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Human Ingenuity through Vernacular Architecture in Arid Environments, the Case of the Ancient Core of Biskra

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Algerian regions have distinct characteristics, particularly in terms of traditional dwellings with vernacular architecture. The current work exhibits these qualities by conducting a typo-morphological examination of a vernacular urban fabric created by Biskra's historic center. Using the analytical model developed by Borie and Denieul (1984), the results show that this urban fabric, characterized by its linear layout that follows that of the seguias and its introverted dwellings built with local materials, fits perfectly into the site and honestly illustrates the spontaneous awareness of Saharan human ingenuity.

Keywords: Vernacular architecture, Saharan human ingenuity, typo-morphological reading, ancient core of Biskra.

INTRODUCTION

Nesson et al. (1973) note out in their book "Oasis of the Algerian Sahara" that there are various human settlements across the world that were established by the know-how of the generations that lived there, each of which has its unique character. Because of its architectural and urban qualities and features, these communities are now a highly qualified legacy and a living monument to the process of ongoing adaptation of form to location (Chaline, 1996). Indeed, the built environment was never commissioned by architects, urban planners, or other professionals; rather, it is the result of a popular architecture that architecture history and theory had largely ignored (Boudon et al., 1977). When compared to the blandness, dullness, and uniformity of current architectural forms, the beauty and vitality of historic forms may be attributed to the simple appeal of the picturesque, as in the case of Athens at its peak or the Mayan settlements (Choay, 1980). The majority of experts respond positively to the ancient cities' unity in layout, location, and materials. Nonetheless, the landscape's harmony is chiefly responsible for this sense (Hassoun, 2003; Schulz, 1997). This is especially true in Saharan towns, where human presence needs a particular level of organization and architectural creation (Kouzmine, 2007), which must adapt to a number of logics, including social, historical, geographical, and techno-economic logics (Zerari et al, 2019, Cote, 2005a).

According to Marouf (1980), Saharan cities are distinguished by the presence of a palm grove (stratified crops, palm trees, fruit trees, vegetables) and a unique hydraulic typing (Foggaras and seguias, which are irrigation canals in oasis cities) in which several lineages of varying origins and status cohabit. The Ksar is always shown as a defensive castle, with an impenetrable posture that provides ultimate security. It is fortified, has its own food supply, protected community wells, and just one guarded and angled entry (Cote, 2005). A series of walls that not only confine the space but also connect the residences to one another and to the landscape, providing a sense of intimacy (Djeradi, 2012). In truth, each Ksar is a model of geographical isolation and social particularism, but it also possesses an extraordinary aspect that raises it to the level of a historical fact, an ancient monument whose existence is both mysterious and "a mirror of the universe." (Naoui, 2021). Indeed, the ksar is an urban organism that, via the interweaving of its houses, expresses a desire for touch and solidarity with all members of the society. It is notable for its typical compact urban layout as well as its horizontal earth color in relation to the palm grove (see Figure 1). Its construction is reliant on the availability of water resources, which enable the growth of palm palms and the building of massive gardens. Water, ksar, and palm grove form a system that allows the occupants to live in perfect harmony with the environment (Chaouche, 2007).

Saharan architecture, which connects history, present, and future perspectives, considers numerous constraints, most notably the environment and culture, but especially the climate (Cote, 2005a). The vernacular habitat adopts a range of ways and interacts with its environment, including the prevailing winds and the sun, to become a suitable shelter (Ravéreau, 2017, Wackermann, 2005). Natural adaptation to climate fluctuations in general, and sun radiation in particular, took place. The fundamental idea is to give each structure a direction and form that will allow it to benefit from seasonal fluctuations in the sun (both its position and its intensity). As a consequence, all of heating, cooling, ventilation, and lighting requirements are met. This is the result of man's constant desire to not only defend himself from the rigors of the outdoors, but also to improve the conditions of comfort within his own home.

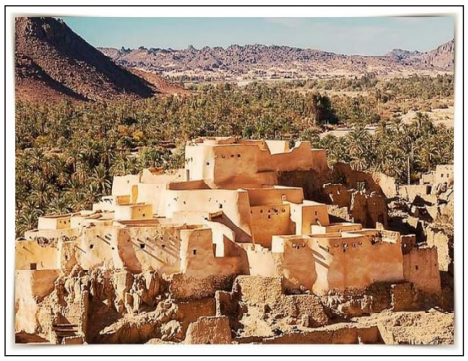


Figure 1. The palm grove-Ksar ratio is well expressed by the ksar of Djanet in Algeria (Source: https://algeriepatrimoine.wordpress.com/2020/10/10/les-ksour-de-djanet/)

Case Study: Biskra's Ancient Core

Biskra adhered to all of these logics and is a more particular example because its urbanization took place in both continuities and subsequent ruptures (see Figure 2).

