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Geographic/Geospatial Information System (GIS) can show different kinds of data on one map which enables people to more easily see, analyze, and understand patterns and relationships. This study uses both questionnaire and GIS methods to assess the level of impingement on electric overhead power-line corridor in Akure, Nigeria.

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Most property owners in the study area got their properties through outright purchase from family land owners while; over 77% of respondents have lived in the corridor for more than 25 years. This paper recommends that all buildings in the corridor should be demolished and compensation paid where applicable; and the corridor be planted with short trees and or grasses under the management of the State Government.

Keywords: GIS, overhead power-line, encroachment, akure, nigeria.

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I. INTRODUCTION

An overhead powerline is a structure used in electric power transmission and distribution to transmit electrical energy across large distances which consist of one or more conductors suspended by towers or poles (Wikipedia, 2021).

The purpose of overhead transmission lines is to transmit electricity in large quantities between the points of generation (power stations) to an electricity substation close to load (demand) centers where the electricity is consumed. This is commonly achieved at voltages of 132 kV, 275 kV or 400 kV. Ramunas and Robertas (2020) submitted that one 400 kV double-circuit quad-conductor transmission line is, for instance, equivalent to three 275 kV double-circuit twin-conductor lines or twenty-one 132 kV double-circuit single conductor lines; also, the double-circuit 400 kV overhead power line can be used for the identification of hazardous areas and cases of electromagnetic pollution. Transmission lines equally provide interconnection between power stations, load centers and other supply systems, forming what is commonly termed 'the grid'. At the electricity substation, the power is either transmitted on to another substation, or transformed to a lower voltage-33 kV or 11 kV-and distributed through the distribution network to the customers (Marshall and Baster, 2002). High population growth is an indicative of the pace of social and economic change, coupled with a corresponding increase in infrastructural development around or under power transmission lines (PTL) has caused numerous adverse effects to humans including damage to the body tissues, cardiovascular disorders, low sperm counts and many other effects on live-line workers who regularly service the lines resulting from electromagnetic radiation emitted from the transmission lines (Aliyu and Ali, 2011)

Regarding the high rate at which city populations grow and countries urbanize, Oyinloye and Olamiju (2015) noted that, London was the only city in the world as at year 1800 with a population of a million people, while the 100 largest cities altogether had a population of only 20 million.

And in 1990 the world's largest 100 cities had a combined population of 540 million with 220 million of these living in the twenty largest cities.

In 2006, the world urbanization figure rose beyond 3.3 billion constituting about half of the entire humankind; and by the target year for the Millennium Development Goals (MDGs); cities in the world are estimated to grow to two-third or 6 billion people by 2050 with most of such taking place in developing countries. Thus, the importance of cities has increased significantly over the centuries, and the current dramatic growth of urban populations is seen as critical to the future of Earth by some (Oloto and Adebayo, 2007). The development from village and rural life to urban civilization has had both social and environmental impacts; the growth of urban populations and associated industrialization has resulted in a range of detrimental and often de-humanizing outcomes resulting to the encroachment of public utilities such as the power-lines.

Oyinloye and Olamiju (2015) pointed out that the population explosion in Akure as a result of massive institutional, commercial, industrial and infrastructural development activities lead to a wide range of urban problems such as acute housing shortage, poor street layout with little or no consideration for setbacks and open space, traffic congestion, disease outbreaks and many other environmental related problems. Such environmental problems are some of the factors that can result to a widespread environmental deterioration and pollution as well as encroachment on the overhead electric power-lines. This paper attempts to assess the encroachment of buildings on overhead electricity power-lines in Akure using GIS techniques to investigate the characteristics of houses, level of encroachment of buildings and infrastructure in the power line corridor with a view to protecting health of residents and ensuring sustainable urban development by proffering mitigating measures at preventing encroachment on the electric power-line corridor.

II. REVIEW OF RELEVANT LITERATURE

Akintonwa and Busari et al, 2009) identified serious health implications for living very close to nonionizing radiation of telecommunication masts (cellular towers) in an urban area of Lagos.

Also, Olapeju and Farotimi (2016), investigated the profiles of buildings located within the setback of high-tension power-lines in Agbado, Ogun state, Nigeria and discovered that buildings were sited within the right-of-way of power-lines in violation of building codes, rules and regulations.

In their study, two residents were discovered to suffer from *acute lymoblastic leukemia* which is associated with *EMF* radiations from the power-lines.

