

Residents' Perceptions of the Environmental Impacts of Urbanization on the Urban Fringes of Port Harcourt Metropolis, Rivers State

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Abstract

Urban expansion at metropolitan edges can change land cover and place additional pressure on drainage, vegetation, waste services, and local natural resources. This study examined residents' perceptions of four environmental impacts associated with urbanization in seven communities on the fringes of Port Harcourt, Rivers State, Nigeria: flooding, loss of green spaces and deforestation, pollution, and natural-resource degradation. A descriptive cross-sectional questionnaire survey was used. The research sample comprised 398 residents from Rukpokwu, Eneka, Iriebe, Igwuruta, Igwuruta-Ali, Omagwa, and Igbo-Etche. Responses to four five-point Likert items were summarized using frequencies, percentages, and reported weighted mean scores. Flooding received the highest mean score (M=4.09), with 331 respondents (83.2%) agreeing or strongly agreeing that urbanization had increased flooding in their communities. Loss of green spaces and deforestation ranked second (M=3.98), with 316 respondents (79.4%) agreeing or strongly agreeing. Natural-resource degradation had a reported mean of 3.77, and 223 respondents (56.0%) agreed or strongly agreed. Pollution had the lowest mean (M=3.33); 177 respondents (44.5%) agreed or strongly agreed, while 149 (37.4%) were neutral. The results indicate that flooding and vegetation loss were the most salient perceived environmental concerns among the surveyed residents. The study recommends that development decisions in fringe communities prioritize flood-sensitive land-use control, protection of drainage corridors and green spaces, and coordinated environmental services. The findings represent residents' perceptions and do not independently establish measured changes in flood frequency, pollution levels, or land-cover extent.

Keywords: *Urbanization; Urban fringe; Residents' perceptions; Flooding; Green-space loss; Port Harcourt; Nigeria*

INTRODUCTION

Urbanisation is one of the most significant socio-spatial transformations of the twenty-first century, reshaping population distribution, economic activities, settlement patterns, land use, and environmental conditions across the world. It involves the increasing concentration of populations in urban areas and the associated physical expansion and functional transformation of cities and their surrounding settlements. According to the United Nations Department of Economic and Social Affairs (UN DESA, 2018), approximately 55% of the world's population lived in urban areas in 2018, and this proportion was projected to increase to 68% by 2050. Although urbanisation can stimulate economic growth, employment opportunities, innovation, and access to essential services, its environmental implications depend substantially on the pace, spatial pattern, and management of urban development. Bai *et al.* (2017) explained that the relationship between urbanisation and the environment encompasses interconnected changes in land use, ecosystems, air quality, water resources, solid-waste management, and urban climate. Consequently, urbanisation should be understood not only as a demographic and economic process but also as a major driver of environmental transformation requiring effective planning and management.

The environmental implications of urbanisation are particularly important in developing countries, where rapid population growth and spatial expansion can place considerable pressure on existing infrastructure, natural resources, and urban management institutions. In many rapidly growing cities, the demand for residential land, transportation networks, commercial facilities, and public infrastructure encourages development beyond established

urban boundaries. Where such expansion is inadequately guided by land-use planning and development control, agricultural land, vegetation, wetlands, and other natural areas may be converted to built-up uses without corresponding improvements in drainage, sanitation, waste management, and other environmental services. The United Nations Human Settlements Programme (Citaristi, 2022) emphasised that effective urban and territorial planning is essential for managing urban growth, limiting unsustainable sprawl, and promoting resilient and environmentally sustainable settlements. These concerns are particularly relevant to urban fringes, where the transition from rural to urban land uses can occur rapidly and where the provision of infrastructure and environmental services may not keep pace with development.

Nigeria provides an important context for examining these challenges because of its large population, continuing urban growth, and expanding metropolitan settlements. The country's urbanisation has been influenced by natural population increase, rural–urban migration, economic opportunities, industrial development, and the concentration of infrastructure and public services in urban centres. The United Nations (UN DESA, 2018) identified Nigeria, alongside India and China, as one of the countries expected to contribute substantially to global urban population growth between 2018 and 2050. This projected growth has important implications for urban planning, housing provision, transportation, environmental protection, and the management of land and natural resources. In particular, the expansion of Nigerian cities into their surrounding settlements raises questions about how development affects environmental quality and how planning authorities can accommodate population growth without intensifying environmental degradation.

Port Harcourt, the capital of Rivers State, represents a significant example of these urbanisation dynamics. As a major commercial and industrial centre in the Niger Delta, its development has been closely associated with petroleum exploration, oil and gas activities, public administration, trade, and related employment opportunities. The expansion of economic activities has attracted residents from different parts of Nigeria, contributing to population growth and increasing demand for housing, commercial land, transportation, and public infrastructure. As development extends beyond established urban areas, surrounding communities increasingly become incorporated into the metropolitan growth process. This outward expansion has contributed to the transformation of settlements such as Eneka, Rukpokwu, Igwuruta, Oyigbo, Akpajo, and Elelenwo, although the extent and characteristics of urban development differ across locations. These changes illustrate the importance of examining the environmental implications of urban growth beyond the traditional urban core.

The outward expansion of Port Harcourt can be examined through the concept of peri-urbanisation, which describes the changing spatial, economic, social, and environmental relationships between urban centres and their surrounding rural or semi-rural settlements. Urban fringes are particularly dynamic because they accommodate new residential neighbourhoods, commercial establishments, industrial activities, roads, and other infrastructure while retaining, in some locations, agricultural land, vegetation, wetlands, and other features of the natural environment. As urban development advances, the conversion of these land uses can alter local ecosystems and increase pressure on environmental resources and services. Bai *et al.* (2017) observed that urbanisation produces interconnected environmental effects whose nature and intensity vary according to geographical conditions, socioeconomic circumstances, and patterns of urban development. Similarly, UN-Habitat (2022) emphasised the importance of managing urban land expansion through integrated planning and sustainable development strategies. The urban fringe therefore provides a relevant setting for investigating the environmental consequences associated with metropolitan expansion.

One important environmental concern associated with urban expansion is flooding. The conversion of vegetated and permeable surfaces into buildings, roads, and other impervious surfaces can increase surface runoff and reduce the infiltration of rainfall into the soil. In addition, construction that encroaches on wetlands, natural drainage channels, and flood-prone areas can obstruct the movement and storage of stormwater. Where drainage infrastructure is inadequate, poorly maintained, or insufficiently integrated with land-use development, these conditions can increase the risk of water accumulation and flooding. In Port Harcourt, Echendu (2021) investigated the relationship between urban planning and flooding through qualitative interviews with five urban planning professionals. The findings identified poor planning practices and inadequate compliance with planning regulations as major contributors to the city's flooding problem. The study also emphasised the importance of infrastructure provision, effective development control, improved waste management, and stronger coordination among planning stakeholders. Although this research provides important evidence concerning the relationship between planning and flooding in Port Harcourt, further investigation is needed to understand how residents of selected urban-fringe communities experience and perceive flooding in the context of continuing urban expansion.

The loss of green spaces and deforestation constitute another important environmental dimension of urbanisation. Green spaces, including trees, vegetation, gardens, and natural open areas, perform ecological functions that contribute to biodiversity conservation, soil protection, local climate regulation, and environmental quality. However, the conversion of vegetated land into residential, commercial, industrial, and infrastructural uses can reduce green-space availability, fragment habitats, and alter ecological processes. Hou *et al.* (2023), in a global meta-analysis involving 34 studies and 163 observations, found that urbanisation generally had negative effects on plant diversity, particularly the richness of native plant species. The authors also highlighted the ecological importance of suburban areas, where relatively high plant richness may persist along the urbanisation gradient. These findings underscore the importance of investigating vegetation loss in rapidly

developing urban-fringe communities. In the context of Port Harcourt, examining residents' perceptions of green-space loss and deforestation can provide insight into the environmental changes they observe as previously vegetated areas are converted to built-up land.

Pollution is a further environmental concern arising from the expansion and intensification of urban activities. Increasing residential density, road construction, vehicular movement, commercial operations, industrial activities, and construction work can generate emissions, dust, wastewater, solid waste, and noise. Where waste collection, sanitation facilities, drainage, and environmental enforcement are inadequate, these activities can contribute to the deterioration of environmental quality. Bai *et al.* (2017) identified air pollution, water pollution, and solid-waste management as important dimensions of the relationship between urbanisation and environmental change. The relevance of these issues to Port Harcourt is heightened by the coexistence of residential development, transportation activities, commercial enterprises, and industrial operations. Nevertheless, the types and severity of pollution experienced by residents may vary between communities according to land use, infrastructure provision, settlement density, and proximity to pollution sources. Investigating residents' perceptions of pollution can therefore help identify the environmental concerns most apparent within the selected urban-fringe communities, while environmental monitoring would be required to establish pollutant concentrations and determine compliance with applicable standards.

Urbanisation also places pressure on natural resources, including land, soil, water, and vegetation. These resources support ecological processes, human livelihoods, and the continued functioning of settlements. Their degradation may occur through the clearing of vegetation, excavation and construction activities, inappropriate waste disposal, contamination, and the conversion of natural areas to built-up uses. In Port Harcourt Metropolis, Igwe and Ukpere (2022) investigated the effects of urbanisation-related activities on soil quality using laboratory analysis, questionnaire surveys, and geospatial techniques. Their study examined soil conditions at 15 sampling locations and incorporated questionnaire data from 800 respondents, demonstrating the value of combining environmental measurements with spatial and socioeconomic information when investigating urban environmental change. However, soil quality represents only one aspect of natural-resource conditions. The broader issue also encompasses the availability and quality of water, the condition of vegetated land, and the loss or deterioration of natural areas that support environmental sustainability. Examining residents' perceptions of natural-resource degradation can consequently complement existing research by identifying the resource-related changes that communities associate with urban development.

Residents' perceptions are particularly relevant to environmental research because people experience environmental change through their everyday interactions with their homes, neighbourhoods, infrastructure, and surrounding natural environment. Their observations can provide information about the frequency of environmental problems, the locations where such problems are experienced, and the changes they associate with urban growth. Community perspectives can also help identify environmental concerns that require further investigation by planning authorities and environmental management agencies. Bai *et al.* (2017) highlighted the importance of integrating social and environmental knowledge into approaches to urban environmental governance. Similarly, UN-Habitat (2022) emphasised the value of inclusive approaches to building resilient and sustainable urban futures. Nevertheless, residents' perceptions must be distinguished from objectively measured environmental conditions. Questionnaire responses can establish how residents assess flooding, vegetation loss, pollution, and natural-resource degradation, but they cannot independently establish the physical magnitude, spatial distribution, or causal mechanisms of these environmental changes. Where feasible, combining perception-based evidence with land-use mapping, field observations, environmental measurements, and relevant secondary data would provide a more comprehensive understanding of the issues under investigation.

Although existing research has addressed important environmental problems associated with urban development in Port Harcourt, the available studies considered here have focused on particular environmental dimensions. Echendu (2021) examined the relationship between urban planning and flooding, while Igwe and Ukpere (2022) investigated the effects of urbanisation-related activities on soil quality. Hou *et al.* (2023) provided broader international evidence concerning urbanisation and plant diversity, while Bai *et al.* (2017) established a conceptual basis for understanding the multiple environmental pathways through which urbanisation affects urban systems. These studies provide useful foundations, but they do not, individually, answer the specific question of how residents in selected communities on the urban fringes of Port Harcourt perceive the environmental impacts associated with urbanisation across the four dimensions addressed in the present study.

It is against this background that the present study examines residents' perceptions of the environmental impacts of urbanisation in selected urban-fringe communities of Port Harcourt Metropolis, Rivers State, Nigeria.

Statement of the Problem

Nigeria has experienced rapid urbanisation over the past several decades, accompanied by substantial population growth and the outward expansion of major urban centres. The country's urban population increased from approximately 15.4% in 1960 to nearly half of the national population by 2017, with projections indicating that more than 67% of Nigerians may live in urban areas by 2050 (United Nations data as cited in Fox *et al.*, 2015). Although urbanisation creates opportunities for economic growth, employment, investment, and improved access to services, its rapid and inadequately managed expansion places considerable pressure on land, infrastructure, and environmental resources. In many developing urban areas, the pace of physical development has exceeded the capacity

of planning institutions and infrastructure systems to accommodate growth sustainably, particularly in peri-urban and urban-fringe communities (UN-Habitat data cited in ISS Africa, 2024).

