A new decade for social changes
Street network and land use in the slum of Chouf Lekdad in Sétif (Algeria)

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Abstract. The phenomenon of slums in Algeria dates back to the 1930s following the deterioration of the rural economy and the mass exodus to the big cities. After independence, this phenomenon was accentuated and generalized to several towns. State efforts to eradicate informal settlements and relocate their inhabitants have not succeeded in solving this problem; on the contrary, slums have evolved into permanent settlements. The Chouf Lekdad district in Sétif illustrates this evolution and this change in status, hence the need to take a different look at this type of district. The objective of this work is to explore the spatial configuration of the Chouf Lekdad district through the study of its network of streets and the distribution of houses in space. To achieve this, we opted for the theory of space syntax using the axial map, all-line analysis and the Visibility graph analysis (VGA). The results revealed a hierarchy of streets and spaces as well as the importance, of certain areas such as mechanical access and the center of the slum.

Keywords: Chouf Lekdad, Sétif, slum, space syntax, street network, land use.

1. Introduction

Beyond countries and cultures, housing is one of the basic needs for human beings, it ensures their comfort and well-being. However, there is a disparity in access to housing between developed and underdeveloped countries. The United Nations and the World Bank have estimated the number of people living in slums at nearly 881 million [1], this figure is particularly high in underdeveloped countries where the phenomenon affects almost half of the population [2]. Today, it is estimated that one person in eight lives in informal settlements, that is to say in poor hygienic conditions as well as limited access to the conveniences of life and to education [3]. This figure continues to increase due to population growth and urbanization which lead to an exodus to the cities. This migration of populations leads to the proliferation of slums in the suburbs of large cities [4].

From an urban planning and architectural point of view, informal settlements convey a negative image. Thus, the construction on land at risk, the use of heterogeneous materials and the absence of sanitation networks affect the urban landscape. From a social point of view, we are witnessing a stigmatization of the inhabitants who occupy this type of neighborhood. Poverty, social ills, marginalization and delinquency are associated with slums.
The Algerian context presents certain specificities which are due to the history of the country and certain major facts having involved the appearance of this phenomenon. In Algeria, slums date from the colonial era when the policy of the French authorities marked an imbalance between the city and the countryside [5]. The strategy of the colonial authorities led to the dispossession of agricultural land and the dislocation of the social fabric in the countryside, this led to waves of exodus of peasants. Land dispossession and the indigénat code marked a break for rural populations [6]. In order to improve their living conditions, these populations had no choice but to migrate to the large coastal cities. Thus, the beginning of the 20th century was marked by the emergence of the first nuclei of slums which constituted a base for populations seeking a better life and a decent job. During the colonial period, poverty and the status of second-class citizens meant that people could not stay in the countryside [6].

In the middle of the 20th century, the Algerian revolution (1954-1962) led to new waves of exodus of populations fleeing the war in rural areas. Thus, the imbalance between the countryside and the city as well as the precariousness of the habitat in the suburbs in large cities persisted until the independence of Algeria. The emergence of an Algerian state has not solved the problem of slums, they have experienced new networks, new mechanisms and new strategies that have made it possible to perpetuate this phenomenon [6].

The city of Sétif experienced the phenomenon of informal settlements after the start of the Algerian revolution. The exodus of rural populations led to the appearance of the district of Yahiaoui better known as Tandja, this district evolved over time to give a “formal” residential district. During the 1980s, Sétif saw the emergence of a new informal neighborhood in its western suburbs, the Chouf Lekdad neighborhood. The security crisis that Algeria experienced during the 1990s accelerated the flow of migration to this new slum. The gradual evolution of slums means that they now occupy an area of one hundred hectares with a population of around 8,000 inhabitants [7].

The precarious neighborhood of Chouf Lekdad has gone beyond its informal and archaic character to endure over time, we have seen the emergence of public facilities such as a primary school, a postal agency, a health center, a town hall office, a mosque and some shops. We have also witnessed the asphalting of some streets inside the district, which has improved accessibility and the circulation of vehicles.

This article aims to shed light on the spatial configuration of the informal settlement of Chouf Lekdad, on its layout of streets and the logic of the location of houses. It is estimated that any operation of regularization of the inhabitants of this district passes by an understanding of the logic of occupation of the ground. After more than thirty years of existence, the inhabitants of this district have developed their own logic of land use, this logic remains to be explored and analyzed in order to grasp the underlying structure of the district.

2. Slums, phenomenon or scourge

The phenomenon of informal neighborhoods is universal, although it has taken on several names depending on the geographical context, such as the "ashwa'iyat" of Cairo, the "shantytowns" of Lagos and the "favela" of Rio de Janeiro [4].

