ISSN No:-2456-2165

Monitoring by Remote Sensing of the Spatial Spread of the City of Douala in the Urbanization Era

*Emmanuel Kengmoé Tchouongsi, Department of Geography University of Yaoundé 1
Joachim Etouna, National Institute of Cartography of Cameroon

Abstract:- The issue of spatial spread remains topical in any society, especially in cities. Today, cities are expanding at an exponential rate towards their peripheries under the influence of a set of factors including urban growth. African cities, and particularly Cameroonian cities, are characterized by their strong spatial growth. This situation is mainly due to the strong growth of the population but also the multiplication of human activities. It is in the light of this observation that we have oriented our research on the monitoring by remote sensing of the spatial spread of the city of Douala in the era of urbanization. The objectives are to analyze the spatial spread of the city of Douala, to identify the factors at the origin of the spatial spread, the consequences and the analytical tools. To achieve this objective, we started from the general hypothesis according to which the sprawl of the city of Douala is linked to demographic growth, the development of buildings, economic activities, etc. We have, of course, relied on documents to approach this study, but most of the work has been done in the field where direct observation, etc. were effective tools for the outcome of this research. Landsat's images and shape files were also used etc. Results from our field investigations show that the city of Douala experienced strong spatial growth between 1975 and 2019. In 1975, we note that built-up areas represented 2.40% of the total area of the city of Douala. In contrast, forest represented 84.47% and crops 1.53% of the study area. In 2007, built-up areas represented 9.96% of the total area of the study area. On the other hand, the forest represented 79.09% of the studied area. In 2019, buildings made up 21.31% of the city of Douala, forests 58.69%, crops 8.56% and rivers 11.44%. The sprawl of the city of Douala is linked to various factors: the development of economic activities, the development of communication routes, the administrative center etc. The consequences among others are the development of precarious neighborhoods, the difficulties of access to basic urban services, the reduction of arable land, etc.

Keywords:- *Landsat's Images, Spatial Dynamics, the City.*

I. INTRODUCTION

The strong demographic growth experienced by large cities in developing countries has led to their rapid urbanization. We are witnessing a rural exodus which attracts populations in search of jobs to the cities. Once they arrive in town, without a stable job and without an income, they find it difficult to adapt to their new living environment, their first concern being to find low-cost housing in inexpensive spaces, unclaimed because they are poor, little urbanized and therefore of little economic interest. Thus, neighborhoods with spontaneous settlements are created in illegality and precariousness on sites that are often flooded or on a steep slope [1].

The rapid growth of cities and the inherent demographic concentrations have negative consequences: the disruption of the ecological balance, the difficulties in dealing with waste, the explosion in pollution levels, the degradation of the quality of life and the increase in urban violence. Studies of urban change are important tools for town planners. These studies, using remote sensing and GIS, make it possible to provide decision-makers with spatial and quantitative information on the evolution of urban areas and to monitor the effectiveness of actual and potential development policies. Thus, obtaining, processing and presenting information constitutes a relevant research field for understanding, improving and correcting urban planning [2].

Located in the Littoral zone, the city of Douala, the economic capital of Cameroon, is no exception to this phenomenon. Indeed, the latter, which alone accounts for 75% of the country's industrial production (MINEPAT, 2010), saw its population increase from 458,426 inhabitants in 1976 to 1,907,479 inhabitants in 2005 for an average annual growth rate of 4 , 7% [3]. This strong demographic growth, according to [4] is accompanied by an anarchical spatial development which escapes every control of the public authorities.

The city of Douala is therefore very urbanized with a speed such that the land reserves, the zones of cultures, the zones of depression and infiltration or of natural passages of rainwater are constantly being transformed into residential zones at a disturbing pace. The implementation of urban policies for the regular monitoring of this phenomenon of urbanization requires the acquisition of reliable and up-to-date information on all forms of development. The use of aerial photographs, a traditional method of acquiring information, has always been expensive. This is how digital techniques such as satellite remote sensing have undergone considerable development and constitute an interesting alternative for monitoring the urban sprawl of cities in developing countries such as Douala.

ISSN No:-2456-2165

II. MATERIAL AND METHODS

A. Delimitation of Study

The city of Douala is an estuarine city established on the banks of the Wouri River which divides it into two. Located approximately 30 km from the Atlantic Ocean, between 3 ° 52'0 "and 4 ° 3'0" N latitude and 9 ° 23'0 "and 9 ° 45'0" E longitude. It covers an area of approximately 1,920 km2. It is bounded to the North-West by Moungo and Fako Divisions, to the North-East by the Moungo and Nkam Divisions, to the South-East by the Dibamba and the Nkam Rivers and to the South-West by the Atlantic Ocean and Fako Division (Cf. Figure 1).

