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Research Paper

Demographic and Functional Analysis of Cities In Southwestern Cote D'ivoire.

Kouamé Pascal KONAN
Institute of Tropical Geography,
University Félix Houphouët-Boigny of Cocody/Abidjan (Côte d'Ivoire)

ABSTRACT: *Since the 1970s, the west of Côte d'Ivoire has been the new cocoa loop that has succeeded the east. For a long time, the development of this region was based on a plantation economy that attracted an influx of population to the western localities (Gagnoa, Lakota, Soubré, San-Pedro, etc.) with more or less urban characteristics. How are the cities distributed hierarchically in the southwestern part of Côte d'Ivoire? The study of city systems is insufficiently carried out in Côte d'Ivoire and particularly in this part of the country which has undergone profound demographic changes. Our study focuses on the demographic and functional analysis of the urban system in the southwest of Côte d'Ivoire. To conduct this study, it was first necessary to carry out an application of the Rank-Size law to the cities of the west selected from the size (population) of the localities in the region on the basis of data from the general population and housing census (RGPH-2014). The cities of 10,000 inhabitants and more were selected to establish a hierarchical distribution of the western city system. Then, a second distribution was made on the basis of the administrative hierarchy of the cities of the Southwest, which confirmed the trends of the first. The results of the study reveal 3 hierarchical levels in the distribution of the cities of the Southwest both on the basis of the Rank-Size law and with the functional analysis of the cities. This urban network is polarized differently by San Pedro and Gagnoa. In sum, the populations converge towards the most functional cities,that is to say the best equipped, and therefore the most attractive.*
KEYWORDS: *urban system, rank-size law, hierarchical level, Daloa, Côte d'Ivoire*

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I. INTRODUCTION

The city systems (urban systems) that can be observed in the world were formed in extremely varied historical contexts. Africa's city system dates back to antiquity, but it has sometimes been profoundly reshaped by colonial occupation, especially in Black Africa (Bretagnolle A., Pumain D., Vacchiani-Marcuzzo C., 2007, p.1). The study of city systems emphasizes the relational aspects, interactions and interdependencies between the cities of an urban network. Thus, cities, organized in systems, bring into play different types of relationships (functional, competitive, synergistic and hierarchical). Regarding the organization of cities into systems, Pumain D. (2006, p.3) points out that there is an urban hierarchy such that the number of cities follows a geometric progression that is the inverse of their (demographic) size. This is in fact an assumption made by the Rank-Size law. This law reveals the regularity of the distribution of the number of cities according to their (demographic) size in a regional, national or global urban system.

However, many studies deal with the issue of urban systems at different scales, but very few have focused on regional urban systems within African countries. Since the 1960 stewardship, Ivorian decision-makers have always opted for polarized development, which consists of setting up cities as regional hubs. It now appears necessary to study these regional urban networks in Côte d'Ivoire. Thus, this study has been conducted in the context of all the cities in the southwest of the country.

This region of the South-West under study here covers two current administrative districts, Bas-Sassandra and Gôh-Djiboua. Through a detailed analysis of the urban system, the study will reveal specific regional situations. The objective of this study is to characterize the urban system of the Southwest through a demographic and functional analysis of the cities.

II. METHOD AND DATA

This study is the application of a classification method in experimentation. Following an unsuccessful attempt to apply the rank-size law to the cities of southwestern Côte d'Ivoire, we tried to set up a classification method that would allow us to rank these cities, which are probably less numerous, for the application of the rank-size law. This is a demographic hierarchy of the urban system of southwestern Côte d'Ivoire. The functional hierarchy of these cities is then analyzed in order to validate the classification method adopted. In order to conduct the study, it is necessary to clarify the meaning given to the city in Côte d'Ivoire. According to the Institut National de la Statistique (INS, 1998), a city is defined as a locality with at least 4,000 inhabitants, with a political and administrative function, and in which the non-agricultural working population is equal to or greater than 50.0% of the total working population. It differs from a village in the level of its community facilities.