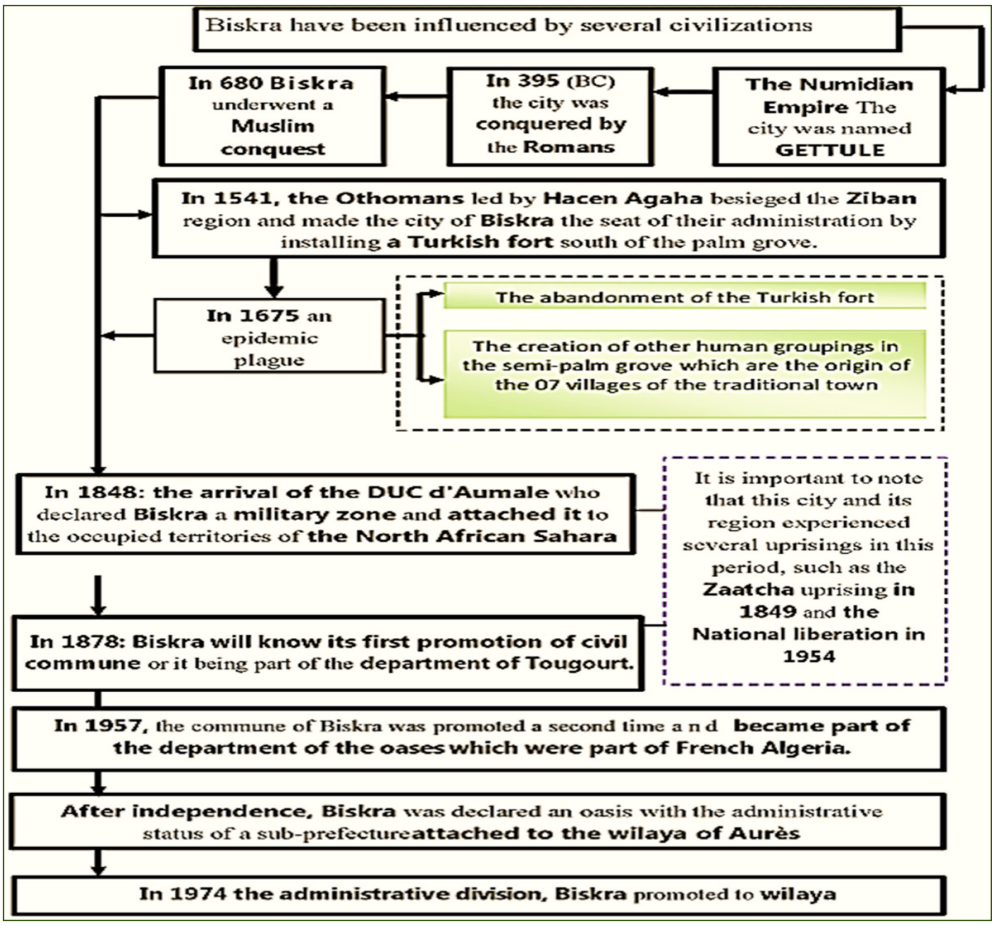


Figure 2. Historical overview of the city of Biskra (Source: authors, adapted from Alkama, 1995)

To begin with, Major Seroka, a member of the Duke of Aumale's staff in 1856, stated that Biskra was the capital of the Roman occupation in the Ziban. Ad-Piscinam was the name given to the city at the time because of its hot springs, and it was located on the eastern bank of the Oued Biskra. It was possible to manage the water as well as the exploitation of the palm grove due to its strategic placement. The Romans gave this oasis on a north-south trade route its current name, Vescera. The only remains of this civilisation are a few odd archaeological artefacts discovered during construction work in 1986. However, actual urbanization in Biskra did not begin until the Arabs arrived in 680 (Farhi, 2002). According to Ibn Khaldun's writings, the part established by Muslims during the Middle Ages (1332-1402) perished completely during the pandemic that struck the city about 1675 (Agli, 1988). The succession of these historical periods, their juxtaposition and superposition, are reflected in the urban morphology of this city, which takes the form of an aggregation of four different morphologies of urban fabrics (the native core, the colonial city, the popular districts, and the programmed urbanization zones) because they correspond to four different times of urbanization. The old core has aroused our curiosity; it reveals itself in Biskra, whose construction dates back to the Turkish period and is today made up of seven main settlements (M'cid, Bâb Derb, Bâb El Fath, Guedacha, Ras El Guerria, Medjniche, El Korra). In this article, we will just look at the typo-morphological properties of the M'cid village, which has caught our interest for a number of reasons that we will explain as we go.

