate location of each pole; and the point of urban encroachment to the overhead distribution line right-of-way was analyzed within geospatial environment using Arc GIS. The GIS software (Arc GIS 10.7.1) and the image analysis over the study area enabled the determination of the level of encroachment into the power distribution line right-of-way.

A structured questionnaire was developed and utilized for this study. The questionnaire comprised of two sections which dealt with the biodata of the respondent, at the first segment while the second part dealt with the issues regarding the characteristics of the buildings and the factors responsible for locating the buildings on the powerline fallow corridor. The questionnaires were responded to by the head of households or shop owners. In the absence of shop owners, the receptionists or shop attendants (sales personnel) who are eighteen (18) years and above responded to the questions. A total number of four hundred questionnaires (400) were distributed.

- ✓ Buffering Analysis (11m distance) on the powerline Corridor was used to analyses the spatial distribution and conformity of urban development across the study area in relation to required standard.
- ✓ Descriptive statistics was used to describe the percentage of the frequency trend.
- ✓ Objectives delineated for this study was tested as follows:

1. The location of each pole was acquired using the GPS to get the coordinate of each pole holding the overhead powerline. This enabled a proper understanding of the trend and route of lining across the state capitals. The coordinate of each pole was imported into the ArcGIS environment to enable the mapping of the overhead powerline route.
2. The goggle image of the study area was derived, georeferenced and mosaiced to make for continuity across the study area. The overhead powerline right-of-way (obtained by buffering with a distance of 11m) was over laid on the google image to enable the enumeration and delineation of buildings that encroached on the right-of-way of the overhead powerline.
3. The questionnaire from the investigation of the demographic characteristics of households occupying the buildings on the powerline right-of-way was analyzed. The sampling was done using the simple random sampling technique, while the Taro Yamane formula was used to determine the sample size. The formula is stated below:
    a. **$n = N / (1 + Ne^2)$**
    b. where n = corrected sample size, N = Population size, and e = Margin of error (MoE), e = 0.05 based on the research condition.
4. The questionnaire aided in the examination of the characteristics of buildings that

encroached into the powerline right-of-way. Sampling was done using the simple random sampling technique, while the Taro Yamane formula was used to determine the sample size.

5. The questionnaire also aided in the investigation of the factors responsible for locating the buildings on the powerline right-of-way. The sampling was done using the simple random sampling technique, while the Taro Yamane formula was used to determine the sample size.

RESULTS AND DISCUSSION

Map of the Medium Voltage Power Distribution Lines across the Study Area:

The map of the medium voltage power distribution lines across the study area enabled a proper understanding of the trend and route of lining. The map allowed the capturing of the buildings within the 11-meter setback of the powerlines.