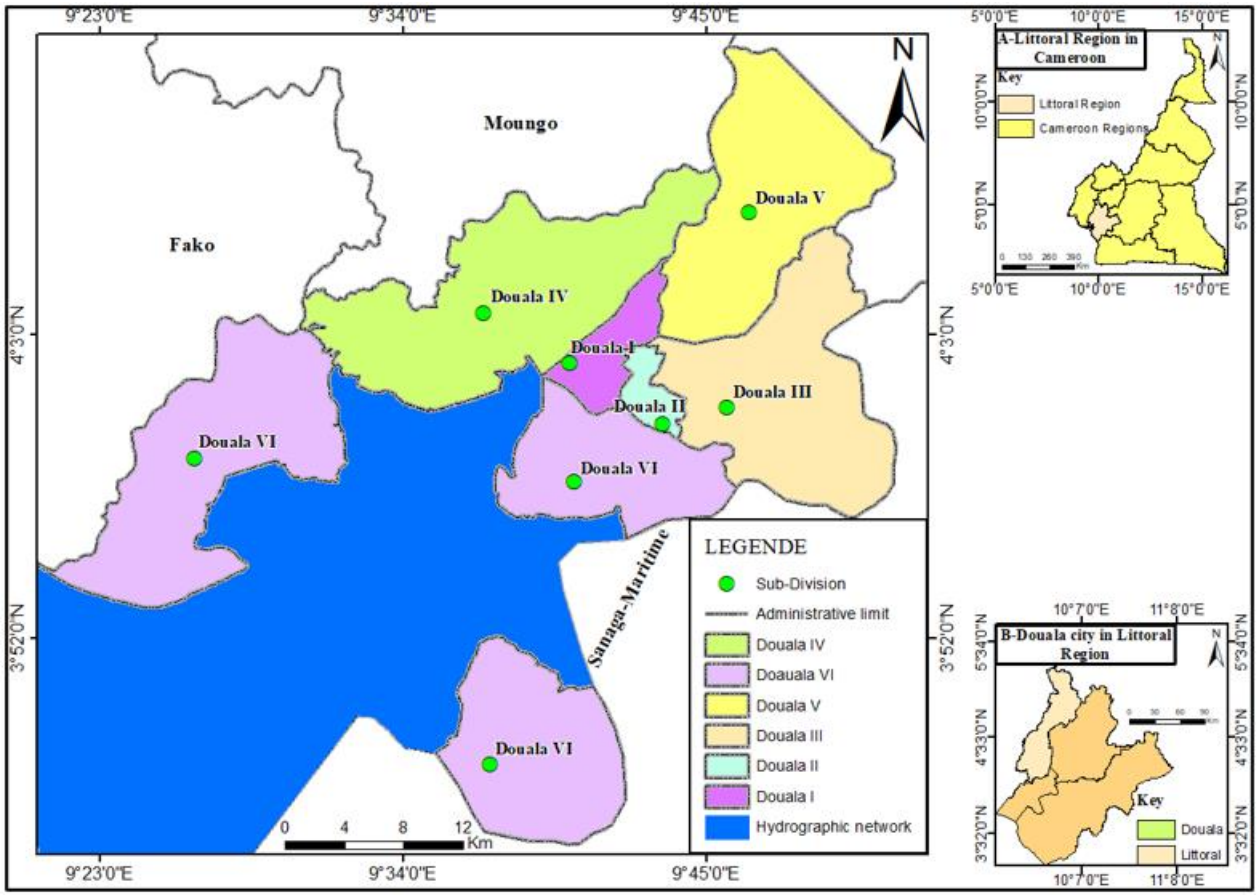

Fig 1: Location of the city of Douala
Source: Shape file National Institute of Cartography, 2018

The climate of the city of Douala is of humid equatorial type characterized by abundant precipitation which ranges from 4000 to 6000 mm of rain per year and an average rainfall of 4200 mm per year. The annual average temperature is around 27 ° C.

The hydrographic network of the city of Douala is made up of its main river, the Wouri, which divides the city into two parts. In addition to the Wouri River, the hydrography of the city of Douala is spread over nine major hydrographic catchments that flow into the Wouri River: Bonassama, Besséké, Bobongo, Mgoua, Kambo, Nsapé, Mbopi, Mbanya and Tongo bassa.

The urban space of Douala is established on a set of three low plateaus whose altitudes are between -12 and 127 meters; these plateaus are sheared by the deep valleys of the tributaries of the Wouri

The vegetation of the city of Douala in general is characterized by the presence of a mangrove, with mangroves and raffias in the marshy lowlands and a tree savannah which is the result of strong deforestation linked to urbanization.

B. Data collection

The data we used for our work are of several types, namely shape files, base maps and Landsat's images.

- *Shapefiles of our study area*

These are file formats for geographic information systems (GIS). They contain all the information related to the geometry of the described objects, which can be points, lines and polygons. Its extension is conventionally called SHP. These are shape files on the administrative boundaries of Douala, the hydrographic network, the road network, economic activities, etc. These data come from INC and BUCREP.

➢ *Images used*

- *Images from Google Earth pro*

The Google Earth image gives us a 2 or 3 dimensional graphical representation of land use. This allows us to see in real time everything that is in the city of Douala (physical and human facts) with very specific characteristics of each area of land use.

- *Landsat Images*

The Landsat sensor images we obtained are those downloaded from the GLCF website (http: /glcfapp.glcf.umd.edu: 8080 / esdi / index.jsp). They relate to three periods, namely 1975, 2007 and 2020. The satellite image of the Landsat sensor is known for its many applications in land use analysis and diachronic study. The images used are among others Landsat MSS (1975), Landsat ETM + (2007) and Landsat OLI (2019).

Questionnaire surveys were conducted among households in the six districts of the city of Douala. A total of 300 households were surveyed. The questionnaire subdivided into five sections intended for households focused on: a- access to water, b- access to health, c- access to electricity, d- access to sanitation e-The action of local authorities in terms of preservation of the living environment.

