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of Development in the Brazzaville Suburbs, the Case of
Madibou (District No. 8)**



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Urban Growth and Spatial Restructuring: The Dynamics of Development in the Brazzaville Suburbs, the Case of Madibou (District No. 8)

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ABSTRACT

Purpose: This study analyzes the dynamics of urban growth and spatial restructuring in Madibou District 8, on the outskirts of Brazzaville (Republic of the Congo). It aims to understand how urban expansion influences territorial structuring through the morphological, land-use, and socio-spatial transformations observed in an area subject to intense demographic and land-use pressure.

Methodology: A descriptive and analytical approach based on a mixed-methods methodology was employed. Primary data were collected through household surveys, interviews with institutional stakeholders, direct observations, and GPS surveys. Secondary data include multi-date satellite imagery, urban planning documents, regulatory texts, and demographic statistics. The analysis relies on morphological, land-use, and socio-spatial indicators, processed using statistical tools and geographic information systems (GIS), to assess the dynamics of expansion and structuring in the periphery.

Findings: The study reveals a 32.15% increase in urbanized area between 2010 and 2026, corresponding to an average land consumption of 78.8 ha/year and a land use rate of 64.43%. This growth results in extensive urbanization and intra-urban densification, but remains dominated by informality (30% informal land occupation) and low land-title regularization (35%). Socio-spatial vulnerability is high: limited access to basic services (27%), increased exposure to risk zones (55%), infrastructure deficits, and territorial fragmentation.

Unique Contribution to Theory, Policy and Practice: The spatial restructuring of Madibou results from the interaction between urban growth, land pressure, informality, and governance limitations. It sheds light on the mechanisms shaping African urban peripheries and underscores the urgency of strengthening planning, land regularization, basic infrastructure, and the management of constrained spaces to promote sustainable and controlled urban development.

Keywords: *Urban Growth, Spatial Restructuring, Urban Periphery, Land Structuring, Socio-Spatial Vulnerability*

JEL Codes: *R11, R14, R58, O18, Q56*

1.0 INTRODUCTION

Urban growth is today one of the major phenomena driving territorial transformation on a global scale. In 2021, approximately 56% of the world's population lived in urban areas, a proportion expected to reach 68% by 2050—an increase of more than 2.2 billion additional city dwellers (UN-Habitat, 2022). This trend is part of a historical process of urban transition, marked by a shift from 10% of the population living in urban areas in 1900 to over 50% in 2007, reflecting rapid and irreversible urbanization (UN-Habitat, 2017). Furthermore, nearly 96% of future urban growth will be concentrated in developing countries, particularly in Africa and Asia (UN-Habitat, 2020), confirming the shift of global urbanization toward the Global South.

This urban growth is accompanied by the spatial expansion of cities, which often outpaces population growth. Between 1990 and 2015, global urban space grew 1.8 times faster than the population (UN-Habitat, 2020), while urbanized areas could triple between 2000 and 2030, with an estimated expansion of over 1.2 million km² (UN-Habitat, 2017). This process is part of a spatial restructuring characterized by the formation of peri-urban areas, the merging of urban agglomerations, and the expansion of suburbs. Globally, nearly 828 million people live in slums (UN-Habitat, 2017), and more than 1.12 billion people live in informal settlements, often located in high-risk areas (HFHI, 2025). This trend contributes to increasing land conversion, with approximately 60% of land urbanized since 1970 having been formerly agricultural land (United Nations, 2025).

Empirical analyses confirm this trend, with an increase of up to 185% in urbanized areas in less than two decades, as observed in Antananarivo, while built-up areas grew by 40% between 1975 and 2015 (i.e., +621 km²) in some contexts, reflecting rapid and largely uncontrolled spatial expansion (Fetrandiaina et al., 2019; Paula & Hosein, 2024). This dynamic is accompanied by a spatially dispersed organization, characterized by high levels of urban disorder (0.75 to 0.95) and significant variability in growth rates (9.81% to 171.45%), revealing unevenly distributed and poorly planned urbanization (Fetrandiaina et al., 2019).

In Africa, these trends are particularly pronounced. The continent is experiencing one of the fastest rates of urban growth in the world, with the urban population projected to rise from 704 million to nearly 1.4 billion by 2050 (OECD et al., 2025). The urbanization rate is thus projected to rise from 54% in 2020 to 65% in 2050, with nearly 80% of population growth absorbed by cities (OECD et al., 2025). However, this urbanization remains largely characterized by informality, both in terms of housing and employment, reflecting urban dynamics that are insufficiently regulated.

This situation reflects a low level of coordination between urban growth and economic development, with an index rising from 0.464 to 0.526 between 2001 and 2020, while 48.08% of African countries remain in a state of imbalance (Ren et al., 2025). In certain contexts, projections indicate that urbanized areas could increase by a factor of 2 to 5, or even up to 7, intensifying

pressure on peripheral areas and reinforcing processes of spatial restructuring (Paula & Hosein, 2024).

The Republic of the Congo is fully part of these dynamics. The country has an urbanization rate exceeding 70% (PLU, 2022), with urban growth estimated at approximately 3.2% per year (INS/RGPH-5, 2023). The national population, estimated at 6,142,180 in 2023, is characterized by a high concentration in the country's two main cities, Brazzaville and Pointe-Noire, which together account for more than 58% of the national population (INS, 2023). As the political and administrative capital, Brazzaville has 2,145,783 inhabitants, or nearly 34.94% of the national population, with a density of 3,646.81 inhabitants per km², more than 200 times the national average (17.96 inhabitants per km²), reflecting significant pressure on urban space (INS, 2023).

This growth is accompanied by urban sprawl toward the outskirts, marked by the development of predominantly informal neighborhoods that account for approximately 60% of the urban area and are home to nearly 58% of the population (World Bank, 2021). Furthermore, nearly 90% of housing is self-built or informal (World Bank, 2023), illustrating urbanization largely outside regulatory frameworks.

The urban peripheries of Brazzaville thus emerge as the primary areas driving this dynamic. They are characterized by rapid urbanization, poor planning, a lack of infrastructure, and a high degree of land informality, with only 5 to 8% of plots holding a land title (PLU, 2022). Furthermore, the most vulnerable populations often occupy high-risk areas (flooding, erosion, landslides, siltation), exposing more than 5.5% of the urban population to flooding (World Bank, 2023). Thus, urban growth in Brazzaville is accompanied by a profound spatial restructuring, marked by the expansion of the outskirts, urban fragmentation, and the occupation of land unsuitable for urbanization. In this context, District 8 Madibou emerges as an emblematic space for these dynamics, where demographic growth, spatial expansion, and the informal structuring of urban space intersect. Consequently, it becomes essential to analyze the structuring mechanisms of this urban periphery in order to better understand the logics of spatial production and the challenges associated with contemporary urbanization in Brazzaville.

