

Urban Dynamics of Edea and Strategic Position Between Metropolitan Centers in Cameroon

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ABSTRACT

Urbanization in sub-Saharan Africa is progressing rapidly, particularly in intermediate cities that serve as strategic interfaces between rural areas and major metropolitan centers. This study investigates the spatial and demographic dynamics of the city of Edéa (Cameroon) and the influence of neighboring metropolitan areas, Douala, Yaoundé, and Kribi, on its urban development. A multi-temporal analysis of satellite imagery from 1986, 2001, and 2024 (Landsat 5, Landsat 7, Sentinel-2), combined with demographic data and field surveys of 383 households, was used to evaluate land use/land cover change and population dynamics. Between 1986 and 2024, built-up areas expanded from 1.446.12 ha to 2.609.30 ha, a relative increase of 80.43%, while the population grew from 42.902 to 122.524 inhabitants, an increase of 185.47%. Vegetation cover declined by 3.773.87 ha, at an average rate of approximately 100 ha/year, whereas cultivated areas fluctuated, showing a net increase of 577.58 ha between 2001 and 2024. Indicator 11.3.1 (ratio of land consumption to population growth) decreased from 0.82 (1986–2001) to 0.30 (2001–2024), yielding an overall value of 0.43, indicating that urban densification outpaced spatial expansion. Migration data show that 50% of newcomers originate from Douala, 30% from Yaoundé, and 10% from Kribi, confirming Edéa's role as a relay city in the regional urban network. Although Edéa benefits from its position at the crossroads of major transport corridors, its proximity to larger metropolitan areas also intensifies its economic dependence and spatial marginalization. These findings highlight the urgent need for integrated urban planning, strategic infrastructure investments, and governance reforms to strengthen Edéa's economic autonomy and manage sustainable urban growth.

Keywords: Urban dynamics, Metropolitan influence, Remote sensing, SDG 11.3.1, Intermediate cities, Edéa, Cameroon.

INTRODUCTION

Urban planning in sub-Saharan Africa faces various challenges, including land disputes and site morphology. While African cities differ in size, they are all experiencing continuous transformation, and pinpointing the underlying causes of this change can be complex (Aswal et al., 2018), (Chetry, 2022). We must correlate this objective with demographics, as African cities will become major population centers by 2050 (Didier & Simonneau, 2022). According to United Nations projections, sub-Saharan Africa is expected to have 1.2 billion city dwellers by 2050, surpassing the urban populations of China and India. (Jaglin et al., 2018). In this context, the rapid and impressive expansion of African cities is reflected in spatial growth due to both population growth and an increase in space consumption by inhabitants (Sylvain, 2012). This observation is the same in both secondary cities and capitals. Today, secondary cities are brimming with potential, making them drivers of territorial balance. (González & Gale, 2021). This balance is compelling with the support of effective governance and differentiated development policies. Similarly, (OCDE, 2024) and (Canton, 2021) advocate for better integration of intermediate cities into national urbanization and accessibility strategies, using indicators of territorial attractiveness and resilience. According to (Jamali & Ghorbani Kalkhajeh, 2019) areas undergoing rapid urbanization have several typical characteristics: accelerated urbanization accompanied by a decline in rural activities, disorderly development with inadequate infrastructure, and the loss of agricultural land, forests, and quality water resources. They mainly accommodate residents with low or middle income, who are often unaccustomed to urban life and particularly vulnerable to environmental degradation.

The dynamics of urbanization and city growth are generally influenced by demographic factors, particularly in developing countries (Riad et al., 2020). In contrast, population growth in Africa strongly influences the expansion of agriculture, making it one of the main drivers of land use and vegetation cover change (Leta et al., 2021). Secondary or intermediate cities are attracting growing interest for their role as interfaces between rural areas and metropolitan areas. In Cameroon, certain studies have highlighted urban dynamics research that focuses more on large cities than on secondary cities. The study by (Bah & Tegui Kenmegne, 2025) highlights socio-environmental dynamics and the plurality of norms existing in land governance. These norms vary from one city to another according to its size ; thus, it advocates for the harmonization of these diversities for sustainable and resilient land governance. Other research, such as that of (Mumbang et al., 2025) evaluates changes in the extent of mangroves over a 42-year period in the Douala-Edéa National Park to advocate for a sustainable management plan for these sensitive areas, without however integrating urban dynamics. Regarding Edéa, the study by (TENDE, 2020) highlights Edéa's expansion and the causes of its decline without integrating the metropolitan dimension or the SDG development indicator 11.3.1. This indicator, which was studied by (Cardenas-Ritzert et al., 2024) highlights an approach to using the indicator by associating it with open data, and particularly sheds light on the difficulties of applying this index in the African context, taking the cases of Nigeria, Ethiopia, and South Africa, which present both political, economic, and social dynamics. Among them, the city of Edéa, located in the Littoral region of Cameroon, occupies a strategic position at the crossroads of the major routes connecting Douala, Yaoundé, and Kribi. Long perceived as a major industrial center due to the presence of the Cameroon Aluminum Company (ALUCAM) and other agro-industrial units, Edéa now seems to face a double challenge: maintaining its economic attractiveness while asserting its own urban dynamics in an environment dominated by neighboring metropolises. This positioning as an intermediate city raises the question of the effects of metropolitan proximity on its urban development. Edea appears to be a relevant case study for understanding how metropolitan proximity both can stimulate and hinder the development of an intermediate city. The literature has uncovered studies undertaken in Edea, including Tende's examination of indicators of stagnation in the colonial city of Edea. However, in order to evaluate Edea's dynamics and the future of sustainable development, this study will focus on indicator SDG11.3.1 of sustainable development.

The article therefore examines the nature and intensity of urban dynamics in Edéa through a cross-analysis of its internal changes and external influences exerted by Douala, Yaoundé, and Kribi. The objective of this study is to analyze the influence of metropolitan proximity on urban dynamics in Edéa. Specifically, it seeks to characterize the urban and demographic evolution of Edéa between 1986, 2001, and 2024 and to assess the spatial, economic, and functional impact of neighboring metropolitan areas (Douala, Yaoundé, Kribi).

METHODOLOGY

It is divided into two main sections: a presentation of the study area, followed by the materials and methods used to obtain the data contained in this article.

Presentation of the Study Area

The city of Edéa comprises two (2) municipalities, Edéa 1 and Edéa 2. It is bordered to the north by Ngambe and Massok, to the south by Lokoundje, to the east by Ngwei and Pouma, and to the west by Dizangué, Mouanko, and Dibamba. It is located 65 km from Douala and 187 km from Yaoundé. In addition, a paved road of nearly 105 km connects Edéa to the port area of Kribi (Figure 1). Edéa was selected due to its historical significance and strategic location at a crossroads among major cities, including the political and economic capital. It is also accessible via two national roads, specifically numbers 7 and 3. Edéa displays an equatorial climate with Guinean characteristics, featuring high humidity, annual rainfall surpassing 3000 mm, and an average temperature of 27.5 °C. Edéa is traversed by the Douala railway line leading to Ngaoundéré and is situated along the Sanaga River, the longest river in Cameroon, originating from the Adamaoua Plateau and emptying into the Atlantic Ocean.

