Land Use Plan for Mararaba Odege-Development Area, Nasarawa Local Government Area, Nasarawa State, Nigeria

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ABSTRACT

Land use planning is both an art and a science directed toward creating functional, aesthetic, and balanced physical environments that promote order and purpose within neighborhoods. It fundamentally addresses locational efficiency among urban activity areas by controlling and allocating land use amid competing demands. Driven by existing and projected socio-economic factors, modern land use planning establishes a conceptual framework for urban and rural spatial organization to ensure optimal conditions for living, working, circulation, and recreation. As established by Hall (1974) and amplified by Button (1976), contemporary physical planning operates as a continuous, iterative process designed to deploy appropriate urban control mechanisms and monitor their long-term efficacy. This study examines the practical administration and systemic challenges of local physical planning policies in Mararaba Odege. Employing a mixed-methods approach and descriptive survey design, spatial data were captured during a field campaign in late 2024, and socio-economic data were collected in early 2025 from 50 urban planners and residents across Odege-Development Area, Nasarawa Local Government Area, Nasarawa State, Nigeria utilizing structured questionnaires, GIS spatial mapping, and key informant interviews. The collected data were analyzed using descriptive statistics, weighted analytical matrices, and spatial analysis software. The results indicate that current zoning laws are only 45% effective due to administrative bottlenecks, revealing a significant gap between policy layout and practical implementation. Furthermore, the findings show that rapid informal settlements severely disrupt locational efficiency. The study concludes that proactive, continuous monitoring, geometric demographic modeling, and collaborative administrative frameworks are critical to resolving systemic land-use conflicts and achieving sustainable urban development.

Keywords: land use planning, spatial organization, urban control systems, locational efficiency, environmental aesthetics

INTRODUCTION

1.1 Background to the Study

Globally, land use planning has become a fundamental component of sustainable development, as it helps to manage the spatial distribution of land resources while ensuring economic growth and environmental protection. In many parts of the world, urbanization and population growth have intensified the need for effective land use plans that cater to the diverse needs of communities while safeguarding natural ecosystems. The United Nations emphasizes that sustainable urban planning and land use are critical in achieving the Sustainable Development Goals (SDGs), particularly Goal 11, which focuses on creating inclusive, safe, and resilient cities (UN-Habitat, 2019). Effective land use plans aim to reduce urban sprawl, promote compact development, and protect green spaces, water bodies, and agricultural lands (Zhu et al., 2020).

In Africa, the rapid pace of urbanization has brought unique challenges to land use management. The continent is experiencing one of the highest rates of urban growth globally, with projections indicating that over 50 of the African population will live in urban areas by 2030 (World Bank, 2021). This urban expansion has placed pressure on infrastructure, housing, and land resources, leading to unplanned settlements and environmental degradation. Countries like Kenya, South Africa, and Ghana have implemented land use reforms to address these challenges by creating frameworks for equitable land distribution and efficient urban planning

(Acheampong & Silva, 2018). However, limited resources, weak regulatory frameworks, and inadequate enforcement often hinder the effectiveness of land use plans in many African cities (Agunbiade et al., 2022).

In Nigeria, the issue of land use planning is critical given the country's growing population and urbanization challenges. The Nigerian Urban and Regional Planning Act of 1992 provides a legal framework for managing land use at the federal, state, and local levels (Olawale et al., 2021). Despite this framework, land use management in Nigeria faces challenges such as weak institutional capacity, poor enforcement of regulations, and a lack of political will (Olaleye & Aduwo, 2018). Rapid population growth, especially in cities like Lagos, Abuja, and Port Harcourt, has led to informal settlements and unregulated land development, exacerbating issues of housing deficits, poor infrastructure, and environmental degradation. The need for effective land use planning is critical to achieving sustainable development and reducing the strain on urban infrastructure in Nigeria.

In Nasarawa State, urbanization trends have become increasingly pronounced in areas such as Karu, Keffi, and Lafia. These areas have seen significant population growth due to their proximity to the Federal Capital Territory (FCT), Abuja, leading to increased demand for land, housing, and basic services (Nigerian Institute of Town Planners, 2020). The lack of comprehensive land use planning in these areas has contributed to uncontrolled development, with informal settlements emerging and environmental challenges such as deforestation, soil erosion, and flooding becoming prevalent (Yakubu et al., 2020). Addressing these issues requires a robust land use plan that aligns with the region’s development needs while ensuring environmental sustainability.

Mararaba Odege is rapidly growing administration center being headquarter of development area in Nasarawa Local Government Area (LGA) is one of the regions in Nasarawa State facing significant pressure from rapid urbanization. Its location near the capital city has spurred population growth, with many people migrating from rural areas in search of better opportunities. However, the absence of a formal land use plan has led to haphazard development, poor infrastructure, and environmental degradation. Informal settlements dominate the landscape, lacking basic amenities such as water, sanitation, and electricity, which compromises the quality of life of residents (Ajayi et al., 2022).

To address these challenges, a comprehensive land use plan for Mararaba Odege is essential. Such a plan would guide the sustainable use of land resources, promote orderly urban growth, and prevent environmental degradation. Additionally, it would provide a framework for improving infrastructure, housing, and basic services while ensuring that land development aligns with the broader goals of Nasarawa State’s urban and regional development strategies. By integrating principles of sustainable urban planning, the proposed land use plan would support economic growth, enhance residents’ quality of life, and contribute to environmental conservation (Eze et al., 2023).

The development of a land use plan for Mararaba Odege is not only crucial for addressing the immediate urbanization challenges but also for ensuring the long-term sustainability of the area. A well-designed plan would help the community cope with future population growth and economic development while mitigating the risks of environmental degradation and infrastructure deficits. Engaging key stakeholders, including government agencies, community members, and private developers, were critical to the success of this initiative, as it will ensure that the plan reflects the needs and aspirations of the community (Usman et al., 2021).

1.2 Statement of the Research Problem

The rapid pace of urbanization in many parts of Nigeria has brought significant structural challenges to physical land use planning, particularly in peri-urban fringes such as the Mararaba Odege Development Area within Nasarawa Local Government Area (LGA). Despite its critical location within the direct economic and spatial expansion corridor of the Federal Capital Territory (FCT), Abuja, the study area lacks proactive regulatory planning mechanisms capable of managing rapid growth. The ongoing absence of an operational, structured land use plan has led to haphazard and uncoordinated development. Dwellers frequently engage in informal construction activities without regard for zoning laws, structural infrastructure thresholds, or

environmental limits. This unplanned growth creates significant challenges across land use distribution, public service delivery, and environmental safety.

A core challenge facing Mararaba Odege is the severe mismatch between population density and basic public infrastructure. Applying the National Population Commission geometric growth model (r = 2.9%) to the 2006 census baseline reveals that the local population has grown from 29,117 to an active 2026 planning population of 51,591 residents, and is projected to reach 68,675 by the 2036 master plan horizon. This rapid expansion creates intense pressure on local infrastructure. Currently, residential land use dominates the urban footprint at 53.8% (953.57 hectares), while commercial land use is limited to 2.7% (47.08 hectares), and industrial activity remains marginal at 0.5% (9.25 hectares). This structural imbalance limits local economic opportunities and causes uncoordinated sprawl. It drives low-income residents (with 59.8% earning below ₦50,000 monthly) into informal settlements that lack access to piped water networks, functional drainage, and stable electricity grids.

Furthermore, the lack of an integrated layout plan creates significant environmental risks across different topographic elevations. In the low-lying areas of Mararaba Odege (elevations between 107m and 153m), uncontrolled residential encroachment onto natural floodplains creates a severe seasonal flood risk (identified as an 80% environmental constraint) . This risk is worsened by a poorly maintained drainage network that is mostly limited to major roads, where waste accumulation reduces flow capacity . Conversely, informal developments in the high-elevation zones (199m to 244m) face severe soil erosion risks due to vegetation clearing. This lack of environmental management directly threatens public health. Because a centralized water distribution network is absent, the population relies on 25 decentralized boreholes . Many of these water points are located near domestic soakaways, creating a high risk of waterborne disease contamination.

This situation is worsened by ineffective enforcement of development controls by local authorities. Although the Nigerian Urban and Regional Planning Act of 1992 provides a statutory framework for land use regulation, its implementation in Mararaba Odege remains weak due to administrative bottlenecks, limited technical capacity, and insufficient spatial data. This regulatory gap has reduced zoning law effectiveness to just 45% . This allows speculative land grabbing, building violations, and the conversion of open spaces to proceed without regulatory oversight. If left unaddressed, this disorganized growth will lock the area into an unsustainable urban form, increase environmental risks, and reduce the quality of life for residents. This situation highlights the urgent need for a comprehensive land use plan that balances environmental resilience, infrastructure provision, and demographic growth.

1.3 Research Questions

To achieve a sustainable spatial framework for the study area, this research addresses the following guiding questions:

- What is the efficiency and structural composition of the existing land use patterns and circulation networks within the Mararaba Odege Development Area?
- What are the active demographic trends, geometric population projections (2026–2036), and socio-economic characteristics influencing land demands in the area?
- What are the specific physical, environmental, and institutional potentials and constraints affecting land use allocation, evaluated through an empirical, weighted suitability framework?
- What structural design layout, utilities infrastructure framework, and phased master plan proposal can be formulated to manage future urban expansion and mitigate environmental risks?

1.4 Objectives of the Study

The primary aim of this study is to prepare a sustainable, data-driven Land Use Plan for the Mararaba Odege Development Area to guide its physical growth and structural development. The specific objectives designed to achieve this aim are to:

- Map, classify, and evaluate the current land use distribution and physical layout characteristics of Mararaba Odege using GIS spatial mapping and field ground-truthing.

- Analyze the spatial demographic profile and socio-economic characteristics of the population, incorporating geometric growth models to project population capacities for the 2026 and 2036 planning horizons.

- Establish an empirical Potential-Constraint Matrix using a Weighted Linear Combination (WLC) suitability framework and water quality risk indices to isolate areas requiring conservation or physical infrastructure upgrades.

- Formulate a comprehensive land use plan and phased design proposal for Mararaba Odege that integrates commercial modules, public utilities, and infrastructure networks to support sustainable urban growth over a ten-year horizon.

1.5 Scope of the Study

The scope of this study on the Land Use Plan for Mararaba Odege Development Area, Nasarawa LGA, Nasarawa State, Nigeria, encompasses various key elements that are crucial for understanding and addressing the urban planning challenges faced by the area. The study will focus on analyzing the current land use patterns within Mararaba Odege, identifying issues related to haphazard development, infrastructure deficits, environmental degradation, and the absence of a structured planning framework. Through spatial analysis and land use surveys, the study will evaluate the existing state of land allocation, infrastructure provision, and the overall urban form to establish a basis for future land use planning.

