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Morphic Logic of the Urban Macroform of the Intermunicipal Grouping of Batna -Algeria-

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Abstarct

Studies in urban geography have focused their research axes lately on understanding the reality, and morphological identity, of urban macroforms. Through the use of reliable mathematical approaches, innovative methods through purely geometrical notions and indices.

In this context, this article focuses first on the use of fractal analysis, as a reliable research stream, a geometric morphological approach that analyzes the global level of urban macroforms to understand the morphic logic and reality of the formal system in our inter-municipal grouping of Batna, over time.

Secondly, to determine the current position of the urban area of Batna, using the combinatory method of geometric indices employed by Marianne Guerois.

The research tasks used the following software: FRACTALYSE; GIS, XLSTAT, to perform the calculation and evaluation steps in order to obtain reliable results.

Finally, the results of the two sections have shown that the agglomeration of Batna is characterized by a dispersion and fragmentation that tend towards urban sprawl currently with a morphic surface identity less homogeneous, less hierarchical, less complex, a dendricity and a roughness of edge is decreasing with time.

Key words: fractal, urban patch, Batna, macroform, geometric indices, urban sprawl.

INTRODUCTION

Rapid urbanization has led to changes in the urban morphologies of cities in recent decades. This acceleration is reflected in a diversification of intra-urban spaces, a change in the morphology of urban fabrics and a modification of land use and land cover.

In this context, Algerian cities have experienced this important urbanization that is progressing at a rapid pace. The inter-municipal grouping of the city of Batna consisting of (Ouedi Chaaba, Tazoult, Fesdis, Batna), does not make the particularity, it is affected by this phenomenon of acceleration.

This kind of theme provokes researchers in urban geography who have focused their studies on the knowledge of urban morphologies with designs, and geometric notions through reliable analyses, innovative methods and particular tools.

In this regard, Maignant (2005) expressed that the inability to simply define the forms prompted scientists to devise a new geometry that would allow them to be comprehended, fractal geometry. one of the research methods of urban geography, which qualified, the preconceptions of the fractal analysis of cities are based on a theoretical representation of the city as a complex system (Badariotti ,2005). It was created in the second half of the 20th century as a result of research by the mathematician Mandelbrot (Da Costa and Dotto Stump), its definition, is given from the Romanian Explanatory Dictionary, clearly deposits their character, which aims the study of forms and has a chaotic quality in their distribution. FRACTALE in French; Latin Fractus, is a word that means «to overcome, break or tear» (Cîrnu , 2014). The use of such method has proven to be useful in a variety of domains, including biology, materials physics, and hydrodynamics, where complex structures must be described (Frankhauser ,2002). This geometry is a generalization of Euclidean geometry, which determines only the full dimensions of 0, 1, 2, etc., although fractional dimensions are

accepted (Terzi and Kaya, 2008). Since fractal geometry provides a way of functioning that surpasses the limitations of Euclidean geometry (Cîrnu , 2014).

Fractal are natural occurrences that are frequently used to describe complicated natural phenomena like the length of a shoreline, the shape of a cloud, or the contour of a leaf (Zhao C et al., 2021), because, Fractals are objects with geometric aspects that encompass irregularity, scale dependence and self-similarity (De Keersmaecker et al., 2003).

currently, Researchers prefer the fractal technique because it can describe all of the layers, systems, and structures that make up the city (Erdoğan ,2020), according to Dimitrios , Triantakonstantis (2012), that the nonlinear complexity of the structural structure of urban space is addressed by fractal theory (Thomas, Frankhauser , Biernacki , 2008 and Tannier et al., 2011). This approach would have explained the spatial allocation of urban areas and the irregular shape of the urban periphery (Theiler, 1990), it helps to understand complex systems at various scales and the numerous morphological transformations (Erdoğan ,2016) , it can even be used to improve the spatial structure of cities with future urban planning (Chen ,2010), it is an analysis that offers the creation of the necessary tools to describe the examined spatial specimens (Tannier and Pumain , 2005) and gives information on the existing urban structure, the course of the mutation of the land use distribution (Myagmartseren et al ., 2018).

Fractal analysis describes the spatial patterns and quality of built-up environments (Dekolo et al., 2015), It evaluates the development process by determining the level of complexity of morphological differentiation and connection between spatial parts. (Terzi and Kaya, 2008). And it is used in urban geography for a variety of purposes, including analyzing the shape of cities and simulating urban expansion (Tannier , 2018).

The calculation and evaluation of this geometry through the fractal dimension which is expressed as a vigorous and effective tool for a quantitative study of urban morphology (Batty et al., 1987), it is intended to discover new ways of describing the diversity of urban morphologies (Tannier and Pumain, 2005). Therefore; fractal dimensions of land use are essential for urban planning and management, as they provide "leading indicators" for future growth (Myagmartseren et al., 2015). This dimension has a very specific meaning and purpose. It measures the degree of occupied site concentration across the scale, or, more accurately, the proportionate drop in mass as distance from any site where mass is concentrated increases (Frankhauser,2004).

In the same sense, the use of reliable mathematical approaches, and geometrical methods are based on exclusively geometrical thoughts and indications. Numerous indices have been set up to evaluate the shape. By trying two or various parameters such as surface, perimeter or radii (Bennasr, 2003). These different metric indications that are used to indicate the extent of urban sprawl (Bennasr ,2006) and even to quantify, evaluate the urban patches of urban macroforms.

The estimation and calculation of this type of index is by defining and delimiting the contours of the urban unit (Bennasr, 2003). Where the agglomeration is determined by the continuity of built masses (Levy and Loussault ,2003). This kind of method is based on geometric indices that was adopted by Guerois (2003) in her thesis, it is an approach that includes a series of geometric indicators to compare, estimate and position the spatial configurations of different European cities and their macroforms between compactness and sprawl. Using a multivariate principal component analysis (MCA) by combining shape indices and comparing these latter to standard shapes that are considered as reference shapes. This leads to differentiate the various spatial configurations of the studied macroforms.

This research paper has been divided into two parts:

The first part will focus on fractal geometry, more specifically, the level of global study of urban macroforms via urban patchs. In order to understand, and know the morphic logic as well as describe the identity of the formal system of inter-municipal grouping of Batna over time, using the Geographic Information System (GIS) and the fractal analysis software (Fractalyse).

The second part will determine and estimate the positioning of the current urban patch of the agglomeration of Batna, the indices of geometric shapes were used in the combinatorial analysis of Guerois Marianne, which are based on different geometric relationships such as: perimeter, area and distance of the axes of digitation, radii. Using a map that was previously elaborated by GIS and a principal component analysis (PCA) realized and executed by the statistical software XLASTAT.

The results obtained from this research inform us that: a strong fragmentation leads to an urban sprawl now with a morphic surface reality less homogeneous, less hierarchical, less complex and an urban edge of low dendricity and roughness over time.

CASE STUDY

Batna, capital of the Aures, is located on the eastern highlands, in the center of the Aurès massif, in a valley where the Atlas tellienne and Saharan meet. This city is located 400 kilometers East of Algiers, the capital. And it reaches a height of more than 900 meters from the sea. It is located between the following geographical coordinates: North Latitude: 35°33′21′′, And 6°10′26′′ East Longitude, in the coordinate system. And by the global satellite position of WGS 84.

The inter-municipal grouping of the city of Batna contains a set of four municipal communes, the commune of Batna is located in the middle of the communes of Fesdis, Tazoult, and Ouedi Chaaba; this urban grouping is considered as a crucial set and a strategic junction place where important transport axes are articulated; which contribute to the revitalization of the region in its globality. The communes bordering this inter-communal grouping are **North**: Seriana, Oued lma. **East**: Djerma, Elmadhar, Ouyoun Alassafir. **West**: Hidoussa and Ain Touta. **South**: Oued Taga, Bni Fdhala.