This situation is evident in the expanding metropolitan area of Port Harcourt, Rivers State, where urban growth has progressively extended into formerly rural settlements and surrounding communities. Areas such as Rukpokwu, Eneka, Iriebe, Igwuruta, Igwuruta-Ali, Omagwa, and Igbo-Etche are experiencing changes in settlement patterns and land-use activities as residential development, commercial establishments, and supporting infrastructure expand into previously less-developed areas. These changes reflect the increasing integration of fringe communities into the wider urban system. However, the resulting development pattern may be uneven, with planned residential estates and improved access roads existing alongside neighbourhoods with inadequate drainage, poorly maintained access roads, insufficient waste-management facilities, and limited provision of other essential infrastructure. Such contrasts raise concerns about the capacity of existing planning and environmental management systems to respond effectively to the demands of urban expansion (Wokekoro and Owei, 2006; Ameme *et al.*, 2025).

One of the major concerns associated with this expansion is its potential effect on the local environment. As agricultural land, vegetation, and other undeveloped surfaces are converted to residential, commercial, and infrastructural uses, the natural characteristics of the landscape may be altered. The removal of vegetation and the increasing coverage of land with impermeable surfaces can modify surface runoff and natural drainage patterns, while poorly managed development and waste-disposal practices may contribute to pollution and the deterioration of environmental quality. These processes can also reduce the availability of green spaces, disturb ecological functions, and increase pressure on land, water, and other natural resources. Although the nature and severity of these effects depend on local physical conditions, the intensity of development, and the effectiveness of environmental management, they represent important sustainability concerns in rapidly expanding urban areas (Bai *et al.*, 2017; UN-Habitat, 2022; Zhang *et al.*, 2022).

In Port Harcourt, flooding is a particularly significant environmental concern, and existing research has associated urban flood risk with deficiencies in urban planning and non-compliance with development regulations (Echendu, 2021). As development extends into fringe communities, the interaction between changing land-use patterns, modified drainage channels, vegetation loss, and inadequate infrastructure may aggravate existing environmental vulnerabilities. Similarly, the progressive reduction of green spaces and the conversion of natural surfaces into built-up areas may affect local environmental quality and the capacity of the landscape to perform essential ecological functions. Pollution and the degradation of natural resources may also become concerns where the expansion of residential and commercial activities is not accompanied by adequate environmental infrastructure and effective management practices (Igwe and Ukpere, 2022; Zhang *et al.*, 2022). Nevertheless, the existence of these potential environmental pressures does not establish that their effects are uniform across all fringe communities or that residents experience them with the same degree of severity.

The central problem, therefore, is the need to understand how residents perceive the environmental impacts associated with urbanisation in the fringe communities of Port Harcourt. While existing research and technical assessments can provide evidence about urban expansion, land-use change, flooding, and environmental degradation, these forms of evidence do not necessarily explain how people living in affected communities experience and interpret environmental changes in their immediate surroundings. Residents interact daily with their local drainage systems, vegetation, waste-disposal facilities, and natural resources. Their experiences and perceptions can consequently provide valuable insights into the environmental problems they encounter and the changes they associate with urban development. However, such perceptions must be investigated systematically rather than presumed, since residents' assessments may differ according to their location, experiences, and exposure to particular environmental conditions.

A related problem is the need to examine the principal environmental concerns associated with urbanisation in a structured and integrated manner. Flooding, the loss of green spaces and deforestation, pollution, and natural-resource degradation represent four important dimensions through which residents may perceive the environmental implications of urban expansion. Although these issues may be interrelated, their perceived occurrence, severity, and association with urbanisation may vary across communities. Without systematic evidence on these dimensions, planning authorities and other relevant stakeholders may have an incomplete understanding of the environmental concerns most evident to residents and the areas in which environmental management, infrastructure provision, and development control may require greater attention. Community-level evidence is therefore necessary to complement existing planning and environmental assessments and to support responses that are sensitive to the experiences of people living in rapidly urbanising fringe areas.

It is against this background that this study examines residents' perceptions of the environmental impacts of urbanisation in seven selected fringe communities of Port Harcourt.

Aim and Objectives of the Study

Aim of the Study

The aim of this study is to examine residents' perceptions of the environmental impacts of urbanization on the urban fringes of Port Harcourt, Rivers State, Nigeria.

Specific Objectives

The specific objectives are to:

i. assess residents' perceptions of the relationship between urbanization and flooding in the selected communities;
ii. examine residents' perceptions of the loss of green spaces and deforestation associated with urban expansion;
iii. determine how residents perceive the relationship between increasing urbanization and pollution; and
iv. assess residents' perceptions of urbanization-related natural-resource degradation.

The Study Area

Geographical Location

The study is situated on the urban fringes of Port Harcourt, the capital of Rivers State in southern Nigeria. Port Harcourt is an important urban centre in the Niger Delta, with economic activities and urban development influenced by commerce, transportation, industry, and the petroleum sector. The expansion of the metropolitan area into surrounding settlements has made the urban fringe an important geographical context for examining changes in land use, settlement patterns, and environmental management requirements.

The study covers seven selected communities: Rukpokwu, Eneka, Iriebe, Igwuruta, Igwuruta-Ali, Omagwa, and Igbo-Etche (Fig. 1 and Fig. 2). These communities constitute the study locations for investigating residents' perceptions of environmental impacts associated with urbanization. Their inclusion enables the research to examine perceptions across several fringe settlements rather than limiting the investigation to the established urban core.

LITERATURE REVIEW

Conceptual Review

The conceptual review examines the major concepts underpinning the study titled Residents' Perceptions of the Environmental Impacts of Urbanization on the Urban Fringes of Port Harcourt. It establishes the conceptual meaning of urbanization, urban fringes, environmental impacts, and residents' perceptions, while explaining the relationships among these concepts in the context of urban development and environmental sustainability. The review is organized around the study's four environmental dimensions: flooding, loss of green spaces and deforestation, pollution, and natural-resource degradation.

Concept of Urbanization

Urbanization refers to the increasing concentration of people, economic activities, and built infrastructure in urban areas, accompanied by an increase in the proportion of a population living in urban settlements. It is a demographic, spatial, economic, and social process through which settlements grow and rural or previously undeveloped areas become increasingly integrated into urban systems. Urbanization is commonly associated with population growth, rural–urban migration, natural population increase, economic restructuring, and the expansion of housing, transportation networks, commercial activities, and public infrastructure. However, urbanization is not limited to an increase in the urban population; it also involves changes in land use, settlement morphology, resource consumption, and the relationship between human activities and the natural environment (Bai *et al.*, 2017).

From a spatial planning perspective, urbanization involves the physical expansion and intensification of built-up areas as land is converted from agricultural, forested, vegetated, wetland, or other non-urban uses to residential, commercial, industrial, and infrastructural uses. The process may occur through infill development within existing urban areas, redevelopment of previously developed land, or outward expansion into adjoining settlements and peri-urban landscapes. Outward expansion is particularly significant where population growth and increasing demand for urban land extend development beyond established urban boundaries. In such circumstances, the distinction between urban and rural environments becomes less clear as traditional rural settlements acquire urban characteristics, land markets change, and agricultural or natural landscapes are progressively transformed.

Urbanization can generate important socioeconomic benefits, including employment opportunities, improved access to markets, increased investment, and the concentration of educational, health, and other services. Nevertheless, these benefits depend partly on the capacity of institutions and

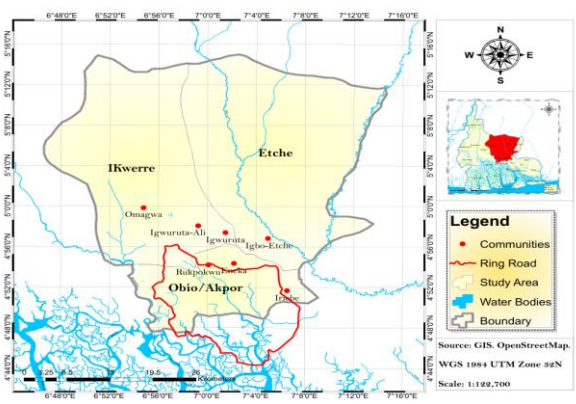


Fig. 1: Map of the study area showing the sampled communities along and outside the Ring Road.
Source: Researchers Map Data (2024)

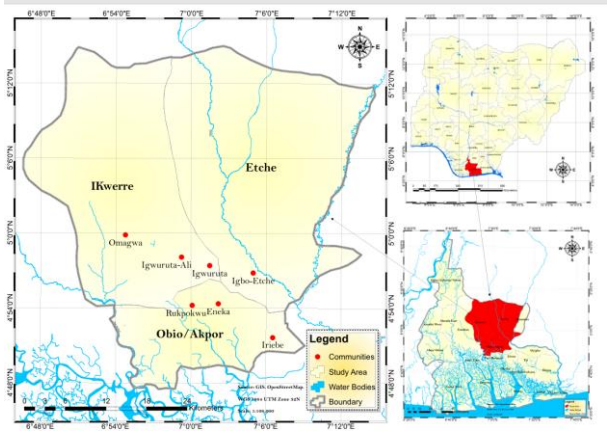


Fig. 2: Map showing study locations/ sampled settlements.
Source: Author's design, 2024.

infrastructure to accommodate urban growth. Where land-use planning, drainage infrastructure, waste management, and development control fail to keep pace with expansion, urbanization can intensify environmental pressures. Bai *et al.* (2017) explained that urbanization affects environmental systems through changes in land cover, energy use, pollution, resource flows, and ecosystem processes. Similarly, the United Nations Human Settlements Programme (Citaristi, 2022) emphasizes the importance of planning and managing urban growth to achieve more sustainable urban futures.

In the Nigerian context, urbanization is particularly relevant to cities experiencing rapid population growth and outward spatial expansion. Port Harcourt, the capital of Rivers State and an important commercial and industrial centre in the Niger Delta, provides a relevant setting for examining the relationship between urban development and environmental change. As urban development extends into adjoining communities, the conversion of land and the changing intensity of human activities can create new demands for drainage, transportation, waste disposal, and other environmental services. The implications of these changes depend not only on the rate of urban expansion but also on the suitability of development locations, the enforcement of planning regulations, and the availability of infrastructure.

For this study, urbanization is conceptualized as the expansion and intensification of human settlement, built-up land, infrastructure, and associated activities within and around Port Harcourt. The concept is important because it provides the context for examining how residents perceive changes in flooding, vegetation cover, pollution, and the condition of natural resources in selected urban-fringe communities. The study does not assume that all environmental problems are caused exclusively by urbanization; rather, it investigates residents' perceptions of the relationship between urban expansion and the environmental conditions they experience.

Concept of Urban Fringe

The urban fringe refers to the transitional zone at the outer edge of a city where urban and rural land uses, activities, and settlement characteristics coexist and interact. It is an area in which the physical, economic, social, and environmental characteristics of the established city gradually merge with those of surrounding rural settlements. Unlike the central urban area, which is generally characterized by a greater concentration of buildings, infrastructure, commercial activities, and population, the urban fringe often contains a mixture of residential developments, agricultural land, undeveloped plots, remnant vegetation, informal settlements, industrial establishments, and emerging commercial corridors. The extent and character of this transition vary according to the size of the city, the intensity of development, accessibility, land-market conditions, and the effectiveness of urban planning (Simon, 2008).

The urban fringe is closely related to the concept of the peri-urban area. Although the terms are sometimes used interchangeably, the urban fringe commonly emphasizes the spatial boundary or transitional edge of an expanding city, whereas peri-urban development may also encompass wider areas functionally connected to the city through commuting, trade, infrastructure, resource flows, and changing livelihoods. Both concepts describe spaces in which urban and rural systems interact and where land use, economic activities, settlement patterns, and environmental conditions are undergoing transformation. Simon (2008) emphasizes the environmental and developmental complexities of these transitional zones, where competing land uses and the interaction between urban and rural processes create distinctive planning challenges.

One defining characteristic of the urban fringe is the rapid conversion of land from non-urban to urban uses. As demand for housing, commercial premises, industrial sites, and transportation infrastructure increases, developers and households may seek land beyond the established urban core. This expansion can occur through planned extensions, incremental development, or uncoordinated settlement growth. Where development proceeds without adequate infrastructure provision or effective land-use controls, the resulting settlement pattern may be difficult and costly to service. UN-Habitat identifies unplanned expansion at urban fringes as a challenge associated with inefficient land consumption, pressure on marginal land, and difficulties in providing infrastructure and services.