III. RESULT

A. *Monitoring by remote sensing of the spatial spread of the city of Douala between 1975 and 2020*

To carry out this study, we used land use maps.

➢ *Land use in the city of Douala in 1975*

In the years 1975, urbanization was very weak in the city of Douala, the economic capital of Cameroon. Indeed, the discretization of the satellite image of the city of Douala in 1975 shows that urban sprawl was not very pronounced. There is a high density of the plant cover and a low density of the building (Cf. Table 1). Vegetation brings together crops and forests. The hydrographic network is very dense.

Table 1: Types of land use and their areas in 1975

Thematic classes	Surface area in 1975 (m2)	Surface area in 1975 (ha)
Building	23 433 115	2 343,31
Forest	823 566 143	82 356,61
Culture	14 945 418	1 494,54
Hydrographic network	112 986 094	11 298,60
Total	974 930 770	97 493,07

Source: MSS landsat image of the city of Bafoussam, 1975

At the end of the image processing (Cf. Figure 5), we note that the built surfaces represented 2.40% of the total area of the city of Douala, the forest 84.47% and the crops 1.53%. The rivers represented 2.02% (see Figure 2).

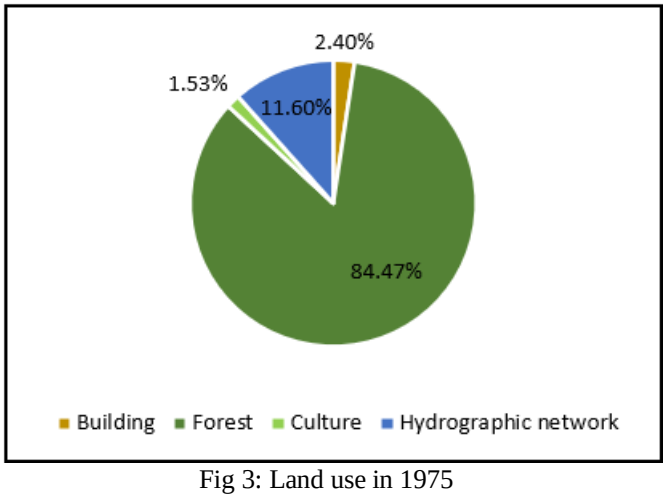

Fig 3: Land use in 1975
Source: Landsat MSS image, 1975

The populations were concentrated in a small area of the districts of Douala I, Douala II, Douala III and Douala V, mainly in the districts of Brazzaville, Bonaloka, Newbell, Bonapriso, Akwa, Bonadibong, Bassa and Bépanda, etc. The outskirts consisted of a vast expanse of forest and Douala VI was unoccupied.

➢ *Land use in the city of Douala in 2007*

Between 1975 and 2007 the city of Douala experienced strong demographic growth, the result of migration and natural increase. In this context, spatial spread has accelerated mainly in four Sub-Divisions, namely Douala I, Douala II, Douala III and Douala V, especially from the center to the periphery. This strong urban growth did not have any major negative effects on the vegetation cover and gave birth to new districts such as Bonabéri, Bonanjo, Deido, Akwa Nord, Nkolbong, etc.

ISSN No:-2456-2165

Table 2: Types of land use and their areas in 2007

Thematic classes	Surface area in 2007 (m2)	Surface area in 2007 (ha)
Building	94 542 847	9 454,28
Forest	750 424 893	75 042,48
Culture	2 909 164	290,91
Hydrographic network	100 877 462	10 087,74
Total	948 754 366	94 875,43

Source: ETM + landsat image of the city of Douala, 2007

The built-up areas, the result of the expansion of the city, increased sharply in 2007, indicating the decline in plant cover in favor of the growth of buildings (Cf. Figure 5).

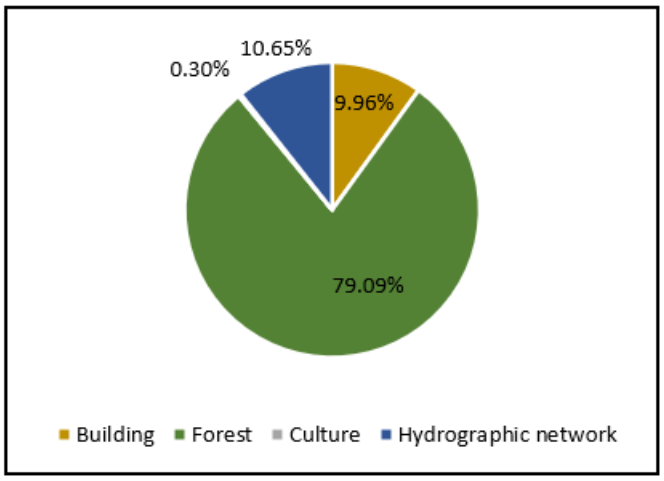

Fig 3: Land use in 2007
Source: Image landsat ETM +, 2007

Built-up areas represented 9.96% of the total area of the study area in 2007, forest 79.09%, crops 0.30 and rivers 10.65% (Cf. Figure 5). There is a progressive presence of buildings in the city of Douala VI.