Secondly, the study will assess the factors contributing to the unregulated growth of the area, such as population pressure, economic activities, weak enforcement of planning regulations, and socio-economic dynamics. It will explore the relationship between these factors and the current land use patterns, with particular emphasis on how informal developments have shaped the urban landscape. The study will also consider the role of local governance and planning institutions in managing urban growth and the effectiveness of existing planning policies and regulations in Nasarawa LGA. The assessment will involve consultation with planning authorities, local stakeholders, and community residents to capture their perceptions and experiences regarding land use and development challenges.

The spatial extent of the study were limited to Mararaba Odege Development Area, focusing on its residential, commercial, industrial, and public land uses. The research will also cover land designated for future development, public amenities, green spaces, and transportation networks. The study will incorporate the surrounding areas of Mararaba Odege to understand the interactions and spillover effects from neighboring towns and the broader Nasarawa LGA. Through GIS mapping and analysis, the study will provide visual representations of existing and proposed land use patterns, highlighting areas where intervention is most needed.

In terms of time frame, the study will focus on data collected within the last five years to ensure that the analysis reflects recent developments and trends in the area. It will also consider projections for future growth and land use requirements to guide sustainable development in the coming decades. The findings from this study were essential for developing a comprehensive land use plan that addresses current challenges and provides a sustainable framework for managing future growth in Mararaba Odege. The study will also propose policy recommendations for improving land use planning and enforcement mechanisms in Nasarawa LGA, contributing to the broader discourse on sustainable urban planning in Nigeria.

1.6 Significance of the Study

The Land Use Plan for Mararaba Odege Development Area, Nasarawa LGA, Nasarawa State, Nigeria, holds significant relevance for several reasons, both at the local level and in the broader context of urban planning and sustainable development in Nigeria. One of the primary contributions of this study is its potential to provide a structured framework for managing land resources in an area that is currently characterized by

haphazard and unregulated growth. By analyzing existing land use patterns and identifying areas of conflict or inefficiency, the study will offer insights into how better planning can optimize land allocation for residential, commercial, industrial, and public uses, ensuring a more balanced and organized development process. This will directly contribute to improving the quality of life for residents by providing access to well-planned infrastructure, amenities, and services.

Additionally, the study is crucial for addressing environmental concerns. The lack of a proper land use plan in Mararaba Odege has likely led to environmental degradation, including the loss of green spaces, poor waste management, and encroachment into flood-prone areas. By proposing a sustainable land use plan, the study aims to mitigate these issues, promoting environmentally friendly development that considers the ecological balance of the area. This will not only protect natural resources but also reduce the risk of disasters such as flooding and soil erosion, which are common challenges in poorly planned urban areas.

The findings of this study will also have practical implications for policy formulation and urban governance. In many Nigerian cities, including Mararaba Odege, the weak enforcement of planning regulations and the lack of comprehensive development plans have been major obstacles to orderly urban growth. This study can serve as a blueprint for policymakers in Nasarawa LGA and beyond, offering evidence-based recommendations for improving land use planning practices, strengthening regulatory frameworks, and fostering collaboration between government agencies, private developers, and local communities. By addressing these governance gaps, the study can contribute to more effective urban management and help avoid the chaotic development patterns seen in other rapidly urbanizing areas in Nigeria.

Furthermore, the study's significance extends to its contribution to the academic and professional discourse on land use planning in Nigeria. As an area experiencing rapid growth but lacking formal planning, Mararaba Odege presents a unique case for understanding the dynamics of urban expansion in semi-rural environments. The study will provide valuable data and insights that can be used by urban planners, geographers, environmentalists, and policymakers to guide future research and practice in similar contexts. Ultimately, the study's recommendations could help shape more sustainable and equitable urban development policies across Nasarawa State and other parts of Nigeria.

METHODOLOGY

3.1 Study Area

The community of Mararaba Odege is bounded by several villages: to the north by Agwada, Apawu, and Onda; to the east by Bassa; to the south by Odege-mbeki town, Eyenu, and Mararaba; and to the West by Angwa-kwano Endo, Akpaku, and Agba-Ogana. Historically, the Odu settlement cluster—which forms an essential indigenous component of the broader Mararaba Odege Development Area—came to be in the early sixteenth century and was inhabited by the Eloyi (Afo) speaking tribe of Nasarawa State. The Odu people originally lived together with their own lineage at Epowu-Mbakadu but later relocated to the foot of the mountain to leverage the fertile alluvial soils ideal for agricultural practices, as their major occupations are farming and hunting.

On a general note, the Afo (Ajiri) are industrious and skilled in various crafts; besides farming, they maintain active cottage operations in sculpture carving, pottery, blacksmithing, cloth weaving, basket making, and mat making. Mararaba Odege is located approximately 35 kilometers from the headquarters of Nasarawa Local Government Area of Nasarawa State. By implication, it functions within the direct economic and expansionist footprint of the Federal Capital Territory (FCT), Abuja. The town is linked by a major arterial road running from Abuja through Nasarawa to Makurdi in Benue State, ensuring regional accessibility. The primary baseline drivers for settlement at this specific locus include its rich alluvial soil composition, mineral deposits, proximate lakes and rivers, protective mountain topography, and a habitable temperate climate situated within the Guinea Savannah belt of Nigeria, sharing select climatic traits with Jos, Plateau State.

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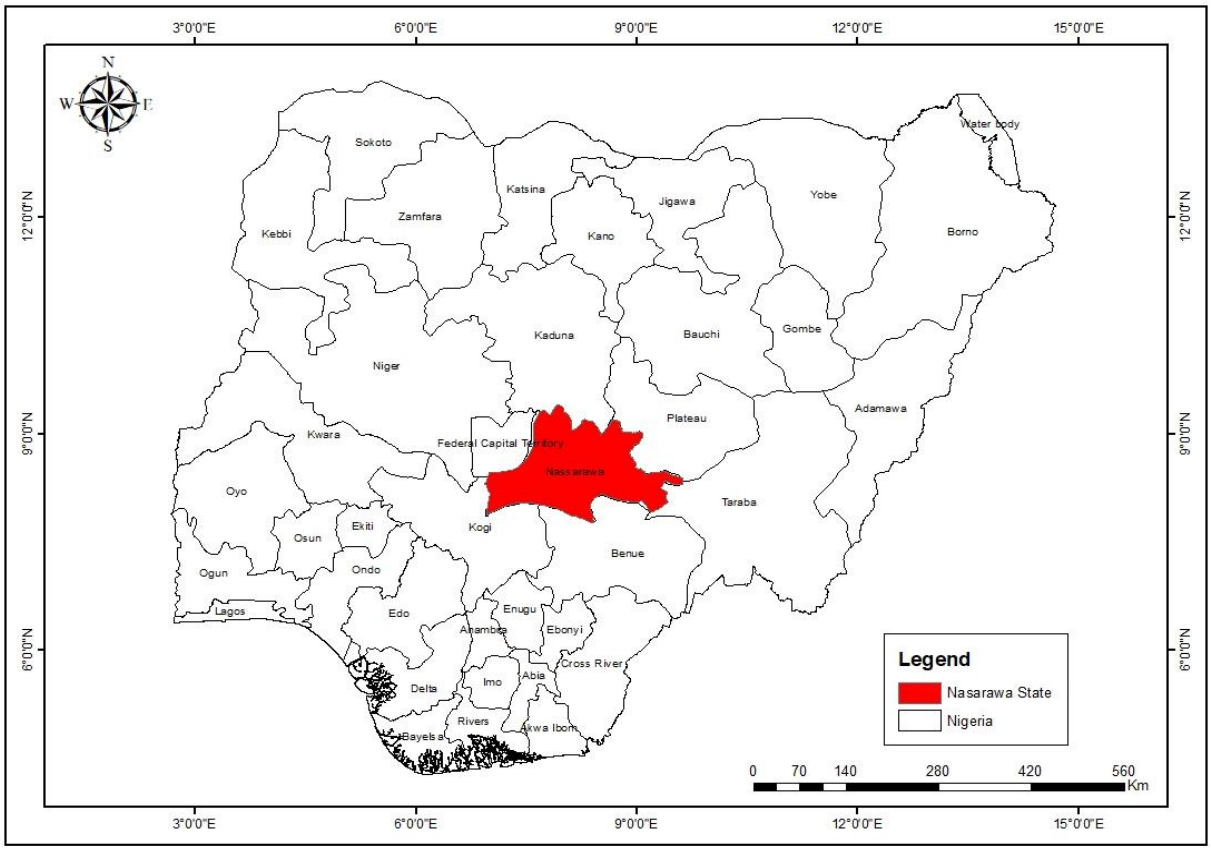


Figure 3.1: Nigeria showing Nasarawa State.

