

THE SPATIO-TEMPORAL ANALYSIS OF URBAN EXPANSION OF BISKRA CITY (SOUTH EASTERN ALGERIA) BY THE USE OF LANDSAT SATELLITE IMAGES

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Abstract: Understanding urbanization and better management of the city implies a historical perspective of its dynamics. Urban extension which today is a major challenge, is materialized by a rapid urbanization of territories in the margins of cities. Its study in a medium sized city (city of Biskra) is an important issue where it requires monitoring and a detailed analysis of accurate and geolocalized informations. Our research is part of an approach which is based on the use of new geomatics techniques for better analyzing the dynamics of urban extensions. In order to spatialize and evaluate this dynamic, we used a series of Landsat satellite images of medium resolution with three different dates TM 1987, TM 2009 and 2014 for SCEA. The comparison of results obtained confirm that the urban area has increased from one year to another and that the city of Biskra has a medium level of urban sprawl.

Key words: Biskra, dynamic, extension, Landsat, spatiotemporal analysis,

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INTRODUCTION

The urban area of the world has expanded rapidly from 1970 to today. In 2008, half of the world's population began living in urban areas (Tewolde & Cabral, 2011). This population growth has caused a major expansion at the expense of surrounding farmlands, because the urban built was not always under control. In Algeria, the rapid growth of urban population representing 64% of the population in 2008, where it was of 49% in 1987 and 31% in 1966

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according to the general census figures of populations and housing (RGPH), this growth caused a significant uncontrolled extension. The phenomenon of urban sprawl is complex. First of all, it strengthens itself and it is difficult to distinguish its causes from its effects.

The urban sprawl is the advancement of the city on agricultural and forest areas, it is the transformation of the "*natural*" zones into built-up areas. Urban sprawl is also a process of social and functional differentiation of the city, resulting in a heterogeneous distribution and responding mainly to economic criteria and population activities in the territory. Any form of urban growth is not necessarily synonymous with urban sprawl; the urban sprawl is the propensity of urban areas grow and develop over much wider areas. While some use this term interchangeably with that of suburbanization, others distinguish: urban sprawl is an urban extension in continuity with the compact city while suburbanization is an urban extension in discontinuity.

However, urban sprawl, as a concept, is suffering from difficulties in definition (Barnes et al., 2001; Roca et al., 2004; Peiser, 2001) believes that the term urban sprawl is used to mean the space of the greedy and inefficient use, the monotonous development without interruption and discontinuity.

The city of Biskra occupies national ranking of the ninth city of Algeria (in terms of population) and is ranked at the top of urban stratum (S.U.S.). The city reached a growth rate of 2,15% between 1987 and 1998, and a growth rate of 1,5% between 1998 and 2008; with a natural increase of 37,08 %, reflecting the strong population growth of the city and as its main urban dynamic factor.

The pressure and population growth of the city of Biskra is not only due to natural increase, other reasons involved in this demographic dynamics; those are the rural exodus, internal and external migration dynamics. On the contrary, the rural population showed a decrease of 68% in 1966 to 33% in 2008 related to the transformation of the relations between town and country (immigration and the transfer of rural population to urban centers).

Therefore, the extension of the city is faster than population growth and the consumed area per capita increases. In this framework and to control urban growth and to minimize the caused problems, policymakers should obtain accurate spatial data to detect the growth of this city and develop strategies for monitoring and environmental management. These strategies must be based on technological performance (Garouani, 1993; Benmessoud, 2011).

The application of remote sensing has made possible the study of the occupation and land use in less time, at lower cost and with great accuracy (Kachhwaha, 1985).

Currently, Landsat satellite imagery is an important source of information for observing the Earth surface because of its digital nature, repetitive and availability.

The objective of this study is the analysis of spatio-temporal evolution of land use, especially the extension of the city of Biskra, from the processing of Landsat satellite images of different dates; 1987, 2009 and 2014.

PRESENTATION OF THE STUDY AREA

The study area is part of the Wilaya of Biskra, which is between the Tell and the big Sahara of Algeria, it occupies the northern part of the South East region of the country.

The Wilaya of Biskra covers an area of 21,671.20 km², currently account 12 dairas and 33 municipalities.

Biskra occupies a strategic position that gives it synonymous with desert door of Algeria. The city of Biskra is part of a fertile oasis to the southwest of the massif of the Aures. It is considered as an important economic and intellectual center, even was a trading center for the nomads of the region.

The cultivation of fruits (dates, olives, apricots and pomegranates) is a dominant activity, but also its mild climate has made it a popular health resort. The climate of Biskra is defined by two variable seasons with a short season of comfort; hot and dry in summer, cold and wet in winter.