From the on-going, it is pertinent to maintain safe distance from electric power-lines. However, it is difficult to do this due to variations in EMF emissions from various sources. Therefore, a special instrument - *Gauss-meter*- was used by Neuert (2012), who discovered that electric transformers are more dangerous to human health than power-lines. In addition, Neuert and Michael (2012), discovered that stray electricity current from metal water pipes of the neighborhood could aggravate the effect of EMF emissions from overhead power-lines.

It is pertinent at this point to ask why people encroach on marginal lands? Agbola (2001) attributed this phenomenon significantly to urbanization. The authors posited that, the process of urbanization is a global phenomenon caused by migratory movement, natural increase and the globalization of the world economy. For instance, the projected urbanization for Nigeria between 2010 and 2020 was 3.39%. The National Population Commission (NPC) put the reviewed population of Nigeria at 167,000,000 (Oketola, 2012). Notwithstanding its constantly increasing population, its total land area is still fixed at 923,700 square kilometers. Hence population density, in the face of competing uses of land will continually soar. This explosion had caused unusual land and demographic pressure directing migration and development towards the fringes.

This invasion usually leads to uncontrolled and unorganized development. The encroaching communities lack basic infrastructure and are developed chaotically (Oloto and Adebayo, 2007).

The second factor accounting for land use encroachment is the absence of sound institutional arrangement to manage urban fringe growth (Fahria, 2009).

One of the effect of **e**ncroachment on electric power-line corridors is land use change. Land use change occurs when the utilization of which land is put is contrary to what it was planned for. For instance, a power-line corridor which is expected to be an open space, or a forested zone could transform into a developed zone. Abolade and Adeboyejo (2006) observed that urban communities in most non-industrial nations like Nigeria have been going through extraordinary changes both in populace and spatial degree and subsequently are confronted with an assortment of issues like awkward land improvement, clashing area and high densities in specific pieces of the metropolitan region.

In Akure, observations show that set backs to high tension power-lines are expected to remain green and planted with trees that are properly managed.

Unfortunately, this marginal land has been partly converted to residential, commercial and industrial land uses occupied by illegal developments such as commercial and residential buildings, makeshift shops and mechanic workshops among others. On the contrary, Ojambati (2007), noted that the history of cities is the story of invasion of one landuse by another and that a viable city is always in the process of change and cities that do not change become historical tourist attractions or stagnant backwaters. This author however, did not consider awful developments such as encroachment on marginal lands (e.g setback to power-lines) that should have been preserved for safety, beauty and health reasons.

III. DATA AND METHODS

3.1 Research Locale

Akure is the administrative capital of Ondo State since 1976. It is situated on Latitude 7°17' N and Longitude 5° 4' E of the Greenwich Meridian. It is about 370m above the mean ocean level. The city is situated within a 48-kilometer sweep to significant towns in Ondo State which are Ondo toward the South, Owo toward the East and Iju/ItaOgbolu toward the North. The zone towards Ado – Ekiti and Idanre are sloppy and studded with enormous stone development, ascending to 410 meters and 496 meters above the sea level separately. The simple access and topographical centrality of Akure close to towns like Ondo, Owo, Ilesa and Ado-Ekiti., have upgraded the development possibilities of the city.

3.2 Population

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The number of inhabitants in Akure was put at 38,852 in 1952. In 1961, it was 71,000; 109,000 in 1980; 112,000 in the year 1981; 114,000 in year 1982, 117,000 in 1983; 120,000 between the year 1984; and 123,000 in 1985. The total number of populations in Akure as at 1991 was 239,712 individuals. The National Population Projection for the year 1996 and 2000 put the Akure populace at 269,207 and 298,712 respectively (Olamiju and Oyinloye, 2015). In 2006, the population had expanded to 3,441,024 with 1,761,263 male and 1,679,761 females, which address 2.46% of the all-out populace of Nigeria.

This phenomenal increase in population had hitherto increased land value and demand for land at the suburb and rural-urban fringes of Akure. In addition, marginal lands such as river floodplains, mountain tops and set back to electric power-lines had been encroached upon due to increase in population and land value (Olamiju, 2014).

Enhancements in transport facilities were given conspicuousness in Akure not long after 1976 when the city turned into the seat of government.