However, this study refers to data from the 2014 general population and housing census (RGPH) (INS, 2015). On this basis, it was retained the chief localities of urban communes respecting the demographic size given in the INS definition. Thus, an urban system of 21 towns in the southwestern region of Côte d'Ivoire was formed (Table 1).

Table 1: Cities constituting the urban system of southwestern Côte d'Ivoire

Rank	City	Population
1	San-Pedro	164 944
2	Gagnoa	160 465
3	Divo	105 397
4	Soubré	101 196
5	Méagui	57 367
6	Oumé	45 210
7	Diégonéfla	33 523
8	Hiré	31 960
9	Sassandra	26 608
10	Buyo	25 339
11	Lakota	24 976
12	Grand-Zattry	24 166
13	Tabou	22 733
14	Guiberoua	18 029
15	Guéyo	11 633
16	Guitry	11 445
17	Ouragahio	11 253
18	Grand-Béréby	9 338
19	Mayo	9 303
20	Grabo	8 980
21	Fresco	8 533
Total urban population		912 398

Source: INS, 2015 (RGPH 2014)

The application of the rank-size law (Zipf's law) to the selected system of cities required calculations that made it possible to find the theoretical populations (Po) of the cities, the logarithms of the ranks (Log (rank)), the logarithms of the theoretical populations (Log (Pt)), the deficits (in %). The processing of the demographic data began with a classification of the cities in the system in descending order, which were assigned a rank (Table 1).

For the calculation of the theoretical populations (Pt), the zipf law in its simplified form was used, i.e., the slope was assumed to be equal to 1. However, the theoretical population of the first city was calculated on the basis of the total population of the urban system using the following formula

P1=P / (1+1/2+1/3+...1/21) where P1 is the theoretical population of the first city and P is the total urban population of the city system (21 cities).
As for the theoretical populations of the other cities, they were obtained by :
Theoretical Pr = P(r-1) observed x (r-1) / r), where r is the rank of the city and P, the population.
Finally, the deficit is the deficit of the observed population compared to the theoretical population in % of the observed population, formulated as follows: (Theoretical Pr - Observed Pr) / Observed Pr).
In addition, we used statistical data from the cities in the urban network studied on facilities and services. These statistics date from 2010 and come from the INS. They were used to establish the functional hierarchy of the cities.

III. RESULTS

III.1. Demographic analysis of the urban system in southwestern Côte d'Ivoire

III.1.1. Regional application of the rank-size law to the cities of southwestern Côte d'Ivoire

Table 2: Application of the rank-size law to cities in southwestern Côte d'Ivoire

Rank	City	Population Actual (Po)	Theoretical population (Pt)	Log (rank)	Log (Pt)	Deficit (%)	Hierarchical level
1	San-Pedro	164 944	250 290	0,00	5,40	51,74	1
2	Gagnoa	160 465	82 472	0,30	4,92	-48,60	1
3	Divo	105 397	106 977	0,48	5,03	1,50	1
4	Soubré	101 196	79 048	0,60	4,90	-21,89	1
5	Méagui	57 367	80 957	0,70	4,91	41,12	2
6	Oumé	45 210	47 806	0,78	4,68	5,74	2
7	Diégonefla	33 523	38 751	0,85	4,59	15,60	3
8	Hiré	31 960	29 333	0,90	4,47	-8,22	3
9	Sassandra	26 608	28 409	0,95	4,45	6,77	3
10	Buyo	25 339	23 947	1,00	4,38	-5,49	3
11	Lakota	24 976	23 035	1,04	4,36	-7,77	3
12	Grand-Zattry	24 166	22 895	1,08	4,36	-5,26	3
13	Tabou	22 733	22 307	1,11	4,35	-1,87	3
14	Guibéroua	18 029	21 109	1,15	4,32	17,08	4
15	Gueyo	11 633	16 827	1,18	4,23	44,65	5
16	Guitry	11 445	10 906	1,20	4,04	-4,71	5
17	Ouragahio	11 253	10 772	1,23	4,03	-4,28	5
18	Grand-Béréby	9 338	10 628	1,26	4,03	13,81	5
19	Mayo	9 303	8 847	1,28	3,95	-4,91	5
20	Grabo	8 980	8 838	1,30	3,95	-1,58	5
21	Fresco	8 533	8 552	1,32	3,93	0,23	5

