GLL
Geomatics, Landmanagement and Landscape No. 1 • 2025, 173–198

ISSN 2300-1496 https://doi.org/10.15576/GLL/201221

Research paper

Received: 7.09.2024
Accepted: 19.01.2025
Published: 31.03.2025

Hierarchy of urban agglomerations and attraction theory: case study of Laghouat

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Summary

Based on the observation of the great imbalance in the development policies in the rural urban centers of the wilaya of Laghouat, which caused the exacerbation of the phenomenon of rural displacement towards the capital of the wilaya and the emergence of the unemployment crisis, and in addition to all this the gross lack of provision of necessary services and facilities that contribute to the stabilization and stability of the population, this study came as an attempt to determine the urban pattern 'dysfunctional/balanced'. The study also seeks to determine whether the urban system of the network of urban centers in the wilaya of Laghouat takes the pattern of the first dominant city or takes the regular pattern. The aim is providing planners with the opportunity to control the direction and distribution of the development process in a regular and equiTable manner and reduce the intensity of urban dominance to break the population concentration confined to the state capital.

The article is based on the latest statistical data issued by the Directorate of Planning and Programming of the wilaya of Laghouat '2023' with a comprehensive sample of all municipalities of the region '24'. It also uses mathematical measurement models for urban growth and concentration 'Lorenz's curve and index, Hoover's index, and Zipf's rank and size base,' in addition to a comprehensive comparative study of groups of jobs as well as economic and service activities. The study showed strong variations in that the environmental frame does not correspond to human exploitation, as spatial boundaries reflect a spatial political organization that is inconsistent with ideal hierarchical relationships.

Keywords

urban inflation • urban development • urban network • economic growth • population concentration • city of Laghouat

1. Introduction

The world is witnessing rapid and increasing growth in population. This growth has not been achieved in a balanced manner. The population concentration was limited to a small number of cities, which are often only political capitals; hence, large cities and poles of attraction have emerged dominating urban agglomerations within the same urban network, 'there is a relationship between the sizes of cities and numbers, with the less volumes cities increased in number and vice versa' [Entezar 2016]. The global population grew from 2.5 billion in 1950 to 6 billion by the end of the 20th century, reaching 7.8 billion in 2020. This phenomenon of urbanization and expansion has affected Third World countries the most since the middle of the twentieth century. As of 2020, the worldwide urban population reached 4.4 billion, an estimated rate of 56.2% of the total world population, with this figure rising to about 70% by mid-century. As a result, most of the world's population now resides in urban areas. This rapid rate of growth has led to a large migration from the countryside to the cities, which will necessarily lead to the complete disappearance of the rural population, as happened with the Bedouin populations. This also means that the heavily inflated cities will be a graveyard for the rural population [Toumi 2023].

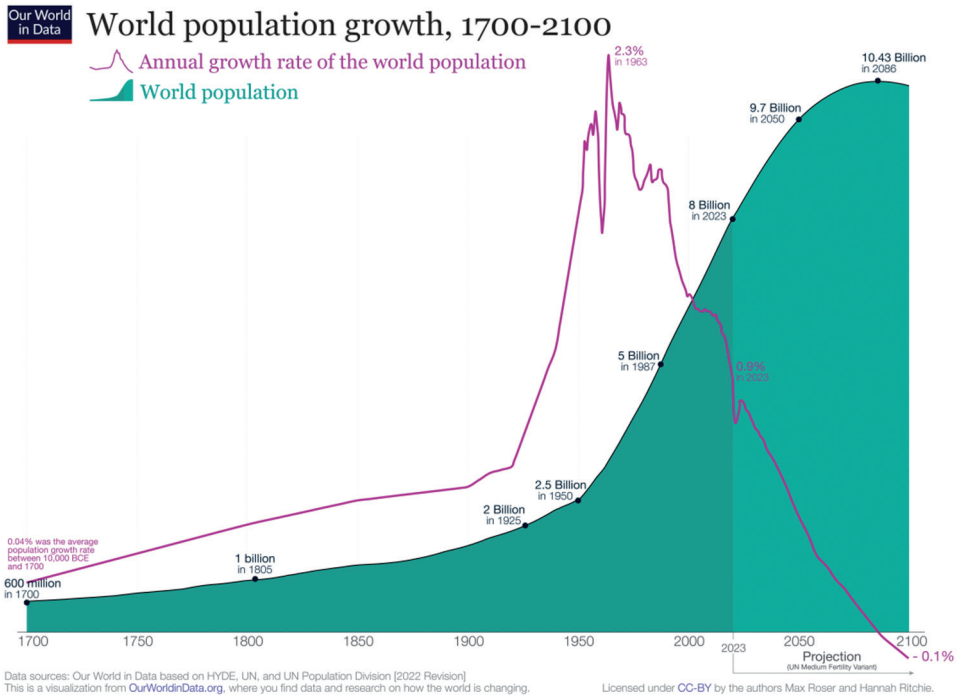
The urban network is a group of large and small cities in addition to the open inter-spaces between them, as these cities and their urban centers, which form the urban network, are complete among themselves, and reinforce each other in points of strength in order to achieve more with each other than a city or an urban center alone [Jagt 2009]. The regional urban network differs from the traditional human settlements network in that it is not just small settlements in a vast area; it consists of continuous networks composed of key focal points and a number of radiant branches.

Urban life is the goal of every individual who wants to live in stability and social well-being. This is why urban areas are attracting many people [Remmache 2022]. This urban growth in the Arab countries began to manifest itself since the second half of the twentieth century, as a result of a combination of several factors and incentives that contributed to the development of the population of Arab cities in a manner that does not keep pace with the changes taking place in their social and economic structure [Bouafia 2019].

The total dependence on the industrial sector, the establishment of the Algerian economy on rentier policy and the concentration of urban development within a specific group of cities led to the emergence of urban poles, which encouraged internal migration movements. Urban development policies were also based on a number of urban procedures and measures that contributed to the drawing a complex and distorted picture of the urban environment in Algerian cities, 'and a set of social and economic imbalances emerged that the city has suffered from and whose intensity is increasing every day' [Farhi 2002].

Regional planning remains the missing link in the urban planning system although there are many opportunities that support the principle of developmental balance in the urban network of the wilaya of Laghouat. There are smaller urban centers with near-complete infrastructure, like the capital of the wilaya. However, the challenge seems to lie in the psychological appeal of the capital, which has not been adequately

studied, in other words, the dilemma of wanting to live in the capital, regardless of what is available in small centers. This, in short, indicates that regional planning needs a closer look and a renewed focus on its importance so that it takes its role as a starting point for solving urban problems [Alarabi 2023].



Source: Our World in Data

Fig. 1. The future rate of annual human population increase from 1970 to 2100 according to the site

1.1. Study objectives

The study of population geography is of great importance, and this importance comes through its direct study of humans in terms of number, growth, spatial distribution, and variables that occur over time in terms of size, composition, population distribution and their scientific interpretation [Amera 2021]. This study examined the diagnosis and analysis of the Laghouat region through its 24 urban centers – 24 municipalities located within the administrative boundaries of the region. This allowed us to understand the balance in the urban network by analyzing trends in urban concentration, the sequence of urban centers, their size, and differences in regional development between them. We also aim by following the methodology and scientific analytical models to establish the theoretical aspect with regard to the balance in the urban network in

terms of concept and rooting, and methods of measuring it to detect imbalances and try to address them, and to determine the future prospects of this urban concentration in the urban centers of the wilaya.