1.1 RESEARCH QUESTION

In Brazzaville, the Madibou district is a rapidly changing outlying area, characterized by rapid urbanization and intense pressure on land use due to its role as a destination for new residents. Created by Law No. 9-2011 of May 17, 2011, it covers 80.45 km² (8,045 ha) and had a population of 272,852 in 2023 (INS/RGPH-5, 2023), reflecting strong population growth. This trend encourages households particularly those with low incomes to settle in areas that lack adequate infrastructure.

The main challenge lies in the largely uncontrolled structuring of the urban space, characterized by spontaneous urbanization, informal land use, and disorderly development of the urban fabric.

This situation is fueled by strong demand for housing, in a context where nearly 90% of housing is self-built or informal (World Bank, 2023), exacerbating land insecurity, a shortage of urban services, and poor spatial organization.

These challenges are exacerbated by the shortcomings of the Congolese land tenure system. Governed by Law No. 10-2004 of March 26, 2004, and Law No. 17-2000 of December 30, 2000, this system is based on the coexistence of modern law and customary law, which fosters a largely informal land tenure system. As a result, only 5 to 8% of property owners hold a land title (PLU, 2022), which encourages irregular subdivisions and unregulated land occupation.

Madibou's urbanization is also accompanied by a significant infrastructure deficit. Access to drinking water is available to approximately 53% of the urban population, compared to 20% for sanitation and 55% for electricity (PLU, 2022; World Bank, 2021). This deficit results in inadequate roads, drainage systems, and basic facilities.

Furthermore, the occupation of areas unsuitable for urbanization increases environmental vulnerability. More than 5.5% of the urban population is exposed to flooding (World Bank, 2023), while 35% of young people live in poor households and nearly 89% of jobs are in the informal sector (ILO, 2016), revealing significant socioeconomic precariousness.

Despite the existence of Law No. 6-2019 of March 5, 2019, establishing the Urban Planning and Construction Code, as well as planning instruments such as the Master Plan for Urban Development and the Local Urban Development Plan, urbanization in Madibou remains largely uncontrolled. Regulatory provisions are frequently circumvented, reflecting a gap between urban planning standards and land-use practices. Furthermore, studies devoted to the dynamics of spatial structuring in the outskirts of Brazzaville, and particularly in Madibou, remain limited.

Consequently, the central question of this research is as follows:

To what extent does urban growth influence the dynamics of spatial structuring in the outskirts of Brazzaville, particularly in the Madibou district?

To answer this question, this study aims to analyze the dynamics of spatial structuring in Madibou in order to better understand the mechanisms of urban space production in a context of rapid urbanization. It pursues the following objectives:

- To characterize the forms of urban land use and organization in Madibou;
- To analyze the demographic, land-use, and institutional factors that influence this spatial structuring;
- Assess the spatial, environmental, and socioeconomic impacts of these dynamics;
- Examine the limitations of regulatory frameworks in order to propose avenues for improvement toward the sustainable management of urban peripheries.

2.0 LITERATURE REVIEW

Urban growth is today one of the most defining processes of contemporary territorial transformations, particularly in African metropolises characterized by rapid urbanization, strong demographic pressure, and spatial expansion largely driven by the peripheries. In these contexts, urban dynamics cannot be understood as a simple expansion of the built environment or population growth, but rather as a complex process of socio-spatial restructuring, in which land use patterns, centers of activity, mobility, land tenure relations, and modes of urban integration are simultaneously redefined. Recent literature thus highlights that African urban growth occurs less through the densification of central cores than through the expansion of the peripheries, making the outskirts the primary spaces of production in the contemporary city (Schmid, 2018; Culwick Fatti et al., 2023; Dürrnagel, 2025).

In cities across sub-Saharan Africa, this dynamic is accompanied by a profound reconfiguration of urban peripheries, where residential expansion, land-use restructuring, forms of informal urbanization, and infrastructure deficits all converge. Far from being mere residual spaces or passive zones of urban expansion, the peripheries now appear as strategic territories of urban structuring, where the major contradictions of contemporary growth are evident: inequalities in access to infrastructure, hybridization of governance modes, morphological fragmentation, and the everyday production of space through largely informal mechanisms. From this perspective, Madibou's study offers a critical analysis of the Brazzaville periphery as an active space of growth, structuring, and spatial reconfiguration, within which the relationships between urbanization, territorialization, and metropolitan integration are being redefined.

2.1 Theoretical Review

Madibou's analysis of urban growth and spatial reconfiguration draws primarily on the theory of the Just Urban Transition (JUT), developed in the recent work of Christina Culwick Fatti and systematized in the collective volume *Governance of the Just Urban Transition* (Culwick Fatti et al., 2023). This approach offers a critical reading of urban transformations, arguing that the city's growth cannot be reduced to a simple process of physical expansion or functional modernization, but must be analyzed as an urban transition deeply shaped by social inequalities, planning choices, and power relations. It demonstrates that the peripheries absorb the bulk of urban growth without benefiting from an equivalent redistribution of infrastructure, services, and planning capacities, making these areas the primary indicators of the contradictions of contemporary urbanization. Within the framework of this study, this theory allows us to understand Madibou not as a mere extension of Brazzaville, but as a territory of urban transition marked by rapid growth, incomplete integration, and strong socio-spatial differentiation.

From a complementary perspective, the work of Fiona Anciano (2019; 2023) provides a particularly relevant framework through the theory of hybrid governance, which demonstrates that African urban peripheries are not produced by the exclusive action of the state, but by a plurality

of actors simultaneously involved in the structuring of space. This approach emphasizes that peripheral dynamics are based on forms of territorial co-production involving public institutions, local authorities, traditional actors, informal developers, political networks, and resident communities. The periphery thus appears as a space governed by multiple, often competing regulations, where official norms, informal practices, and local arrangements overlap. Applied to Madibou, this theory allows us to analyze spatial reconfiguration as the product of a hybrid structuring, based on mechanisms of land negotiation, spontaneous subdivision, gradual appropriation, and social regulation, largely at odds with formal planning instruments.