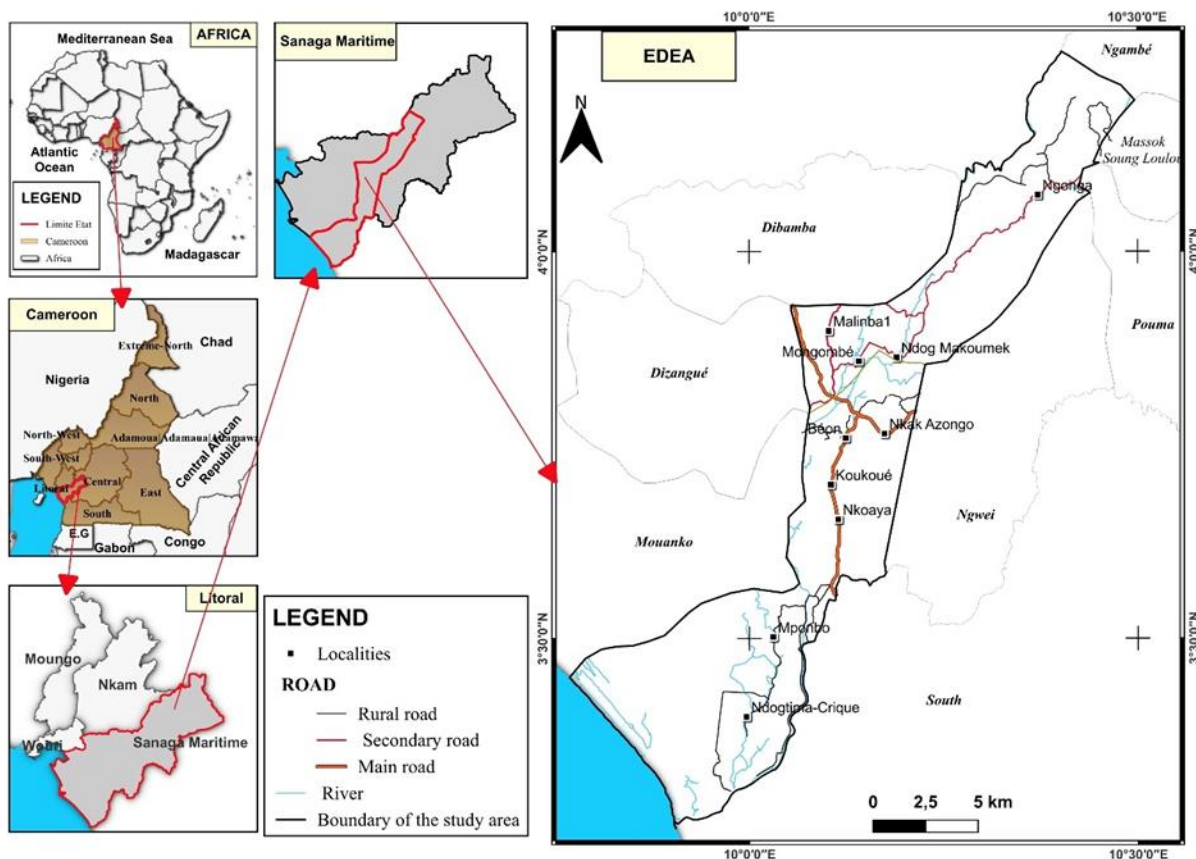


Figure 1. Map showing the location of the city of Edéa.

MATERIALS AND METHODS

A mixed approach was adopted with the aim of studying urban dynamics in the city of Edéa. This involved qualitative analysis of primary data (field survey) and secondary sources (previous work, cartography).

Field Survey of Households

Data from household surveys conducted on a sample of 383 households was combined with population census data from the 1976 General Population and Housing Census (RGPH), 2005, from the Ministry of Territorial Planning (MINEPAT) and the Economic Development Report (RADEC) for Sanaga Maritime. The sample was determined using the simple random sampling technique (Florentin, 2021) and was estimated from the entire population of Edéa using the Daniel Schwartz formula as in (Teadoum Naringué et al., 2024), (DOUNWOURGUE & KOLA, 2025), (Azagoun et al., 2025), (Saha et al., 2018) and (Allarané et al., 2023) research. The sample size "n" (383) was estimated using $Z = z$ value corresponding the 95% confidence level or $Z_{\alpha/2} =$ Level of significance = 1.96, a prospected proportion (p) of 50% percent and d being the margin of error of 5%: $Z(2) p(1-p) / d(2)$ or $n =$ The final yields a sample of 383. Using the last household size survey conducted in Cameroon in 2005 as project projection. But using the urban planning master-plan, a household in Edéa is taken to be 5 persons. The population is calculated using $P_n = P_0(1+t)^n$. Where $P_n =$ population for year n, $P_0 =$ population in the reference year. $t =$ growth rate, and $n =$ difference between target year and reference year.

Table 1. Population, number of household and projections as appear in [22].

ZD EDEA	Number of households (N) (2005)	2025 Population	2024 Population	2024 households	Sample
Plateau administratif	299	1495	1 970	394	9
Bonamikengue	448	2240	2 952	590	14
Centre commercial	86	430	567	113	3
Domaine Sanaga	504	2520	3 321	664	16
Amour	1103	5515	7 269	1 454	35
Bisseké	1671	8355	11 012	2 202	53
Mbanda	1832	9160	12 073	2 415	58
Gare	522	2610	3 440	688	17
Pongo - edea	1362	6810	8 976	1 795	43
Elog - bélé	295	1475	1 944	389	9
Mboué	194	970	1 279	256	6
Haoussa	668	3340	4 402	880	21
Béon	189	945	1 246	249	6
l'Île d'ALUCAM	129	645	850	170	4
Ekité	1029	5145	6 781	1 356	33
Mongombé	56	280	369	74	2
Malimba	1431	7155	9 431	1 886	45
Malimba farm	22	110	145	29	1
village - pilote	41	205	270	54	1
Kopongo	74	370	488	98	2
Ntoumba	127	635	837	167	4
TOTAL	12082	60410	79 623	15 925	383

The ODK Collect mobile application was used to administer the survey questionnaire in person using Android phones after it was integrated into the KoboToolbox platform, as in (Azagoun et al., 2025). Before analysis, the data was downloaded into Excel and sorted, cleaned, and organized. This data was analyzed and displayed in Excel and R as a word cloud that displayed the regions of origin of the people residing in Edéa, as well as a diagram that showed population trends and various ethnic groups.

