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Sprawl, Specificity and Dynamics of Inter-Municipal Urban Agglomerations of the Souf Valley (South East Algeria): Using GIS Techniques

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ABSTRACT: The Souf is part of the northern North Eastern Sahara. Its geographical configuration characterized by a flat topography and absence of natural outlet. Formerly, it located in the Eastern Erg of the caravan routes which has prevented the emergence of major cities. The voluntarism of Saharan integration and the reconsideration of territorial grid have led to massive unorganized urbanization; the latter is responsible for serious problems related to the urban environment; the degradation of architectural heritage and cultural heritage; soil degradation and water. Changes in land use and land cover are critical elements of contemporary strategies for natural resource management, and for monitoring environmental change. In this context, a GIS derived from the application stages of geospatial technologies and remote sensing methodology from 1972 to 2016. This article attempts to analyze the spatial consequences of these policies on morphological transformation, and the changes imposed on this space. The change detection analysis indicates that the built-up area was increased by almost 30 times for the northern conurbation where the merger took place between Guemar and Taghzout, towards the south of the valley the built-up area was increased by more of 108 times or agglomerations Kouinine; El Oued; El Bayadha and Robbah eventually join. In this context, the predominance of traditional culture has declined as a result of market gardening, where the area occupied by the pivots has increased from 122 square kilometers to more than 317 square kilometers between 2005 and 2016.

KEYWORDS: Administrative promotion, Urban sprawl, Conurbation, Remote sensing and GIS, Souf, Algeria.

1 INTRODUCTION

The Sahara is perceived as a space of non-place, binding to all human presence, a space crossed and traveled, a space inhabited by man in oases, places of outcropping tablecloths and springs. The Sahara is a space of commercial transit, but also of nomadic circulation [1]. The Algerian Sahara for thirty years is engaged in a process of rapid unfinished urbanization, its demographic growth is stronger than the rest of the country [2]. The souf was an obstacle to caravan traffic, according to [3] it "long had been a blind spot", its urbanity was very limited. The urban reality of the souf did not emerge until the 19th century it signed the result of the combination of facts and time having shaped the Sufi Oases territory by attributing to it forms and roles increasingly greater. Indeed, it went through all urbanization operations. The ancient fabrics considered as a Saharan architectural heritage, the old European villages in checkerboard, and Daïra following Wilaya after 1984 with its special plan of development. Besides a border area, it has become, today, one of the three metropolises of the Low-Sahara (Biskra, Touggourt), and a regional pole in the national urban framework through all the stages of the urban planning carrying a program in pieces, which led to the bursting of its space.

The Urbanization Boom or its main causative is the administrative promotion to generate morphological mutations that knew the Soufian agglomerations, is a process of spatial expansion of the built-up areas, the Spectacular urban sprawl, passed

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by the Saharan city to the city in the Sahara, and ended by Inter- Municipal Urban Agglomerations, two conurbations (Kouinine, El Oued, Bayadha, Robbah) and (Guemar, Taghzout)), rare in a desert like this.

With regard to the question of conurbation; the cities broadcast, the subject that has been treated with moderation in Algeria, more precisely in Algiers by (Bakour, M, Baouni, T. 2015) despite the heavy impact of these consequences in all areas.

Through the establishment of a database under GIS, the supervised classification allowed us a better spatial and temporal reading of the changes that the different agglomerations of this oasis underwent, by sorting out the land use of the valley. Between built space (old, new and extension) and Ghouts (dead and flooded). The possible academic entries for this article are as follows. First, this article will be a convertible model to other similar areas, as it deals with the urban sprawl in time and space in the desert of eastern Algeria. Urban sprawl is one of the most dramatic difficulties of modern spatial planning [4]. This study can be used to qualify and control this spread for the best exploitation of Saharan fauna and flora. This article concluded the evaluation and the transformations of the big forms of the spatial configuration of the agglomerations between 1972 and 2016. From the spatial transformations measured at the inter-municipal level of the Souf valley, and according to various socio-demographic criteria, in order to account for urban spatial dynamics, and the factors that condition the sprawl.

2 DESCRIPTION OF THE STUDY AREA

2.1 GEOGRAPHY OF OUED SOUF

The Souf is located in the south-east of Algeria, on the northern borders of Grand Erg Oriental, between 33° and 34 ° of latitude north, and 6 ° and 8 ° of east longitude. With an area of about 350,000 ha [5] touching the Tunisian and Libyan borders. This immense sandy area is, on the one hand, halfway between the Mediterranean Sea in the North and the southern limit of the Grand Erg Oriental in the South, on the other hand, at equal distances between the Gulf of Gabes at the East and the Saharan Atlas in the West (Fig. 1). This position earned him a warm and dry climate [6], which was particularly conducive to palm cultivation, and a particularly favorable environment for caravan traffic. This double privilege is certainly less sensitive today than in the past, because of the rise of the automobile which has, in a way, shortened distances and accelerated the sedentarization of nomadic or semi-nomadic pastoralists. The immediate surroundings of the Souf are: El-Djerid Chott (Tozeur region) in the East, Chott Melghir and Chott Merouane in the North (Biskra region), Oued-Righ (Touggourt region) in the West, and the Oriental Erg in the South. Covering an area of 80,000 km2, the Souf forms a dune massif stretching 650 km from the Libyan border (Ghadames) to the neighboring northern Sebkhas, with a width of about 160 km. The average altitude of Souf is 80 m, while that of the Chotts du Nord, it goes down to less than 35 m from sea level. In the northern part of the Souf, the Grand Erg Oriental falls and loses mass with the disappearance of the dunes that give way to clay and limestone plateaus covered with a scanty vegetation that extend to arid and bare shoots. This last portion of the desert, poorly scrubby, becomes an excellent pasture after good rains. These inter- municipal Urban Agglomerations referred to in this work are Guemar, Taghzoute, Kouinine, El Oued, Bayadha and Robbah.

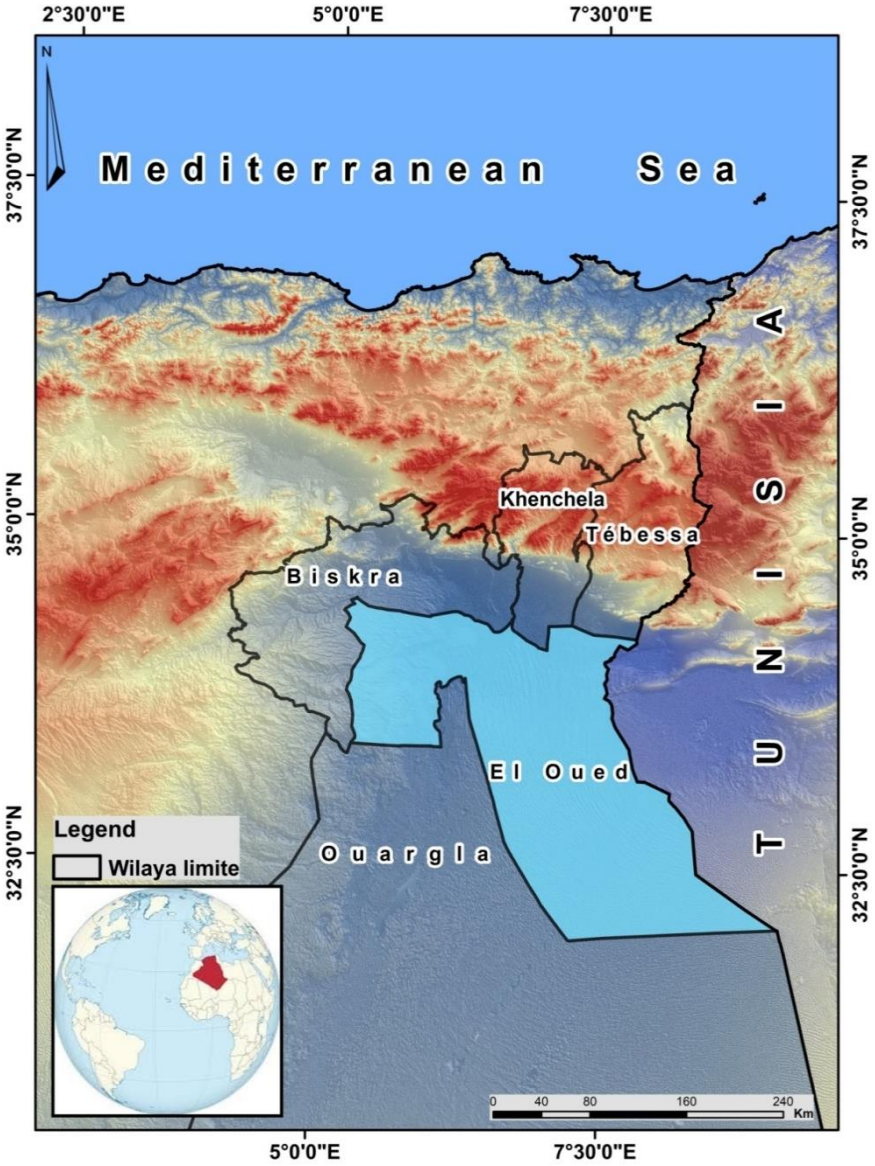


Fig. 1. Study area location map

2.2 THE CULTURE SYSTEM

A traditional process unique in the world [7], [8], in set oasis Sufi palms are planted in manually dug bowls popularly called Ghout (Fig. 2) and draw water instantly from the phreatic aquifer [9]. Thanks to this method the water goes up to the roots by capillarity of the water table, an ingenious system of non-expensive auto irrigation [10], [11]. In reality, the Ghout is a cultural heritage that places an identity stamp for the area, it is classified a world agricultural heritage in 2005 by the FAO given its environmental and economic importance [12].