Building on this line of thought, the work of Charlotte Lemanski (2020; 2023) offers key insights through an analysis of the peripheries grounded in the relationship between infrastructure, urban citizenship, and spatial inequalities. This approach demonstrates that access to urban infrastructure is not merely a technical issue but a profoundly political one, insofar as infrastructure embodies the relationship between residents and the state. Urban infrastructure thus becomes a fundamental indicator of territorial integration, urban inclusion, and effective citizenship. In African peripheries, urban growth frequently precedes infrastructure development, resulting in residential areas with weak connections to basic networks and persistently marked by infrastructure deficits. In this research, this theory allows us to interpret Madibou as a space where residential expansion is accompanied by incomplete integration into urban networks, revealing extensive but unevenly urbanized development.

Furthermore, the approach developed by Margot Rubin (2023) reinforces this interpretation by analyzing urban peripheries as active spaces of social and territorial reconfiguration. Rubin shows that the peripheries are not merely zones of passive urban expansion, but genuine spaces of urban production, where social relations, forms of habitation, land uses, and territorialization logics are simultaneously reconfigured. This perspective highlights the structuring role of ordinary dynamics of densification, spontaneous housing, functional diversification, and the emergence of new peripheral centers. Applied to Madibou, this approach allows us to view the periphery not as a space dependent on the Brazzaville center, but as an active territory of urban fabrication directly participating in the overall restructuring of the metropolitan area.

The theoretical analysis also draws on the theory of global urbanization, developed by Christian Schmid (2018) as an extension of Lefebvre's work on generalized urbanization. This theory argues that urbanization is no longer limited to spaces traditionally defined as urban, but extends to the entire territory, including the margins, peripheries, and intermediate spaces. It conceives of the urban as a multiscalar, diffuse, and continuously reconfigured process that redefines the relationships between center and periphery. This approach is particularly useful for understanding African peripheries, not as spaces outside the city, but as components fully integrated into its process of expansion and transformation. Within the framework of this study, this theory allows us to understand Madibou as a territory fully embedded in the urbanization process of Brazzaville,

whose growth stems less from marginal expansion than from a territorial reconfiguration integrated into the metropolitan dynamic.

From a convergent analytical perspective, Christian Schmid (2018) also develops the theory of urban decentralization, which critiques interpretations of the city focused exclusively on historic centers and proposes shifting the analysis toward the peripheries, margins, and spaces in transition. This approach demonstrates that the most significant transformations of contemporary urbanization are precisely evident in these peripheral spaces, where urban forms, social relations, and the logics of territorialization are being reconfigured. It thus confers upon the periphery a central status in scientific observation. Applied to this research, this theory justifies the analysis of Madibou as a strategic observatory of contemporary changes in Brazzaville's urban growth.

In the same vein, Axel Prestes Dürrnagel (2025) draws on the theory of peri-urbanization to show that contemporary urban growth unfolds primarily in peripheral spaces, which constitute the main fronts of the city's transformation. This approach views the periphery not as a transitional or secondary space, but as a sustainable territory of urban structuring, within which land uses, densities, functions, and the relationships between urban and rural areas are being reconfigured. In the case of Madibou, this theory allows for an analysis of the southern periphery of Brazzaville as an active front of urban expansion, where forms of land use, residential densities, and territorial functions are gradually being redefined.

Building on this approach, Dürrnagel (2025) develops the theory of peri-urban governance, which demonstrates that peripheries are structured by complex governance systems based on a plurality of actors, institutional hybridization, and the coexistence of formal and informal regulations. This theory emphasizes that the state is not the sole actor in the production of space and that peripheral structuring results from multiple interactions, negotiations, and power relations. In the context of this study, this approach sheds light on the institutional, land-use, and social mechanisms involved in the structuring of Madibou, through the interaction between public authorities, local governments, land stakeholders, and residents.

Finally, recent literature on urban informality, notably through the work of Soliman (2021; 2024) and the extensions proposed by Prieto (2026), provides a major theoretical framework for analyzing the everyday production of urban peripheries. These approaches show that informality is neither an organizational vacuum nor spatial disorder, but rather a structured mode of urban production, based on social norms, land practices, self-organization mechanisms, and alternative forms of territorial regulation. Informality thus emerges as an ordinary, sustainable, and structuring mode of urban space production, particularly visible in expanding peripheries. From this perspective, Madibou can be analyzed not as a disorganized periphery, but as a space structured by progressive logics of land occupation, self-construction, local regulation, and daily territorialization, which play a full part in the spatial reconfiguration of the Brazzaville periphery.