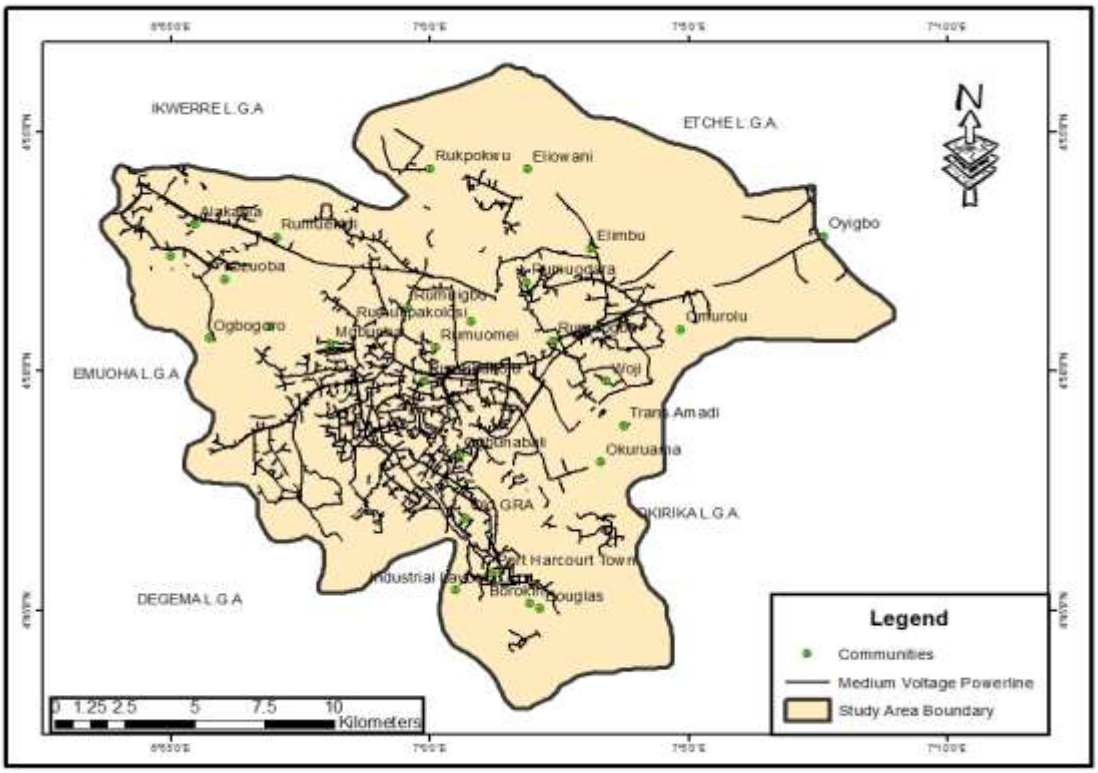
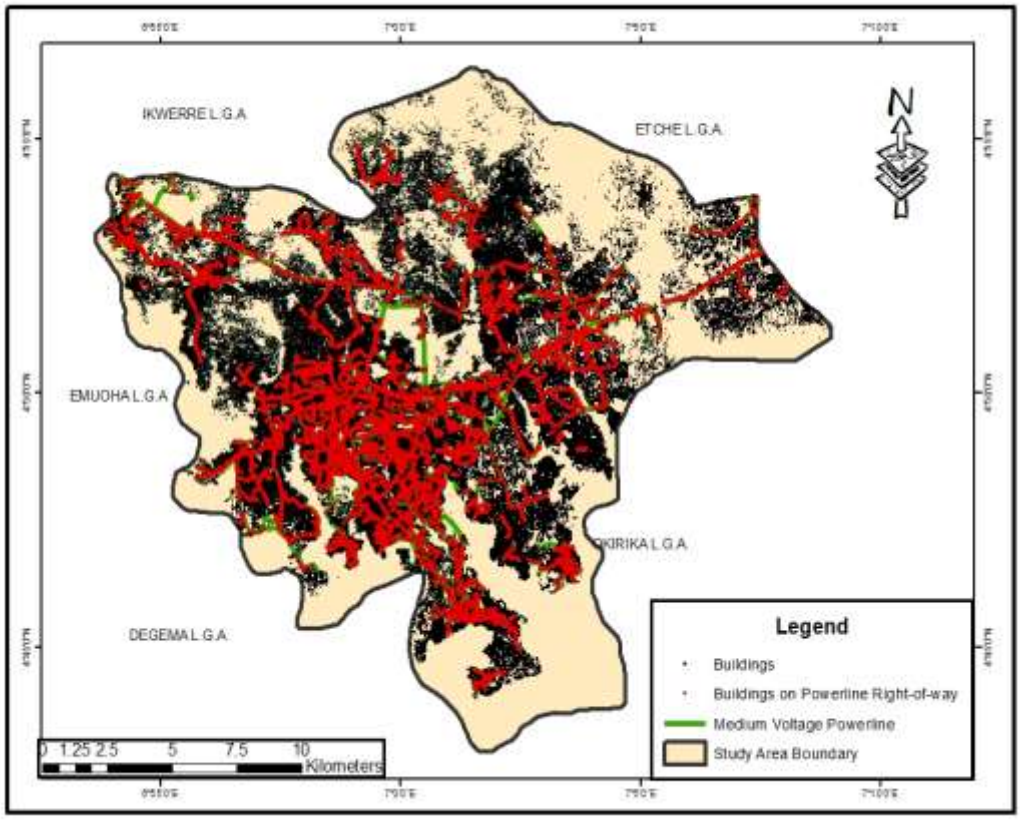


Fig. 2. Medium Voltage Overhead Powerline Map (Port Harcourt, Nigeria).

Source: Researcher's field work, 2020.

4.1.2 The Extent of Building Encroachment:

The extent of building encroachment was analyzed in other to depict the buildings that did not comply to the stipulated 11-meter setback from medium voltage power distribution lines (fig: 3).



Source: Researcher's field work, 2020.

Fig. 3: Building encroachment into the overhead powerline right-of-way in Port Harcourt.

The extent of encroachment into the powerline right-of-way was shown in figure 3. The essence was to illustrate the number of houses present in the study area, the number that encroached into the clearance zones of powerlines and as such exposed to the powerline hazards, and the number that complied to the stipulated 11-meter setback. However, the study area recorded about 239,048 number of houses, of which about 12% (29,030) encroached, while 88% (210,018) complied.

Socio-Economic Data of Respondents

Gender of Respondent

Respondents' gender was included to gain the perception of both male and female respondents on their vulnerability as they reside within the overhead powerline right-of-way across the study area.