International bodies such as the United Nations speak of precarious and marginalized housing. These dwellings are located in risky areas such as steep terrain, floodplains and swamps [8]. Furthermore, the living space in the slums is insufficient and does not meet the basic needs of the occupants. There are even hygienic conditions that are detrimental to the health of the occupants, such as the discharge of wastewater into public spaces [9]. In some countries like Egypt, this phenomenon is most critical and has social, economic and security
repercussions, which represents a burden for society [10]. Slum dwellers are even considered a threat to society, they represent a potential danger to the safety of citizens. Slums represent a place where the state is absent, they are therefore a breeding ground for social evils such as crime, prostitution and delinquency.

On a social level, slum dwellers cohabit in narrow spaces, which generate neighborhood problems, noise and odor nuisances. We also note the proliferation and expansion of diseases due to poor hygienic conditions [2]. Despite the diversity of forms taken by slums, we agree on a number of common characteristics such as: overcrowding, lack of public facilities, lack of sanitation and drinking water network, lack of development of outdoor spaces and lack of household waste collection [2].

In 2003, United nations human settlements program mentioned a number of factors that give a neighborhood its informal and precarious character:

The slums are overcrowded with a high density of houses, they are exposed to natural hazards such as landslides and floods. The social status of the inhabitants is low, they suffer from poverty and social marginalization. They do not own legal deeds to the land and houses they occupy, so they are subject to eviction at any time. In the slums, there is a lack of basic infrastructure such as: the road network, drinking water, electricity and sanitation networks. Moreover, on the ecological level, the health of the inhabitants is threatened because of the anarchic disposal of household waste and solid waste [1].

There are factors that lead to the perpetuation of the phenomenon of informal settlements: some factors are political, such as poor governance, others are economic, such as vulnerability and exposure to crises. There is also the security factor such as the displacement of inhabitants during wars, as well as natural disasters such as earthquakes, floods, etc. Other factors lead to the aggravation of this phenomenon such as: the rural exodus, the difficulty of accessing housing and demographic growth [8].

2.1. Change of strategy and new approaches

Because of the precarious situation of the slums and the poor conditions that reign there, only one solution was envisaged, namely the eradication of the shacks and then the exploitation of the land base for the establishment of new buildings. This approach has proven its failure, because the demolished huts are replaced by new huts on the same site or on other sites. The persistence of informal settlements has made all the clearance and rehousing operations ineffective. This state of affairs is due to the maintenance of the networks that connect the city to the countryside as well as to the social and economic mechanisms available to these networks [6]. This situation makes the slum a social and economic phenomenon that is materialized by shacks and informal neighborhoods. These occult networks have thus survived the countless rehousing operations of the inhabitants and have made it possible to maintain this phenomenon [6]. Once created, informal settlements are driven into an irreversible process of deterioration, it is a kind of vicious circle of decline, this process leads to the continuous degradation of these districts [11].

This situation is due to the low urban vitality of certain districts and their unfavourable locations on land at risk or of low economic value. The spatial configuration of slums is complex, the spontaneous and informal character of slums leads to the emergence of spaces whose logic is fuzzy and the boundaries are flexible [12]. In some cities like Jeddah in Saudi Arabia and Agra in India, the pattern of land use at a micro-scale is closely linked to local spatial structures. Slums thus have their own spatial structure and function in isolation from the rest of the city; this spatial autonomy leads to social and spatial segregation [13]. Paradoxically, this
spatial configuration leads to positive social effects; we note that slums promote social interaction between inhabitants [14]. Some slums are well connected to their environment and have functional diversity, which gives them potential for development and urban vitality [15].

The persistence of slums has led to an evolution in the architectural and social aspect, such as the use of durable and resistant materials as well as the appearance of a community life and social ties between the inhabitants [16]. This state of affairs led to a change of strategy by the political authorities. Instead of the eradication long advocated, a new approach had to be adopted based on the recognition of slums and the improvement of the living conditions of their occupants [17]. The challenges of the future for cities would be the redevelopment of slums while avoiding the displacement of inhabitants, this requires an understanding of the internal logic of informal settlements [15].

