Global Scientific JOURNALS

GSJ: Volume 9, Issue 12, December 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

ANALYSIS OF URBAN DEVELOPMENT AND THE EFFECTS ON OVERHEAD POWERLINE RIGHT-OF-WAY IN PORT HARCOURT, RIVERS STATE

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Keywords: ***Encroachment, GIS, Image Analysis, Medium Voltage, Powerline, Right-of-way, Setback.***

Abstract

The study analyzed urban development and its effect on overhead powerline right-of-way in Port Harcourt, Nigeria, with the view of suggesting strategies for controlling development in the study area. To map medium voltage powerlines across the study area, ArcGIS 10.7.1. was used. The coordinates of each pole holding the lines were obtained using the Global Positioning System (GPS). This was digitized in ArcGIS environment and the map of medium voltage overhead powerline of the study area was produced. 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 12% of the structures in the study area were under the menace of medium voltage powerline hazards. Furthermore, Landsat images was used to delineate the extent of encroachment into the powerline right-of-way. The area extent of development into the overhead powerline right-of-way was delineated from the overlay of the powerline on the image analysis of urban development across the state capitals. The result also revealed that, the built-up areas with powerline coverage experienced constant and rapid increase especially in Port Harcourt. This was as a result of increase in urbanization and the need for power supply. The respondents experienced some hazard events such as shock, burns, electrocution, powerline sagging and flash lights. 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 showed the importance of Geographic Information System (GIS) in environmental monitoring and planning.

INTRODUCTION

With the population growth and rising urbanization especially in the Niger Delta, the capital cities keep expanding with many buildings constructed near and under medium voltage overhead power distribution lines (otherwise known as high tension lines). The quest for power supply has resulted to continuous distribution of enormous quantities of electricity across long distances. Medium voltage distribution line produces electric and magnetic field stresses which are detrimental to both humans and objects/structures in close proximity to it or within its right-of-way.

For instance, in October 2021, a lady by name Latifia Seiyi and her four-month-old baby got electrocuted in Port Harcourt (Agip Estate, Obio/Akpor L.G.A) when an 11kv cable formed an arc flash which ignited fire and fell over the roof of her house which was located on the right-of-way of powerline (Olerum, 2021).

Similarly, in Feb, 2010, eleven (11) passengers in Port Harcourt got electrocuted while on transit when 33kv cable snapped and struck two Nissan busses plying on the road located on the right-of-way of powerline.

In the same vein, a female student of Rivers State University got electrocuted in June 2017 while trying to cross over an erosion which was within the school premises while trying to move across an erosion after a downpour. According to National Helm (2017), the erosion she was trying to get across had a high-tension wire in it as a result of a pole that fell the previous day. It was gathered that the Port Harcourt Electricity Distribution (PHED) Company was contacted the same day the high-tension pole fell but all effort to get them address the situation seemed fruitless.

April 2017, about thirty (30) football fans in Calabar got electrocuted when a high-tension power cable fell over their viewing center which was located on the right-of-way of overhead powerline (Punch online Newspaper, 2017).

Similarly, 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 atleast three (3) persons were electrocuted every week between April and June 2019 across the land (Punch online Newspaper, 2017). 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).

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

(Plate1). For instance, any obstruction on the overhead powerlines right-of-way can cause electricity from the lines to “flash” or cause a short circuit. Obstructions such as swimming pools also can create situations (such as a person using a long aluminum pole to clean the pool) that increase the danger from overhead powerlines. Again, while the top of a shed might be outside the required clearance zone, standing on the shed roof or using a ladder near the shed could cause an unsafe situation. Obstructions in the right-of-way are dangerous and can lead to power outages. They become more of a problem during periods of peak electricity usage, such as summer heat waves, when powerlines can sag significantly due to heavy loading.

In addition, some of the health issues associated with living in close proximity to powerline are as follows: different types of cancers (such as leukaemia, tumour etc), genetic flaws and abnormal hormone production and regulation, damages to the skin, impairment in cell activities, memory changes, sleep and daily rhythm disturbances; also blood and circulatory problems, immune system deficiencies, gland abnormalities, nervous system abnormalities, psychological and social issues, birth defects, conception difficulties, as well as still births (Wagner et.al, 2006).

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). However, Contacts with powerlines can occur when utilizing long-handled tools and ladders; constructing outside walls and roofs; or when using any form of lifting equipment, such as backhoes, truck-mounted man-lifts, scissor lifts, or conveyors. When a hazard is not detected and remedied before personnel enter the area, or when employees are not trained to recognize the hazard, these accidents occur (for example, recognizing the difference between telephone cable lines vs. power lines). For these reasons, PHCN has a mandatory "no-obstruction" policy in place for its overhead powerline rights-of-ways. This is based on the reality that electric transmission and distribution lines are critical to the country's economic health and security. It is vital to keep the areas beneath them clear for the residents' and PHCN staff' safety.

Minimum clearance distances between powerlines and any form of developmental activity on ground are 11m, 11m, 30m, and 50m for 11kv, 33kv, 132kv, and 330kv, respectively (Nigerian Electricity Supply and Installation Standards Regulations, 2015). 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. 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. Therefore, it is essential to assess the level of property encroachment or compliance to regulations governing distribution lines right-of-way and safety of people living near, working on or in close proximity to such lines.

Source: Researcher's field work, 2020

Plate 1: A fallen medium voltage overhead powerline in Baba Street, Rumigbo, Port Harcourt.