METHODS AND MATERIALS

This study is largely based on typo-morphological analysis, which is a historical-spatial method and scientific tool that allows us to evaluate manufactured environments from the standpoint of their genesis and alteration on several levels linked by time (Caniggia, 1986). (Tomas, 2003). This multidisciplinary approach of urban morphology and architectural typology, according to Pinson (1998), focuses on describing the city based on the types of structures and urban voids that exist. In actuality, architectural typology is presented as a "posteriori reading" that serves as a tool for classifying information while remaining completely scientifically neutral with regard to its subject of study, specifically structures (Duplay & Michel, 1982; Conzen, 1960). In other words, it is a separate typology aimed at categorizing and developing a critical method of studying creative activities (Aymonino. 1975). In contrast, urban morphology is concerned with the logic of hereditary house building and change (Vernez-Moudon, 1997), as well as the techniques of formation, development, and mutation of urban fabrics. (Caniggia, op.cit.; Malfoy and Caniggia, 1986).

This concept of urban fabric is, in fact, the key element of this approach (Borie et al., 1979), because it integrates its built component, which is primarily materialized by buildings (Noppen, 2006), and situates it in relation to the other components, which are roads, parcels of land, open spaces, and site (Gibberd, 1972). Rather than being concerned with constructing architectural style, typo-morphology is concerned with the relationship of structures to the components of the urban fabric (Vernez-Moudon, 1992). As a result, Lévy (2005) emphasizes the significance of typo-morphologists' work in better understanding the urban fabric in its materiality, because the object of their studies is, on the one hand, the five aforementioned components of the urban fabric and, on the other, the syntactic interrelationships that underpin them. Lévy further underlines the distinctiveness of the typo-morphological approach and its use in planning in terms of both operational and project goals. It is a matter of knowledge for him that no other approach can provide (see Table 1). This gives it a large role and relative autonomy in relation to other urban planning disciplines (Racine, 1999).

We study the typo-morphological criteria of the old Biskri fabric and reveal the complexities of the syntactic interrelationships between its various components using the analytical model developed by Allain Borie and Francois Denieul (1984). They proposed breaking down the urban fabric into four subsystems (parcels, roads, buildings, and open space) and then recomposing them based on topological, geometric, and dimensional criteria (see figure 3). The attraction of this model originates from the fact that it can reveal the properties of any fabric, regardless of scale (neighborhood, village, city), allowing conservation and development efforts to be focused (Borie et al., 1978). It is used to define the areas of intervention and then to outline the rules that must be followed by the interventions that are implemented.

Table 1. disciplines concerned with the city's physical and geographical dimensions

Fields of research	Date	Strategy	Method	Focus	Ethos	Partial list of major contributions	Impact on the practice
Study of urban history	1920	Literature phenomenological	Historico-descriptive	Objects Or topics	Ethics	Artibise and Linteau (1984); Bacon(1976) Banham (1971); Barnett (1986); Benovolo (1980), Blumenfeld (1979); Fishman(1987); Freidman(1988); carreau (1991) Girouad(1985); Hayden (1981-1984); Iliorens (1956) Huxtabel (1970); J. B. Jackson and Schultz (1972); J. Jacobs(1961); Johnson (1983);Konvitz (1985); Kostof	Critical analysis of the development of cities and the forces that make up the built environment.
Picturesque study	1950 1960	Literary Phenomenological	Historical-descriptive Empirical-inductive	Object	ethics	Ashihara (1983); Bacon (1976);Guellen (1961) Halprin (1966,1972); Higuchi (1983); Charp (1946) Sitte (1889); Sprergen (1965); Unwin (1909)	Visual elements of the city
Location studies	1970	Literary Phenomenological Positivist	historical-descriptive empiric al-inductive	Object or subject	ethics	Appeltun (1975,1980); Ashirara (1983); Clay (1973); francis ethaster (1990); Goudiener (1985); Greenbie (1981); A. Jacobs (1985); Jakle (1987); Lerup (1977) Lynch (1972,1981); C.Moore et Al (1988); Neberg; Shcultz (1980,1985); l'erin (1970 ,1977)	How people perceive and read cities and relate to their surroundings
Typo morphological study	1950	Positivist literature	-historical-descriptive empirical-inductive	Object	Ethics	Aymonino et Al (1966); Caniggia (1983); Caniggia and Maffei (1979); Castel et Al (1980); Conzen (1960,1980); Maretto (1986); Moudon (1986); Muratori (1959); Muratori et Al (1963); Panerai et Al (1980); Rossi (1982)	City building production and process
Study of the morphology of the site	1950	Positivist	Histórico descriptive t heorico-deductive	Object	ethics	Anderson (1977); Boudon (1971,1991);Bourne (1971) Gottdiner (1986); Hiller and Harson (1984); Lynch and Rodwin (1958); Mitchell (1990); March (1977) Martin and March (1972); Passoneau and Wurman	Urban form and its geometry