This system depends on the phreatic aquifer so it is very vulnerable to the fluctuation of these waters; therefore the phoeniculture is threatened by the fall or the rise of the piezometric level [13], [14].

3 MATERIAL AND METHODS

3.1 DATA COLLECTION

The statistical data are collected from the editions of the national statistics office, the latter concerning the general population and housing censuses of the years 1966, 1977, 1987, 1998, 2008 as well as their urban framework, merging

agglomerations. Our work uses the contagion principle, described by [15]. This is a very logical approach to urban sprawl where a main center, and even a secondary center, arrives through a sustainable space-time dynamic to mutate surrounding non-urban spaces. This approach clearly fits our study area or a set of initially separated cities coalescing by extension of their peripheries between which is established a complementarities and a distribution of functions [16], [17]. It is a conurbation by nature multipolar.

Fig. 2. Agriculture traditional under Ghout system

The first phase consists in determining the existing urban entity through expansion in space. "The expansion of the cities on the surface has become considerably faster than the growth of their population" [18] for these two principles are retained:

In Algeria and according to General Population and Housing Census (GPHC) 1998, 2008 an agglomeration is a set of constructions for that, two principles are retained at least one 100 meters such that none of them is separated from the nearest of more than 200 meters.

The same municipality may include several main cities (MC) in the administrative center, the other agglomerations of the same municipality are called secondary agglomerations (SA). Agglomerations that extend over several municipalities are called Inter-municipal Urban Agglomerations (IMUA). The use of these principles facilitated the delineation of the urban entities involved in the study with high resolution images to detect the change in urban sprawl [19], [20]. (Google earth images using ArcBruTil extension in ArcGis® 10.6). Very frequent field trips made it possible to bear witness of certain observations on the images.

The interactive approach by manual digitization of urbanized surfaces (obtained by Supervised classification technique), is a method to restore the conurbation of Sufi IMUA.

3.2 GIS AND IMAGE CLASSIFICATION PROCESSING

The classification process is a multi-step workflow [21]. In our case, we have chosen the supervised classification [22]; [23]; [24], [25] the probability that the pixels have a singular class is the key principle of the maximum likelihood classifier [26]; [27], uses spectral signatures obtained from training samples to classify an image [28]. With the help of the image classification toolbar, we had to create training samples to represent the classes we want to extract, and also easily create a signature file from the training samples, which is then used by multi-varied classification tools to classify the image [22]. What is beautiful and simple in this work is the space chosen for the study, which means that the simplicity of the topography of the space (dunes, sand, palms, habitats, pivots) simplified the contrast and gave very reliable results.

The use of supervised classification has allowed for greater clarity of images and a sharper classification of the territory into classes [29], for each land-use class to be fragmented were sorted and used in the classification algorithm [30].

Raised by the mapping and monitoring of urban growth more precisely urban sprawl from the use of satellite images and geographical information system [31]. LANDSAT images (table 1 a and b) were obtained free of charge, via this link https://earthexplorer.usgs.gov/. The downloaded images have different dates in the order of 1972, 1976, 1987, 1995, 2005, and 2016 for the following reasons:

Table 1. a/ precision of causes and reasons for choice of dates of images; b technical and geographical characteristics of the selected images

a)

Date	Choice the reason
1972	First date of the satellite image archive uploaded.
1976	Two years after the upgrade of the administrative framework to the rank of Daïra (Wilaya Biskra) (this year represent the real departure of socio-economic development).
1987	-Three first deep wells in the Continental Intercalaire (CI) aquifer are executed; two for AEP 1 for agriculture. They are artesian and flow rates in the order of 200 L/s, are 5 to 10 times greater than in the Complexe Terminal (CT) aquifer [32]. -3 years after the 2nd upgrade of the administrative framework to the rank of Wilaya (disruption and irrational exploitation of water resources to comply with this administrative rank)
1995	Change of the economic strategy of trade (souk Lybia) towards the erected farm (potato).
2005	five years later.
2016	Actual state.

b)

Scene	Ellipsoid	Date	Landsat satellite	path	Row	UTM zone
1972	WGS84	11/10/1972	Landsat1	207	037	32
1976	WGS84	24/06/1976	Landsat2	207	037	32
1987	WGS84	01/07/1987	Landsat5	193	037	32
1995	WGS84	24/07/1995	Landsat5	193	037	32
2005	WGS84	22/04/2005	Landsat7	193	037	32
2016	WGS84	08/08/2016	Landsat8	193	037	32

4 RESULTS AND DISCUSSION

4.1 LAND USE LAND COVER (LULC)

The study of the roofing of soils by the function of the soil would enable us to conceive the city as it was envisaged in the past and to lead the direction of its future growth and extension [17]; [33]. Ten classes of land cover are identified from the supervised classification Fig.3 the vegetation cover classes identified in the study area were the palm tree; the Ghout and pivot potato, Non-vegetated land covers include dune, sand, water treatment plant and flooded Ghout. The urban class appeared in the order of El Oued, the order of Guemar and building. The surface mutation of the (IMUA) has imposed another functional mutation, agriculture is the dominant function, or the date palms planted in the Ghouts were its catalyst. But in recent years, it has spread to new crops planted with pivots, an irrigation system is entirely dependent on the exploitation of underground water from the water table that covers the entire region, in 2015 the Souf's agricultural sector consumed about 88% (63,453 l / s) of water requirements, of which 99% (62,883 l / s) from the aquifer this consumption is almost tripled for 24 years from 21211 l / s. at 63453 l / s in 1991 and 2015 [13].. Fig.4 treated from the land cover maps reveals the mutations of this activity, mutations that affect the quality and quantity of groundwater. These waters are hard with high salinity, which is a distinct hazard for plants [34], and the quality of the soil (salinity).