Source: field survey, 2024

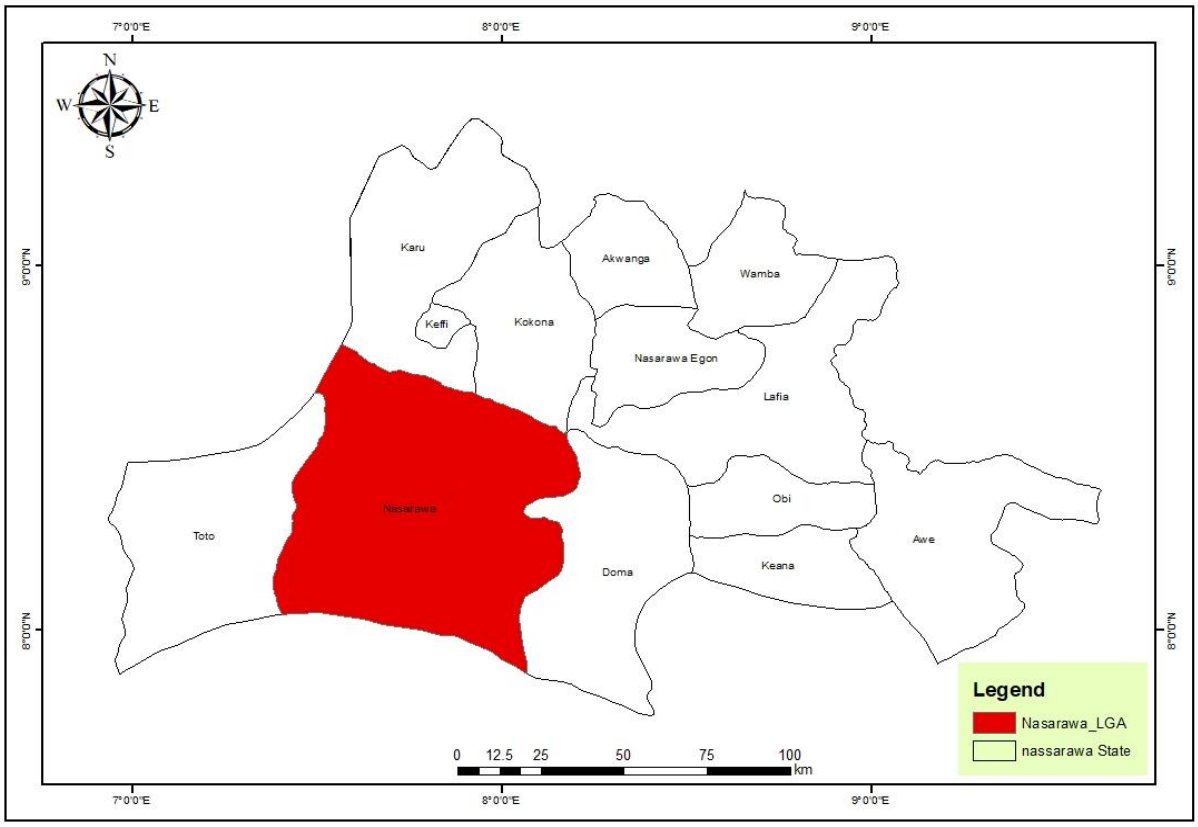


Figure 3.2: Nasarawa State Showing Nasarawa LGA

Source: field survey, 2024

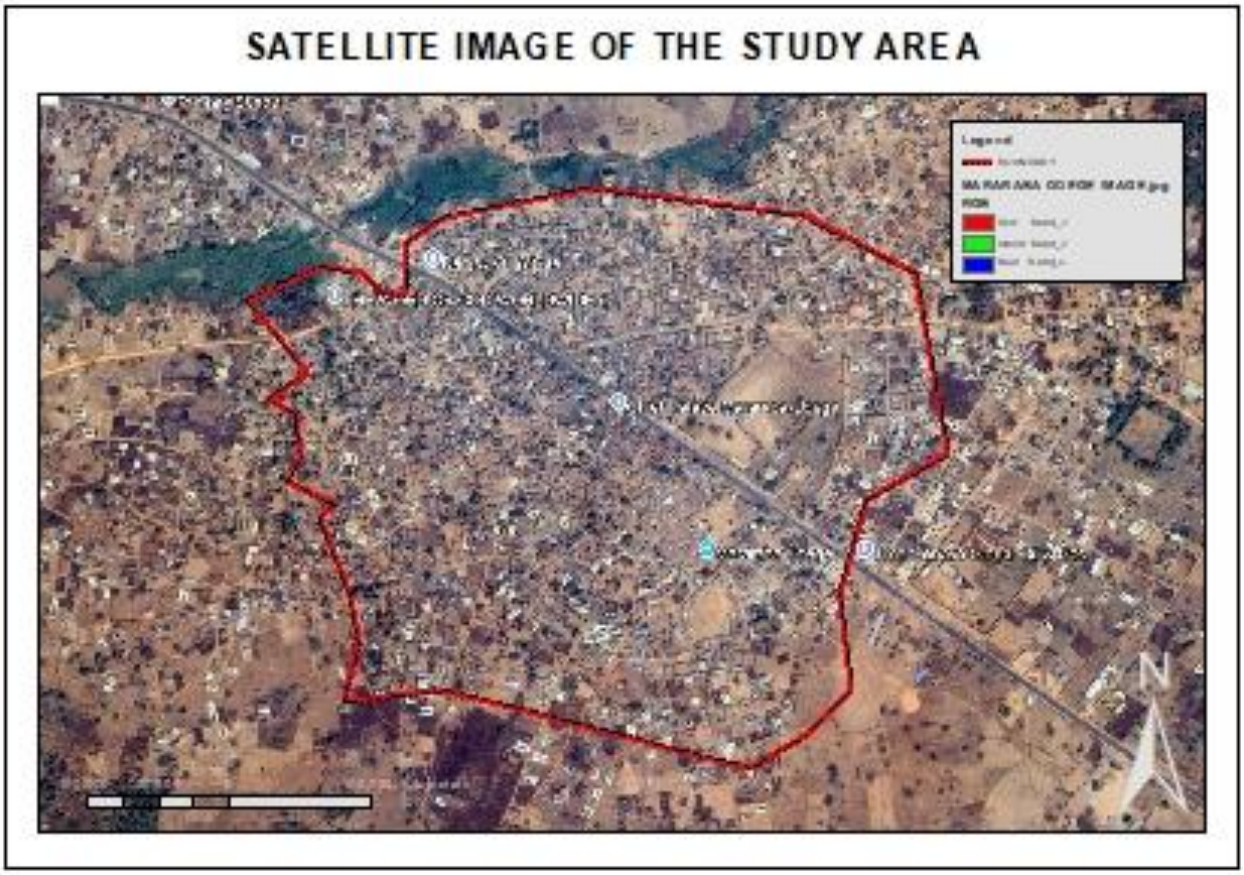


Figure 3.3: Map of the Study Area

Source: field survey, 2024

3.2 Research Design

This chapter outlines the systematic approach used to gather, analyze, discuss, and interpret field data. It encompasses the methods, techniques, and tools required to answer the research questions and provide insights into effective land use planning for Mararaba Odege, Nasarawa State. Data for this research were obtained from both primary and secondary sources. Secondary data involved online materials, peer-reviewed journals, textbook standards, and published or unpublished postgraduate development studies. Primary data collection was split into two sequential phases to ensure historical and seasonal alignment: spatial imagery and geographic ground-truthing campaigns were executed between October and December 2024, whereas socio-economic household questionnaires were fully deployed and parsed in the first quarter of 2025. Primary inputs were augmented with digital photographs illustrating active infrastructural deficits and satellite imagery sourced from Google Earth.

3.2.1 Population Baseline and Geometric Projection Model

The raw population figure for the study area was established at 29,117 people according to the last official National Population Census conducted in 2006, spanning all demographic cohorts (adults, children, males, and females). Because planning interventions require current and future capacities, this baseline was updated using the official National Population Commission (NPC) geometric growth model for peri-urban fringe areas under the direct influence of the FCT expansion corridor. An annual growth rate (r) of 2.9% (0.029) was applied using the following formula:

$P_t = P_0 * (1 + r)^t$

Where:

P_t = Projected population at the target planning horizon

P_0 = Baseline population from the 2006 Census (29,117)

r = Annual population growth rate (0.029)

t = Number of elapsed years since the baseline census year

Applying this model establishes the following milestone horizons for the Mararaba Odege master plan:

- 2006 Baseline Census: 29,117 residents
- 2016 Historical Midpoint: 38,751 residents
- 2026 Current Active Planning Year (t = 20): 51,591 residents
- 2036 Future Design Horizon (t = 30): 68,675 residents

3.2.2 Sample frame

The sampling framework for this study encompasses households, socio-economic groups, and key stakeholders across the street networks of the study area, operationalized via a cluster sampling technique. Households serve as the primary unit of analysis because they are directly impacted by localized land use modifications and development control decisions. By centering on household heads, the study gathers representative demographic data, structural housing typologies, and resident perspectives regarding active zoning enforcement.

Furthermore, formal and informal socio-economic groups, such as traders and small business owners, were integrated to capture the impacts of development controls on local commercial livelihoods. Key institutional stakeholders—including local town planning officials, municipal engineers, and community leaders—were interviewed to evaluate regulatory implementation bottlenecks. The cluster sampling method grouped respondents geographically by neighborhood street segments to guarantee equitable spatial representation across varying densities.

3.2.3 Sample Size Determination

The active sample size was calculated by converting total population figures into distinct household units. Dividing the baseline population of 29,117 by the average national household size coefficient of 6 yields an estimated structural footprint of 4,852 distinct households. To achieve a statistically sound representation within regional research resource parameters, a fixed sample fraction of 5.0% (0.05) was applied to the household universe. This mathematical calculation establishes a strict sample target of 243 representative households, which were uniformly distributed across the geographical neighborhood clusters during the 2025 primary survey.

3.3 Data Types

The development of the Land Use Plan for Mararaba Odege relies on a dual-matrix framework of spatial and non-spatial data types.

3.3.1 Spatial Data

Spatial data inputs provide a detailed understanding of the physical landscape and current land allocation trends. This data layer comprises high-resolution satellite imagery, topographical contour datasets, and Geographic Information System (GIS) shapefiles illustrating the active distribution of residential, commercial, industrial, public, and open space zones. It explicitly captures circulation networks, hydrological elements, and community facilities, allowing urban planners to run geometric overlays, establish no-build buffer zones along low-lying floodplains, and track structural encroachment into open public land plots.

3.3.2 Socio-Economic Data

Socio-economic data layers provide the human context necessary to anchor spatial designs. This dataset includes compiled household sizes, gender splits, youth density metrics, occupational categories, average monthly income thresholds, and access metrics to basic public utility configurations. This information was collected directly via household surveys and localized administrative lookups, allowing the final master plan to balance geometric spatial allocation with the real purchasing power and community requirements of the Mararaba Odege population.

3.4 Data Collection and Field Validation Procedure

3.4.1 Spatial Data Acquisition Procedure

Primary spatial data layers were mapped using remote sensing techniques. Base vector layouts and structural footprints were derived from Landsat and Google Earth satellite imagery captured during cloud-free windows in late 2024. These images were imported into processing software for georeferencing and initial layout stratification.

3.4.2 Reconnaissance Survey and Ground Truthing

An initial site reconnaissance was completed to establish neighborhood boundaries and structure primary survey routes. To resolve ambiguous features or misclassified land boundaries visible on the satellite imagery, a systematic field verification ("ground-truthing") campaign was conducted. Field teams utilized a Garmin Etrex 30X Handheld Global Positioning System (GPS) to record precise coordinates (X, Y) for notable civic landmarks, road intersections, and visible infrastructural limits. These physical coordinate check-points were imported into ArcGIS 10.3 software to cross-verify the raster satellite layers, thereby ensuring maximum spatial accuracy for all produced thematic maps

3.4.2 Ground Truthing

Ground verification, also referred to as "ground truthing," was carried out to confirm ambiguous areas detected on the satellite images. This process involved the use of a Garmin Etrex 30X Handheld Global Positioning System (GPS) to record the coordinates (X, Y) of significant landmarks for georeferencing, aiding in the analysis of satellite imagery for the study. The data gathered utilized to develop a digital map using ArcGIS 10.3 software, facilitating the production of the required outputs for the Land Use Plan in Mararaba Odege Development Area.