The environmental significance of the urban fringe arises from its position between expanding urban development and the natural or semi-natural landscapes that surround cities. These areas may contain vegetation, agricultural land, wetlands, waterways, and other environmental resources that support drainage, biodiversity, local livelihoods, and ecological functions. When such land is converted to built-up uses, the resulting changes may alter surface-water movement, reduce vegetation cover, increase waste generation, and intensify pressure on natural resources. The consequences depend on the location and form of development, the sensitivity of the receiving environment, and the adequacy of planning and environmental management.

In Port Harcourt, the urban fringe is relevant because metropolitan growth extends into surrounding communities where established settlements and developing built-up areas coexist with undeveloped land and other environmental features. The selected communities for this study, Rukpokwu, Eneka, Iriebe, Igwuruta, Igwuruta-Ali, Omagwa, and Igbo-Etche, provide the geographical context for examining residents' perceptions of environmental change associated with urban expansion. The fringe is therefore understood in this study not simply as a fixed administrative boundary, but as a transitional landscape experiencing changing land uses, settlement patterns, and environmental pressures.

Conceptually, the urban fringe provides the spatial context within which the study's environmental concerns are examined. It helps explain why urbanization-related environmental changes may be particularly visible in communities undergoing rapid development, where infrastructure and environmental services may not expand at the same pace as settlement. However, the presence of

development or environmental problems in these communities does not automatically establish urbanization as their sole cause. The study therefore focuses on how residents perceive the relationship between urban growth and the environmental conditions within their communities.

Concept of Residents' Perceptions

Residents' perceptions refer to the ways individuals interpret, evaluate, and assign meaning to conditions and changes in their immediate environment. These perceptions are influenced by personal experience, observation, knowledge, social interaction, livelihood activities, expectations, and the significance individuals attach to particular environmental conditions. In environmental and urban studies, perception is important because environmental problems are experienced not only as physical processes but also through their consequences for everyday activities, residential comfort, safety, property, health, and livelihoods.

Perception should be distinguished from objective environmental measurement. An objective assessment of flooding, for example, may involve rainfall records, flood-depth measurements, drainage analysis, elevation data, or mapped flood extent. Residents' perceptions of flooding, in contrast, may be based on how frequently water enters their homes or streets, how long it remains, whether movement becomes difficult, and whether they believe flooding has become more severe as their community develops. Both forms of evidence can be useful, but they answer different questions. Objective measurements establish physical characteristics, while perception-based research examines how people experience and interpret those characteristics.

Residents' perceptions are also shaped by differences in exposure and vulnerability. Individuals living close to drainage channels or low-lying land may experience flooding differently from those living on higher ground. Households whose livelihoods depend on farming or other land-based activities may be particularly attentive to vegetation removal and the conversion of agricultural land. Similarly, residents who regularly encounter smoke, dust, wastewater, or improperly disposed refuse may have different perceptions of pollution from those who experience less direct exposure. Consequently, perceptions of environmental change may vary within the same community as a result of differences in residential location, occupation, length of residence, and daily environmental experience.

The relevance of residents' perceptions extends to environmental governance and urban planning. Residents possess locally situated knowledge about recurring environmental conditions, changes in land use, the functioning of infrastructure, and the practical consequences of development. Such knowledge can complement technical assessments and provide information useful for identifying community concerns and improving public participation in environmental decision-making. Bai *et al.* (2017) identify stakeholder participation and the co-production of knowledge as important developments in urban environmental governance. This suggests that understanding residents' experiences can contribute to a more comprehensive understanding of urban environmental challenges, particularly where formal monitoring data are limited or do not adequately reflect local experience.

Nevertheless, residents' perceptions should not be interpreted as conclusive scientific proof that urbanization caused a particular environmental condition. Perceptions may be affected by recall, personal expectations, access to information, or the visibility of a problem. A respondent may associate an increase in flooding with new buildings in the neighbourhood, for example, even when rainfall intensity, tidal conditions, drainage obstruction, topography, or other factors also contribute. Perception-based studies are therefore valuable for understanding public experience and interpretation, but causal attribution may require additional evidence from environmental monitoring, spatial analysis, or other research methods.

For the present study, residents' perceptions are conceptualized as the evaluations and judgments residents make about the relationship between urbanization and environmental changes in their communities. The concept is operationalized through residents' responses concerning four dimensions: flooding, loss of green spaces and deforestation, pollution, and natural-resource degradation. This approach allows the study to examine how residents interpret the environmental implications of urban expansion without treating their opinions as substitutes for direct physical measurements.

Concept of Environmental Impacts of Urbanization

Environmental impacts of urbanization refer to changes in environmental conditions arising from, or associated with, the expansion and intensification of urban populations, settlements, infrastructure, and economic activities. These changes may affect land, vegetation, water, air quality, ecosystems, and the availability or condition of natural resources. Environmental impacts can be direct, such as the removal of vegetation to accommodate construction, or indirect, such as increased surface runoff resulting from changes in land cover. They may also be cumulative, developing over time as successive construction projects, population growth, transportation activities, and waste-generation practices place additional pressure on environmental systems.

The relationship between urbanization and environmental change is complex because environmental outcomes depend on the interaction of natural conditions, the form and intensity of development, infrastructure provision, and human behaviour. Bai *et al.* (2017) explain that urbanization affects environmental systems through multiple interconnected processes, including land-use change, ecosystem modification, air and water pollution, waste management, and climate-related effects. These impacts are not uniform across all urban areas. Their severity and distribution vary according to geographical conditions, socioeconomic circumstances, development patterns, and environmental governance.

A central mechanism through which urbanization affects the environment is the conversion of land to built-up uses. Buildings, roads, parking areas, and other constructed

surfaces replace or fragment natural and semi-natural land cover. Such transformations can affect water infiltration, vegetation distribution, local ecological processes, and the movement of surface water. Urban growth can also increase demand for construction materials, water, energy, and other resources while generating greater quantities of solid waste, wastewater, and emissions. Where environmental infrastructure and regulatory systems are inadequate, these pressures can contribute to deteriorating environmental conditions.

Urban environmental impacts are particularly important in transitional areas because development may occur alongside existing rural livelihoods and natural environmental features. The conversion of land can affect agricultural production, local drainage, green spaces, and access to natural resources. In addition, the environmental consequences of urbanization may interact: the removal of vegetation and the expansion of impervious surfaces may influence runoff; inadequate waste disposal may obstruct drainage; and pollution may affect the quality of soil and water resources. Urban environmental problems should therefore be understood as interconnected rather than as entirely independent phenomena (Bai *et al.*, 2017).

In Port Harcourt, environmental impacts associated with urban development require attention to local conditions and planning practices. Echendu (2021), in a study of the relationship between urban planning and flooding in Port Harcourt, identified inadequate planning practices and non-compliance with planning regulations as important contributors to the city's flooding problem. This provides relevant context for examining how residents perceive flooding in expanding fringe communities. Research by Igwe and Ukpere (2022) also investigated urbanization-related activities and soil quality in Port Harcourt Metropolis, illustrating the relevance of land-based environmental pressures to the study of urban development in the area.

For this study, environmental impacts of urbanization refer to the environmental changes that residents associate with the expansion of built-up areas and related human activities in the selected fringe communities. The concept is examined through four specific dimensions: flooding; loss of green spaces and deforestation; pollution; and natural-resource degradation. Each of these four dimensions is discussed in turn, beginning with flooding.

Urbanization and Flooding

Flooding refers to the temporary inundation of land that is normally dry when water exceeds the capacity of a natural or artificial drainage system, accumulates in low-lying areas, or spreads beyond the banks of rivers and other water bodies. Flooding may result from intense or prolonged rainfall, river overflow, storm surges, inadequate drainage capacity, blocked waterways, changes in land cover, or combinations of these factors. In urban areas, the nature and severity of flooding are influenced by the interaction between rainfall, topography, soil characteristics, drainage infrastructure, land-use patterns, and development practices.

Urbanization can influence flooding by altering the natural hydrological characteristics of an area. The construction of buildings, roads, paved compounds, and other impervious surfaces reduces the proportion of rainfall that can infiltrate the ground. This may increase surface runoff and accelerate the movement of water into drainage channels. Where drainage systems are insufficient, poorly maintained, obstructed, or disconnected, runoff may accumulate on roads, residential plots, and other low-lying surfaces. Urban development that encroaches on natural drainage corridors or flood-prone land can further expose residents and property to flooding. Contemporary research on urban hydrology similarly identifies urbanization and climate change as interacting pressures that can increase flood risk and contribute to ecosystem degradation (Fletcher *et al.*, 2024).

However, urbanization should not be treated as the sole cause of flooding. The occurrence and severity of flood events also depend on rainfall intensity, antecedent soil moisture, tidal or river conditions, elevation, the condition of drainage infrastructure, and the capacity of the surrounding environment to receive and convey water. Poor solid-waste management may aggravate flooding when refuse obstructs drains and waterways, while unsuitable construction practices can interfere with natural flow paths. Effective assessment therefore requires attention to both physical environmental conditions and human activities.

Flooding is a significant environmental and planning concern in Port Harcourt. Echendu (2021) examined the relationship between urban planning and flooding in the city and reported that inadequate planning and non-compliance with planning regulations were important factors identified by participating planning professionals. The study also discussed the conversion of surrounding agricultural land to residential development in the context of urban growth. This research establishes a relevant local context for investigating the relationship between expanding settlements, development control, and flood risk in Port Harcourt.

The effects of flooding may extend beyond the immediate presence of water. Flood events can disrupt movement, damage buildings and household possessions, affect businesses, damage roads, contaminate water sources, and interfere with access to essential services. Where flooding occurs repeatedly, residents may face additional expenses for repairs, protective measures, and alternative transport. These experiences can shape how residents evaluate changes in their environment and whether they associate such changes with increasing urban development.

From a residents' perception perspective, flooding is relevant because people may assess changes in flood frequency, extent, duration, or disruption through their everyday experiences. Such assessments can provide useful information about perceived environmental change, although they do not independently establish the hydrological causes of flooding. Residents' accounts are most informative when interpreted in relation to drainage conditions, land-use change, topography, and other contributing factors.

In this study, the concept of urbanization-related flooding concerns residents' perceptions of the relationship between

urban expansion and flooding in their communities. The focus is on how residents interpret flooding as an environmental concern associated with development, rather than on establishing through hydrological measurement that urbanization alone caused particular flood events.

Urbanization, Loss of Green Spaces, and Deforestation

Green spaces are areas containing vegetation within or around settlements. They may include parks, gardens, urban forests, roadside vegetation, open spaces, wetlands, and other vegetated areas that contribute to environmental quality. At the urban fringe, green spaces may also include agricultural plots, fallow land, and remnants of natural vegetation. Although these land-cover types differ in ecological characteristics and function, they can provide important environmental services, including supporting biodiversity, regulating local temperatures, intercepting rainfall, facilitating water infiltration, reducing soil erosion, and contributing to the visual and recreational quality of settlements.

Deforestation refers specifically to the removal or conversion of forest cover to other land uses. It should therefore be distinguished from the broader concept of green-space loss. Green-space loss can involve the removal of many forms of vegetation, including trees, shrubs, grass, and other vegetated open spaces, whereas deforestation relates to the clearance or conversion of forested land. In expanding urban areas, these processes may occur together when land is cleared for housing, commercial facilities, roads, industrial development, and other infrastructure.

Urbanization contributes to vegetation loss when previously vegetated land is converted to built-up uses or when existing green spaces are fragmented by roads and construction. The environmental implications depend on the type and extent of vegetation removed, the characteristics of the land, and whether development incorporates measures to retain or replace green cover. The loss of vegetation may reduce habitat availability, affect ecological connectivity, expose soil to erosion, and diminish the capacity of land to intercept and absorb rainfall. It can also reduce shade and evapotranspiration, potentially intensifying local heat exposure.