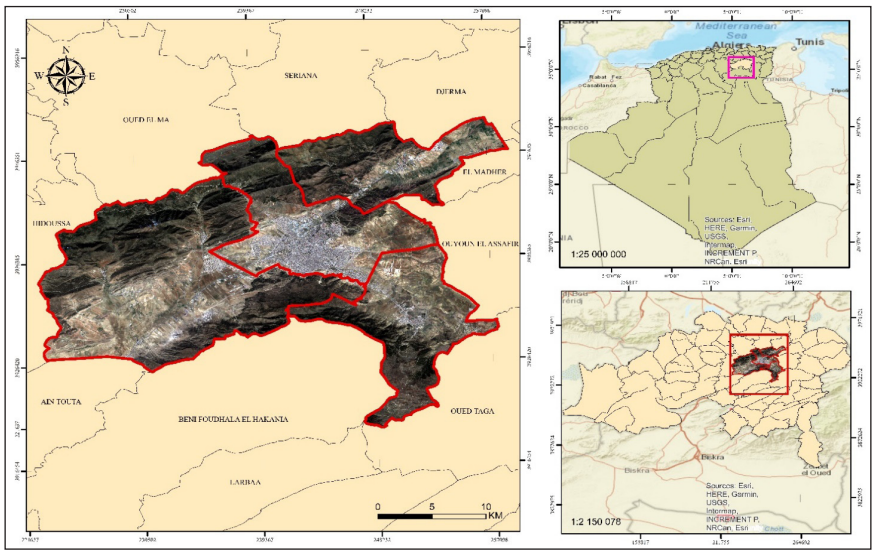


Figure 1. Location of the Batna intermunicipal grouping

MATERIALS AND METHODS

First of all, the use of fractal analysis to know and determine urban morphologies, the geometric nature of this method is appealing because it allows for the development of metrics that may be used as morphological descriptors for urban fabrics (Benamar and Selka , 2001) , through the fractal dimension that explains the surface-to-perimeter ratio of land uses and shows the territory's ability to fill space as well as the intricacy of city limits and built-up land (Rajashree et al., 2014) . Two fractal methods: correlation and dilation were used to provide information on the distribution of built-up areas and the morphic identity of the edges of urban fabrics.

Correlation Analysis

Correlation analysis works on a simple principle. Each occupied pixel is surrounded by a small square window of size ε on a raster image of the built-up area to be analyzed and the number of occupied pixels within each of these windows is calculated, and the number of occupied pixels within each of these windows is counted: then M(ε), the average number of points evaluated per window, is calculated for that window size. For windows of increasing size by gradually expanding. The result is a set of points that can be represented as an exponential-shaped curve (scalant behavior curve), with ε on the x-axis and M(ε) on the y-axis The means M(ε) follow a relationship equivalent to: $N(\varepsilon) = L \times \varepsilon D$ *with* $N(\varepsilon) = M(\varepsilon)$ *(1).* This relationship takes the following form, after linearization by the logarithm: $\log N(\varepsilon) = L + D - \log \varepsilon$ *(2)* (Badariotti, 2005).

The fact that the correlation analysis is based on averaging, for fractal behavior, smoothes the curves. Furthermore, this method can be used to examine both the extracted surfaces and edges (Frankhauser, 2003).

Dilatation Analysis

The dilation analysis suggested by Minkowski is the oldest analysis method. We replace each occupied point j with a solid square of size centered on j to perform this analysis. These squares become more and more dilated. As a result, the voids separating the occupied sections progressively decrease and larger and larger aggregates appear during the dilation phases. This method can theoretically be used to explain the dispersion of a built mass as well as to evaluate the tortuosity of a boundary (Frankhauser ,2002).

Urban Edge Analysis

This method uses dilation analysis and involves gradually increasing the surface area of buildings by surrounding them with a band of employed surface. Large aggregates are created as the system grows, at the expense of the gaps that separate the occupied sections.

Overall, some stages of dilation satisfy to eliminate the road network and the inner courtyards at the block scale; only the boulevards, corridors penetrated by railroads and huge public squares remain. As a result, the edge of these aggregates has been extracted. The urban edge morphology was studied in two ways: On the one hand, the overall edge of all aggregates was examined, as shown in Figure 2c, and on the other hand, the edge of the main aggregate was studied (Fig 2d) (Frankhauser ,2005).

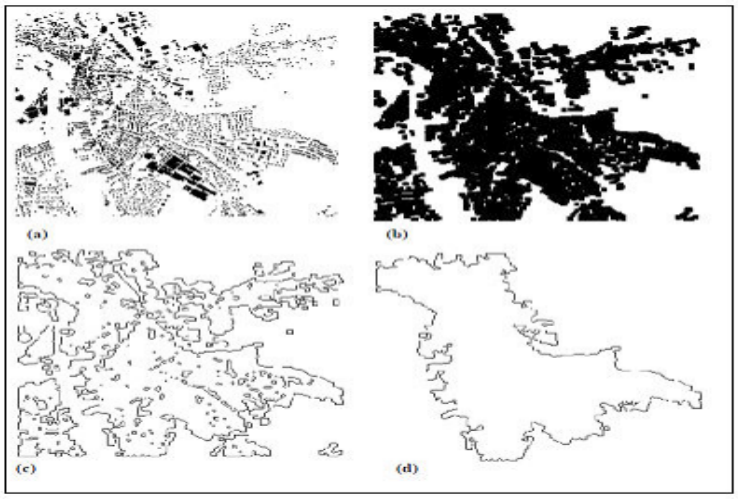


Figure 2. The method of edge extraction expressed for Valentigney (Montbéliard country).

A dilation of the building of about 5 to 10 m is enough to eliminate the yards and the road network. Aggregates appear and it is possible to identify an urban edge. Figure (c) shows all the edges while in figure (d) only the edge of the main aggregate is extracted (Frankhauser, 2005).

Morphic Identity Indicators

These are indices and degrees (of fragmentation, roughness, dendricity, ...) that use the fractal dimensions acquired by previous analyses (correlation, dilation) such as edges and surfaces, aggregates ... to act as informants in the description of space and morphological research of urban structures and urban management planning of intercommunal grouping of Batna.

According to (Arrouf et al., (2015), Barrou et al., (2017) and Zenati Bouiche et al., (2020), the most important indicators used for the morphological analysis of urban fabrics are:

The Level of Homogeneity

It provides information on the homogeneity or heterogeneity of the built-up mass distribution, by measuring the fractal dimension of the correlation D

The Level of Hierarchy

It provides information on the hierarchy, of the distribution of mass built by measuring the fractal dimension of the correlation D, with the observation of the scalant behavior curve.

The Level of Complexity (A)

It notifies about the complexity of the fabric by taking into account the prefactor of type «a» if the value is high, the fabric is complex.

The Level of Compactness (N)

The number of iterations resulting from the dilation analysis provides information on the reality of the compactness or degree of density of the urban fabric.

A Fragmentation Index (Φ)

The fragmentation index has a value between zero and one, according to Fankhauser (2005):

$$\varphi = \frac{D_{bord/tot}}{D_{bord/agr}} - 1$$

If the structure has a value of zero, it consists of a single aggregate. While if it is around one it indicates that the tissue is fractured and fragmented and consists of a large number of islands that cover the surface almost uniformly.

Dendricity Index (Δ)

$$\delta = 2 - \frac{D_{surf}}{D_{bord/agr}}$$

According to Frankhauser (2005), the index varies from 0 to 1. If the value is close to one, it corresponds to a Sierpinski mat. When the structure is compact and smooth, coincides with the zero value.

