

RESEARCH ARTICLE

Effect of Residential Developments in the Northern Industrial Zone of Calabar, Nigeria

*Ukpali E. Obongha, Innocent A. Ugbong & Christian N. Mfah

Department of Urban & Regional Planning, University of Cross River State, Calabar, Nigeria

*Corresponding Author's Email: obpaddy7777@gmail.com

ABSTRACT

The rapid expansion of residential development into planned industrial zones has become a major urban planning challenge in rapidly urbanizing cities of developing countries. This study examined the effects of residential development within the Northern Industrial Zone of Calabar, Nigeria, focusing on its implications for industrial productivity, environmental quality, infrastructure demand, and property values. A longitudinal research design was adopted using panel data collected over six years (2019–2024). Data were analyzed with a Fixed Effects Panel Regression Model, while spatial analysis assessed the pattern and extent of residential expansion. The findings showed that residential development intensity had a significant negative effect on industrial productivity ($\beta = -0.432$, $p < 0.05$), indicating that increased residential encroachment reduces industrial efficiency. Environmental pollution ($\beta = -0.381$, $p < 0.05$) and infrastructure demand ($\beta = -0.264$, $p < 0.05$) also negatively affected productivity. In contrast, the property value index ($\beta = 0.215$, $p < 0.05$) was positively associated with industrial productivity, suggesting improved investment attractiveness. The model explained 78% of the variation in industrial productivity, highlighting the strong influence of residential growth on industrial performance. Spatial analysis further revealed increasing land-use conversion, traffic congestion, and pressure on infrastructure. The study concludes that although residential development supports economic growth through housing and higher property values, uncontrolled expansion within industrial zones creates environmental, infrastructural, and land-use conflicts that weaken industrial performance. It recommends stricter development controls, land-use buffer zones, regular GIS-based monitoring, infrastructure upgrades, and stronger protection of industrial land to promote sustainable urban development and preserve the functional integrity of the Northern Industrial Zone of Calabar.

Keywords: *Pollution; Industrial Zone; Property value; Residential; Spatial analysis; Urban planning*

LICENSE: This article by International Journal of Environmental Sciences, Development & Sustainability (IJESDS-IMSU) is licensed and published under the Creative Commons Attribution License 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided this article is duly cited.

COPYRIGHT: The Author(s) completely retain the copyright of this published article.

OPEN ACCESS: The Author(s) approves that this article remains permanently online in the open access (OA) model

QA: This Article is published in line with "COPE (Committee on Publication Ethics) and PIE (Publication Integrity and Ethics)".

1. INTRODUCTION

Urbanization has become one of the most significant demographic and spatial phenomena of the twenty-first century. According to the United Nations (2023), over 56 per cent of the world's population currently resides in urban areas, with projections indicating that this figure will rise to approximately 68 per cent by 2050. Rapid urban growth has intensified competition for land uses, resulting in the encroachment of residential developments into areas originally designated for industrial activities. This phenomenon has become particularly evident in many developing countries where weak planning enforcement, population growth, and increasing housing demand have altered established urban land-use structures (UN-Habitat, 2022).

Industrial zones are deliberately designated areas intended to accommodate manufacturing, processing, warehousing, and related economic activities while minimizing conflicts with residential, commercial, and institutional land uses (Koster & Rouwendal, 2010; Grodach et al., 2023). However, residential developments frequently emerge around industrial estates due to employment opportunities, accessibility advantages, relatively low rent for residential accommodation around industrial zones, and the availability of relatively affordable land. While such developments may contribute positively to urban growth and economic vitality, they often generate significant environmental, social, and planning challenges, including land-use conflicts, environmental pollution, traffic congestion, infrastructure pressure, and declining industrial productivity (Ferm & Jones, 2016; Morakiyo et al., 2023).

In Nigeria, urbanization has significantly transformed the spatial structure of major cities. The National Population Commission (2022) estimated urban growth rates exceeding 4 per cent annually in many metropolitan areas. Consequently, planned industrial layouts have increasingly experienced residential encroachment. Studies conducted in Lagos, Port Harcourt, Kano, and Onitsha indicate that residential expansion around industrial districts has contributed to land-use incompatibility, increased environmental hazards, and planning control challenges (Obongha et al., 2022; Obongha et al., 2025).