Source: Synthesized by Naidja (2014) based on Vernez-Moudon (1992)

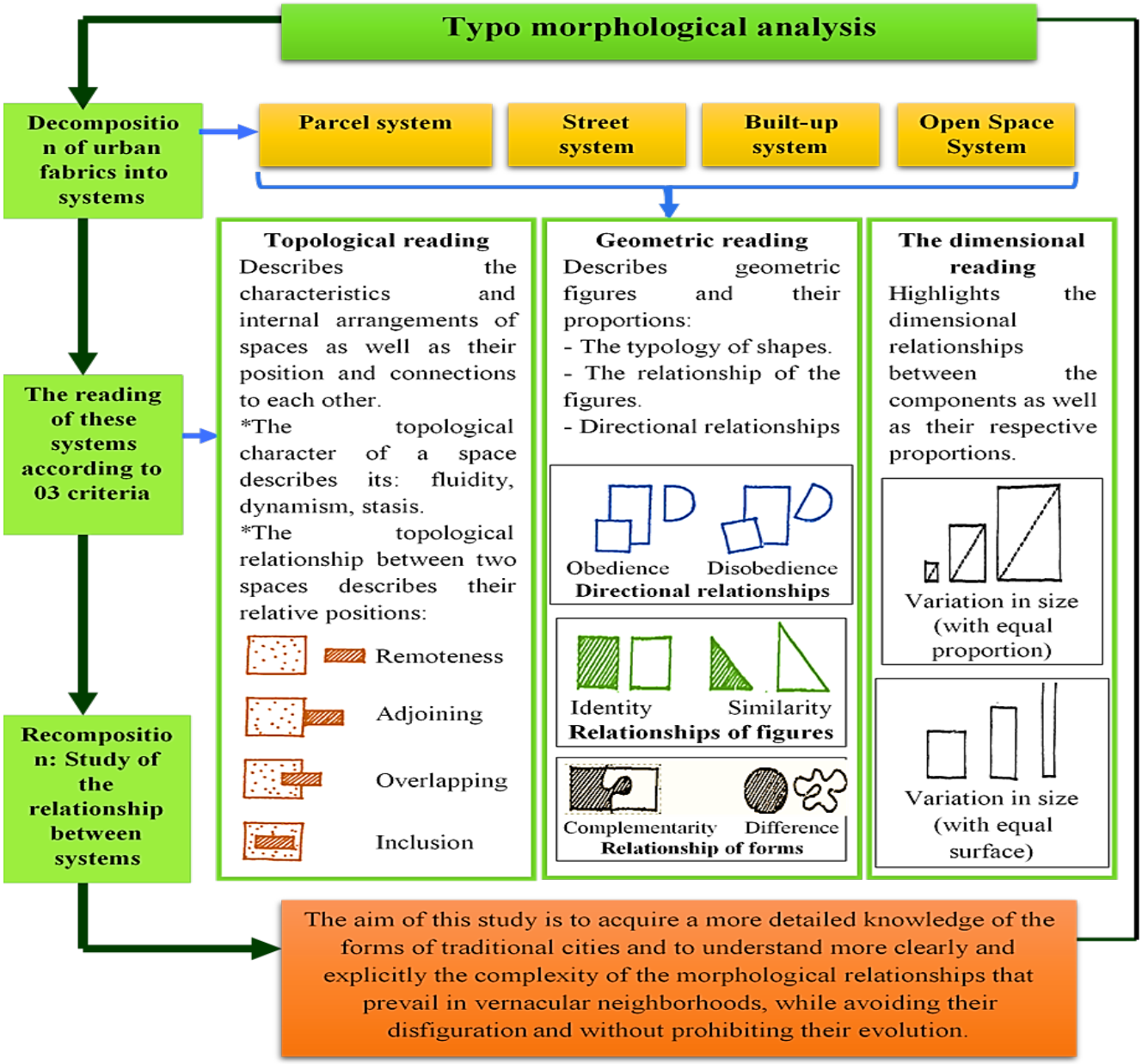


Figure 3. synthesis of the typo morphology analytical framework provided by Borie & Denieul (Authors, 2022)

THE OLD BISKRI CORE'S URBAN MORPHOLOGY

Although all ancient Saharan cores are distinguished by the compactness of their houses due to environmental constraints, the Biskra experience is unique in that compactness is not a feature of its fabric. The built units are spread around the palm grove (see Figure 4), where the vegetation significantly lowers solar radiation. As an integral part of the urban form and a source of development, the palm grove serves as both an economic basis and a bioclimatic envelope, cooling the oasis region and residences for many years through evapotranspiration of vegetation. Each individual enjoys the coolness of the palm grove while increasing the property.