The Synthetic Complexity Indicator, or Roughness (Is)

According to Badariotti (2005), the formula of the roughness index (Is) is as the following:

$$Is = (2 - Dsurf) - (1 - Dbord) = 1 - Dsurf + Dbord$$

With reference to the Euclidean dimension, the synthetic complexity indicator, or roughness, has been developed, it synthetically quantifies the deviation from dimension 2 for D_{surf} and the deviation from dimension 1 for D_{bord}.

- When the index is 0, we are dealing with a Euclidean shape, exceptionally smooth both on the surface (Dsurf near 2) and on the perimeter (Dbord near 1).
- When it is equal to 1, the difference in Euclidean surface dimension compensates for the difference in Euclidean line dimension. The value 1 corresponds to a variety of conditions, but in all cases a value of 1 already indicates a high degree of roughness in the objects considered.

METHODOLOGICAL APPROACH

Through the previous indices and analyses, the first section of this research will perform fractal analyses to:

- compare and study the diachronic morphological evolution of urban fabrics, in order to shed light on the process of urban growth through time.
- Determine the morphic reality of urban fabrics, in order to describe the urban morphologies of the urban intermunicipal grouping of Batna over the last 36 years.

Using in the first part remote sensing and geographic information system (GIS) through the use of satellite images extracted from Landsat TM and ETM +, Sentinal 2 of the years 1984, 1996 and 2008 and 2020, through supervised classification, and Kappa indices that exceed 0.8. The obtained maps are processed and rasterized into binary images, in uncompressed format (Tiff). Where built-up areas were presented by black pixels while gaps (empty spaces) were represented by white pixels and all steps are executed by the Arc Gis 10.8 software.

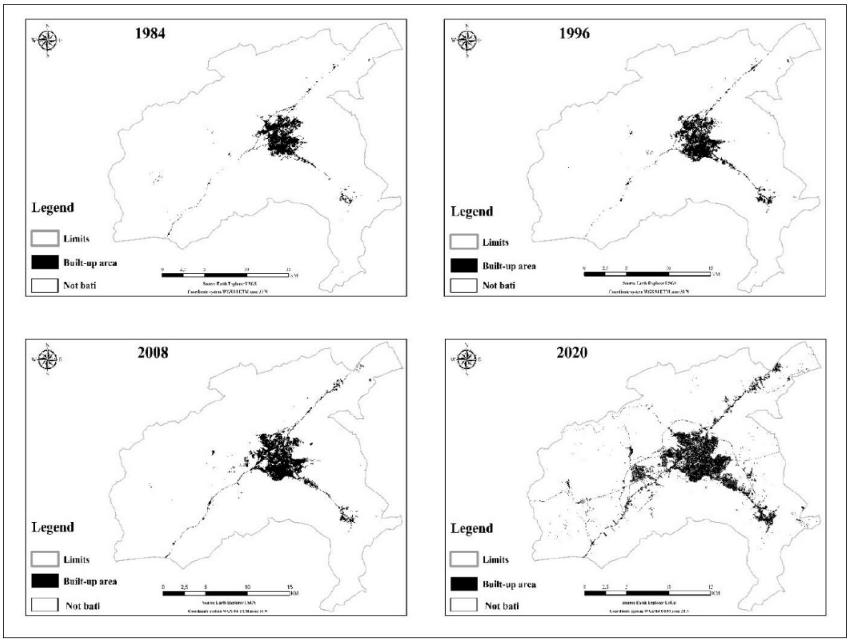


Figure 3. land use and Land cover maps of the Batna intermunicipal grouping for the years 1984-1996-2008-2020

The Geometric Indices of Guerois Marianne between Compactness and Elongation

Guerois (2003) showed, in her thesis of doctorate that according to Cauvin, Rimbert, 1976 that numerous processes transposed to the comparative study, spatio-temporal, of the forms in geography, they were exposed to determine statistical indices, which admit to present the examined forms of commensurable way calculable, interpreting them by numerical data.

Guerois' research is based on a comparison of the shape to be searched with standard geometric figures. Consequently, six numbered geometric indices are established, allowing to classify the shapes according to their degree of resemblance with the reference figures. (Standard). These indices, according to Marianne, measure the length of the perimeter relative to the area, the area of the largest inscribed circle relative to the smallest circumscribed circle, or the length of the largest axis relative to the area. Six standard geometric shapes were compared to the specified indices, which are defined by varying degrees of elongation, digitation and indentation.

Each of these indices has its own «signature», consisting of the figures' different positions on their own reference scale (Guerois ,2003).

In this respect, this article will depend on the analytical analysis of geometric indices by Guerois to evaluate the macro urban form of the Batna intercommunality. Using GIS and XLSTAT statistical software, a multivariate principal component analysis (PCA) that was performed.

Delimitation of the Shape of the Urban Patches of the Batna Agglomeration

The 2020 binary map previously established by remote sensing and supervised classification analysis using the Geographic Information System (GIS) through ArcMap software (version 10.8), in order to know the current positioning of the urban macro-form of the Batna inter-municipal grouping, we will determine its urban patch by the continuity of the built-up area, the built-up masses must be close to each other to form a distinct and well-defined whole.

In Algeria, as in many other countries, the distance criterion is 200 meters, ignoring green spaces and large facilities that interrupt the urban space (Bennasr , 2003).

As a result, two masses were formed: a central grouping called «The inter-municipal grouping of Batna» and a second grouping more than 200 meters away (the urban tentacle of Ouedi Chaaba). We have excluded all the isolated and non-joined built pixels.