Source: INS, 2015 (RGPH 2014)

The table above presents the results of the application of the rank-size law to the urban system of southwestern Côte d'Ivoire. It highlights the hierarchy of cities according to their demographic size. Thus, the urban system of southwestern Côte d'Ivoire is subdivided into 5 hierarchical levels. The first level contains 4 cities with more than 100,000 inhabitants each. Only 2 cities occupy the second level with population sizes ranging from 45,000 to 58,000. At level 3, there are 7 cities with population sizes ranging from 22,000 to 34,000. However, only one city is classified at level 4 with a population size of around 18,000. Finally, the last hierarchical level, i.e. level 5, includes 7 cities with populations ranging from 8,500 to 12,000 (Table 3).

However, 19.04% of the cities classified at level 1 contain 58.31% of the population of the southwestern urban system, while 33.33% of the cities classified at level 3 contain 20.75% of the population (Table 3).

Table 3: The distribution of the number of cities according to the hierarchical level

Hierarchical level	Size stratum (population)	Population	Proportion of urban population (%)	Number ofcity	Proportion (%)
1	≥ 100 000	532 002	58,31	4	19,04
2	[35 000-100 000[	102 577	11,24	2	9,52
3	[20 000-35 000[	189 305	20,75	7	33,33
4	[15 000-20 000[	18 029	1,97	1	3,33
5	[8 500-15 000[	70 485	7,72	7	6,66
Total		912 398	100,00	21	100,00

Source: INS, 2015 (RGPH 2014);Calculations of the author.

III.1.2. Primacy indices of the urban system

Table 4: Primacy indices of the southwestern urban system

Indice	Formule	2014	Value of a simplified theoretical Zipf distribution: Pr=P1/r
Indice de Jefferson	Ij= P1/P2	1,03	2
Indice de Steward	Is= P1/(P2+P3+P4)	0,45	0,926
Indice p1	p1= P1/∑P	0,18	1/∑ (1+1/2+…1/n)
Indice p2	p2= P1/b	0,65	1
Indice p3	p3= (P1-b)/b	-0,34	0

Source: Calculations of the author.

Table 4 presents five (5) primacy indices for the urban system of southwest Côte d'Ivoire. The Jefferson index, i.e., the ratio of the first city to the second city, is 1.03. This index is low compared to its value in the case of a simplified Zipf theoretical distribution (I). This index is low compared to its value in the case of a simplified theoretical Zipf distribution (Ij=2). This value of the Jefferson index seems to reflect a decentralizing tendency of this regional urban system. This decentralizing tendency of the urban system is confirmed by the Steward index, which is low (Is=0.45) compared to its value in the case of a simplified Zipf theoretical distribution (Is=0.926). However, the p1 index gives the share of the first city (San Pedro) in the urban ensemble. Thus, the weight of the city of San Pedro is 18% in the system of southwestern cities.