Aim and Objectives

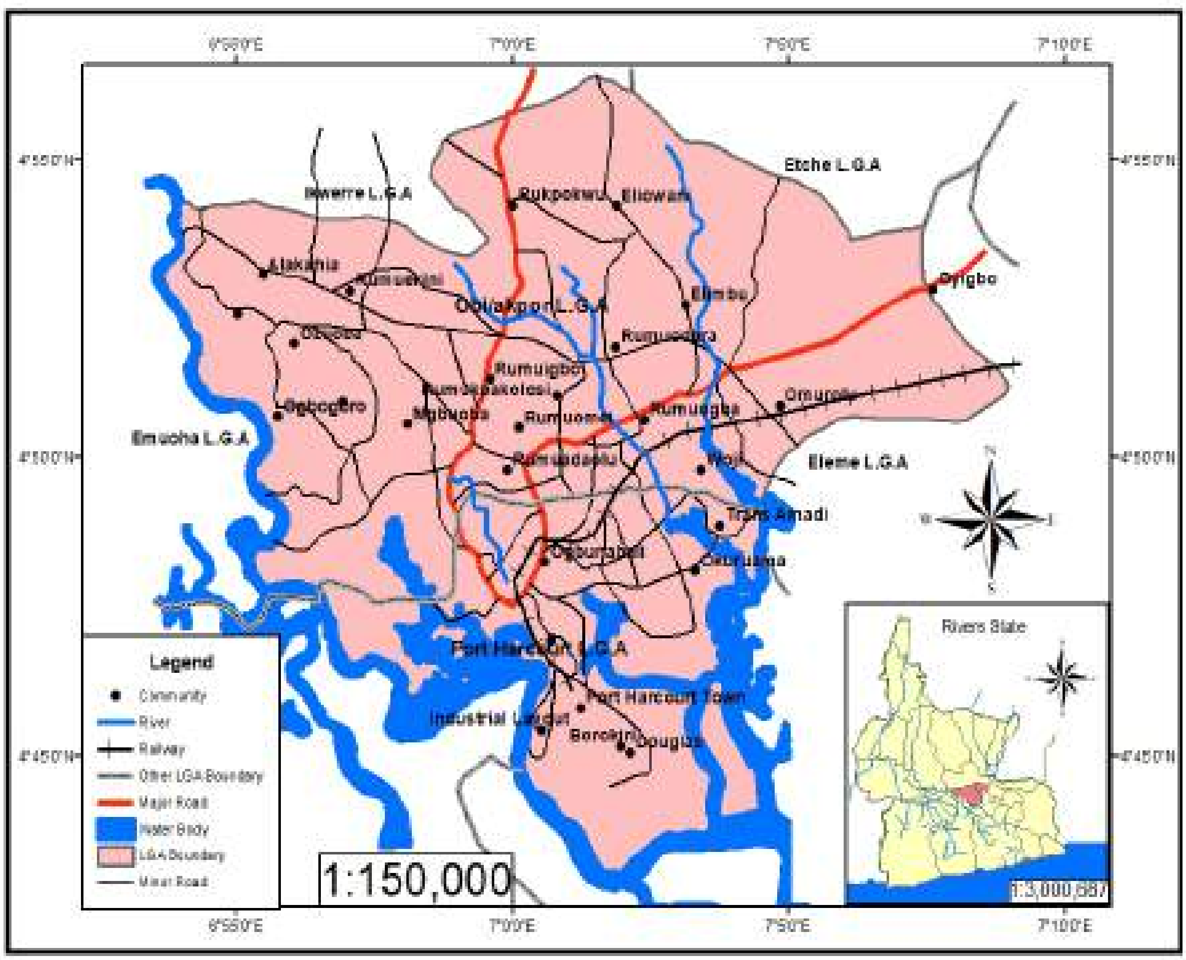
The aim of this study is to analyzed urban development and the effect on overhead powerline right-of-way in Port Harcourt, Nigeria. The objectives of the study were to:

1. Map the medium voltage powerline across the study area

2. Enumerate buildings encroaching on the stipulated 11m setback from powerline,
3. Examine the area extent of development on the stipulated 11-meter right-of-way for four decades (1986, 2006, 2013 and 2020)
4. Enumerate the characteristics of hazard that has impacted the urban residents.

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 2: Port Harcourt City

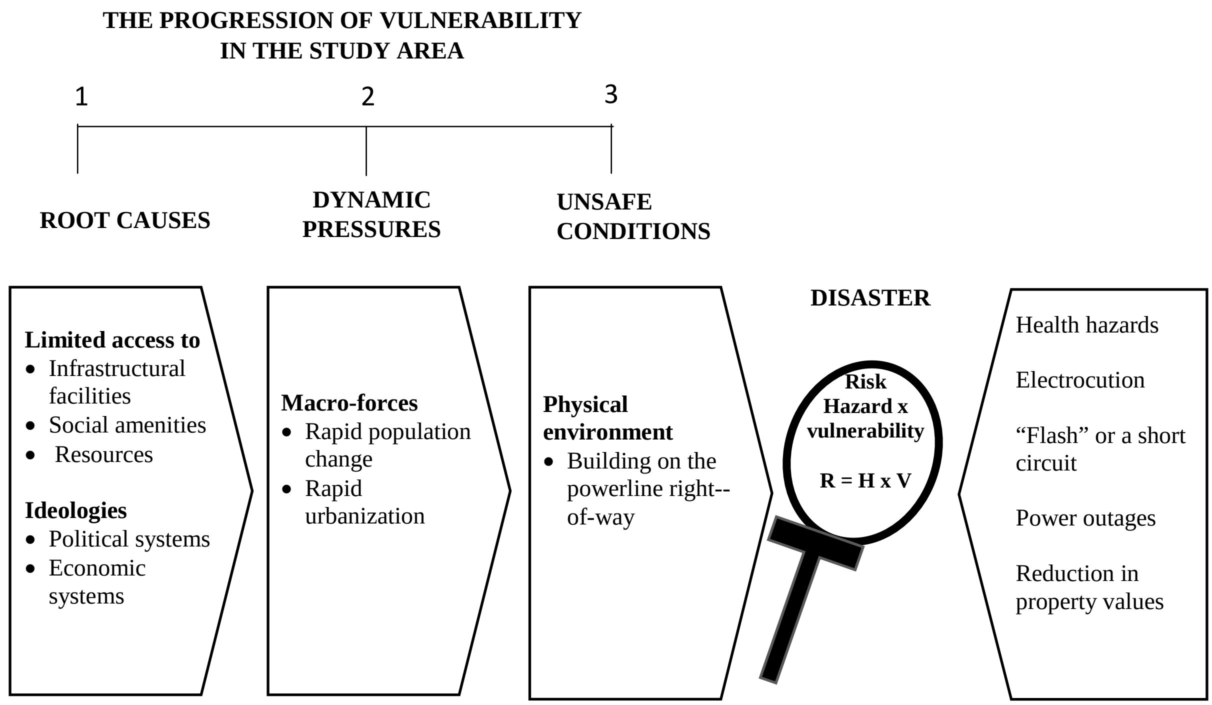
Literature Review:

Theoretical /Conceptual Framework

This thesis work reviewed some theories/conceptual frameworks that are closely related to the study in other to add to the existing body of knowledge. Some of these theories include: the Bid Rent Theory, the Rural-Uban Fringe Concept, the Pressure and Release Model, Concept of Power.

The 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

Rural-Urban Fringe Concept

The Rural-urban fringe concept which was first used by T.L Smith in connection with the Louisiana, USA, is applicable to this study. Rural-Urban fringe is seen as a dynamic zone at the outer borders of the city. It is a zone that simultaneously reflects the existence of both the rural and urban sectors (Fahria, 2009). Aruna (2010) posits that rural-urban fringe is related to the growth of cities which lies immediately outside designated urban limits. The zone usually has strong interaction with the present city, and reflects its physical occupational and demographic characteristics. The rural-urban fringe is the consequence of invasion process.