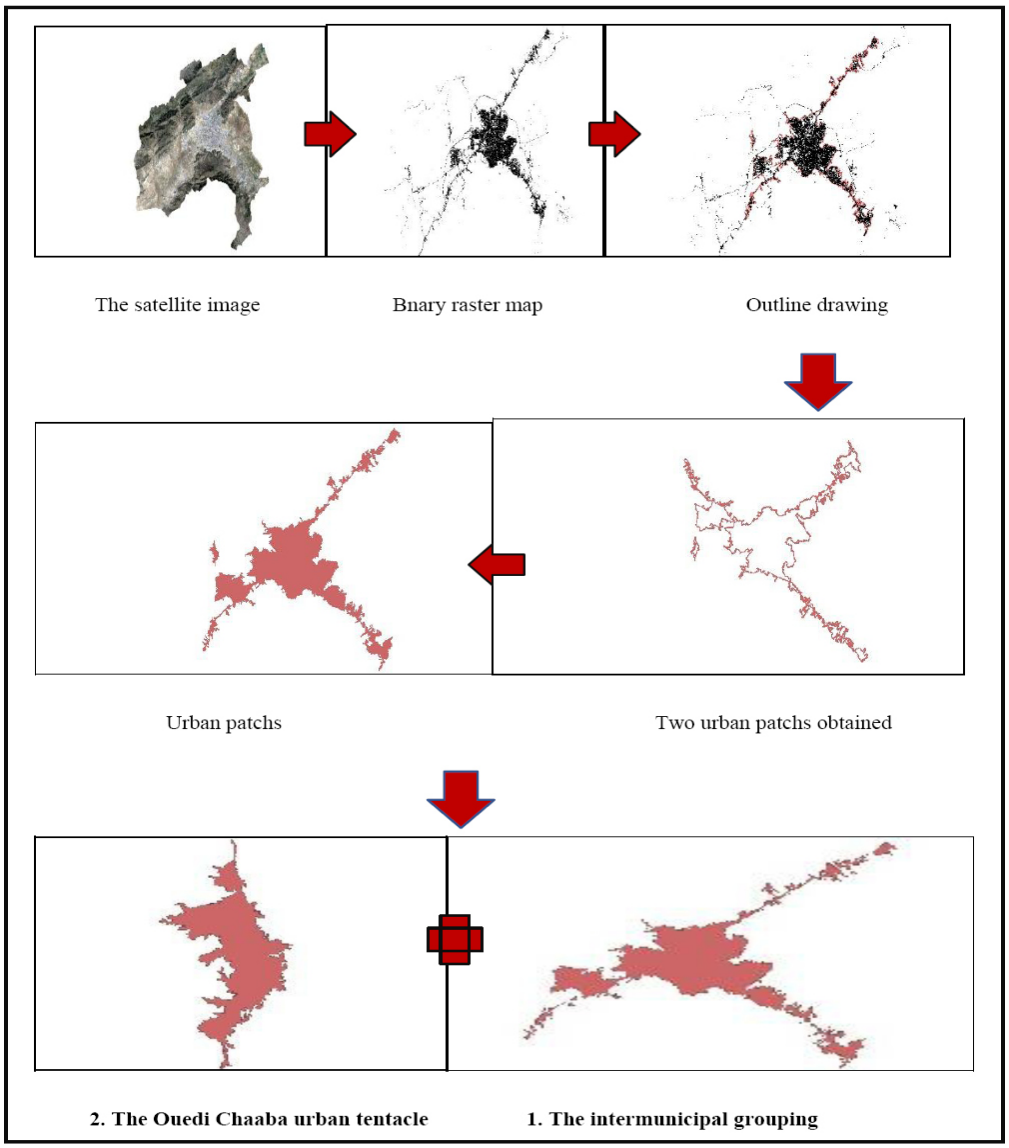


Figure 4. Extracting urban patch from the intermunicipal grouping of Batna for the years 1984-1996-2008-2020

RESULTS AND DISCUSSIONS

Correlation Analysis

The Level of Homogeneity

Table 1. Values of correlation dimensions during 1984-1996-2008-2020 of the Batna intermunicipal grouping

Years	Dimensions
19984	1,34
1996	1,36
2008	1,47
2020	1,56

The level of homogeneity informs on the homogeneity or heterogeneity of concentration of the built mass in the studied area through the evaluation of the fractal dimension of correlation D. whose values close to two coincide with a rather homogeneous fabric while the values close to zero designate a strong heterogeneity in the dispersion of the built masses.

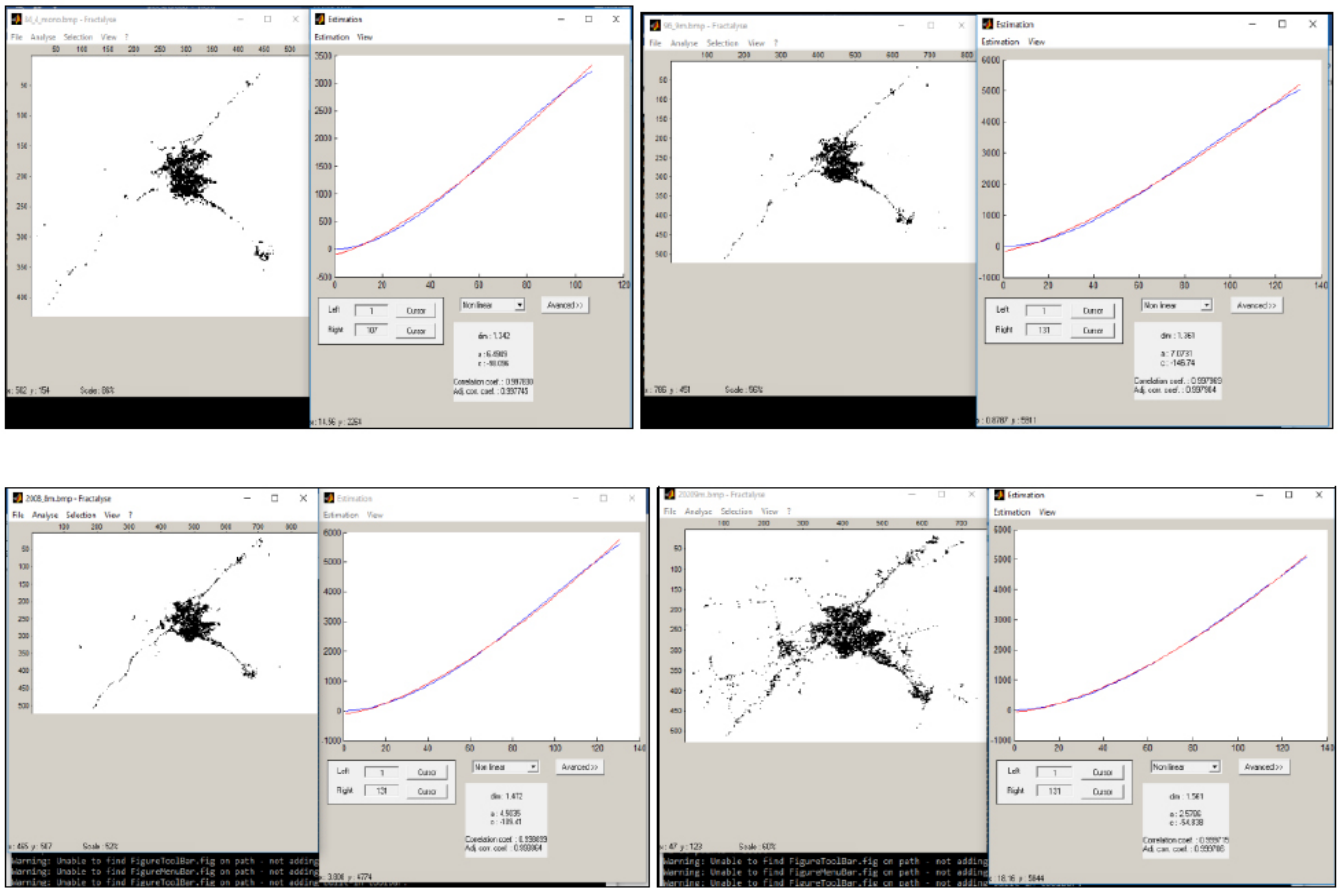
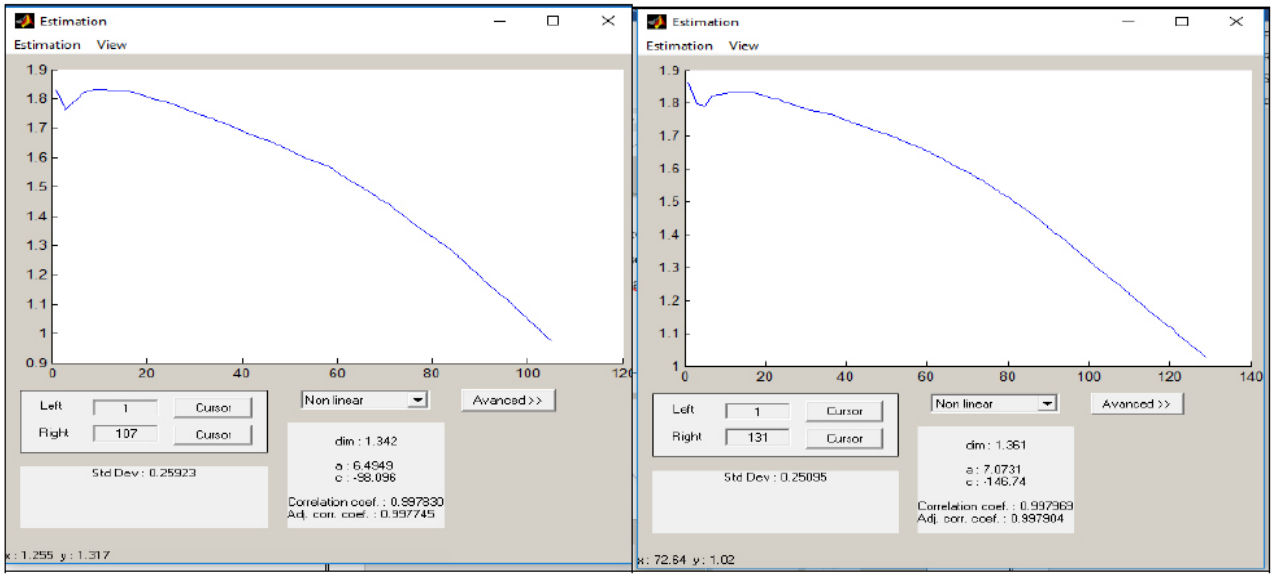


Figure 5. Results of correlation analysis of Batna's intercommunal grouping for the years 1984-1996-2008-2020

The values of the fractal dimensions of correlation differ from one year to another, ranging from 1.34 in 1984 to 1.36 in 1996, 1.47 in 2008 and 1.56 in 2020. These are values that lean towards 2, and are close to 1.5, indicating that the urban fabrics of the Batna urban macroform have become less homogeneous over the last 36 years.