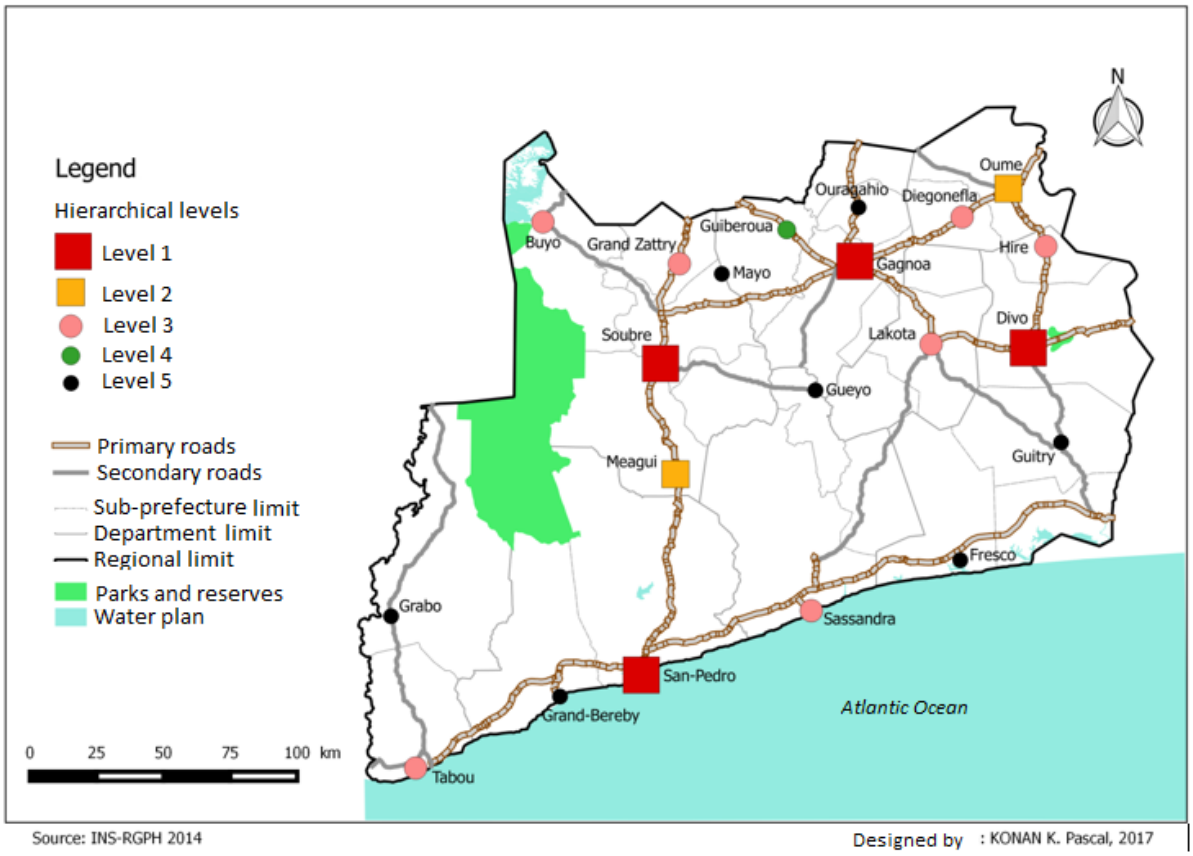
However, the p2 index, which is the ratio of the actual population to the theoretical population of the first city, is 0.65. This value of the p2 index, which is less than unity, reflects the settlement at the top of a group of cities in the urban system. Finally, the p3 index is negative (-0.34). This means that the actual size of the first city (San Pedro) is smaller than its theoretical size.

In sum, the analysis of the various parameters of the city system of southwestern Côte d'Ivoire in 2014 allows us to characterize it as follows: there is no primatial city in this system insofar as no city really stands out from the rest of the cities (no large gap). The system is characterized by decentralization and a reduction in the size of the first four cities (San-Pedro, Gagnoa, Divo and Soubré), which account for 58% of the urban population of the system. These four cities constitute the first hierarchical level of the urban system. However, in order to establish a complete urban hierarchy, a functional analysis of the urban system must be conducted.

III.2. Functional analysis of the urban system in southwestern Côte d'Ivoire

III.2.1. The structure of the urban system by the road network

Figure 1: Structuring of the urban system in southwestern Côte d'Ivoire



The analysis of the above figure highlights the following findings:

-San-Pedro, Soubré, Gagnoa and Divo seem to radiate over the entire southwest region. They are very well connected to each other by a network of primary roads. Their layout covers two-thirds (2/3) of the region.

-Level 2 centers are relays between level 1 centers (Méagui) or between Abidjan and the region as a whole (Oumé). However, these centers are relays to the country's two port cities (San Pedro and Abidjan).