However, this invasion or growth rate of cities outside designated urban limits do not give room for planned development. Any development without planning regulations would infringe on the setbacks or right-of-way. This happens when such cities have very high land value as postulated by the bid rent theory.

The Bid Rent Theory

The encroachment of population into natural and reserved areas is as a result of high demand on residential space as well as for agricultural purposes. These demands have been placed in spatial context by bid-rent models (Olapeju 2017). David Ricardo is credited with the pioneer of the well-known bid rent theory that connects the land value and locations of different land uses in a theoretically sound analytical approach.

The argument here presents the fact that increase in the value of land give rise to the occupation/development of every available land including reserved areas or right-of-way. However, the increase in land value within the study area resulted to the encroachment of urban development on the reserved areas which include the setbacks of power lines.

Concepts in Power Transmission

According to Gönen (2014), overhead power distribution and transmission lines are classified in the electrical power industry by the range of voltages:

- Low voltage (LV) – less than 1000 volts, used for connection between a residential or small commercial customer and the utility.
- Medium voltage (MV; distribution) – between 1000 volts (1 kV) and 69 kV, used for distribution in urban and rural areas.
- High voltage (HV; subtransmission less than 100 kV; subtransmission or transmission at voltages such as 115 kV and 138 kV), used for sub-transmission and transmission of bulk quantities of electric power and connection to very large consumers.
- Extra high voltage (EHV; transmission) – from 345 kV, up to about 800 kV, used for long distance, very high-power transmission.
- Ultra high voltage (UHV) – higher than 800 kV. According to Kynge (2018) UHV lines are a "game changer", making a global electricity grid potentially feasible. UHV enables the

transmission of five times more power, over six times the distance when compared with conventional lines (Kynge, 2018).

According to Gönen (2014) Structures for overhead lines take a variety of shapes depending on the type of line. Structures may be as simple as wood poles directly set in the earth, carrying one or more cross-arm beams to support conductors, or "armless" construction with conductors supported on insulators attached to the side of the pole. Tubular steel poles are typically used in urban areas. High-voltage lines are often carried on lattice-type steel towers or pylons. For remote areas, aluminum towers may be placed by helicopters (Johnson, 2015). Concrete poles have also been used. Poles made of reinforced plastics are also available, but their high cost restricts application (Nweke et.al, 2018).

In the study area, medium voltage (MV; distribution) – between 1000 volts (1 kV) and 69 kV, used for distribution in urban and rural areas, are mostly found. The other two voltages - High voltage (HV; subtransmission less than 100 kV; subtransmission or transmission at voltages such as 115 kV and 138 kV), used for sub-transmission and transmission of bulk quantities of electric power and connection to very large consumers and ultra-high voltage (UHV) are few and as a result were not be considered in the course of this work.

Several literatures are known to have looked into transmission power lines, their influence on land ownership, rental structure, health, industry, and a variety of other things. Other studies have looked at the impact of power transmission lines on property values and human health.

However, the level of property encroachment into the power distribution line right-of-way or setbacks was not recognized and measured in their investigations. Furthermore, the extent to which properties complied with the required setbacks of overhead electricity distribution line right-of-way was not investigated, the factors responsible for occupying the buildings under the powerline right-of-way was not examined as well.

Abidoye and Oyedeji (2014), on the other hand, investigate "The Impact of High Voltage Power Lines 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 power lines.

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.

In Abakaliki, Ebonyi State, Nwofe (2016) explores the risks linked with electrical equipment in households and power lines. The likely reasons, and implications, are x-rayed utilizing a literature based conceptual approach; hence the author studies the literature on electrical and power lines 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 power lines, including health risks and property value losses, are frequently limited to the power lines' 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 to this day, 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.

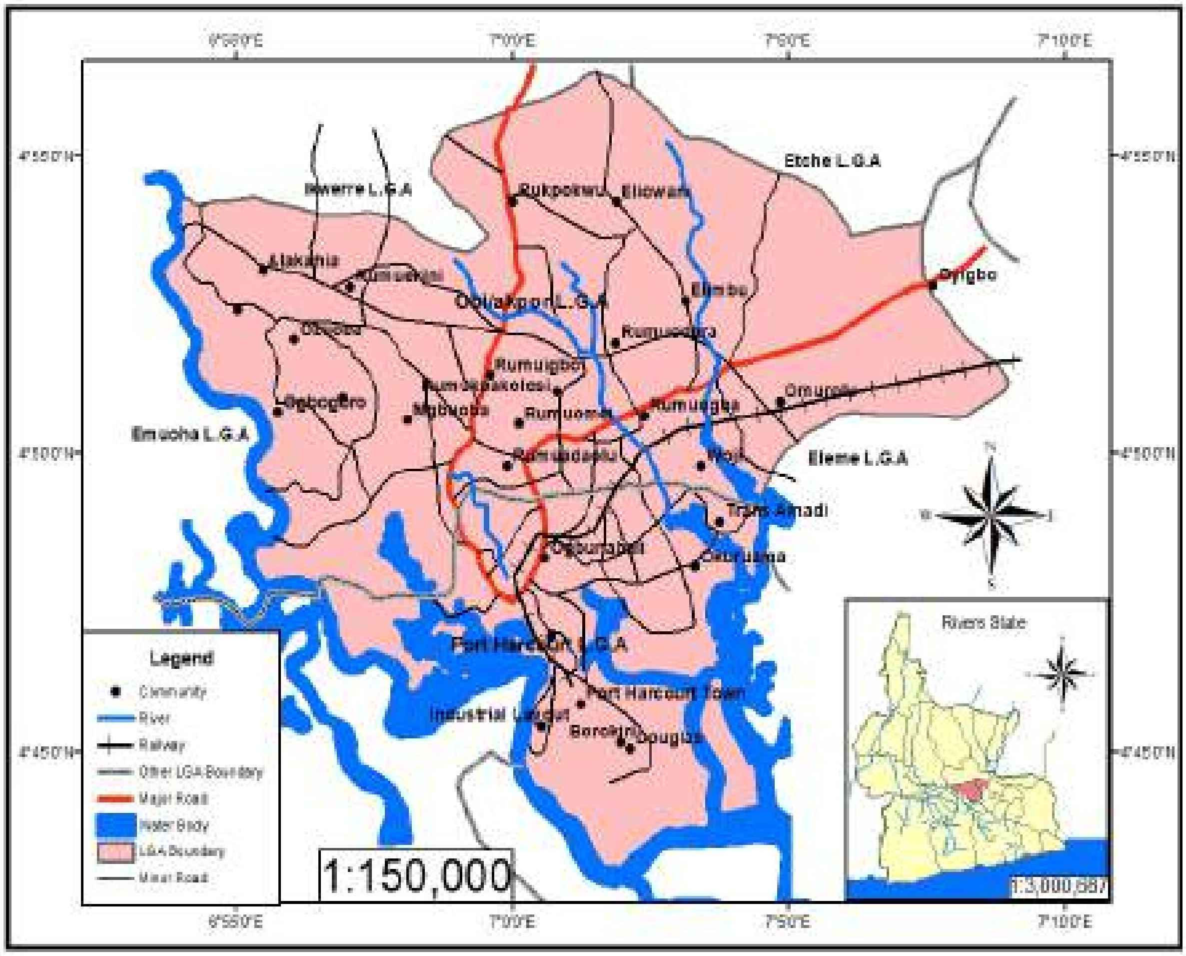
While the findings of these studies may provide some general insights, the conclusions are unlikely to have direct application to the Nigerian scenario in all circumstances due to significant disparities in legislation and socioeconomic context. This research used qualitative statistics and questionnaires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