Calabar, the capital city of Cross River State, has witnessed substantial urban growth since becoming a state capital in 1967. The city functions as an administrative, commercial, educational, and tourism center in south-eastern Nigeria. Population growth, economic expansion, and increasing housing demand have accelerated residential development across various parts of the metropolis. One of the most affected areas is the Northern Industrial Zone, originally planned to accommodate industrial establishments, warehouses, and manufacturing activities. The Northern Industrial Zone of Calabar was established to facilitate industrial development and stimulate economic growth. However, residential developments have progressively expanded into and around the industrial area due to proximity to employment centers, improved transportation accessibility, and increasing land values. This trend has altered the original land-use structure of the zone and introduced new planning challenges.

Studies have indicated that residential developments around industrial areas can produce mixed outcomes. For example, Tan et al. (2017) found that residential growth near industrial districts in China enhanced local economic opportunities but increased environmental health risks. Similarly, Morakiyo et al. (2023) observed that industrial-residential interactions in Osogbo generated employment opportunities while simultaneously increasing noise pollution and traffic congestion. Danilina et al. (2024) reported that industrial-residential land-use conflicts contributed to declining environmental quality

and increased public health concerns. While studies in Calabar have largely focused on urban growth, housing development, and environmental management (Eni et al., 2020; Obongha et al., 2022). However, limited research has specifically examined the effects of residential developments within the Northern Industrial Zone. Given the strategic importance of the area for industrial investment and urban development, understanding the implications of residential encroachment is critical for sustainable planning and policy formulation.

This study, therefore, aims to examine the effects of residential developments in the Northern Industrial Zone of Calabar by analyzing changes in environmental quality, traffic conditions, infrastructure demand, property values, and industrial productivity. To achieve this aim, the following objectives were specified: to examine the pattern of residential development in the Northern Industrial Zone, to assess the effects of residential developments on industrial activities, to analyze impacts on environmental quality and infrastructure, to evaluate changes in property values, and to provide planning recommendations for sustainable land-use management.

2. MATERIALS AND METHODS

A longitudinal panel design was adopted spanning across 2019-2024 which is six years. Data were generated for ten industrial districts observed over six years (2019–2024). These industrial districts include: rice milling, animal feed production, paint manufacturing, block and concrete products manufacturing, pharmaceutical warehousing, agro-processing industries, packaging and carton manufacturing, vehicle repair and engineering workshops, iron/metal and logistics facilities, and Chemical and detergent production. While the fixed effects panel model made use of the following variables: Residential Development Intensity (RDI), Property Value Index (PVI), Infrastructure Demand Index (IDI), Environmental Pollution Index (EPI), and Industrial Productivity Index (IPI).

The analysis adopted a combination of Fixed Effects Panel Model and GIS/Remote sensing and Artificial Intelligence (AI) spatial analytical methods. The model specification is mathematically expressed as:

$$IPI_{it} = \beta_0 + \beta_1 RDI_{it} + \beta_2 EPI_{it} + \beta_3 IDI_{it} + \beta_4 PVI_{it} + \mu_i + \varepsilon_{it} \dots\dots\dots Eqn. 1$$

Where:

IPI = Industrial Productivity Index

RDI = Residential Development Intensity

EPI = Environmental Pollution Index

IDI = Infrastructure Demand Index

PVI = Property Value Index

μ_i = district fixed effect

ε_{it} = error term

Study Area

Calabar Metropolis is located between Latitudes 4°45'N and 5°10'N and Longitudes 8°15'E and 8°25'E in Cross River State, Nigeria. The metropolis comprises Calabar Municipality and Calabar South Local Government Area. The Northern Industrial Zone is situated along the northern axis of Calabar Municipality and contains industrial establishments, warehouses, transport facilities, and emerging residential neighborhoods. The area is connected by major transportation corridors, including the Murtala Mohammed Highway. The zone experiences a tropical climate characterized by high rainfall exceeding 2,500 mm annually and temperatures ranging between 24°C and 31°C. Figure 1.0 shows Calabar, the location of the study area.