Spatio-Temporal Analysis of Land Use

A diachronic approach was adopted to study the dynamics of land use in Edéa. The choice of images was based on their availability and related to the population census. The year 1986 was chosen to refer to the 1985 population census, 2001 to approximate the 2005 census, and the current image to 2024. The classification of land use types followed the nomenclature established by the Environmental Systems Research Institute (ESRI). Five major classes were selected: vegetation (gallery forests, wooded/shrubby savannas, herbaceous vegetation), buildings (buildings, roads, electrical network, etc.), bare ground (fields, fallow land), flood zones (flood plains, marshy banks).

Table 2. Characteristics of the satellite images used.

N°	Years	Satellite	Capture	Resolution	Source
1	1986	Landsat 5	TM	30 m	USGS EarthExplorer
2	2001	Landsat 7	ETM+	30 m	USGS EarthExplorer
3	2024	Sentinel-2	MSI	10-20 m	Copernicus Open Access Hub

Data Preprocessing

The satellite images were acquired during the dry season (December) in order to minimize cloud cover, and several processing steps were then applied (Table 3).

Table 3. Processing techniques used.

Id	Pre-treatments	Description
1	Atmospheric correction	Use of the FLAASH algorithm
2	Geometric correction	Georeferencing Wizard using control points
3	Ortho-rectification	Digital Elevation Model (DEM) and RPC coefficients
4	Pansharpening	Improvement of the spatial resolution of multispectral images, then combination with the panchromatic band (B8), except for the 1987 image.
5	Band fusion	Use of layer stacking to create virtual rasters
6	Scene mosaicking	Use of scenes with Path 186 / Row 057 characteristics
7	Cutting	Use of the Clip Raster algorithm in QGIS based on the administrative boundaries of the city of Édéa..

Data Processing and Post-Processing

The analysis was based on supervised classification by segmentation, using the Mean shift algorithm. This algorithm groups pixels into homogeneous objects according to their spectral, textural, and spatial characteristics. The parameters used are spatial radius (10), spectral radius (15), minimum region size (20 pixels), maximum iterations (100), and convergence threshold (0.1). The segments thus generated were used to extract features used for supervised classification. Post-processing was then used to correct errors by merging small segments, refining contours, and improving the internal consistency of the classes. The results were validated using a confusion matrix. Finally, photo interpretation was performed to precisely identify each land cover class, resulting in five land cover classes.

To enhance the reliability of the results, two types of validation were performed: A comparison with an unsupervised classification (k-means algorithm), the results of which confirmed the supervised classification. The Kappa index obtained was 0.99, indicating very good accuracy (Mavunda et al., 2022). As a result, transects were constructed in the field to validate the land use units identified with observations made in situ (Koumoui et al., 2013). Later, the areas of the different validated classes were calculated in QGIS 3.22.

With the land use classes obtained on different dates, indicator 11.3.1 can be calculated. This index was developed as part of the Sustainable Development Goals (SDGs) to measure the rate of land artificialization in relation to population growth. It provides information on how urban expansion is progressing at the expense of natural environments, i.e., index 11.3.1 reveals the extent of urban sprawl and sustainable forms of development (Angel et al., 2024). Indeed, when cities spread out, land consumption (agricultural and natural) accelerates in order to meet the needs of population growth, especially in the context of unplanned urbanization (Sondou et al., 2024) (Combarry et al., 2024).

LCR is given by Equation 1:

$$LCR = \frac{LN \left(\frac{Urb_{t_f}}{Urb_{t_0}} \right)}{n} \times 100 \quad (1)$$

LCR = land consumption rate ;

n = number of years between the two measurement periods (t_0 and t_f).

Urb_{t_f} = total build up area for final year.

Urb_{t_0} = total built up area for initial year.

As for the average annual growth rate of the population (PGR), it is given by Equation 2:

$$PGR = \frac{LN \left(\frac{Pop_{t_f}}{Pop_{t_0}} \right)}{n} \times 100 \quad (2)$$

PGR = population growth rate (average over n years).

n = number of years between the two measurement periods (t_0 and t_f).

Pop_{t_f} = total population within the city in the final year.

Pop_{t_0} = total population within the city in the initial year.

N = the number of numbers between the two measurement periods.

On this basis, we calculated the SDG indicator 11.3.1 (ratio of land consumption rate to population growth rate, LCRPGR) with Equation 3:

$$\text{LCRPGR} = \frac{\text{LCR}}{\text{PGR}} \quad (3)$$

Interpretation

If $11.3.1 > 1$: urban expansion outpacing population growth (unsustainable consumption).

If $11.3.1 = 1$: proportional urban expansion.

If $11.3.1 < 1$: urban densification (population growth outpacing land development).

RESULTS

The Intertwining of Urban Issues: Demographic Dynamics and Residential Mobility

The urban issues in Edéa are initially apparent when we closely examine the evolution of its urban population, using official census data and demographic projections produced by the Ministry of Territorial Planning (MINEPAT) and the municipality. The demographic data obtained shows the effectiveness of three censuses between 1976 (the oldest year) and 2024 (the projection).

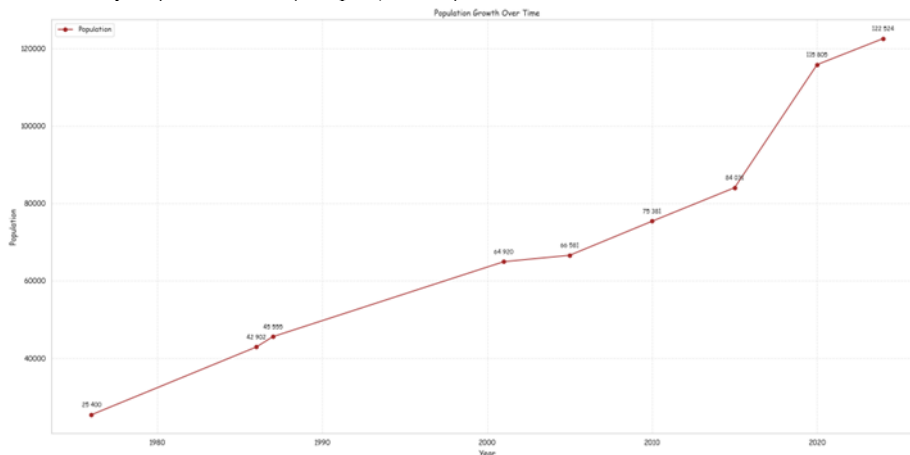


Figure 2. Population growth curve for Edéa.

Source: RGPH, 1976; 1987; 2005; Minepat, 2017, Communal File, 2022, and projections.

The general population census is conducted every ten years. Thus, while the city of Edéa had 25.400 inhabitants in 1976, the population had not yet exceeded 50.000 in 1987. Over the years, the growth rate has continued to rise to the point that the city exceeded 110.000 inhabitants in 2020, 44 years after the first census. Overall, the demographic trend is less pronounced when the analysis is limited to the last two decades, comparing data from 2005 and 2017, then from 2017 and 2022. According to each time frame, the population grew by 17.360 and 37.119 inhabitants, respectively. The factors explaining this demographic change can be found in the rural exodus correlated with infrastructure development, i.e., roads and industries, starting in 1970.