The arrangement is dictated by the seguia, which provides drinking water to the residences as well as irrigation for the palm groves (see Figure 5). It exhibits the logic of cohabitation between buildings and palm trees. The existence of these seguias, in fact, spurred the construction of shaded streets and alleys, as well as the formation of linear groupings. As a result, the fabric's urban structure is defined by a linearity in which the constructed units are positioned on either side of the seguia and are grouped according to a plot sharing logic: either between heirs or after informal sale, resulting in twisting alleyways (Adad, 2004).

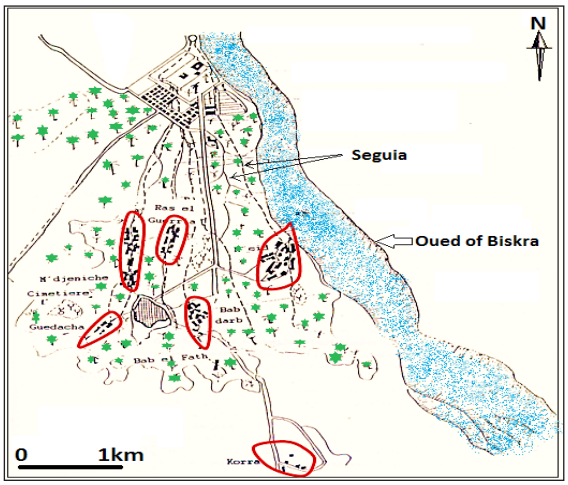


Figure 4. Map of the city of Biskra in 1863 and the habitat of the seven villages of the pre-colonial period (Source: adapted from the military engineering map)

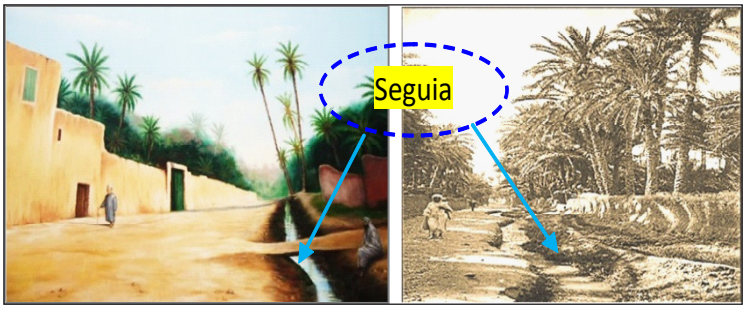


Figure 5. An example of Seguia in old Biskri core's (source: Naidja, 2014)

These clusters, like the street, go from the street to the alley, to the dead end, and eventually to the threshold (see figure 6), but they preserve the neighborhood's intimacy and respect. Furthermore, the primary entrances of the street-facing dwellings, each of which has a back garden, are given special care. This ancient fabric is a paradigm of integration with the environment, economy, social life, and even the resourcefulness of Biskri residents in the face of harsh desert circumstances (Laour, 2008). The pair "seguia-palm grove" that built the urban space, created a habitat type that is unique to the Biskra region, resulting in an exquisitely balanced ecosystem (Alkama, 1995). As a consequence, the seven previously described communities, grouped in fragmented groupings, constitute an oasis system with a cohesive urban organization.

Figure 6. Street, Alley, Impasse in the M'cid district (Source: authors)

Organization of the Vernacular House

The traditional home is characterised by its introversion and central location (see Figure 7), with surfaces that vary depending on the size and needs of each family. It is either trapezoidal or rectangular and typically follows the irregular contour of the palm grove area.

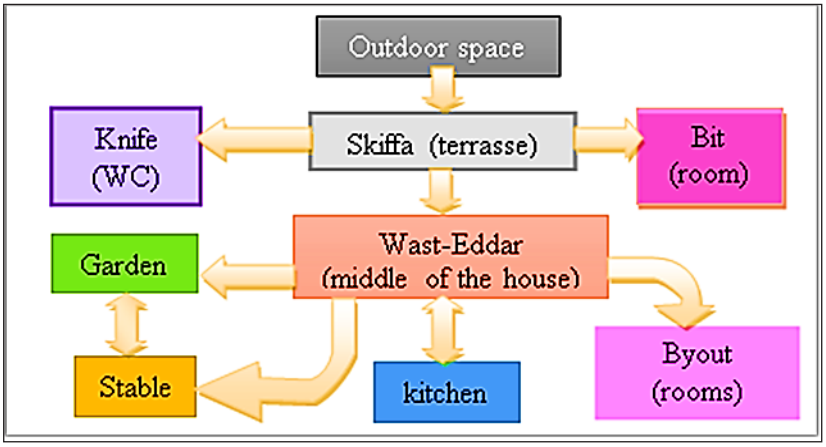


Figure 7. Spatial distribution in a typical traditional house (Source: Adad, 2000)

The dwelling, like any other traditional house, is a social and economic institution that houses not only family members but also shops and animals. Every home has two stories, one on the first and one on the second. They typically congregate in the regions illustrated in Figure 8.