Based on the rapid urbanization in the city of Laghouat, which often precedes the operations planned by the relevant authorities, and because its urban area is distorted in shape, disconnected in structure, and degraded in the environment, the question arises: what are the factors responsible for the dysfunctioning in the city of Laghouat and what are their effects on its urban area?

In response to this question, it was necessary to make assumptions based on the assumptions on which this research is based, and through this research, we seek to prove or refute them. A hypothesis was taken according to which the city lives in a spatial duality:

1. An area characterized by the specificity of the oasis, dominated by traditional houses, and another area that extends along the main roads, characterized by modernization and organized urbanization.
2. Public services and facilities play a significant role in urban dynamics, as the more these services increase, the more urban growth a city sees by attracting immigrants from neighboring centers.

This study differs from its predecessors because it is the first urban study that deals with and includes this region of Algeria with this type of analysis and study. Previous studies were limited to patterns of urban growth in terms of land use and territorial division. However, this study covers the entire area of the wilaya of Laghouat with all its municipalities, unlike previous studies that were confined to the capital of the wilaya only.

1.2. Analysis of urban hierarchies – Zipf's law

Many authors have delved into the subject of urban hierarchies and their evolution in recent years [Duranton 2019]. with the aim of studying and explaining the observed regularity in the distribution of cities based on their size. This phenomenon is commonly referred to as Zipf's law. Geographers use this law to compare the size differences between geographical entities. [Pumain 2012]. At the same time, they contribute to the systematic debate on the most effective ways to estimate the sequence coefficient in the distribution of cities by size [Dimou 2007]. Among these studies are:

- Al-Dajani [2009]: This research addressed the issue of urban concentration and analyzed the causes of urban dominance in the provinces of Syria. It identified the future probabilities of urban concentration based on several mathematical measures, which showed the urban dominance of the capital, Damascus.
- Al-Shadid [2012]: This study addressed the issue of spatial developmental disparity among the provinces of Iraq by examining and analyzing the developmental conditions of these provinces and measuring their level of development using precise methods. The results indicated a clear disparity in spatial development among the provinces.

- Al-Anbar and Al [2014]: The aim of this study is to reveal the hierarchical ranking of urban centers in Babylon in terms of rank and size. It relied on analytical models represented in the rank-size rule and concluded with results confirming a high concentration of population in the city of Hilla, followed by the city of Alexandria and then the city of Qasim.
- Selatnia [2015]: This study started from the hypothesis that the city of Biskra experiences urban congestion due to the significant concentration of investments and activities in the center of the province, which has led to the attraction of a large number of residents.
- Jabbar [2016]: This study addressed the importance of city size as an indicator of the hierarchical ranking of cities and concluded by identifying the most significant factual characteristics of the urban system in Babil Governorate.
- Claude [2018]: This article presents a variant of Reilly's law of gravitation which is applicable to regional metropolises and their spheres of influence.
- Bouafia [2019]: This study addressed the analysis and diagnosis of the Biskra Province region through its urban centers to understand the balance present in the urban network by analyzing urban concentration trends.
- Toumi [2023]: This study includes monitoring the phenomenon of urban explosion in the sense of the spread and expansion of cities across all regions of the world, and the tendency of people to be attracted to live in urban areas and flee from rural, village, and nomadic areas.

1.3. Urban network and spatial cohesion

An urban network is defined as a national or regional group of interconnected cities, meaning that every significant change in activity, employment structure, income, or population in one of them directly or indirectly results in modifications to other cities in the network. The physical environment, population, activities, networks, and nodes are in close symbiosis maintaining different relationships and at various levels both within and outside the micro-territorial space with neighboring regions. Dynamism, hierarchy, and openness are the main characteristics of any urban network [Farhi 2001].

It should be noted that the urban network in developing countries is classified as an incomplete type, where the group of cities with a dysfunctional hierarchy is a regional metropolis with the ability to spread its influence and radiance. It is a regional metropolis that lacks sufficient equipment and services and has limited radiance.

2. Materials and methods

2.1. Data collection

Using statistical data issued by the Directorate of Programming, Planning and Budget Control of the wilaya of Laghouat, the study included all 24 municipalities that make

up the territory of the wilaya, focusing on studying the most important activities and facilities that attract the population in detail, to conduct a comprehensive examination of their social and economic impacts and highlight their vital role in urbanization. In this study, we did not rely on other data collection techniques such as interviews, questionnaires, and models, which provide qualitative information and data; our research relies on quantitative data.

2.2. Methods

It is known that the administrative space is determined by the law of 'wilaya, district, municipality,' while the functional space is that which is regulated by flows and activities around different nuclei. Administrative space rarely matches functional space within a specific geographical space. 'Systematic analysis can help to understand the studied space in all its dimensions. It does not provide prescriptions but is a guide and a set of guidelines' [Selatnia 2015].

In order to better understand the dynamics of the city of Laghouat, attention must be paid to its wilaya, because the development of the region in the wilayas is linked to the location of investments and the interdependence between the administrative space and the functional space. Additionally, it is important to highlight the disadvantages that characterize the levels of centers and their repercussions on the first city. It is, therefore, necessary to adopt a systematic analysis method that deals with the state space in all its components as well as its internal and external relations. To monitor the situation of the population, the activities, and the relationships between the centers, and to determine the size and ranks of these centers within their urban network, we relied on a set of approaches and applied quantitative analytical models.

2.2.1. Demographic Analysis Models 'Zipf'

It is a principle that explains the relationship between spatial concentration and size based on the premise that cities and urban centers not only increase in size due to higher rates of natural population growth, but increase in size and expand through increased investments and higher labor flows due to the availability of jobs, making them attractive areas for those seeking a better life, encouraging migration from poor to rich areas [Abdallah 2015]. The results show a coordinate system with a double logarithmic scale, on the x axis and y axes, following the curve representing the set of points representing the population and the order of cities as a straight line of rounding. Any significant deviation 'residue' can be considered an anomaly. When the first city protrudes clearly above the line, it is considered a case of urban inflation. 'The vertical axis includes the population count for each urban center, while the horizontal axis includes the rankings of the urban centers according to their population' [Bouafia 2019].

2.2.2. Beckmann's Model

This model relates to the population of the first city 'the dominant city,' where all centers must be corrected according to the first city. This model consists of the correlation of

three variables: the population of the mother city, the population and rank of a center, and the constant (m) according to the following mathematical relationship [Schaffar 2022]:

$$Y_n = \frac{x}{z_n \cdot \mu}$$

where:

Y_n – the population of the center (n),
x – the population of the first city,
z_n – the rank of the center (n) [Shaouaoura 2012].

2.2.3. Lorenz's Curve

It is a quantitative cartographic method to measure the degree of population concentration, through which the extent to which the distribution of population in a specific region over successive periods of time is known. It is also used to measure the concentration of income and wealth [Amera 2021].

2.2.4. Lorenz's Index

It is a technique used to measure the degree of concentration in spatial distributions; it is also used to measure the dispersion in those distributions, as well as measure the difference in the repetitive distributions from the regular distribution. It is calculated according to the following equation [Aikali 2009]:

$$I = \frac{(A - R)}{(M - R)}$$

where:

I – Lorenz's index,
A – the overall sum of the cumulative repetitions of the distribution,
R – the overall sum of the cumulative repetitions of the structured distribution,
M – the overall sum of the cumulative repetitions of the distribution.