2.2 Conceptual Framework

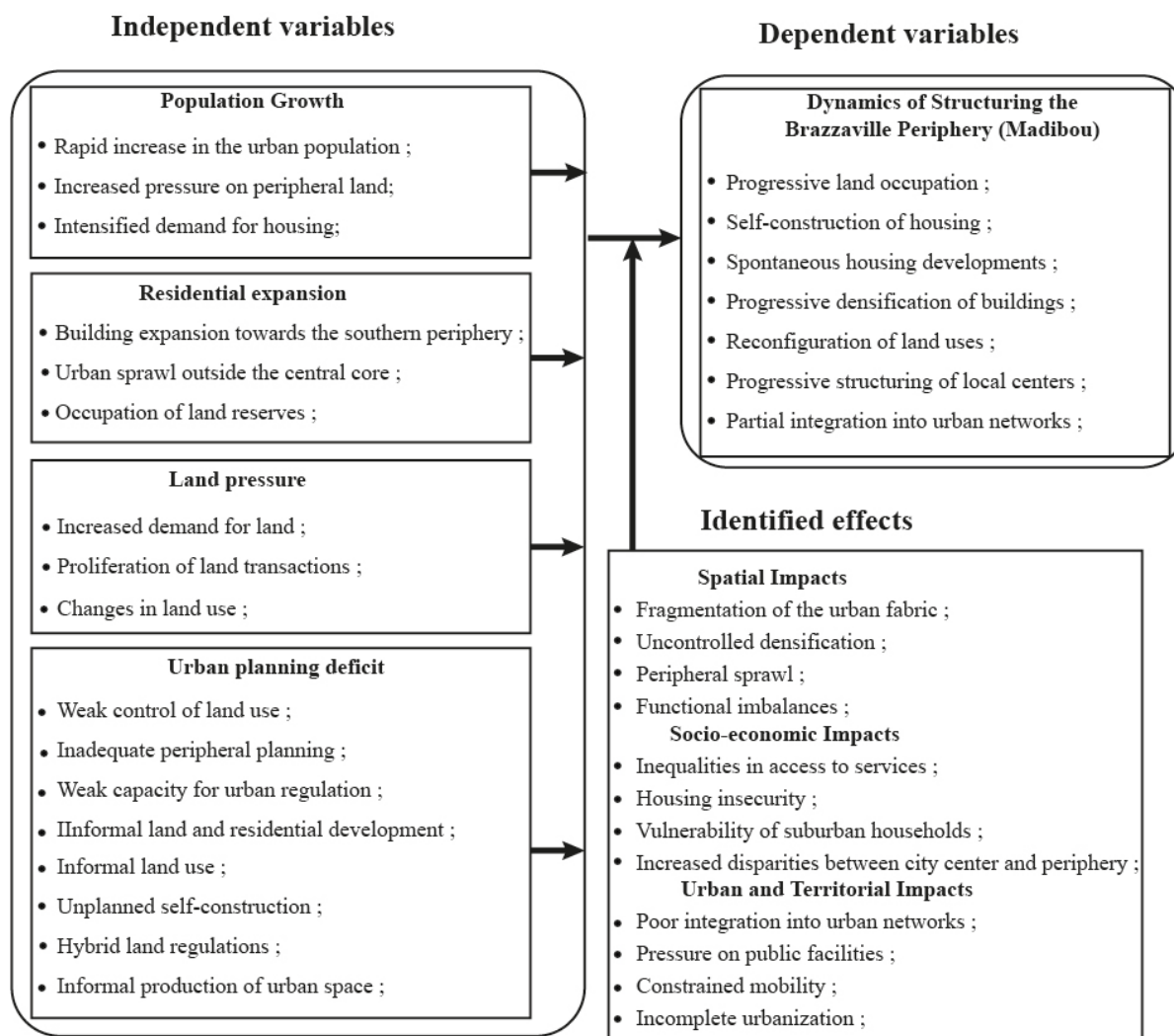


Figure 1: Conceptual Framework

Source: Researcher (2026)

2.3 Research Gaps

The literature on urban growth in Africa highlights the structuring role of the peripheries in urban expansion, emphasizing informality, hybrid governance, land pressure, and socio-spatial reconfiguration (Schmid, 2018; Culwick Fatti et al., 2023; Dürrnagel, 2025). These studies provide solid theoretical frameworks but remain focused on general or metropolitan, which are insufficiently localized to the scale of Brazzaville's peripheries.

In Brazzaville, the Urban Development and Restructuring of Precarious Neighborhoods Project (DURQuaP) has improved road infrastructure, sanitation, street addressing, and certain local amenities. However, these interventions targeted established neighborhoods (Moukoundzi-

Ngouaka, Diata, etc.), leaving the rapidly expanding southern outskirts on the margins, particularly Madibou, where the most intense dynamics of residential growth, land informality, and spatial restructuring are concentrated. The DURQuaP thus addressed the visible manifestations of urban precariousness without analyzing the structural mechanisms of spatial production in these developing areas.

There therefore remains a lack of empirical analysis on land-use patterns, territorial structuring logics, land tenure mechanisms, residential practices, and the spatial effects of urbanization in the outskirts of Brazzaville. Madibou, in particular, remains poorly documented as an independent subject of scientific study. This research aims to fill this gap through a territorialized and empirical analysis of the structuring dynamics of Madibou, in order to understand how urban growth there produces specific spatial reconfigurations.

3.0 METHODS AND MATERIALS

Study Design: This research adopts a descriptive and analytical approach with an explanatory focus. It employs a mixed-methods approach combining quantitative and qualitative tools to analyze the relationships between urban growth, spatial reconfiguration, and the structuring dynamics of the Brazzaville periphery in the Madibou district. The study is based on an integrated analysis of the morphological, land-use, socio-spatial, and institutional transformations of the territory, combining a spatio-temporal analysis of urban expansion, a characterization of land-use patterns, and an evaluation of the mechanisms shaping the peripheral area. This approach allows us to understand Madibou as a space in transition, where demographic dynamics, patterns of informal urbanization, and territorial reconfigurations intersect.

Study Area: The study was conducted in District 8, Madibou, located on the southern outskirts of Brazzaville, the capital of the Republic of the Congo. Created by Law No. 9-2011 of May 17, 2011, Madibou covers an area of approximately 80.45 km², or 8,045 hectares, and constitutes one of the main contemporary fronts of urban expansion in the Brazzaville metropolitan area. This peripheral area is characterized by rapid urbanization, intense land pressure, a shortage of essential infrastructure, and predominantly informal land use. The selection of this site is justified by its emblematic role in the current dynamics of urban growth, spatial restructuring, and the gradual development of Brazzaville's metropolitan periphery.

Target population: The study was conducted over a four-month period, from January to April 2026. The target population includes households residing in the urbanizing areas of Madibou, particularly those located in areas of spontaneous urbanization or with limited infrastructure, local authorities, technical departments responsible for urban planning, land management, and development, as well as institutional actors involved in territorial regulation and urban management. This diversity of stakeholders allows for the integration of social, land-use, institutional, and operational dimensions of the structuring of the peripheral area.

Sampling: A stratified and purposive sampling method was used to select households based on the main forms of land use observed in Madibou, particularly planned housing developments, areas of spontaneous urbanization, underserved areas, and zones subject to environmental constraints. Households were selected based on their location, length of residence, and land tenure status to ensure the representativeness of different socio-spatial configurations. Key informants were identified based on their institutional role, their involvement in land and urban management, and their knowledge of local territorial dynamics. This method aims to provide a nuanced and representative understanding of the mechanisms shaping the periphery.

Data Collection: Primary data were collected through household questionnaire surveys, semi-structured interviews with institutional and land stakeholders, direct field observations, and GPS surveys enabling the geolocation of land-use patterns, infrastructure, and areas undergoing change. Secondary data include multi-date satellite imagery (Landsat, Sentinel, and Google Earth), land-use maps, urban planning documents (Master Urban Plan, Local Urban Development Plan), administrative archives, regulatory texts related to land use and urban planning, as well as demographic and socio-economic data from institutional reports. All of these sources enabled the integration of morphological analysis, spatial restructuring, land tenure structuring, and the assessment of urban governance dynamics.

Statistical Analysis: Data analysis is based on a set of indicators structured across five dimensions: morphological, spatial, land-use, socio-environmental, and institutional. Statistical processing is carried out using descriptive and multivariate analysis tools, while spatial analysis and thematic mapping are performed using GIS to assess the dynamics of urban growth and spatial restructuring in the outskirts of Madibou.

- Morphological Analysis of Urban Growth

The dynamics of Madibou's spatial expansion are assessed based on the urban expansion rate (UER), determined by:

$$TEU = \frac{S_{u2} - S_{u1}}{S_{u1}} \times 100$$

Where S_{u1} represents the initial urbanized area and S_{u2} the urbanized area at the subsequent date.