The Level of Hierarchy of Urban Fabrics

By evaluating the fractal dimension of the D correlation and inspecting the scalant behavior curve, it is possible to determine whether, the concentration of built mass in the study area is homogeneous or heterogeneous. Values close to two with less fluctuating scalant behavior coincide with a low hierarchical fabric.



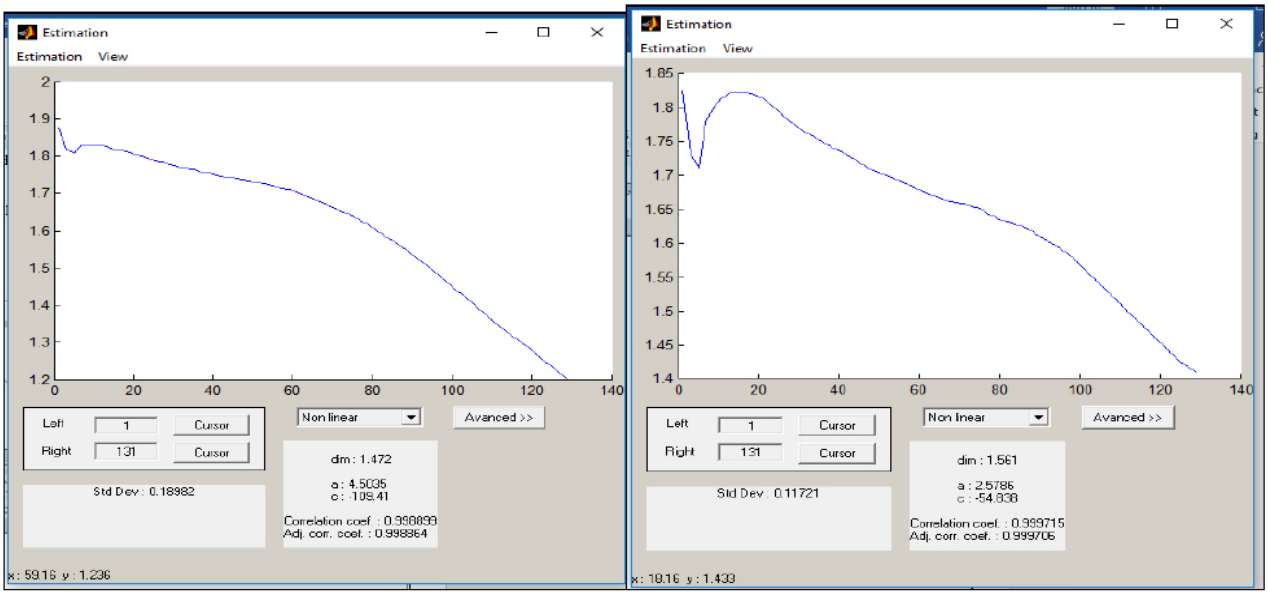


Figure 6. Scalant behavior curves resulting from the correlation analysis of Batna macroforms for the years 1984-1996-2008-2020

The fractal dimensions resulting from the correlation analysis of Batna macroforms vary between 1.34 and 1.56 for the years 1984 1996 2008 2020; leans towards 2 with curves of scalant behavior of slight fluctuations, which go almost in the same direction; this means therefore that these fabrics are characterized by low hierarchical built-up areas during the last 36 years.

The level of complexity

The level of complexity is determined by measuring the shape prefactor «a» and announcing the complexity of the tissue. The tissue becomes more complex if the values are huge and high; whereas , when the values are small the tissue is less complex.

Table 2 . The values of pre factors correlation during 1984-1996-2008-2020 of Batna intercommunal grouping

Years	A
19984	6,4949
1996	7,073
2008	4,503
2020	2,578

The urban fabrics studied between 1984,1996, 2008,2020 have a value of «a» which is interpreted as 6.49, 7.07 4.50 , 2.57, respectively are low, indicating that the urban fabrics of these last 36 years are less complex.

Comparaison between Fracatals Dimensions of Correlation

Table 3. The values of the correlation dimension by pixels during 1984-1996-2008-2020 of Batna intercommunal grouping

Pixels	Dimension 84	Dimension 96	Dimension 2008	Dimension 2020
20	1,83	1,83	1,82	1,82
40	1,75	1,78	1,77	1,77
60	1,66	1,72	1,74	1,72
80	1,54	1,65	1,69	1,68
100	1,4	1,55	1,63	1,64
120	1,34	1,43	1,53	1,59
140	1,34	1,36	1,47	1,56

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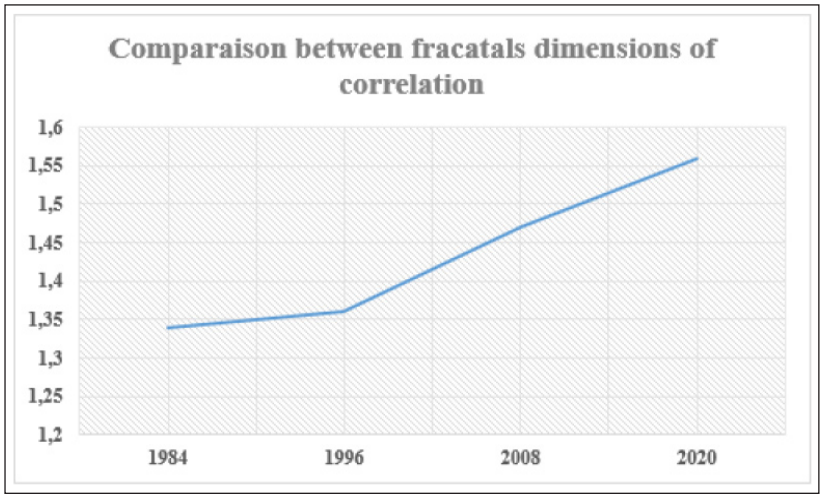


Figure 7. Comparison curves between the fractal dimensions of correlations of Batna intercommunal grouping for the years 1984-1996-2008-2020