Green spaces also contribute to the environmental functioning and liveability of urban settlements. Vegetation can provide shade, improve the quality of public spaces, support recreation, and contribute to the regulation of surface runoff. Where urban growth occurs without adequate protection of vegetated land, these functions may be weakened. Bai *et al.* (2017) identify land-use change and ecosystem impacts as important components of the relationship between urbanization and the environment. Their review supports treating vegetation loss as part of a wider system of environmental change rather than as an isolated land-cover issue.

The environmental significance of green-space loss is particularly relevant to urban-fringe communities because these areas may contain a mixture of undeveloped land, agricultural land, and natural vegetation that becomes increasingly attractive for construction as cities expand. Conversion may occur incrementally, with individual plots cleared for housing or commercial activities, or at a larger scale through estate development and road construction. Where development control does not adequately consider environmental sensitivity, the cumulative effect of these changes may reduce the amount and continuity of vegetated land.

Nevertheless, the relationship between urbanization and vegetation loss is not uniform. Some developments may retain trees, establish landscaped areas, or incorporate planned open spaces, while others may remove existing vegetation with limited replacement. The environmental consequences therefore depend on development density, site planning, the protection of ecologically important areas, and the implementation of green-space policies.

For Port Harcourt's urban fringe, the conversion of vegetated and other undeveloped land into residential and infrastructural uses provides a relevant context for investigating residents' perceptions of green-space loss and deforestation. Residents may observe the disappearance of trees, the clearing of previously vegetated plots, or the reduction of open spaces as development intensifies. Their perceptions can help describe how these changes are experienced locally, although land-cover mapping and field observation would be required to quantify the extent of vegetation loss independently.

Accordingly, this study conceptualizes the loss of green spaces and deforestation as the perceived reduction or removal of vegetated land associated by residents with urban expansion. The distinction between general green-space loss and forest-cover loss remains important when interpreting the concept: not all vegetation removal constitutes deforestation, but both processes may form part of broader changes in the urban-fringe landscape.

Urbanization and Pollution

Pollution refers to the introduction or accumulation of substances, materials, or forms of energy in the environment at levels that adversely affect environmental quality, human well-being, or ecological systems. In urban environments, pollution may involve air, water, and soil contamination, as well as noise and other environmental disturbances. Its sources vary according to the nature of settlement and economic activity and may include vehicle emissions, industrial processes, construction activities, open burning, poor sanitation, wastewater discharge, and inappropriate solid-waste disposal.

Urbanization can intensify pollution by increasing the concentration of people, vehicles, buildings, commercial activities, and industrial operations. Construction and road development may generate dust and suspended particles, while transport and industrial activities can release pollutants into the atmosphere. Increased consumption and population concentration also generate larger quantities of solid waste and wastewater. Where collection, treatment, and disposal systems are inadequate, these wastes may accumulate in open spaces, enter drains, or contaminate surface water and soil.

Bai *et al.* (2017) identify air pollution, water pollution, and solid-waste management as major dimensions of the urbanization–environment relationship.

Air pollution involves the presence of gases, particles, or other contaminants in the atmosphere at concentrations that can harm people or the environment. In urban-fringe areas, potential sources include traffic, construction dust, generators, industrial activities, and the burning of waste or other materials. The type and concentration of pollutants depend on the emission source, fuel or material used, weather conditions, and the effectiveness of pollution-control measures. The expansion of built-up areas can change the distribution and intensity of these sources, although the extent of resulting air pollution must be established through appropriate monitoring rather than inferred from urban growth alone.

Water pollution occurs when contaminants enter rivers, streams, groundwater, drainage channels, or other water bodies and impair water quality. Potential urban sources include untreated wastewater, leachate from improperly managed waste, runoff from developed land, and discharges from commercial or industrial activities. Water pollution can affect aquatic ecosystems and reduce the suitability of water for domestic, recreational, or other uses. Soil pollution, in turn, may arise from the deposition or accumulation of harmful substances associated with waste disposal, petroleum-related activities, industrial processes, and other human activities. These forms of pollution may interact, particularly where contaminated runoff transports substances from land into drainage channels and water bodies.

Research in Port Harcourt provides a local basis for considering the relationship between urban activities and environmental quality. Igwe and Ukpere (2022) investigated urbanization-related activities and soil quality in Port Harcourt Metropolis, examining activities such as dumpsites, mechanic workshops, abattoirs, industrial operations, and urban agriculture. Their study illustrates the relevance of examining specific urban activities when assessing environmental conditions. It does not, however, mean that every activity or every fringe community experiences the same level or type of pollution.

Pollution may also be perceived differently by residents according to their exposure and the visibility of environmental conditions. Smoke, dust, odour, visible refuse, discoloured water, and noise may be readily noticed, whereas some contaminants cannot be identified reliably without testing. Perception-based research is therefore useful for documenting residents' experiences and concerns, but it should not be treated as a substitute for laboratory analysis or air- and water-quality monitoring.

For this study, pollution is conceptualized as the environmental contamination or disturbance that residents perceive in association with urban expansion and related activities in their communities. The concept encompasses perceived concerns involving air, water, and land pollution, while recognizing that establishing pollutant concentrations or tracing specific sources would require separate environmental measurements.

Urbanization and Natural-Resource Degradation

Natural resources are materials, land, water, and ecological assets derived from the natural environment that support human survival, economic activities, and ecosystem functioning. They include land, soil, surface water, groundwater, forests, vegetation, minerals, and other biological and physical resources. Natural resources may be renewable, such as vegetation and water when replenished under suitable conditions, or non-renewable, such as mineral deposits that form over geological timescales. Their availability and condition influence settlement development, livelihoods, agricultural production, public health, and environmental sustainability.

Natural-resource degradation refers to the deterioration in the quality, productivity, availability, or ecological functioning of natural resources resulting from human activities or natural processes. It may involve soil erosion, declining soil quality, contamination of water sources, depletion of groundwater, destruction of vegetation, loss of productive land, and deterioration of ecosystems. Degradation is not necessarily the same as resource consumption: using a resource does not automatically mean it has degraded. Degradation occurs when the resource's condition or capacity to perform its functions is impaired, or when its use exceeds its ability to recover.

Urbanization can contribute to natural-resource degradation through land conversion, construction, excavation, waste disposal, increased demand for water and building materials, and the concentration of commercial and industrial activities. The conversion of agricultural or vegetated land to built-up uses may reduce the area available for cultivation and alter the physical characteristics of the soil. Construction activities can expose soil to erosion, while poorly managed waste disposal and the discharge of untreated wastewater may contaminate land and water. Increased demand for groundwater and other resources can also create pressure on local supplies where extraction is inadequately managed.

The relationship between urbanization and natural-resource degradation is multidimensional. Bai *et al.* (2017) explain that urban development affects environmental systems through interconnected changes in land use, ecosystems, pollution, waste generation, and resource flows. These processes may reinforce one another. For example, the removal of vegetation can expose soil to erosion, while erosion and runoff can transport sediment and contaminants into drainage channels. Similarly, the conversion of productive land to buildings and roads can reduce its availability for agriculture, even where the remaining soil has not been physically contaminated.

In Port Harcourt, urban activities and their implications for environmental quality have been examined in research on soil conditions. Igwe and Ukpere (2022) investigated the effects of urbanization-related activities on soil quality in Port Harcourt Metropolis, considering a range of activities associated with waste disposal, workshops, industrial operations, and other land uses. This work demonstrates the importance of considering the environmental consequences

of urban activities when examining the sustainability of urban development.

The implications of natural-resource degradation for residents may include reduced access to productive land, concerns about water quality, deterioration of the local environment, and changes in the availability of resources used for domestic or economic purposes. However, these implications vary according to the resources available in a community, the nature of development, and residents' dependence on particular resources. Consequently, residents' perceptions provide one means of understanding how environmental changes are experienced and interpreted at the local level.

For this study, natural-resource degradation is conceptualized as the perceived deterioration in the condition, quality, or availability of land, soil, water, vegetation, and other locally relevant environmental resources that residents associate with urban expansion. The concept is distinct from the loss of green spaces and deforestation, although the two may overlap. Green-space loss focuses primarily on the removal or reduction of vegetated areas, whereas natural-resource degradation addresses the broader deterioration of environmental resources and their capacity to support human and ecological functions.

Relationship Between Urbanization and Environmental Impacts in Urban-Fringe Communities

The relationship between urbanization and environmental impacts in urban-fringe communities is best understood as a process involving land-use transformation, increasing human activities, infrastructure demand, and changes in environmental conditions. As cities expand outward, land previously used for agriculture, vegetation, or other rural activities may be converted to residential, commercial, industrial, and transportation uses. These changes can modify natural drainage, reduce vegetated land, increase the generation of waste and wastewater, and intensify pressure on local resources. The extent to which these pressures become environmental problems depends on the characteristics of the physical environment, the pattern of development, infrastructure capacity, and the effectiveness of planning and environmental management (Bai *et al.*, 2017).

The four environmental dimensions examined in this study are related but conceptually distinct. Flooding concerns the accumulation and movement of water in areas that are normally dry. Loss of green spaces and deforestation concern the reduction or removal of vegetated land. Pollution concerns the introduction of contaminants or harmful disturbances into the environment. Natural-resource degradation concerns the deterioration of the condition, quality, availability, or functioning of resources such as soil, land, and water. Keeping these dimensions distinct is important for constructing the questionnaire, interpreting responses, and linking the conceptual review to the study's specific objectives.

These dimensions may nevertheless interact. For instance, vegetation removal and the creation of impervious surfaces can alter runoff patterns, while inadequate waste disposal can obstruct drainage channels and contribute to flooding. Poorly managed construction and commercial activities may generate pollution, and contaminated runoff may affect soil and water quality. Such interactions mean that an environmental problem observed by residents may be associated with several processes rather than one isolated cause. Research on urban environmental systems therefore supports an integrated perspective that considers the relationships among land use, ecosystems, pollution, waste management, and water processes (Bai *et al.*, 2017).

The relationship is also influenced by the quality of urban planning and environmental governance. Land-use planning can guide development away from environmentally sensitive areas, protect drainage corridors, and provide space for green infrastructure. Infrastructure planning can help ensure that drainage, sanitation, and waste-management services respond to the demands generated by population and settlement growth. In Port Harcourt, Echendu (2021) highlights the relevance of planning practices and compliance with planning regulations to flooding, demonstrating why urban expansion must be considered alongside development control and infrastructure management.

Residents' perceptions are important within this relationship because environmental changes are experienced at the community level. Residents may observe alterations in drainage, vegetation, environmental cleanliness, and access to natural resources as development progresses. Examining these perceptions helps establish which environmental conditions residents associate with urbanization and how they interpret changes in their surroundings. However, the perceptions themselves should be distinguished from independently measured environmental conditions and from proven causal relationships.

In the context of this research, the relationship between urbanization and environmental impacts is examined through residents' perceptions in Rukpokwu, Eneka, Iriebe, Igwuruta, Igwuruta-Ali, Omagwa, and Igbo-Etche. The conceptual framework treats urbanization as the broader development process and flooding, loss of green spaces and deforestation, pollution, and natural-resource degradation as the four environmental dimensions investigated. Residents' perceptions provide the basis for assessing how these dimensions are understood within the selected communities.

METHODOLOGY

Research Design and Study Area

The study adopted a descriptive cross-sectional survey design to examine residents' perceptions of the environmental impacts of urbanization on the urban fringes of Port Harcourt, Rivers State, Nigeria. The design was considered appropriate because it enabled the collection of standardized information from residents at a specific period, providing a basis for describing their perceptions of environmental changes associated with urban expansion.

Population, Sampling and Data Collection

Population

The study population for this research comprises residents of the urban fringes of Port Harcourt Metropolis, Rivers State. Specifically, it includes the populations of Obio/Akpor, Ikwerre, and Etche Local Government Areas (LGAs).

These areas were selected because they form part of the expanding peri-urban zone surrounding Port Harcourt city, which is directly affected by urbanization and infrastructural expansion. The target population is households.

Sampling Procedure

A probability sampling technique was adopted to ensure fair representation of households within the study area. Out of thirty-five (35) communities located outside the Port Harcourt Ring Road, 20% (seven communities) were selected for the study.

The sampled communities and their respective LGAs are as follows:

- Obio/Akpor LGA: Rukpokwu, Eneka, Iriebe
- Ikwerre LGA: Igwuruta, Igwuruta-Ali, Omagwa
- Etche LGA: Igbo-Etche

Population projections for the year 2024 were computed using 1991 National Population Census data as the baseline, since the 2006 census did not disaggregate population at the community level. Table 1 presents the population and sample size determination for the study area, showing the 1991 population, projected 2024 population, estimated households, percentage share of households, and the number of questionnaires allocated to each sampled community.