➢ *Land use in 2019*

In order to better illustrate the phenomenon of the spatial extension of the city of Douala, the processing of a third image was necessary (Cf. Figure 7). The discretization of the Landsat's image made it possible to distinguish, as in the other images (1975 and 2007), the different forms of land use in the study area. We can see that the plant cover has declined considerably, while the building has gained space (Cf. Table 3).

Table 3: Types of land use and their areas in 2019

Thematic classes	Surface area in 2019 (m2)	Surface area in 2019 (ha)
Building	207 823 349	20 782,33
Forest	572 229 814	57 222,98
Culture	83 451 785	8 354,17
Hydrographic network	111 431 893	11 143,18
Total	974 936 841	97 493,68

Source: ETM + landsat image of the city of Douala, 2019

Buildings, made up of housing and socio-collective infrastructure, etc. occupies 21.31% of the surface area of the city of Douala. Forests occupy 58.69%, crops 8.56% and rivers 11.44% (Cf. Figure 4).

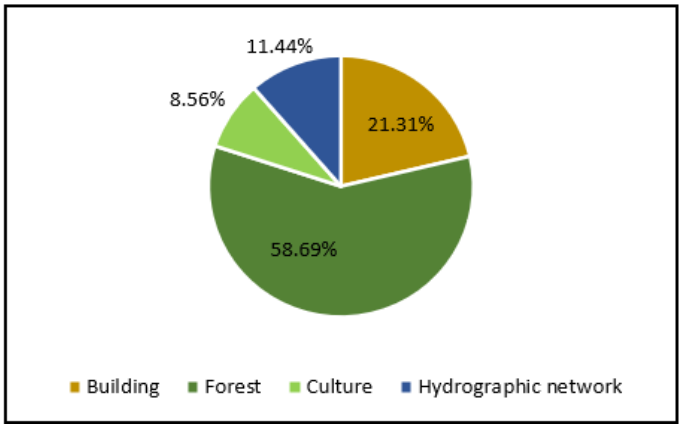

Fig 4: Land use in 2019
Source: Landsat OLI image, 2019

The sharp increase in the area of buildings is mainly linked to urbanization. Cultivated areas have also increased in order to satisfy urban populations with food resources. District municipalities such as Douala I, Douala II, Douala III and Douala V have experienced a strong expansion of buildings.

