

The Urban Expansion Characterization of the Bir El Djir Municipality Using Remote Sensing and GIS

Zakaria Smahi, Khadidja Remaoun, Fatima Achouri

Abstract—Bir El Djir is an important coastal township in Oran department, located at 450 Km far away from Algiers on northwest of Algeria. In this coastal area, the urban sprawl is one of the main problems that reduce the limited highly fertile land. So, using the remote sensing and GIS technologies have shown their great capabilities to solve many earth resources issues.

The aim of this study is to produce land use and cover map for the studied area at varied periods to monitor possible changes that may occurred, particularly in the urban areas and subsequently predict likely changes. For this, two spatial images SPOT and Landsat satellites from 1987 and 2014 respectively were used to assess the changes of urban expansion and encroachment during this period with photo-interpretation and GIS approach.

The results revealed that the town of Bir El Djir has shown a highest growth rate in the period 1987-2014 which is 1201.5 hectares in terms of area. These expansions largely concern the new real estate constructions falling within the social and promotional housing programs launched by the government.

The most urban expansion is characterized by the new construction in the form of spontaneous or peripheral precarious habitat, but also unstructured slums settled especially in the southeastern part of town.

Keywords—Urban expansion, Remote Sensing, Photo-interpretation, Spatial dynamics.

I. INTRODUCTION

THE Mediterranean coastline in northern Algeria and particularly the coast of Oran has undergone since the early seventies profound changes related to the accelerated installation of tourism infrastructure and a very important socio-economic growth instead giving urbanization and growing urban development of that region.

Bir El Djir is a town and commune in Oran Province, Algeria. The city remained primarily agricultural until the late 80's, it became a major center of Oran city. So, follow the evolution of the city of Bir El Djir has always been the concern of geographers and planners where traditional cartographic approach was favored long to trace the urban spatial extension [7]. These methods involve collecting old cartographic documents and compare them. Now, with the development of computers and remote sensing techniques and tools such as GIS has evolved methods. However, the use of the satellite remote sensing is considered as a potentially powerful means of monitoring land-use change at high

Z. Smahi is with the Department of Physics, University of USTOMB, Oran 31000, Algeria (e-mail: smahi@mail.com).

K Remaoun is with the Department of Geography, University of Oran2, Oran 31000, Algeria (e-mail: kremaoun@yahoo.fr).

Fatima Achouri is with the Department of Civil Engineering, University of USTOMB, Oran 31000, Algeria (e-mail: achourifati@yahoo.fr).

temporal resolution and lower costs than those associated with the use of traditional methods. The remote sensing imagery is very useful data because of its synoptic view, repetitive coverage and real time data acquisition [8].

This study aims to map and quantify urban growth between 1987 and 2014 townships of BIR EL DJIR using a time series of satellite images with high resolution. The result of this research will be enriched by the analysis of the statistical study of data from the population of the region on a four GCPH censuses.

II. GEOGRAPHICAL LOCATION

The study area is located in the northwest of Algeria (Fig. 1). Bir El Djir (formerly Arcola in the colonial era) is an Algerian city of Oran, located 9 km east of Oran.

It is bordered to the north by the Mediterranean Sea, to the west by the city of Oran, in the south by the municipality of Sidi Chahmi, on the east by the Hassi Ben Okba and Hassi Bounif, townships. This municipality covers an area of 32.46 Km². According to the 2008 census it has a population of 152151, a density 5 295 people per km² and an annual growth rate of 4.1%.



Fig. 1 Location map of Bir El Djir's municipality

III. MATERIALS AND METHODS

A. Data Used

This study utilizes two forms of data. The map data concerns topographic maps of 1/25000 1/50000 scale covering all Bir el Djir township. Remotely sensed data concern the Landsat TM and SPOT5 satellite imageries of respectively February 1987 and April 2014 (a 27-year time span) was obtained from Global Land Cover and Google Earth Facility. The Landsat and SPOT5 image have ground resolutions respectively of 28.5 m and 10 m.

Bir El Djir and its environs were carved out using the local

government boundary map and Algerian Administrative map obtained from National Institute of Cartography and Remote Sensing (INCT).