2.2. Genesis and evolution of informal neighborhoods in Algeria

For a century, the phenomenon of slums in Algeria went through four important periods, each of which stemmed from a specific context: the rural exodus following the dispossession of land by the French colonial authorities, the Algerian revolution, the rural exodus after independence and finally the security crisis of the 1990s [6]. Within the framework of French colonial policy, the dispossession of land in rural areas and the code of indigénat created discrimination against the indigenous population. This situation generated the first wave of exodus to the cities. Thus, the deterioration of the rural economy and the difficult living conditions have forced the inhabitants of the countryside to migrate to the city. They thus formed the core of the first slums in Algeria [5]. In 1954, the beginning of the revolution and the armed conflict created a climate of insecurity in the rural areas, which pushed the populations to migrate towards the cities, thus resulting in the creation of new slums. These events took place in the face of the laxity of the colonial authorities who saw the emergence of new informal neighborhoods without reacting, the example of the Yahiaoui district (Tandja) and Andréoli in Sétif constitute edifying cases. These slums were erected on the outskirts of the city along the roads leading to the countryside.

The independence of Algeria did not solve this problem, on the contrary, the exodus movement continued, hence the idea of Sidi Boumediene (2016) on the persistence of the networks that linked the countryside to the city. During the 1970s, there were 98 slums in the city of Algiers alone, these neighborhoods had a total population of about forty thousand inhabitants. This figure evolved during the 1980s to reach one hundred thousand inhabitants for a total of seventeen thousand barracks [6]. Faced with this situation, the Algerian State has adopted a policy of eradication of slums and rehousing of the inhabitants. This strategy proved ineffective; it even perpetuated this phenomenon. This is due to the occupation of the places by newcomers just after the departure of the rehoused populations [16].

The security crisis that affected Algeria during the 1990s led to another movement of rural exodus. The climate of insecurity which reigned caused the displacement of the populations threatened towards the city, but one notes the absence of official figures and studies for this period. The 2008 population census gave the figure of two hundred thousand inhabitants who lived in informal settlements. The latest official figures date from 2012, they mention more than three hundred thousand families living in slums spread throughout Algeria [18].

3. Case study

The informal neighborhood of Chouf Lekdad is located in the western suburbs of the city of Sétif (fig. 1), the first houses were built there at the end of the 1980s. This shantytown
was established on a rocky and steep terrain, due to the security crisis of the 1990s, the number of migrants has gradually increased to transform the slum into a real neighborhood.

Fig. 1: Situation of the slum of Chouf Lekdad. Source: openstreetmap.org
Today, Chouf Lekdad extends over an area of about one hundred hectares, there is also mention of the existence of about four hundred houses [7]. Over time, we witnessed the establishment of a social life within the district, as well as the creation of a mosque and a number of shops created by the inhabitants themselves. In addition, the city authorities have created a number of public facilities such as a health center, a primary school, a town hall office and a post office. These public facilities are located at the southern end of the slum (fig. 2). This step of the State constitutes a form of recognition of the slum as a district in its own right, this step of the State is also illustrated by operations of asphalting of the roads inside the district itself. The slum is served by an important road network, to the west, there is a national road and to the east, a street which connects Chouf Lekdad to the city of Sétif. Each of its two roads offers three accesses for vehicles (fig. 2).

Inside the slum, residents created informal pathways that formed an intricate, tree-like network of streets. These streets make it possible to serve the houses scattered throughout the site. Despite the difficult topography of the land, these roads ensure mechanical and pedestrian accessibility for residents to their homes. The rugged terrain had an effect on the distribution of houses, so steeply sloping land remained unoccupied. The majority of the streets inside the slum are unpaved, the few paved streets form a large distorted ring in the heart of the district. This ring connects two accesses to the south of the district by making a loop of two kilometers and limiting an area of 20 hectares. The other paved street connects the eastern access to the district to its center and more exactly to the street in the form of a loop.

4. Materials and methods

The informal neighborhood of Chouf Lekdad is characterized by an irregular and tree-like layout of streets, for their part, the houses are distributed in a way that seems random. In order to distinguish the contours of the spatial configuration of Chouf Lekdad, the theory of space syntax was resorted to. This theory was developed by Bill Hillier’s research team at UCL (University College London) in the late 1970s. Space Syntax offers techniques and quantitative measurements for understanding the distribution of houses and the shape of outdoor spaces. According to this theory, the components of space exert an influence on the way inhabitants use it. Space generates practices and can be studied as a configuration, that is to say as a set of components that act on each other [19].
Fig. 3: The street network in Chouf Lekdad.

For our research, we established two plans of the informal neighborhood of Chouf Lekdad, in the first we left only the tarred and untarred streets (fig. 3). In the second plan, we retained only the houses by removing the network of streets (fig. 4). Subsequently, we proceeded to a modeling of these plans by means of the software Depthmap (version X 0.8), we generated the map of all lines (All-line analysis), the axial map and the VGA map (visibility graph analysis). For both planes, measures of connectivity, global integration, local integration, choice, intelligibility and synergy were identified.

Fig. 4: The distribution of houses in Chouf Lekdad.