Population Projection Formula

Population projection was made using the Exponential Growth Formula as follows:

$$P_e = P(1 + R/100)^n \quad (1)$$

where:

- P_e = Projected population for 2024
- P = Base year population (1991)
- R = Annual growth rate (6.5%)
- n = Number of years between 1991 and 2024 (33 years)

$$P_e = P(1 + 0.065)^{33} \quad (2)$$

This formula was applied to each of the seven (7) selected communities listed in Table 1.

Determination of Sample Size

The total sample size was determined using Taro Yamane's (1967) formula at a 5% level of significance:

$$n = \frac{N}{1+N(e)^2} \quad (3)$$

where:

- n = sample size
- N = total projected household population
- e = level of precision (0.05)

The total projected population of the selected communities was 244,185 persons, as shown in Table 1. Assuming an average household size of five (5) persons, the number of households (N) was estimated as:

$$N = \frac{244,185}{5} = 48,837 \text{ households} \quad (4)$$

Substituting into Taro Yamane's formula:

$$n = \frac{48,837}{1+48,837(0.05)^2} = \frac{48,837}{1+1220.93}$$

$$= \frac{48,837}{1221.93} \approx 39.97 \times 10 = 398 \text{ households (approx.)}$$

Thus, 398 questionnaires were distributed across the sampled communities, as detailed in the final column of Table 1.

Proportional Allocation of Questionnaires

To ensure proportional representation, the number of questionnaires per community was computed using the Proportional Allocation Formula:

$$n_i = \frac{N_i}{N} \times n \quad (5)$$

where:

- n_i = Number of questionnaires allocated to each community
- N_i = Household population of each community
- N = Total number of households in the seven communities
- n = Total sample size (398)

The proportional allocation of questionnaires to each of the seven communities is presented in Table 1, which shows the percentage share of households and the corresponding

Table 1: Determination of population and sample size for the study area.

LGA	Sampled Community	1991 Population	Projected 2024 Pop	Households (Pop ÷ 5)	% of Households	Questionnaires (allocated)
Obio/Akpor	Rukpokwu	4,699	37,544	7,509	15.38%	61
	Eneka	6,219	49,689	9,938	20.35%	81
	Ireibe	3,549	28,356	5,671	11.62%	46
Ikwerre	Igwuruta	7,104	56,760	11,352	23.25%	92
	Igwuruta-ali	2,805	22,411	4,482	9.18%	37
	Omagwa	3,821	30,529	6,106	12.51%	50
Etche	Igbo-Etche	2,365	18,896	3,779	7.74%	31
Totals		30,562	244,185	48,837	100%	398

Source: Author's projection and conceptualization (2024); National Population Commission (1991).

number of questionnaires allocated to Rukpokwu, Eneka, Iriebe, Igwuruta, Igwuruta-Ali, Omagwa, and Igbo-Etche.

Primary data were collected using a structured questionnaire. The questionnaire was designed to obtain respondents' perceptions of the relationship between urbanization and the four environmental dimensions investigated. Responses were recorded using a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5), with undecided responses assigned a score of 3. The questionnaire items addressed residents' perceptions of flooding, the loss of green spaces and deforestation, pollution, and natural-resource degradation associated with urban expansion.

Data Analysis

The data were analyzed descriptively using response frequencies, percentages, and reported weighted mean scores.

Percentages were calculated by expressing the number of responses in each category as a proportion of the sample size. The percentage of respondents agreeing with an item was calculated by combining the "agree" and "strongly agree" categories.

Table 2: Interpretation of mean scores.

Mean score	Interpretation
1.00–1.49	Strongly disagree
1.50–2.49	Disagree
2.50–3.49	Neutral/undecided
3.50–4.49	Agree
4.50–5.00	Strongly agree

Source: Authors' decision rule for the five-point Likert scale.

The mean scores were interpreted using the following decision bands reported in the original study (Table 2):

The analysis was descriptive. It was not designed to establish causation or determine whether the differences between environmental indicators were statistically significant.

ANALYSIS AND DATA INTERPRETATION

Socioeconomic Characteristics of Respondents

Table 3 presents the socioeconomic characteristics of the 398 respondents surveyed in the selected urban-fringe communities of Port Harcourt Metropolis. The variables examined include age, sex, occupation, length of residence, and monthly income. These characteristics are important for understanding the composition of the respondents and the socioeconomic circumstances that may shape their perceptions of the environmental impacts of urbanization.

Age Distribution of Respondents

The age distribution shows that respondents aged 26–40 years constituted the largest proportion, accounting for 188 respondents (47.2%). This was followed by those aged 41–50 years, with 144 respondents (36.2%). Respondents aged 60 years and above accounted for 39 (9.8%), while those aged 51–59 years represented 16 respondents (4.0%). The youngest age group, 18–25 years, had the lowest representation, with 11 respondents (2.8%).

The results indicate that the sample was predominantly composed of adults aged 26–50 years, who collectively accounted for 83.4% of the respondents. This concentration suggests that the survey captured the views of a substantial number of adults who may be actively engaged in employment, business activities, household management, and other aspects of community life. Their experiences may be particularly relevant to understanding changes in housing conditions, land use, transportation, drainage, and access to environmental infrastructure associated with urban expansion.

The representation of respondents aged 60 years and above also provides an opportunity to incorporate the perspectives of older residents, some of whom may have experienced changes in their communities over an extended period. However, age alone does not establish the extent of an individual's knowledge of historical environmental changes; such knowledge depends on factors including length of residence and personal experience. Similarly, the relatively

Table 3: Socioeconomic characteristics of respondents (N = 398).

Socioeconomic variable	Category	Frequency	Percentage (%)
Age	18–25 years	11	2.8
	26–40 years	188	47.2
	41–50 years	144	36.2
	51–59 years	16	4.0
	60 years and above	39	9.8
	Subtotal	**398**	**100.0**
Sex	Male	280	70.4
	Female	114	28.6
	Non-binary/genderqueer/genderfluid/agender	4	1.0
	Subtotal	**398**	**100.0**
Occupation	Artisan	31	7.8
	Business	82	20.6
	Businessman	41	10.3
	Civil servant	10	2.5
	Driver	18	4.5
	Electrician	23	5.8
	Mason	26	6.5
	Phone technician	3	0.8
	Retired	13	3.3
	Security guard	10	2.5
	Student	16	4.0
	Teacher	28	7.0
	Trader	97	24.4
	Subtotal	**398**	**100.0**
Length of residence	1–5 years	2	0.5
	6–10 years	67	16.8
	11–15 years	73	18.3
	16 years and above	256	64.3
	Subtotal	**398**	**100.0**
Monthly income	Low (₦70,000 and below)	153	38.4
	Middle (₦70,001–₦200,000)	150	37.7
	High (above ₦200,000)	95	23.9
	Subtotal	**398**	**100.0**

Source: Field survey, 2026.

low representation of respondents aged 18–25 years means that the findings contain fewer perspectives from younger adults. Overall, the age profile provides a substantial representation of the middle-aged population, although the distribution should be considered when interpreting the findings across different age groups.

Sex Distribution of Respondents

The sex distribution indicates that 280 respondents (70.4%) were male, while 114 respondents (28.6%) were female. The remaining four respondents (1.0%) were classified as non-binary, genderqueer, genderfluid, or agender. Therefore, male respondents constituted the majority of the study sample, with their proportion considerably higher than that of female respondents.

This distribution indicates that the responses largely reflect the experiences and perceptions of male participants. In the context of urban-fringe development, residents' perceptions of environmental change may be influenced by their household responsibilities, occupations, daily mobility, exposure to environmental hazards, and participation in community activities. Men and women may experience or prioritize environmental problems differently because of differences in their daily activities and socioeconomic circumstances. However, Table 3 does not establish that such differences occurred among the respondents; this would require a comparative analysis of their responses.

The inclusion of female respondents and respondents in the non-binary and related gender categories broadens the range of perspectives represented in the survey. Nevertheless, the marked difference in the numbers of male and female respondents should be acknowledged when drawing conclusions about the views of the wider population. In particular, the results should not automatically be interpreted as equally representative of the experiences of all sexes and gender groups.

Occupational Distribution of Respondents

The occupational distribution reveals that traders formed the largest reported occupational category, accounting for 97 respondents (24.4%). This was followed by respondents classified as business operators, with 82 respondents (20.6%), and businessmen, with 41 respondents (10.3%). Artisans accounted for 31 respondents (7.8%), while teachers represented 28 respondents (7.0%). Masons accounted for 26 respondents (6.5%), and electricians represented 23 respondents (5.8%). Drivers constituted 18 respondents (4.5%), while students accounted for 16 respondents (4.0%). Retired respondents numbered 13 (3.3%). Civil servants and security guards each accounted for 10 respondents (2.5%), while phone technicians formed the smallest occupational category, with three respondents (0.8%).

The results indicate that trading and business-related activities constitute prominent occupational categories among the respondents. Traders, business operators, and businessmen collectively accounted for 220 respondents, representing approximately 55.3% of the sample. This concentration suggests that commercial activities are an important feature of the respondents' livelihood profile. In rapidly urbanizing fringe communities, commercial activities may be influenced by population growth, changing land uses, improvements in accessibility, the development of roadside markets, and the expansion of residential settlements. At the same time, traders and other business operators may be affected by flooding, poor drainage, waste accumulation, dust, and disruptions to access and transportation. These are potential relationships that can be investigated using the study's environmental-impact findings; they cannot be established from the occupational distribution alone.

The presence of artisans, electricians, masons, drivers, and phone technicians also demonstrates that the sample includes respondents engaged in skilled trades and service-related activities. These occupations may be associated with construction, maintenance, transportation, and other services that support expanding urban settlements. Teachers and civil servants represent respondents employed in formal-sector occupations, while students and retired persons represent different stages of working life. This occupational diversity provides a broader socioeconomic context for interpreting residents' perceptions of urbanization. Nevertheless, the occupational categories labelled “Business” and “Businessman” have been retained separately because they were reported separately in the original data. Their precise distinction should be confirmed from the questionnaire or coding framework before the final thesis is submitted.

Length of Residence

The distribution of respondents by length of residence shows that 256 respondents (64.3%) had lived in their communities for 16 years and above. This was followed by 73 respondents (18.3%) who had resided in their communities for 11–15 years. A further 67 respondents (16.8%) had lived in their communities for 6–10 years, while only two respondents (0.5%) had resided in their communities for 1–5 years.

The findings indicate that the sample was dominated by long-term residents. Respondents who had lived in their communities for at least 11 years accounted for 329 respondents, representing approximately 82.7% of the sample. This is an important characteristic for a study examining residents' perceptions of environmental impacts associated with urbanization because long-term residents may have experienced changes in the physical and environmental conditions of their communities over time.

Such experience may help respondents identify perceived changes in vegetation cover, open spaces, drainage systems, flood occurrence, waste disposal, pollution, and the availability of natural resources. Long-term residence may also provide opportunities to observe the effects of road construction, housing development, commercial expansion, and the conversion of previously undeveloped land to built-up areas. These experiences may strengthen respondents' ability to compare present conditions with those they remember from earlier periods.

Monthly Income Distribution

The monthly income distribution shows that 153 respondents (38.4%) belonged to the low-income category, defined as earning ₦70,000 or less per month. The middle-income

category, comprising respondents earning between ₦70,001 and ₦200,000 monthly, accounted for 150 respondents (37.7%). The high-income category, defined as earnings above ₦200,000 per month, comprised 95 respondents (23.9%).

The results indicate that the low-income category constituted the largest income group, although its share was only slightly higher than that of the middle-income category. Together, the low- and middle-income groups accounted for 303 respondents, representing 76.1% of the sample. This suggests that most respondents were classified within the two lower-income categories used in the study. The finding is relevant to the assessment of environmental impacts because household income can influence residents' ability to obtain adequate housing, improve household sanitation, install protective measures, manage flood-related losses, and access locations with better infrastructure and environmental services.