B. Methodology and Results

In this study of urban multi-temporal evolution, the image of SPOT and Landsat TM cover respectively ground areas of 1532 km² and 6516 km². The images preprocessing consisted primarily to establish a false color combination of 4-3-2 channel Landsat image and the three bands of the visible SPOT to visualize and thereafter performing a linear contrast on the two image results [6]. The Landsat image was extracted from the same size to the SPOT to cover our study area thereby covering the entire municipality of Bir El Djir.

The analysis of the work is predicated basically on the use of remote sensing and GIS techniques. ENVI 4.7 was used in carving out Bir El Djir and its environs out of the whole image within the path/row. Also, the processing and enhancement of imagery was done using this software. MapInfo 11 was also used in displaying, subsequent processing, overlaying and analysis of the vector layers results from images.

In addition, geometric correction was applied to two images from two different dates when the Landsat image was selected as a geographic reference. The SPOT image was georeferenced with a mean square error (RMS) of 0.9 pixels and was brought to Universal Transverse Mercator projection UTM in zone 30 north using the ellipsoid Clarke, 1880.

The Landsat image has undergone a re-sampling by the nearest neighbor method to be at the same resolution than SPOT, that is to say 10 meters.

Our approach which is based on photo-interpretation was reinforced by the introduction of the topographic map of the INCT (National Institute of Cartography and Remote Sensing, 1987) as well as 1/25000 of the ground truth. This map served as additional information for the 1987 Image. To this end, our images were incorporated into the GIS MapInfo to measure the temporal evolution of the urban space of Bir El Djir between 1987 and 2014. Based on the photo-interpretation supported our knowledge in the field, all open spaces have been digitized as polygons in two layers corresponding to the two dates (1987 and 2014). During this operation, each

polygon represents a frame unit without differentiating in urbanized areas

Therefore, in order to measure the urban evolution between the two dates, we applied an approach based on the overlay maps. This method was to eliminate in a first, common areas in order to extract a second extension or urban development between the two dates. Thus, this work has enabled us to quantify and geographically locate the built environment and changes in the dates (1987, 2014).

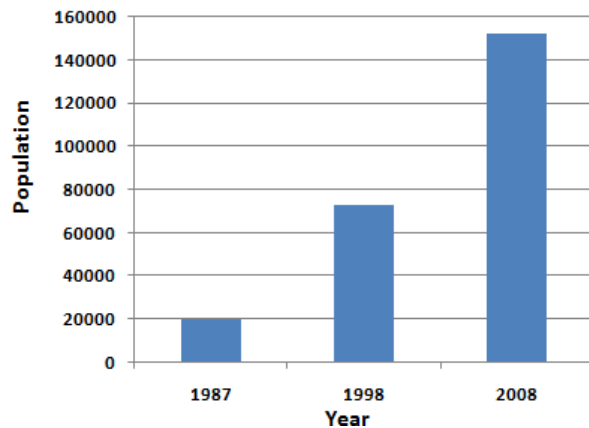


Fig. 2 Mapping Population growth of Bir El Djir from 1987 to 2008 [5]

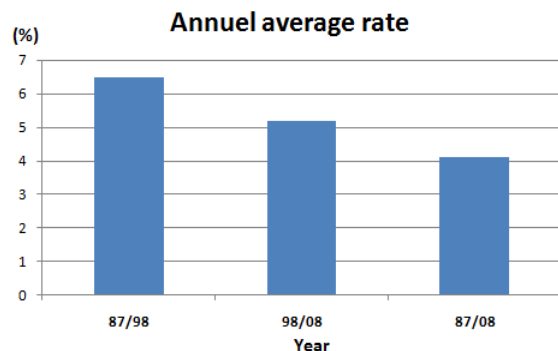


Fig. 3 Annual average rate of Bir El Djir from 1987 to 2008

TABLE I
UNITS URBAN AREA AND ITS EVOLUTION BETWEEN 1987 AND 2014

Township	Area (ha)	1987		2014		Expansion (ha)	Growth rate (%)
		Area urbanized (ha)	%	Area urbanized (ha)	%		
Bir El Djir	3903	265.5	6.8	1467	37.6	1201.5	452.5