2.2.5. Urban Concentration Ratio 'Hoover Index'

This percentage is closely related to the study of population distribution and understanding their concentration pattern within a specific area that knows the tendency of the population to concentrate or disperse within the boundaries of the area. The population distribution ratio does not give importance to the absolute numerical distribution of the population as much as it focuses on studying the density distribution in these sections, emphasizing the relationship between numerical distribution and the size of the populated area [Ayyana 1993].

According to Latif [2013], this degree takes values ranging from 0% to 100% to give significance to the degree of concentration or dispersion according to its numerical value, i.e. The closer it is to zero, the more it is an indication of a high degree of dispersion, and the higher the value, the higher the indicative of the presence of degrees of concentration. The Hoover Index is the most widely used measure for assessing the concentration or deconcentration tendencies of a country's evolving population distribution [Peter 2012]. This ratio is calculated by calculating half of the positive differ-

ence between the percentage of the area and the percentage of the population, which is known as the 'Hoover Index.' This equation results in a number of different ratios known as the degree of concentration criterion as is shown in Table 2.

2.2.6. Gini coefficient

It is a calculation method used to detect the extent of variation in the distribution of populations among cities, measuring the ratio of the area between the Lorenz curve and the line of symmetry to the sum of the area of the triangle whose line of symmetry is the hypotenuse and the horizontal coordinate line is its base.

The coordinates on the Lorenz direction are determined according to the correspondence of the proportions on the vertical axis and the corresponding proportions on the horizontal axis (see Fig. 6). When combined, a Gini coefficient is extracted, which shows the percentage of population concentration in the area according to the following equation (Brahim, 1999):

$$\text{Gini coefficient } \left(\text{concentration index}\right) = \frac{\text{GC} - 550}{1000 - 550}$$

where:

GC – the sum of the ratios accumulated on the horizontal axis based on what corresponds to them on the vertical axis (see Fig. 6).

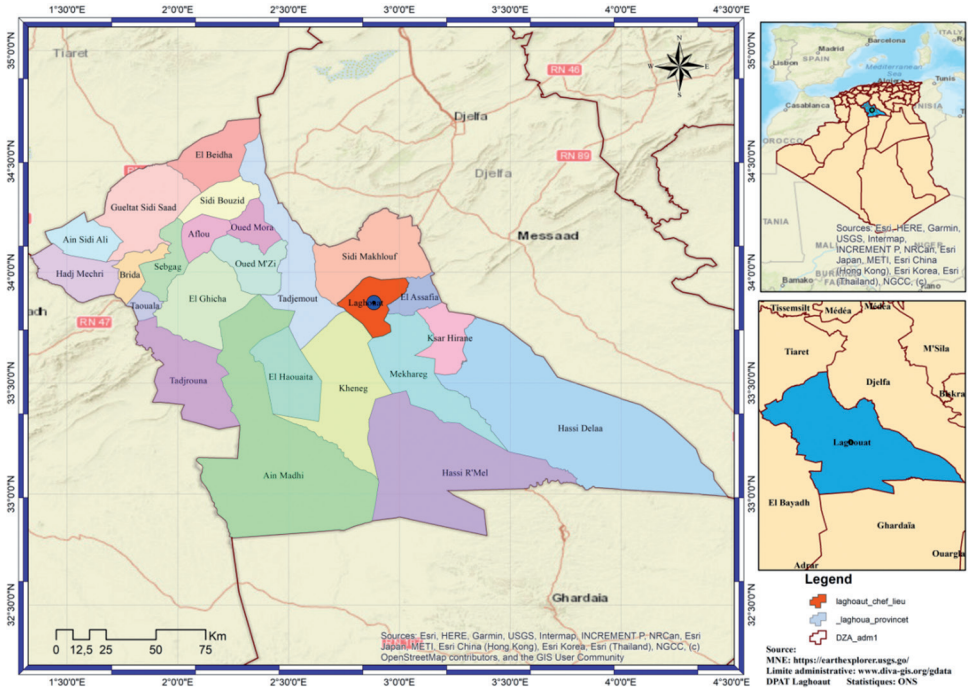
2.2.7. Functional analysis

It consists of understanding the functional role of various centers accurately through all the services they provide to the residents and the impact they have on space. And for this reason, reliance on the analysis network 'Cote.' It relies on five criteria: equipment, commercial activities, service activities, administrative function, and the number of served population [Selatnia 2015].

These models were relied upon because they are based on accurate numerical data and realistic statistical results derived from accredited bodies 'Directorate of Planning and Programming of the wilaya of Laghouat 2023'. It also manages and processes data in a clear and precise mathematical way.

3. Characteristics of the study site and diversity of wealth

The wilaya of Laghouat, located in central Algeria on the slopes of the Saharan Atlas Mountains, occupies an area of 25,052 square kilometers 1.05% of the national territory. The climate is dry, with cold and dry winters and hot and dry summers. The average annual temperature is 20.38°C, with a minimum of 5.3°C in the north, 9.7°C in the south, a maximum of 27.2°C in the north and 33.4°C in the south. The wilaya receives less than 160 mm of rainfall per year. It has a good hydrographic network that intersects the territory of the wilaya. The most important valleys are M'zi, Tawil and Musaed. The wilaya of Laghouat contributes an important share to the economy and gross nationa income thanks to its hydrocarbon fields 'gas in particular in the Hassi R'mel region,' in addition to power stations and share of livestock 'about 3 million heads'.



Source: Authors' own study

Fig. 2. A map of Laghouat City

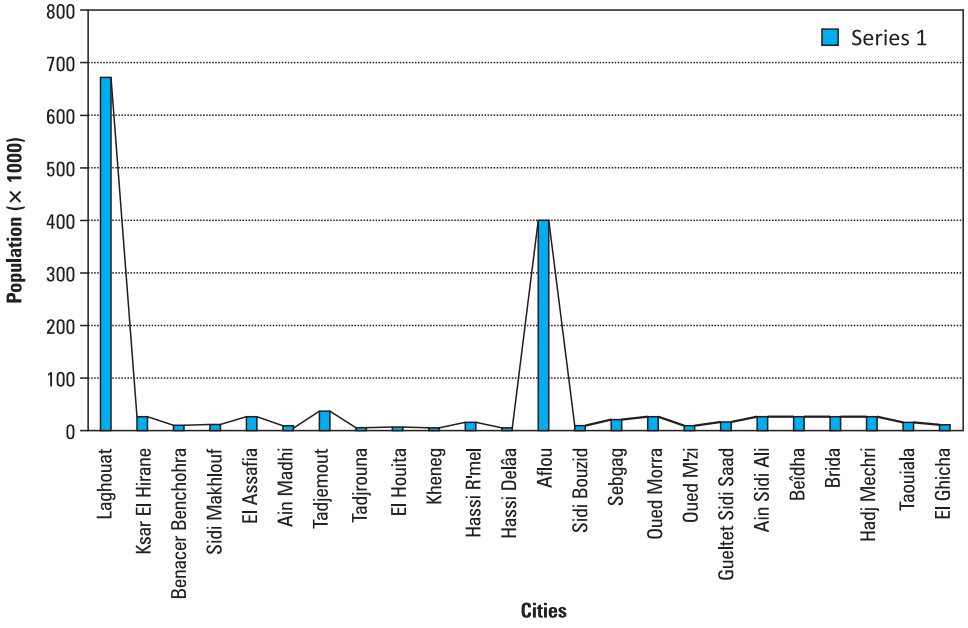
The region has important economic potential, especially in the field of barley and animal feed cultivation, as well as livestock breeding, not to mention the presence of the largest natural gas field in Algeria in the Hassi R'mel region in the south of the wilaya. The latter remains of limited impact on attracting residents, as state policy dictates that most oilfield jobs are allocated to the local population. On the other hand, the state has long been working to move the population adjacent to oil and gas fields due to the potential damage to human health resulting from air and groundwater pollution due to materials used in drilling and exploration. Two large cities were planned to replace Hassi R'mel and Hassi Messaoud – the latter being the largest oil field in Algeria.