The diverse functions of administrative and commerce, performed by Akure, impact the longing to develop new streets and restore the old ones to deal with the conceived new jobs and status of the city. Consequently, houses were crushed along significant streets to accommodate dual carriage ways (Oyinloye and Olamiju,2015).

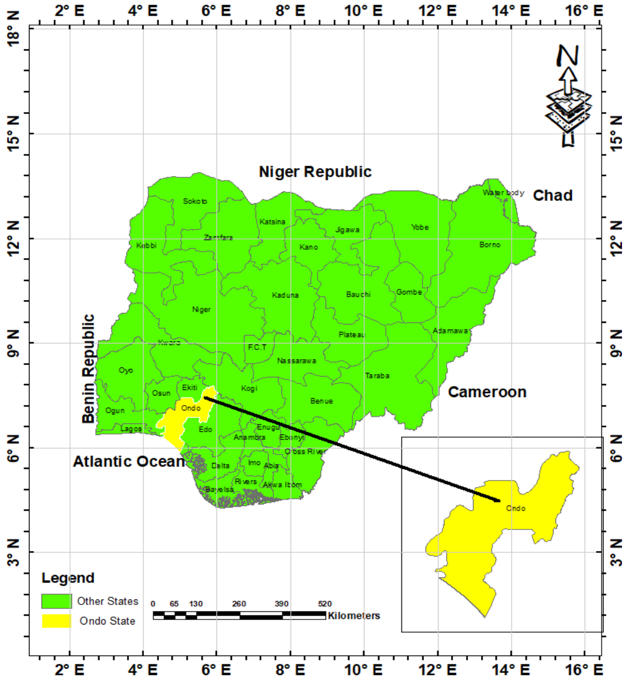

Figure 1: Akure in its National Setting

Source: GIS Map Extract, 2021

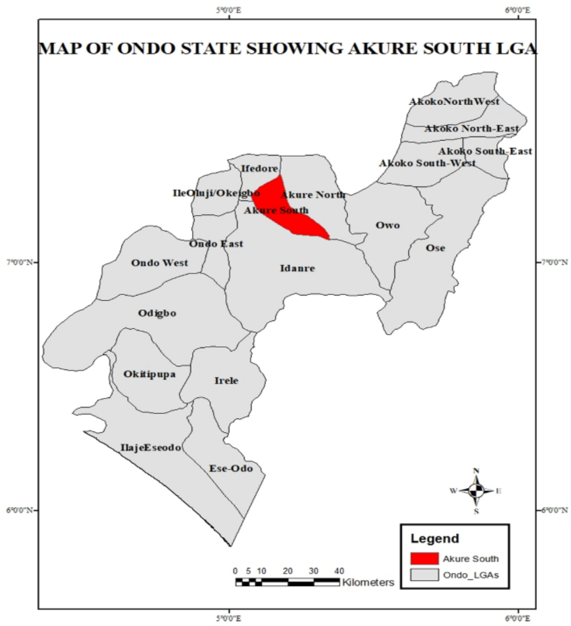

Figure 2: Akure in its Regional Setting

Source: GIS Map Extract, 2021

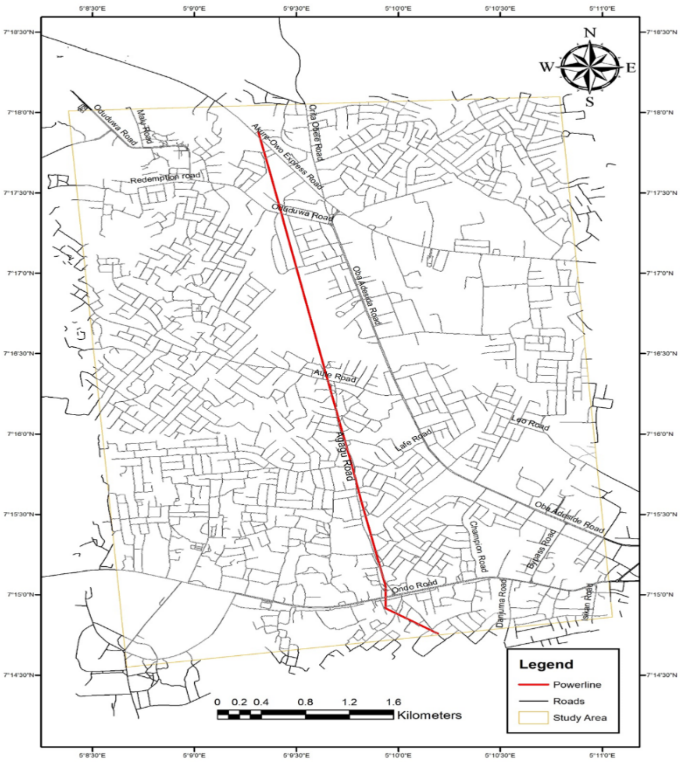

Figure 3: Akure Street Guide Map Showing the Power-line Location

Source: GIS Analysis, Author's Fieldwork, 2021

3.3 Methods

This paper combines the primary and secondary data sources in its analysis. The primary source included direct observations, photographs of scenic locations and the use of structured questionnaires; while the secondary data sources included data collected from the Ondo State Ministry of Works and Housing (ODSMWH), relevant journals, textbooks, coordinate points from GPS and Google earth map extracts of the study area. Four buffer corridors of 50m, 100m, 150m and 200m respectively, were created along the power-line to identify buildings encroaching on it (Table 1). The number of buildings identified along the corridors were 206, 267, 313 and 315 respectively. Cumulatively the total number of buildings was 1,101 with a purposive 20% sample size of 221. Two hundred and twenty-one (221) questionnaires were administered to the most senior household member in each building (Table 1).

Table 1: Sampling along Power-line Buffer Corridors in Akure

S/N	Buffer Distance	No of buildings	20% of Buildings
1	50m	206	42
2	100m	267	53
3	150m	313	63
4	200m	315	63
Total	-	1101	221

Source: Author's Fieldwork, 2021

IV. FINDINGS AND DISCUSSIONS

4.1 Socio-Economic Characteristics of Respondents

Table 2 shows the socio-economic characteristics of respondents resident in the study area.

Table 2 shows that about 70% of respondents are male while 30% are female. This data confirms that the study area is a male dominated household neighborhood which is typical of households in the western part of Nigeria.