The urbanized area of Bir El Djir in 2014 is estimated at 1467 hectares, an evolution of 1201.5 hectares compared to the urbanized area in 1987 (Table I) where the average annual urbanization rate is 16.8% in this period. Moreover, this municipality has known a sizeable urbanization of 452.5%, with in the period 1987-2014. This urban sprawl is mainly noticed on the Bir El Djir's periphery and is characterized essentially in different types: urban shantytowns, new construction in the form of spontaneous or peripheral precarious habitat, but also unstructured slums settled

especially in the southeast of town (Douar Sidi El Bachir and Ben Daoud) [4]. We also note the occurrence of two great universities: one in the south west (USTOMB at Hosni el Djiwar neighborhoods) and the other to the northeast (University of Oran2, Olympic Stadium at Douar Belgaid)

Other land invasions by new buildings are concentrated around the peripheral settlements as illegal allotment with an unstructured and uncontrolled spatial production. These districts form of individual habitats subdivisions of disadvantaged and middle classes are trained mostly without

formal management plan or compliance with planning standards, so they are "spontaneous" as opposed to "planned" neighborhoods. These houses concern in particular the extensions agglomerations of Sidi El Bachir, Douar Ben Daoud and Douar Belgaid (Fig. 4).

TABLE II
POPULATION EVOLUTION AND THE AVERAGE ANNUAL GROWTH OF BIR EL DJIR AND ITS ENVIRONS FROM 1987 AND 2008 [5]

Township	Population according to GCPH			Average annual growth		
	1987	1998	2008	87/98	98/08	87/08
Bir El Djir	20510	73029	152151	6.5	5.2	4.1
Oran	603931	634113	609014	0.4	-0.4	0.04
Sidi Chahmi	16935	58857	104498	6.5	4.4	4.0

As for Bir El Djir, extensions largely concern the new real estate constructions falling within the LSP, AADL and social housing programs (LSP: Social Housing Promotion, AADL: National Agency for Housing Improvement and Development) in USTO neighborhoods, Hai Yasmine and also by individual buildings (Hai El Emir AEK, Hai Khemisti, Douar Belgaid, Douar Ben Daoud, Sidi El Bachir). Note here that the town of Oran has almost exhausted its territory in terms of urbanized land in which, its estate housing construction programs (LSP, AADL) have been projected in the neighboring municipalities (Hai Hosni Djiwar and Hai Yasmine of Bir El Djir's municipality, Hai Sabah of Sidi Chahmi's municipality).

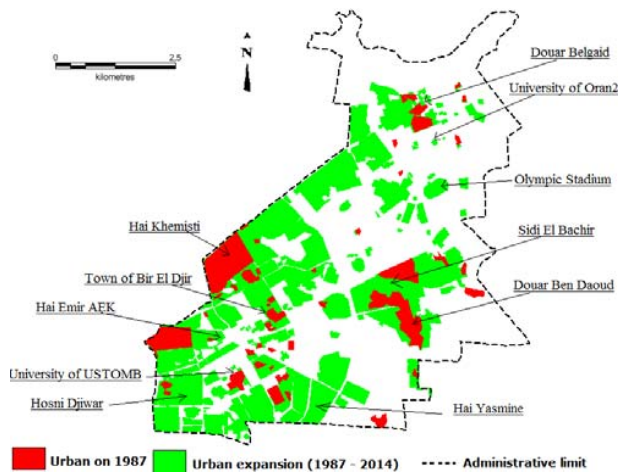


Fig. 4 Urban expansion of Bir El Djir between 1987 and 2014

C. Evolution of the Population and Its Impact on Urban Expansion

According to the last three censuses GCPH (Table II), the population of Bir El Djir has increased almost eightfold between 1987 and 2008 in which it went from 20,510 to 152,151 people. The decline in the annual growth rate for this group was mainly observed in the town of Oran. This can be explained mainly by the migration from the city of Oran and settling in the towns of Bir El Djir by the creation of new construction as residential habitats individual (real estate cooperatives, resettlements) and also collective habitats (LSP,

AADL, Social etc.).

It is important to note that if the population growth of the town of Oran stagnated between 1987 and 1998 (Table II) while its peripheral municipality as Bir El Djir is continually increasing know higher (Table II and Fig. 2).