3.4.3 Empirical Utility and Risk Assessments

To supplement standard asset tallies, two dedicated assessment protocols were introduced during field validation:

A) Potential-Constraint Matrix Scoring Framework: Rather than relying on purely narrative accounts, the selection of land for future development was governed by a Weighted Linear Combination (WLC) suitability framework:

$$S = \sum (W_i * C_i)$$

Where (S) is the composite suitability score, (W_i) represents a calculated relative weight assigned to an environmental or physical criterion (where $\sum W_i = 1.0$), and (C_i) represents a raw field score graded from 1 (severe constraint/high risk) to 5 (optimal potential/low risk). This scoring system classifies terrain explicitly to identify parts of the study area suitable for immediate design interventions.

B) Borehole Water Quality Risk Framework: Because the utility inventory identifies 25 functional boreholes as the dominant water supply source for the community, a Water Quality Index (WQI) safety protocol was integrated into the research design. Field monitoring observations track key indicator risks (such as physical

proximity to domestic soakaways and unlined drainage lines) against Nigerian Industrial Standards for Drinking Water Quality (NIS 554:2015) and WHO thresholds. This empirical checklist evaluates the risk of bacterial and physico-chemical contamination, classifying water supply points into Low Risk (WQI < 50), Moderate Risk (50 ≤ WQI ≤ 100), and High Risk (WQI > 100) zones to determine where centralized water treatment infrastructure must be proposed.

3.4.3 Questionnaire Administration:

Primary socio-economic data collection was executed using structured field questionnaires deployed digitally via the Kobo Toolbox platform. Field enumerators approached randomly selected households within each defined neighborhood cluster, targeting the designated household head or an eligible adult representative. In localized spots displaying poor mobile network connectivity, physical paper questionnaires matching the digital forms were utilized. Prior to entering responses, participants were briefed on the purpose of the Mararaba Odege Land Use Plan, and explicit consent was secured..

3.5 Data Analysis

Collected research inputs were processed using a split analytical toolkit:

- Spatial Data Analysis: Georeferencing, coordinate projection adjustments, shapefile digitizing, and thematic layer generation (drainage infrastructure, elevation contours, existing land use splits) were completed using ArcGIS 10.3 software.

- Non-Spatial Data Analysis: Socio-economic data sheets, questionnaire entries, and descriptive demographic statistics were compiled and verified inside Microsoft Excel before being processed using the Statistical Package for the Social Sciences (SPSS) software to output frequency tables, percentages, and baseline correlation figures.

3.5.1 ArcGIS 10: For the Land Use Plan for Mararaba Odege Development Area, Nasarawa LGA, Nasarawa State, Nigeria, data were georeferenced in both raster and vector formats using Geographic Information System (GIS) software, specifically ArcGIS 10. This process allowed the transformation of data into multiple layers. ArcGIS 10 assigned these layers to maps that correspond to specific geographical areas, enabling precise spatial analysis and visualization.

The data analysis tools for primary data include: Once the survey instruments are finalized, a detailed analysis plan were developed. This plan includes charts, tables, and descriptive analysis. Various techniques such as descriptive and multivariate statistics were employed for data analysis. Data were entered into Kobo Toolbox, Microsoft Excel, and Statistical Package for Social Sciences (SPSS), and the results were presented in tables and charts.

3.6 Data presentation

Data presentation For the Land Use Plan for Mararaba Odege Development Area, Nasarawa LGA, Nasarawa State, Nigeria, the data were displayed using various maps. These include a land use map showing bare surfaces, built-up areas, vegetation, and water bodies. Other maps included building footprint maps, topographic maps, facility maps, and maps illustrating relief and drainage patterns.

Table 3.1 Operationalization Table

Objectives	Sub-Variables	Indicator (Data Types)	Data Collection Technique	Data Collection Instrument	Data Source	Data Analysis Tool	Data Presentation
Examine the existing land use and physical	- Land use map	- Commercial, residential, recreational,	- Ground truthing	- GPS, Satellite Imagery, Google Earth	- Primary Data, Satellite Imagery	- GIS	- Maps, Tables, Charts, Illustrations

characteristics of Mararaba Odege		agricultural					
	- Utility map and infrastructure	- Roads, bridges, drainage systems, electricity distribution, water lines	- Field Survey	- Direct physical observation, questionnaires	- Direct Field Observations	- GIS, Spatial Data, Descriptive Statistics	- Maps, Tables, Charts
	- Infrastructural map	- Communication facilities, utility networks					
Examine demographic and socio-economic characteristics of Mararaba Odege	- Demographic data	- Household size, age group, marital status, employment status, education level	- Field Survey	- Structured interviews, questionnaires	- Primary Data	- SPSS, Descriptive Statistics	- Tables, Charts
	- Economic data	- Income level, occupation					
Identify potentials and constraints for land use planning in Mararaba Odege	- Natural and man-made features	- Environmental, social, and economic factors	- Field Survey/Publication	- Direct physical observation, questionnaires	- Primary and Secondary Data	- ArcGIS, SPSS, Descriptive Statistics	- Maps, Tables, Charts
			- Review of relevant documents				

Source: Field survey, 2025

RESULTS AND DISCUSSION

4.1 Introduction

Data presentation and analysis played a critical role in understanding the current land use patterns and guiding the formulation of a sustainable land use plan for Mararaba Odege. This process involves the systematic organization of data collected from surveys, field observations, and existing records into tables, charts, and maps to reveal spatial relationships and usage trends. By analyzing the existing land use, demographic characteristics, and socio-economic factors, the study provides insights into the interplay between land use dynamics and urban growth. This analysis also highlights the potentials and constraints for effective land use planning, offering a foundation for strategic recommendations aimed at optimizing land utilization, improving infrastructure, and enhancing the quality of life for residents. The findings will serve as a guide for decision-makers in implementing a comprehensive and sustainable land use plan for Mararaba Odege.

4.2 The existing land use and physical characteristics of Mararaba Odege.

Mararaba Odege is a mixed-use area characterized by a blend of residential, commercial, institutional, and public land uses. Residential land use dominates, ranging from low-density detached housing to medium-density compound housing. The commercial areas are concentrated along major roads, such as the road, featuring markets, shops, and small-scale businesses. Institutional land uses include government offices, schools, and religious centers, while public spaces such as parks are limited. The area is predominantly flat, with gentle undulating terrain, making it suitable for various developments. However, poorly defined drainage systems and inadequate road infrastructure in some parts pose challenges to accessibility and flood management during the rainy season.

Table 4.1 Existing Land Use Distribution in Mararaba Odege

SN	Land Use	Area (Ha.)	Percentage (%)
1	Commercial	47.08	2.7
2	Industrial	9.25	0.5
3	Mix use	39.26	2.2
4	Public /Semi Public	194.84	11
5	Residential	953.57	53.8
6	Open Space	528.99	29.8
	Total	**1773**	**100**

Source: Field Survey, 2025

Table 4.1 presents the distribution of land use across Mararaba Odege, providing insights into how the available 1,773 hectares of land is allocated to various uses. Residential land use occupies the largest share, with 953.57 hectares, accounting for 53.8 of the total area. This indicates the dominance of housing developments in the area, reflective of Mararaba Odege Central's role as a key urban settlement. Open spaces constitute the second-largest category, covering 528.99 hectares (29.8), highlighting the availability of undeveloped or underutilized land, which presents opportunities for future urban expansion and infrastructure development. Public and semi-public land uses, such as schools, government offices, and religious centers, account for 11 of the total area, emphasizing the significance of institutional functions in the urban fabric.

Commercial land use accounts for only 47.08 hectares (2.7), indicating limited allocation for business and economic activities within the area. This relatively small proportion suggests a potential need for further investment in commercial zones to stimulate local economic growth. Mixed-use development, combining residential, commercial, or institutional uses, occupies 39.26 hectares (2.2), reflecting emerging trends in urban integration but suggesting limited adoption of this concept. Industrial land use, at just 9.25 hectares (0.5), is the smallest category, pointing to minimal industrial activity in Mararaba Odege, likely due to its administrative focus and proximity to residential areas.

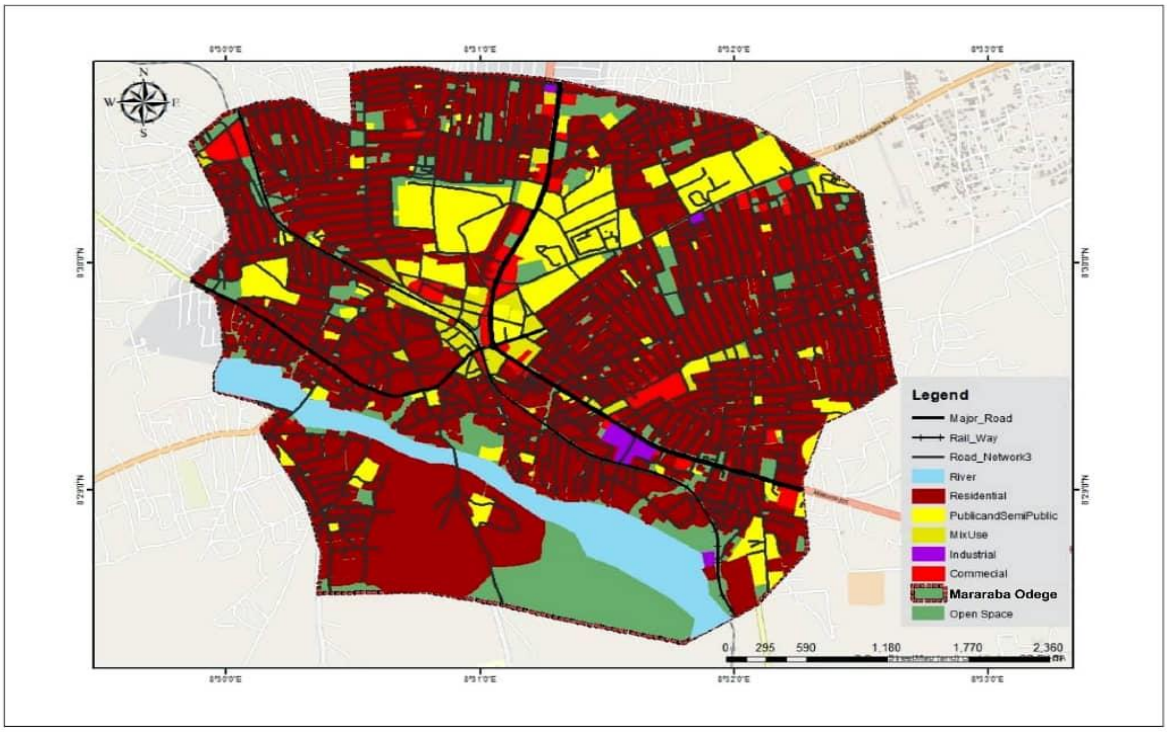


Figure 4.1 Land Use Map of Mararaba Odege

The dominance of residential land use (53.8) underscores Mararaba Odege's role as a major residential hub. While this highlights the area's capacity to accommodate its growing population, it also implies potential

challenges such as housing deficits, unplanned urban sprawl, and pressure on basic amenities. To address these issues, there is a need for careful planning to ensure the provision of adequate infrastructure, including roads, water supply, and waste management systems, to support the residential population effectively.