On the age of respondents, it is apparent that 6.3% are within the age bracket of 15-25 years; 43.9% of the respondents are within the age group of 26-40 years; 39.8 % falls between 41-65years while; 10.0% falls between the age range of 65 years and above. This implies that majority of the respondents are in the economically energetic age range of adulthood (18years) and retirement (65 years). Again, Table 2 shows that 66.1% of the respondents are married, 27.6% are single, and 3.2% are divorced, while 3.2% are widowed. Since majority of the respondents are married, it is implied that there is a likelihood of population explosion which can further aggravate the impending impingement on sustainable livelihood in the study area.

Table2: Socio-Economic Characteristics of Respondents. N=221

Variable	Frequency	Percentage (%)
Sex		
Male	154	69.7
Female	67	30.3
Age		
15-25 years	14	6.3
26.40 years	97	43.9
41-65 years	88	39.8
65 years above	22	10.0
Marital Status		
Single	61	27.6
Married	146	66.1
Divorced	7	3.2
Widow/widower	7	3.2
Education		
None	28	12.7
Primary	63	28.5
Secondary	81	36.7
Tertiary	49	22.1
Occupation		
Farming	30	13.6
Trading	110	49.8
Public Service	38	17.2
Artisanal	36	16.3
Unemployed	7	3.2
Income		
Below 20,000	46	20.8
20,000-40,000	86	38.9
40,000-60,000	53	24.0
Above 60,000	36	16.3

Source: Authors' Fieldwork, 2021

Additionally, it is obvious from Table 2 that 12.7% of the respondents has no formal education, 28.5% were primary school leaving certificate holders, 36.7% secondary school leavers and 22.2% had tertiary education. From the on-going, it is clear that encroachment on power-line corridor by the residents was not out of ignorance; about 80% of them could read and write, hence, choosing to live under this hazardous condition could be as a result of reasons beyond their control: such as poverty, lack of access to buildable land and joblessness among others.

Table 2 equally shows that 13.6% of respondents were farmers; 49.8 %, traders; 3.2%, unemployed; 17.2%, public servants and 16.3 % engaged in artisanal works. From the analysis, over 66% of respondents are into artisanal works and trading which implies that the power-line corridor is majorly pre-occupied by commercial activities.

This phenomenon could be due to the recent posture of the State government at prohibiting illegal trading and enforcing it along major roads in the city.