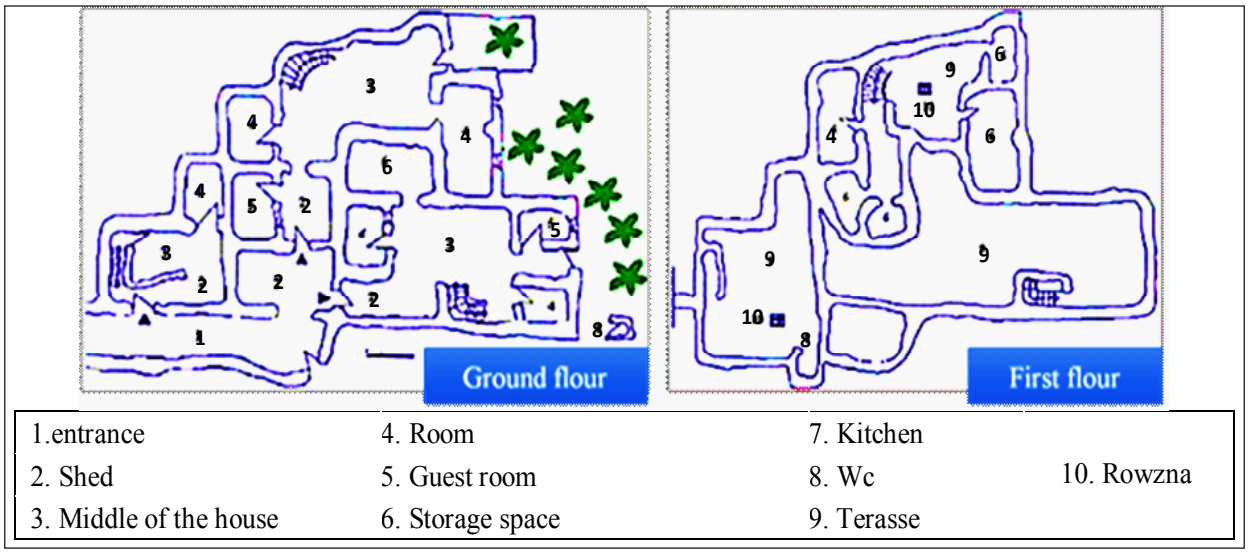


Figure 8: Traditional housing plan in M'cid (Source: adapted from Dib, 2001)

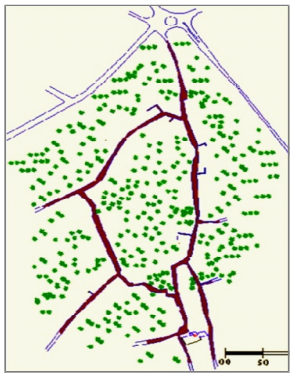
TYPO-MORPHOLOGICAL ANALYSIS OF THE OLD URBAN FABRIC (M'CID DISTRICT)

Our assessment was done in two parts, using the analytical model presented by Borie and Denieul (explained above) to the ancient Biskri nucleus, notably the M'cid region. The first is a typological knowledge of infrastructure, as reflected by the road and plot systems (Baird, 1988). The second is a synchronic interpretation of the superstructure, which consists of the open space system and constructed environment.

a- Typological reading of the infrastructure: This entails studying the road and parcel systems using three different readings: topological, geometric, and dimensional (Malfoy, 1986).

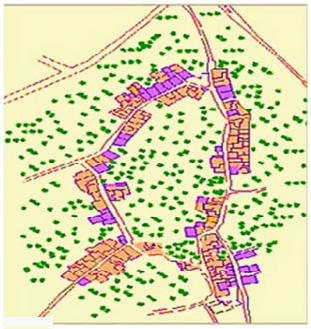
- **The road system**: The reading of the road system based on the three above-mentioned factors enabled us to identify the findings that are described in Table 2.
- **The parcel system**: Following the numerous alterations that this system has seen, whether by twinning or by parcel division, a first reading of the dividing bounds of these parcels reveals a crenellated grid. Nonetheless, in order to understand this system in its initial condition, and in the absence of ancient maps indicating the original parcel subdivision, we relied on the map recreated by the architect Dounia Laour due to her field surveys in 2008. This is possible because the parcel system is more stable than the others, particularly the constructed system (Borie & Denieul, op.cit). Table 3 displays the results.