The significant proportion of open spaces (29.8) presents opportunities for sustainable urban planning and development. These open areas can be strategically utilized for recreational facilities, green infrastructure, or public spaces to improve the quality of life for residents. Additionally, the availability of undeveloped land creates room for future expansions, but unregulated encroachment or misuse of these areas could pose a threat to orderly development. Policymakers must prioritize zoning and land use regulations to safeguard these open spaces for productive and environmentally sustainable uses.

The low percentage of commercial (2.7) and industrial (0.5) land uses indicates a lack of diversified economic activities in Mararaba Odege. This limited allocation constrains the area's economic growth and employment opportunities. Expanding commercial zones and introducing light industrial activities could help stimulate economic development while maintaining compatibility with the predominantly residential character of the area. However, this requires strategic planning to ensure that such developments do not conflict with residential areas or strain existing infrastructure.

The presence of public and semi-public land uses (11.0) is essential for supporting administrative, educational, and religious functions in Mararaba Odege. However, the relatively small allocation of mixed-use developments (2.2) suggests an underutilization of opportunities for land use integration. Encouraging mixed-use developments could help optimize land use efficiency, reduce urban fragmentation, and enhance access to essential services. Overall, the current land use distribution highlights the need for balanced urban planning to address the limitations while leveraging the potentials of Mararaba Odege for sustainable development

Table 4.2: Circulation Network as Land Use in Mararaba Odege

Road Category	Length (KM)	Area (KM2)	Percentage (%)
Major Road	12.58123	1.132311	5
Distributor Road	14.3	1.287	6
Access Road	211.5657	19.04091	89
Total	238.4469	21.46022	100

Source: Field Survey, 2025

The data presented in Table 4.2 provides a comprehensive analysis of the circulation network as a component of land use in Mararaba Odege. The table categorizes roads into three types—Major Roads, Distributor Roads, and Access Roads—and provides their respective lengths, areas, and percentages of the total circulation network. Major Roads constitute the smallest proportion, covering 12.58123 km in length and 1.132311 km² in area, which accounts for 5 of the total road network. Distributor Roads make up a slightly larger share, with 14.3 km in length and 1.287 km² in area, representing 6 . The bulk of the network is dominated by Access Roads, which span an extensive 211.5657 km in length and 19.04091 km² in area, accounting for 89 of the total road network.

The implications of this data highlight the overwhelming reliance on Access Roads within Mararaba Odege circulation netw ork. With 89 of the network dedicated to Access Roads, it indicates that the urban layout is heavily focused on smaller, localized roads that connect neighborhoods and facilitate direct access to residential and commercial areas. While this is beneficial for local connectivity, the relatively limited proportion of Major and Distributor Roads (11 combined) suggests potential challenges in accommodating high-capacity traffic flow and efficient citywide mobility. This imbalance could result in congestion on primary routes and inadequate linkage between different parts of the city.

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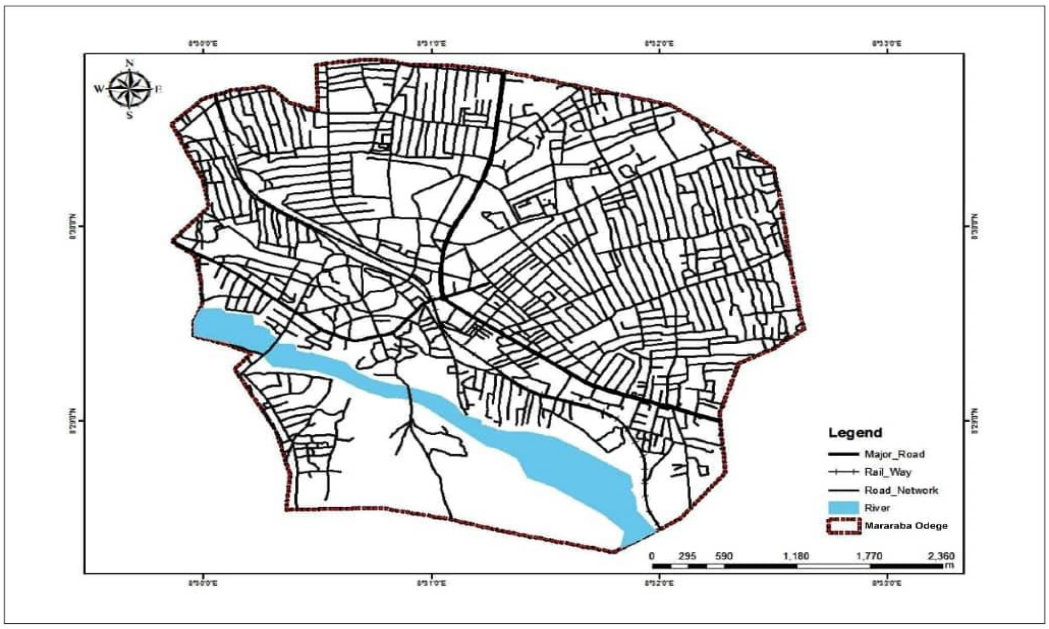


Figure 4.2: Circulation Network as Land Use in Mararaba Odege

The dominance of access roads also underscores the need for improved urban planning to enhance transportation efficiency and land use. The limited area allocated to Major and Distributor Roads may hinder economic activities and regional accessibility, as these categories are crucial for facilitating higher-speed traffic and reducing travel time. To address these implications, urban planners in Mararaba Odege may need to prioritize expanding and upgrading Major and Distributor Roads while maintaining the functionality of Access Roads. This balanced approach can improve overall traffic flow, support economic growth, and ensure sustainable urban development.

Transportation infrastructure includes six terminals and 12 auto-mechanic workshops, totaling 18 facilities. While this indicates some level of accessibility for residents, the number of terminals might be insufficient to support the growing transportation needs of an urban area. Large-scale commercial areas consist of one market and nine shopping complexes, totaling 10 facilities. This highlights the prominence of small-scale commercial activities but suggests the need for more centralized and diversified markets to support economic growth and trade within the city.

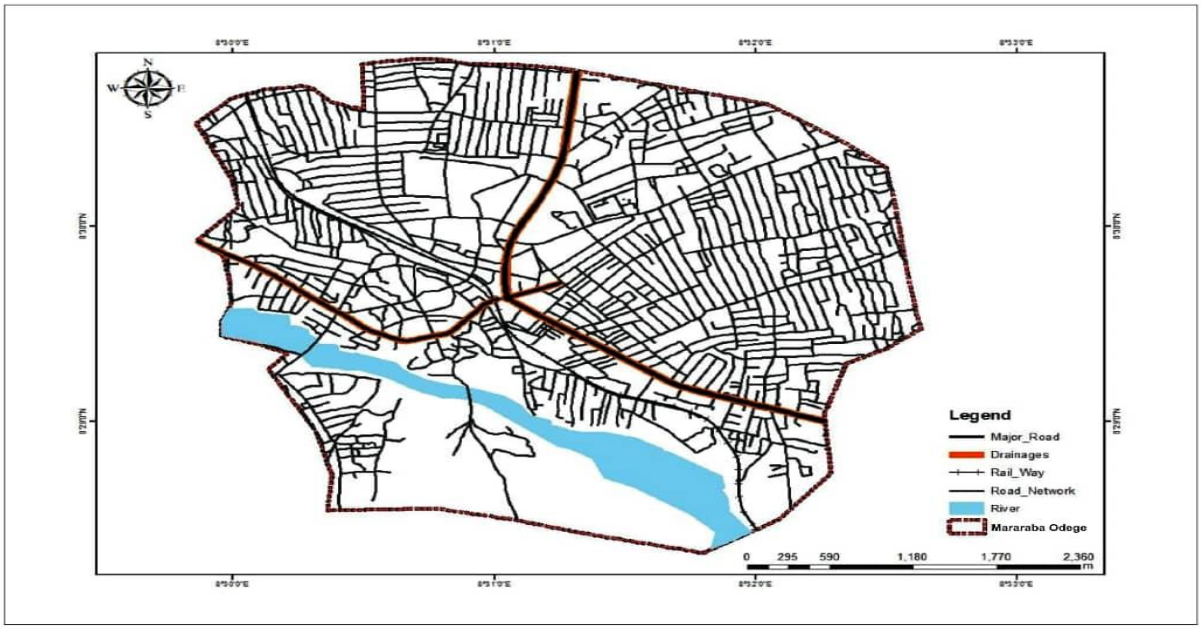


Figure 4.3: Existing Drainage System

The drainage system in Mararaba Odege is primarily concentrated along major roads and collectors, where it

serves to channel rainwater and prevent flooding. These drainage networks are essential for managing stormwater, reducing waterlogging, and protecting road infrastructure. However, despite their strategic importance, the drainage system in Mararaba Odege is poorly maintained. Blockages caused by waste accumulation, silt, and vegetation growth are common, significantly reducing the system's efficiency. This results in frequent flooding during heavy rainfall, disrupting transportation, damaging infrastructure, and creating hazardous conditions for residents and commuters.

The neglect of the drainage system not only affects the functionality of the infrastructure but also poses serious health and environmental risks. Stagnant water in blocked drains becomes a breeding ground for mosquitoes and other disease vectors, increasing the prevalence of waterborne diseases such as malaria and cholera. Additionally, the lack of proper maintenance contributes to soil erosion and further degradation of urban infrastructure. To address these challenges, it is crucial to implement regular cleaning and maintenance schedules, enforce waste management regulations to reduce littering, and invest in upgrading the drainage network to accommodate the growing urban population and changing climate patterns. Proper management of the drainage system is essential for ensuring a safer and more sustainable urban environment in Mararaba Odege.

Table 4.3: Mararaba Odege Infrastructure: Utilities, Facilities and Services Inventory Ground Truthing

S/N	FACILITIES, UTILITIES, & SERVICES	Number of Facilities
1	EDUCATIONAL	
	Nur/Primary	3
	Secondary	2
	Total	5
2	HEALTHCARE	
	Primary	3
	Secondary	0
	Tertiary	0
	Total	3
3	WATER Borehols	25
4	SANITATION/HYGIENE	
	Public toilet	3
	Abattoir	2
	Total	5
5	ELECTRICITY	15
6	TRANSPORTATION	
	Terminals	6
	Auto-mechanic workshop	12
	Total	18
7	LARGE SCALE COMMERCIAL AREAS	
	Markets	1
	Shopping complex	9
	Total	10
8		
	Churches	4
	Mosques	8
	Total	12

Source: Field Survey, 2025

The data in Table 4.3 presents an inventory of facilities, utilities, and services in Mararaba Odege, derived from ground truthing. The table provides insights into various categories, including education, healthcare, water, sanitation, electricity, transportation, commercial areas, and places of worship, detailing their distribution across the area. This inventory reveals significant disparities in the availability and distribution of essential services and highlights gaps that may affect the quality of life and development in Mararaba Odege.