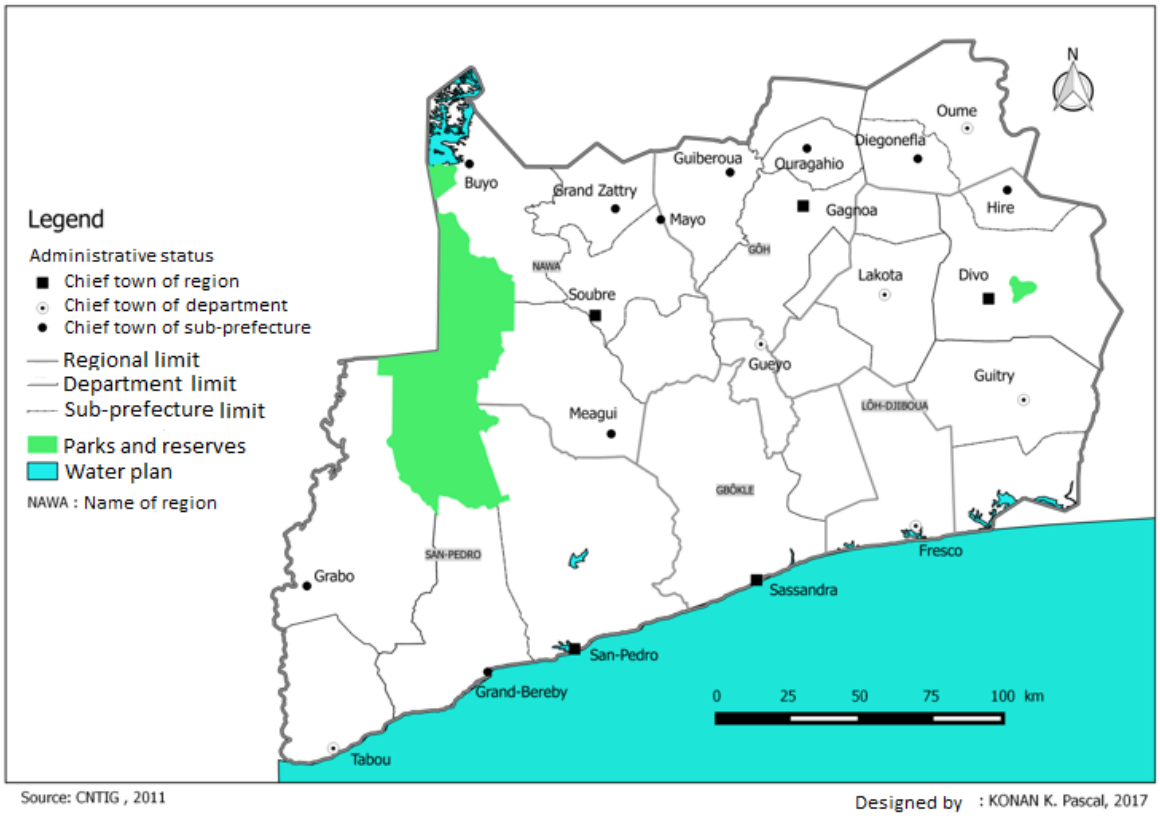
-Level 3 cities are located outside the group of level 1 and 2 centers and can be described as peripheral centers whose role is to extend the effects of level 1 and 2 centers to the surrounding area.

-There is only one level 4 center (Guibéroua) that is developing to fill a void left by level 3 centers on the Gagnoa and Issia axis.

-Finally, the level 5 cities are distributed essentially within the system on the secondary roads. Most of these centers owe their growth to the plantation economy, particularly cocoa.

III.2.2. An urban system guided by the administrative division

Figure 2: Administrative division of the Southwest region



Urban development in Côte d'Ivoire is a 20th century phenomenon. The current cities are colonial creations that responded to a concern for effective occupation of the territory under the control of military and administrative posts (Cotten A-M, 1974). Thus, Ivorian cities are more administrative centers that attract populations thanks to the administrative facilities present in these localities. In the southwestern urban system, the four dominant cities (Figure 1) are regional administrative centers (Figure 2) with a full range of administrative facilities. They are therefore the most attractive because they are better equipped.