The rate of land conversion is measured by the average annual land consumption (CFAM), calculated as follows:

$$CFAM = \frac{S_{u2} - S_{u1}}{\Delta t}$$

Where Δt corresponds to the time interval between the two observations.

The average annual urban expansion rate (TAMEU) allows us to estimate the average growth rate of urbanized area over the entire study period:

$$TAMEU = \left(\frac{SU_1}{SU_2} \right)^{1/n} - 1$$

Where SU_1 represents the urbanized area at the initial date, SU_2 the urbanized area at the final date, and n the number of years between the two observations.

The land use rate (LUR) measures the proportion of the total area that is actually urbanized:

$$TOT = \frac{S_u}{S_t} \times 100$$

Where S_u represents the urbanized area and S_t the total area of the studied territory.

- Analysis of land structure and land use

Land pressure on the peripheral area is assessed by the land regularization rate (TRF):

$$TRF = \frac{P_r}{P_t} \times 100$$

Where S_r represents the occupied residential area and S_t the total area under study.

The degree of land informality is measured by the informal land occupancy rate (Tofi):

$$Tofi = \frac{P_i}{P_t} \times 100$$

Where P_i denotes the number of plots occupied without a recognized land title and P_t the total number of plots surveyed.

The intensity of land fragmentation is assessed by the land fragmentation index

(Imf) :

$$Imf = \frac{N_p}{S_t}$$

Where N_p corresponds to the total number of parcels and S_t to the total area of the study area.

These indicators make it possible to assess land-use patterns, land pressure, and the degree of informal structuring of the urban fabric.

- Socio-spatial analysis and urban vulnerability

The level of access to urban services is measured by the basic service coverage rate (Tds):

$$Tds = \frac{M_d}{M_t} \times 100$$

Where **Md** represents the number of households with access to basic services (drinking water, electricity, and individual sanitation facilities) and **Mt** represents the total number of households surveyed.

Population exposure to urban risks is assessed using the exposure rate to risk areas (Tezr):

$$Tezr = \frac{P_z}{P_t} \times 100$$

Where P_z represents the population living in risk zones and P_t the total population surveyed.

Socio-spatial vulnerability is estimated using the urban precariousness index (Ipu):

$$Ipu = \frac{(1 - Tds) + Tofi + Tezr}{3}$$

This index aggregates the lack of infrastructure, land informality, and exposure to risks.

These indicators make it possible to assess the social effects of urban growth, the level of urban integration, and the forms of vulnerability produced by peripheral expansion. They highlight disparities in access to infrastructure and basic services, mobility challenges linked to inadequate transportation networks, and the varying exposure of populations to environmental risks.

4.0 Analysis Results

4.1 Morphological Analysis of Urban Growth

adibou is undergoing rapid transformation of its peri-urban area due to the expansion of Brazzaville. Initially characterized by scattered development and largely undeveloped land, the district is now undergoing sustained urbanization, resulting in the continuous expansion of built-up areas, the proliferation of housing developments, the densification of plots, and the emergence of new residential neighborhoods. This growth, which is primarily horizontal and poorly controlled, is leading to the gradual occupation of areas with significant physical constraints, particularly unstable slopes, sandy soils prone to erosion, and flood-prone or poorly drained areas. The resulting urban morphology is characterized by a heterogeneous spatial organization, an irregular road network composed of narrow, poorly developed streets, and a weak hierarchy within the road system. These characteristics reflect urbanization largely driven by individual initiatives and land pressure, contributing to the gradual reshaping of the peripheral landscape and a

morphological structure that remains somewhat heterogeneous. The images presented below illustrate the main forms of this spatial evolution.



Photo 1: Land use in erosion-prone areas observed on the outskirts of MADIBOU



Source: Researcher (2026)

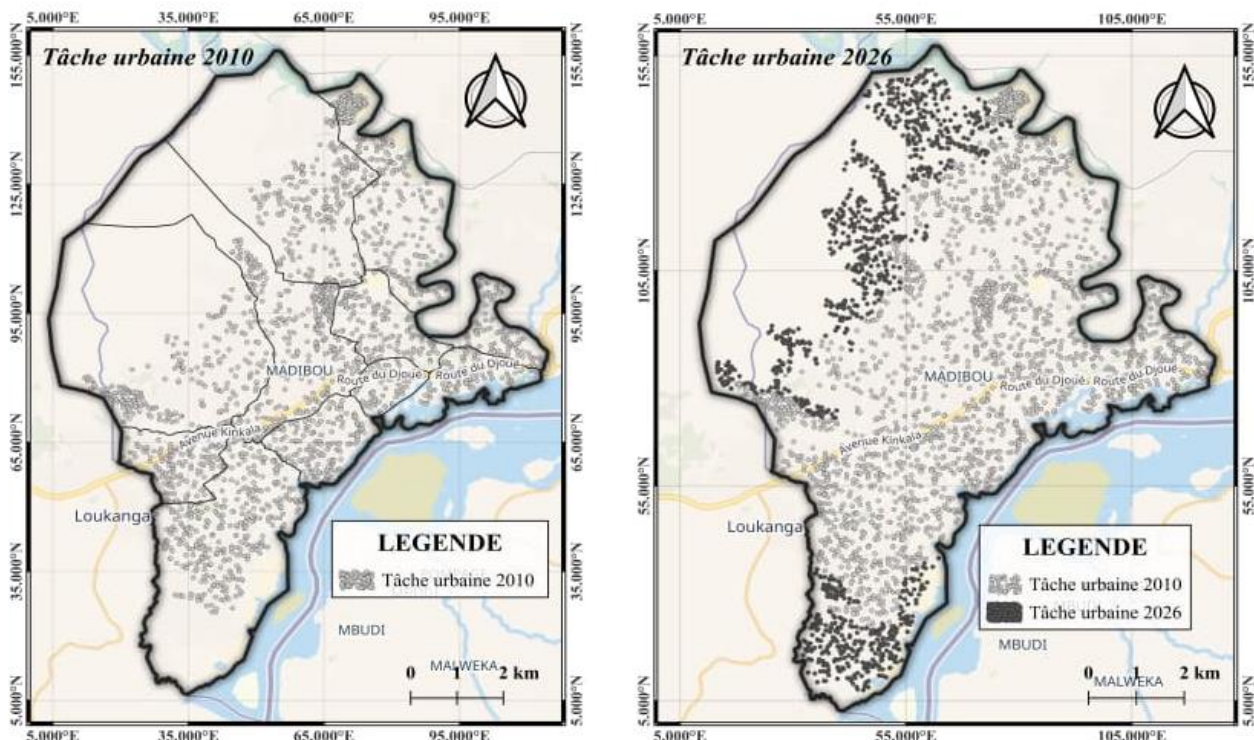


Photo 2: Occupation of collinear zones observed on the outskirts of MADIBOU

Source: Researcher (2026)