The table shows that Mararaba Odege has a total of five educational facilities, comprising three nursery/primary schools and two secondary schools. This limited number of schools relative to the population size of an urban center suggests a potential inadequacy in educational infrastructure. A lack of sufficient schools could lead to overcrowding in classrooms, lower quality of education, and limited access for children in certain parts of the area. Expanding educational facilities is crucial to ensuring better access to quality education and fostering human capital development.

The healthcare infrastructure in Mararaba Odege is even more concerning, with only three primary healthcare facilities and no secondary or tertiary healthcare institutions. This is a critical shortfall, as it indicates that residents may lack access to advanced medical care, especially in emergencies or for specialized treatments.

The reliance on primary healthcare facilities could strain their resources and limit their effectiveness in addressing public health needs. Expanding healthcare infrastructure, particularly at the secondary and tertiary levels, is vital for improving health outcomes and reducing the burden of preventable diseases.

The water infrastructure in Mararaba Odege is represented by 25 boreholes, which serve as the primary source of water for residents. Boreholes are often considered a cost-effective and reliable solution for water provision in urban areas, especially where centralized water systems are limited or nonexistent. However, the adequacy of these boreholes depends on several factors, including their distribution across the city, their capacity to meet daily water demand, and their functionality. If the boreholes are unevenly distributed, certain areas may face water scarcity, forcing residents to travel long distances to access water. Moreover, the dependence on boreholes alone could be problematic during periods of high demand or if the groundwater table is depleted due to overuse. This underscores the need to expand and diversify water infrastructure to include centralized water supply systems and rainwater harvesting to ensure sustainable water access.

Another concern is the quality of water sourced from boreholes. Without proper treatment, borehole water can be contaminated with pathogens or pollutants, posing significant health risks to users. The presence of only boreholes as a water source may leave Mararaba Odege vulnerable to outbreaks of waterborne diseases such as cholera and typhoid. To improve water infrastructure, it is necessary to integrate water treatment facilities and implement routine water quality monitoring. Additionally, investing in public awareness campaigns about water conservation and hygiene practices can enhance the sustainable use of water resources and improve the health outcomes of the population. Addressing these issues is essential for ensuring reliable and safe water supply in Mararaba Odege.

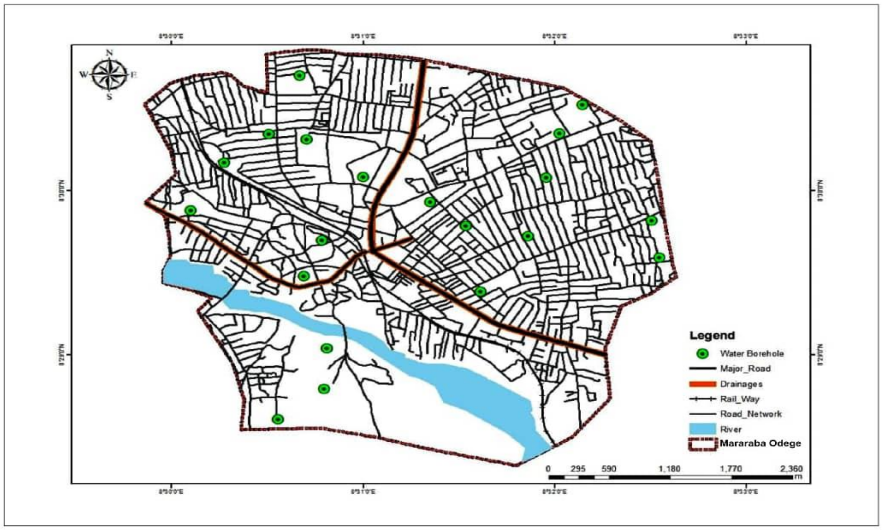


Figure 4.4: Existing Borehole in Mararaba Odege

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Electricity infrastructure in Mararaba Odege comprises 15 facilities, which indicates limited capacity to support the energy needs of the population. This number is likely insufficient to provide consistent and equitable power distribution across the urban area, especially in a rapidly growing city where demand for electricity is high. Electricity is essential for residential, commercial, and industrial activities, and inadequate supply can significantly hinder economic growth and reduce the quality of life for residents. Power outages or inconsistent electricity can disrupt daily activities, limit access to essential services such as healthcare and education, and increase reliance on costly and environmentally damaging alternatives like generators.

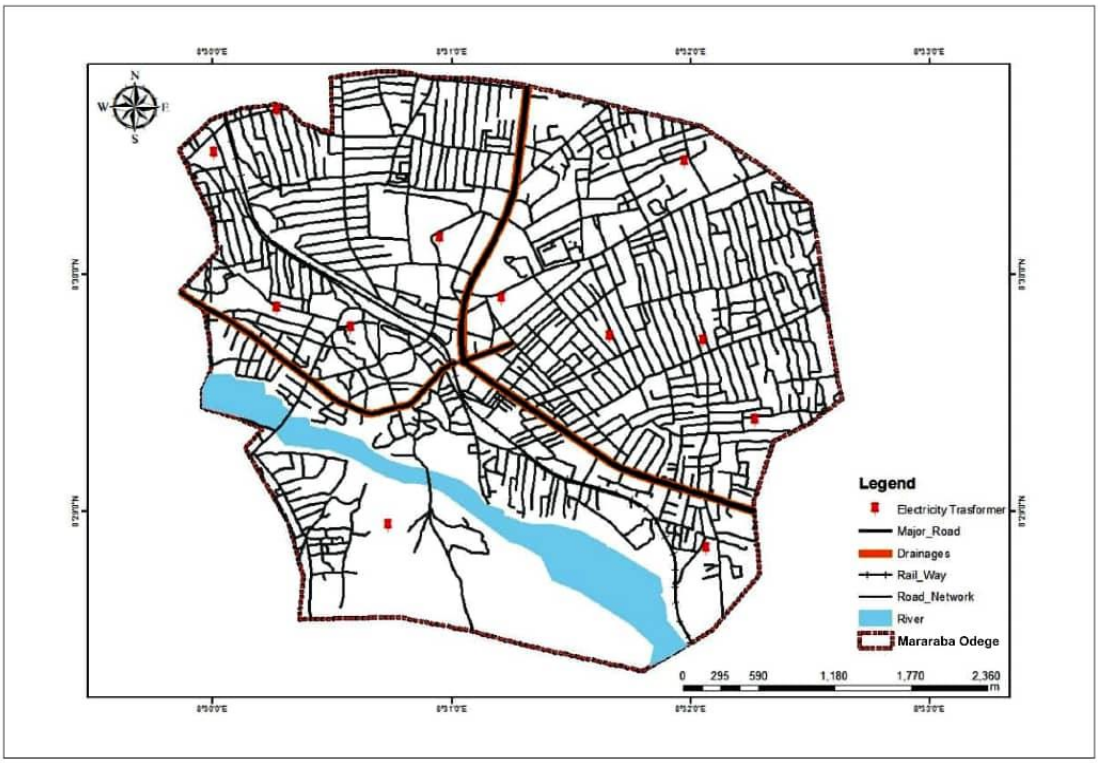


Figure 4.5: Existing Electric Transformer .

This makes improving the electricity infrastructure a critical priority for Mararaba Odege's development.

Furthermore, the limited number of electricity facilities may contribute to challenges such as illegal connections, voltage fluctuations, and poor maintenance of existing infrastructure. Expanding the electricity network, incorporating renewable energy sources like solar power, and upgrading existing facilities can help address these issues. In addition, implementing policies that encourage energy efficiency and conservation among residents can reduce the strain on the power grid. Strategic planning and investment in electricity infrastructure are essential for supporting urban development, fostering economic activities, and improving the overall well-being of the residents of Mararaba Odege.

Mararaba Odege has 12 places of worship, including four churches and eight mosques. These facilities serve the spiritual and social needs of the community, reflecting its religious diversity. However, their distribution and capacity relative to the population density may need to be assessed to ensure equitable access. The inventory of utilities, facilities, and services in Mararaba Odege underscores the need for strategic urban planning to address gaps in infrastructure, improve service delivery, and promote equitable access to essential facilities for residents.

4.3 The demographic and socio-economic characteristics of Mararaba Odege

The population of Mararaba Odege is diverse, comprising individuals from various ethnic groups and socio-economic backgrounds. The majority of residents are within the working-age bracket of 18–45 years, reflecting a youthful and active population. Educational attainment levels are relatively high, with a significant proportion of residents having completed secondary or tertiary education. Economic activities are centered on

civil service, trading, agriculture, and artisanal work, with a growing informal sector. While monthly incomes vary, most residents earn between ₦20,000 and ₦50,000, indicating a predominance of low to middle-income earners. Access to basic services such as water, electricity, and healthcare is moderate, but gaps in service provision persist, particularly in informal housing areas.

Table 4.4 demographic and socio-economic characteristics of Mararaba Odege

Variable	Categories	Frequency (n)	Percentage (%)
Gender	Male	470	51
	Female	452	49
Age Group (Years)	18-24	184	20
	25-34	276	29.9
	35-44	230	24.9
	45-54	138	15
	55+	94	10.2
Marital Status	Single	411	44.6
	Married	470	51
	Divorced/Separated/Widowed	41	4.4
Education Level	No Formal Education	92	10
	Primary	184	20
	Secondary	368	39.9
	Tertiary	276	30.1
Occupation	Civil Servant	276	29.9
	Trader/Businessperson	184	20
	Artisan	138	15
	Farmer	184	20
	Unemployed	138	15
Monthly Income (₦)	Less than ₦20,000	230	24.9
	₦20,000–₦50,000	322	34.9
	₦51,000–₦100,000	230	24.9
	Above ₦100,000	140	15.3
Housing Type	Detached	368	39.9
	Semi-detached	276	29.9
	Compound/Shared	276	29.9
Access to Basic Amenities	Adequate Water Supply	598	64.9
	Electricity (Daily Supply)	460	49.9
	Healthcare Facility Nearby	690	74.8
Household Size	1–3 Members	276	29.9
	4–6 Members	460	49.9
	7+ Members	184	20

Source: Field Survey, 2025

Table 4.2 highlights the demographic and socio-economic attributes of Mararaba Odege, providing essential insights into the composition and conditions of the population. The gender distribution shows a near balance, with males making up 51.0 and females 49.0 . This parity indicates equal opportunities for planning interventions that target both genders. The population is predominantly youthful, as the largest age groups are 25–34 years (29.9) and 18–24 years (20.0), signifying a vibrant, active workforce. However, this youth dominance underscores the need for job creation, education, and recreational facilities to cater to their needs.