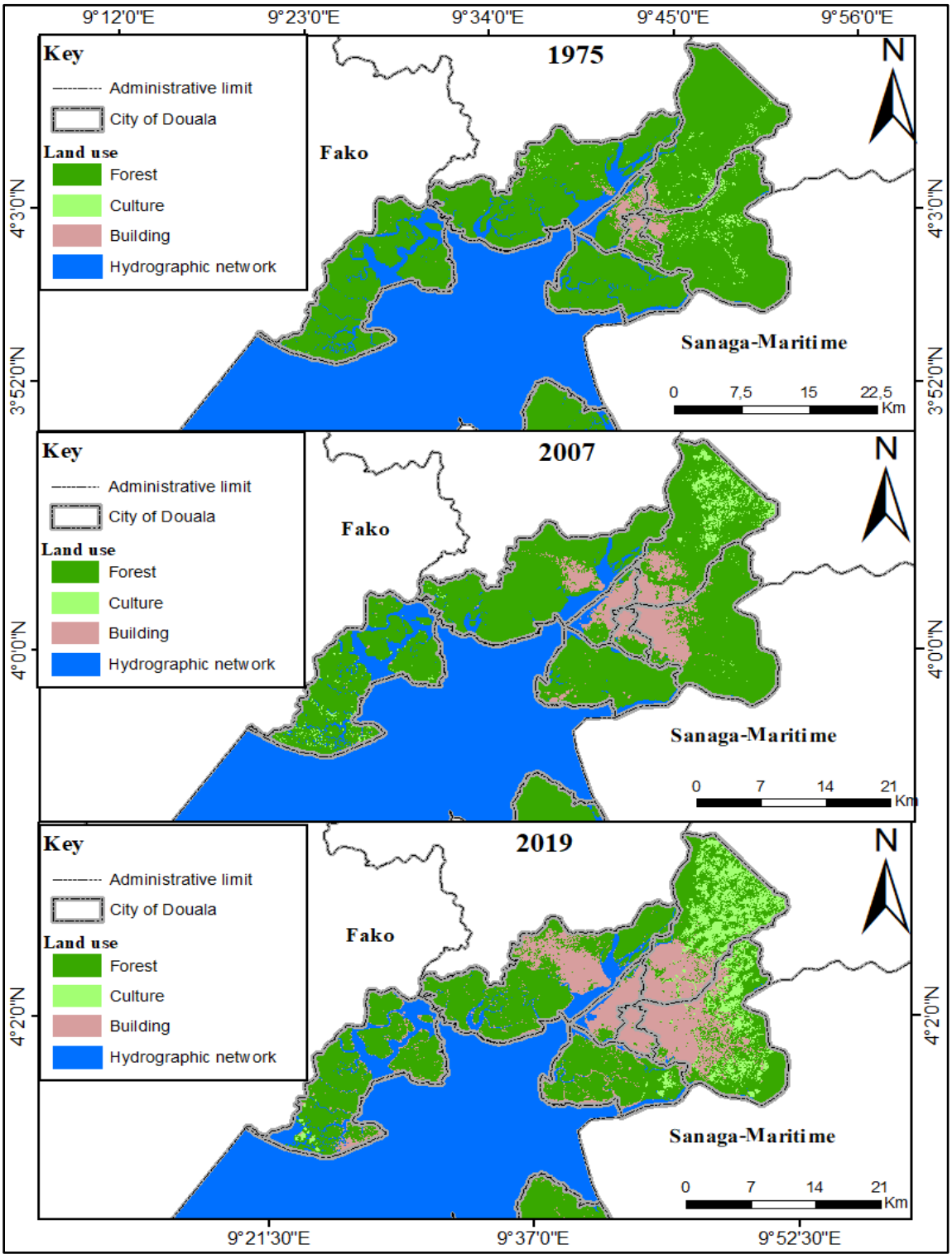

Fig 5: Evolution of land use in the city of Douala in 1975, 2007 and 2019
Source: Landsat image of the city of Douala in 1975, 2007 et 2019

ISSN No:-2456-2165

The spatial extension (Cf Photo 1) of the building mainly in the four districts namely Douala I, Douala II, Douala III, Douala IV and Douala V is due to the fact that these districts are the seat of the economic activities of the city of Douala [5].

Photo 1: Urban sprawl in Douala
Source: Municipality of Douala II, 2020

It should also be noted that agricultural activities have developed well in the outskirts to meet the needs of the increasingly large populations.

B. Analysis of the Causes of The Space Spread of the City of Douala

The spatial spread of the city of Douala is linked to a set of causes including population growth, the development of basic services and equipment, opening up of the city and the development of economic activities, etc.

➢ *A growing population*

The city of Douala is home to a dense and heterogeneous population. It is a community made up of a minority of in-migrants and the vast majority of indigenous people. According to the last census carried out in 2005, the population of the city of Douala was estimated at 1,907,479 inhabitants and represents 76% of the entire population of the Littoral Region. Its annual average growth rate was estimated at 4.7% between 1987-2005. It tripled in twenty years from 1980 to 2000 and attracts over 100,000 newcomers each year. The population density is estimated at 3,830 inhabitants per km2.

Table 4: Evolution of the population of the city of Douala between 1976 and 2020

Years	Population
1976	637 000
1987	810 000
1991	884 000
1999	1 448 300
2001	1 574 978
2005	1 907 479
2014	2 943 000
2020	3 375 000

Source: Bucrep, 2020

Nevertheless, Douala is today a mosaic of the different ethnic groups that make up Cameroon. The inhabitants of the city of Douala are made up of Bamiléké, Bassa, Béti, the "Northerners" and "Anglophones". The city owes its recent growth to the rural exodus which has pushed hundreds of thousands of Cameroonians to leave their countrysides to settle in the cities. The city of Douala has 3 indigenous peoples namely the Bassa, the Douala and the Bakokos and foreigners such as Africans, Europeans, Asians and Americans [6]. Today, that population is estimated at approximately 3 375 000.

➢ *Development of human activities, factor of spatial expansion*

The city of Douala, the economic capital of Cameroon is spread over the boundaries of the Wouri Division and is divided into six districts (Douala I, Douala II, Douala III, Douala IV, Douala V and Douala VI). It has 118 sub-districts districts unevenly distributed among the different districts.

The city of Douala is considered the economic heart of Cameroon. It is the main gateway to and from the country. Its port and airport are among the most important in Africa.

The city of Douala alone accomodates 80% of the country's industrial production. The industrial sector consists of manufacturing activities in the areas of food products and manufacturing. Most of these industries were built in downtown Douala and in some outskirts. The Bonabéri district has a high concentration of industries close to the port. There are industrial companies in districts such as Bébanda, Bonamoussadi, Cité CICAM, Makèpè, Ndogbong, Ndokotti, etc. They played a role of attracting the populations, who came to settle there and have developed other activities which contributed to the sprawl of the city of Douala [7].

The general business census carried out in 2009 by MINEPAT reveals that out of 93,669 businesses and establishments listed in Cameroon, 35.1% are located in Douala [8]. These numerous economic opportunities of the city of Douala are at the origin of its high rate of urbanization. The Yassa district owes its development to the Japoma stadium.