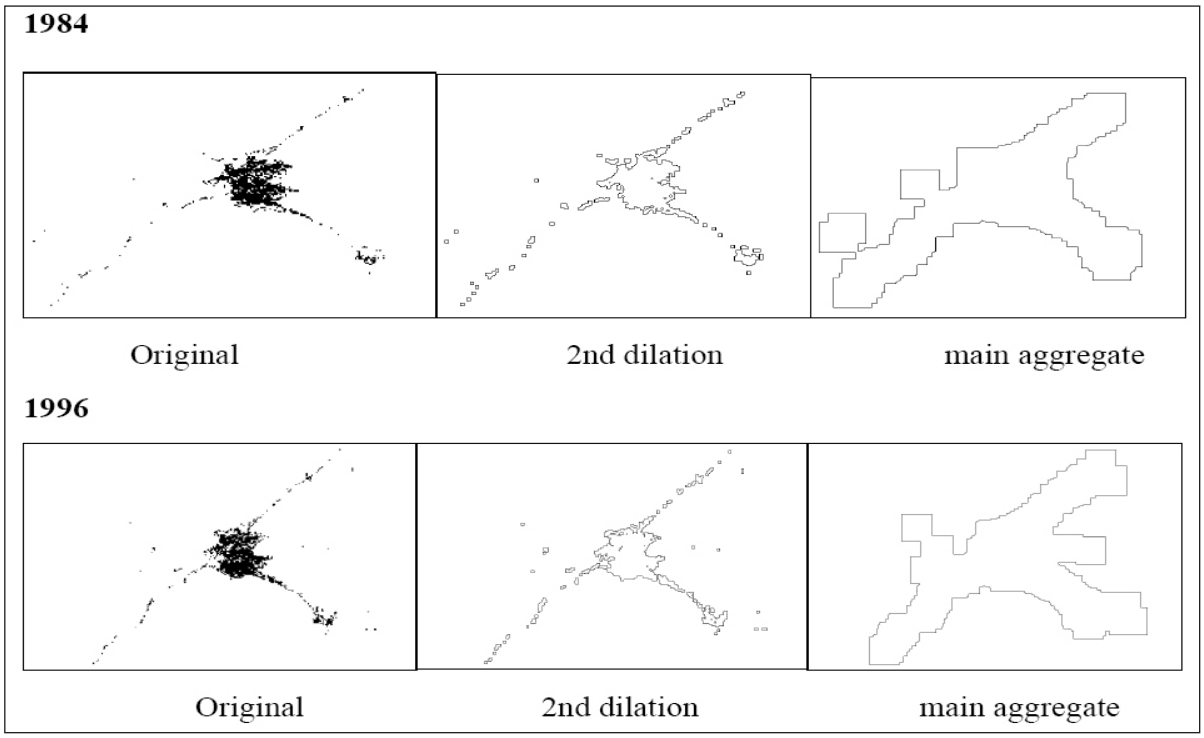
The fractal dimensions of correlation acquired in the years: 1984, 1996, 2008, 2020 are 1.34,1.36,1.47, 1.56 respectively have increased steadily gradually , and progressively in a stable way, they are stagnant values, and converge between them. From the lowest value of 1.34 in 1984 to a slightly higher value of 1.56 in 2020 and leans to 2. This increase which tends towards 2 shows that the distribution of built-up area and the occupation of the surface becomes more uniform and tends towards homogeneity over time.

According to (Frankhauser and Genre-Grandpierre (1998)), these findings of increasing uniformity is justified and is explained by the progressive improvement of the road network, which allows a quasi-homogeneous peri-urbanization.

According to the results of the correlation study, the morphic descriptors of the urban fabric of the urban macroform of Batna between the years 1984, 1996, 2008 and 2020 demonstrate a morphic logic is less homogeneous, little hierarchical and less complex.

Dilatation, Morphic Indicators of Urban Fabric Differentiation

Extraction of Urban Edges



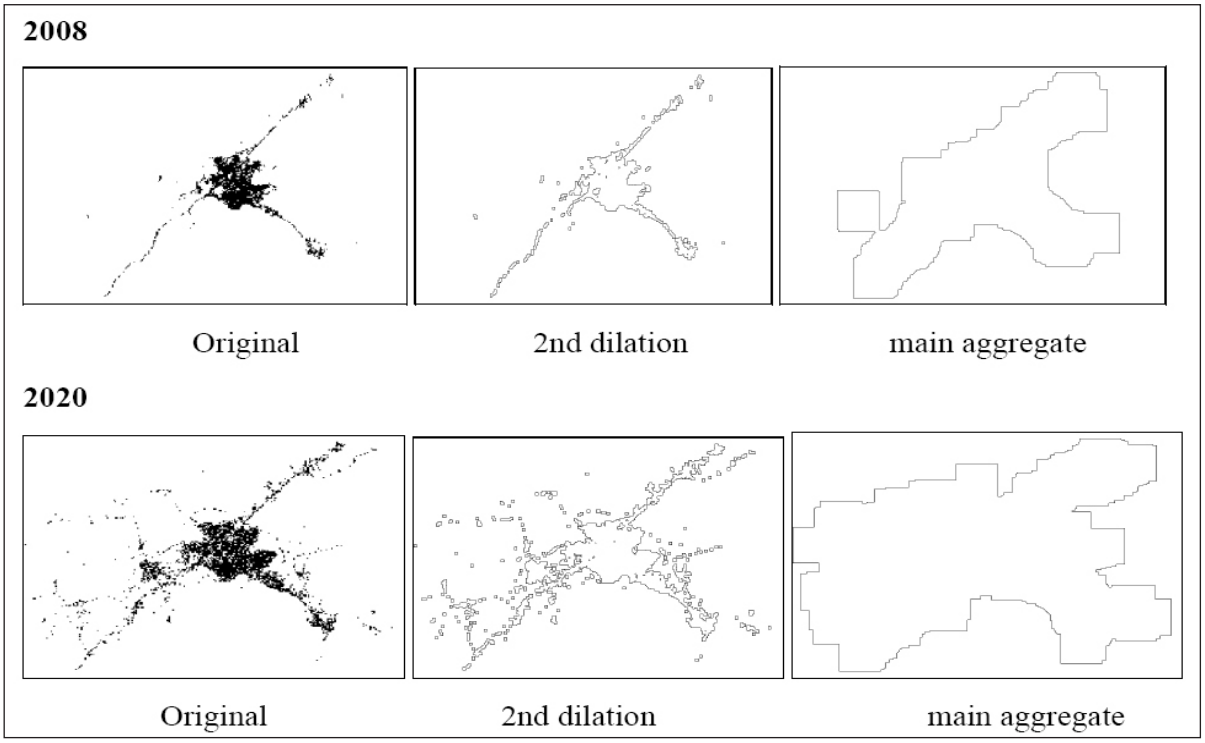


Figure 8. Extraction of the urban borders of the intermunicipal grouping of Batna for the years 1984-1996-2008-2020

Table 4. Morphic Indicators values during 1984-1996-2008-2020 of Batna intercommunal grouping

Les années	Dcorrel	Dbordur tot	D aggregate	Number of dilation	Fragmentation φ	Dendriticity index (δ)	Roughness indicator (Is)
1984	1.34	1.26	1.29	30	0.02	0.96	0.95
1996	1.36	1.18	1.25	35	0.056	0.91	0.89
2008	1.47	1.28	1.23	52	0.04	0.80	0.76
2020	1.561	1.53	1.177	44	0.30	0.66	0.61

Level of Homogeneity of Edges

The urban fabrics of the Batna intercommunal grouping have more diversified values (1.29-1.25-1.23-1.17) close to 1.5, indicating that the perimeter is less heterogeneous.

Urban Edge Dendricity and Fragmentation

Morphological analyses revealed that the Batna urban area has a high dendricity, with values of 0.96, 0.91, and 0.80, respectively, reaching a maximum value of 1 and approaching that of a Sierpinski mat between the years 1984-1996-2008. While the fragmentation indices are significantly low in the same years, equal to 0.02, 0.056 and 0.04, respectively (these low values approach the minimum value of 0 and correspond to an isolated Euclidean object), this low value indicates that the Batna agglomeration has a very low fragmentation and is dominated by a main aggregate.