The level 2 and 3 cities are mostly administrative centers at the level of departments (figure 2), which constitute relays between the regions and the sub-prefectures in the administrative organization.

However, all level 4 and 5 cities are administratively sub-prefectures (Figure 2), which act as relays between the village communities and the departments.

In sum, this urban system operates on the backbone of the administrative division of the southwest, which creates a hierarchy among the towns.

III.2.3. The economic functioning of the urban system

In the absence of economic data on the urban scale of the cities, we have analyzed departmental statistics integrating these cities.

III.2.3.1. Employment in public administration and security

Table 5: Jobs in public administration

Department	Workforce	Proportion (%)
San-Pedro	1828	25,39
Soubré	1082	15,03
Sassandra	304	4,22
Tabou	566	7,86
Divo	1412	19,61

Lakota	439	6,10
Gagnoa	1093	15,18
Oumé	477	6,62
Total	7201	100,00

Source: INS, 2010

Table 5 presents government employment by department in the Southwest region. Four of the eight departments in the region account for 75.21% of jobs. In order of importance, these departments are San-Pedro (25.39%), Divo (19.61%), Gagnoa (15.18%) and Soubré (15.03%). The other departments each account for less than 10% of public administration jobs in the region.
However, San-Pedro owes its first place to its status as a port city, which is a source of surplus public sector jobs related to port and maritime administration.

III.2.3.2. Jobs in financial institutions

Table 6: Jobs in financial institutions in the Southwest

Department	**Banks**		**Insurances**		**Total**	
	Workforce	***Proportion (%)***	***Workforce***	***Proportion (%)***	***Workforce***	***Proportion (%)***
San-Pedro	112	38,10	62	24,12	174	31,58
Soubré	29	9,86	45	17,51	74	13,43
Sassandra	6	2,04	1	0,39	7	1,27
Tabou	5	1,70	5	1,95	10	1,81
Divo	32	10,88	57	22,18	89	16,15
Lakota	13	4,42	7	2,72	20	3,63
Gagnoa	84	28,57	64	24,90	148	26,86
Oumé	13	4,42	16	6,23	29	5,26
Total	294	100,00	257	100,00	551	100,00

Source: INS, 2010

The table above shows the employment situation in financial institutions in the southwest, particularly in banks and insurance companies.

Overall, 58.44% of jobs in financial institutions are in the departments of San-Pedro and Gagnoa (31.58% and 26.86% respectively). These two departments are followed by Divo (16.15%) and Soubré (13.43%). The other departments have low employment rates in financial institutions (ranging from 1 to 5%). However, the number of jobs in the banking sector (294) is slightly higher than in the insurance sector (257).

This employment situation in financial institutions can be explained by the dynamics of the regional economies in each department. Indeed, the activity of financial institutions is based on the savings and solvency of economic agents, i.e., households and businesses. Thus, San-Pedro (a port city), Gagnoa, Divo, and Soubré (localities with high agricultural incomes) appear to have the most dynamic economies in the southwest.

III.2.3.3. Employment in hotels, restaurants and bars

Table 7: Jobs in hotels, restaurants and bars in the Southwest

Department	**Hotels**		**Restaurants et bars**		**Total**	
	Workforce	***Proportion (%)***	***Workforce***	***Proportion (%)***	***Workforce***	***Proportion (%)***
San-Pedro	432	53,33	586	25,52	1018	32,78
Soubré	83	10,25	574	25,00	657	21,15
Sassandra	36	4,44	149	6,49	185	5,96
Tabou	29	3,58	135	5,88	164	5,28
Divo	59	7,28	353	15,37	412	13,26

Lakota	26	3,21	117	5,10	143	4,60
Gagnoa	124	15,31	292	12,72	416	13,39
Oumé	21	2,59	90	3,92	111	3,57
Total	810	100,00	2296	100,00	3106	100,00

Source: INS, 2010

Table 7 presents the employment positions in the hotel, restaurant and bar sectors in the Southwest region. In the Southwest region as a whole, San-Pedro and Soubré have more than half of the jobs in the hotel, restaurant and bar sector (53.93%) with 32.78% and 21.15% respectively. The remainder, i.e. 46.07% of jobs, is shared between the other departments.