On the income status of respondents, Table 2 also shows that 20.8% of the respondents earned below ₦20,000; 38.9% earned between ₦20,000 - ₦40,000; 24.0% earned between ₦ 40,000 – ₦ 60,000 and 16.3% earned above ₦ 60,000. This implies that with the current exchange rate of NGR411.499 to 1USD, less than 50% of respondents earn between $40 and $50 per month. This amount is about 1.33 USD per day, which is below the universal standard of S1.9 per day for measuring global poverty line (World Bank, 2016). This shows that residents along the power-line corridor are among people living under extreme poverty.

4.2 Length of Stay of Respondents

Figure 1 shows the length of stay of respondents in the study are.

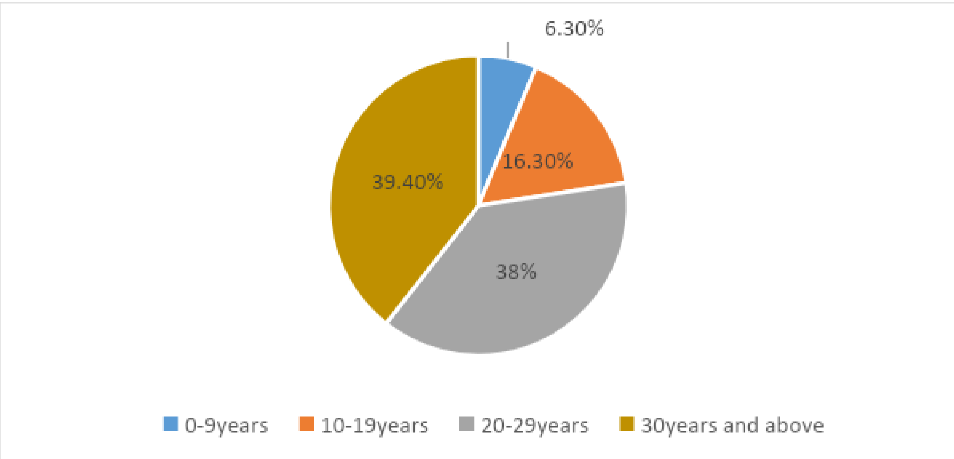

Figure 4: Length of Stay of Respondents in the Study Area

Source: Author's Fieldwork, 2021

From Figure 4, it is obvious that respondents who have stayed in the study area between 0-9 years constitute about 6.3% of the total number of respondents, 77% of them have stayed in the study area for over 25 years. This phenomenon shows that contravention in the Corridor had been an incessant and protracted one.

4.3 Delineating the Buffer Corridors in Akure

In order to mark out purposively, in details, the extent or edge of the powerline corridors in the study area, the GIS and Remote Sensing technologies were adopted. The corridors were delineated using different buffer widths of 50, 100,150 and 200 meters. In each corridor, the total number of buildings identified and the percentage of the total are as shown in Table 3

Table 3: Buffer Corridors and Total Number of Buildings

S/N	Buffer Corridor	No of Buildings	Percentage
1	50m	206	18.7
2	100m	267	24.3
3	150m	313	28.4
4	200m	315	28.6
Total	-	1101	100.0

Source: Author's Fieldwork, 2021

Moreover, Figures 5, 6, 7 and 8 show the buffering operations at 50m, 100m, 150m and 200m distances respectively. From Table 3 the total number of buildings encroaching on the powerline corridors are 206, 267, 313 and 315 with percentages of 18.7, 24.3, 28.4 and 28.6 respectively. The trend reveals that the farther one moves away from the center of power-line the more the number of buildings. The implication of this is that the people are conscious of encroaching on the power-line.