For example, households with limited financial resources may face greater difficulties repairing flood-damaged property, improving drainage around their residences, relocating from environmentally vulnerable locations, or managing the costs associated with poor environmental conditions. Income may also influence the extent to which residents can access private waste collection, reliable water supplies, and improved sanitation facilities. Conversely, higher-income households may have greater financial capacity to adopt protective measures, although their actual exposure to environmental hazards depends on their residential location and other circumstances.

The 23.9% of respondents in the high-income category indicates that the sample also includes households with comparatively greater reported monthly earnings. This variation is useful because it permits the study to consider whether perceptions of environmental problems differ across income categories. Nevertheless, Table 3 alone cannot demonstrate that low-income respondents experienced greater environmental impacts or that higher-income respondents were better protected. Such conclusions would require further analysis linking income categories to responses on specific environmental issues. The income thresholds should also be interpreted as the study's operational classifications rather than as independently established measures of poverty or national income status.

Taken together, Table 3 shows that the respondents were predominantly adults aged 26–50 years, male, engaged in trading or business-related activities, long-term residents of their communities, and classified within the low- or middle-income categories. These characteristics provide an important basis for interpreting the study's investigation of the environmental impacts of urbanization in the selected urban-fringe communities of Port Harcourt Metropolis.

Resident Perception of Environmental Changes and Urbanisation

This section examines residents' perceptions of the environmental changes associated with urbanisation in the study area. It focuses on four major environmental issues: flooding, loss of green spaces and deforestation, pollution, and natural resource degradation. Data obtained from 398 respondents were analysed using frequency distributions, percentages, and mean scores to determine the extent to which residents associate urbanisation with environmental changes in their communities.

Table 4: Residents' perceptions of the relationship between urbanisation and flooding in the community.

S/N	Response	Frequency	Percentage (%)
1	Strongly Disagree	29	7.3
2	Disagree	20	5.0
3	Undecided	18	4.5
4	Agree	151	38.0
5	Strongly Agree	180	45.2
	Total	398	100.0

Source: Authors' field survey, 2025.

Urbanisation and Flooding

The findings presented in Table 4 show residents' perceptions of the extent to which urbanisation has contributed to increased flooding in their communities. Of the 398 respondents, 29 (7.3%) strongly disagreed, while 20 (5.0%) disagreed with the statement. A further 18 respondents (4.5%) were undecided. In contrast, 151 respondents (38.0%) agreed, while 180 (45.2%) strongly agreed that urbanisation had contributed to increased flooding in their communities.

Collectively, 331 respondents, representing 83.2% of the sample, either agreed or strongly agreed with the statement. This indicates a strong perception among residents that flooding is an important environmental challenge associated with urbanisation in the study area. This perception may be associated with the conversion of natural land surfaces into built-up areas, inadequate drainage infrastructure, obstruction of drainage channels, occupation of flood-prone locations, and the reduction of vegetation that facilitates infiltration and surface-water retention.

The relatively small proportion of respondents who disagreed suggests that the perceived relationship between urbanisation and flooding is widely recognised among residents.

Urban Expansion, Loss of Green Spaces and Deforestation

The results presented in Table 5 examine residents' perceptions of the effects of urban expansion on the loss of green spaces and deforestation in the study area. Of the 398 respondents, 5 (1.3%) strongly disagreed and 10 (2.5%)

Table 5: Residents' perceptions of urban expansion as a cause of green-space loss and deforestation.

S/N	Response	Frequency	Percentage (%)
1	Strongly Disagree	5	1.3
2	Disagree	10	2.5
3	Undecided	67	16.8
4	Agree	220	55.3
5	Strongly Agree	96	24.1
	Total	**398**	**100.0**

Source: Authors' field survey, 2025.

disagreed that urban expansion had contributed to the loss of green spaces and deforestation. A further 67 respondents (16.8%) were undecided.

Conversely, 220 respondents (55.3%) agreed, while 96 (24.1%) strongly agreed with the statement. The combined proportion of respondents who agreed or strongly agreed was 79.4%, indicating that a substantial majority perceived a relationship between urban growth and the deterioration of natural vegetation.

Urbanisation and the Worsening of Pollution

Table 6 presents residents' responses regarding whether air, water, noise, and land pollution have worsened as urbanisation has increased in their communities. The results show that 29 respondents (7.3%) strongly disagreed and 43 (10.8%) disagreed with the statement. In addition, 149 respondents (37.4%) were neutral about the perceived relationship between urbanisation and increasing pollution.

On the other hand, 121 respondents (30.4%) agreed, while 56 (14.1%) strongly agreed that pollution had worsened alongside urbanisation. Together, these categories account for 177 respondents, representing 44.5% of the sample. By comparison, 72 respondents (18.1%) either disagreed or strongly disagreed, while 37.4% expressed a neutral position.

Urbanisation and Natural Resource Degradation

The findings presented in Table 7 examine residents' perceptions of the relationship between urbanisation and natural resource degradation. The results indicate that no respondent strongly disagreed with the statement, while 27 respondents (6.8%) disagreed. A further 148 respondents (37.2%) were neutral. In contrast, 112 respondents (28.1%) agreed, and 111 (27.9%) strongly agreed that urbanisation had contributed to natural resource degradation.

The combined proportion of respondents who agreed or strongly agreed was 56.0%, indicating that more than half of the respondents perceived urbanisation as contributing to the deterioration of natural resources. These resources include land, vegetation, surface water, groundwater, and other components of the natural environment that support human livelihoods and ecological functions.

Table 6: Residents' perceptions of worsening pollution as urbanisation increases.

S/N	Response	Frequency	Percentage (%)
1	Strongly Disagree	29	7.3
2	Disagree	43	10.8
3	Neutral	149	37.4
4	Agree	121	30.4
5	Strongly Agree	56	14.1
	Total	**398**	**100.0**

Source: Authors' field survey, 2025.

Table 7: Residents' perceptions of urbanisation as a contributor to natural resource degradation.

S/N	Response	Frequency	Percentage (%)
1	Strongly Disagree	0	0.0
2	Disagree	27	6.8
3	Neutral	148	37.2
4	Agree	112	28.1
5	Strongly Agree	111	27.9
	Total	**398**	**100.0**

Source: Authors' field survey, 2025.

Table 8: Summary of residents' perceptions of the environmental impacts of urbanisation.

S/N	Environmental Issue	Mean Score	Interpretation
1	Urbanisation and flooding	4.09	High agreement
2	Urban expansion and loss of green spaces	3.98	High agreement
3	Pollution worsening with urbanisation	3.33	Moderate perception
4	Urbanisation and natural resource degradation	3.77	General agreement
	Overall Mean	3.79	General agreement with negative environmental impacts

Source: Authors' field survey, 2025.

Urban expansion can place pressure on natural resources through the conversion of undeveloped land, removal of vegetation, increased demand for water and construction materials, generation of waste, and modification of natural drainage systems. Where development occurs without adequate environmental management and land-use control, these pressures may contribute to resource depletion, ecosystem disturbance, and declining environmental quality.

Statistical Measurement of Residents' Perceptions of Environmental Changes and Urbanisation

The mean scores presented in Table 8 provide a comparative assessment of residents' perceptions of the environmental effects of urbanisation. The mean score for flooding is 4.09, indicating a high level of agreement that urbanisation has contributed to increased flooding. This corresponds with Table 4, where 83.2% of respondents agreed or strongly agreed with the statement.

The loss of green spaces and deforestation recorded a mean score of 3.98, reflecting substantial concern about the conversion of vegetated areas to built-up land. This finding is consistent with Table 5, where 79.4% of respondents agreed or strongly agreed that urban expansion had resulted in green-space loss and deforestation.

Natural resource degradation recorded a mean score of 3.77, indicating general agreement that urbanisation has contributed to the deterioration of natural resources. This is supported by Table 7, where 56.0% of respondents agreed or strongly agreed with the statement.

Pollution recorded a mean score of 3.33, the lowest among the four environmental issues. This corresponds with Table 6, where 37.4% of respondents were neutral. Although 44.5% agreed or strongly agreed that pollution had worsened with urbanisation, the substantial neutral category indicates that residents' perceptions of this relationship are less pronounced than their perceptions of flooding and green-space loss.

In general, the findings indicate that residents perceive urbanisation as an important contributor to environmental change in the study area. Flooding and the loss of green spaces emerged as the most prominent concerns, while natural resource degradation also attracted considerable agreement. Pollution received a more mixed response, with a substantial proportion of respondents remaining neutral.

DISCUSSION OF FINDINGS

Flooding as the Leading Perceived Environmental Impact in Port Harcourt

The findings of this study identify flooding as the leading perceived environmental impact of urbanisation in the study area. As presented in Table 4, 151 respondents (38.0%) agreed that urbanisation contributes to flooding in their communities, while 180 respondents (45.2%) strongly agreed. Combined, 331 respondents, representing 83.2% of the 398 respondents, expressed agreement with the relationship between urbanisation and flooding. In contrast, 49 respondents (12.3%) disagreed or strongly disagreed, while 18 respondents (4.5%) were undecided. The mean score of 4.09 further indicates a high level of agreement among respondents. This finding suggests that flooding is a prominent environmental concern in the study area and that residents perceive a substantial connection between ongoing urban development and the occurrence or severity of flooding.

The finding is consistent with the empirical study by Echendu (2021), which examined the relationship between urban planning and flooding in Port Harcourt through interviews with urban planning professionals. The study found that poor urban planning and inadequate compliance with planning regulations were important factors contributing to flooding in the city. It highlighted the implications of development occurring without sufficient consideration of drainage systems, land-use suitability and planning controls. The present study reinforces this observation from the perspective of residents: whereas Echendu examined the views of planning professionals, the current findings show that a substantial majority of surveyed residents also associate urbanisation with flooding. The agreement between these findings indicates that flooding in Port Harcourt is not only a technical or planning concern but also a visible environmental problem recognised by people living in the affected communities.

Similarly, Echendu (2023), in a study of expert perspectives on the drivers of flooding in Nigeria, found that although climate change influences rainfall intensity, frequency and duration, human factors—including inadequate infrastructure, poor urban planning, weak governance and ineffective enforcement of relevant laws and policies—were considered important drivers of flooding in the study context. The study recommended a combination of structural and non-structural interventions to improve flood-risk management. This finding provides further support for interpreting the present result in the context of urban development. Where population growth and physical expansion occur without corresponding investment in drainage infrastructure, effective development control and adequate flood-risk management, the capacity of the urban environment to accommodate stormwater may be reduced. The high level of agreement recorded in the present study is therefore consistent with the wider evidence that flood risk is shaped not only by rainfall and other natural processes but also by the quality of urban planning, infrastructure provision and development management.

The findings also correspond with Dan-Jumbo *et al.* (2018), who investigated historical and projected land-use dynamics in the Greater Port Harcourt watershed using land-use and land-cover data. Their study documented rapid urbanisation and found that urban land expansion occurred substantially at the expense of agricultural land. The authors explained that changes in land use within the watershed have implications for environmental systems and could amplify flood risk as urban development continues. This evidence is relevant to the present study because the conversion of vegetated and agricultural land into buildings, roads and other impervious surfaces can reduce the amount of rainfall that infiltrates the ground and increase surface runoff. Where drainage channels are insufficient, obstructed or poorly maintained, increased runoff can contribute to water accumulation and flooding. The residents' strong perception of the relationship between urbanisation and flooding is therefore consistent with the land-use changes documented in the Greater Port Harcourt watershed.

Further support is provided by Akukwe and Ogbodo (2015), whose spatial analysis examined variations in vulnerability to flooding across the zones of Port Harcourt metropolis. Their study assessed flood vulnerability through indicators relating to exposure, sensitivity and adaptive capacity, demonstrating the importance of considering the spatial distribution of flood risk and the capacity of communities to cope with flooding. This is pertinent to the present findings because the environmental consequences of urbanisation may not be uniform across all communities. Areas characterised by low-lying terrain, inadequate drainage, intense development or limited capacity to manage flood events may experience greater impacts than other locations. Consequently, the high mean score of 4.09 in the present study should be understood as an overall expression of residents' perceptions; the degree and nature of flood exposure may still vary from one community to another.

Taken together, these empirical studies reinforce the interpretation that flooding is a major environmental challenge associated with urbanisation in Port Harcourt. The present finding is particularly significant because 83.2% of respondents agreed or strongly agreed that urbanisation contributes to flooding, while the mean score of 4.09 was the highest among the four environmental issues assessed in the survey. This suggests that, among the environmental changes considered by residents, flooding is the most prominent concern. The result also highlights the importance of understanding urbanisation as more than population growth and physical development: it involves changes in land cover, drainage patterns, settlement locations and the demand for infrastructure.