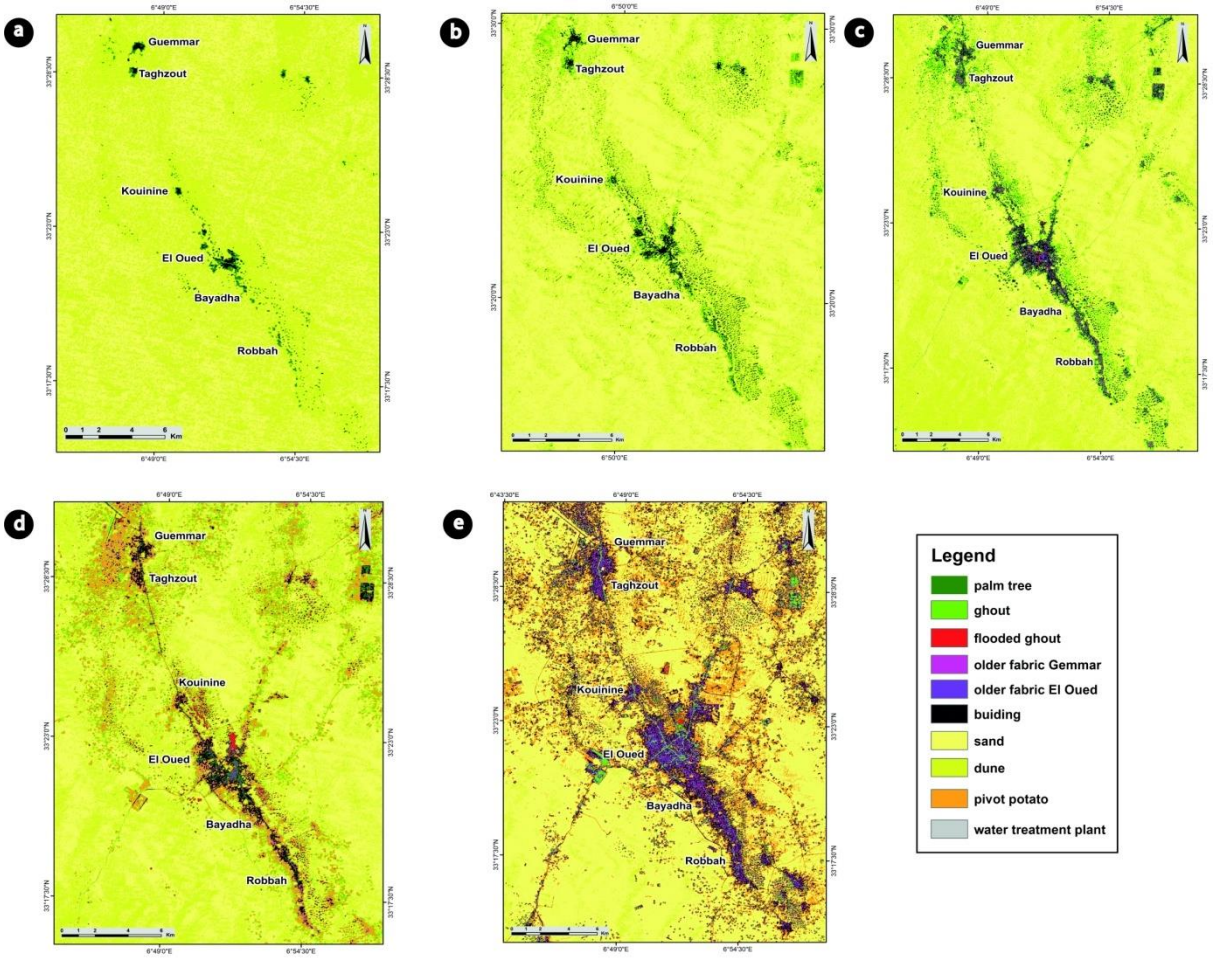
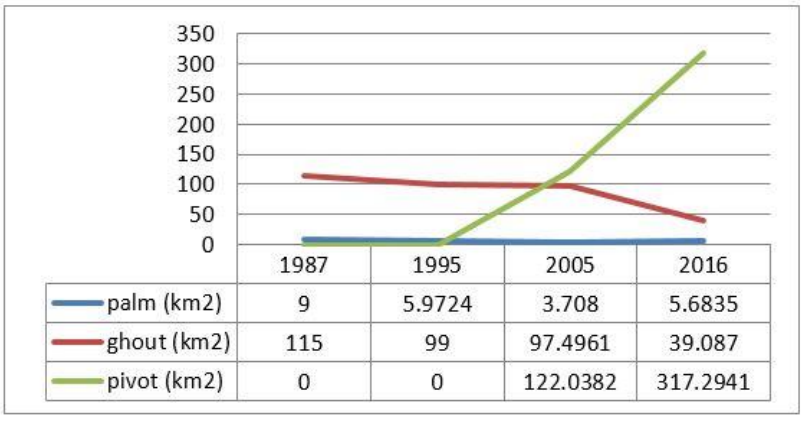


Fig. 3. Land Use Land Cover: a/ LULC 1972, b/ LULC 1987, c/ LULC 1995, d/ LULC 2005, e/ LULC 2016



	1987	1995	2005	2016
palm (km2)	9	5.9724	3.708	5.6835
ghout (km2)	115	99	97.4961	39.087
pivot (km2)	0	0	122.0382	317.2941

Fig. 4. Evolution Of Agricultural Mutations

4.2 Before Urban Sprawl (Period Between 1966 And 1998)

During independence, El Oued has included four mains cities (including the Debila MC is outside the study area) and eight Secondary Agglomeration (Table. 2). These agglomerations are considered as a potentially modifiable territory, because their distances are very close to the center of chief Daïra, on the one hand, on the other hand, the spectacular influx of the Algerian

refugees in Tunisia that recorded the Daïra of El Oued and the stability of the nomads. According to the GPHC (1966) statistics, the population for the main cities is 21.3%, and the population for secondary agglomerations (SA) is estimated at 32.82%, and 45.87% for the scattered areas. The ratio of the total rural population is estimated at 78.69%.

These percentages clearly reflect the strong rural dominance of space. In order to better read the spatiotemporal dynamics, the results of the land-use maps were removed and population numbers and their densities could be estimated (Table. 5) by applying the following equation:

$$\mathrm{Pn} = P_0 \left[\left(1 + \frac{r}{100}\right)\right]^n$$

where:

Pn: final population.
P0: initial population
r: population growth rate
n: difference of years 0 and n.

The increase in population between 1966 and 1977 is estimated at 25% for Guemar, 20% Kouinine and 26% El Oued. This population is spread over an area of about 23 hectares (Guemar); 9 hectares (Kouinine); 48 hectares (El Oued); and 9 hectares (Taghzout) (Fig.5/a). It should be noted that after the second administrative division which was carried out in 1974, El Oued city kept the same urban stratum, it remains always one of the daïra of the wilaya of Biskra, except Robbah MC included a new Banghazlia SA (Table. 3).

To create a spatial, social and economic balance through the growth of the network of local authorities; as well as their broadcasts; towards a tighter mesh, and the improvement of equipment services in the most disadvantaged areas, a new administrative division took place in 1984 [35], the upgrade of the administrative framework of El Oued to the rank of wilaya, gave birth to two new MC Taghzout (new commune resulting from Kouinine) and Robbah (new commune resulting from El Oued or the (SA): El Gara, Lasnam, Ouled Touati, Souhan el Mast, Tiksebt merged with Bayadha MC, giving a total of 6 main cities (MC), as well as a new secondary agglomeration affinity from Soualahand N'zlet Mehd SA from El Oued MC, the population of the administrative center presents 95% of the total population of the study area in front of a small 5% of the secondary agglomeration's population, In addition to that, the footprint of the urban area is multiplied by 7 (greater 7 times than) passed from 67.90519 ha in 1972 to 461.204556 hectares in 1987 (Table. 5), which clearly reflects the dynamic implied by the administrative territorial orientation of 1984 (Fig. 5/b),

Fourteen years after upgrading to wilaya rank (new administrative subdivision 1984), new secondary agglomerations have been established which are in the order of Ghamra, Ghour Debaa and Nezla. This peripheral area in Guemar provides micro-urbanization with a population of 3930 inhabitants, represents 16.34% of the total main city's population, which is somewhat significant, will announce future urbanization that we will reveal later. At the same time the SA merged with their MC's (Table. 4), this merger mainly confirms the evolution of the footprint of the urban area which doubled the case of Guemar and Kouinine, almost tripled for El Oued, and quadrupled for Robbah and Taghzout (Fig. 5/c) (Table. 5).

Since GPHC (1987) is based on the criteria retained, El Oued and Bayadha are now defined as an urban environment, and Robbah, Guemar, Taghzout, Kouinine are classified in the Semi Urban Stratum, and this classification was also retained by the GPHC (1998).

4.3 URBAN SPRAWL (PERIOD BETWEEN 1998 AND 2008)

The analysis of the satellite image (2005) (Fig. 5/d) revealed the urban sprawl (Table. 5) between Guemar and Taghzout because Guemar has easements to respect which are both obstacles of its extension to the north or there is the military zone and to the north west where there is the Aerodrome, so the sprawl was to the south align with the national highway on a surface of 242,1930 hectares, and a human density of 133 inhabitant / hectare, a little further south to the diffuse urbanization results an inevitable cohesion between El Oued and Bayadha on a surface of 747, 7830 hectares with a more severe density of the order of 206 inhabitants / hectare. According to the 2008 urban framework, the peripheral area becomes the major theater of urbanization.