The marital status distribution shows that 51.0 of the population is married, while 44.6 are single, reflecting a mix of family-oriented and individual residents. This has implications for housing and community services, as families often demand larger housing units, educational facilities, and healthcare services. Educational attainment is relatively high, with 39.9 having secondary education and 30.1 having tertiary education, suggesting a literate population. However, the 10.0 without formal education points to gaps in access to educational opportunities that need to be addressed to promote inclusive development.

In terms of occupation, the population is fairly diversified. Civil servants make up the largest group (29.9), followed by traders and farmers (both 20.0), with artisans and the unemployed each comprising 15.0 . This distribution suggests an economy reliant on the public sector, small-scale trade, and agriculture. Income levels reveal that 34.9 of residents earn ₦20,000–₦50,000 monthly, while 24.9 earn less than ₦20,000. This indicates that a significant proportion of the population belongs to low- and middle-income brackets, which may influence affordability for housing and services. Only 15.3 of the population earns above ₦100,000, pointing to a limited upper-income class.

Housing types in Mararaba Odege are predominantly detached units (39.9) and semi-detached or compound/shared housing, each accounting for 29.9 . This mix highlights diverse housing preferences, but the prevalence of shared housing indicates pressure on land availability and affordability. Access to basic amenities varies, with 64.9 having adequate water supply and 74.8 living near healthcare facilities, while only 49.9 enjoy daily electricity supply. This uneven access to services signals the need for infrastructural improvements to enhance the quality of life.

The near-equal gender distribution (51 male and 49 female) implies that land use planning must account for the needs of both genders. This includes the provision of gender-sensitive public spaces, safety measures, and equal access to economic and social facilities. The predominance of youth (50 under 35 years) suggests the need for youth-centric planning interventions. Recreational facilities, vocational training centers, and affordable housing should be prioritized to cater to the aspirations and needs of this demographic. With over half of the population (51.0) being married, family-oriented land use planning is crucial. This includes allocating land for schools, parks, and healthcare facilities, as well as ensuring adequate housing units with larger capacities to accommodate families. The high literacy rate (70.0 with secondary or tertiary education) presents an opportunity to foster skill-based industries and educational institutions. However, the 10.0 without formal education calls for inclusive policies to improve access to education, especially for underserved communities.

The occupational distribution highlights a reliance on the public sector and small-scale activities. Land use planning should consider zoning for industrial parks, markets, and business hubs to diversify economic activities and generate employment opportunities for artisans, traders, and the unemployed. The mix of detached, semi-detached, and shared housing indicates varying levels of affordability. Policies should promote affordable housing schemes and regulate land prices to prevent overcrowding and the proliferation of informal settlements.

The disparities in access to basic amenities highlight the need for targeted infrastructure improvements. For instance, enhancing electricity supply and expanding water distribution systems would improve living conditions. These upgrades should be integrated into land use plans to ensure equitable service delivery.

4.4 The potentials and constraints for land use planning in Mararaba Odege

Mararaba Odege has significant potential for effective land use planning, given its strategic location as the administrative and economic hub of Nasarawa State. The area's flat terrain and existing road networks provide a foundation for further urban development and expansion. The presence of government institutions and a growing population create opportunities for structured growth and investment in infrastructure. However, constraints such as rapid urbanization, encroachment on public lands, and inadequate enforcement of development control regulations hinder orderly planning. Additionally, limited funding, insufficient public participation, and a lack of comprehensive land use data pose challenges to the implementation of sustainable

urban planning strategies. Addressing these issues were key to optimizing land use and promoting equitable development in Mararaba Odege.

Table 4.5 potentials and constraints for land use planning in Mararaba Odege

Factor	Category	Description	Potential (%)	Constraint (%)
Natural Features	**Topography**	Generally flat terrain, favorable for construction and infrastructure development.	80	20
	Soil Quality	Fertile soil supports agriculture and green spaces.	70	30
	Water Bodies	Proximity to water bodies for irrigation, recreation, and aesthetics.	60	40
Man-Made Features	**Road Network**	Existing road networks provide connectivity for development.	65	35
	Existing Structures	Presence of government buildings and institutions supports planned expansion.	50	50
	Open Spaces	Large open spaces available for recreation, green areas, and future development.	75	25
Environmental Factors	**Climate**	Tropical climate supports diverse land uses, including agriculture and recreation.	70	30
	Flood Risks	Low-lying areas near water bodies are prone to seasonal flooding.	20	80
Social Factors	**Population Structure**	Predominantly youthful population provides an active workforce and demand for housing and services.	60	40
	Community Cohesion	Strong social ties encourage participation in planning initiatives.	70	30
	Housing Demand	High demand for housing supports residential development but requires careful planning.	50	50
Economic Factors	**Agricultural Economy**	Active farming economy provides opportunities for agro-industrial development.	65	35
	Income Levels	Prevalence of low- to middle-income earners may limit affordability for infrastructure projects.	40	60
	Commercial Potential	Opportunities for expanding commercial zones and trade activities.	55	45

Source: Field Survey, 2025

The table highlights the potentials and constraints for land use planning in Mararaba Odege, analyzing factors such as natural, man-made, environmental, social, and economic characteristics. Natural features present significant opportunities, with the flat terrain (80 potential) and fertile soils (70 potential) supporting construction, agriculture, and green space development. However, water bodies, while useful for irrigation and recreation (60 potential), also pose a constraint (40) due to the risk of flooding in low-lying areas. These natural features require careful zoning to maximize benefits while mitigating risks.

Man-made features are another critical aspect of land use planning in Mararaba Odege. The road network (65 potential) provides connectivity, but its 35 constraint suggests the need for upgrades to enhance accessibility. Open spaces, with 75 potential, represent a major asset for recreation, future development, and environmental conservation. However, existing structures, while beneficial for institutional support (50 potential), pose an equal constraint (50) due to the challenge of integrating new developments into an already occupied urban landscape. Efficient land use planning must balance these opportunities and challenges to achieve sustainable growth.

Environmental and social factors further shape land use planning decisions. The tropical climate (70 potential) supports diverse land uses, such as agriculture and recreation, but the high risk of flooding (80 constraint) highlights the need for floodplain management. Socially, the predominantly youthful population (60 potential) provides a vibrant workforce and demand for housing, yet housing demand itself is both an opportunity (50 potential) and a constraint (50) due to the pressure it places on infrastructure and land availability. Community cohesion (70 potential) is a valuable factor, as it can facilitate public participation in planning initiatives.

Economic factors demonstrate both opportunities and limitations. The active agricultural economy (65 potential) creates avenues for agro-industrial development, and the commercial potential (55 potential) supports trade and business growth. However, low income levels (40 potential, 60 constraint) limit the affordability of infrastructure projects, creating challenges for funding and implementing large-scale developments. Addressing these economic constraints through strategic planning and public-private partnerships can unlock Mararaba Odege's full potential, ensuring sustainable and inclusive growth.

Table 4.6 Topography of Mararaba Odege

Elevation	**Valures (m)**
Low	107-153
Moderate	153-199
High	199-244

Source: Field Survey, 2025

The topography of Mararaba Odege, as presented in Table 4.6, reveals three distinct elevation zones: low, moderate, and high, ranging from 107 meters to 244 meters above sea level. The low-elevation areas, between 107 meters and 153 meters, are primarily located in the valleys and flat plains of Mararaba Odege. These areas are often characterized by higher susceptibility to flooding, especially during the rainy season, due to their lower altitude and poor drainage. The flat nature of the terrain in these zones makes them ideal for farming and certain types of construction; however, they require extensive flood control measures to mitigate environmental and infrastructural challenges.

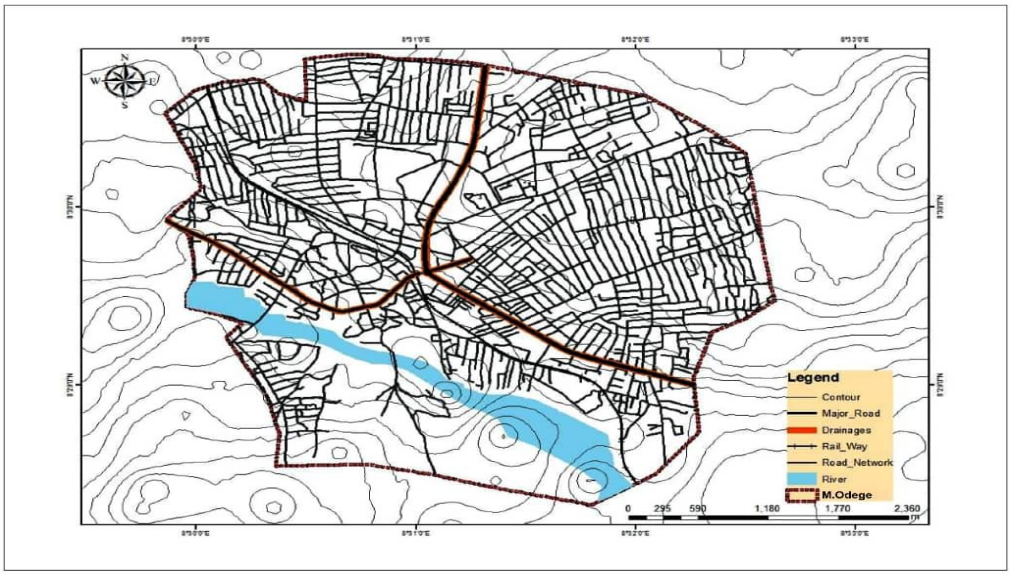


Figure 4.6: Topographical Map of the Study Area.

The moderate-elevation zones, ranging from 153 meters to 199 meters, represent transitional areas between the low and high terrains. These areas are less prone to flooding compared to the lowlands but may still experience water accumulation in poorly drained locations. The moderate elevation provides a balance that is favorable for various land uses, including residential development, infrastructure, and transportation networks. However, erosion can still pose a challenge in some parts of these zones, particularly where vegetation cover has been reduced due to urban expansion or agricultural activities.

The high-elevation zones, which span from 199 meters to 244 meters, are typically located on ridges and elevated terrains within Mararaba Odege. These areas are less vulnerable to flooding but may face other challenges, such as soil erosion and difficulty in accessing water sources. The elevated terrain often provides scenic views and is suitable for specific developments, such as high-end residential neighborhoods or public facilities requiring stable foundations. However, the steep slopes in certain parts of the high-elevation areas may require additional engineering interventions to prevent landslides or the degradation of roadways.