Methods and Results

The research design adopted for this study was the Time-Series/longitudinal research design. The Time-series/longitudinal research design does not allow interference with the subject matter. Observation is conducted on the subject matter over a period of time, sometimes lasting many years to detect developments or changes in the characteristics of the target population at both the group and the individual level. Hence, time-series/longitudinal research design adopted enabled the researcher to understand the changes that has taken place in these phenomenon (overhead powerline right-of-way/set back, urban development extent and level/extent of encroachment into the right-of-way) over the specified time frame. It was appropriate in the assessment of the phenomena in question which is the level of urban developmental encroachment into the overhead powerline right-of-way. Therefore, this design enabled the researcher to predict sequence of events that could occur as a result of the trend observed from the assessments.

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

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.

Method of Data Collection

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

The GPS was used to acquire the coordinate of each pole holding the powerline; 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. Satellite images for the four decades were collected for the year 1986, 2006, 2013 and 2021. The images were analyzed using supervised classification method in the geospatial environment. The overhead powerline right-of-way was delineated and overlaid on the yearly image to enhance the calculation of the extent of encroachment anomaly over the period of study.

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 hazards that has impacted on the inhabitants, 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 area extent of development into the overhead powerline right-of-way was delineated from the overlay of the powerline on the image analysis of urban development across the study area. This analysis enabled the consideration and comparison to see the extent of encroachment in each year of consideration i.e., 1986, 2006, 2013 and 2020. This also allowed consideration and comparison to see the extent of development into the powerline right of-way.
4. The questionnaire from the investigation of the characteristics of hazards that has adversely impacted on the urban inhabitants within the stipulated overhead 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.

Result

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 of powerlines in the study area. The map permitted the capturing of the buildings within the 11-meter setback from the powerlines.

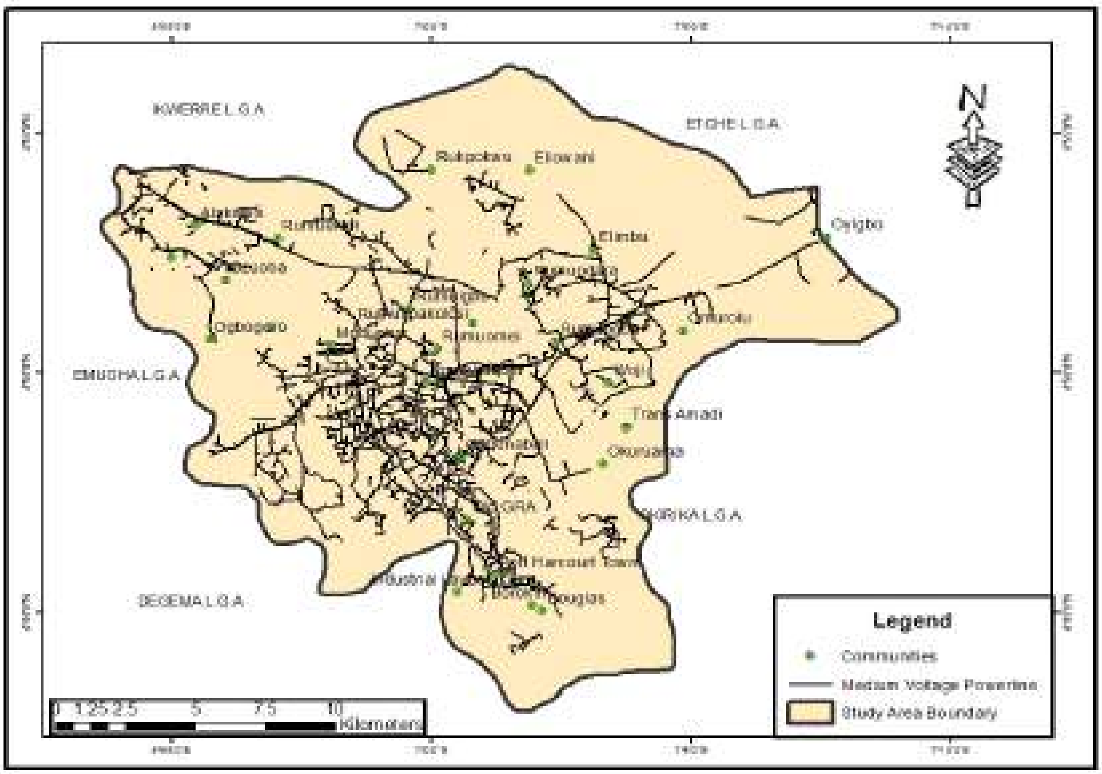
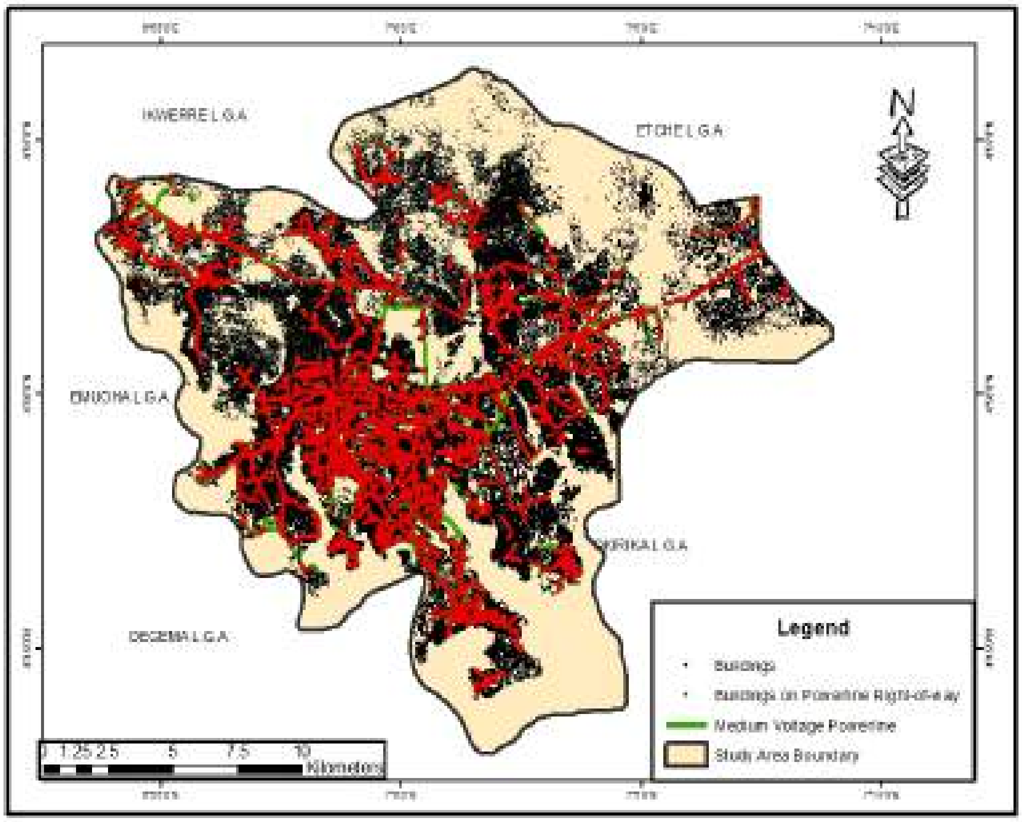