Table 2. Evolution of the main agglomerations of the Souf Valley (1966-1987): [36], [37]

Municipality	RGPH 1966			RGPH 1977			RGPH 1987			Observation
	Agglomeration	Type	Population	Agglomeration	Type	Population	Agglomeration	Type	Population	
Guemar	Guemar	MC	4685	Guemar	MC	7586	Guemar	MC	12285	
							Ghamra	SA	2787	
		1	4685		1	7586	-	2	15072	
Taghzout	Taghzout	MC	2760	Taghzout	SA	4524	Taghzout	MC	7136	New Municipality from Kouinine.
		1	2760		1	4524		1	7136	
Kouinine	Kouinine	MC	2514	Kouinine	MC	3801	Kouinine	MC	5520	
		1	2514		1	3801		1	5520	
El Oued	El Oued	MC	24474	El Oued	MC	47173	El Oued	MC	70073	
		1	24474		1	47173	N'zlet Mehd	SA	838	
								2	70911	
Bayadha	Bayadha	SA	6136	Bayadha	SA	9579	Bayadha	MC	18138	New Municipality coming from El Oued. SA: El Gara, Lasnam, Ouled Touati, Souhan El Mast, Tiksebt merged with MC Bayadha.
	El Gara	SA	2145	-	-	-	-	-	-	
	Lasnam	SA	2445	-	-	-	-	-	-	
	Ouled Touat	SA	1600	-	-	-	-	-	-	
	Souhan El Mast	SA	550	-	-	-	-	-	-	
	Tiksebt	SA	2292	-	-	-	Soualah	SA	1357	
	Soualah	SA	550	Soualah	SA	492	Ababssa	SA	568	
		7	15718	-	2	10071	-	3	20063	
Robbah	Robbah	MC	4293	Robbah	MC	5825	Robbah	MC	10665	
				Banghazlia	SA	621	Banghazlia	SA	1111	
		1	4293	-	2	6446	-	2	11776	

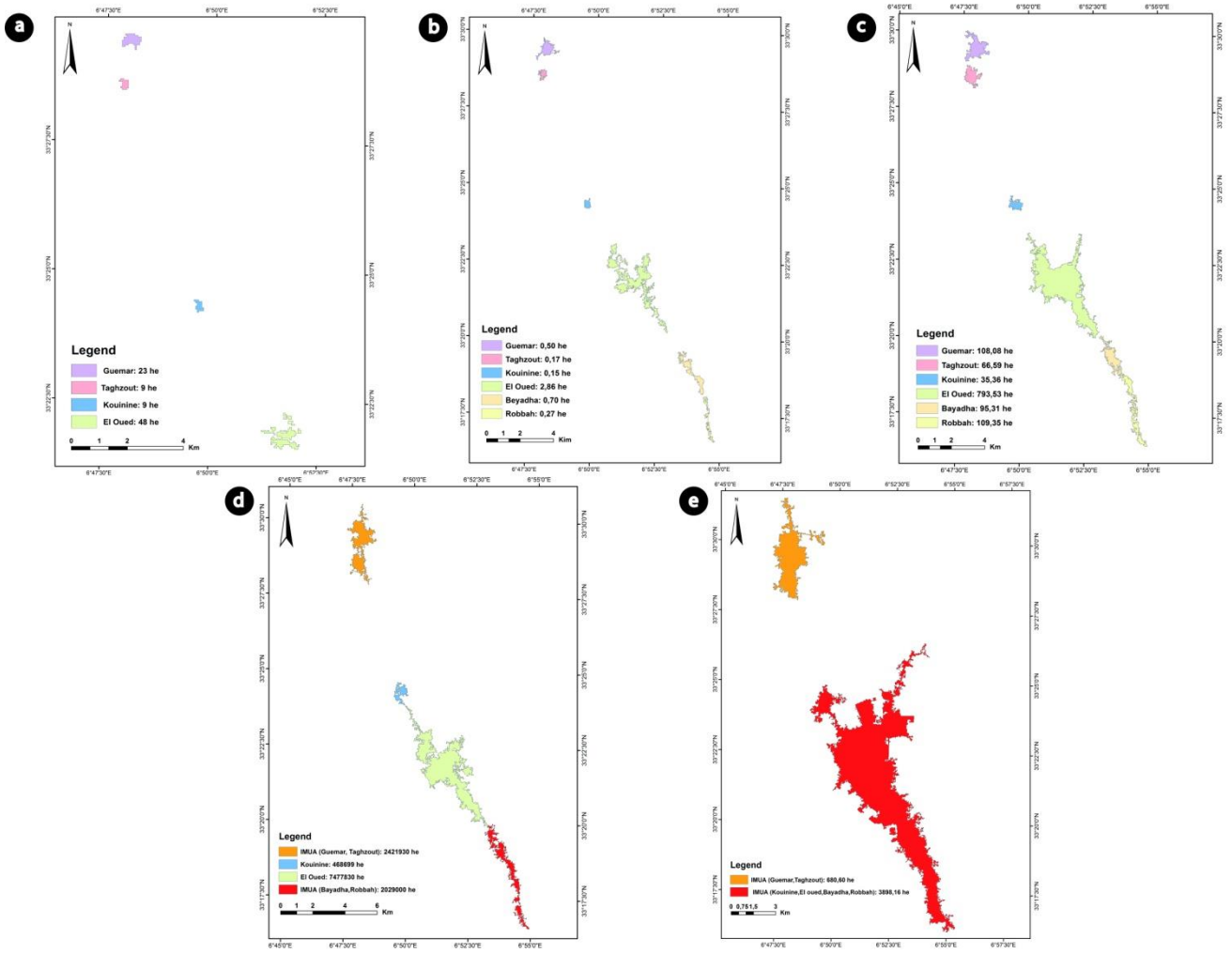


Fig. 5. a/ Urban area in 1972. b/ Urban area in 1987. c/ Urban area in 1995. d/ Urban area in 2005. e/ Urban area in 2016

Table 3. Evolution of the main of the agglomerations Souf Valley (1987-1998): [38], [39], [40]

Municipality	RGPH 1987			RGPH 1998			Observation
	Agglomeration	Type	Population	Agglomeration	Type	Population	
Guemar	Guemar	MC	12285	Guemar	MC	16186	New secondary agglomerations.
	Ghamra	SA	2787	Ghamra	SA	2133	
	-	-		Ghour Debaa	SA	916	
	-	2	15072	Nezla	SA	881	
	-				4	20116	
Taghzout	Taghzout	MC	7136	Taghzout	MC	10191	New Municipality From Kouinine.
		1	7136		1	10191	
Kouinine	Kouinine	MC	5520	Kouinine	MC	7528	
		1	5520		1	7528	
El Oued	El Oued	MC	70073	El Oued	MC	105151	N'zlet Mehd merged with MC El Oued
	N’zlet Mehd	SA	838	-			
		2	70911		1	105151	
Bayadha	Bayadha	MC	18138	Bayadha	MC	24443	Ababssamarged with SA Soualah.
	-	-	-	-	-	-	
	-	-	-	-	-	-	
	-	-	-	-	-	-	
	-	-	-	-	-	-	
	Soualah	SA	1357	Soualah	SA	2032	
	Ababssa	SA	568	-			
	-	3	20063	-	2	26475	
Robbah	Robbah	MC	10665	Robbah	MC	16927	Banghazlia marged with MC of Robbah
	Banghazlia	SA	1111	-			
	-	2	11776	-	1	16927	

Table 4. Evolution of the main agglomerations of the valley (1998-2008): [39], [40]

Municipality	RGPH 1998				RGPH 2008				Observation
	Agglomeration	Type	Population	Stratum	Agglomeration	Type	Population	Stratum	
Guemar	Guemar	MC	16186	Urban	Guemar	IMUA	48413	Urban	Conurbation between the different secondary agglomerations and agglomeration chief place. And they are organized Inter-municipal Urban Agglomerations (IMUA). This IMUA ranked in the Urban stratum.
	Ghamra	SA	2133	-					
	Ghour Debaa	SA	916	-					
	Nezla	SA	881	-					
	-	4	20116	-					
Taghzout	Taghzout	MC	10191	Urban					
		1	10191	-		1	48413		
Kouinine	Kouinine	MC	7528	Urban	EL OUED	IMUA	186525	Super Urban	Conurbation between different secondary agglomerations and agglomerations chief place. And they are organized in Inter-municipal Urban Agglomerations (IMUA). This IMUA is classified in the Urban Superior Stratum
		1	7528						
El Oued	El Oued	MC	105151	Urban					
	-	1	105151	-					
Bayadha	Bayadha	MC	24443	Urban					
	Soualah	SA	2032	-					
	-	2	26475	-					
Robbah	Robbah	MC	16927	Urban					
	-	1	16927	-		1	186525		

The proximity between agglomerations has strengthened a conurbation. The dynamics of agglomerations is increasingly visible in the peripheral area where (Table. 5) confirms this Conurbation between the different secondary agglomerations and chief town and between two (MT) s Guemar and Taghzout, they are organized in Inter-Municipal Urban Agglomerations (IMUA). This IMUAs ranked in the Urban Stratum with 48413 inhabitants.

The same table shows that the agglomerations of Kouinine and Robbah as well as (SA) of Soualah join the conurbation of El Oued and Bayadha all these are Inter-Municipal Urban Agglomerations, This IMUA is classified in the Stratum of Urban Superior, and she is one of the 5 IMUAs in the South East of Algeria, and one of the 7 IMUA sin the South [40] and one of the 33 IMUAs in all the Algerian territory. El Oued IMUA concentrates a large number of higher types of services (higher education, hospitals, and very dense basic infrastructures).