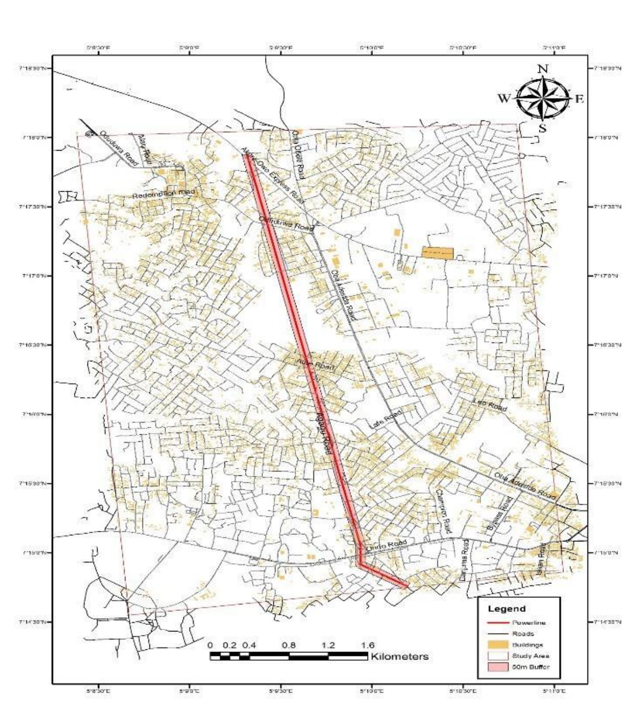

Figure 5: 50m Buffer on Powerline Corridor in Akure

Source: GIS Analysis, Author's Fieldwork 2021

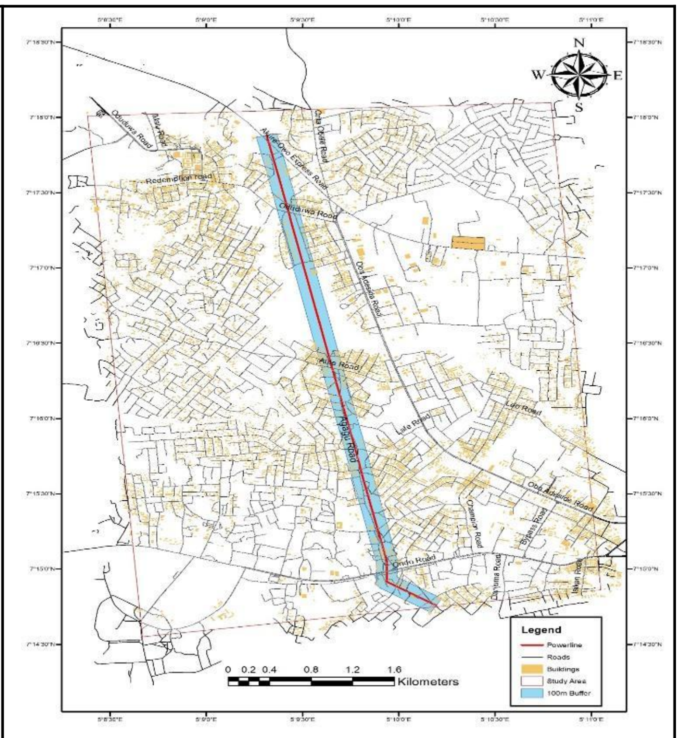

Figure 6: 100m Buffer on Powerline Corridor in Akure

Source: GIS Analysis, Author's Fieldwork 2021

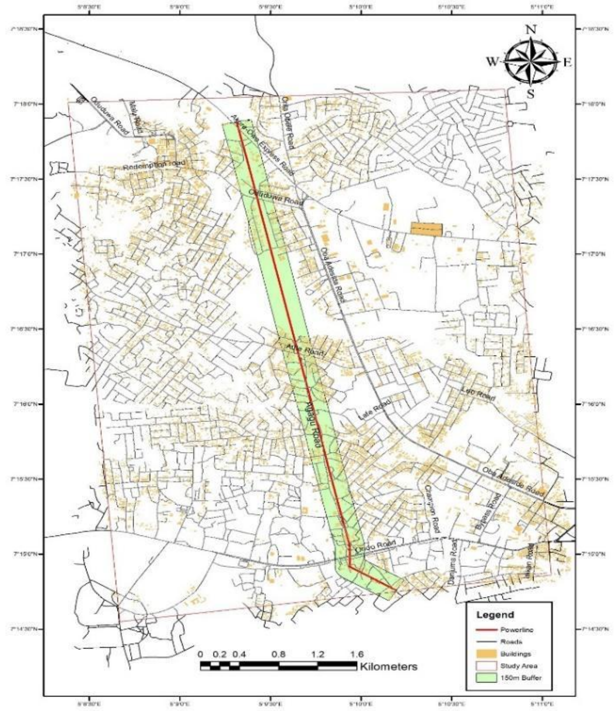

Figure 7: 150m Buffer on Powerline Corridor in Akure

Source: GIS Analysis, Author's Fieldwork 2021

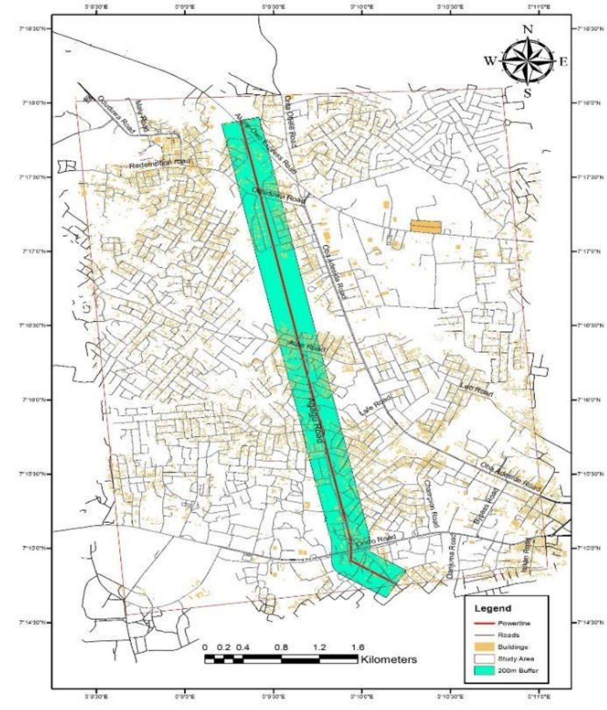

Figure 8: 200m Buffer on Powerline Corridor in Akure

Source: GIS Analysis, Author's Fieldwork 2021