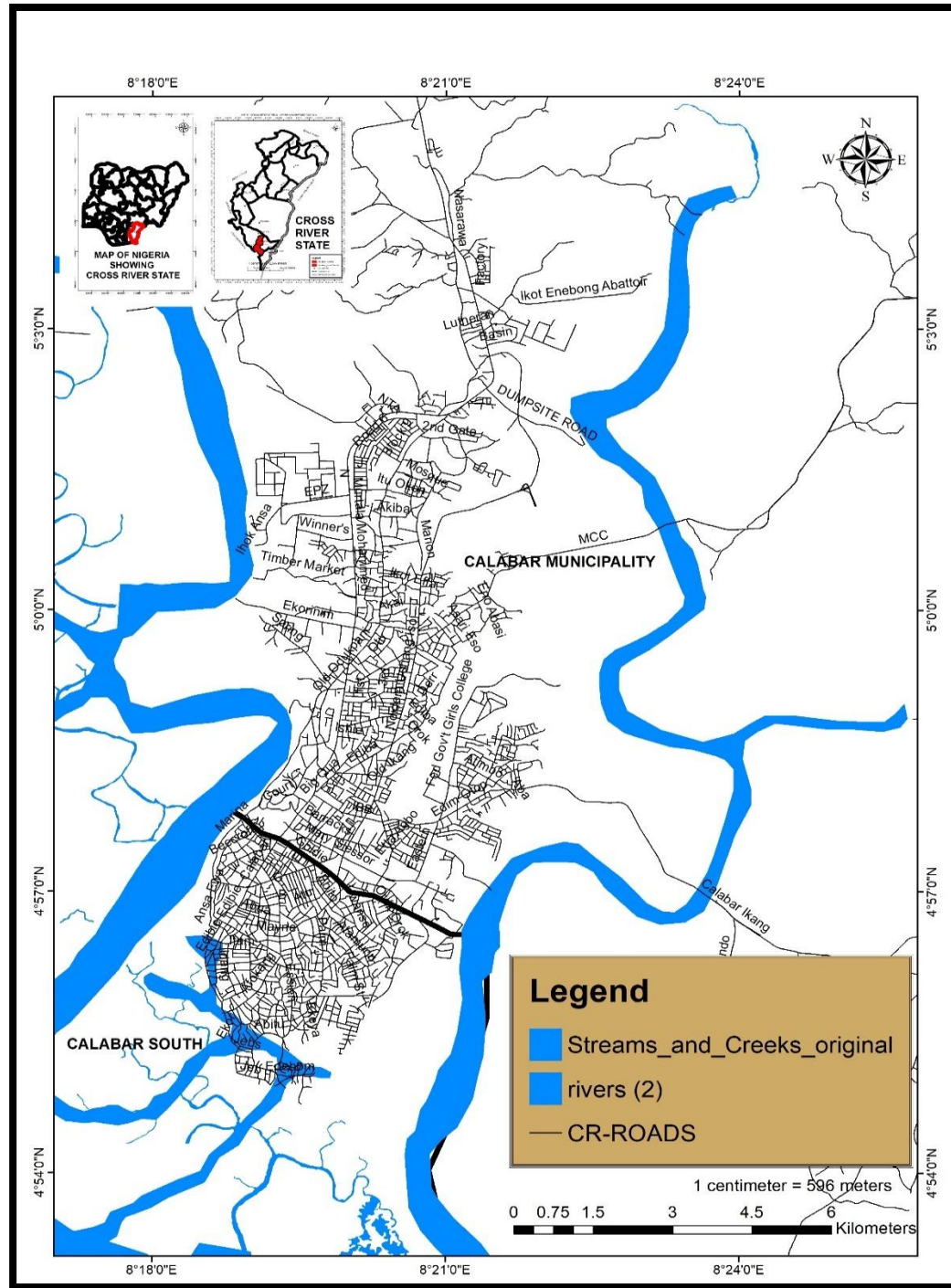


Figure 1. Calabar showing the study area (Source: GIS Unit of Urban and Regional Planning, University of Cross River State, Calabar, 2026).