The footprint is increased by 6.19% between 2005 and 2016 for the Guemar IMUA, tending that El Oued IMUA its footprint has high of 19.18% between 2005 and 2016, these two IMUA and their urban and clearly visible footprint with the processing of the satellite image of 2016 (Fig. 5/e). For IMUAs, we observe that over time, the urbanized area has grown faster than the population that shelters it, shows that the population density has decreased by 48.12% for the IMUA of Guemar, the second IMUA of El Oued its density of the population has decreased by 30.09%.

Measuring the rhythm of urbanization (Fig. 6), the Guemar's rhythm and Taghzout is higher than the national rhythm, and that of the South East. So the increase in the ratio of the urban population (or proportion of urban dwellers) to that of the total population is very clear. The city of Kouinine and El Oued at a negative rhythm this is explained by the deterioration of the

environment inherent to the upwelling, at the same time their higher rural growth rate reflects the magnitude of its impact on water exploitation in irrigation and the consequences for rising water.

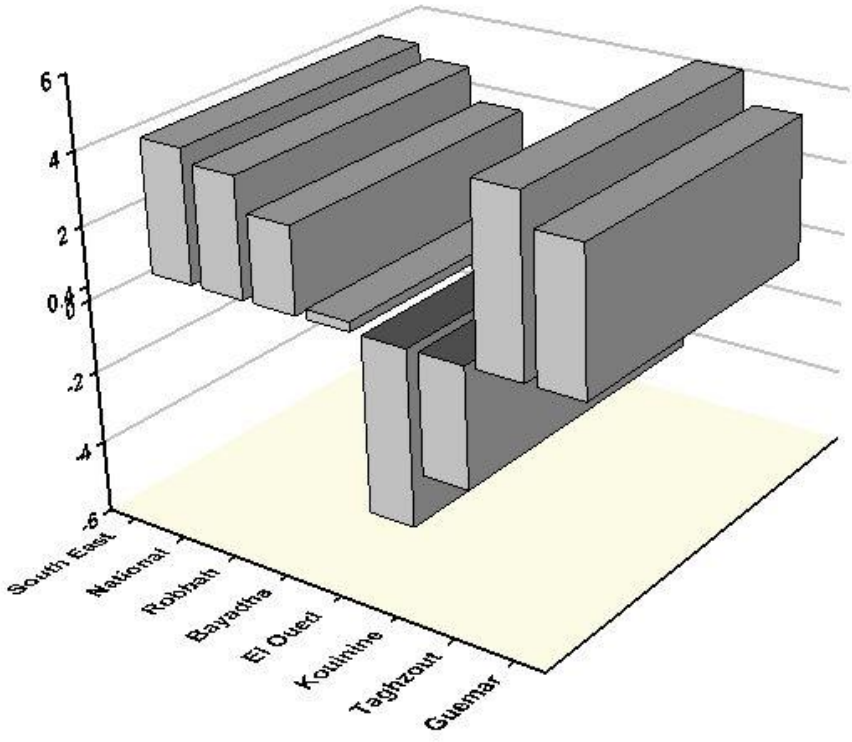


Fig. 6. Measuring Rhythm of Urbanization [40]

5 FACTORS THAT HAVE CONTRIBUTED TO THE SPRAWL PHENOMENON

Research on the driving dynamics that are direct and other potential factors of urban sprawl explains the sustainable management of urban changes that change the pattern of cities; direct factors related to settlement dilation, industry development, and infrastructure development, while potential factors related to spatial factors, population, policy, economy, and technology [41]; [42]; [43], [44]. In this context, the direct factors related to the establishment of employment poles the Wilaya of El Oued comprises 14 multi-activity zones with a total surface area of 2136435 m² spread over 1328 lots [45], [46] being an important investment area, El Oued (265 lots), Kouinine (90 lots) and Bayadha (128 lots) have exhausted their reserves because of the high attractiveness of these agglomerations. The aspects of the city, must adapt to the morphological disposition of the roads. The souf network is in the form of X (Fig. 7), that extend from north-west to south-east (from Biskra to El Ogla), and from southwest to northeast (from Touggourt to Tunisia), which runs through

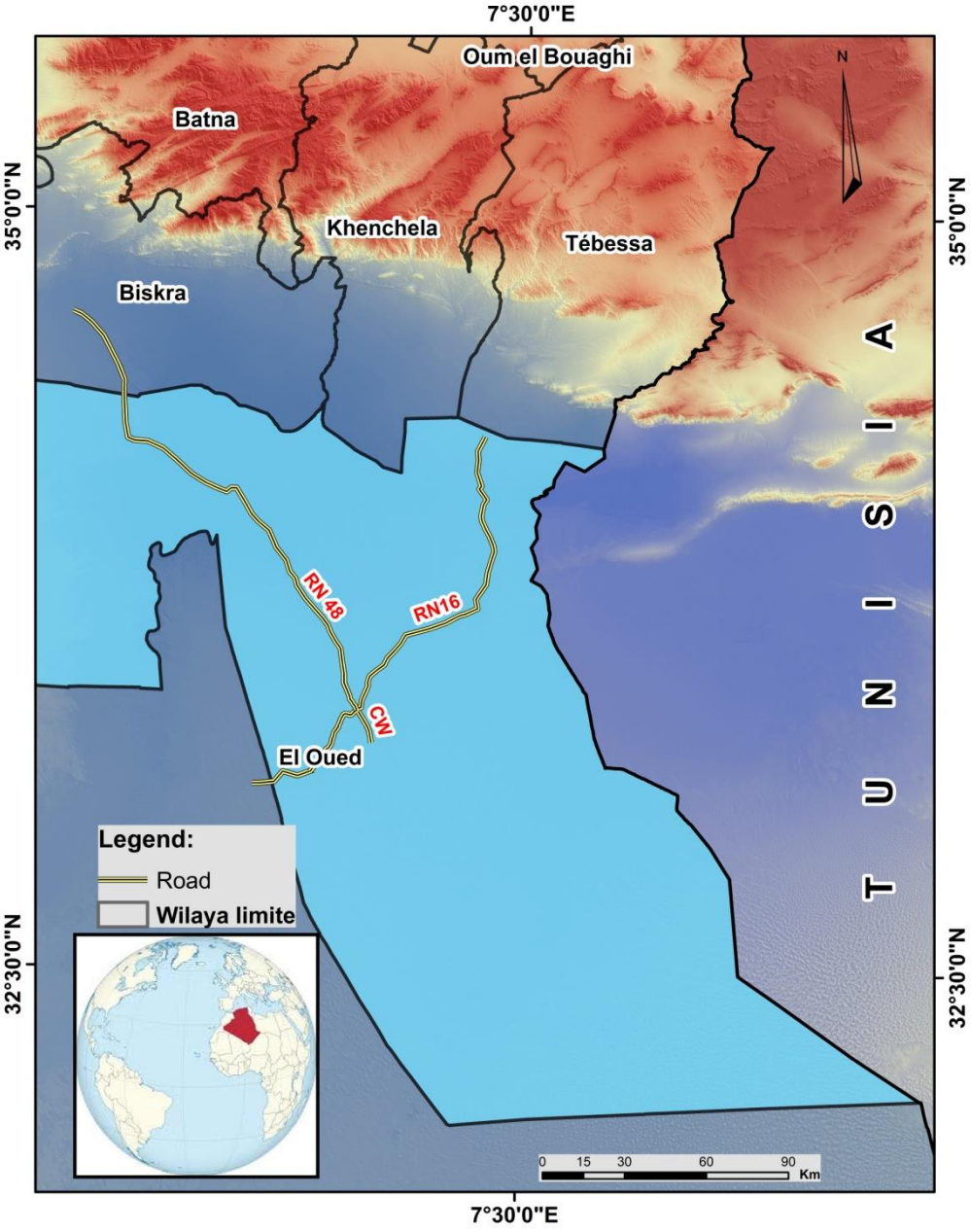
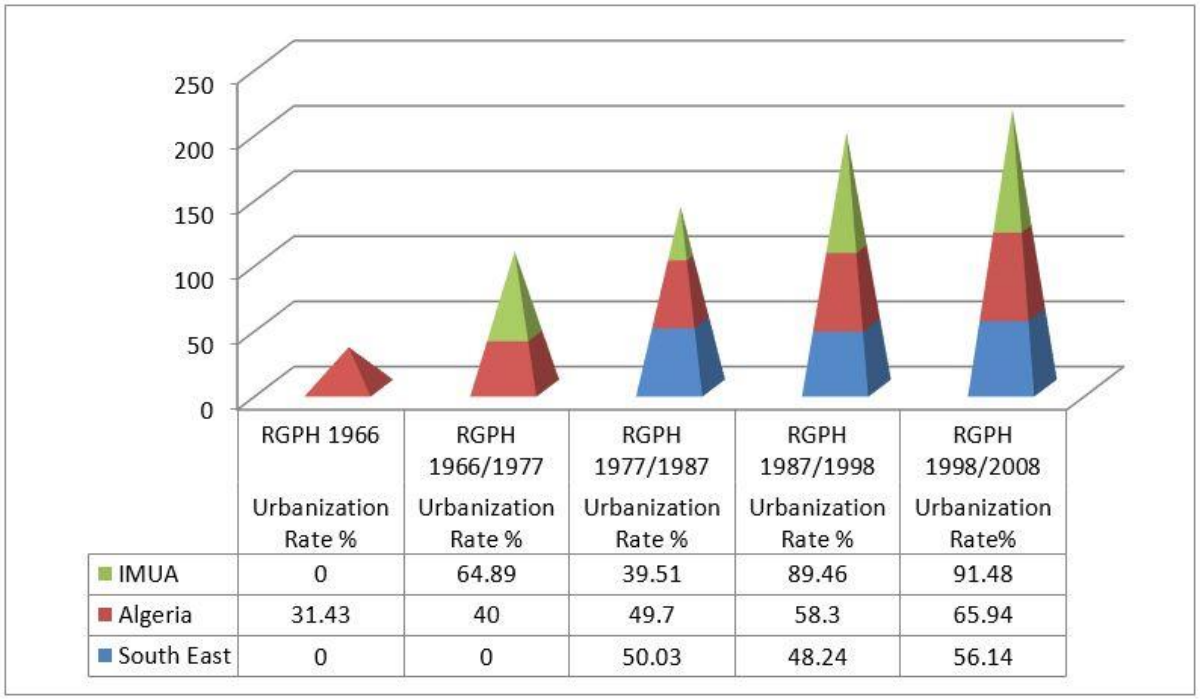