Fig. 2. Medium Voltage Overhead Powerline Map (Port Harcourt, Nigeria).
Source: Researcher's field work, 2020.

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).



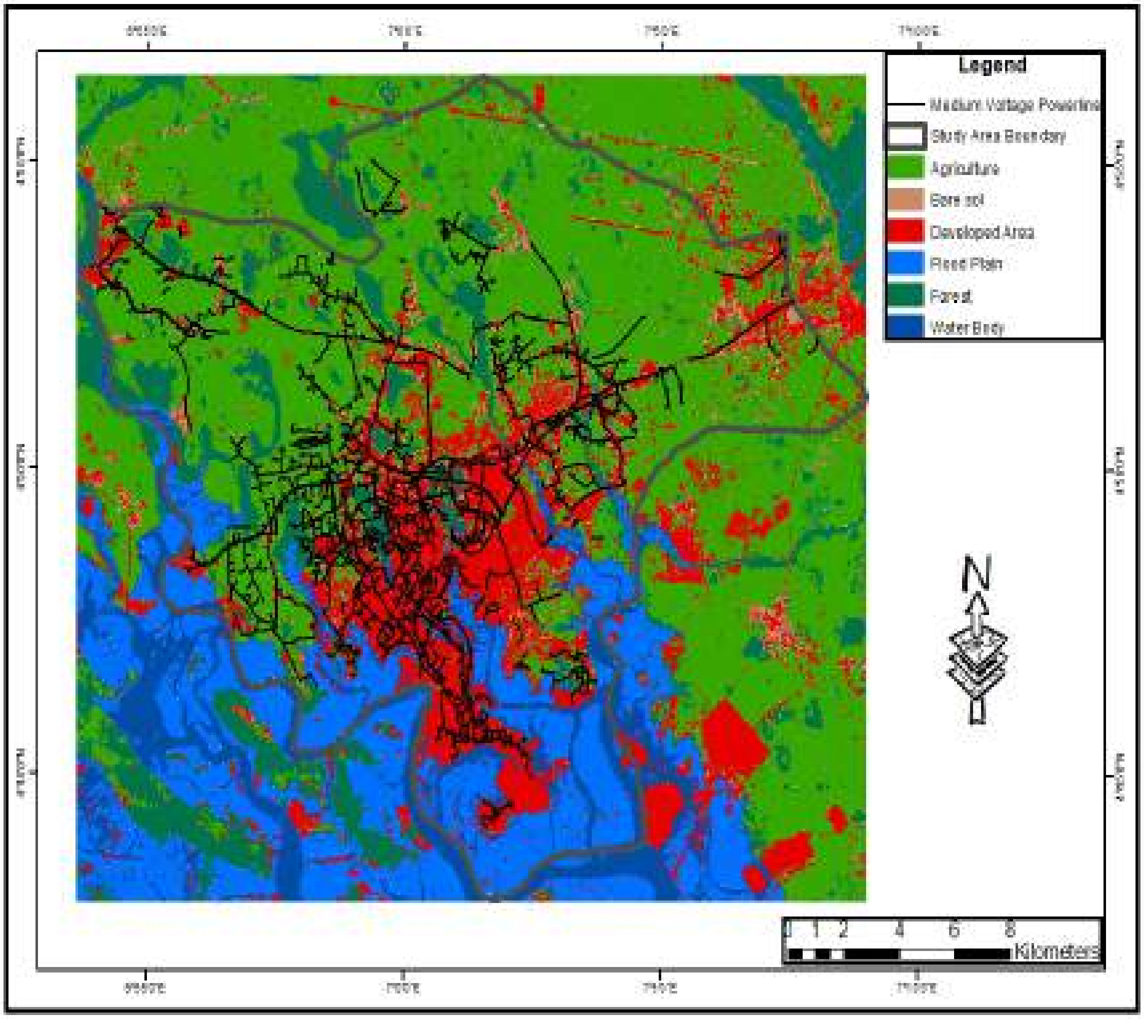
Source: Researcher's field work, 2020.

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.