In addition, Figure 9 shows the combined sections of the 50, 100, 150 and 200m buffer corridors in the study area. The total number of buildings in the combined buffers is 1,101.

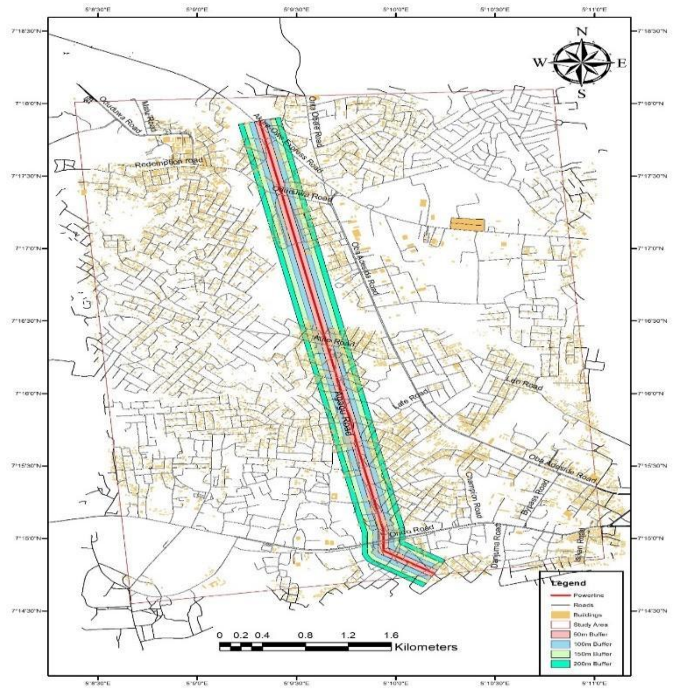

Figure 9: Combined Sections of 50, 100, 250 and 200m Buffer on Power-line Corridors in Akure

Source: GIS Analysis, Author's Fieldwork 2021

4.4 Ownership Status of Buildings on the Power-line Corridors

Figure 10 shows that about 60.60% of the respondents attested that the apartments they are occupying were rented out to them by the original owners; while 29.90% got theirs through inheritance and 9.50%, by outright purchase from the original owners.