Fig. 7. The morphological Arrangement of The National Roads

The center of the city of El Oued. In this dense network, the IMUA extend linearly along the national road, their diffuse urbanization to the south is aligned with the national road no. 48. Concerning the potential factors the city of El Oued is by far the center whose radiation of its souk (market) goes far beyond the borders of its Wilaya. Retailers across the country are supplied weekly. The amount of its annual auction is more than 11 million Algerian dinars [35], on the sociological side; the Sufi individual tends to live in an individual dwelling, due to traditional factors and climatic factors, including high temperature. This means that this trend requires accelerated horizontal consumption of space. After Independence in 1975 the territorial division gave birth to the municipality, decentralization unit. At that time, the Souf was part of the Ziban constituency; El-Oued was an important Daïra in the Wilaya of Biskra. In January 1984, another national administrative division, El-Oued was promoted Wilaya, (30 municipalities and 12 Daïras). These voluntary initiatives imply for the promoted space a considerable public investment endowment, which induces the creation of massive jobs, the diversity of activities, the construction of housing and infrastructure, the multiplication of equipment [47]. Following this division, the valley faces new challenges, decisions, new sociological changes, population flows, all of which must be controlled by the capital of the valley. The PUD strategy was completed in 1978, this first master plan, does not contain detailed guidelines or laws, but general ideas and theories about the urban and organizational aspect of the city. What distinguishes this stage is the appearance of subdivisions

and some spontaneous urban tissues [48]. Between 1991 and 1993 another plan was put in place: the PDAU. It is a regulatory tool whose role is the allocation of land use [49]. A dramatic and uneven Saharan population dynamics, the Sahara becomes a land of appeal because other times it was a land of emigration [50]. The city becomes captive; it fixes the population [51]. The rate of urbanization increased in the Sahara from 23.74% in 1954 to 31.98% in 1966, higher than the national rate 31.50% in 1966, 38.94% in 1977, 50.05% in 1987 and 63.98% during 1998 and finally 70.97% in 2008 (Urban structures 2008). The (IMUA's) studied have experienced upsetting development and progression characterized by hypertrophy, an increase in the volume of a tissue due to an excessive development of the size of its constituent (Larousse 2001). The total population of agglomerations increased from 180426 in 1998 to 235150 in 2008, representing an average annual growth rate of 2.64%. As for the rate of urbanization, it went from 89.43% in 1998 to 91.46% in 2008. It is important to note that the rate of increase as well as the urbanization rate in the study air is much higher than the national average and the average of South-East Algeria (Fig. 8). The summarizes the demographic development, population growth according to major censuses (GPHC) 1966, 1977, 1987, 1998, 2008.



	RGPH 1966 Urbanization Rate %	RGPH 1966/1977 Urbanization Rate %	RGPH 1977/1987 Urbanization Rate %	RGPH 1987/1998 Urbanization Rate %	RGPH 1998/2008 Urbanization Rate%
IMUA	0	64.89	39.51	89.46	91.48
Algeria	31.43	40	49.7	58.3	65.94
South East	0	0	50.03	48.24	56.14

Fig. 8. Distribution of Urbanization Rate in Algeria, South East and IMUA

Table 5. Population, density and area of main agglomerations in the Souf Valley (1972-1987-1995 2005-2016)

Agglomeration	1972			1987			1995			2005			2016		
	population (Inh)	UR surface (Ha)	Pop density (Inh/Ha)	population (Inh)	UR surface (Ha)	Pop density (In/h)	population (Inh)	UR surface (Ha)	Pop density (Inh/Ha)	population (Inh)	UR surface (Ha)	Pop density (Inh/Ha)	population (Inh)	UR surface (Ha)	Pop density (Inh/Ha)
Guemar	6239	23.059	271	12285	50,916	241	14956	108.089	138.366	19907	242.193	133	27556	680.597	64
Taghzout	3619	Scattered areas	/	7136	17.5264	407	9195	66.599	138.063	12222			16261		
Kouinine	3137	8.786	357	5520	15.106	365	6885	35.369	194.65	9208	46.8,699	196	12638	3898.162	62
El oued	33231	36.059	922	70073	280.009	250	93564	793.529	117.908	125248	747.783	206	164866		
Bayadha	8973	Scattered areas	/	18138	70.683	257	22429	95.309	235.32	28524			36355		
Robbah	6136	Scattered areas	/	10665	26.961	396	14822	109.350	135.54	20162	202.9	99	26540		

6 UR: URBANIZED SURFACE

Table 6. Demographic development of the population: [39], [36], [54], [52], [53], [55]

Cities	RGPH 1966 (1)	RGPH1977 (2)			RGPH1987 (3,4)			RGPH1998 (5)			RGPH 2008 (6)		
	pop (Inh)	pop (Inh)	UR rate (%)	P G rate (%)	pop (Inh)	UR rate (%)	P G rate (%)	pop (Inh)	UR rate (%)	P G rate (%)	pop (Inh)	UR rate (%)	P G rate (%)
Guemar	4685	7586	99.99	4.54	12285	81.50	4.89	16186	55.46	2.49	25251	64.47	3
Taghzout	2760	4524	0	4.66	7136	99.90	4.62	10191	91.42	3.22	13164	94.47	2.63
Kouinine	2514	3801	99.00	3.88	5520	99.90	3.76	7528	99.43	2.80	9998	99.23	2.92
El Oued	24474	47173	99.99	6.23	70073	98.81	5.23	105151	99.99	3.68	134699	99.84	2.53
Bayadha	6139	9579	0	4.19	18138	90.40	6.53	24443	92.12	2.69	30392	92.30	2.23
Robbah	4284	5825	90.36	2.87	10665	90.56	6.17	16927	98.17	4.20	21646	98.54	2.53
Sud Est	/	/	/	/	/	50.03	3.2	/	48.24	3.0	/	56.14	2.3
Algérie	/	/	40	3.17	/	49.7	3.12	/	58.3	2.10	/	65.94	1.61

UR rate: Urbanization Rate.
P G rate: Population Growth Rate.
6 Urban Sprawl impacts

6.1 RELATIONSHIP BETWEEN THE EVOLUTION OF THE URBAN POPULATION AND THE URBANIZED SURFACE

The growth of the population is always greater than the growth rate of the urban fabric. This confirms the massive influx of rural populations and the influx of refugees to the cities, (Fig. 9). shows that this increase is rapid between 1972-1987 before that of other years this is explained by the decline in the rate of increase of the population in all Algeria (1.61% in 2008) as well as the south east and necessarily the cities of the study area (Table. 7), because These voluntary initiatives imply is in plain demographic transition due to changes in lifestyle [56].