The city of Laghouat is currently in a state of real saturation in quantity and quality due to its administrative function, its strategic location in the past like 'the crossing point of migratory commercial caravans from south to north' and recently the meeting point of important national and state roads. In addition, it is a semi-desert area and is one of the most important gates of the desert 'the middle gate of the desert.' That is combined to its proximity to the Hassi R'mel gas field 'the third largest gas reserves in the world.' In addition to all this, its connectivity has been strengthened by developing the railway project 'Ring of the South' which connects it with the city of Djelfa at 106.6 km and the city of Ghardaïa at a distance of 170

km. All this is one of the factors encouraging attraction, which makes many of those interested in management and development and researchers to wonder about the city, its career and field future, and where it can receive its future population surplus [Ferradji 2017].

3.1. Population imbalance between municipalities

The total population of Laghouat is estimated to be 730,543 according to the 2023 census; two out of the 24 municipalities in the wilaya have a total population of 431,168, or 59% of the total population. Within this group, the municipality of Laghouat stands out with a population of 267,843 inhabitants, or 36.66% of the total population, followed by the municipality of Aflou with a population of 163,334, then Ksar al-Hiran, Hassi R'mel, Tajmot and Khneg, with a population between 20,000 and 30,000 inhabitants. Other cities have a population of less than 20,000 inhabitants. This disparity between the state capital and the rest of the municipalities has created an imbalance at all levels. The first of these imbalances relates to density which is represented by 669.59 inhabitants per square kilometer in the state capital to dwindle to 5.26 inhabitants per square kilometer in the municipality of Hassi Delaa (Fig. 3). This imbalance in the population distribution is due to the availability of employment opportunities, proximity to goods and services and the level of equipment available.



Source: Authors' own study

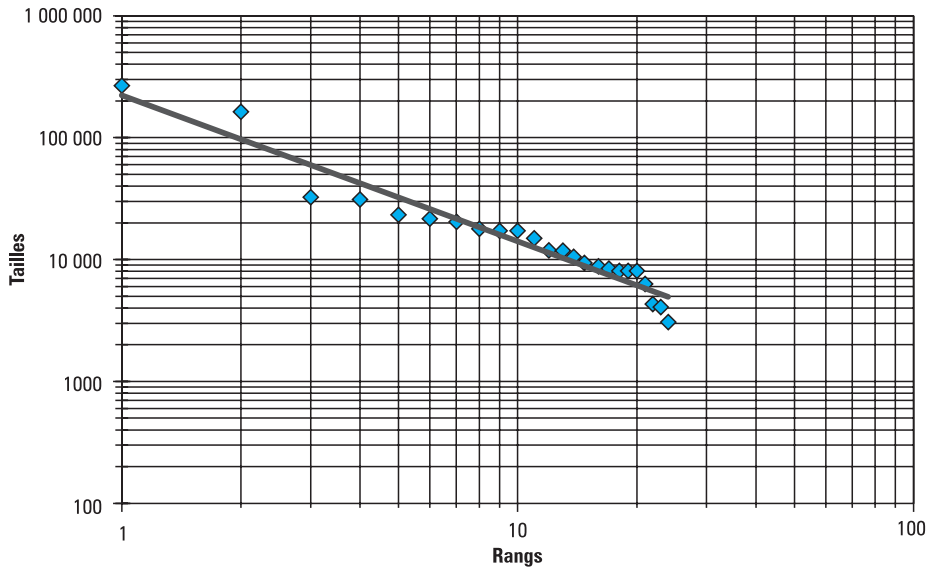
Fig. 3. Classification of Laghouat municipalities according to population density

4. Results and discussion

4.1. Rank/Size Model and Misalignment Confirmation

When applying the curve to the wilaya of Laghouat (Fig. 4), the curve showed an anomaly in the ranking, starting with the emergence of the great superiority of the city of Laghouat over other urban centers, including those with a population of more than 100,000 people, in addition to recording a steep slope of the curve between several successive urban centers in the ranking in relation to the real size of the population:

- Aflou – rank 2 – and Qasr al-Hiran – rank 3.
- Sebkak – rank 20 – and Tadjrona – rank 21.
- Tadjrona – rank 21 – and Oued M'zi – rank 22.
- Tawyala – rank 23 – and Al-Huwayta – rank 24.



Source: Authors' own study

Fig. 4. The demographic coherence of the urban system of Laghouat according to the Ziph model, Population 2023

With regard to the ideal distribution line, we have recorded urban centers that exceed the supposed ideal size, namely Laghouat, Aflou, Sidi Makhlouf, Ain Madi, Ben Nasser Ben Chahra, Ain Sidi Ali, Beida, Assafia, Oued Morra, Hajj Mechri, Brida, Sidi Bouzid, Gheisha, Sebkak, Tadjrona, all of which are consecutive in order – from rank 09 to rank 21 – with the exception of the urban centers of Laghouat and Aflou. The increases did not exceed 2,240 inhabitants, which may represent a high percentage in some centers such as Sebkak – 24.94 %. The maximum increase was in the urban center

of Aflou – 64,334 inhabitants, which reflects the great trend of development in this urban center, followed by the city of Laghouat with an increase of 38,146 inhabitants.

We have also recorded urban centers that are less in size than the ideal size – Qasr al-Hiran, Hassi R'mel, Tadjmot, Khneg, Oued M'zi, Tawyala, al-Huwayta. The maximum shortage was recorded in the urban center Qasr al-Hiran with 27,613 people. We have, on the other hand, recorded two cases of match between the ideal size and the actual size in both Hassi Delaa and Gueltat Sidi Saad..

4.2. Confirmation of misalignment according to Beckmann's model

According to Beckmann's model, the study confirmed the results obtained through Zipf's law, where the deficit or surplus population depends on the value of the constant (m) for each center depending on its numerical value if it is greater or less than 1.

Table 1. Hierarchy of centers according to the Beckman model

Cities	Constant (μ)	Results	Cities	Constant (μ)	Results
Houita	3.63	μ > 1: shows under population	Hassi Dalaa	1.84	μ > 1: shows under population
Taouiala	2.86		Assafia	1.80	
Oued M'zei	2.84		Gaicha	1.75	
Ksar Hirane	2.76		Beidha	1.75	
Tadjemout	2.31		Sidi Makhlouf	1.73	
Hassi R'mel	2.15		Sebgag	1.67	
Kheneg	2.06		B.B.C	1.63	
Tadjerouna	2.02		Ain Madhi	1.55	
Hadj Mechri	1.90		Aflou	0.82	μ < 1: overcrowding in relation to the rank
Oued Morra	1.88				
Ain Sidi Ali	1.88				
Brida	1.87				
G. Sidi Saad	1.87				
Sidi Bouzid	1.85				

Source: Directorate of Programming and Budgetary Monitoring. Laghouat and improved by Authors

The two models 'Zipf's and Beckmann's' agreed that there was demographic overcrowding in the city of Laghouat, where more than a third of the population of the wilaya is concentrated in its capital, while the distribution of the population in the rest of the centers is completely unbalanced, as the value of the constant (m) for all centers was greater than the value 1 except for the city of Aflou, where the constant was less than 1.