4.2 Evolution of the Madibou urban area between 2010 and 2026

Map showing the evolution of the urban area between 2010 and 2026



Source: Researcher (2026)

A diachronic analysis of Madibou's urban area reveals significant spatial expansion between 2010 and 2026, marked by horizontal urban sprawl and intra-urban densification. In 2010, development was concentrated in the central and southern- al sectors, while the northern areas remained sparsely occupied. By 2026, urbanization extends northward, northwestward, and southwestward, reflecting the opening of new urbanization fronts and the consumption of undeveloped land. This dynamic, fueled by land and demographic pressures, results in a profound spatial restructuring: a reduction in open spaces, the occupation of gaps, increased continuity of the urban fabric, and the expansion of the peripheral urban fringe. This evolution thus combines extensive growth (expansion of the urbanized perimeter) and intensive growth (increased occupation of already built-up areas), permanently altering the district's territorial structure.

Table 1: Morphological Analysis of Urban Growth in Madibou (2010–2026)

Indicator	Formula	Data used	Result
Urban expansion rate (UER)	$TEU = \frac{S_{u2} - S_{u1}}{S_{u1}} \times 100$	SU ₁ = 3,922 ha; SU ₂ = 5,183 ha	32.15%
Average annual urban expansion rate (AAUER)	$TAMEU = \left(\frac{SU_1}{SU_2} \right)^{1/n} - 1$	SU ₁ = 3,922 ha; SU ₂ = 5,183 ha; n = 16 years	1.76%/year
Average annual land consumption (AALC)	$CFAM = \frac{S_{u2} - S_{u1}}{\Delta t}$	SU ₁ = 3,922 ha; SU ₂ = 5,183 ha; Δt = 16 years	78.8 ha/year
Increase in urbanized area	$S_{u2} - S_{u1}$	5,183 ha – 3,922 ha	1,261 ha
Urbanized area (occupied - area) in 2026		GIS data	5,183 ha (51.83 km ²)
Administrative area of - Madibou		Administrative data	80.45 km ²
Land use rate	$TOT = \frac{S_u}{S_t} \times 100$	Urbanized area (S _u) = 51.83 km ² ; Total area (S _t) = 80.45 km ²	64.43%
Unoccupied area	$S_t - S_u$	Total area (S _t) = 80.45 km ² ; Urban area (S _u) = 51.83 km ²	28.62 km²

Source: Researcher (2026)

The results highlight a strong trend of urban expansion in the Madibou district between 2010 and 2026. The urbanized area increased by 1,261 ha, rising from 3,922 ha to 5,183 ha, corresponding to an urban expansion rate of 32.15%. This growth represents an average urbanization rate of 1.76% per year, reflecting a steady advance of the urban fringe throughout the period.

At the same time, the average annual land consumption of 78.8 ha/year indicates a continuous encroachment of peripheral areas for urbanization. By 2026, urbanized areas already cover 64.43% of Madibou's territory, illustrating the significance of urban sprawl.

These results show that Madibou's urban growth has primarily taken the form of a spatial expansion of the built environment rather than a densification of already urbanized areas. This dynamic contributes to the spatial restructuring of Brazzaville's outskirts by gradually transforming undeveloped areas into new residential sectors, amenities, and infrastructure. Madibou thus emerges as one of the main fronts of urbanization in Brazzaville, where the spatial changes associated with contemporary urban growth are taking shape.

4.3 Analysis of Land Structure and Land Use

Land tenure in Madibou has undergone significant changes due to Brazzaville's urban expansion and population growth. The gradual scarcity of available land in central neighborhoods has shifted land demand toward peripheral areas, driving up land values in Madibou. This trend has resulted in a significant increase in land transactions, the proliferation of housing developments, and the opening of new urbanization fronts.

A comparative analysis of land prices shows that, although downtown land remains more expensive, the value gap between central and peripheral areas is narrowing. This trend reflects Madibou's growing appeal, linked to the availability of land reserves and the relative affordability of land for low- and middle-income households.

At the same time, land use has undergone a profound transformation. Natural areas, savannas, and undeveloped land have gradually been converted into residential zones, leading to an increase in urbanized area. This trend is accompanied by increased building density in previously urbanized sectors and the expansion of housing toward the district's periphery.

However, this land-use evolution often occurs in a context of weak land-use control, marked by the urbanization of areas with physical constraints and by a spatial organization that is sometimes inconsistent. The observed land use pattern thus reflects the growing influence of the land market on the spatial restructuring of Madibou and confirms the role of land pressure as the primary driver of peripheral urban expansion.

Table 2: Evolution of land prices between downtown Brazzaville and its outskirts (2010–2026)

Year	Downtown (FCFA/m ²)	Peripheral (Madibou) (FCFA/m ²)	area	Price difference (FCFA/m ²)	Downtown/Outskirts Ratio
2010	50,000	5,000		45,000	10
2026	150,000	25,000		125,000	6

Source : Researcher (2026)

In 2010, the average price per square meter in the city center was estimated at approximately 50,000 CFA francs, compared to 5,000 CFA francs in the outskirts of Madibou, a ratio of 1 to 10. This significant difference reflected the low appeal of land in the outskirts, which were still underdeveloped and sparsely urbanized.

By 2026, Brazzaville's urban expansion and the scarcity of available land in central neighborhoods have contributed to a widespread increase in land prices. The average price per square could thus reach approximately 150,000 CFA francs in the city center, compared to 25,000 CFA francs in Madibou. Although the absolute price gap has widened, the ratio between the two areas is narrowing (from 10 to 6), reflecting a gradual increase in the value of peripheral land driven by land pressure and expanding urbanization.

Table 3: Indicators of land structure and land use in Madibou

Indicator	Formula	Result
Informal Land Occupancy Rate (ILOR)	$TOFI = \frac{P_i}{P_t} \times 100$	30%
Land Regularization Rate (TRF)	$TRF = \frac{P_r}{P_t} \times 100$	35%
Land Fragmentation Index (LFI)	$IMF = \frac{N_p}{S_t}$	0.25 plots/km ²

Source: Researcher (2026)

The results show that 30% of households occupy their plots without recognized land titles, while only 35% have a land status comparable to a regularized situation. These figures reflect a land structure that remains fragile on the outskirts of Madibou.