ISSN No:-2456-2165

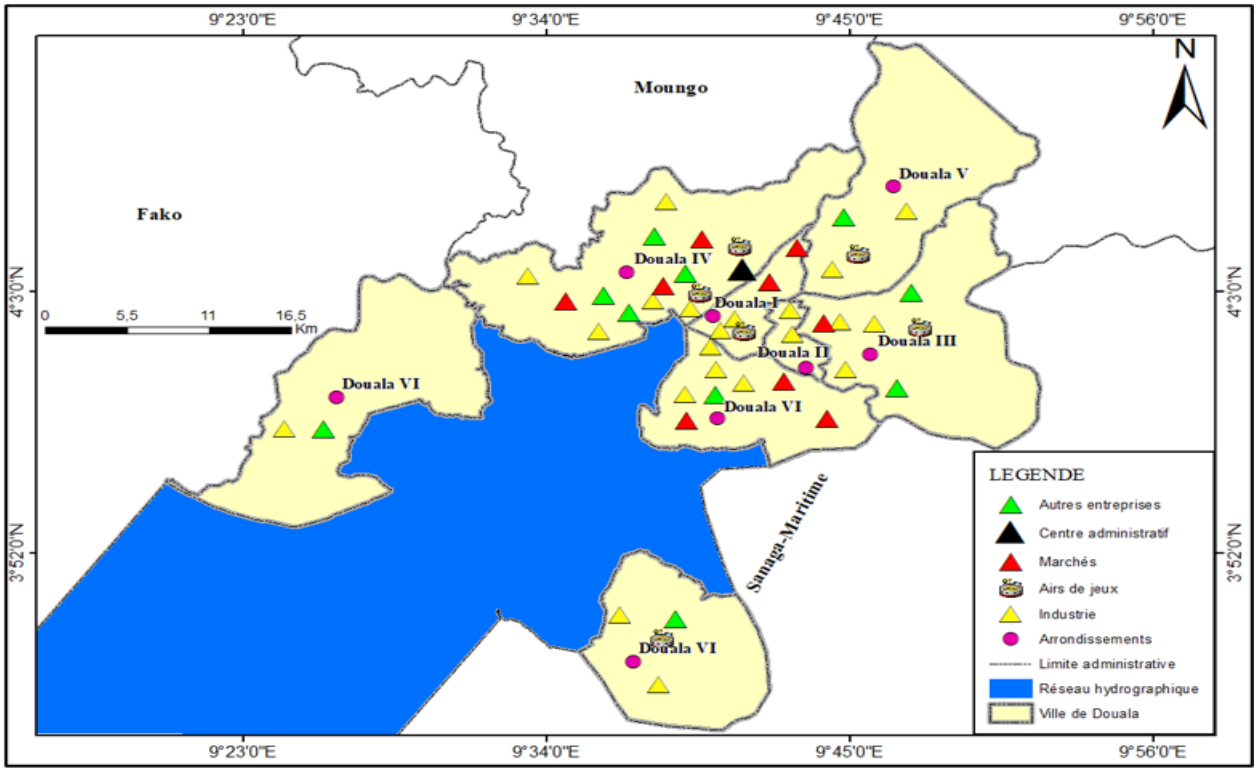

Fig 6: Factors of expansion of the city of Douala
Source: GPS surveys 2020 plus CUD archives, 2017

Other factors such as administrative structures, markets (Congo market, Akwa market, Ndokoti market, etc.) football stadiums (Japoma and Bépanda stadium), university institutions, the development of communication channels have led to the spatial extension of the city of Douala (Cf. Figure 6).

C. Analysis of the Consequences of Space Spreading in the City of Douala

The spatial growth of the city of Douala mainly linked to human activities has multiple consequences. These include, among other things, the development of precarious neighborhoods, the reduction of agrarian spaces, the anarchical occupation of areas at risk, etc.

➢ *Development of precarious neighborhoods*

The sprawl of the city of Douala has been accompanied by the development of precarious neighborhoods. The expression precarious neighborhoods designates unhealthy urban neighborhoods, made up of precarious constructions and lacking for the most part of coherent networks of water supply, electricity, sanitation, etc. Space is small, whether it is the width of the communication routes, the size of the rooms and their number per dwelling. These are underprivileged urban areas whose constructions are largely made using recycled materials and the environment (Cf. Plate 1) is characterized by general unsanitary conditions. Precarious neighborhoods like New-Bell, Bépanda petit wouri, Bépanda yong yong, Bépanda road network, Village, Makèpè Missokè, Makèpè Maturity, Makepè old landfill, etc. which yesterday were sparsely populated areas which experienced stronger population growth [9].

Plate 1: Degraded road in Village and housing to demolish a lowland in New-bell
Source: Image Kengmoé Emmanuel, 2020

ISSN No:-2456-2165

The populations who occupy these "non-aedificandi" areas in the city of Douala are foreigners in particular made up of resourceful people who have not been able to obtain space in the subdivided areas. They invest in the hydromorphic zones, the uneven slopes, the tops of the interfluves, etc. and are exposed to the risk of landslides and floods. Some of them are, like the swamps, considered by the public authorities as unbuildable sites that fall within the national domain.

The hydromorphic lowlands have also been invaded by the destitute. These are sites vulnerable to flooding. They are the receptacle for all wastewater and waste from heights.

There is still a certain alternation between areas where the flow of water is continuous and the marshy reaches characterized by the slowness of the flow. These hydromorphic zones are declared non-constructible by the town planning documents, because the hygiene and sanitation conditions are deplorable.

➢ *Difficulty accessing health*

The spatial spread of the city of Douala ultimately poses difficulties in accessing health care for certain households, in particular those located in the perimeters and peripheries of our study area. The chronological and spatial evolution of the supply of healthcare highlights the dynamics that determine their distribution. The provision of public health care in the city of Douala is the result of a long process rooted both in the history of its development and in health policies. The distribution of health facilities leads to inequalities, limiting the possibilities of some city dwellers to access health care. Indeed, the health establishments are concentrated in the central districts [10].

The Wouri health district also includes public health facilities (district hospital of the city of palm trees and Laquintinie Hospital) which are not managed by the Ministry of Health. Apart from a few private denominational establishments, most of the districts of the city of Douala do not have public health care structures.

The distance to access healthcare is a good indicator of the availability of health services [11]. According to the WHO, a health service is geographically accessible if it is located within 5 kilometers of the user. In the city of Douala, city dwellers travel long distances to access health care.