These results confirm the existence of overpopulation in the capital of the wilaya as well as the urban center Aflou 'which will be upgraded within the new administrative division as an independent wilaya' and the existence of a population deficit in the rest of the other urban centers, where the value of the deficit in some of them reached three times the real value, including Al-Huwayta, Tawyala, Oued M'zi being of the lowest rank, and Qasr Al-Hiran as well, despite its advanced rank (rank 03).

This population density in the city of Laghouat has led to a more complex urban life due to the persistence of a series of dysfunctions. This has led to pressure on public utilities, growth of informal construction, and housing divisions with unfinished urban landscapes and fragmented urban structures, transportation problems. Consequently, urban, and environmental functions deteriorate, as confirmed by Ferradji [2017]. Furthermore, the oasis area has decreased dangerously despite the efforts of laws and regulations to preserve the unique environment of oases [Benarfa 2018]. This urban imbalance in the region confirms that the administrative logic of the territorial division cannot alone achieve a regular and ideal hierarchy, as it reflects a political spatial organization whose purpose is to facilitate a more representative administrative and political follow-up of the interests of the population. This finding is supported by an analysis of scientific literature related to Zipf's law [Arshad 2018].

5. Laghouat: A dominant city with a big head

5.1. Urban Concentration Ratio 'Hoover Index'

Based on the calculations in Table 2, we observed that most of the urban centers that make up the territory of the wilaya had a positive ratio of population to area E-A, with the exception of the municipalities of Laghouat, Aflou, Tajmot, which had a negative ratio of E-A. Since the negative mark indicates an unfair distribution of the population in relation to the area of the urban center in question, taking into account that the score E-A for each center is an indicator of the percentage of population who must leave the center to achieve a fair distribution of the area, the highest percentage was recorded in the capital of the wilaya Laghouat 35.06%, followed by Aflou 20.74%.

Calculation of the Hoover Index for the population concentration of the city of Laghouat

$$\text{Hoover Index} = \tfrac{1}{2} \text{ Total (E-A)} = \tfrac{1}{2} (113.03) = 56.52\%$$

After calculating the Hoover index for the region, it was 56.52%, which is a high value and deviates from the ideal population distribution pattern according to the following division [Latif 2013]:

- From 0% to 24%: Uniform distribution.
- From 24% to less than 50%: evenly distributed.
- From 50% to 75%: Average distribution.
- From 75% to 100%: Highly concentrated.

Table 2. Hierarchy of centers according to population and area ratio

Cities	Superficies [km²]	Superficies [%] (E)	Population [%] (A)	(E-A)	Cities	Superficies [km²]	Superficies [%] (E)	Population [%] (A)	(E-A)
Taouiala	255	1.02	0.56	0.46	Gaicha	730	2.91	1.1	1.81
Brida	355	1.42	1.15	0.27	Beidha	780	3.11	1.61	1.5
Oued Morra	360	1.44	1.3	0.14	Sidi Bouzid	860	3.43	1.1	2.33
Hadj Mechri	375	1.5	1.2	0.3	Guetet Sidi Saad	1040	4.15	2.45	1.7
Sebgag	385	1.54	1.1	0.44	Tadjerouna	1130	4.51	0.86	3.65
Laghouat	400	1.6	36.66	–35.06	Ksar Hirane	1240	4.95	4.43	0.52
Aflou	405	1.62	22.36	–20.74	Sidi Makhlouf	1420	5.67	2.36	3.31
Ain Sidi Ali	410	1.64	1.63	0.01	B. Benchouhra	1460	5.83	2.04	3.79
Assafia	420	1.68	1.46	0.22	Ain Madhi	1790	7.14	2.36	4.78
Oued M'zei	425	1.69	0.59	1.1	Hassi R'mel	1957	7.81	4.26	3.55
Houita	450	1.79	0.42	1.37	Kheneg	3830	15.29	2.96	12.33
Tadjemout	620	2.47	3.18	–0.71	Hassi Dalaa	3955	15.79	2.85	12.94
Σ(E-A) = 113.03									

Source: Directorate of Programming and Budgetary Monitoring. Laghouat and improved by authors

This confirms that there is a disparity in distribution controlled by several direct and indirect factors, including land, terrain, soil, and water, as well as human factors which include job creation, development programs, and investments related to the provision of industrial projects and infrastructure. Although most urban centers have elements of development and investment, they still need more population stability to achieve spatial justice in the distribution of the population or else they will remain areas for population flow. From this standpoint, it has become necessary to create a balance in the distribution of the population within the Laghouat region, which provides an opportunity to reduce the disparities in levels of development in all their economic, social, and urban dimensions.

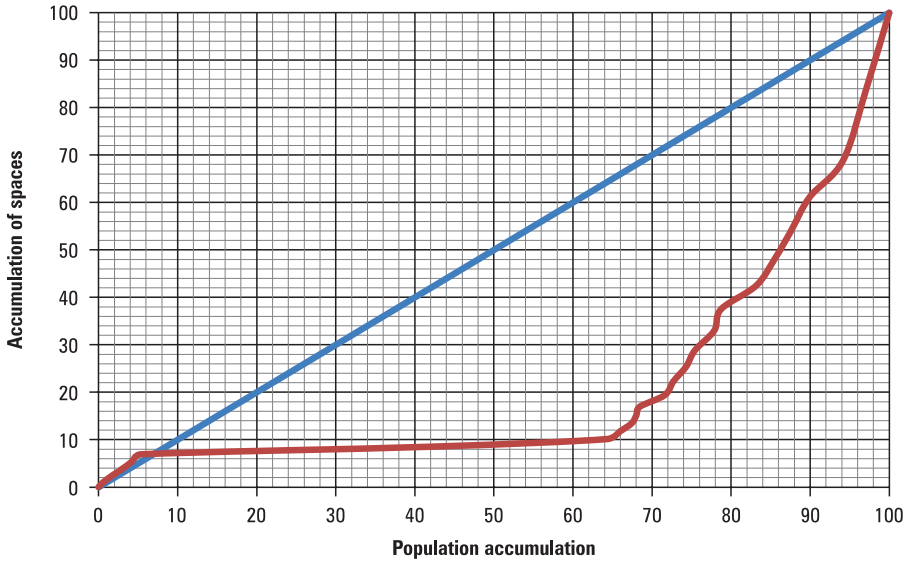
The phenomenon of population concentration exists in all urban regions, but it appears less severe in developed countries for reasons related to the pattern of population migration from rural to urban areas, where migration takes place in stages from the countryside to a small city, then to an intermediate city, and then to a larger city. This migration can take a long time; while the migration process in developing countries has been and continues to be in one stage [Al-Dajani 2009]. In addition, the urban network in developed countries is classified as a complete type where the group of cities has a balanced functional hierarchy that maintains different relationships and levels within the regional space, which slows down internal migration processes as the need for major centers is limited to a specific set of jobs and services, as confirmed by relevant studies [Mohamed 2023].