4.1. All line-analysis

This technique represents all possible lines of sight in a space taking into account the obstacles it contains; it is useful for the analysis of two-dimensional spaces such as public squares and open spaces [20]. The lines drawn are tangent to the vertices of objects that can see each other [21].

4.2. Axial map

From a plan view, the Depthmap software transforms the network of streets into a number of lines called "axial lines". The axial line is a line of sight with underlying movement
logic [22], it is the longest line of sight that indicates a path of movement in a space [20]. The axial map is generated by drawing a set of intersecting lines through all the spaces of the analyzed area [19]. After establishing the axial map, the following measurements were taken:

Connectivity: this is a local static measure, it provides information on the importance of a street on a local scale, i.e., in its immediate environment [19].

Global integration: it is a global static measurement; it indicates the average depth of a space. The integrated space is shallow and accessible, on the other hand the weakly integrated or segregated space is difficult to access [19] [21].

Local integration: defines the integration of axial lines within a radius of three topological steps, it indicates the accessibility of spaces at a local scale [21].

Choice: this is a global dynamic measure; it indicates how often a street or a portion of a street is found on the shortest paths [23].

Intelligibility: it is the correlation of two measures which are connectivity and global integration, it informs whether it is possible to read the whole system from its components. Values close to 0 indicate that it is difficult to circulate in the system, on the other hand values close to 1 inform on the ease of circulation and orientation [21].

Synergy: this is the correlation between global integration and local integration (radius3). Synergy informs about the relationship between local structures and the global structure and whether the system offers coherence in its configuration [21]. Values close to 1 indicate a good relationship between the local and global scale, values close to 0 indicate a lack of coherence.

In axial maps, red lines have high values, blue lines have low values. The yellow and green lines have mean values.

4.3. Visibility graph analysis (VGA)

This technique represents the intervisibility of spaces, it is based on the logic of isovists [20]. The isovist represents the visualization of the panoptic view of a person from a specific point in space, this is the 180° or 360° field of vision [24].

VGA integrates all the isovist fields of all the location points of a space, this analysis is done on the basis of a pre-established grid by depthmap [22]. Visual integration indicates the degree of intervisibility that a space offers, some places offer a large visual field (red color), other places offer a weak visual field (blue color). Visual integration also indicates spaces that offer social interactions [22].

5. Results and discussion

5.1. Street network analysis

The axial map reveals 693 axial lines for the entire informal settlement. The maximum value of connectivity is 17, the average value is 4.289, as for the minimum, it is 1 which corresponds to dead ends. Of the 693 axis lines, 436 lines have values below the average, which makes the majority of the axis lines weakly connected. Only 94 lines have values between 7.4 and 17. Although the maximum value is large, the street network has quite low connectivity values. Note that the well-connected parts (a, d and e) are near the mechanical accesses to the shantytown (fig.5). Parts “a” and “b” are close to the ring street that forms the center of the slum. The axial map of connectivity reveals that the mechanical accesses contribute to the emergence of dynamic zones near the accesses.
For their part, the values of global integration are low and close together, the minimum value is 0.353, the average is 0.589 and the maximum is 0.855 (table 1). For the distribution of values on the space, the axial map reveals that the most integrated part is in the heart of the slum (fig.6), this area is served by the northern part of the asphalt street (ring street). Overall, the heart of the district is the most integrated part despite its distance from the external environment and access. The peripheral parts (in blue) are the most segregated parts and therefore the least accessible. These results indicate the existence of a centrality at the level of the heart of the slum; this centrality is due to the fact that the six accesses lead towards the center of the district which gives it ease of access. The peripheral parts are attached to this central part and are served by the ring street.

Regarding local integration (R3) the axial map (fig.7) reveals the existence of five zones with high values (maximum value of 3.290). Zones “a” and “b” are at street level in a ring, the other three zones “c”, “d” and “e” are on the outskirts of the slum. These three areas have low global integration values but exert a significant influence at a local scale. This result demonstrates that at the shantytown level of Chouf Lekdad emerge secondary centralities. We also note that zones “a”, “c” and “d” are close to the mechanical accesses to the shantytown.

Note also that the axial maps of local integration and connectivity reveal the importance of the same parts. There is a perfect correspondence between these two measurements. For the values of the choice, they are average, thus, out of 693 axial lines, 605 lines present values close to the average value (0.035). Only a few lines (36 axial lines) show values between 0.203 and the maximum, which is 0.678 (fig.8). The axial lines with high values are
superimposed on the layouts of the paved streets. These streets connect the accesses of the slum to its heart and therefore constitute shortcuts for the circulation of vehicles and pedestrians.