➢ *Access to solid and liquid waste sanitation*

The management of waste and household refuse is becoming more and more difficult in a context marked by the spatial spread of the city of Douala. It is increasingly difficult for Hysacam's services to cover the entire increasingly expanding study area.

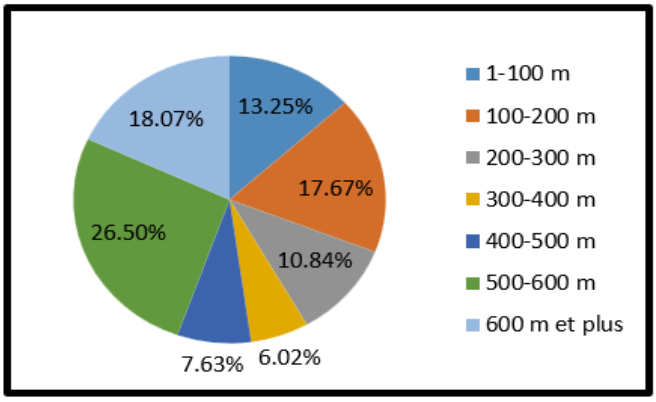

Fig 7: Distance traveled by households in the city of Douala to dispose of household waste
Source: Field surveys, 2020

The populations of the study area discharge a large part of their waste in unauthorized places. Here, waste management is the responsibility of each household. Collection and removal, theoretically the responsibility of each municipality since July 1, 1989, have not been put into practice due to the scarcity of available resources. People travel long distances to dispose of household waste. Field investigations show that 13.25% of households travel between 1 and 100 m to evacuate garbage, 17.67% between 100 and 200 m, 10.84% between 200 and 300 m, 6.02% between 300 and 400 m, 7.63% between 400 and 500 m, 26.50% between 500 and 600 and 18.07% 600 m and more (Cf. Figure 7).

In isolated areas with a high population density, piles of garbage pile up and sometimes even occupy traffic routes, while in lowlands, rivers are the main medium used to evacuate all waste (water waste and household waste). It is not too much to say that the rivers in the study area are open sewers (Cf. Plate 2).

ISSN No:-2456-2165

Plate 2: Living environment degraded by waste
Source: Kengmoé Emmanuel, 2020

In all districts of the city of Douala, illegal solid waste dumps proliferate near the tracks (Cf. Plate 2), in gullied or flooded sectors, in riverbeds, and everywhere. Hysacam's garbage bins are non-existent or very few in number compared to the number of households served.

- *Difficulty accessing electrical energy*

Electric power is distributed in the city of Douala by ENEO. It is distributed by aerial networks on poles (in iron, wood, or concrete). The electricity is carried out by cables stretched between the poles. For a city in full growth and confronted with a spatial spread, the infrastructures are insufficient to remedy the problems of electric energy. As a result, the districts served with electricity are located in the city center most particularly. The outskirts of the city of Douala are poorly supplied with electrical energy [12].

In the study area, few households are connected. Consumers for domestic use are regularly confronted with the load shedding they experience all the time.

- *Drinking water supply*

In the study area, households are finding it increasingly difficult to access drinking water. This situation is explained by the fact that, urban sprawl has led to an inability to connect urban districts, in particular the surrounding and peripheral districts, to the Camwater supply network. This company faces technical and material difficulties.

The supply of drinking water in the city of Douala essentially involves two aspects: the Camwater network, and decentralized water supply solutions (BFP, BFC, wells, sources, etc.).

- *Reduction of agricultural land*

The sprawl of the city of Douala is at the origin of peri-urbanization. This is the process of developing the outskirts of cities. This phenomenon has negative effects on agricultural land. It contributes to the reduction of cultivable spaces. All the agricultural land that was located in the peripheral spaces of the study area is occupied by buildings.

Other consequences of the spatial spread of the city of Douala are to be noted, including the problem of displacement. City dwellers located in the outskirts of the study area are sometimes forced to make long journeys to reach shopping centers, schools, the administrative center, etc.

IV. DISCUSSION

The first results illustrate a clear progression of the urban fabric which, in particular is more intense in Douala I, Douala II, Douala III, Douala IV and Douala V but with slightly different annual growth rates. The extent of the sprawl phenomenon of the city of Douala between 1975 and 2019 resulted in a fragmentation of landscape structures through the increase in the number of new urbanized areas. With an increase in the number of urban fragments reaching 21.31%. The results indicate a rapprochement of artificialized surfaces and a sprawl of agricultural and natural peri-urban areas, particularly during the period 2007-2019. Moreover, the reconstruction of the trajectories of land use changes shows that urban expansion has occurred more to the detriment of crops and forests. Nevertheless, the peripheral green spaces constitute more than 50% of the surface area of the city of Douala. These results confirm the observation that the city, as it expands, increasingly degrades green spaces from the city center to its periphery [12]. This trend illustrates the anarchical development of urban space to the detriment of the environment in recent years from [13]. It reflects the spontaneity observed in the sprawl of cities in Third World countries, especially on the outskirts of the city [15]. The comparison between the three periods makes it possible to identify the main evolutions. Depending on the periods considered, this continuous consumption of space took place with slightly different growth rates (± 10 ha / year), the equivalent of 111 pixels of 30 m spatial resolution. The strongest urban expansion was recorded during the 2007 and 2019 period. The lowest land consumption was observed during the two periods 1975-2007, while the 2007-2019 period was marked by a new acceleration in the expansion of artificial surfaces. . The continued urban expansion is partly explained by the fact that the period 2007-2019 was characterized by high urbanization [16]. The year 2019,