The relatively high rate of informal land occupation highlights the importance of informal mechanisms for accessing land in the process of peripheral urbanization. This situation reflects urban growth that is taking place, in part, outside of formal land-use planning and management procedures. Land occupation without title thus fosters the development of spontaneous housing forms and contributes to the expansion of a poorly regulated urban fabric.

Furthermore, the land regularization rate, limited to 35%, indicates a low level of land rights security. This situation acts as a barrier to household investment in sustainable housing improvements and complicates public interventions in urban planning and neighborhood infrastructure.

The land fragmentation index ($LFI = 0.25$ parcels/km²), calculated from the surveyed sample, highlights a gradual subdivision of land under the influence of household settlement. Although this value remains indicative, it reflects a trend toward land fragmentation, characteristic of peripheral areas subject to strong urban pressure. This phenomenon fosters the emergence of new residential plots and contributes to the gradual densification of certain sectors of Madibou.

In the context of Madibou, these results confirm that urban growth is accompanied by a spatial reconfiguration largely driven by informal land-use patterns. The urbanization of the periphery is thus proceeding more rapidly than institutional regulatory mechanisms, which contributes to the formation of urban spaces characterized by weak land control and a gradual restructuring of the territory.

The combination of rapid urbanization, partially informal land occupation, and increasing parcel fragmentation reflects a profound transformation of Madibou's spatial organization. This dynamic contributes to the redistribution of residential functions toward the urban margins and reinforces the role of the periphery as the primary area accommodating Brazzaville's urban growth.

Generally speaking, the coexistence of a TOFI of 30%, a TRF of 35%, and an IMF of 0.25 plots/km² highlights the land-use challenges facing the Brazzaville periphery. These indicators illustrate the tensions between the dynamics of urban expansion, growing land pressure, and limited institutional regulatory capacities. They also reflect a process of spatial restructuring marked by the expansion of peripheral housing, land fragmentation, and the gradual establishment of new forms of territorial organization within the Madibou district.

4.4 Socio-spatial Analysis and Urban Vulnerability

Madibou's urban expansion is leading to socio-spatial fragmentation characterized by the settlement of low- and middle-income households in peripheral areas lacking basic infrastructure (schools, healthcare, markets, public spaces). The inadequacy of the road network exacerbates accessibility constraints, particularly during the rainy season. At the same time, land pressure encourages the occupation of sites with significant environmental constraints (unstable slopes, erosion-prone areas, flood-prone zones), exposing populations to natural hazards such as erosion,

gully formation, and flooding. Urban vulnerability thus results from a combination of rapid population growth, insufficient infrastructure, and development on high-risk land, posing a major challenge for sustainable urban planning in the outskirts of Brazzaville.

Table 2: Indicators of socio-spatial vulnerability in Madibou

Indicator	Formula	Result
Basic Services Coverage Rate (BSCR)	$Tds = \frac{M_d}{M_t} \times 100$	27%
Exposure rate to risk areas (ERRA)	$Tezr = \frac{P_z}{P_t} \times 100$	55%
Urban Precarity Index (UPI)	$Ipu = \frac{(1 - Tds) + Tofi + Tezr}{3}$	0.53

Source: Researcher (2026)

The results highlight a relatively pronounced situation of socio-spatial vulnerability in the Madibou district. The estimated basic service coverage rate of 27% reveals a significant deficit in urban facilities and infrastructure. Access to drinking water remains particularly low, as only 5% of households have a tap connection, while the majority rely on wells, rivers, or boreholes. Similarly, regarding on-site sanitation, only 5% of households are equipped with modern toilets, while 95% still use traditional latrines.

The 55% exposure rate to risk zones indicates that a significant portion of the population faces environmental constraints, particularly flooding, which has been identified as one of the region's main problems. This situation reflects the gradual encroachment into vulnerable areas driven by urban expansion and land-use pressure on the city's outskirts.

The urban precariousness index of 0.53 reflects a high level of socio-spatial vulnerability. This value results from the combination of three major factors: the lack of access to urban services, the extent of informal land occupation, and exposure to environmental risks. It highlights the limitations of urban integration in the peripheral areas of Madibou.

5.0 DISCUSSION

The results show that the outskirts of Madibou are currently one of the main areas where Brazzaville's urban growth is taking shape. The 32.15% increase in urbanized area between 2010 and 2026, combined with an average annual land consumption of 78.8 ha and a land use rate reaching 64.43%, reflects a sustained dynamic of spatial expansion driven primarily by the

urbanization of the city's periphery. These results confirm trends observed in many African cities where urban growth occurs more through peripheral sprawl than through the densification of central cores (Schmid, 2018; Dürrnagel, 2025; OECD et al., 2025). They also align with the findings of Paula and Hosein (2024) as well as those of Fetraniana et al. (2019), which highlight a rapid increase in urbanized areas driven by the combined effects of population growth, land pressure, and inadequate planning mechanisms.

Beyond this quantitative expansion, the evolution of the urban footprint observed in Madibou reflects a process of spatial restructuring characterized by the opening of new urbanization fronts, the gradual consumption of undeveloped spaces, and the growing integration of the peripheries into metropolitan functions. This dynamic confirms the theory of global urbanization developed by Schmid (2018), according to which the peripheries no longer constitute spaces outside the city but are essential components of the contemporary urbanization process. The observed transformations show that Brazzaville's growth is no longer confined to central neighborhoods but is now spreading to peripheral areas, which now play a decisive role in the dynamics of the metropolitan area's expansion and restructuring. Madibou thus emerges as an active front of urban territorialization where land-use patterns, residential densities, and urban functions are simultaneously being redefined.

The findings regarding urban morphology also highlight a largely extensive and loosely structured urbanization. The presence of an irregular road network, scattered housing developments, and the gradual occupation of areas with significant physical constraints point to urban development that relies more on individual initiatives than on coordinated planning. This situation aligns with the analyses of Rubin (2023), who argues that African peripheries are shaped by ordinary mechanisms of land appropriation, self-construction, and gradual densification. The peripheral space thus does not appear as a disorganized territory but as a space structured according to its own logic of urban production, based on households' ability to adapt in the face of insufficient public action.