On the other hand, we found that the Batna agglomeration has a lower dendricity of 0.66 and a fragmentation index of 0.30 for the year 2020. This indicates that the agglomeration has a fragmented fabric composed of a large number of patches that cover the area almost uniformly, have a compact structure, and a relatively smooth border.

Synthetic Index (The Degree of Roughness (Is))

The synthetic indicators of roughness of the urban fabric of the Batna agglomeration of different dates are very close and have the following values: 0.95 in 1984, 0.89 in 1996, 0.76 in 2008 and 0.61in 2020, are extremely high and extremely close to the maximum value 1, suggesting a strong roughness, (a more rough and complex shape).

All these values lead us to conclude that the urban fabrics of the Batna agglomeration are rough. Where (Dbor/agr) ,which is close to the value 1.5. therefore have a less heterogeneous perimeter and a fairly homogeneous surface (Dsurf) approaching the value 2.

Level of compactness

Table 5. The values of number of iterations during 1984-1996-2008-2020 of Batna intercommunal grouping

Years	The number of iterations (N)
1984	31
1996	35
2008	51
2020	44

The level of compactness informs about the compactness of urban fabrics according to the number of iterations resulting from the dilation analysis.

The dilation analysis offered the number of iterations essential to the dilation for each urban fabric. This analysis presented the following values : 31, 35, 51, 44 iterations. These numbers are high, so these fabrics are loose, which is logical and normal given that the agglomeration is in a phase of urbanization and expansion.

Comparison of three indicators Is, φ, δ

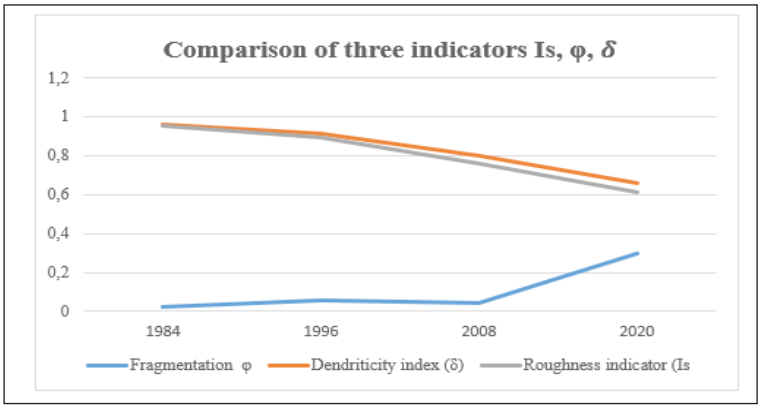


Figure 9. Comparison of three indicators Is, φ, δ of Batna inter-municipal grouping for the years 1984-1996-2008-2020

In the same direction, the values of the fragmentation index increase inversely with the values of dendricity and roughness., This shows that the urban fabrics of the macroforms are characterized by an increase in fragmentation (greater fragmentation) which tends towards urban dispersion (the appearance of sprawling branches, a sprawling structure in which the built environment has developed along the axes of transport, this is due to the constraints either physical or natural; they are fragmented inside with gaps of different sizes). A degree of dendricity and roughness that gradually decreases with time.

This analysis of fractal models revealed that the spatial distribution of the urban area of the Batna inter-municipal grouping changes with time, becoming more dispersed and expansive.

Characterization of the current urban patch of the Batna agglomeration

In order to assess the urban patch of the Batna agglomeration, a variety of shape indices based on various geometric relationships and ratios such as perimeter, area, and distance between digitation axes were used.

the shapes of the examined urban patch will be compared to six typical geometric figures with varying degrees of elongation, digitation, and indentation to assess their accuracy. Based on a theoretical reference scale.

The different values of the indices produced, given for each standard figure, taking into account the geometric characteristics of the circle, as they are bounded between 0 and 1.

(Guechi 2016, Fekkous 2015, Dechaicha 2013, Guerois 2003), are presented in Table N. 06 with the forms of the urban patch of the agglomeration of Batna to make the comparison.

Table 6. Values of the indices of attributed forms.

Theoretical form	Description	Values obtained on each index					
		I1	**I2**	**I3**	**I4**	**I5**	**I6**
	Circle	1.00	1.00	1.00	1.00	1.00	1.00
	Circular shape contour very indent	0.54	0.79	0.78	0.79	0.80	1.00
	Circular shape very digitized	0.09	1.00	_	1.00	0.45	1.00
	Circular shape digite	0.15	1.00	_	1.00	0.24	1.00
	Linear form sinuous	0.10	0.15	0.21	0.15	0.10	0.10
	Straight linear form	0.00	0.00	_	_	_	1.00
	The intermunicipal grouping	0.0047	0.552	0.234	0.148	0.09	0.06
	Tentacle Ouedi Chaaba	0.045	0.33	0.147	0.15	0.156	0.42

The geometrical indices are marked by a «signature», constituted by the location of the various figures on their reference scale. (Distinguish that in figure **N° 10**).

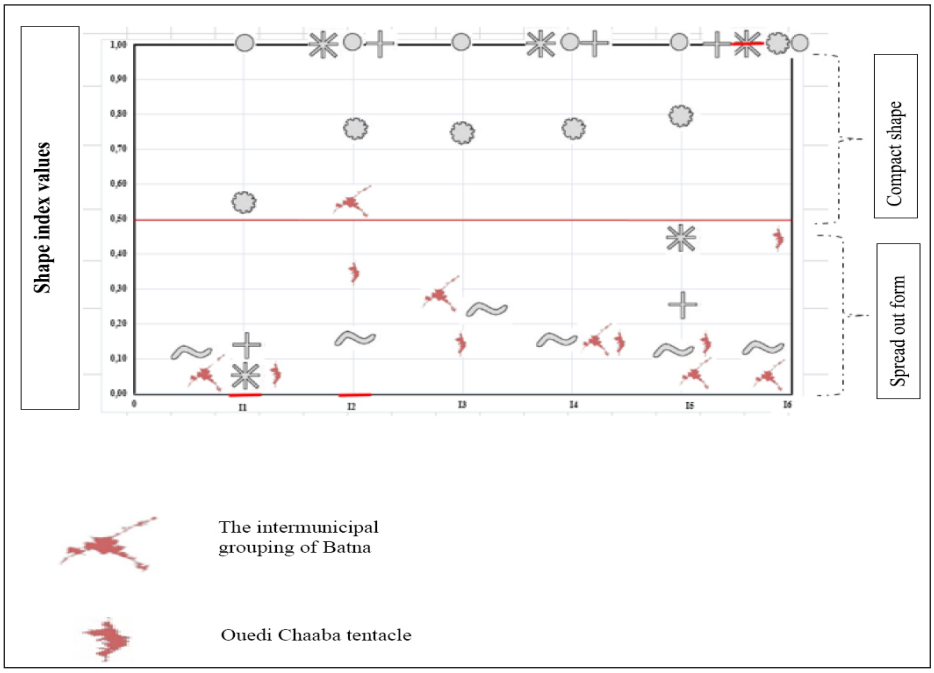


Figure 10. Location of the figures of the urban grouping of Batna in comparison with the Situations of the standard figures on each shape index.

The observations extracted and induced from this comparison show that the shape of the urban patch of Batna intercommunal grouping and the secondary tentacle Ouedi Chaaba are classified in the spread zone (less than 0.50), so they are positioned and approximate to that of the elongated sinuous figure.

So the forms of the urban patchs of the agglomeration of Batna (of inter-municipal grouping, Ouedi Chaaba), they are located in the spread out zone.

The Differentiation of the Spatial Configurations by the Presentation of the Results of PCA

We are going to put the values of the indices of forms taken from each urban patch and the standard figures, schematic has a multicriteria analysis (multivariate analysis in principal components (PCA); that directed us to compress, to summarize, the synthesis of the information, wich has a graphic representation; that detects the relations between the variables. And to be able to discriminate the main dimensions of the morphological differentiation.