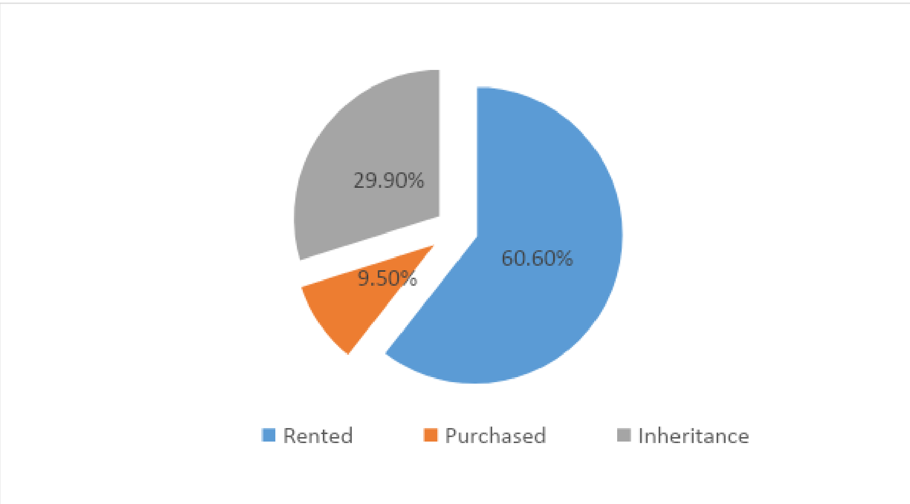

Figure 10: Ownership Status of Buildings in the Study Area

Source: Authors' Fieldwork, 2021

From the data presented, it is obvious that the power-line corridor which is expected to be government acquisition area is still being owned by individuals who claimed to be *'omo oniles'* (original land owners), and still rent such lands out or sell it out by outright purchase to unsuspecting, innocent buyers. On the year of construction of buildings in the Corridor, empirical analysis shows that 33.9 % respondents adjudged that buildings in the study area have been constructed before year 1980 while 24.4 % were built between year 1981-1990, 19.5 % were erected between the year 1991-2000 and 22.2% were built in year 2000 till date.

Table 5: Year of Construction of Buildings in the Power-Line Corridor

Year of Construction	Frequency	Percentage (%)
Before 1980	75	33.9
1981-1990	54	24.4
1991-2000	43	19.5
Year 2000 till date	49	22.2
Total	221	100.0

Source: Authors' Fieldwork, 2021

V. MAJOR ACTIVITIES IN THE POWER-LINE CORRIDOR

Table 4 shows the major activities directly operating in directly under the Power-line. Respondents perception of the major activities under the Power-line shows that welding works account for 20.4%; auto-repairing, 30.8%; trading, 13.6%; farming, 13.1%block making, 15.8% and others, 6.4%. From the data presented, it is clear that auto-repairing constitute the major activity in the Corridor. Observation shows that welding and panel beating activities are co-located with auto-repairing especially along Akure/Ilesha highway, FUTA South Gate area and Agagu Road.

Table 4: Major Activities in the Power-Line Corridor

Activities	Frequency	Percentage (%)
Welding	45	20.4
Auto repairing	68	30.8
Trading	30	13.6
Farming	29	13.1
Block making	35	15.8
Others	14	6.4
Total	221	100

Source: Authors' Fieldwork, 2021

For instance, Figure 11 shows auto-repairing, volcanizing, block making, and residential activities in the study area.

(a). Auto-repairing activity along Agagu Road

(b). Volcanizing activity at FUTA Gate area

(b). Block-making activity along Akure/Ilesha Highway

(d). Residential activity in Awule Community

Figure 11: Various Activities in the Study Area

Source: Authors' Fieldwork, 2021

In addition to the above-listed activities, farming was also a major activity along the corridor. At locations traversed by streams or rivers, farming activity occurs all-year round while in other areas it is seasonal. Figure 12 shows farming activity in the corridor. The major crops planted include vegetables, maize, cassava and soya-beans among others.

Figure 12: Maize Farm directly under the overhead Power-line

Source: Authors' Fieldwork, 2021

VI. CONCLUSION AND RECOMMENDATIONS

This paper revealed that, there are more males (69.7%) than females (30.3%) in the study area; majority of respondents (80%) are below the age of 65years signifying a youthful population; Most of the respondents are married (66.1%) indicating a possible population explosion; about 77.3% of respondents are educated. The major activities in the corridor include: auto-repairing, welding works, trading, farming and block-making. Over 90% of respondents earn less than $100.0 per month which is about 10 times below the UN standard and over 77% of the inhabitants have been living in the study area for over 20 years showing a long period of residents living/working under unhealthy condition.

Going by the high number of buildings encroaching on the corridor, it is imperative for the State Government to urgently strengthen existing laws and promulgate new codes that will prevent encroachments on the power-line with a view to protecting the health of residents and ensuring sustainable urban development in the study area. Also, educating the public on codes, rules and regulations, prohibiting buildings close to high voltage electrical transmission lines and base station rights-of-way must be prioritized.

Shanties along the corridor distorts the beauty of the cityscape, hence power-line setbacks should be landscaped for aesthetic purpose.

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