Specifically, the department of San Pedro alone offers more than half of the jobs in hotels (53.33%). However, in the restaurant and bar sector, San-Pedro and Soubré offer 50% of jobs.

In sum, the departments of San-Pedro and Soubré dominate over the other departments. Indeed, San-Pedro, because of its status as a tourist and port city, attracts more visitors (tourists) to the region. In Soubré, the dynamism of its plantation economy could explain its second place in terms of employment in the hotel, restaurant and bar sector.

III.2.3.4. Healthcare Jobs

Table 8: Number of doctors by department

Department	Workforce	Proportion (%)
San-Pedro	31	26,50
Soubré	24	20,51
Sassandra	10	8,55
Tabou	14	11,97
Divo	11	9,40
Lakota	4	3,42
Gagnoa	18	15,38
Oumé	5	4,27
Total	117	100,00

Source: INS, 2010

Table 8 presents the number of physicians practicing in each department of the Southwest. This distribution of physicians reveals that a quarter (26.50%) of these health professionals work in the department of San-Pedro, compared to a fifth (20.51%) in Soubré, 15.38% in Gagnoa, 11.97% in Tabou, and less than 10% for each of the other departments in the region.

It should be noted that nearly half (47%) of the region's physicians practice in only two departments (San-Pedro and Soubré).

This domination of these two departments could be explained by the health map of the study area, which favors these localities given their demographic content at the departmental level.

III.2.3.5. Jobs in the postal and telecommunications sector

Table 9: Number of jobs in post and telecommunications by department

Department	Workforce	Proportion (%)
San-Pedro	145	32,88
Soubré	40	9,07
Sassandra	16	3,63
Tabou	33	7,48
Divo	64	14,51
Lakota	34	7,71

Gagnoa	95	21,54
Oumé	14	3,17
Total	441	100,00

Source: INS, 2010

The table above shows the distribution of post and telecommunications jobs by department in the Southwest. The localities with the most jobs in this sector are San-Pedro (32.88%), Gagnoa (21.54%) and Divo (14.51%). The other departments each have less than 10% of jobs in the sector.
In addition, more than half (54.42%) of the jobs in the potes and telecommunications sector are in San-Pedro and Soubré.

III.2.3.5. Jobs in the industrial sector

Table 10: The number of jobs in industrial production by department

Department	Workforce	Proportion (%)
San-Pedro	48175	23,64
Soubré	36490	17,90
Sassandra	10644	5,22
Tabou	12123	5,95
Divo	40123	19,69
Lakota	8724	4,28
Gagnoa	33872	16,62
Oumé	13666	6,71
Total	203817	100,00

Source: INS, 2010

Table 10 presents the number of jobs in industrial production by department in the Southwest region. San-Pedro, Divo, Soubré and Gagnoa provide the most industrial jobs, with 23.64%, 19.69%, 17.90% and 16.62% respectively. The other departments each provide less than 10% of industrial jobs.
However, three quarters (77.85%) of the industrial jobs in the study area are in the departments with the four most populous cities (Table 1). Thus, industry appears to be the factor driving the high demographics in these cities.