Table 2. Typo-morphological reading of the road system in the M'Cid district

Type of reading	Elements of reading	Results	
Topological	Linking of tracks with frames	Inclusion of a linear and tree system in a loop frame	 Road network
	Relative positions of the road network frames	Juxtaposed	
Geometric	Directional relationships between a frame and an axis	Disobedience	
	Directional relationships between frames	Disobedience	
	Figure relationships between frames	Similar	
Dimensional	Relative dimensions of track widths	Hierarchical	

Source: authors, 2022

Table 3: Typo-morphological reading of the parcel system in the M'Cid district

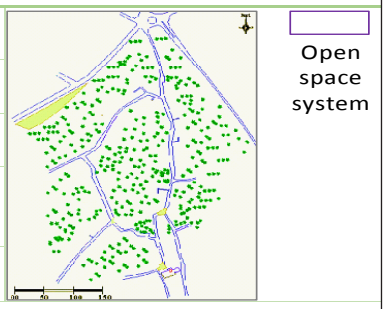
Type of reading	Elements of reading	Results	
Topological	Relative positions of the parcels	72.78% of the parcels are included while 27.21% of them are attached	 72.78% Inclusion 27.21% Adjoining Relative positions of the parcels in in the M'Cid district
	The space between the parcels	Continuity	
	Relative positions of parcel frames	Proximity	
Geometric	Directional relationships between plots	Disobedience	
	Figures	Irregular	
	Directional relationships between parcel	Disobedience in their directional relationships.	
Dimensional	Average proportion of parcels in the plot	Generally squat and deformed plots of which 36.30% are close to the square and 5.95% have elongated rectangular	
	Parcel sizes within the parcel system	Constance	

Source: authors, 2022

b- Synchronic reading of the superstructure

- **The open space system**: The underdeveloped component comprises of the layout's road network, tiny squares, and open areas (see Table 4).

Table 4. Typo-morphological reading of the open space system in the M'Cid neighborhood

Type of reading	Elements of reading	Results	
Topological	Relative position of public places	Non-contiguous	 Open space system
	Connection between the squares	Do not communicate	
	Linking of open spaces to each other	Discontinuity	
Geometric	Directional relationships between axes	Disobedience	
	Figure relationships	Difference	

Source: authors, 2022

- **The built system:** In contrast to earlier systems, this one reads at four levels, as seen in table 5.

Table 5. Typo-morphological reading of the built system of the M'Cid district

Type of reading	Elements of reading	Results	
Topological	Relative positions of built elements	Adjoining	
	Position of singular buildings in relation to the built-up area	Regular	
	System for linking the built-up area	Continuous in one direction (Linear)	
Geometric	Figures of built elements	Deformed	
	Figure relationships between built elements	Similar	
Dimensional	Dimensional relationships between built elements	Constance	
Materials and construction techniques	Nature of the building materials	Local (Toub made from soil + palm tree trunks)	

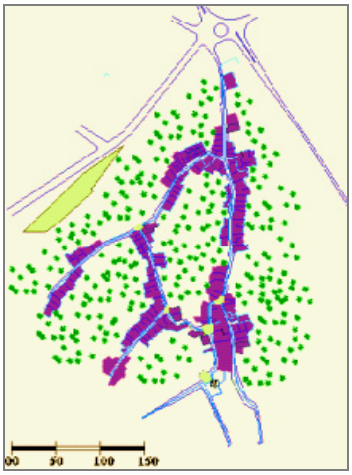
Source: authors, 2022

c- Analysis of the relationships established between the different systems:

This interpretation of the established links between the various systems follows the same logic as previously described. In other words, these interactions are characterized using a topological, geometrical, and dimensional interpretation, as seen below.

- **The relationships established between the built system and the open space system:**

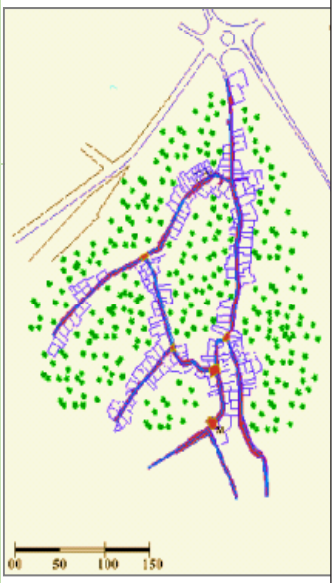
Table 6. Relationship between the built system and open spaces in the M'Cid neighborhood

Type of reading	Elements of reading	Results	
Topological	Position of singular buildings in relation to open spaces	Adjoining	
	Communications of buildings with respect to open	Unique	
Geometric	Directional relationship	Disobedience	
	Relationship of residual figures to each other	**Residual space of irregular buildings**	

Source: authors, 2022

- **The relationships established between the parcel system and the road system:** Topological, geometric, and dimensional links connect these two systems, as seen in Table 7.