5.2. Population concentration using the Lorenz Curve

Based on the Lorenz curve (Fig. 5), the phenomenon of population concentration is evident in the territory of the wilaya of Laghouat, where we recorded the concentration of 72% of the population in 20% of the total area of the region, and we recorded the concentration of 81% of the population in 40% of the total area of the region. The curve shows the unfairness of distribution, as 87.56% of the total population is concentrated in 65% of the total area of the region, while 50% of the population is concentrated in 9% of the area of the region. We also note that the beginning of the Lorenz curve is of high value at the dependent variable 'population' and of low value on the axis of the independent variable 'area', which reflects the high concentration of population. Additionally, the large area between the real distribution line and the ideal distribution line is an indicator of the extent of population concentration. Hence, the move away from the ideal distribution curve increased the breadth of the asymmetry area in the Lorenz curve, which is an indication that the population phenomenon in the wilaya of Laghouat tends to be one of concentration.

Calculation of population concentration using the Lorenz Index

The numerical value of the Lorenz index varies from 0 to 1. The closer it is to 0, the distribution tends to be uniform, and the closer it is to one 1, the distribution tends to be concentrated. From what was calculated based on Table 3, the Lorenz index for the



Source: Authors' own study

Fig. 5. Lorenz curve for urban agglomerations in the province of Laghouat

Table 3. Lorenz's index calculation for the state of Laghouat

Cities	c.r.f	c.u.d	c.c.d	Cities	c.r.f	c.u.d	c.c.d
Hassi Dalaa	0.37	4.16	100	Taouiala	9.25	54.16	100
Tadjerouna	0.76	8.33	100	Gueltet Sidi Saad	10.45	58.32	100
Kheneg	1.15	12.5	100	Sebgag	11.9	62.49	100
Houita	1.63	16.66	100	Hadj Mechri	13.53	66.66	100
Sidi Bouzid	2.28	20.83	100	Brida	15.18	70.82	100
Ain Madhi	2.95	24.99	100	Assafia	16.95	74.99	100
Oued M'zei	3.65	29.16	100	Ksar Hirane	18.77	79.16	100
B. Benchouhra	4.36	33.33	100	Oued Morra	20.61	83.32	100
Gaicha	5.13	37.49	100	Ain Sidi Ali	22.63	87.48	100
Sidi Makhlouf	5.98	41.66	100	Tadjemout	25.24	91.65	100
Beidha	7.03	45.83	100	Aflou	53.34	95.82	100
Hassi R'mel	8.14	49.99	100	Laghouat	100	100	100

Note: c.r.f. – cumulative relative frequencies.
c.u.d. – cumulative uniform distribution.
c.c.d. – cumulative concentrated distribution.

Source: Directorate of Programming and Budgetary Monitoring. Laghouat and improved by authors

wilaya of Laghouat took the value of 0.77, a value that indicates the complete distance from the regular ideal distribution, as the distribution within the territory of the wilaya of Laghouat can be considered irregular and tends to be concentrated by virtue of the proximity of the value of the Lorenz index to the number 1.

Calculation of population concentration using the Gini coefficient

It should be noted that the area between the real distribution line and the ideal distribution line represents the area of concentration; its breadth indicates the concentration of the population in one area, i.e. the distance of the region from an ideal distribution. The smaller this area is, the closer the distribution of the population an ideal distribution is.

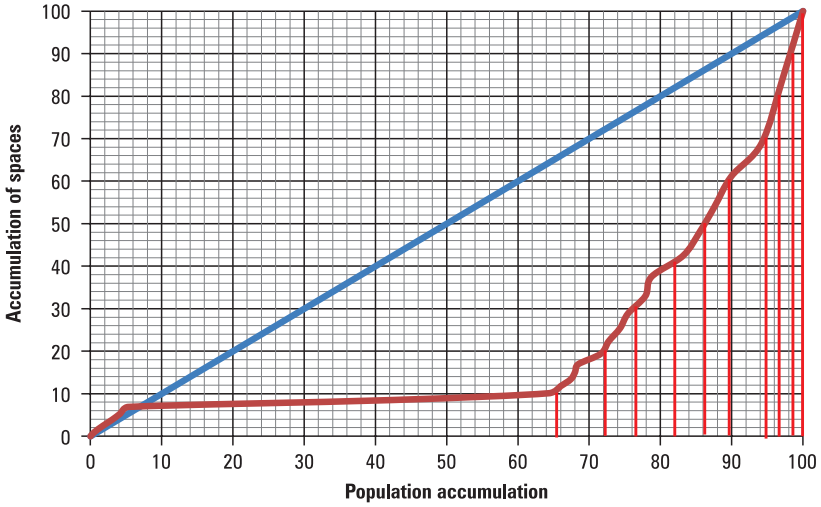
Gini coefficient for the territory of the wilaya of Laghouat = 0.78

By calculating the Gini coefficient based on the Lorenz curve of the state of Laghouat, and when comparing the value of this coefficient 0.78, we notice that it is approaching the number 1. This is an indication that the spatial distribution of the population of the wilaya of Laghouat is far from the ideal distribution that is worth 0, which is also evidence of a large distance between urban centers distributed over the territory of the wilaya of Laghouat.

Based on the previous results, the Laghouat region suffers from an imbalance in the spatial distribution characterized by concentration and instability. Consequently, this population attraction witnessed by the urban centers in the wilaya was limited to the regional capital Laghouat and the new urban center in Aflou. This centralization came at the expense of the balance in the urban network, causing a clear disparity between urban centers in population growth rates. Here we point out that there are urban centers that we can classify as attractive centers for the population, such as Laghouat and Aflou, because of their attractiveness to migrants and their acquisition of a range of commercial activities and services that distinguish them from other centers. By contrast, there are other centers that push out residents, such as Hassi Delaa and Gueltat Sidi Saad. This is due to the extreme vulnerability and low level of services experienced by these urban centers, in addition to limited employment opportunities, which in turn reduce the likelihood of population migration. We also note that the idea of varying growth rates and increasing spatial population concentration is what has recently characterized the Laghouat region, which requires decision-makers to direct the process of population distribution and development away from absolute randomness and determine its continuity.

Such a phenomenon will inevitably deepen economic, social, and urban gaps in the long term. According to studies [Piketty 2015], economic growth is directly proportional to population growth and this is fully consistent with findings from other studies [Baker 2005, Wesley 2017]. Therefore, all necessary measures must be taken to select a strategy that redistributes population density at the regional level and creates a balance in the urban network. This can only be achieved through initiatives to encourage the allocation of comprehensive development investments in all regions of the country, without limiting their scope to one city or favoring one municipality over another.

Everyone benefits from social and economic benefits, leading to a spatial population redistribution that achieves a kind of balance in the urban network due to inclusiveness in the distribution of development [Piketty 2014].



Source: Authors' own study

Fig. 6. Lorenz curve for urban agglomerations in the province of Laghouat

6. Functional analysis and disparity of services and centers

The physical environment and the distribution of equipment and activities show strong variations in which the environmental framework does not coincide with human occupation. Urbanization and economic growth are tightly linked. Much of the increase in number and population sizes of cities has resulted from the process of economic growth and development [Henderson 2005, Desmet 2015, Duranton 2019]. The unequal distribution among the urban centers of the territory of the wilaya of Laghouat is due not only to the environment, but also due to the quality of equipment, employment opportunities and proximity to goods and services.