Edea, Between Migratory Dynamics and Residential Mobility

Edea is characterized by significant migratory movements in and around the city. The challenge is to understand and analyze the period of settlement of new city dwellers in Edea, which has a certain appeal. The objective was to distinguish between the indigenous population (natives) and the non-indigenous population, whose presence in Edea is assessed at five-year intervals, with a maximum of more than 20 years of occupation (Figure 3).

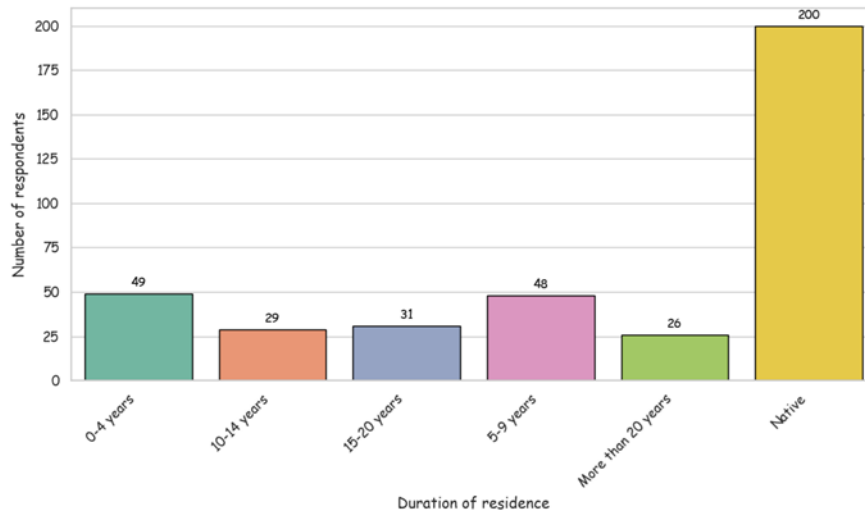


Figure 3. Settlement of populations in Edéa.

At first glance, the results show that the majority of respondents, i.e., heads of households, are from the municipality of Edea, accounting for 60% of the total. The “native” category dominates, with nearly 200 people and about 50% of the total. The other seniority categories (less than 5 years, 5 to 10 years, 11 to 15 years, 16 to 20 years, more than 20 years) have much smaller numbers, all well below 50 people. Those with less than 5 years and 5 to 10 years of seniority are the most represented groups after natives, with percentages of around 10–15% each. The year intervals 11 to 15, 16 to 20, and over 20 have smaller populations, around 5 to 10% each. The significant proportion of natives (born locally) reflects a predominantly locally rooted population, which can promote social cohesion and the transmission of traditions. The significant proportion of residents who have been living there for less than 10 years indicates recent arrivals linked to economic or educational opportunities or family reunification. The intermediate age groups (11 to 20 years of residence) are small, suggesting either that some residents leave after a certain period of time or that there is difficulty in attracting and retaining newcomers in the long term.

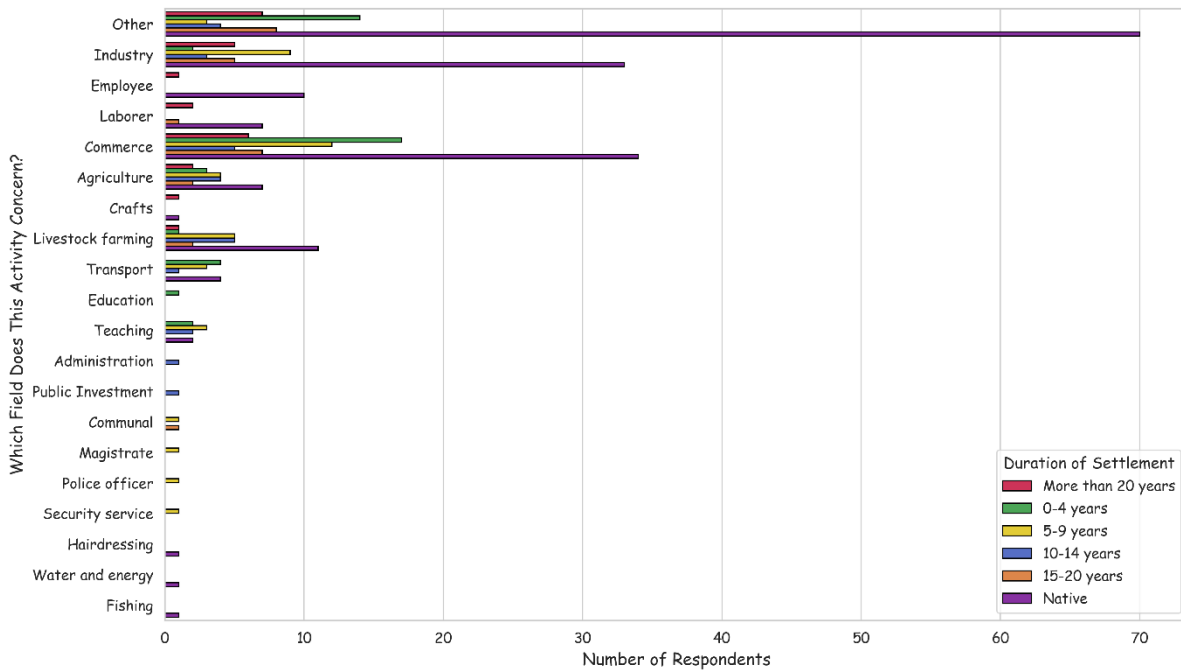


Figure 4. Duration of settlement and type of activity.

Figure 4 shows that the duration of residence influences the type of activity. For example, natives and those who have resided for more than 20 years work in commerce and industry, demonstrating mastery of the economic sector, and their seniority has facilitated their recruitment in industry. This reflects a gradual shift in activity type. In contrast, residents of less than 5 years are primarily engaged in commerce, indicative of limited financial means as they familiarize themselves with the local market.

Furthermore, the geographical location of the city of Edea gives it the right to be called a crossroads city. Field surveys have revealed that the population comes from several regions of Cameroon, including the west, north, center, and even the south of the country (Figure 5).



Figure 5a. Areas of origin of the population in Edea.

Analysis of the areas of origin of the population in the study area reveals in Figure 5 above that most of the inhabitants of Edea come from neighboring cities, namely Douala (44 km), 50% of respondents, Yaoundé (153.18 km), 30%, and Kribi (95.70 km), 10%. These results show the influence of these cities on Edea. These populations who have come to Edea, except those who have been assigned there, are looking for better living conditions or better jobs (50%). Given the constant competition in large cities, Edea is seen as a place to start over. In addition, Edea has become a cosmopolitan city, with a population made up of natives who are mostly from the Littoral region, as well as people from other regions of the country, including the South, East, West, and North.