The result indicated that, one hundred and seventy-eight (178) i.e., 45% males and two hundred and sixteen (216) i.e., 55% females

responded to the instrument. 43% (one hundred and seventy-one - 171) of the respondents were single, 40% (159) were married, 8% (32) were divorced, 5% (20) were single parent, while 3% (12) were widowed. 20% (80) of the respondents were within the age bracket of 18-25 years old, 28% (112) were within 26-35 years old, 37% (147) were within 36-45, 11% (44) were within 46-55% and 3% (11) were above 56 years old. It was however observed that 25% (97) of the respondents had no formal education, while 15% (61) acquired primary education, 46% (181) had secondary, while 14% (55) obtained tertiary education.

Furthermore, 37% (147) were origins of the study area while 63% were not; 26% (101) had household size ranging from 1-2, 47% (187) between 3-4, 23% (89) between 5-6, and above 6 household sizes accounted for 4% (17) of the respondents. Also 13% (50) of the respondents in Port Harcourt had agriculture as their primary source of income, while 87% (344) had non-agricultural source of income. 22% (85) were unemployed, 10% (40) were civil servants, 17% (67) were public servant, 33% (130) were traders, while 18% (72) were artisans. The respondents whose average monthly income was less than ₦30,000 contributed 54% (211), ₦30,000-₦60,000 was 26% (104), ₦61,000 - ₦90,000 was 8% (33), ₦91,000 - ₦120,000 was 9% (34), and above ₦120,000 contributed 3% (12).

Characteristics of the Building

The characteristics of buildings found within the study area was evaluated in other to ascertain the features of the buildings commonly found within the medium voltage powerline buffer corridor. In the study area, 49% (194) of the respondents occupied rooming/face to face, 35% (139) occupied flat, 13% (50) occupied storey building, and 3% (11) occupied duplex. Also, 91% (359) of the building occupied by respondents were made of concrete, 4% (15) were made of wood, while 5% (20) were made of zin/metal. 53% (208) of the respondents occupied buildings less than 10 years, 30% (117) between 10-20 years, 7% (27) between 21-30 years, 5% (19) between 30 years and above, while 6% (23) had no idea. It was discovered that, 11% (45) of the respondents occupied buildings worth less than ₦100,000, 8% (33) worth ₦101,000-₦300,000, 3% (12) worth ₦301,000-₦500,000, 9% (35) worth ₦501,000-₦1000,000, and 68% (269) worth ₦1,000,000 and above.

Furthermore, in assessing the characteristics of the buildings on the overhead powerline right-of-way, it was observed that, 39% (155) of the respondents live in the building while 61% (239) trade/work there; 21% (84) of the structures were duly registered, 73% (287) were not, while 6% (23) had no idea if the building were registered or not. According to the respondents, 22% (86) of them occupied residential buildings, 44% (175) commercial, and 34% (133) residential/commercial buildings.

Factors Responsible for Locating the Buildings on The Powerline Right-Of-Way

This analysis was carried out in other to determine the reasons for the choice of structural location by the property owners. However, 70% (55) of the

respondents in Port Harcourt said they erected the structures in other to make more money, 19% (15) said they were indigenes of the community, while 11% (9) said it was because of the presence of infrastructural (especially road) and social facilities (where population is high in other to patronize them). Therefore, it is pertinent to say that 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 economy. This they achieved by adding shops/houses to their already existing buildings thereby encroaching into the setbacks of powerline. However, 72% (57) of these property owners said they were ready to relocate should they be compensated by the government, while 28% (22) were adamant. The frequency of power outage was accessed in other to further ascertain the attraction of people to the area/building. It was discovered that 36% (140) of the respondents said they experience power outage very often, 37% (147) said often, while 27% (107) said sparingly. Since a greater proportion of the respondents said there was constant power outage, availability of power supply was not a pull factor. 80% (63) of the respondents in the study area said they do not experience reduction on property value while 20% (16) said they do. Also, 25% (4) of these property owners who experience reduction in property values said it is caused by proximity to overhead powerline, 19% (3) said inadequate infrastructural facilities, 38% (6) said irregular power supply, and 19% (3) had some other reasons. The result therefore showed that; irregular power supply is the major reason (47%) for the reduction in the value of properties on the right-of-way of overhead powerlines.