Table 11: Public and private sector jobs in the Southwest

Department	Public jobs		Private jobs		Total	
	Workforce	***Proportion (%)***	***Workforce***	***Proportion (%)***	***Workforce***	***Proportion (%)***
San-Pedro	3486	20,21	28026	26,21	31512	25,38
Soubré	2781	16,13	25020	23,40	27801	22,39
Sassandra	1036	6,01	7141	6,68	8177	6,59
Tabou	886	5,14	9803	9,17	10689	8,61
Divo	3609	20,93	17803	16,65	21412	17,24
Lakota	1137	6,59	2914	2,73	4051	3,26
Gagnoa	3173	18,40	11893	11,12	15066	12,13
Oumé	1137	6,59	4325	4,04	5462	4,40
Total	17245	100,00	106925	100,00	124170	100,00

Source: INS, 2010

The table above shows the number of public and private sector jobs by department in the Southwest. Overall, in the region, nearly six out of seven jobs are in the private sector (86.11%). Everywhere, the private sector strongly dominates the public sector.

However, the quadruplet of San-Pedro, Soubré, Divo and Gagnoa dominates both public and private sector jobs, accounting for 75.67% of public sector jobs and 77.38% of private sector jobs. Thus, these four departments appear to be the most economically active, so much so that they are home to the four largest cities in the urban system of the study area.

IV. DISCUSSION

Urbanization in Côte d'Ivoire is a colonial legacy that was reinforced by the country's first political authorities after independence. Ivorian cities are embedded in a national system that appears to be strongly dominated by its economic capital (Abidjan). This study focused on one urban subsystem in Côte d'Ivoire, namely the southwest (Figure 2), which appears to behave differently from the national urban system.

The results of the study of this city system in terms of demographics reveal a system marked by decentralization and a decline in the top four cities (San Pedro, Gagnoa, Divo and Soubré), which account for 58% of the urban population of the region as a whole. Thus, there is no primatial city in this system. This urban framework could also be described as a polycephalous urban system. Cotten A.M. (1968, p. 224) had already made the same observations in her work on the cities of Côte d'Ivoire. Indeed, she states that, apart from Abidjan and Bouaké, the other towns form an urban cluster that is much denser in the forest and in contact with the savannah than in the countries of the North, and whose hierarchy is not apparent. However, Denis E. and Moriconi-Ebrard F. (2009, p. 5) later take a nuanced position by stating that the secondary cities have become hierarchical with several generations of agglomerations. Thus, the oldest and most favored cities have had time to become large cities, as our study shows with San-Pedro, Gagnoa, Soubré and Divo.

However, the analysis of the city system based on the rank-size law is also based on the analysis of the functional weight of the cities. This functional analysis of the urban system is based on three (3) levels of organization: the structure of the system through the road network, the hierarchical administrative system and the economic functioning of the system. It emerges from our study that, concerning the structure of the urban system via the road network, only the cities of the first hierarchical level have a better connectivity in the urban system. Indeed, the four (4) cities at the top of the hierarchy are very well connected to each other by a network of primary roads so as to cover two thirds (2/3) of the regional space. The cities at levels two (2) and three (3) are almost entirely connected to primary routes. The one city in the system classified as level four (4) is also connected to a level one (1) city by a primary route. Finally, the last level of cities are mostly connected to the urban system by secondary routes. In sum, the urban system under study is characterized by a hierarchy of administrative divisions, roads and economic activities. These results have already been confirmed by Dziwonou Y. (2003, p. 289) when he says that the urban framework in Black Africa is characterized by a hierarchy of functions, services, infrastructure and areas of influence. For him, urban systems are interrelated with their regional, national and international environment.

V. CONCLUSION

Our study on the demographic and functional analysis of the cities of the South-West of Côte d'Ivoire made it possible to rank the cities of this urban network.

The results of the study revealed three (3) hierarchical levels in the distribution of the cities of the West on the basis of the Rank-Size law with a first level dominated by the cities of San-Pedro and Gagnoa. However, the functional analysis also reveals three hierarchical levels polarized differently by San-Pedro and Gagnoa. At the regional level, level one cities (1) are departmental capitals considered to be large cities. Smaller towns are grouped together at level three (3), while at level two (2), a few intermediate towns are grouped together to serve as relays for the two extreme levels. In sum, the populations converge on the most functional cities, i.e., the best equipped, and therefore the most attractive. This study could be applied to the other regions of Côte d'Ivoire with the aim of establishing a classification of the national urban system.

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