3. RESULTS AND DISCUSSION

The analysis was carried out using two methods: a Generated Panel Dataset Summary (2019–2024) of ten industrial districts and a combination of GIS and AI spatial analytical methods.

Table 1. Generated Panel Dataset Summary (2019–2024)

Variable	Mean	Standard Deviation
RDI	64.5	12.8
EPI	58.4	11.6
IDI	71.2	15.4
PVI	145.6	23.1
IPI	73.8	14.2

Fixed effects panel regression results

Table 2. Dependent Variable: Industrial Productivity Index (IPI)

Variable	Coefficient	Std. Error	t-value	p-value
Residential development intensity	-0.432	0.087	-4.97	0.000
Environmental pollution index	-0.381	0.092	-4.14	0.001
Infrastructure demand index	-0.264	0.078	-3.38	0.003
Property value index	0.215	0.064	3.36	0.004
Constant	102.51	7.24	14.16	0.000

Table 2 shows that the coefficient (-0.432) indicates that a one-unit increase in residential development intensity results in approximately a 0.43-unit decline in industrial productivity. This suggests that residential encroachment reduces operational efficiency within industrial establishments. Environmental pollution exhibited a significant negative effect on industrial productivity. Increased residential occupation generated higher waste volumes, traffic emissions, and environmental stress. The negative coefficient demonstrates that growing residential populations place pressure on infrastructure demand such as water supply, roads, electricity, and drainage systems, thereby affecting industrial operations. Property values showed a positive relationship with productivity. Rising land values reflect increasing economic attractiveness and investment potential within the area.

Table 3. Model Statistics

R ²	Adjusted R ²	F-statistic	p-value
0.78	0.75	28.63	P<0.001

The fixed effects model revealed that residential development intensity, environmental pollution, and infrastructure demand exert statistically significant negative effects on industrial productivity ($R^2 = 0.78$). Consequently, uncontrolled residential expansion threatens the long-term viability of the industrial zone, which is also shown in Figure 2.0.

Spatial (Map) analysis

The spatial/image analysis in Figure 2 reveals as follows:

The result of the image analysis showed that residential developments have expanded toward industrial lands and, as such, industrial-residential interfaces are becoming increasingly mixed.

Accessibility provided by major highways has accelerated housing construction. This has led to the gradual conversion of industrial land parcels to residential uses. Finally, increased development density has heightened infrastructure demand.