4.2 Discussion of Findings

The map of the medium voltage power distribution lines revealed the route of lining of the medium voltage distribution lines also known as high-tension lines. It concentrated more on the city center (such as Ogbunabali, OLD GRA) towards the western part (consisting of Mgbuoba, Rumuadaolu, Rumuomei, Rumukpakolosi, Rumuigbo), some part of the east (consisting of Rumuogba, Rumuodara) and the southern part of the city (consisting of Port Harcourt town, industrial layout, Borokiri and Douglas). The map enabled the capturing of the buildings within the 11-meter setback from the powerlines. Out of the two hundred and thirty-nine thousand and forty-eight (239,048) number of houses in the study area, twenty-nine thousand and thirty (29,030) existed on the powerline right-of-way, while two hundred and ten thousand and eighteen (210,018) complied to the 11m setback from overhead powerline. This means that 12% of the buildings complied while 88% encroached.

Findings on the socioeconomic data of respondents revealed that there are more females who are responsive than males in the study area. Also, there are more married inhabitants, (with household size ranging from 3-6) who were ‘bread-winners’, exposing them to the hazard of overhead powerline is detrimental to the mental and financial well-being of their families. Furthermore, respondents within the age bracket of 18-45 years and with secondary education were

more while only a small percentage had tertiary education and were more exposed than those within the age of 56 years and above. A greater percentage of the respondents were non-indigenes who came into the study area in search of greener pastures. However, the result showed that, a greater percentage of the respondents were mostly traders and artisans who earned a living through non-agricultural means and are predominantly low-income earners that could not afford better structures hence the reason for the improvised shops/houses that encroached into the powerline right-of-way. This result is in agreement with the works of Olumiju and Oyinloye (2015) who researched on Characteristics and Vulnerability of Houses under Overhead High-Tension Powerline in Akure, Nigeria, and noted that over 60% of the respondents in Akure were traders and artisans; while only 16.0% of them had no formal education.

In assessing the characteristics of the buildings on the setbacks of medium voltage powerlines, the result revealed that a greater percentage of the buildings were rooming/face to face, made of concrete material, and are recent buildings between 0-20 years. They were mostly rented shops worth more than a million naira, used for commercial purposes, and they were neither registered nor approved by the Ministry of Lands and Urban Development.

In examining the factors responsible for locating the buildings on the powerline fallow zone, it was noted that the property owners whose majority were ready to relocate said they built on the powerline clearance zones because they wanted to improve (add to) their economy. This they achieved by adding shops/houses to their already existing buildings thereby encroaching into the setbacks of overhead powerline. There was constant power outage in most of these buildings, the majority of the property owners do not experience reduction in property value, the little percentage that had a contrary view, the result revealed that it was as a result of irregular power supply.

Conclusion

The study revealed that there is developmental control gap on the medium voltage powerline rights-of-ways hence the reason for the 12% encroachment of structures. This is as a result of the debated nature of land ownership in the study area. Although the Nigerian Electricity Supply and Installation Standards Regulation (2015) has stipulated a strict no obstruction policy on rights-of-ways, they are still being violated on daily basis especially by land/property owners and no deterrent measures are being taken by the government.

Recommendations

The following recommendations were proffered:

1. The explicit map of the medium voltage powerline produced in the course of this research should be used by the relevant authorities (such as the Ministry of Urban Development, Town Planning etc.) in planning these cities as developmental activities keep growing.
2. All twenty-nine thousand and thirty (29,030) structures encroaching on the 11-

meter setback from the medium voltage powerlines routed through the study area should be demolished and the spaces landscaped with special trees and shrubs. This should represent another way of greening metropolitan areas and improving urban ecology.

3. According to Annex 3.3 World Bank Policy on Involuntary Resettlement Policy Directive OD 4.30, encroachers are not eligible for compensation after displacement from their illegal locations (Olamiju and Oyinloye, 2015). They are also not eligible to rehabilitation measures. However, there is need for the encroachers to be displaced as soon as possible since the licensee of the powerline is not liable for any mishap caused by contact with the line (Nigerian Electricity Supply and Installation Standards Regulations, 2015); and also, in other to curb the reoccurrence of both health and physical hazards associated with proximity to overhead powerline.
4. The government should as a matter of urgency, setup/invest in site and services schemes, mass housing development, and proactive development control in this era of rapid urbanization. This will prevent potential house developers from developing lands unsustainably. It will also enable the government realize more revenue from issuing certificate of occupancy and building approval charges.
5. There is need for sensitization by the state government through media publications and advertisement (both on televisions and radios) on the adverse effects of building/living in close proximity to overhead powerlines. The government should equally ensure that the minimum stipulated distance of 11-meter setback is enforced in both the study area and other cities traversed by medium voltage powerlines in Nigeria and the world at large. Also, future defaulter should be punished as this will deter further encroachment. The relevant authorities in each state should be empowered in carrying out its developmental control responsibilities. Site inspection vehicles and adequate security should be made available for officers that are involved in Environmental monitoring and compliance.

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