Urban Expansion, Loss of Green Spaces and Deforestation

The survey responses on green-space loss and deforestation indicate that urban expansion is widely perceived by residents as a major contributor to the loss of green spaces and deforestation in the urban fringes of Port Harcourt Metropolis. As shown in Table 5, out of the 398 respondents, 220 (55.3%) agreed that urban expansion has resulted in the loss of green spaces and deforestation, while 96 (24.1%) strongly agreed. Thus, 316 respondents, representing 79.4% of the sample, acknowledged the relationship between urban expansion and the loss of vegetation. In contrast, 10 respondents (2.5%) disagreed, five (1.3%) strongly disagreed, and 67 (16.8%) were undecided. The mean score of 3.98, reported in Table 8, further indicates a high level of agreement with the statement. These findings suggest that the loss of green spaces is a prominent environmental concern among residents of the selected communities.

The finding is consistent with the study by Dan-Jumbo *et al.* (2018), which examined urban land-use dynamics in the Greater Port Harcourt watershed using land-use and land-cover data. The researchers documented substantial urban expansion and changes in the distribution of land-use categories, with urban development occurring largely at the expense of agricultural land. Their findings demonstrate that the expansion of built-up areas has transformed the landscape of Greater Port Harcourt and placed increasing pressure on land previously used for agriculture and other non-urban purposes. This evidence supports the present study because the conversion of agricultural land and vegetated areas into residential buildings, roads, commercial developments and other urban infrastructure can reduce the availability of green spaces. The fact that 79.4% of respondents agreed or strongly agreed with the survey statement suggests that the environmental implications of this transformation are also recognised by residents living within the expanding urban fringe.

However, the findings of Dan-Jumbo *et al.* (2018) should be interpreted carefully. Their evidence of increasing built-up land and conversion of agricultural land supports the broader argument that urban expansion places pressure on open and vegetated spaces, but agricultural land conversion is not necessarily equivalent to deforestation. The present study combines green-space loss and deforestation in one questionnaire item; consequently, its survey result establishes residents' perceptions of these related environmental changes rather than independently measuring the amount of forest cover lost. Nevertheless, the agreement between the survey result and the documented land-use changes in Greater Port Harcourt strengthens the argument that urban expansion is an important source of pressure on the natural environment.

Evidence from research on wetland change in Port Harcourt further supports this interpretation. Wali (20115) in the study of urbanisation and wetland loss in Port Harcourt Metropolis examined changes associated with the expansion of the built environment and the pressure exerted on wetlands by urban development. Wetlands and other natural spaces perform important ecological functions, including providing habitats, retaining stormwater and supporting the environmental stability of urban areas. Where these areas are reclaimed or converted to residential and commercial uses, their ecological functions may be diminished. The present finding is therefore consistent with the wider environmental concern that the expansion of Port Harcourt and its surrounding settlements can threaten natural landscapes. Nevertheless, wetland loss should be distinguished from deforestation because wetlands may contain different forms of vegetation and do not necessarily constitute forest land.

The result also reflects a broader pattern observed in rapidly urbanising Nigerian cities. Research using remote sensing and geographic information systems in urban areas such as Abuja and along the Lagos–Ibadan corridor has documented the conversion of vegetation and other non-built-up land into developed surfaces as cities expand. Such studies provide comparative evidence that increasing demand for residential land, transport infrastructure and commercial facilities can place pressure on existing vegetation. Although findings from other cities cannot directly establish the magnitude of green-space loss in the selected Port Harcourt communities, they reinforce the plausibility of the relationship identified by the present survey.

The high level of agreement recorded in this study may be explained by the nature of development occurring in urban-fringe communities. As the built-up area expands outward from the established city, previously undeveloped plots, agricultural land and vegetated areas may be converted into housing estates, individual residential buildings, access roads and commercial properties. These changes can progressively reduce the amount of open land and vegetation available within communities. Where development occurs without adequate provision for public parks, green corridors and the protection of environmentally sensitive areas, the cumulative effect may be a landscape dominated increasingly by buildings and paved surfaces. The survey result indicates that residents widely perceive this transformation as an important environmental consequence of urban expansion.

The findings are also significant because the loss of green spaces may contribute to other environmental problems identified in this study. As discussed earlier, flooding emerged as the leading perceived environmental impact of urbanisation, with 83.2% of respondents agreeing or strongly agreeing that urbanisation contributes to flooding. The loss of vegetation can be connected to this concern because trees, grasslands and permeable vegetated soils help intercept rainfall, support infiltration and slow surface runoff. When vegetation is removed and the land is covered by buildings and impermeable surfaces, a greater proportion of rainfall may become surface runoff. Depending on the local topography, drainage capacity and intensity of rainfall, this can increase pressure on drainage systems and contribute to flooding. Green-space loss may also reduce shade and evapotranspiration, thereby contributing to elevated local temperatures. These relationships demonstrate that vegetation loss and flooding should be understood as interconnected dimensions of urban environmental change rather than entirely separate problems.

The 16.8% of respondents who were undecided presents a further dimension of the findings. This proportion indicates that, although the majority recognised a relationship between urban expansion and green-space loss, some residents did not express a definite opinion. Differences in the visibility of vegetation change, the rate of development in individual communities, and residents' experiences may contribute to variations in perception. However, the relatively small proportion who disagreed or strongly disagreed, at 3.8% combined, shows that the perceived relationship was widely accepted among the respondents.

Urbanisation and the Worsening of Pollution in Port Harcourt

The survey responses on pollution indicate that residents perceive a relationship between urbanisation and worsening pollution in Port Harcourt, although the level of agreement is lower than that recorded for flooding and the loss of green spaces. As shown in Table 6, 121 respondents (30.4%) agreed that pollution worsens as urbanisation increases, while 56 respondents (14.1%) strongly agreed. Collectively, 177 respondents, representing 44.5% of the 398 respondents, expressed agreement with the statement. Conversely, 43 respondents (10.8%) disagreed, and 29 (7.3%) strongly disagreed, giving a combined disagreement of 18.1%. The remaining 149 respondents (37.4%) were neutral. The mean score of 3.33, presented in Table 8, indicates a moderate perception of the relationship between urbanisation and pollution. This suggests that pollution is recognised as an environmental concern in the study area, but residents do not express a uniformly strong view that it necessarily worsens with urban growth.

The finding is supported by Nwachukwu *et al.* (2026), whose study, Assessment of Environmental Impacts of Urbanization in Port Harcourt Metropolis, Nigeria, examined the environmental implications of urban growth in the metropolis. The study identifies poorly regulated and rapid urbanisation as a factor associated with increasing environmental pollution and declining urban liveability. This evidence is relevant to the present findings because urban expansion typically increases the concentration of human activities, construction, transportation and waste generation. Where environmental infrastructure and regulatory controls do not keep pace with development, these activities can contribute to pollution. The agreement expressed by 44.5% of respondents is therefore consistent with the concern that poorly managed urbanisation can intensify environmental pressures in Port Harcourt.

Further empirical support is provided by Igwe and Ukpere (2022), who investigated the effects of urbanisation-induced activities on soil quality in Port Harcourt Metropolis. Their study combined laboratory analysis of soil samples collected from 15 locations with questionnaires administered to 800 respondents. The researchers identified waste dumpsites, mechanic workshops and abattoirs among the urban activities associated with changes in soil quality. Their laboratory analysis reported a mean lead concentration of 120.62 mg/kg, demonstrating the presence of a measurable soil-quality concern in the study area. The authors recommended regular soil-quality assessment, better control of the locations of mechanical workshops and waste dumpsites, and enforcement of physical planning and development control regulations. These findings support the present study by demonstrating that activities associated with urban development can contribute to environmental pollution beyond what residents report in perception surveys. However, the soil measurements do not, by themselves, establish that urbanisation caused every observed contaminant or that pollution increased uniformly across the metropolis.

The findings are also supported by Eyetan and Ifuwe (2024), who investigated the effects of atmospheric pollution on human health in Port Harcourt and considered the implications for urban planning. Their research involved field measurements of sulphur dioxide, nitrogen dioxide, carbon monoxide, and particulate matter (PM_{10}), alongside hospital records relating to airborne diseases. The researchers examined air pollution across different land-use zones and selected congested traffic intersections for monitoring. Their approach provides empirical evidence that atmospheric pollution in Port Harcourt can be investigated through direct measurement rather than relying exclusively on residents' opinions. The study is particularly relevant to the present findings because traffic concentration, fuel combustion and urban activity can expose residents to air pollutants. Nevertheless, the authors' statistical findings on individual pollutants and health outcomes require careful interpretation; the study should not be cited as proving that every measured pollutant had a statistically significant effect on airborne diseases.

More directly, Nwachukwu *et al.* (2026), in their study Assessment of Environmental Impacts of Urbanization in Port Harcourt Metropolis, Nigeria, examined residents' assessments of urbanisation-related environmental challenges. Using a questionnaire survey, the researchers retrieved 267 completed questionnaires from 384 distributed. Their results indicated that 82.4% of respondents agreed or strongly agreed that urbanisation was associated with air pollution, while 82.4% also expressed agreement regarding water contamination and 82.4% regarding noise pollution. These findings provide an important comparison with the present study. While 44.5% of respondents in the current research agreed or strongly agreed that pollution worsens as urbanisation increases, Nwachukwu *et al.* reported substantially higher agreement with specific pollution-related concerns. The difference may reflect variations in questionnaire wording, the environmental indicators assessed, the sampled communities and respondents' experiences. It does not necessarily mean that pollution is more severe in one study area than another, because the two studies did not use identical measures. Nevertheless, both studies recognise pollution as an important environmental concern associated with urbanisation in Port Harcourt.

The broader relationship between urbanisation and environmental deterioration is also discussed by Ikporukpo (2018), who reviewed the environmental implications of urbanisation in Abuja and Yenagoa. The study considered competing perspectives on whether urbanisation inevitably

produces environmental deterioration or whether its effects depend on the stage of development and the capacity of institutions to manage urban growth. This perspective is useful for interpreting the present findings because urbanisation does not automatically result in worsening pollution in every circumstance. The environmental outcome depends partly on the adequacy of infrastructure, the regulation of human activities and the effectiveness of environmental management. In Port Harcourt, where residential, commercial, transport and industrial activities coexist, pollution pressures may increase where these activities expand without corresponding improvements in environmental services and regulatory enforcement.

When the empirical evidence is considered alongside the present survey results, the relatively moderate mean score of 3.33 becomes particularly important. Although pollution is independently documented in Port Harcourt through soil and atmospheric measurements, only 44.5% of respondents in this study agreed or strongly agreed that pollution worsens as urbanisation increases. The 37.4% neutral response indicates that a substantial proportion of residents did not express a definite position on the relationship. This does not contradict the empirical evidence of pollution. Rather, it suggests that the general statement used in the questionnaire may not have captured the different ways in which residents experience air, water, soil and noise pollution. Some respondents may encounter pollution frequently, while others may be more concerned about flooding or vegetation loss, which are more immediately visible in their surroundings.

Furthermore, pollution in Port Harcourt cannot be attributed exclusively to urbanisation. Industrial operations, petroleum-related activities, vehicle emissions, waste disposal, construction and other sources may overlap. Urbanisation can intensify these pressures by increasing the number of people, vehicles, buildings and commercial activities, but the extent of pollution also depends on the nature of the activities involved and the effectiveness of pollution-control measures. Accordingly, the present finding supports the existence of a perceived relationship between urbanisation and pollution, while the independent studies provide evidence that pollution is an actual environmental concern in the metropolis. Together, they suggest that urban growth and environmental management should be examined as interconnected planning issues.

Urbanisation and Natural Resource Degradation in Port Harcourt

The responses on natural resource degradation indicate that residents generally perceive urbanisation as a contributing factor to natural resource degradation in the urban fringes of Port Harcourt Metropolis. As shown in Table 7, 112 respondents (28.1%) agreed that urbanisation contributes to natural resource degradation, while 111 respondents (27.9%) strongly agreed. Together, 223 respondents, representing 56.0% of the 398 respondents, agreed with the statement. A further 148 respondents (37.2%) were neutral, while 27 respondents (6.8%) disagreed. No respondent strongly disagreed. The mean score of 3.77, presented in Table 8, indicates general agreement that urbanisation contributes to natural resource degradation. These results suggest that more than half of the respondents recognise the environmental pressures associated with urban growth, although the substantial proportion of neutral responses indicates that this perception is not uniform across the study population.