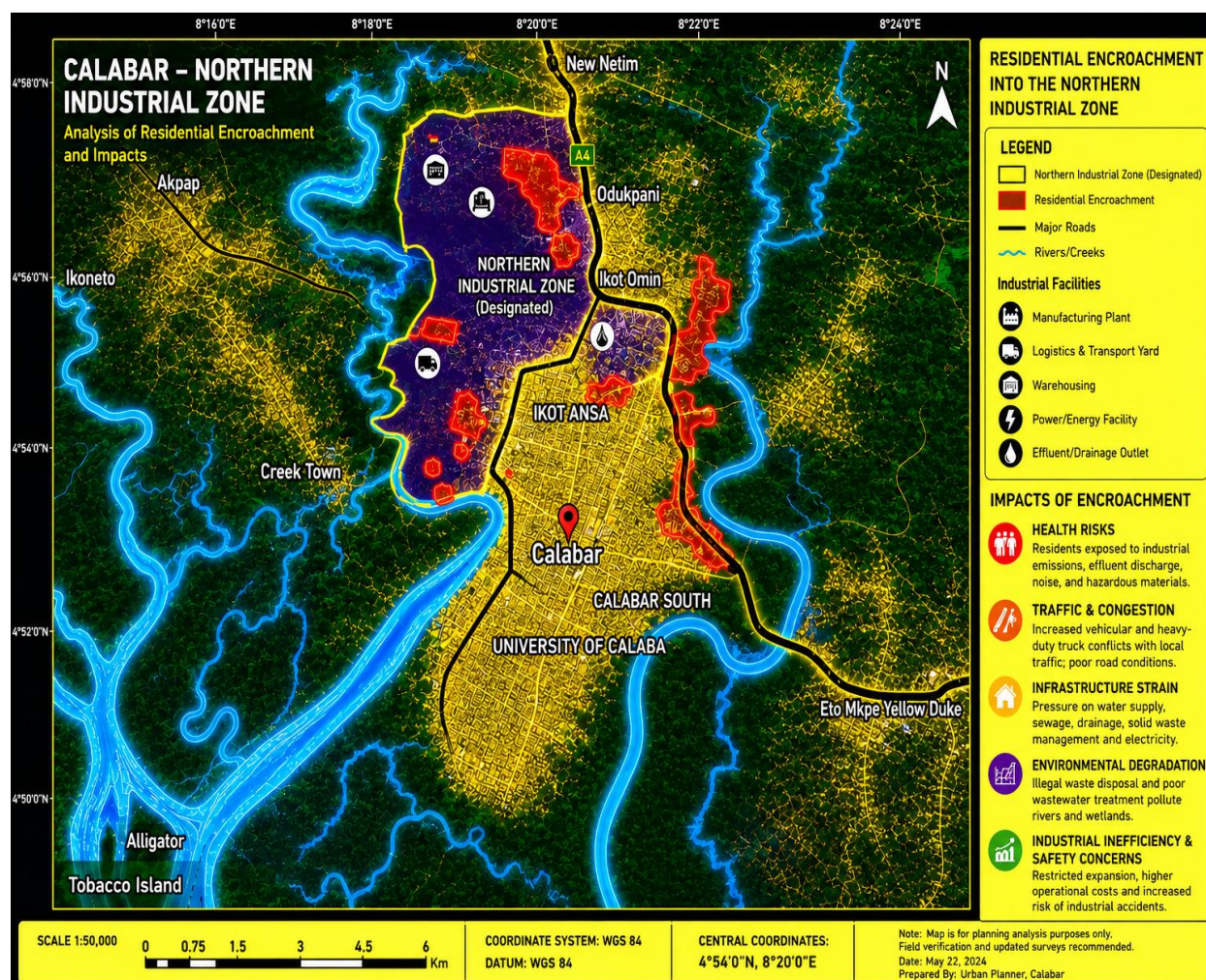


Figure 2. Spatial/image analysis of residential encroachment in the Northern Industrial Zone of Calabar (Source: GIS Unit of Urban and Regional Planning, UNICROSS, Calabar, 2026)

Table 4. Major Spatial Effects Identified

Spatial Indicator	Observation
Residential expansion	High
Industrial land conversion	Moderate

Traffic congestion	High
Environmental pressure	High
Infrastructure stress	High

Discussion of findings

The findings indicate significant land-use transformation/change within the Northern Industrial Zone. The negative effects of residential development intensity on industrial productivity corroborate findings by Wang et al. (2020), Owolabi & Oduwaye (2021), and Nwankwo and Chima (2022). Residential developments have generated economic opportunities through increased property values and market expansion. However, environmental degradation, traffic congestion, and infrastructure overload have reduced industrial efficiency. The observed pattern aligns with urban ecological processes that emphasize competition among land uses in rapidly growing cities. Without effective development control, industrial zones may lose their economic functionality and become mixed-use areas characterized by incompatible activities.

Industrial zones provide jobs, drive economic activity, and support local businesses. On the other hand, residential development aims to create housing opportunities and improve living conditions for the residents, but their intermix can lead to conflicts with industrial operations, such as noise, pollution, and traffic congestion. This conflict can result in regulatory challenges, and as such, planning authorities must balance the needs of both sectors. Striking a compromise that accommodates residential growth while preserving the functionality of industrial zones is crucial for sustainable development of the city.