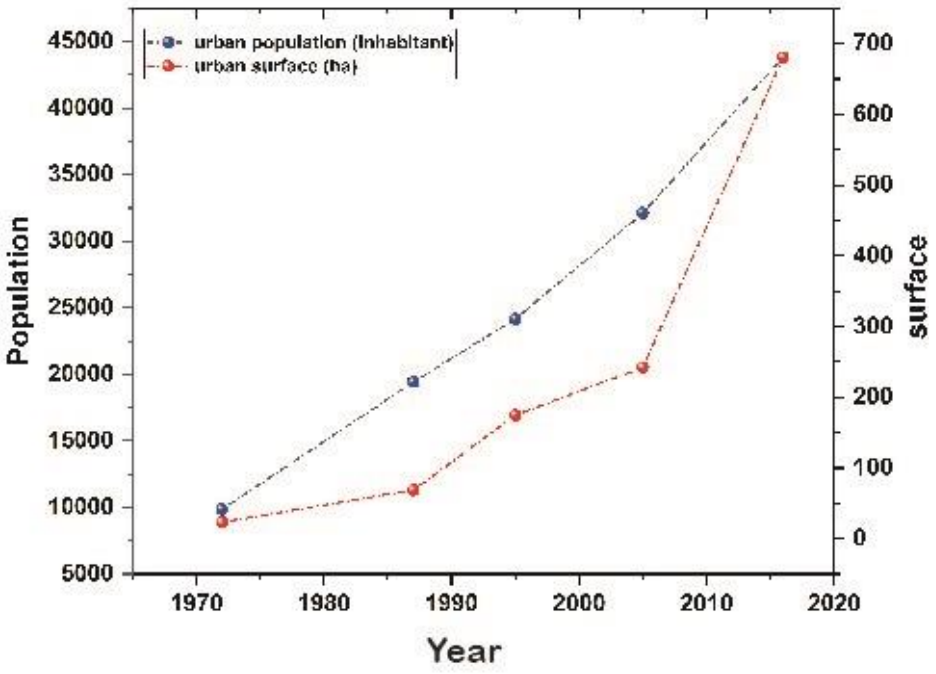


Fig. 9. Relationship between the urban area and the urban population of the Conurbation 1 (Guemar, Taghzout)

The increase in urban area (Fig. 10) was modest until 2005, between this year and 2016 the same graph shows the jump of this urban area is almost doubled by 3 times passed from 242,193 hectares to 680,597308 hectares due to the demand of land and the improvement of environmental conditions through the establishment of indispensable networks such as sanitation and drainage.

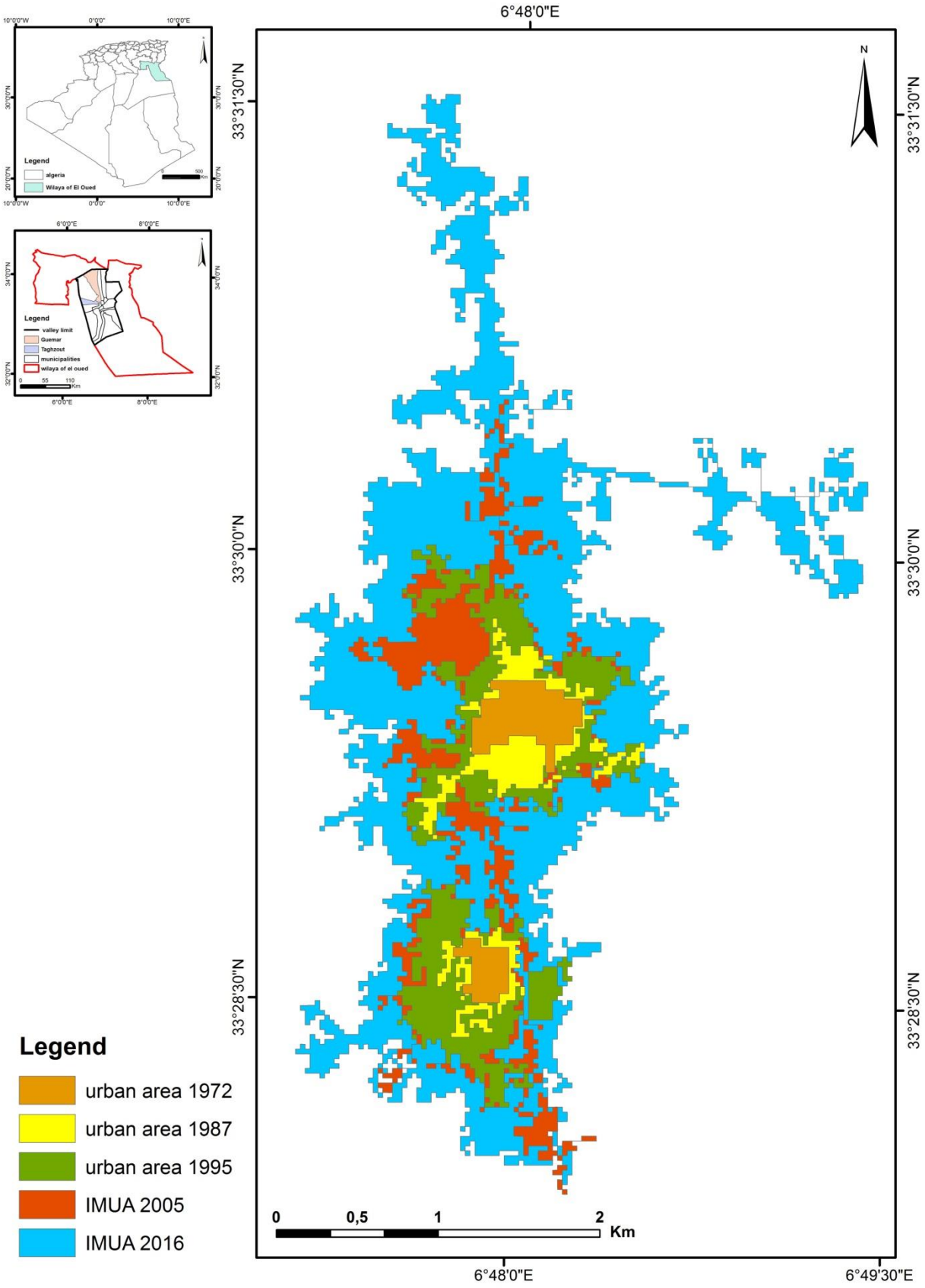


Fig. 10. The First Conurbation 1972 – 2016

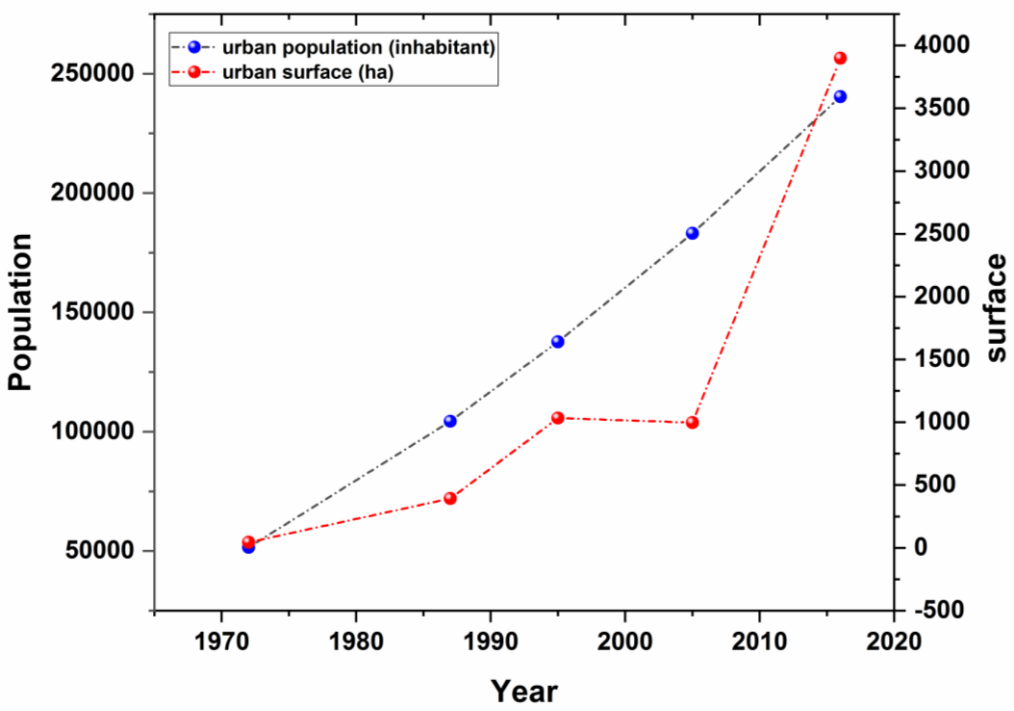


Fig. 11. Relation between the urban area and the urban population of the conurbation 2 (Kouinine, El Oued, Bayadha, Robbah)