Spatial Dynamics and Urban Expansion of the City of Edea

The evolution of Edea's urban perimeter is evident in uncontrolled urban growth within sensitive areas and agricultural land. Today, there is clear spatial disarticulation, ecological imbalance, increased flood risk, and land tensions. The combination of these factors influences the residential (population) and economic attractiveness of the city of Edea (investors). The geo-historical approach (1986 to 2024) highlights the evolution of land use. This shows that the built area is more concentrated in the central part of the city, with the rest being more vegetated. However, in 2001, the urban area in Edea evolved and expanded to the south of the city, towards the city of Douala. There was also an increase in the area under cultivation, with the rest of the land covered with scattered vegetation. In 2024, the urban fabric continued to expand towards the south and then the east of Edea. This dynamic takes into account the proximity of the cities of Douala, Yaoundé, and Kribi, which are major centers of economic development.

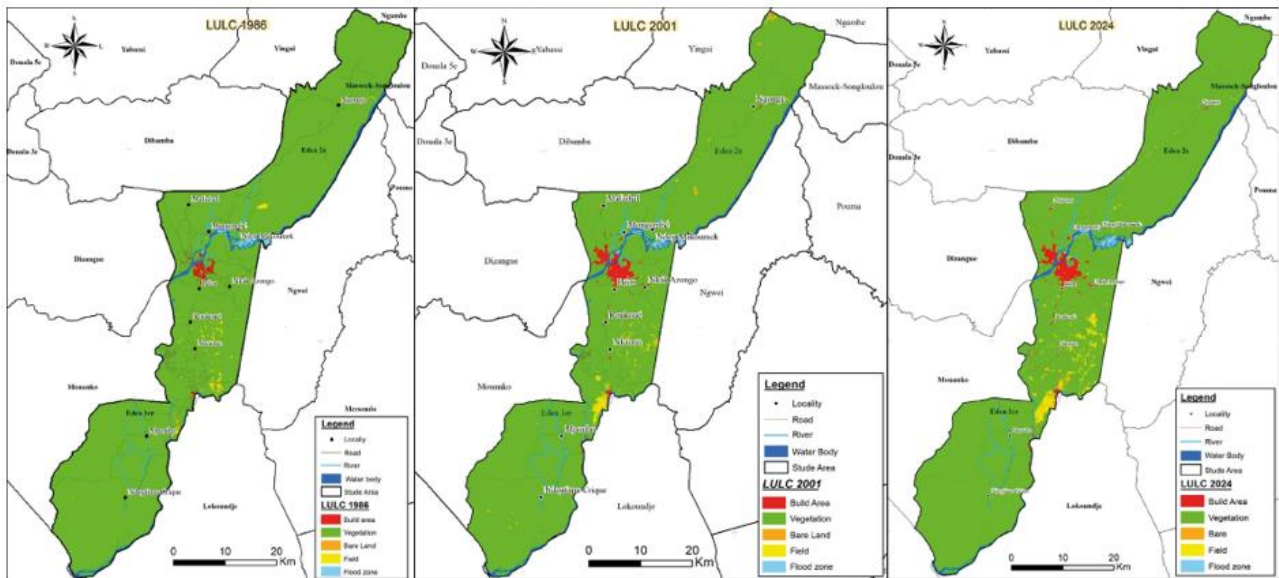


Figure 5b. Edea spatial dynamic.

Based on a spatial analysis approach, the three successive cartographic representations from 1986, 2001, and 2024 show a gradual expansion of the urban area in Edéa. There has been an enlargement of the central urban core, to the detriment of peripheral areas that were initially rural or forested. The urbanized area, shown in red, extends north and south over time, reflecting linear urban growth along the main road axis. This spatial dynamic is typical of cities located near a large metropolitan center, in this case Douala, whose territorial influence acts as a driver of sprawl. However, this expansion is not accompanied by a balanced functional network. It reflects spontaneous and poorly controlled urbanization. This form of urbanization accentuates intra-urban inequalities because it is disconnected from the network of infrastructure facilities such as health, education, and sanitation.

Table 4. Annual variation in land use areas in Edéa.

LULC	Surface area (ha)		
	1986	2001	2024
Built	1446.12	2054.04	2609 ;29
Vegetation	170192.7	168632.36	166418.83
Bare ground	261.109	776.97	361.75
Cultivation area	1463.58	1169.74	2041.16
Flood zone	797.11	732.24	931.68

Looking at the different land use classes in Edéa, the built-up area increased from 1.446.12 ha to 2.609.30 ha, reflecting gradual urbanization between 1986 and 2024. While the area of vegetation cover has decreased significantly, from 170.192.7 ha (1986) to 166.418.83 ha (2024), representing a loss of 3.773.87 ha, which is equivalent to an annual loss of approximately 100 ha. The area reserved for crops decreased by 294 ha (1986 to 2001), then by approximately 872 ha. This demonstrates a collective and firm commitment not to compromise agricultural activity and, by extension, local food security. Floodplains have evolved in the same way as cultivated areas. There was a reduction in flood zones of 65 ha between 1986 and 2001, or 4.33 ha per year. However, as land use has become a viable development policy in these flood zones, this has led to the creation of new flooded areas, covering approximately 200 ha between 2001 and 2024.

Calculation Of Indicator 11.3.1

In the context of rapid urban sprawl, it is relevant to assess the relationship between the rate of land artificialization (growth in built-up areas) and the rate of population growth. This is the challenge addressed by indicator 11.3.1 (Tables 5 and 6).

Table 5. Assessment of progress/regression by grade.

Category	1986	2001	2024	Taux 1986 – 2021	Taux 2001 – 2024	Taux 1986 – 2024
Buildings (ha)	1446.1212	2054.0438	2609.2976	+42.01 %	+27.00 %	+80.43 %
Vegetation (ha)	170192.7062	168632.3655	166418.83	-0.92 %	-1.31 %	-2.22 %
Bare ground (ha)	261.109	776.9789	361.7561	+197.47 %	-53.45 %	+38.52 %
Cultivated areas (ha)	1463.5812	1169.7433	2041.164	-20.10 %	+74.50 %	+39.49 %
Flood zones (ha)	797.1181	732.2408	931.6881	-8.14 %	+27.26 %	+16.89 %
Population	42902	64920	122524	+51.34 %	+88.77 %	+185.47 %

Table 6. Results of the indicator calculation from 1986 to 2024.

Period	Built rate (%)	Population rate (%)	Indicator 11.3.1
1986 – 2001	+42.01 %	+51.34 %	0.82
2001 – 2024	+27.00 %	+88.77 %	0.30
1986 – 2024	+80.43 %	+185.47 %	0.43

Over the period 1986-2001, the growth rate of buildings (42%) was lower than the population growth rate (51%). This shows that indicator 11.3.1 is closer to 1, at 0.82, meaning that the city of Edéa is experiencing moderate densification. For the period 2001-2024, the rates of building and population growth increased to 27% and 88.77% respectively. For this period, the calculation of indicator 11.3.1 gave a result of 0.30, which is very far from 1 and indicates very efficient urbanization in terms of compactness. This suggests that urban development is influenced by the proximity of large cities but unfortunately lacks adequate support. When the analysis takes into account the overall time frame, i.e., from 1986 to 2024, we see that the proportion of buildings is 80%, while that of population is 185%. The value of indicator 11.3.1 obtained is 0.43. Thus, after 40 years, Edéa's urban growth has lagged behind population growth, which has limited urban sprawl and is a positive sign in terms of spatial sustainability.