Correlation Circle: Analysis of Variables on PCA Axes

The correlation circle is essential to explain the significance of the axes. The circle makes it possible to see the correlation or the link between the variables (Guerois, 2003).

In our case, we notice that all the variables (the geometric indices) are well represented in two axes F1 and F2 with an inertia of 89.41%, which means that the information is indisputable on the two new factors is less than 11%, the F1 axis is clearly linked to the geometric indices with an inertia of 68.61%, while the F2 axis is essentially linked to the geometric indices with an inertia of 20.80%. These trends are particularly interesting to identify the interpretation of the graph of individuals.

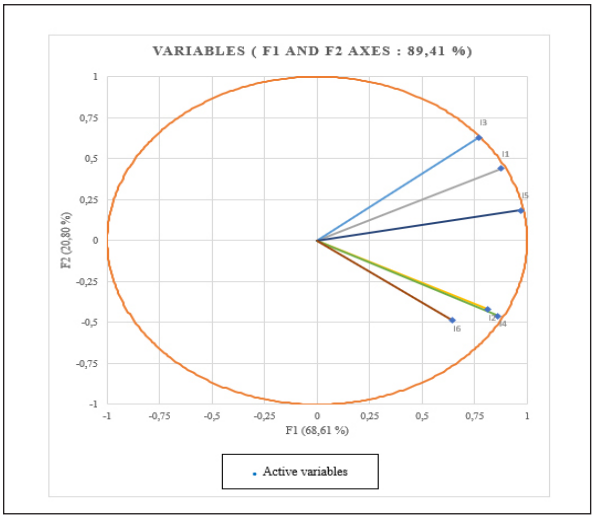


Figure 11. Position of the indices of forms on the axes of the PCA.

According to the position of the indices of forms on the first two factors of the PCA, we can note that all the points of the indices are strongly correlated with the axis F2 with a correlation of more than 0.6.

And we can also see that the indices (I3 I5 I1) are positively correlated with the F1 axis and that I2 I4 I6 are negatively correlated with the F1 axis.

The superposition of I4 and I2 indicates that these 02 variables are well correlated with each other.

Observation Graph: Analysis of Individuals and Position of Communes on the Axes of the PCA factors

From these observations, we can conclude that we have 3 groups of shapes that have a similarity between them:

The first group: Circle and the circular form contour very indent this group has a strongly positive correlation on the axis F2 thus with higher values on the whole of the indices I1, I3, I5, I2, I4, I6 and the strongly positive correlation on the axis F1 with a weak value with the indices I2, I4, I6 compared to the indices I1, I3, I5.

The second group: circular form digitized and circular form very digitized: this group has a moderately positive correlation on the axis F2 thus, with values higher than 0 on the whole of the indices I1, I3, I5, I2, I4, I6 and strongly negative correlation on the axis F1 thus with a weak value with the indices I1, I3, I5 compared to the indices I2, I4, I6.

The third group : sinuous linear form, the intercommunal grouping and tentacle of Oued chaaba this group has a strongly negative correlation on the F2 axis so has low values on all the indices I1, I3, I5 , I2, I4 ,I6 and the strongly positive correlation on the F1 axis has a high value to the indices I1, I3, I5 compared to the indices I2 ,I4 ,I6.

The first group and the third group have different behavior on the F2 axis, but the same behavior on the F1 axis. The second group has a different behavior with the others on the F1 axis.

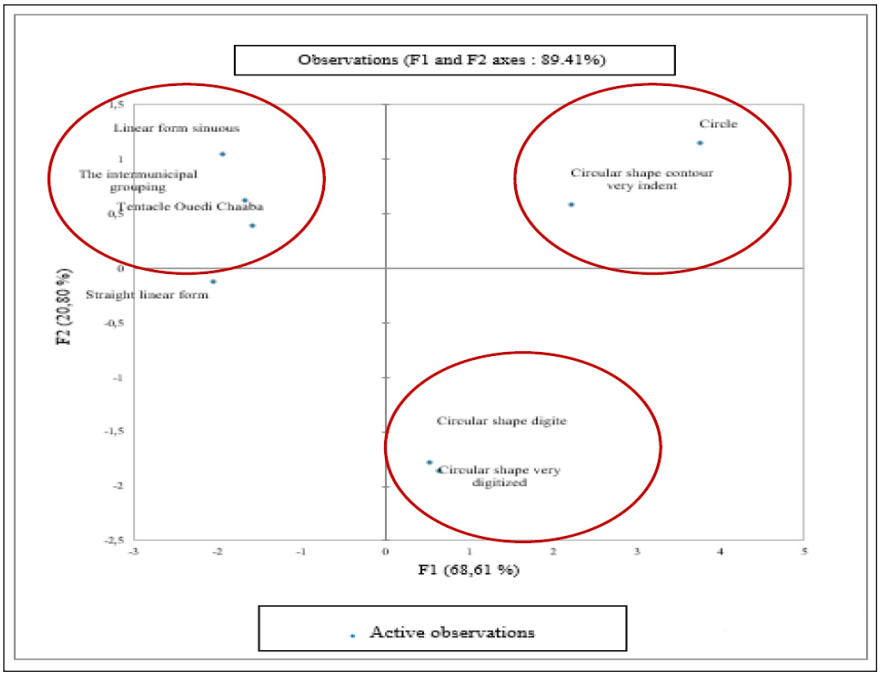


Figure 12. Position of shapes on PCA factor axes.

We can deduce that the shape of the urban patch of inter-municipal grouping and the Ouedi Chaaba tentacle are less compact elongated forms. They are close to the linear forms digited and sinuous.

CONCLUSION

Fractal analysis, is a mathematical research approach that has been widely used during the last decades in the field of urban geography to describe urban morphology, know the organization and spatial reality of macroforms of cities . They offer an essential tool to describe the spatial specimens examined. It is considered as a support for geography , urban planning and management, since it proposes solutions for future growth and expansion.

The results of this approach are provided through the fractal dimensions that are considered as a powerful, reliable tool, as well as an indicator of information and data for the studies of urban morphology.

In our study, the correlation analysis informs us that the morphic logic of the urban fabrics of the Batna intercommunal grouping is characterized by fabrics that are less homogeneous, less hierarchical and less complex.

Furthermore, the distribution of built; along the occupation of the surface becomes more uniform and tends towards homogeneity over time. This is explained by the progressive improvement of the road network, and the transport system.

Morphic Identity Indicators, these are indices that use the fractal dimensions acquired by two analyses (correlation, dilation) to participate as intermediaries in the description of space and morphological investigations of urban structures.

In our case these indices inform us that the urban fabrics of the macroform are characterized by (greater fragmentation) that tends towards urban dispersion, that has developed along the transport axes with a dendrite and low roughness over time. The results also highlight that the impact of urbanization on the morphology of the edges (less heterogeneous, rough, dendric limit).

Thus, in general, this fractal analysis revealed that the spatial distribution of the urban area changes over time, becoming more dispersed and expansive.

Another method was adopted by Marianne Guerois in her thesis, based on geometric indices, which uses a set of geometric indices to compare, estimate and position the spatial configurations of different cities along their macroforms between compactness and sprawl. Combining shape indices and comparing these indices to standard shapes in a multivariate principal components analysis (PCA).

To establish and estimate the location of the agglomeration of the current urban patch of Batna, we use this analysis which is based on geometric relationships such as perimeter, surface and distance between the axes of digitation, radii

The use of this method in our case study resulted in the following: the shape of the urban patch of the inter-municipal grouping and the Ouedi Chaaba tentacle are less compact elongated shapes. They are close to the linear digitized and sinuous forms.

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