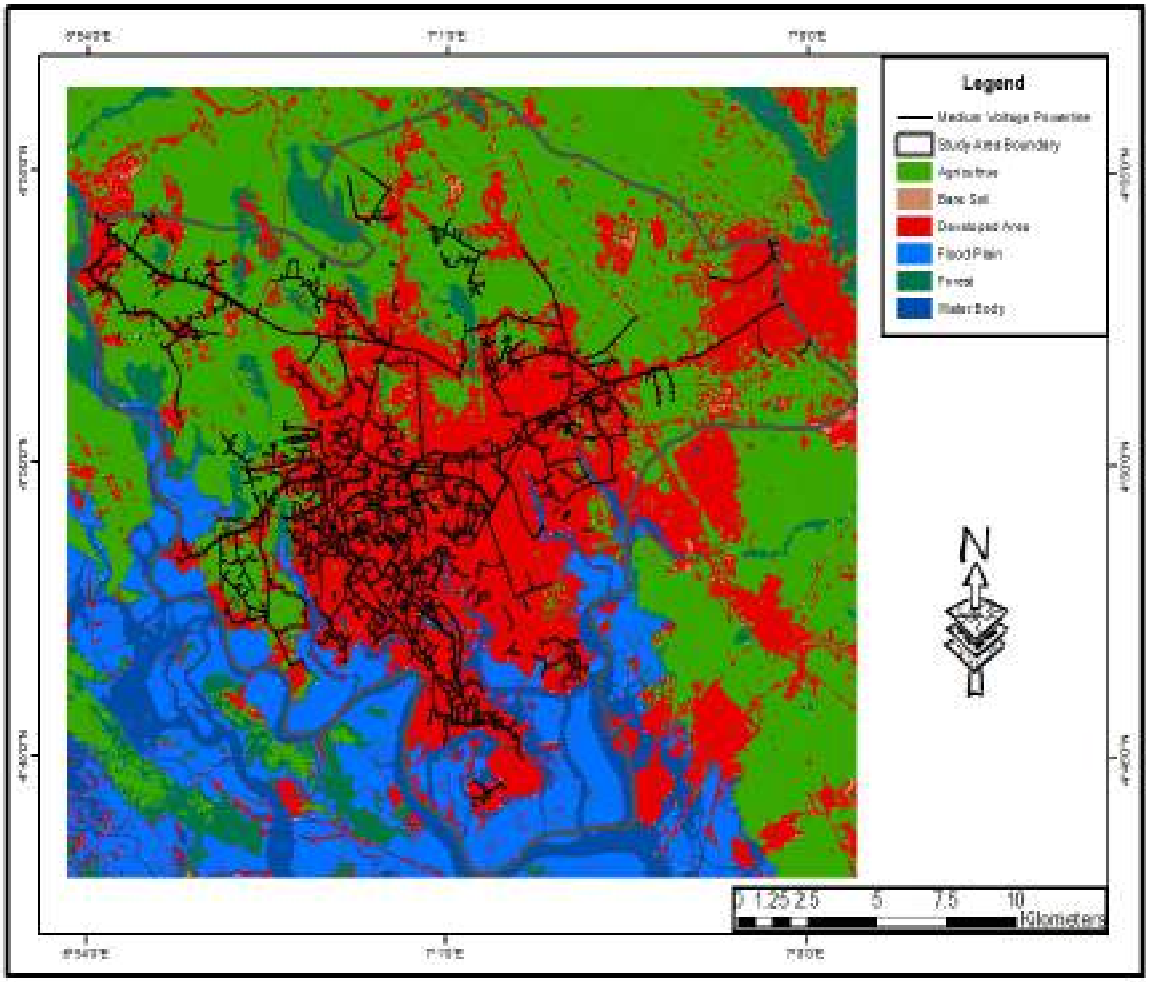
The Area Extent of Development into the Overhead Powerline Right-of-way

The area extent of development into the overhead powerline right-of-way was delineated from the overlay of the powerline on the image analysis of urban development across the state capitals. This analysis enabled the consideration and comparison to see the extent of encroachment in each year of consideration i.e., 1986, 2006, 2013 and 2020 for (fig: 4, 5, 6 and 7).



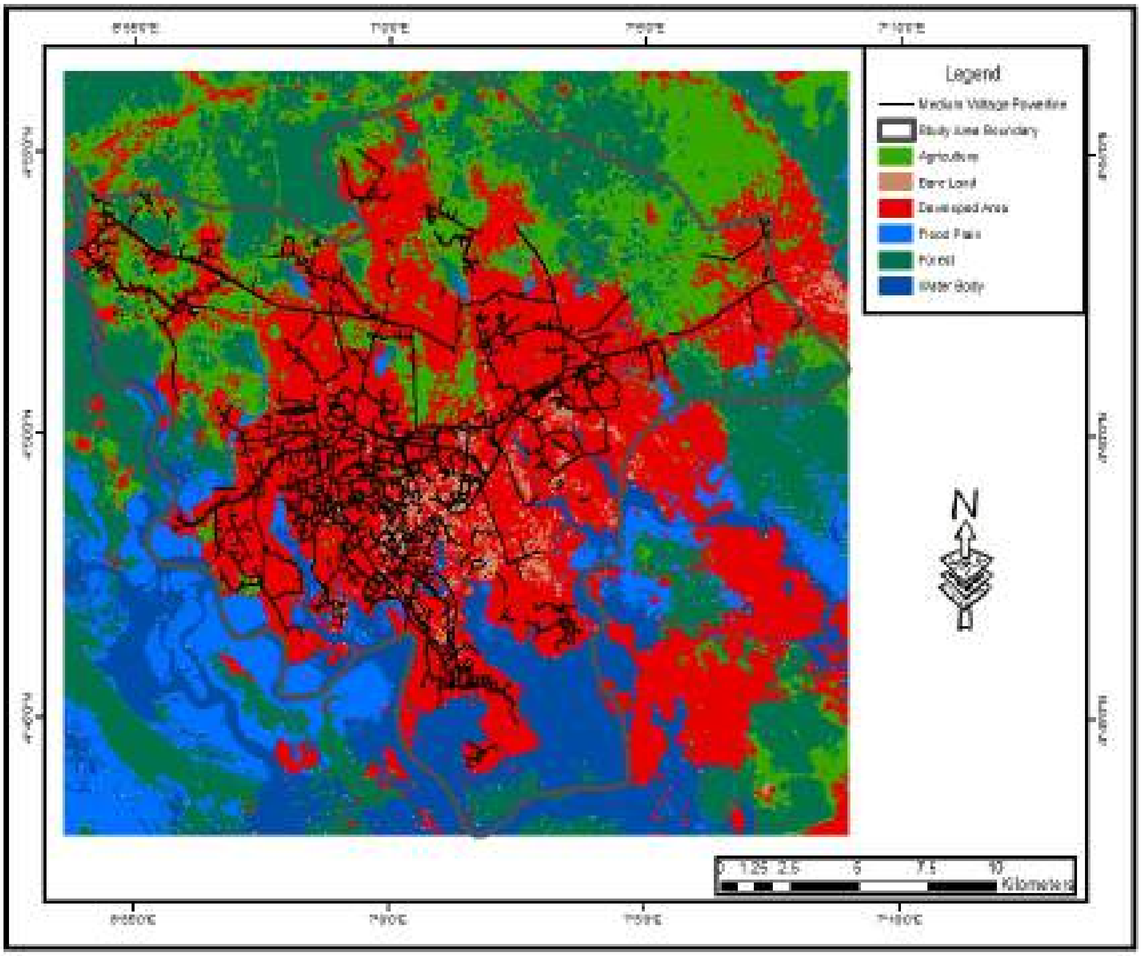
Source: Researcher's landcover classification. 2021