The finding is consistent with Dan-Jumbo *et al.* (2018), whose research examined the effects of urban development and climate change on flooding in the Greater Port Harcourt watershed. The study investigated the relationship between changes in land use, urban development and environmental vulnerability. Its findings highlighted the environmental consequences of urbanisation and the loss of natural landscapes within the watershed. This evidence is relevant to the present study because land is a fundamental natural resource, and its conversion from agricultural, vegetated or wetland uses to built-up development changes the physical and ecological characteristics of the environment. Such changes may also affect the capacity of the landscape to retain rainfall, support vegetation and regulate surface-water movement. The present finding therefore reflects concerns consistent with the documented environmental consequences of urban expansion in Greater Port Harcourt.

Further support is provided by Anthony *et al.* (2026), whose study, Emergence of Wetland Neighbourhoods in Port Harcourt and the Challenge to the Urban Planner, investigated the expansion of residential neighbourhoods into environmentally sensitive wetland areas. Using 131 questionnaires across six purposively selected neighbourhoods, field observations and geospatial analysis, the researchers identified rapid urbanisation, housing affordability constraints, proximity to transport corridors and weak development control as factors contributing to wetland settlement expansion. They also identified encroachment into drainage channels, inadequate infrastructure and heightened flood vulnerability as planning challenges. These findings are particularly relevant to the present study because wetlands are important natural resources that support ecological functions, including water storage, flood regulation and habitat provision. The encroachment documented by Anthony *et al.* suggests that continued urban expansion can compromise these functions when development proceeds without adequate environmental safeguards. Their findings therefore reinforce the view that the natural resource degradation perceived by respondents is consistent with documented development pressures within Port Harcourt.

Additional evidence comes from Owhornuogwu *et al.* (2026), who conducted a geospatial and temporal analysis of land-use and land-cover changes in Port Harcourt Metropolis between 2015 and 2023. Using GIS-based analysis, the researchers documented an expansion of built-up land by more than 23 km², accompanied by a decline in natural ecosystems. Their reported results indicated that forest cover declined by more than 20 km², while farmland also decreased and water bodies experienced a decline associated with reclamation and siltation. These findings provide direct spatial evidence of changes in the extent of natural resources during urban expansion. Compared with the present survey, which records residents' perceptions of natural resource degradation, the geospatial study provides measurable

evidence of changes in land-cover categories. The agreement between the two types of evidence strengthens the interpretation that urban growth in Port Harcourt is placing pressure on forests, agricultural land, wetlands and water-related resources.

The relationship between urban development and changes in the physical environment is also demonstrated by Ezekwe and Anya (2021), who investigated land-use change and sediment yield in an urbanised tropical deltaic catchment in Port Harcourt. Their study examined the relationship between land-use change and sediment dynamics in the Woji River Basin. The researchers drew attention to the problem of river-channel blockage associated with siltation in urbanised catchments, a condition linked to recurring flooding. This evidence is relevant because natural resource degradation may involve changes not only in the quantity of land and vegetation but also in the physical condition of river channels and drainage systems. Sediment accumulation and channel obstruction can impair the functioning of waterways, while unregulated development and land disturbance can increase pressure on these systems. The study therefore provides a hydrological dimension to the present findings, showing how changes associated with urban development can affect the condition and functioning of natural environmental resources.

Nwachukwu *et al.* (2026), in their assessment of the environmental impacts of urbanisation in Port Harcourt Metropolis, also identified depletion of natural resources and overstretched infrastructure among the environmental and urban-management challenges associated with rapid, poorly regulated growth. Their questionnaire survey recorded concerns about several environmental effects, including air pollution, water contamination, and noise pollution. Although these pollution indicators do not independently measure the extent of natural resource depletion, they demonstrate that environmental pressures associated with urbanisation extend across different components of the urban environment. Their findings support the argument that urban development needs to be accompanied by adequate infrastructure, environmental regulation, and planning interventions to reduce pressure on natural resources.

Taken together, these empirical studies provide substantial support for the present finding. The survey results show that 56.0% of respondents agreed or strongly agreed that urbanisation contributes to natural resource degradation, while spatial and environmental studies in Port Harcourt document urban expansion, forest and farmland loss, wetland encroachment and changes affecting river catchments. However, the evidence should be interpreted in relation to the different methods used. The present study measures residents' perceptions, whereas the geospatial studies measure land-cover changes and the wetland and catchment studies examine particular environmental processes. These sources complement one another but do not measure exactly the same phenomenon. Their combined contribution is to demonstrate that the perceived environmental pressures identified by residents are consistent with independently documented changes in the natural environment of Port Harcourt.

The relatively high proportion of neutral responses in the present study also merits consideration. The 148 respondents (37.2%) who were neutral constituted a substantial share of the sample. One possible explanation is that natural resource degradation is not always immediately visible to residents. The gradual deterioration of soil quality, changes in water quality, sediment accumulation in river channels and the loss of wetland functions may require technical assessment to identify and quantify. Furthermore, residents may understand natural resource degradation differently depending on their experiences and proximity to affected locations. These are plausible interpretations of the response pattern rather than causes established directly by the questionnaire. Nevertheless, the fact that 56.0% of respondents agreed or strongly agreed indicates that a majority recognised urbanisation as a factor associated with natural resource degradation.

The finding also reinforces the close link between natural resource degradation and the other perceived impacts already discussed, namely flooding, the loss of green spaces and pollution. Flooding, loss of green spaces, pollution, and natural resource degradation may interact as urban development changes the land surface and places additional pressure on ecological systems. The removal of vegetation can reduce infiltration and increase surface runoff; wetland reclamation can diminish natural water-storage functions; sedimentation can affect river channels; and poorly managed waste can contaminate soil and water. These processes can occur together, although their magnitude and interaction vary by location. The results therefore suggest that environmental problems associated with urbanisation should be addressed through integrated planning rather than isolated interventions.

Comparative Discussion of Residents' Perceptions of Environmental Changes and Urbanisation

The comparative analysis presented in Table 8 reveals differences in residents' perceptions of the environmental implications of urbanisation in the study area. Flooding recorded the highest mean score (4.09), followed by the loss of green spaces and deforestation (3.98), natural resource degradation (3.77), and pollution (3.33). The overall mean of 3.79 indicates general agreement that urbanisation is associated with negative environmental implications in the urban fringes of Port Harcourt Metropolis.

Flooding emerged as the most prominent perceived environmental concern, with 83.2% of respondents agreeing or strongly agreeing that urbanisation contributes to increased flooding. This finding is consistent with research examining the relationship between urban planning, land-use change and flood vulnerability in Port Harcourt (Akukwe and Ogbodo, 2015; Dan-Jumbo *et al.*, 2018; Echendu, 2021). The conversion of permeable land to buildings and roads can increase surface runoff, while development that obstructs drainage pathways may exacerbate existing flood risks. The result therefore underscores the importance of incorporating drainage capacity and flood susceptibility into development control. However, the survey captures residents' perceptions

and does not independently quantify the contribution of urbanisation to observed flooding.

The loss of green spaces and deforestation ranked second, with a mean score of 3.98 and 79.4% agreement. This finding reflects residents' concerns about the conversion of vegetated land to built-up uses as urban development expands. It is consistent with Dan-Jumbo *et al.* (2018), who examined urban land-use dynamics within the Greater Port Harcourt watershed. The reduction of vegetation may affect infiltration, stormwater regulation, and other ecological functions, particularly where development encroaches on wetlands and natural drainage corridors. Nevertheless, confirming the actual extent of green-space loss requires spatial evidence, such as satellite imagery, land-use and land-cover classification, or systematic field observations.

Natural resource degradation recorded a mean score of 3.77, with 56.0% of respondents agreeing or strongly agreeing that urbanisation contributes to the deterioration of natural resources. This result indicates that residents recognise environmental pressures beyond flooding and vegetation loss. The conversion of natural landscapes can affect wetlands, soil, surface-water features and other ecological resources, potentially altering several environmental functions simultaneously. The finding complements the land-use dynamics documented by Dan-Jumbo *et al.* (2018), although the survey does not directly measure the extent or rate of resource depletion.

Pollution recorded the lowest mean score (3.33), with 44.5% of respondents agreeing or strongly agreeing, 37.4% remaining neutral, and 18.1% disagreeing or strongly disagreeing. Unlike the responses concerning flooding and green-space loss, these results reveal less uniform perceptions of the relationship between urbanisation and pollution. Differences in residents' exposure to potential pollution sources, including traffic, construction, commercial activities and waste disposal, may contribute to this variation, although the present data do not establish the reasons for the response pattern. Research on soil quality and atmospheric pollution in Port Harcourt provides a relevant context for examining these concerns (Eyetan and Ifuwe, 2024; Igwe and Ukpere, 2022). The lower mean should not, however, be interpreted as evidence that pollution is objectively less severe than the other environmental problems.

Taken together, the results indicate that residents' concerns are strongest for flooding and green-space loss, while natural resource degradation also attracts considerable attention and perceptions of pollution are more varied. These differences have implications for environmental planning in the urban fringe. Flood-risk management and the protection of natural drainage systems should be considered alongside the conservation of wetlands and vegetated land, monitoring of environmental resources, and assessment of pollution sources. An integrated approach is warranted because changes in land cover, drainage and human activities can interact to influence environmental conditions. The findings provide a basis for identifying residents' priority concerns, but objective environmental assessments are needed to establish the spatial distribution, magnitude, and causes of the reported changes.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study examined residents' perceptions of the environmental implications of urbanisation in seven communities on the urban fringes of Port Harcourt Metropolis, Rivers State, Nigeria. The overall mean score of 3.79 indicates general agreement that urbanisation is associated with adverse environmental conditions. Flooding was the most prominent perceived concern (mean = 4.09; 83.2% agreement), followed by the loss of green spaces and deforestation (mean = 3.98; 79.4% agreement), natural resource degradation (mean = 3.77; 56.0% agreement), and pollution (mean = 3.33; 44.5% agreement).

The findings identify flooding and vegetation loss as the leading environmental concerns in residents' assessments of urbanisation. They also show that natural resource degradation remains an important concern, while responses concerning pollution are less consistent. These results highlight the need to manage urban expansion in ways that account for drainage systems, environmentally sensitive land and the cumulative pressures associated with changing land use. Since the study measures residents' perceptions rather than environmental conditions directly, the findings should be interpreted as evidence of locally experienced concerns, not as independent measurements of environmental degradation or proof of causation.

Recommendations

Based on the findings, three interrelated planning priorities are recommended.

First, flood-risk assessment should be more firmly integrated into development approval in the urban fringes of Port Harcourt. Given the high level of agreement concerning flooding, planning authorities should assess drainage capacity and surface-runoff implications before approving development in flood-susceptible locations. Existing drainage channels and natural waterways should be mapped and protected from obstruction, while drainage interventions should be informed by catchment-level assessments rather than confined to individual developments.

Second, wetlands and remaining vegetated areas should be identified and incorporated into development-control and land-conservation measures. The strong perception of green-space loss supports the use of verified land-use and land-cover information to identify environmentally sensitive areas, guide the location of new development and monitor the conversion of vegetated land. Development proposals should demonstrate how significant vegetation and natural drainage functions will be retained where feasible.

Third, environmental monitoring should be strengthened to address natural resource degradation and clarify pollution conditions. Relevant authorities should combine periodic GIS and satellite-based land-cover assessments with field verification and appropriate air- and water-quality monitoring. This would help identify locations experiencing

substantial land conversion, investigate potential pollution sources, and distinguish perceived problems from measured environmental conditions. The results should inform targeted environmental interventions and be communicated to affected communities.

These measures should be coordinated across land-use planning, drainage management and environmental protection rather than implemented as separate initiatives. Further research combining residents' perceptions with spatial analysis, flood-risk assessment and direct environmental measurements would provide a stronger basis for evaluating the extent and causes of environmental change in the study area.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy, have been completely observed by the authors.

Life Science Reporting

No life science threat was practised in this research.

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