This growth of Bir El Djir's population so significant and also the land saturation of Oran are causing the accelerated expansion of the urban periphery of these two cities which causing their conurbation [1]. However, Bir El Djir is the base for the major expansion of the city of Oran on the eastern flanks grouping and therefore the majority of social housing and promotional programs (Hai Yasmine, Hai Sabah, Hai Hosni Djiwar - USTO, Douar Belgaid) and also residential subdivisions and individual habitats (Hai Emir AEK Bir El Djir).

IV. CONCLUSION

In this study, we have indicated the potential use of Remote sensing data and GIS techniques in characterization of urban expansion of Bir El Djir.

However, the method of diachronic analysis, based on the comparison of satellite images, was used to assess urban dynamics during a given period. It also enabled by the comparison of results with analyzes of demographic data for the last three censuses, to better understand the impact of population growth on the extension of Bir El Djir's municipality [2].

During the period 1987 to 2014, the scale of the spatial extent of this agglomeration gives us an idea about the consumption of agricultural land. This consumption of new agricultural areas was carried out in particular on the conurbation of the city of Bir El Djir with Oran and Sidi Chami towns respectively in the west and south.

This period was characterized by a strong physical breakdown of planned and unplanned built in all nuclei of the urban periphery.

On the other hand, insufficient control of urbanization means spawned the emergence of new qualified unplanned neighborhoods "spontaneous" not obeying no formal management plan in which the absence of courses' official welcome these new urban settle illegally all free zones. Thus, this urban pressure force led to the urbanization of land increasingly inadequate (strong slopes, vacant land, agricultural land, outskirts ...) [3].

REFERENCES

- [1] Bendjelid A., Hadeid M., Messahel A. and Trache S. M., "Différenciations socio spatiales dans les nouveaux espaces urbanisés d'Oran," *Insaniyat journal*, no. 23-24, pp.7-44, 2004
- [2] Faour G., Haddad T., Velut S. and Verdeil E., "Beyrouth: Quarante ans de croissance urbaine," *Mappemonde*, no. 79: 3-2005.
- [3] Josse G. and Pacaud P. A., "Améliorer les quartiers précaires: Approches suivies au Burkina, Djibouti et Haïti," Research document of AFD, 2008
- [4] Lakjaa A., "Les périphéries oranaises: urbanité en émergence et refondation du lien social. Les Cahiers d'EMAM," 2009, no.18, pp. 29-44.
- [5] Office National des Statistiques (ONS), "L'armature urbaine RGPH 2008, Les principaux résultats de l'exploitation exhaustive. Collections statistiques no.163 série: S (ed) Vème Recensement général de la

- population et de l'Habitat (RGPH)", 2008, edition, National Office of Statistics. 2011, Algiers.
- [6] Mohan M., Pathan S. K., Narendrareddy K., Kandya A. and Pandey S., "Dynamics of Urbanization and Its Impact on Land-Use/Land-Cover: A Case Study of Megacity Delhi," *Journal of Environmental Protection*, 2011, Vol.2, pp. 1274-1283.
- [7] Wa Kayembe M. K. De Maeyer M. and Wolff E., Cartographie de la croissance urbaine de Kinshasa (R.D. Congo) entre 1995 et 2005 par télédétection satellitaire à haute résolution," *Belgeo*, 2009, no. 3-4, pp.439-456.
- [8] A. A. Belal, F. S. Moghanm, "Detecting urban growth using remote sensing and GIS techniques in Al Gharbiya governorate, Egypt," *The Egyptian Journal of Remote Sensing and Space Sciences* (2011) 14, pp. 73-79.

Zakaria Smahi was born in Oran, Algeria, in 1969. He received the B.S., M.S., in Remote Sensing and GIS from the national Centre of Spatial Techniques. He is a lecturer at University USTOMB of Oran (Genie Physique department, faculty of Physique). He has been teaching since 2006. His is a PhD student at Oran2 University at the Geography department.

Khadidja Remaoun was born in Fez, Morocco, in 1943. She is professor at the University of Oran2, Geography department.

Fatima Achouri was born in Oran, Algeria, in 1977. She is a PhD student at USTOMB University at the Civil Engineering department.