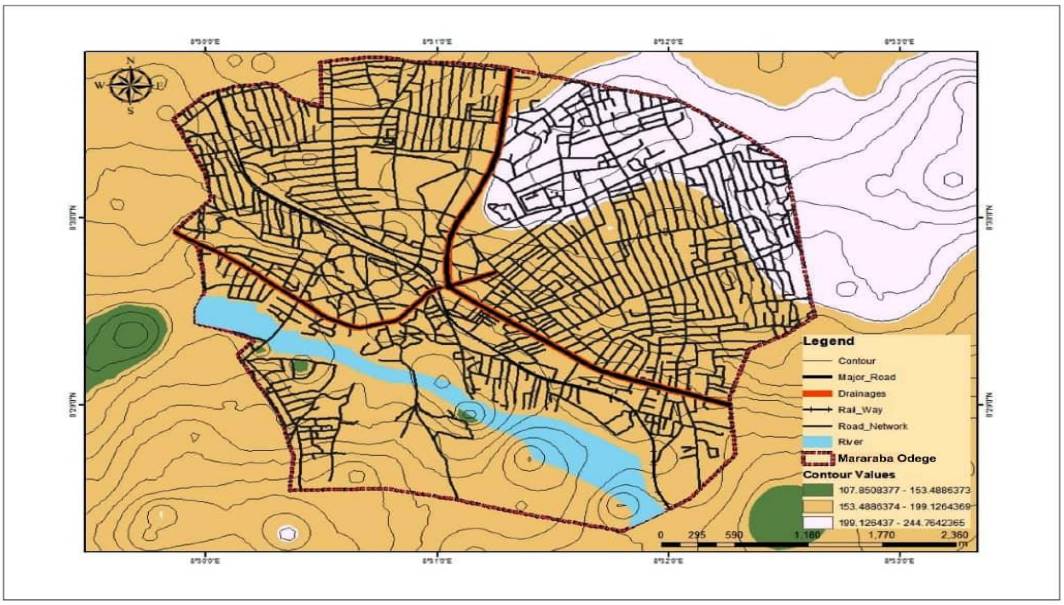


Figure 4.7: Elevation of the Study Area.

The varied topography of Mararaba Odege has significant implications for urban planning and development. The lowlands demand substantial investment in drainage and flood control infrastructure, while the moderate and high-elevation areas require soil conservation measures to prevent erosion. Understanding the elevation profile is crucial for effective land-use planning, ensuring that developments are resilient to environmental challenges and that resources are allocated efficiently to mitigate risks associated with each topographic zone.

CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

The empirical assessment of the Mararaba Odege Development Area highlights an urban landscape experiencing significant structural stress driven by rapid, unregulated population growth. Spatial analysis of the current 1,773-hectare land footprint reveals that residential land use dominates the study area at 53.8% (953.57 hectares), while commercial expansion is severely constrained at just 2.7% (47.08 hectares). This structural imbalance is compounded by critical infrastructure deficits. Ground-truthing data confirm that 89% of the circulation network consists of minor access roads, leaving the urban core poorly linked to regional logistics networks. Furthermore, basic public utility systems are inadequate; the community relies on 25 localized boreholes for water supply and a network of 15 electrical transformers, both of which face high contamination and overload risks under current usage patterns.

Socio-economic analysis indicates that this infrastructure deficit is directly affected by rapid population growth. Applying the National Population Commission geometric growth model (r = 2.9%) to the 2006 census baseline reveals that the population has grown from 29,117 to an active 2026 population of 51,591 residents, and is projected to reach 68,675 by the 2036 planning horizon. With 49.9% of households containing 4 to 6 members and 59.8% of the population earning less than ₦50,000 monthly, planning interventions must focus on affordable, community-scale infrastructure. The potential-constraint matrix confirms that while the area's flat terrain (80% suitability score) simplifies physical construction, the proximity of low-lying areas to local water bodies (80% flood risk constraint) requires strict structural buffers and phased engineering interventions.

5.2 Conclusion

This study demonstrates that Mararaba Odege is transitioning into a significant peri-urban node, but its development is constrained by informal expansion, poor infrastructure management, and an undersized commercial footprint. The historical practice of uncontrolled land allocation has compromised drainage integrity and created public health risks around primary water sources. However, the availability of 528.99 hectares of open space (29.8% of the total area) provides a clear opportunity for structured urban planning. By moving away from reactive zoning enforcement and adopting an integrated master plan backed by sustainable,

diversified financing models, local authorities can guide Mararaba Odege toward organized economic growth and improved environmental resilience.

5.3 Design Proposal Framework

To address these infrastructure gaps and support the projected population growth, the following design interventions are proposed for the Mararaba Odege Development Area. These interventions are organized into distinct physical modules designed to integrate into the proposed land-use layout.

5.3.1 Civic and Commercial Modules

- Automated Teller Machine (ATM) Galleries: Positioned at the intersections of major arterial roads and commercial zones to support local trading networks.
- Organized Outdoor Stalls: Dedicated open-air market areas designed to relocate informal traders from road shoulders, improving traffic flow and pedestrian safety.
- Central Storage Warehouse: A municipal storage facility built near major distribution routes to safeguard agricultural goods and strengthen the local farming economy.

5.3.2 Public Utilities and Environmental Health Modules

- Centralized Water Supply Reticulation: An engineering network designed to upgrade the 25 isolated field boreholes into a integrated system equipped with treatment facilities to meet NIS 554:2015 safety standards.
- Public Conveniences: Integrated sanitation blocks placed near high-density commercial markets and transportation hubs to mitigate open defecation risks.
- Waste Collection Points: Enclosed, accessible neighborhood transit stations designed to prevent solid waste from blocking local drainage networks.

5.3.3 Infrastructure and Landscape Architecture Modules

- Solar-Powered Street Lighting: Installed along major and distributor road networks to improve security, reduce traffic accidents, and support evening commercial activities.
- Soft Landscaping (Targeted Trees and Shrubs): Strips of indigenous vegetation planted along high-elevation ridges to prevent soil erosion and provide natural shading in public open spaces.
- Green Areas and Seat-Out Parks: Reclaimed open spaces reserved for public recreation, environmental cooling, and community socialization.
- Fire Hydrant Networks: Pressurized water access points built into major road rights-of-way and commercial areas to improve emergency response capabilities.

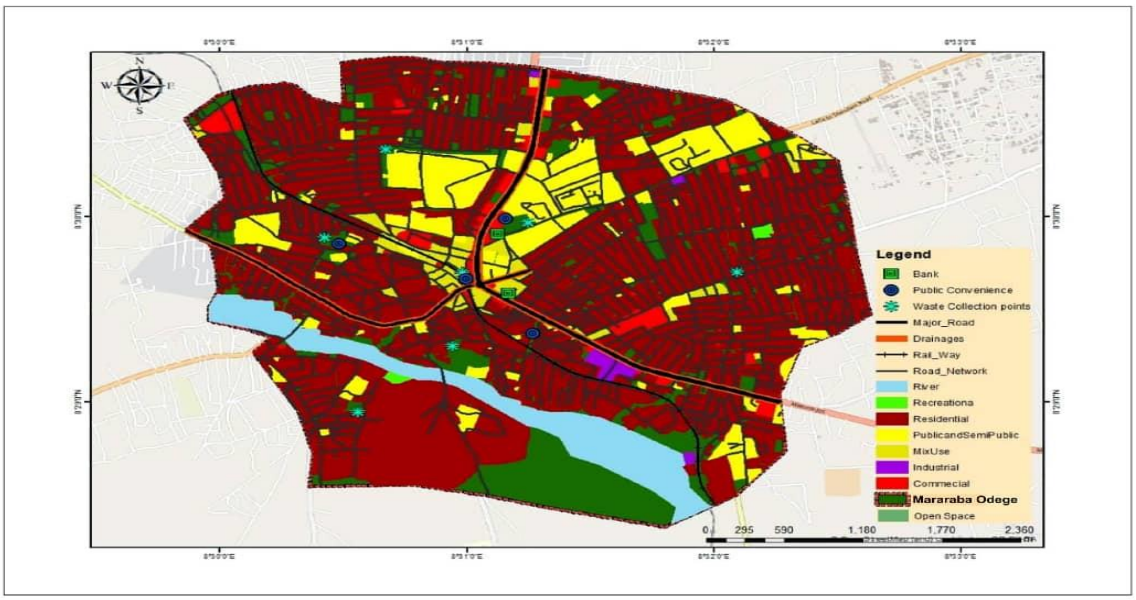


Figure 5.1 Land Use Proposal for Mararaba Odege

5.4 Capital Financing Strategy

Implementing this spatial proposal requires a diversified funding model to reduce reliance on limited municipal allocations:

- Public-Private Partnerships (PPP): Concession contracts for ATM galleries, warehouses, and organized commercial stalls where private developers fund construction in exchange for regulated user-fee collection.
- International Development Grants: Targeted proposals to institutions like the African Development Bank (AfDB) and the World Bank to secure funding for water safety systems, drainage improvements, and climate-resilient upgrades.
- Community-Based Co-Financing: Collaborative maintenance funds set up through local business groups and neighborhood associations to manage waste collection stations and local security lighting.

5.5 Phased Implementation Timeline

To minimize structural disruption and ensure efficient budget utilization, the master plan proposals are organized into three distinct execution phases based on urgency and logistics:

Phase 1: Short-Term Action Window (Years 1–3) — Public Safety & Risk Mitigation

- Delineate and enforce strict no-build buffer zones along low-lying floodplains based on topographical contour data.
- Clear solid waste blockages from primary collector drains and establish 4 designated Waste Collection Points.
- Construct 3 public conveniences near high-density informal settlement clusters to address immediate sanitation risks.
- Deploy water quality testing kits across the 25 functional boreholes to establish safety monitoring frameworks.

Phase 2: Medium-Term Development Window (Years 4–7) — Connectivity & Economic Organization

- Upgrade high-priority access roads to distributor standard and install solar-powered street lighting blocks.
- Construct the Organized Outdoor Stalls and complete the Central Storage Warehouse to stabilize local trade.
- Install targeted tree and shrub buffers along high-elevation contours to manage stormwater runoff and soil erosion.
- Set up the fire hydrant network nodes along primary commercial corridors.

Phase 3: Long-Term Integration Window (Years 8–10) — Network Consolidation

- Connect separate borehole supply points into a unified, centralized water reticulation network.
- Complete the construction of open-space seating parks and green recreational zones across the remaining 29.8% open-space allocation.
- Transition municipal utility management into a public-private co-financing framework to ensure long-term maintenance.

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