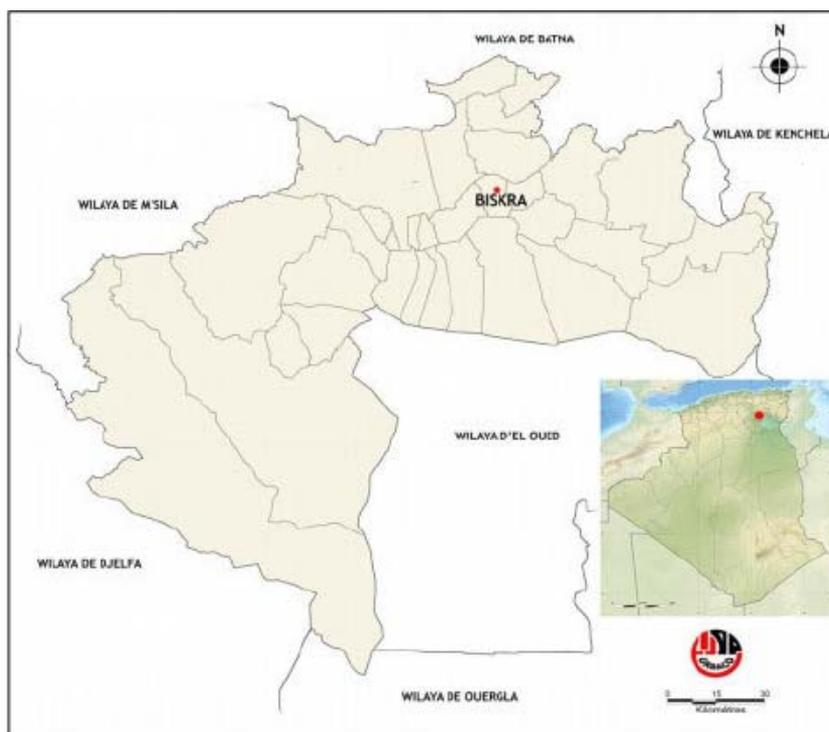


Figure 1. Location of the study area

MATERIALS AND METHODS

We used for this diachronic study three Landsat satellite images of 30x30 m resolution; the first dating 6 May 1987; the second dated 15 April 2000 and the third dated 16 May 2014. We opted for a color composite channel 432 for images TM 1987 and 2000, instead of 543 for the image LDCM, 2014, which allows us to clearly identify the different units of Land Use compared to other colored compositions. Based on the visual interpretations and especially the knowledge of the reality of the field (Bouhata et al., 2015), we defined three classes of land cover, (Buildings, Palmary and bare soils). This choice is made in a way to allow better identification of the city, and its extension in reference space-time.

Pan-Sharpning

Generally, the Pan-sharpening is defined as a combination of two or more different images to form using an algorithm a new image (Manfred et al., 2010). The aim of image fusion is to integrate complementary data in order to obtain more and better information about an object or a study area than can be derived from single sensor data alone (Sarup & Singhai, 2011).

In our work the pan-sharpening is to merge a panchromatic image (band 8) at high spatial resolution (15 m) obtained by the LDCM sensor with a multispectral image of medium spatial resolution (30 m) also obtained by the same sensor and the result produced a multi-spectral image with the same resolution as the panchromatic image. A supervised classification based on the method of maximum likelihood, was used on the previous two colored composition images using the image processing software (ENVI 4.5). This method is considered as a powerful technique for classification. The rule of the decision of this method is based on the probability of a pixel belonging to a given category (Fojstng, 1999) and (Omar et al, 2014). The average performance of classifications is 95,2% for the classification of TM 1987, 96,1% for the classification of TM 2000 and 96,3% for the classification of 2014 LDCM.

According to (Rupali & Karbhari, 2015), when $0,81 < Kc < 0,99$, it means that our results are statistically perfect (table 1).

Table 1. Validation the results of classification by good values of GP and KC

Matrix of Confusion	Global Precision (GP)	Kappa Coefficient (KC)
Confusion Matrix 1987	0,952	0,892
Confusion Matrix 2000	0,961	0,932
Confusion Matrix 2014	0,963	0,952

RESULTS AND DISCUSSIONS

The results of supervised classification of Landsat satellite images TM (1987), Landsat TM (2000) and Landsat LDCM (2014) by the maximum method likelihood will appear as follows: (figure 2, 3 and 4).

The analysis results to determine the occupation surfaces for this built class are presented in the following table (table 2.)