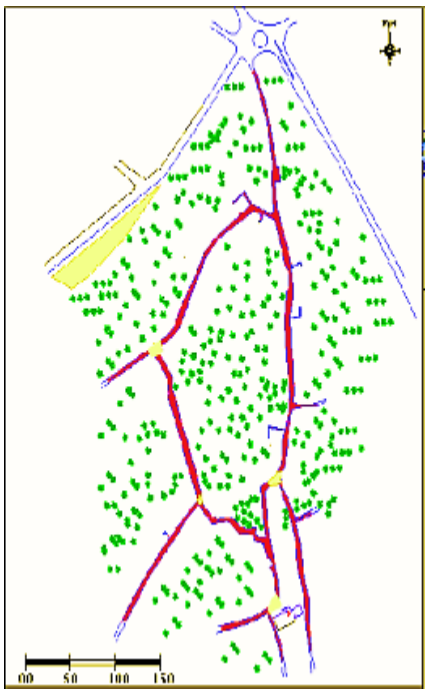
Table 7. Relationship between the parcel system and the road system in the M'Cid district

Type of reading	Elements of reading	Results	
Topological	Position of the parcel in relation to the service road	The parcels are commonly adjoined to the street on one of their facades. This simple phenomenon has very important consequences because it leads to an orientation of the internal space of the parcel; the side of the parcel located along the street thus constitutes the front of the parcel, while the opposite side constitutes the bottom which gives on the palm plantation.	
	Connection between the parcel and the service road	Direct	
Geometric	Directional relationships between the parcel grid and the axis of	Obedience	
	Figure relationships between parcel and road frames	Similar	
Dimensional	Dimensional relationships between parcel and	Constant	
	Dimensions of the parcel frontage on a road	Inconstant	

Source: authors, 2022

- **The relationships established between the road system and the open space system:**

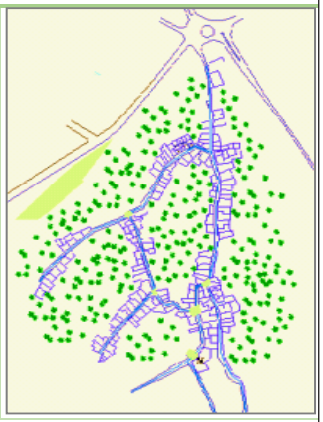
Table 8. Relationship between the road system and open spaces in the M'Cid distric

Type of reading	Elements of reading	Results	
Topological	Squares' relative placements in respect to the road network	80% of the open areas correspond to a specific place on the road network, but the other 20% (the weekly souk) do not.	
	The location of open areas with respect to the road	80% of the open areas are in a position of penetration with regard to the road, while 20% of the latter (the weekly souk) are nearby.	
Geometric	Relationships between the open space axes and the road network	100 % of the open spaces with axes that do not follow the streets. As a result, a disobedient connection exists.	
	Relationship of figures	The bulk of the squares' data are derived from the road network, whereas 20% of the squares (Souk weekly) include figures that are complimentary to the road network.	
	Nature of the connection between road and open space	20% of the vacant areas (weekly Souk) distort the roadway, while the other 80% are cut by the street. The type of connection is a road that cuts across open area.	
Dimensional	Scale of open spaces	The map depicts the presence of unique free spaces created by street crossings, as well as the presence of repeating free spaces created by Rowzna.	

Source: authors, 2022

- **The relationships established between the parcel system and the open space system:**

Table 9. Relationship between the parcel system and open spaces (OS) in the M'Cid neighborhood

Type of reading	Elements of reading	Results	
Topological	Position of OS in relation to parcel grids	80% of the free spaces are articulated to several plots, while 20% of theme (weekly souk) are outside the plots	
Geometric	Directional relationships between axes of singular OS and axes of parcels	Disobedience	
	Relationship of figures	Similarity	
Dimensional	**Scale of OS in relation to parcels**	**Similarity**	

Source: authors, 2022

CONCLUSION

Biskra's vernacular architecture is a shining example of popular brilliance in the creation of an ecological and humanistic architecture; its success is based on a profound understanding of the region, the local environment, and popular know-how. As a result, this construction is the result of an organic approach, as seen by the complementary nature of three elements: the "Seguia" irrigation canals, the palm grove, and the home. Two urban space structuring components, the seguia and palm grove, have regenerated a sort of habitat unique to the region, resulting in a balanced ecosystem. The seguia, or regulating line, has given way to shaded streets and alleyways, as well as the formation of linear clusters. The latter, like the former, adhere to a spatial hierarchy paradigm (street, alley, dead end, threshold, etc.) while respecting the community and protecting privacy. This traditional fabric is a model of integration in terms of environment, economy, and social life, and it brilliantly illustrates the Biskri inhabitant's creativity in the face of the hard desert climate.

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