Population growth is sharper than its predecessor (conurbation 1) seen upgrading to Wilaya rank; The city of El Oued becomes very captive, so the rural or other population is fixed whose purpose is to take advantage of the economic boom that characterized the city after this administrative movement and which has generated the logical increase of the urban area. The (Fig. 11) clearly shows a decrease in the total urban area (Fig. 12), from 1033,560247 hectares in 1995 to 997, 5529 hectares in 2005, this is explained by the effect of the rise of water from the water table which was heavier in the area. City of El Oued where there is high human concentration, stagnant water on the surface at the level of Ghouts and invaded by rushes (Fig. 13 a and b), and real black spots of pollution (Fig. 14), as well as the collapse of the frames. This condition caused a serious public health problem in February 2006; 311 cases of cutaneous leishmaniasis throughout the valley, including 89 cases (28.61%) in El Oued city, 24 cases (7.72%) in Bayadha, 11 cases (3.54%) in Robbah and 2 cases (0.64%) in Kouinine, as well as 84 cases case of typhoid fever of which 49 cases (58.33%) in El Oued city, 2 cases in Bayadha (2.38%) [57]; [58]. In addition, in El Oued city more than 40.03% of all cases (1927 cases), were recorded in 2010 [59], [60]. This critical situation has led to a decline of the urban surface, this regression of the surface is exclusive in the city of Chott (North East of the city) are the cities Nezla (former border quarry of the original nucleus of the city of El Oued) (Fig.15).The mutations resulting from urban sprawl have huge consequences for the ecosystem, the environment, and society [61], [62]. These effects are especially more dramatic in developed countries to cope with the socio-economic and environmental impacts of uncontrolled urbanization [63].

Between 2005 and 2016 the Fig.11 shows a very strong increase of the urban area, higher than the rate of increase of the urban population, it is estimated from 390.77% of 997, 5529 ha in 2005 to 3898,162367 ha in 2016 following the demand for land after the implementation of sewerage network, drainage network, and sewage treatment plant in Kouinine, which has improved the environmental conditions. The remedial measures provided by the sanitation of domestic waters can only form an incomplete reply, if we do not take into account all the factors that contribute to protecting the environment [64]. Add to all this the voluntarist scenarios of the local services in order to metric the axes of the urban expansion of the city towards the north by the establishment of the university of Echahid Hamma Lakhdar on the road axis Tiksbet - Chott city.

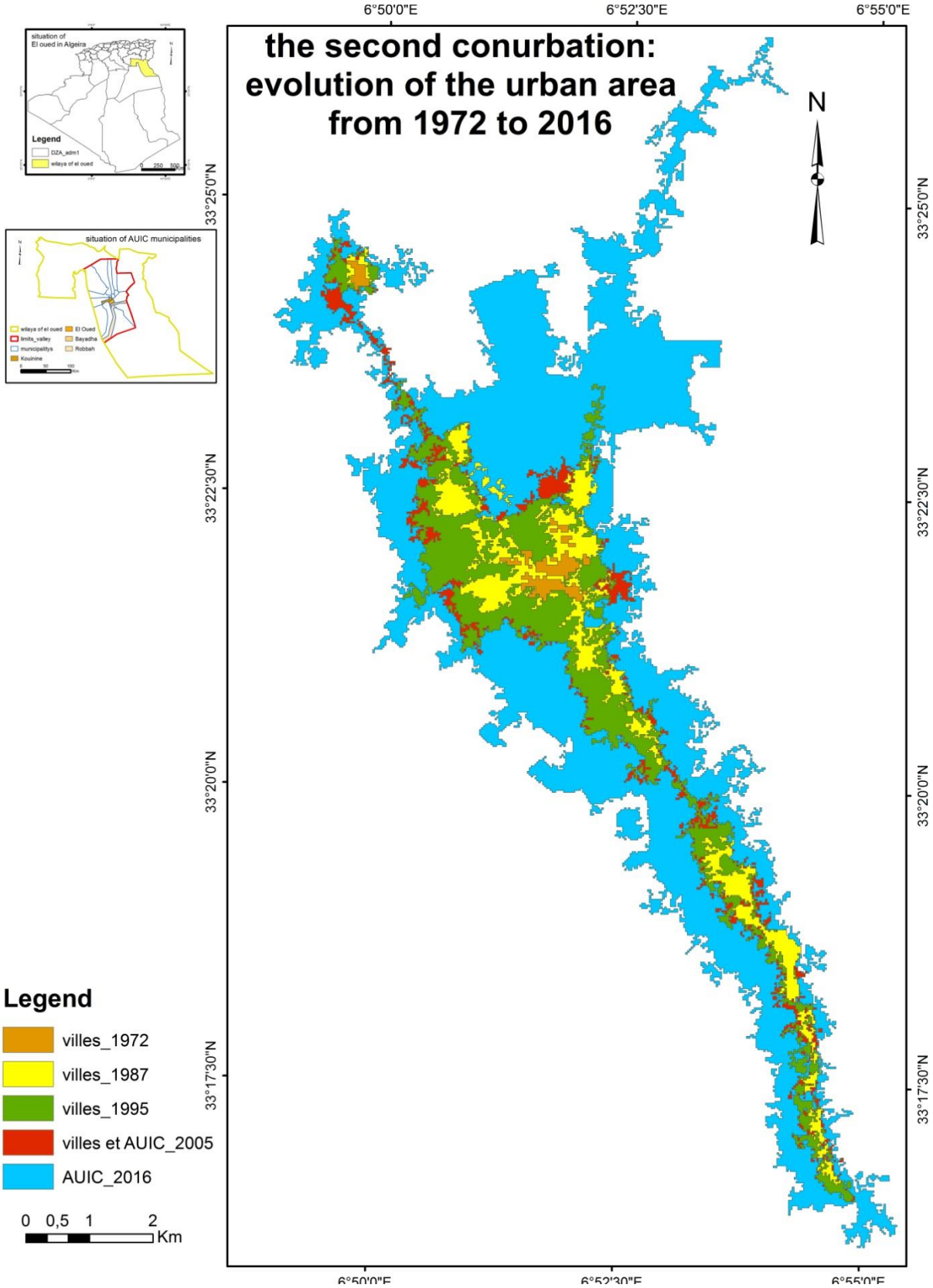


Fig. 12. The Second Conurbation 1972 – 2016

Fig. 13. a/Sidi Mastour neighborhood Inundated Ghout invaded by the rushes. Mars 2006
b/ Kouinine; Inundated Ghout invaded by the rushes. June 2016

Fig. 14. Chott neighborhood; pollution black point. March 2006

Fig. 15. Nezla neighborhood; Collapse of buildings March 2006

7 CONCLUSION

After the independence the space voluntarism took place to face the spatial disparities industrialization and the administrative divisions are arranged, these allow organizing the dynamics of the regional and urban spaces, one of these objectives is to control better the border areas of which El Oued is part.

Administrative promotion, this exogenous factor to generate several consequences; an ever denser and more rapid urbanization which is coming to the absorption of neighboring agglomerations or El Oued has become an illustrative desert case; a strong commercial dynamism that makes the region a center of small and medium-sized industries; as well as the modification of its agriculture by intensive gardening.

All these surface and functional mutations need heavy water sources financed by an aquifer. This aquifer located in the large sedimentary basin of Grand Erg Oriental (Algeria), and covers two deeper aquifers: the Terminal Complex (CT) and the Continental Intercalaire (CI) [65]. In a Saharan environment sui has a closed water system (lack of a natural outlet), the improvised decision of the administrative upgrade in 1984 dropped from his calculations the way of the management of waste water in the absence of sanitation and drainage network. With a population that uses and abuses this source.

In the space of 20 years these data are finished by the deterioration of the architectural identity (fabric of the Ksours, city of a thousand and one cupolas), of the cultural identity (irrigation system unique in the world the Ghouts); public health through water-borne diseases; and the degradation of the environment. Despite the implantation of sewerage, drainage, and sewage study and program by ENHPO BG but environmental problems still exist.

What we did not arrive realized in this article is how to determine the quality of this conurbation of the IMUA, What we intend to realize in our future researches is how to manage and direct the urban extension, in order to avoid the problem of groundwater upwelling, and for the moment we are going to develop a visual diagnosis on the urban areas touch by the ascent to specify the physical and chemical deterioration of the water on the urban components of these urban areas (frame built, infrastructure).

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