6.1. Functional facilities

A reading of the results (Fig. 7) shows a system dominated by higher-ranking urban centers. At level 8, Laghouat – Rank 1, and Aflou – Rank 2, have all facilities except the airport, followed at the fifth level by Ksar al-Hiran – Rank 3, with a significant lack of facilities (one third of the facilities are not available), with all other centers coming in level 4 with a serious lack of equipment. The absence of levels 6 and 7 indicates the weakness of the urban framework at this level of the hierarchy, which means that the inhabitants of the lower centers, which are the majority of the centers, go beyond the

level five center to meet their needs for higher services due to the lack of equipment and head directly to the city of Laghouat, which translates into an additional burden for the capital city.

Table 4. Hierarchical grid of equipment

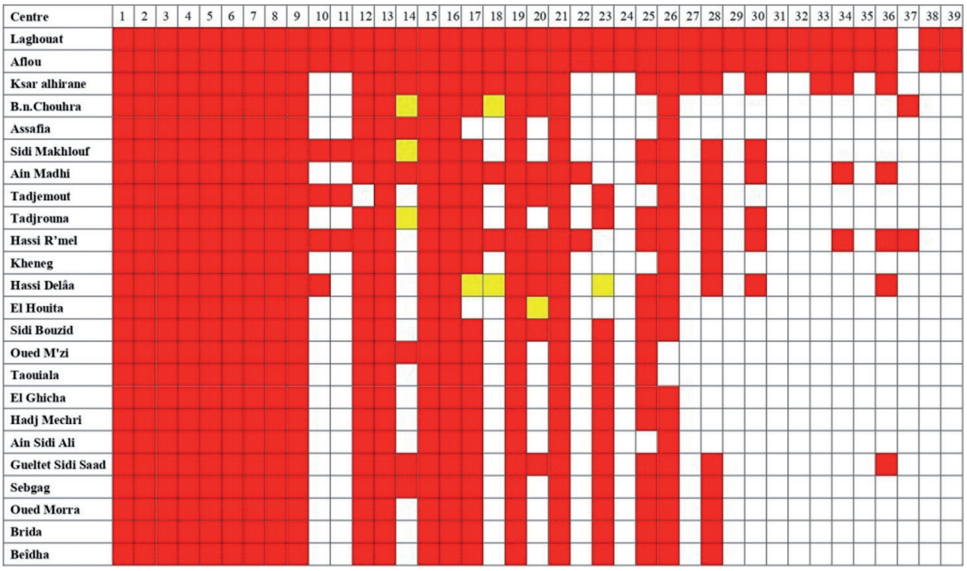
Equipment	N°	Level	Equipment	N°	Level
City hall	1	From 1 to 5 pieces of equipment = LEVEL 1	Pharmacy	21	From 19 to 25 equipment = LEVEL 4
Primary school	2		Hotel	22	
Drinking water supply	3		Multipurpose room	23	
Sanitation	4		Movie theater	24	
Electricity	5		Gas station	25	
Health Center	6	From 6 to 15 pieces of equipment = LEVEL 2	G.edu. high school	26	From 26 to 30 equipment = LEVEL 5
Postal agency	7		Tech. edu. high school	27	
Mosque	8		Profess training center	28	
Asphalt road	9		Paramedical training	29	
Bus service stop	10		Hospital	30	
Taxi	11		Specialist doctors	31	From 31 to 34 equipment = LEVEL 6
Playground	12		Specialized school	32	
Phone	13		Architectural firm	33	
Hammam	14		Bank	34	
Stadium	15		University	35	From 35 to 39 equipment = LEVEL 7
Koranic school	16	From 16 to 18 equipment = LEVEL 3	Med. analysis laboratory	36	
Youth Center	17		Airport	37	
Dentist	18		Regional bank branch	38	
Middle school	19		Travel agency	39	
Polyclinic	20		All Equipment Urban = Level 8.		

Source: Côte [1982] and improved by Farhi [1998].

6.2. Retail commerce

This criterion relates to retail activity, and is one of the tools for measuring the degree of urban centralization, where the analysis is carried out based on a hierarchical network based on the number of industry activists within each center, divided into nine levels ranging from 1 to 13,000 (Table 5). 20,882 business owners are active in the wilaya of

Laghouat, of whom 7,830 are active in retail activities, representing 37.50%, and 7,458 are active within the services sector, representing 35.70%.



Source: Authors' own study

Fig. 7. Existing functional equipment in the Wilaya of Laghouat

Table 5. Retail business activities

Retail businesses, artisans and restaurants	Cities	Level
From 1 to 3	None	1
From 4 to 14	None	2
From 15 to 100	Hadj Mechri – Sebgag – Taouiala – Tadjrouna – El Assafia – Oued M'zi – El Houita – Sidi Bouzid	3
From 100 to 200	Ain Sidi Ali – Beidha – Brida - El Ghicha – Oued Morra	4
From 200 to 500	Ksar Hirane – Benacer Benchohra – Sidi Makhlouf – Hassi Dalaa – Ain Madhi – Tadjemout – Kheneg – Gueltet Sidi Saad	5
From 500 to 1000	Hassi R'mel	6
From 1000 to 3000	Aflou	7
From 3000 to 6000	None	8
From 6000 to 13000	Laghouat	9

Source: Directorate of Programming and Budgetary Monitoring of Laghouat and improved by authors

We note through the Table 5 that the urban center of Laghouat at level 9 completely dominates the system, as the state has 20,882 commercial registers. Their number in the city of Laghouat alone is 8,921 registers, i.e. 42.72 % of the total number of registers 'D.P.S.B.2022'. The city of Aflou, which plays a supporting role, is at level seven and is far from the first city and includes only between 1,000 to 3,000 institutions, which constitutes a vacuum in the absence of level eight, indicating the weakness of the urban system. This weakness is exacerbated with the presence of only one urban center at level six, which is the center of Hassi R'mel, located in the far south of the wilaya in close proximity to the wilaya of Ghardaia.

6.3. Service activities

This criterion is focused on the availability of service activities: wholesale trade, branches of national companies, offices, markets, etc. Table 6 shows the absolute dominance of the city of Laghouat over the rest of the other urban centers, where there are 297 wholesalers in the wilaya as a whole, 248 of whom are active within the capital city, representing 83.50%, followed by the city of Aflou with 9 wholesalers, and Sidi Makhlouf with 8. The number decreases further in the rest of the centers until it is completely absent in 13 centers: Ain Madi, Ain Sidi Ali, El Bayda, Brida, El Ghaisha, El Hadj, El Mechri, Sebgag, Tawyala, Tadjrona, Oued Morra, Oued M'zi, Howayta and Sidi Bouzid. It means that more than 54 of the total urban centers of Laghouat territory do not include wholesalers, which means that they are completely subordinate to the city of Laghouat.