The findings regarding land structuring confirm the central role of informality in the dynamics of spatial reconfiguration. The 30% rate of informal land occupation, combined with a land regularization rate limited to 35%, reveals weak land rights security and significant dependence on non-institutional mechanisms for accessing land. These observations corroborate the work of Soliman (2021; 2024) and Prieto (2026), who view informality not as an urban anomaly but as a sustainable mode of urban production in contexts of rapid population growth. In Madibou, urbanization appears to be largely driven by hybrid land practices where customary norms, local arrangements, and formal regulatory mechanisms coexist. This situation also illustrates the hybrid governance mechanisms described by Anciano (2019; 2023), according to which the production of peripheral space results from the interaction between public actors, local authorities, landowners, customary networks, and households.

Beyond the modalities of land access, the evolution of land values between 2010 and 2026 also confirms the intensification of land pressure on the outskirts of Brazzaville. The rise in price per square meter in Madibou, coupled with the gradual narrowing of the gap with the city center, reflects a growing appreciation of peripheral areas. This trend is driven by the scarcity of available land in central neighborhoods and the shift of residential demand toward the urban periphery. Similar phenomena have been observed in several African cities where rising housing demand is driving rapid expansion of the peripheral land market and a profound transformation of land use (Paula & Hosein, 2024; Fetraniaina et al., 2019; Dürrnagel, 2025). Land pressure thus appears to be one of the main drivers of the spatial restructuring observed in Madibou, consistent with Schmid's (2018) analyses of the decentralization of urban dynamics and Rubin's (2023) work on the structuring role of urban peripheries in contemporary spatial production.

The socio-spatial analysis highlights a particularly marked urban vulnerability. The low rate of access to basic services (27%), combined with an exposure rate to risk zones reaching 55%, reflects the incomplete urban integration of the periphery. These results confirm the work of Lemanski (2020; 2023), which shows that infrastructure is a fundamental element of urban citizenship and territorial integration. In Madibou, residential growth far outpaces the development of urban infrastructure, resulting in areas characterized by persistent shortages of drinking water, sanitation, roads, and public facilities. This situation contributes to reinforcing socio-spatial inequalities and keeping a significant portion of the population in conditions of lasting vulnerability.

The occupation of areas exposed to erosion, flooding, and topographical constraints is also a major finding of this research. It reflects the inability of current land-use regulation mechanisms to effectively direct urbanization toward suitable areas. These observations align with analyses by the World Bank (2023) and Brazzaville's Local Urban Development Plan (PLU) (2022), which highlight the high exposure of peripheral populations to environmental risks. They also illustrate the contradictions highlighted by the theory of Just Urban Transition (Culwick Fatti et al., 2023), according to which the peripheries absorb the bulk of urban growth without benefiting from an equitable redistribution of infrastructure, public investment, and territorial protection mechanisms.

More generally, the findings confirm that Madibou is an emblematic space for the contemporary urban transformations observed in African metropolises. Urban growth there appears as a multidimensional process combining spatial expansion, land-use reconfiguration, restructuring of land-use patterns, and socio-spatial differentiation. The study shows that the periphery is not merely the receptacle of Brazzaville's urban growth, but an active territory of spatial production, where new urban forms, new land relations, and new modalities of metropolitan integration are gradually being constructed. This interpretation aligns with the work of Rubin (2023), Schmid (2018), and Dürrnagel (2025), who view peripheries as central spaces for the fabrication and reconfiguration of the contemporary city. It also fits within the framework of the Just Urban Transition developed by Culwick Fatti et al. (2023), according to which peripheries are now the

primary spaces of urban transformation, where growth dynamics, socio-spatial inequalities, and territorial integration challenges are simultaneously concentrated.

From a scientific perspective, this research contributes to expanding knowledge on the structuring mechanisms of African urban peripheries by integrating the morphological, land-use, and socio-spatial dimensions of urban growth. It confirms the relevance of theoretical approaches related to peri-urbanization, global urbanization, hybrid governance, urban informality, territorial integration through infrastructure, and just urban transition (Schmid, 2018; Anciano, 2019; 2023; Lemanski, 2020; 2023; Soliman, 2021; 2024; Culwick Fatti et al., 2023; Dürrnagel, 2025) for understanding the contemporary dynamics of African cities. At the operational level, the findings highlight the need to strengthen land tenure control, improve urban planning mechanisms, secure land use rights, and accelerate the development of basic infrastructure in order to limit the forms of vulnerability resulting from peripheral expansion. Failing this, continued urban growth risks exacerbating socio-spatial fragmentation and permanently reinforcing territorial inequalities within the Brazzaville metropolitan area.

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study has shown that Madibou's urban growth is part of a process of socio-spatial restructuring closely linked to the expansion of the Brazzaville metropolitan area. The observed transformations, marked by the expansion of built-up areas and the increase in land occupation, reflect an urban dynamic driven by population growth, land pressure, and mechanisms of informal urbanization. This evolution contributes to the emergence of new urban forms characterized by an as-yet-incomplete structure and limited integration into urban networks and infrastructure.

This dynamic is accompanied by a profound transformation of land relations and patterns of land use. Residential expansion, combined with the inadequacies of regulatory and planning mechanisms, encourages the urbanization of underserved areas and the occupation of zones subject to various environmental constraints. The result is growing urban vulnerability, marked by infrastructure deficits, persistent land tenure insecurity, and increased exposure of populations to environmental risks.

Overall, the results confirm that the dynamics observed in Madibou stem from the interplay between urban growth, land pressure, informality, and the limitations of urban governance. The spatial restructuring highlighted here is therefore not solely a matter of the city's physical expansion, but rather a complex process of spatial production involving land issues, territorial vulnerabilities, and planning challenges. Madibou thus emerges as a representative illustration of the current transformations in African urban peripheries and the challenges they pose for sustainable urban development.

6.2 Recommendations

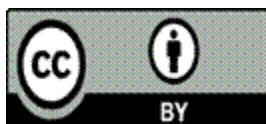
In light of the findings, it appears necessary to strengthen urban planning and land-use control mechanisms in order to better manage Madibou's urban expansion. Particular attention should be paid to accelerating land regularization procedures and securing land tenure rights, as well as strictly controlling urbanization in areas exposed to risks of erosion, flooding, and slope instability. Investments in basic infrastructure and facilities—including roads, sanitation, drinking water supply, electricity, and social amenities—should also be strengthened to improve living conditions for residents and enhance the urban integration of outlying neighborhoods. Furthermore, the development of integrated urban governance involving institutional, land-use, and community stakeholders appears essential to ensure the sustainable management of peripheral areas. Finally, further studies on the land-use, spatial, and socio-environmental dynamics of Brazzaville's outskirts should be encouraged to improve scientific understanding and guide sustainable urban development policies.

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