described as the dissemination phase, is distinguished by a form of urban expansion. It is marked by the urbanization of new spaces through the creation of isolated urban fragments, particularly in Douala VI. Over time, these new fragments serve as a starting point for new centers of urbanization. The urban expansion of the city of Douala is increasingly driven by the peri-urban municipalities which take over and whose pace clearly differs from that of the urban core [17]. Thus, the new artificial surfaces during the period 2007-2019 result from the continuous extension of the existing urban area following a process of polarization of the neighboring rural space. The spread of the city of Douala has enormous consequences, including the development of precarious neighborhoods, the difficulties of access to urban services by city dwellers such as water, electricity, health, education, etc. The spatial growth of cities in poor countries strongly contributes to environmental degradation [18]

V. GENERAL CONCLUSION

At the end of this work, we dare to assert that demographic growth and the development of human activities are the pillars of the spatial spread of the city of Douala. The purpose of this study was to study the spatial spread of the city of Douala using remote sensing. Our investigations show that the city of Douala has experienced spectacular demographic and spatial growth, coupled with an overcrowding of houses for several years. From this situation arose various problems including urban sprawl. It emerges that the city of Douala has experienced strong spatial dynamics in recent decades due to the multiple opportunities it offers. These opportunities have led to waves of migration.

It is shown from satellite data that between 1975 and 2019, the study area experienced a spatial spread from the center to the periphery. This spread of the urban fabric to its periphery can be seen in the invasion of green spaces and farmland. In 1975, the forest occupied an area of 82,356.61 ha and the building 2,343.31 ha. Crops occupied an area of 1,494.54 ha and rivers 11,298.60 ha. In 2007, the built area increased from 2,343.31 ha to 9,454.28 ha, forest from 82,356.61 ha to 75,042.48 ha, crops from 1,494.54 ha to 290.91 ha and rivers from 11,298.60 ha to 10,087.74. In 2016, the built-up area fell from 9,454.28 ha to 20,782.33 ha while the forest area continued to decline. Crop areas increased (8,354.17) in 2016.

This ever-increasing spatial spread of buildings is explained by the increase in the population of the city of Douala. It should also be noted that a large number of elements led to this spatial dynamic, including economic activities such as the autonomous port and industries that gave birth to districts such as Bonabéri, New-bell, Bépanda, ndongbong, etc. and the development of communication channels. The administrative center from its creation, will attract populations who will concentrate around it giving birth to other neighborhoods.

The sprawl of the city of Douala has had various consequences, including difficulties in accessing healthcare, sanitation, the development of deprived neighborhoods, etc. The populations of the study area and those of the peripheries in particular have difficulty rallying together structures such as schools, shopping centers, etc.

REFERENCES

[1]. Ngnikam E, Mougoue B, Tietche F., (2007). Water, sanitation and impact on health: case study of an urban ecosystem in Yaoundé, acts of the jsirauf, p13.
[2]. Demaze M. T. et al. (2012). Mapping and multi-scale assessment of urban sprawl using spot xs images: example of Mans (Ouest-France), five continents 3, p 45-47.
[3]. Bucrep, (2010). Third general population and housing census (RGPH). Results presentation report (March 30, 2010), 65 p.
[4]. CUD-SOGREAH, (2006). Study of the sanitation master plan for the city of Douala and project management of a priority phase of works: final report of phases 3 and 4: comparative analysis of the diagrams and presentation of the solution adopted, 145 p.
[5]. Houvounsaci J. et al., (2011). Douala, economic capital. Architecture, lyon, localities, 56 p.
[6]. René G., (1975). Douala, city and history, Paris, institute of ethnology / museum of man, 402 p.
[7]. Mainet G., (1985). Douala, growth and servitudes, paris, l'harmattan, 187 p.
[8]. Megopé J.P., (1985). Douala, toponymy, history and cultures, yaoundé, ifrikiya, 125 p.
[9]. CUD-Urbaplan., (2009). Development strategy for the city of douala and its metropolitan area, 158 p.
[10]. CUD-group eight-as consultants, (2015), master plan of urbanization of douala horizon, 227 p.
[11]. Michelon B., (2007) “the daily newspaper in douala”, in town planning p 25-30
[12]. Séraphin G., (2000). Living in douala. Imagination and action in an African city in crisis. Paris, l'harmattan, 258 p.
[13]. Nantchop T.V., (2015), urban public action put to the test of water service reforms in douala, géocarrefour, 18 p
[14]. Tende R. T., and Kengmoe, E. T. (2020). Urban overspill and its upshot to the Bafoussam emergent metropolis in Cameroon. advancees in social sciences research journal, 7 (4) 137-147
[15]. Soulillou J., (2018). Douala: a century in pictures, the harmattan, paris, 121 p.
[16]. Urban Community of Douala (2012). Agenda 21 of the city of Douala 96 p.
[17]. Kenfack T., (2019). Spatial growth of the city of Douala and its consequences, Harmattan, Paris, 411 p.
[18]. CUD-SOGREAH, (2006). Study of the sanitation master plan for the city of Douala and project management of a priority phase of works: final report of phases 3 and 4: comparative analysis of the diagrams and presentation of the solution adopted, 145 p.