Fig 4. Urban growth and development in Port Harcourt as at 1986



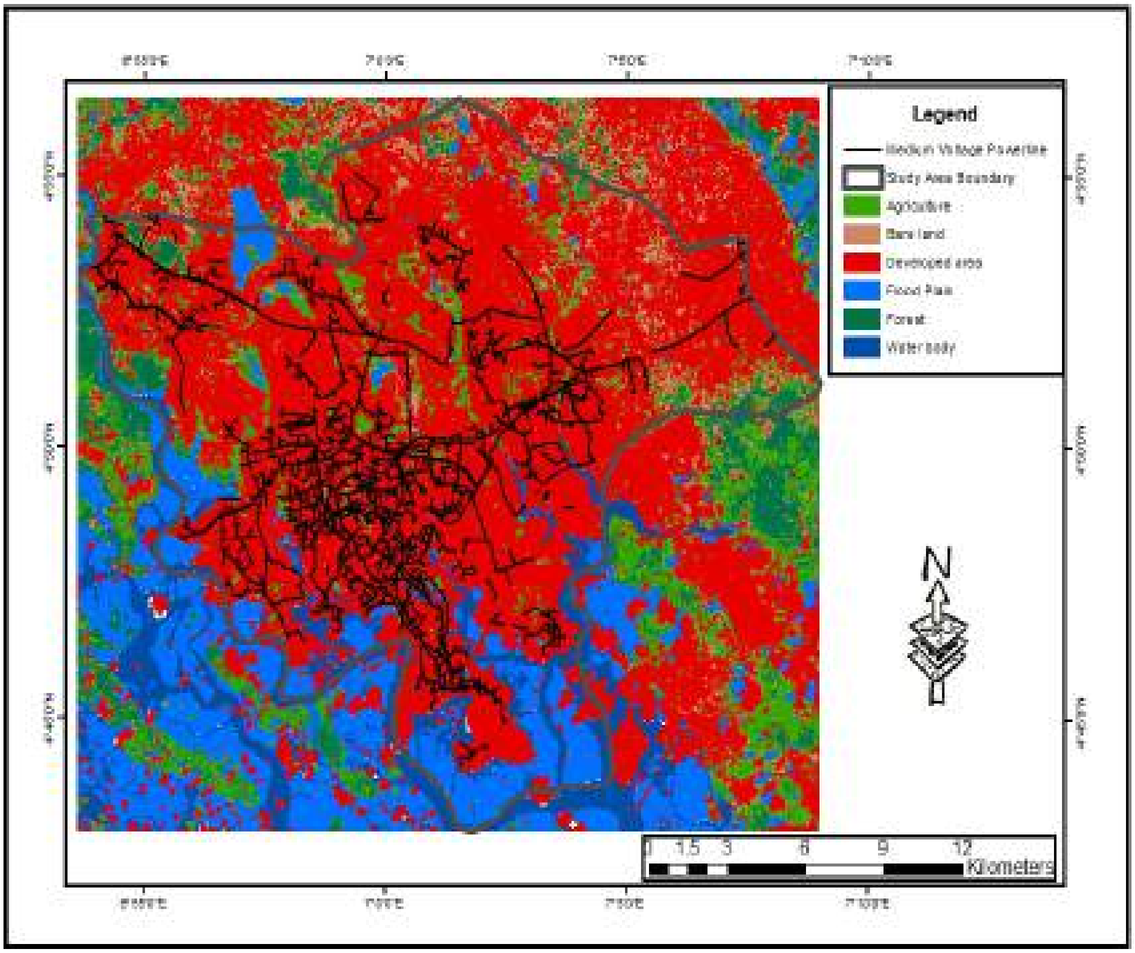
Source: Researcher's Land use classification. 2021

Fig. 5 Urban growth and development in Port Harcourt as at 2006.



Source: Researcher's Land cover classification, 2021

Fig. 6 Urban growth and development in Port Harcourt as at 2013



Source: Researcher's Land cover classification. 2021

Fig. 7 Urban growth and development in Port Harcourt as at 2020

Table 1: Land cover classification for Port Harcourt

Land use Category	Area covered (km^2) for each year and their Percentages							
	1986	%	2006	%	2013	%	2020	%
Agriculture	328	46	285	40	112	16	78	11
Bare soil	21	3	2	0	15	2	40	6
Developed Area	118	17	228	32	375	53	396	56
Flood Plain	102	15	91	13	64	9	101	14
Forest	80	11	49	7	45	6	39	6
Water Body	59	8	53	8	97	14	54	8
Total	708	100	708	100	708	100	708	100

Source: Researcher's Land cover classification. 2021

The Land cover classification for the study area was shown in Table 1. The table portrayed the land cover in various years and the area of land covered in kilometer square. Agriculture covered a total area of 46%, 40%, 16% and 11% for 1987, 2006, 2013 and 2020 respectively. Bare soil covered 3%, 0%, 2% and 6% for 1987, 2006, 2013 and 2020 respectively. Developed area covered 17%, 32%, 53%, and 56% for 1987, 2006, 2013 and 2020 respectively. Flood plain covered 15%, 13%, 9% and 14% for 1987, 2006, 2013 and 2020 respectively. Forest covered 11%, 7%, 6%, and 6% for 1987, 2006, 2013 and 2020 respectively. Water body covered 8%, 8%, 14% and 8% for 1987, 2006, 2013 and 2020 respectively. The total landcover is 708km^2. However, for the purpose of this study, the emphasis was on the trend of development. The result indicated that, developed areas experienced steady increase and constantly gained landcover for the years under study. The increase was as a result of urban expansion, development, construction and opening of new lands such as building on the powerline rights-of-way. The increase in developed area and decrease in forest is in line with the works of Zubair (2006), and Eludoyin, Obafemi and Hardy (2017).