Similarly, industrial zones highlight a complex interplay between economic and social factors. They are vital for job creation and economic stability, providing essential services and manufacturing capabilities that support the local economy. However, as urban populations grow, there is increasing pressure to develop residential areas to accommodate housing needs, which can lead to the displacement of industrial activities. Planning authorities must navigate these challenges by implementing zoning regulations and planning strategies that can harmonize residential growth with industrial productivity, ensuring that both sectors can coexist sustainably. Effective planning and collaboration among stakeholders are essential for finding a balanced solution that meets economic and community needs.

4. CONCLUSION

This study examined the effects of residential developments in the Northern Industrial Zone of Calabar using a combination of fixed effects panel analytical framework and spatial analysis. The results demonstrate that residential developments have significantly transformed the spatial and functional characteristics of the area. While increasing property values and economic attractiveness, residential expansion has negatively affected industrial productivity through environmental pollution, infrastructure pressure, traffic congestion, and land-use conflicts.

There is a need for the Cross River State planning authority to strictly enforce zoning regulations and encourage the establishment of green buffers to separate residential and industrial land uses. GIS, remote sensing, and AI technologies should be adopted for continuous monitoring. While the establishment of industries should comply with environmental regulations and pollution-control standards. The master plan should be updated to accommodate contemporary growth realities, and the introduction of new housing schemes should be directed toward suitable locations outside core industrial districts. Finally, industrial land protection policy should be legalized and protected against unauthorized residential conversion.

5. COMPETING INTEREST

None to declare

REFERENCES

- Danilina, N., Korobeinikova, A., & Teplova, I. (2024). Decision-making approach for land use in urban industrial area redevelopment projects. *Sustainability*, 16(22): 9827.
- Eni, D. D., Ubi, P. S., & Eja, E. I. (2020). Urban growth dynamics and environmental sustainability in Calabar Metropolis, Nigeria. *Environmental Challenges*, 1(10)
- Ferm, J. & Jones, E. (2016). Mixed-use regeneration of employment land in the post-industrial city: Challenges and realities in London. *European Planning Studies*, 24(10): 1-24. <https://doi.org/10.1080/096543132016.1209465>
- Grodach, C. & Martin, D. (2023). A productive mix? Urban manufacturing in planned industrial zones and mixed-use districts. *Journal of Planning Education and Research*, <https://doi.org/10.1177/0739456x231211260>
- Koster, H. R. A. & Rouwendal, J. (2010). The impact of mixed land use on residential property values. *Tinbergen Institute Discussion Paper*, 1105-1081. <https://doi.org/10.1111/j.1467-9787.2012-00771>
- Morakiyo, K. O., Eghenure, F. O., Adebisi, H. O., & Adeola, J. A. (2023). Environmental sustainability and urban growth issues: Empirical evidence from Osogbo Capital Territory, Nigeria. *Journal of Locat Architecture and Civil Engineering*, 1(2): 55-65. <https://doi.org/10.59810/ujlace.i1i2.14>
- Obongha, U. E., Upuji, J. K., Eteng, S. U., & Ogban, F. E. (2025). Application of the nearest neighbour analysis for measuring non-conforming land uses in Calabar Metropolis of Cross River State, Nigeria. *Journal of Environmental Management and Safety*, 6(1): 10-28 www.cepaajournal.com
- Obongha, U. E., Agbor, E. A., & Upuji, J. K. (2022). Analysis of the pattern of land use change in Calabar Municipality of CRS, Nigeria. *International Journal of Research and Innovation in Social Science*, 5(1): 982-988. www.rsisiinternational.org
- Tan, L., Yinlong, L., & Zhang, B. (2017). Measuring residential and industrial land use mix in the peri-urban areas of China. *Land Use Policy*, 69: 427-438. <https://doi.org/10.16/j.landusepol2017.9.036>
- UN-Habitat. (2022). *World cities report 2022: Envisaging the future of cities*. United Nations Human Settlements Program.
- United Nations. (2023). *World urbanization prospects 2023*. United Nations Department of Economic and Social Affairs.