An Ambiguous Centrality: Advantages and Constraints of an Inter-Metropolitan Position

Edéa is located at the crossroads of the cities of Douala, Yaoundé, and Kribi. This position is both an advantage and a handicap for the urban dynamics of the city of Edéa. The intrinsic advantages of the municipality's geographical location include trade, interurban mobility, and access to urban markets. It thus establishes its role as a relay city in terms of its connectivity to the national and regional interurban network and its indispensability in direct links with the central nodes and their reciprocal interconnectivity. Edéa is positioned as a hub for trade between port cities on the one hand and Cameroon's two largest metropolitan capitals on the other.

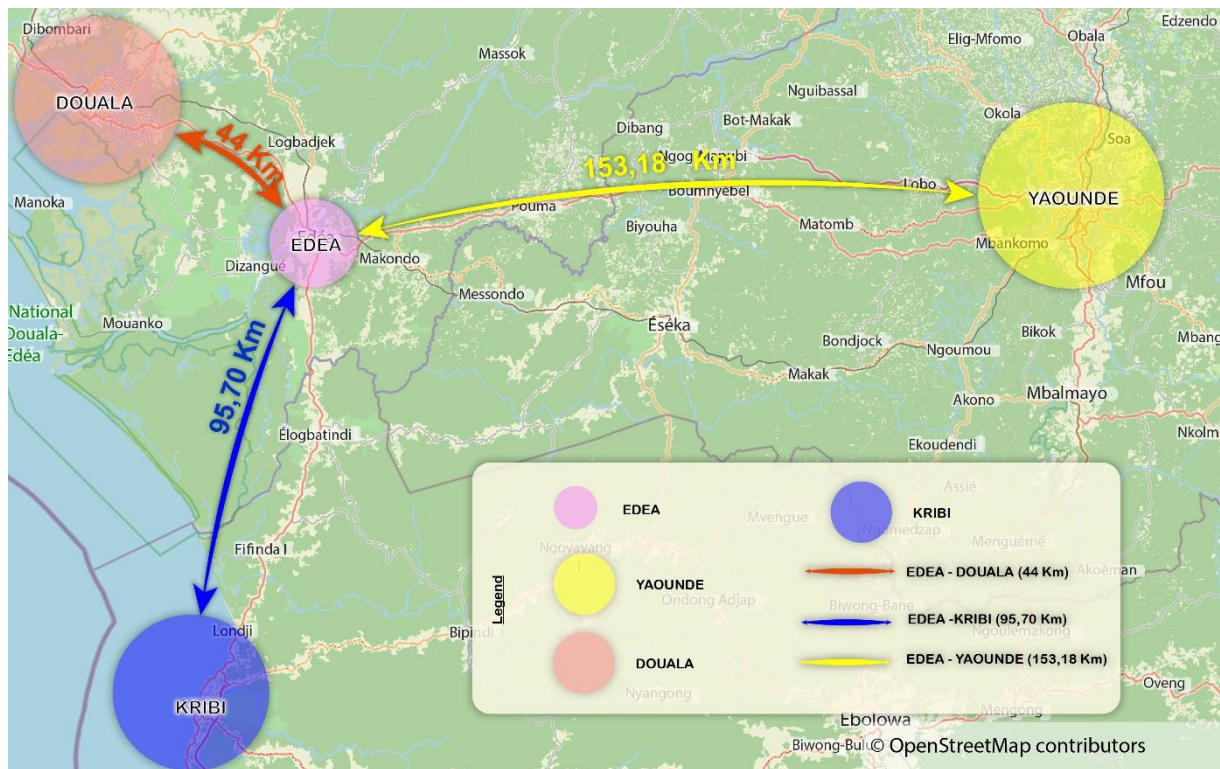


Figure 6. Positioning of Edéa at the intersection of metropolitan urban centers.

However, this proximity to large metropolitan areas paradoxically acts as a factor of marginalization for Edéa. Indeed, regional attractiveness is diverted to Douala and Yaoundé, which concentrate investment, infrastructure, and opportunities, relegating Edéa to the background. The city is confined to a mere relay role, without a strategy to develop its own economic or urban potential. In addition, the rapid growth of neighboring cities is putting pressure on Edéa's periphery, without the city benefiting from any supporting policies or compensatory development. This imbalance confirms that the city of Edéa embodies a form of damaged centrality, marked by urban stagnation that is symptomatic of both a structural and cyclical crisis.

Commercial Interactions and Economic Repositioning of Edéa in the Regional Urban Network