Furthermore, the images of the urban growth and development in Port Harcourt for 1986, 2006, 2013 and 2020 (Fig 4, 5, 6, and 7) showed the state of urban development in relation to the current development in the establishment of powerline. From the images, it can be seen that development from 1986 to 2006 concentrated more on the city center and some part of the south while a greater part of the north, east and west lacked development. As a result, the demand for power supply and the establishment of powerlines was minimal towards the north, east and west, but concentrated more on the developed areas since powerline establishment is part of development and regular power supply attracts population. However, as the year progressed, i.e., from 2013 to 2020, development spread towards the north, east and western part of the city thereby increasing the demand for power supply and the establishment of powerlines.

This showed the rate of development and land cover changes. However, the rate of development led to high demand for land which in turn, led to the development of reserved areas, setbacks or fallow corridors such as powerline rights-of-ways.

Also, the developed areas (km^2) covered by the powerlines for the four years under study was analyzed. This analysis enabled the consideration and comparison to see the area extent of encroachment and the rate of development in each year of consideration i.e., 1986, 2006, 2013 and 2020. The result showed that the developed area with powerline coverage were $86km^2$, $156km^2$, $219km^2$ and $276km^2$ for 1986, 2006, 2013 and 2020 respectively. The result of the analysis showed that the built-up areas with powerline coverage experienced constant and rapid increase. That is, as the year progressed, development increased and the developed land covered by powerlines increased rapidly. This was as a result of increase in urbanization and the need for power supply. However, as urbanization and the need for power supply continues to increase, the opening of new lands, deforestation and the conversion of setbacks/fallow corridors into built-up area will also continue to increase.

The Characteristics of Hazard

The characteristics of hazards that has adversely impacted the urban residence within the stipulated overhead powerline right-of-way was enumerated in this section. This was to ascertain the various hazard encountered or experienced by the inhabitants of the study area. This was achieved through the use of questionnaires.

Types of Electrical Hazard from Medium Voltage Powerline, Experienced by the Respondents and/or their Household(s).

The types of electrical hazards experienced by the respondents was analyzed in other to ascertain the characteristics of hazard that had impacted the respondents. However, 32% (125) of the respondents said they had experienced shock, 2% (8) said electrocution, 16 (63) said burns, 1% (2) said health, while 50% (196) said none.

The frequency distribution table of the severity of electrical hazard from powerline, experienced by the respondents was analyzed. This was to ascertain the extent of damage experienced by respondents living on the setbacks of powerline. 20% (77) of the respondents said bruises, 1% (3) said minor laceration, 21% (82) said second degree burn, 7% (26) said third degree burn, 1% (2) said trauma, 2% (8) said death, while 50% (196) said none. It can be drawn from the analysis that fatality through powerline hazard is a low frequency event, although just one life taken (and in this case 8) is too severe. The duration of time spent by the respondents in the building was equally accessed to determine the duration of exposure to the hazards of powerline. It was therefore noted that 10% (41) of the respondents said they spent less than 5 hours per day in the area, 23% (92) said 5-10 hours, 28% (109) said 11-15 hours, 27% (105) said 16-20 hours, while

12% (47) said 21 hours and above. The result of the analysis showed that, a greater percentage of the respondent were exposed to the threats of powerline for about 11-20 hours per day.

The occurrence of powerline sagging/falling in the study area was examined. The purpose was to determine the extent of exposure of the respondents to the menace of powerline sagging/falling. 80% (315) of the respondents said they had experienced powerline sagging/falling while 20% (79) said they had not. Also, the frequency distribution table of the safety measures taken by the inhabitants to prevent future occurrence of electrical hazard was evaluated to ascertain if the inhabitants were proactive in averting future occurrence. It was however observed that, 66% (262) of the respondents said nothing was done, while 34% (132) said something was done. Since the result of the analysis showed that a greater proportion of the respondents said nothing was done, it means that, the possibility of electrical hazard reoccurring is high. 67% (265) of the respondents said nothing was done by the government, while 33% (129) said something was done. That is to say that there is a possibility of electrical hazard event occurring in the future. Meanwhile, 11% (43) of the respondents said the likelihood of electrical hazard reoccurrence was negligible, 28% (111) said rare, 37% (144) said high, 22% (85) said very high, while 3% (11) were indifferent. The results of the analysis showed that the respondents were optimistic that the electrical hazard event(s) will reoccur in the future.

The frequency of clinic visitation was evaluated. This was to ascertain the medical conditions of respondents as they reside in close proximity to overhead powerline. 3% (13) said they visited the clinic on weekly bases, 9% (37) said on monthly bases, 16% (65) said quarterly, 33% (131) said yearly, while 38% (148) said they had never visited the clinic. The result showed that the frequency of clinic visitation cannot be attributed to their proximity to overhead powerline. Also, 51% (200) of the respondents said they were aware of the health and environmental hazards associated with residing close to overhead powerline while 49% (194) said they were not. 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 medium voltage powerlines were dangerous. The ailment suffered by the respondents and/or their household(s) was analyzed. This was to discover if the ailment suffered by their household(s) were as a result of their choice of residence. 9% (34) of the respondents said the ailment suffered by their household(s) were radiation induced sicknesses (mostly drowsiness, mood swings, tearfulness and eye pain, muscular weakness, nausea, breast cancer, depression miscarriages, heart diseases, and above all severe headache) while 91% (360) said it was not radiation induced. This means that, the ailments suffered by the household(s) of the respondents were not dependent on their place of residence, since a greater percentage (91%) of them said 'No'. 16% (65) of the respondents said flash light occurred very often, 18% (69) said often, 57% (226) said sparingly, while 9% (34) said never. This means that, flash light occurred (whether very often, often or sparingly) and the inhabitants were exposed to the dangers associated with it.

Conclusion and Recommendation.

The Pressure and Release model has proved beyond doubts that it is the most suitable vulnerability assessment framework 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 are classified as being vulnerable to the hazards associated with powerlines. It can therefore be concluded that 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 led to the development of the overhead powerline rights-of-ways. The consequence of such actions i.e., the building on the powerline right-of-way, has resulted to several issues such as electrocution, shocks, burns, deaths, trauma, health issues (such as malaise and headaches, depression, nausea, restlessness, mood swings etc.

Based on this conclusion, the following recommendations were proffered:

1. The map of the medium voltage powerline 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 increasing.
2. All twenty-nine thousand and thirty (29,030) structures encroaching on the 11-meter setback should be demolished and the spaces landscaped.
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 entitled to rehabilitation.
4. The government should as a matter of urgency, provide houses in the form of housing scheme for the low-income earners in other to reduce makeshift houses and shops littered in the study area.
5. There is need for awareness campaign by the state government via 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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