The intelligibility value for the street network is very low, it amounts to 0.163. This figure means that it is very difficult to read the overall configuration of the slum from its various components. This makes orientation within the district very difficult. The tree structure of the street network makes any attempt at orientation in space difficult. For its part, the synergy value is also low, it is 0.239. This number means that the relationship between the local structures and the global structure is weak. It also implies that the street network in the slum is fragmented and lacks coherence.

5.2. Land use analysis

In this second analysis of the shantytown of Chouf Lekdad, we focused on the distribution of houses in space without taking into account the road network. The distribution of the most connected axial lines confirms the results of the axial analysis of the road network. Thus, figure 9 reveals that the most connected zones correspond to zones “a”, “b” and “d” of the axial analysis (fig. 5).

These parts correspond to the two east-west sections of the ring street and which are close to the west access at the top of the hill and the South access at the bottom of the hill. In these parts, there is also a low density of houses and a disparate occupation of the land. In addition, we note that the areas located on the outskirts of the shantytown are weakly connected (blue areas in fig.9).

The global integration map (fig.10) confirms the connectivity results, the most integrated parts are the most connected. About 50% of the axial lines have values above the average; the most segregated parts are very close to the edge of the slum. These results demonstrate that the distribution of houses has generated open and accessible spaces, particularly in the center of the slum and near the western access. The results show that the heart of Chouf Lekdad is easily accessible; the occupants of this area do not intend to isolate themselves from the outside. The least integrated parts occupy a restricted band at the level of the periphery of the district. The results of the global integration bring out a global organizational scheme where the heart of the district is easily accessible and the outskirts are less so.

5.3. Visibility graph analysis (VGA)

The VGA analysis of the slum of Chouf Lekdad confirms the integration values in All-line analysis. Thus, the oblique line that crosses the heart of the district has the highest
integration values (fig.10 and fig.11), it constitutes a kind of radius inside the ring street. The VGA confirms the importance of the center of the slum and the paved street that surrounds it. This confirms the existence of a central space within the district. This center illustrated by the ring street and the area it delimits, has high visual integration values. It is also noted that approximately 60% of the integration values are higher than the average. Moreover, the disparate distribution of houses in the center of the slum generates several empty lots, hence the high integration values in this part.

![Visual integration](image)

Fig. 11: Visual integration.

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<th>Table 1. Syntactic values of the Chouf Lekdad slum.</th>
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The techniques of space syntax and quantitative measurements (table 1) have made it possible to know the properties of the spatial configuration of the slum of Chouf Lekdad. The most integrated streets (the most accessible) and those that offer the shortest paths are part of the paved roads. These streets correspond to the ring street in the heart of the slum towards which several streets converge from the accesses of the district and its peripheral zones. The analysis of the network of streets and the distribution of houses gave identical results, as to the importance of the heart of the slum and its accessibility from the outside. The analysis also demonstrated the segregation of the peripheral parts.

In addition, the analysis at a local level revealed the emergence of peripheral zones accessible for their immediate environment. This informs us about the nature of the relationship between the components of the slum.
6. Conclusion

Informal settlements are integral parts of a number of Algerian cities. The various attempts to eradicate slums have only been partially successful, due to the persistence of the causes that lead to their formation and perpetuation. Over time, we have witnessed the emergence of new solutions, these are based on the regularization of slum dwellers and on the improvement of their living conditions. Although this solution has not yet been applied in Algeria, it constitutes an alternative for the endless resettlement operations of slum dwellers. However, if state authorities decide to apply this approach, it must stem from an understanding of the spatial configuration and land use.

The western end of the city of Sétif, which houses the informal settlement of Chouf lekdad, has been the receptacle of urban growth over the past twenty years. The major program of housing and facilities carried out in this part has brought up the issue of integrating spontaneous housing into the urban fabric. This integration cannot be done without an analysis of the underlying structure of the slum and its components.

Through this work, we shed light on the spatial configuration of the shantytown of Chouf Lekdad, particularly its network of streets and the distribution of houses in space. Thus, the location of the mechanical accesses and the seemingly random layout of the streets had an effect on the spatial configuration. The ring-shaped street in the center of the slum created a real centrality and constituted a convergence zone of the streets. Even the distribution of the houses obeyed the same logic by consolidating the status of the central area.

Our study also demonstrated that the layout of the streets and the occupation of the land did not facilitate the orientation of pedestrians inside the slum. The results of this work constitute a blueprint for future research on spatial organization within informal settlements. It is considered that an understanding of the spatial logic of this type of establishment constitutes the cornerstone for any operation to regularize and improve the living conditions of the inhabitants.

References