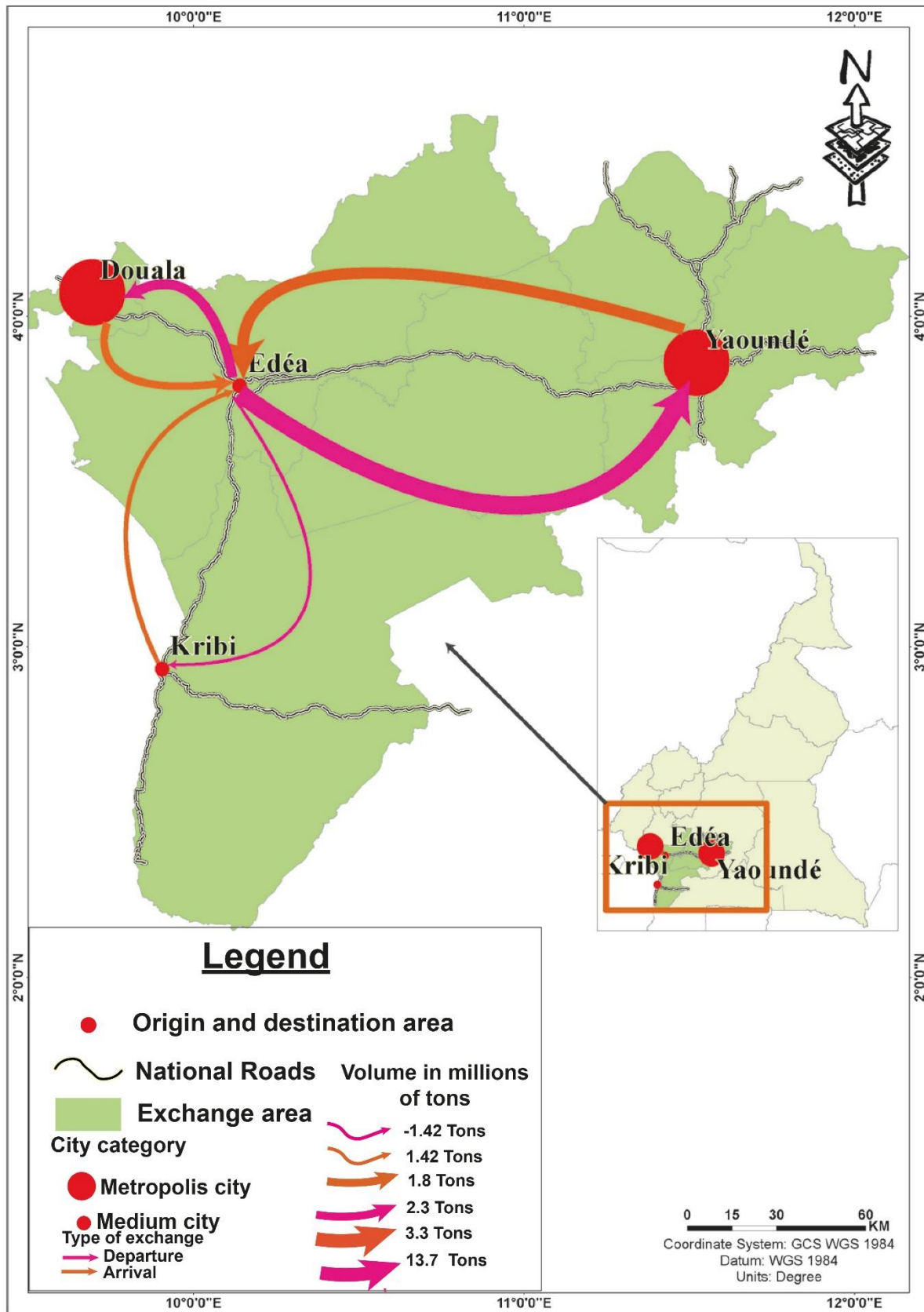


Figure 7. Trade flows between Edéa and major interconnected urban centers.

Figure 7 illustrates trade between Edéa and three major urban centers: Douala, Yaoundé, and Kribi. The arrows, which vary in size, indicate the volume of goods traded in tons. The categorization of flows makes it possible to distinguish between dominant relationships (12 to 16 tons) and secondary trade (3 to 5 tons). Edéa appears here as a logistical hub between the hinterland (Yaoundé) and the port areas (Douala, Kribi). Following a functional analysis approach. However, this function is threatened by its dependence on metropolitan cities, which

weakens its capacity for economic autonomy. The low volume of certain flows also reflects low local productive density in view of the current decline in industrial production in Edéa linked to structural conditions and a lack of investment by economic operators. This situation therefore reveals a direct challenge to the city's attractiveness. Thus, the inadequacy of infrastructure and industrial and commercial production units in this new urban area is hampering its development, causing territorial imbalance. This creates a handicap in trade and contributes to the city's overall loss of attractiveness. It therefore appears that Edéa's centrality is more functional than structural. Without improvements to infrastructure, local industrialization, or quality urban services, this position could erode. The dominance of inbound flows over outbound flows reflects low residential and economic attractiveness, leading to a risk of long-term urban marginalization.

DISCUSSION

Demographic Growth and Urban Status

The results of this article show, on the one hand, a change in the population of Edéa, which has grown from 25.400 inhabitants in 1976 to 122.524 inhabitants in 2022, an increase of approximately 382% in 46 years. The city of Edéa has experienced growing population growth for several decades, especially since 1976 as in (Kana, 2021). This demographic growth led to its transformation into a secondary city (a city with a population of between 50.000 and 100.000 inhabitants) in 2015 as mention in (Nguefack, 2023) and its designation as a satellite or autonomous city (M Cheick, 2023). The slow growth of Edea's population, especially from 1987 to 2005, is due to the economic crisis that hit Cameroon as confirm in (Ferracuti et al., 2023) research. During this period, many inhabitants, unable to survive in foreign cities, resettled in their hometowns, as several businesses had closed. However, in 2008, with the economic recession in Cameroon (Dang & Ngagoum, 2017), little industrial influence was reintroduced into the region. However, this population trend cannot be considered valid, as the last population census in Cameroon dates back to 2005 and does not reflect the current reality in Edéa. In addition, according to data from population surveys, Edéa is a cosmopolitan area with a large population from several ethnic groups, as Edéa was originally a city dominated by the Bakoko and Bassa ethnic groups. Today, several other ethnic groups can be found there, such as the Bamilékés, Eton, and others (TENDE, 2020). These results clearly show that Edéa is a welcoming place and that most of its inhabitants are nationals from neighboring cities, reflecting Edéa's strong dependence on these cities.

It is particularly noteworthy that Edéa has a greater influence on Yaoundé (150 km away) than on Kribi, which is closer (10%). This observation revealed that geographical proximity is not considered to be the only factor influencing urban development. Edéa exerts its pull thanks to its position on the Douala–Yaoundé corridor, its industrial and energy infrastructure, and its repeated economic exchanges with the capital. Kribi, on the other hand, remains focused on port and international activities, thus limiting its functional links with Edéa. These results clearly show that the influence of cities depends on their connection to the networks produced by the economy and logistics (Christaller & Baskin, 1966) or on their spatial integration into these networks (Rodrigue, 2020).

Urban Form, Land Use, and Indicator 11.3.1

Land use dynamics show that natural areas/vegetation formations are declining significantly in favor of anthropized formations, while water bodies remain virtually unchanged (Mavunda et al., 2022) (Lebga et al., 2018). Contrary to the results of our work, those of (TENDE, 2020) show that Edéa has experienced a creeping expansion of built-up areas from 0.56% in 1990 to 3.01% in 2019, with a modest increase in population from 25.398 inhabitants in 1987 to 66.581 in 2005 and 78.601 inhabitants in 2019. (ghislain nyembe Etame, 2020) shows that despite this urban development in Edéa, the city faces a deficit in terms of access to basic infrastructure and facilities. This can be explained by a clear imbalance in the distribution and financing of projects by locality and also by the ineffectiveness of decentralization, with certain localities remaining dependent on central government as confirm in (Ndjeng, 2012). Although positive, this development raises several issues observed by (Kossi Edoh René Agboti, Komlan Kounon Etienne, 2024). in their work on Agoé-Nyivé 4 in Togo, where urbanization is leading to strong pressure on land, conflicts of use, and difficulties in municipal management (Kossi Edoh René Agboti, Komlan Kounon Etienne, 2024). Like Agoé-Nyivé, urbanization in Edéa mainly follows road axes and areas close to industries, which accentuates intra-urban disparities and spatial fragmentation.

Furthermore, (Kokou & Kola, 2016) work on international migration and local development shows that population movements profoundly alter the social structure and spatial dynamics of the area in question (Kokou & Kola, 2016). For Edéa, its proximity to Douala and Kribi has two effects: on the one hand, it attracts migrants from the interior of the country who are looking for opportunities in industry, and on the other hand, it promotes a transit effect, with some migrants using Edéa as a crossroads or stopover before reaching the metropolis. This

confirms Edéa's status as an intermediate city, serving as a hub for the redistribution of human flows and a relay point in Cameroon's urban system.