Table 6. Service activities

Wholesalers	Cities	Level
	None	1
	Hadj Mechri – Sebgag – Oued M'zi	2
1 to 5 wholesalers	Ain Sidi Ali – El Houita – Sidi Bouzid	3
5 to 10 wholesalers	Taouiala – Brida – El Ghicha – Oued Morra	4
10 to 20 wholesalers	Beidha – El Assafia – Tadjrouna – Ain Madhi – Gueltet Sidi Saad	5
20 to 50 wholesalers	Ksar Hirane – Hassi R'mel – Hassi Dalaa – Tadjemout – Kheneg	6
50 to 100 wholesalers	Benacer Benchohra – Sidi Makhlouf	7
100 to 200 wholesalers	Aflou	8
200 to 300 wholesalers	None	9
From 300 to 400 wholesalers or branches of national companies	None	10
+ 400 wholesalers	Laghouat	11

Source: Directorate of Programming and Budgetary Monitoring of Laghouat and improved by authors.

6.4. The administrative situation

The seniority criterion in access to administrative status plays a positive role in building and sustaining the links between the center and its area of influence. For better representation, we assessed the importance of each center according to its seniority in the corresponding managerial situation. Table 7 indicates that levels 1 and 2 relate to secondary cities that have or do not have an effective administrative branch, the 3 and 4 levels are for centers (old and new municipal capitals), while the 5 and 6 levels relate to the main centers of the districts (old and new). Seniority emphasizes the strength of the links between the center and its attraction area. Laghouat is at level 7, being the capital of the state since the administrative division of 1974, after it was a district since 1962 as the oldest district in its urban network. Aflou follows it as a municipality since 1962 to be promoted to the ranks of districts during the administrative division of 1984. The 1984 administrative division has promoted all existing municipalities and districts to their current ranks.

Table 7. The administrative function

Administrative function	Criteria	Cities	Levels
Secondary agglomeration	–	El-Hadjeb – Terkelele – Bordj Essenoussi – Bellil.	1
Administrative branch	–	None	2
Chief town of commune	New Municipality	Hadj Mechri - Sebgag - Taouiala - Tadjrouna - El Assafia - Oued M'zi - El Houita – Sidi Bouzid - Ain Sidi Ali – Beidha – Brida - El Ghicha - Oued Morra - Ksar El Hirane - Benacer Benchohra - Sidi Makhlouf - Hassi Delaa - Ain Madhi – Tadjemout – Kheneg - Gueltet Sidi Saad - Hassi R'mel.	3
Chief town of commune	Former Commune	Laghouat – Aflou.	4
Chief town of Daïra	New Daïra	Ksar El Hirane - Brida - Sidi Makhlouf - Hassi R'mel - Ain Madhi – Tadjemout – Kheneg - Gueltet Sidi Saad - Aflou.	5
Chief town of Daïra	Ancient Daïra	Laghouat	6
Wilaya capital	wilaya	Laghouat	7

Source: Directorate of Programming and Budgetary Monitoring. Laghouat and improved by authors.

The results show the extent to which the concentration of investments and service activities affects the process of attracting and concentrating the population in the state capital. Economic development has multiple dimensions, including changes in institu-

tional, productive, social, and political structures, as well as in habits and values. The justice of development leads to continuous improvements in the structure and method of production, addressing issues of inequality in service provision and income levels, and eliminating poverty and unemployment.

We conclude from all of the above that the spatial imbalance and population concentration in the city of Laghouat and the emergence of large disparities separating the urban centers that make up the territory of the wilaya came as a result of the flow of investments towards the largest population concentration 'the cities of Laghouat and Aflou' and the neglect of the rest of the urban centers, even if they have potential for growth. All this led to the entrenchment of the phenomenon of regional duality and the disparity of spatial attraction in the region, as the forces of attraction emanating from large centers continued to stimulate the forces of expulsion inherent in the lower centers, as confirmed by Al-Shadid [2012] in his study of the urban centers of Iraq.

7. The administrative space and job attraction

The administrative area and functional space do not align fairly across the region of Laghouat Province, where urban settlements depend on their main cities administratively but fall under the functional scope of Laghouat City – the provincial capital.
The sub-areas disassociate from the south, with the city of Hassi Delaa, Bozbir and Bellil administratively belonging to the Hassi R'mel district, Qasr al-Hiran and Ben Nasser bin Shohra belonging to the Qasr al-Hiran district, while the Ain Madi district is in charge of five municipalities: Al-Huwayta, Ain Madi, Tadjmot, Khneg and Tadjrona. All the above districts and municipalities are, however, functionally subject to the sphere of influence of the city of Laghouat.

The same is true in the central urban centers of the region, where both Al Assafia and Sidi Makhlouf administratively belong to the Sidi Makhlouf district, but belong functionally to the city of Laghouat.

The dependency on the city of Laghouat in the northern part is less severe due to the emergence of another urban center, which is the city of Aflou. The municipalities fall under a sphere of influence attracted by two cities, primarily Laghouat and to a lesser extent Aflou.

And for this reason, we find that many countries are working on creating new administrative divisions and establishing additional provinces to relieve the pressure on the older provinces and to create new provinces tasked with overseeing small urban centers, which is what Algeria has done. The number of provinces increased from 48 to 58, then to 63 provinces. In November 2014, the Egyptian government launched the National Population Strategy 2015/2030 with the aim of improving the quality of life. This strategy included the necessity of alleviating the high population density and attracting residents to move to new urban areas [Tareq 2022]. China includes 40,859 fourth-level administrative units divided into 7 geographical regions, which are reorganized and divided into 34 administrative units split between Eastern and Western China [Khaouadja 2024].

8. Recommendations

The coherence of urban space requires an organized hierarchy of urban centers, services, and spaces. Hierarchically organized centers and services that depend on each other for different daily, weekly, or occasional needs allow the spaces to fit together and control the sub-spaces. This adaptation necessarily stabilizes rural populations and limits migration to the cities through equal opportunities for all residents to access goods and services.

The high frequency of transportation to the capital city, the multiplicity of points of sale 'wholesale or retail' the city's daily markets and the quality-to-price ratio mean that the inhabitants of the region prefer to get their needs from the mother city. This process leads to the bypassing of the main centers of the concerned regions.

The need to upgrade these centers to higher levels is necessary to be able to attract residents of neighboring municipalities and reduce the burden borne by the mother city. To this end, we suggest the restructuring of the urban system of the territory of the wilaya of Laghouat according to a model consisting of a main center 'the city of Laghouat' supported by reinforced and well-distributed urban centers interconnected by a strong road network and areas of movement that are close in time.

We have noticed that the central location currently occupied by the city of Laghouat makes it a crossroads in all directions; it is, therefore, necessary to create a road belt that allows communication between the various proposed centers without the need for passing through the capital city.

9. Conclusion

The analytical study of the Laghouat territory shows the weakness of the hierarchical cohesion of the system through the unequal distribution of population and services, where more than 36% of the total population of the territory is concentrated in the city of Laghouat, which represents only 1.6% of the total area of the region as a whole. This number only represents the actual and permanent residents of the city without counting transient people, which indicates that there is a large demographic congestion in the city.

The functional and administrative role in addition to all the services provided by the urban centers to the population have never enabled them to achieve stability of the population within their sphere of influence in the face of the almost absolute domination of the mother city thanks to its possession of all the elements of attraction and influence.

Equipment, wholesale and retail commerce, service, functional and administrative activities are the criteria that have allowed the hierarchy of the territory of the wilaya of Laghouat to be completely subordinate to the mother city as the dominant pole with a sphere of influence that pervades all the urban centers that make up the region.

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