Analysis of indicator 11.3.1 in Edéa reveals a model of moderate, densified, and potentially sustainable urbanization, which nevertheless requires careful anticipation of infrastructure, housing, and public space needs, particularly in light of the recent strong population growth. Indicator 11.3.1 highlights a sober urban expansion dynamic, which is commendable from an ecological and spatial point of view. However, this performance may mask a reality of scarcity, overcrowding, or informal urbanization. Field observations have shown that the city of Edéa is developing along the N03 national highway, the main access route to the city. It is around this main road that the city has developed, with most of the city's infrastructure and facilities located there. This result could be explained by the proximity of neighboring cities, which are encroaching on the rational urbanization of the city of Edéa.

Studies show that indicator 11.3.1 can reach extreme positive or negative values, which makes it difficult to interpret and hinders comparison between cities or regions as in (Sondou et al., 2024) and (Angel et al., 2024) research. Although our ratio of 0.43 indicates densification in Edéa, caution is needed as this ratio has no universal threshold, and a low value does not guarantee the absence of occasional spatial sprawl or measurement errors. Some studies in Africa show that LCR/PGR results vary depending on the temporal and spatial quality of the data (Landsat, GHSL, etc.) and the accuracy of the definition of agglomerated boundaries as confirmed in (Sondou et al., 2024),(Combarry et al., 2024) and (Mudau et al., 2020) further research.

Comparative Positioning and Planning Constraints

In the sub-Saharan Africa region, several secondary cities have an LCR/PGR ratio greater than 1, indicating significant urban sprawl (e.g., Mekelle, Benin City, Polokwane, Kpalimé, and Ho) case study of (Cardenas-Ritzert et al., 2024) and (Sondou et al., 2024). The average ratio varies, but many primary and secondary cities in Africa have experienced land consumption that outpaces population growth (LCR > PGR)(Mudau et al., 2020)(Sondou et al., 2024). With a ratio of $11.3.1 \approx 0.43$, the city of Edéa is an exception. Smaller cities often favor densification rather than urban sprawl, but this ratio is lower than the trends observed elsewhere. This could be due to proactive and well-funded planning that defined the limits of urban growth from the outset(Canton, 2021). The analysis of the indicator in Edéa challenges decision-makers and planners on spatial organization. Urban planners should seize the opportunity to control urbanization by:

- Promoting dense and concentrated urban planning,
- Rehabilitating abandoned land in urban areas,
- Assessing existing centralities and limiting land speculation.

Ultimately, carefully planned densification promotes sustainability, while disorderly densification (lack of infrastructure, absence of green spaces, lack of organized land governance) risk amplifying inequalities and insecurity in urban areas. To better understand Edéa's position, it would be helpful to compare these findings for Edéa with those of some secondary cities of comparable size, like Nkongsamba, Bafoussam, and Ebolowa. With a low ratio, Edéa shows urbanization, which is largely represented by unstable housing and deteriorating infrastructure. In the urban center, this dynamic is more prominent, allowing the outskirts to grow independently. Edéa's urban sprawl is focused on the port city of Kribi, even though it has urban planning documents. Many businesses choose to locate along Kribi's National Road 07 instead of using the space designated for them in the Master Plan. The current urbanization of Edéa follows the two national roads, which are the main access routes to the city, connecting it to neighboring cities. Kribi, currently the largest port, is becoming the main attraction for investors who prefer to be close to the port in order to better distribute their various products.

The development of a city is the result of multiple socio-spatial transformations that take place during its construction phase. These can be both an opportunity and a constraint on its attractiveness. The realities of the urban space in the city of Edéa clearly confirm this dual meaning. Indeed, the dynamics of the urban space of the city of Edéa have contributed to the construction of the city through population densification, an expansion of the urban front fueled by the opening up of urban subdivisions, the arrival of new economic production activities, and the development of socio-community infrastructure that has contributed to the evolution of its administrative status. These transformations of the urban environment have thus contributed to the development of urban infrastructure and facilities (administrative, health, tourism and leisure, educational facilities), the emergence of the industrial fabric (contribution of human resources from migration and hydro-energy resources fueled by the presence of the Sanaga River), as well as the division and organization of urban zoning (residential areas, commercial areas, administrative areas, etc.).

Field investigations have shown that the city remains confined to a centrifugal spatial area that polarizes most of the city's infrastructure and whose desired expansion remains virtually impossible given the natural barriers linked to the terrain and recurring land conflicts. The city of Edéa no longer attracts economic operators due to the weakness of the local market, the decline of commercial activities, and widespread inflation affecting all growth

sectors. The duality of actors and leadership issues in the management of the city between municipal services and decentralized state services further amplify the climate of institutional relations, posing a real threat to the implementation of development projects and the consolidation of systemic approaches. The limited transfer of powers and financial resources (ghislain nyembe Etame, 2020) restricts the ability of the Edéa city council to address local development issues and ensure satisfactory living conditions for the urban population.

LIMITATIONS

Despite the relevance of the results obtained, there are limitations that are important to highlight. Firstly, although the analysis of urban areas was carried out using aerial images, it remains subject to differences between sensors, which may lead to some bias in the interpretation of built-up areas. In addition, the calculation of the SDG 11.3.1 index is based on population estimates, and while it shows the relationship between population and land consumption, it does not take into account the quality of urbanisation or socio-spatial disparities. The analysis of migratory and economic flows has revealed certain metropolitan interactions, but the data on daily mobility and trade flows remain insufficient. In the absence of in-depth primary surveys, it has been difficult to quantify metropolitan dependencies. The research did not include the urban governance dimension. Finally, this research has revealed the dynamics of Edea's expansion and its metropolitan positioning, but it would be beneficial to supplement it with qualitative and prospective analyses.

CONCLUSION

The proximity of Edéa to major cities influences the analysis of its urban dynamics. This phenomenon explains why urbanization has been concentrated more towards the city center and along the national roads leading to these major cities. Edea is transforming its urban space, which has had an impact on its administrative status and architecture. The evolution of the urban environment has contributed to the development of its industrial fabric, the subdivision of peripheral neighborhoods resulting from urban expansion, the diversification of its economic production activities, the densification of its sociodemographic layer, etc. The urban dynamics observed in Edéa, supported by the calculation of SDG indicator 11.3.1, are very important for the city insofar as they have enabled moderate urban sprawl to be observed in Edéa between 2001 and 2024. This result is a call to decision-makers and urban planners who must, among other things:

- strengthen regulatory tools, including urban planning, in order to contain spatial growth.
- encourage functional diversity to control metropolitan proximity.
- redirect investment towards urbanized areas to make them more attractive.
- set up an urban dynamics observatory to continuously monitor trends in densification and urban sprawl.

In light of this study's findings regarding Edea's changing urban landscape, it is critical to evaluate the suitability of Edea's urban planning documents for containing urban sprawl and investigating its effects on the environment.

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