Table 2. Evolution of the area of Biskra city in 1987, 2000 and 2014

Year	Area (ha)
1987	1080,03
2000	1311,31
2014	1655,97

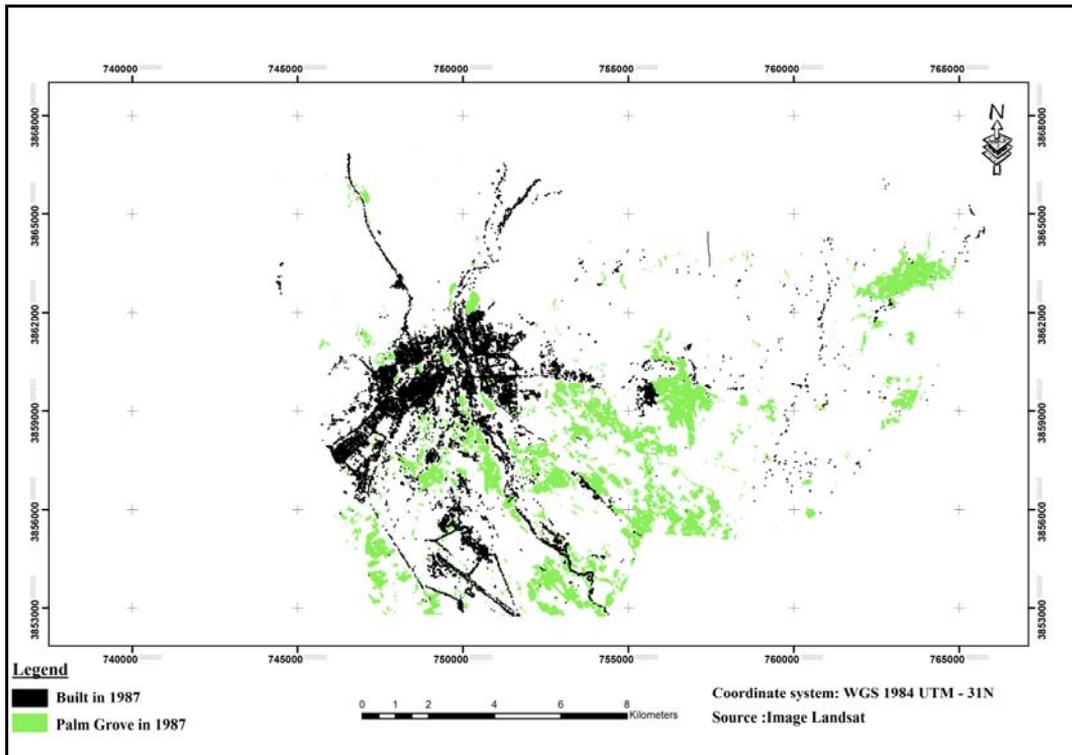


Figure 2. Thematic map of land occupancy in Biskra city in 1987

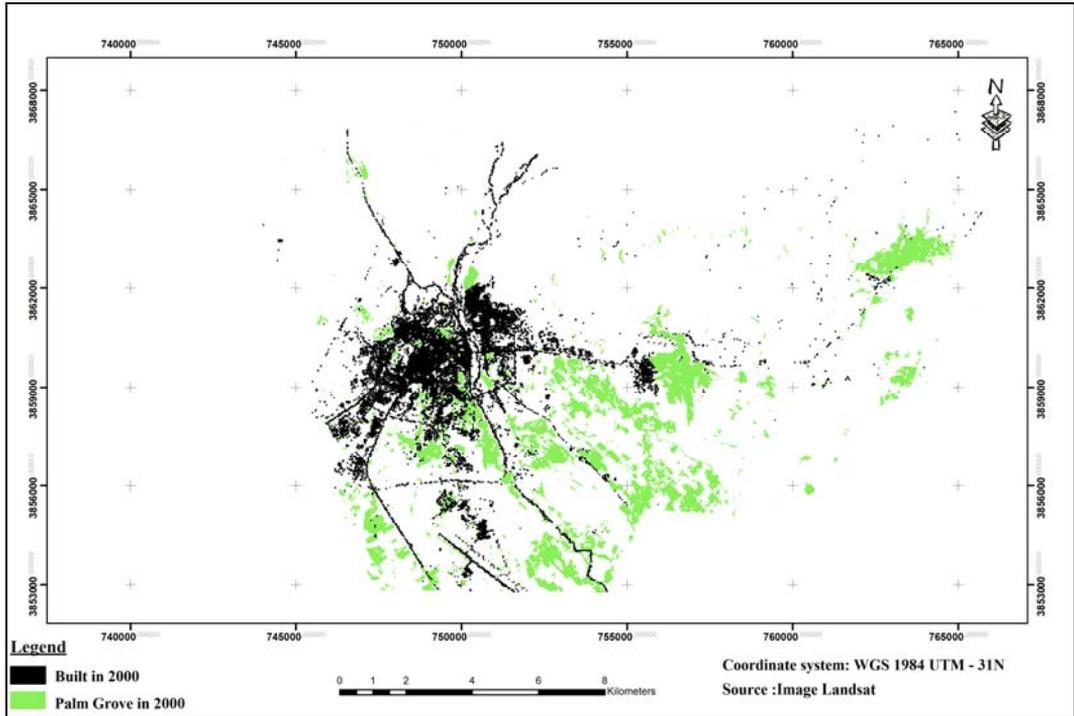


Figure 3. Thematic map of land occupancy in Biskra city in 2000

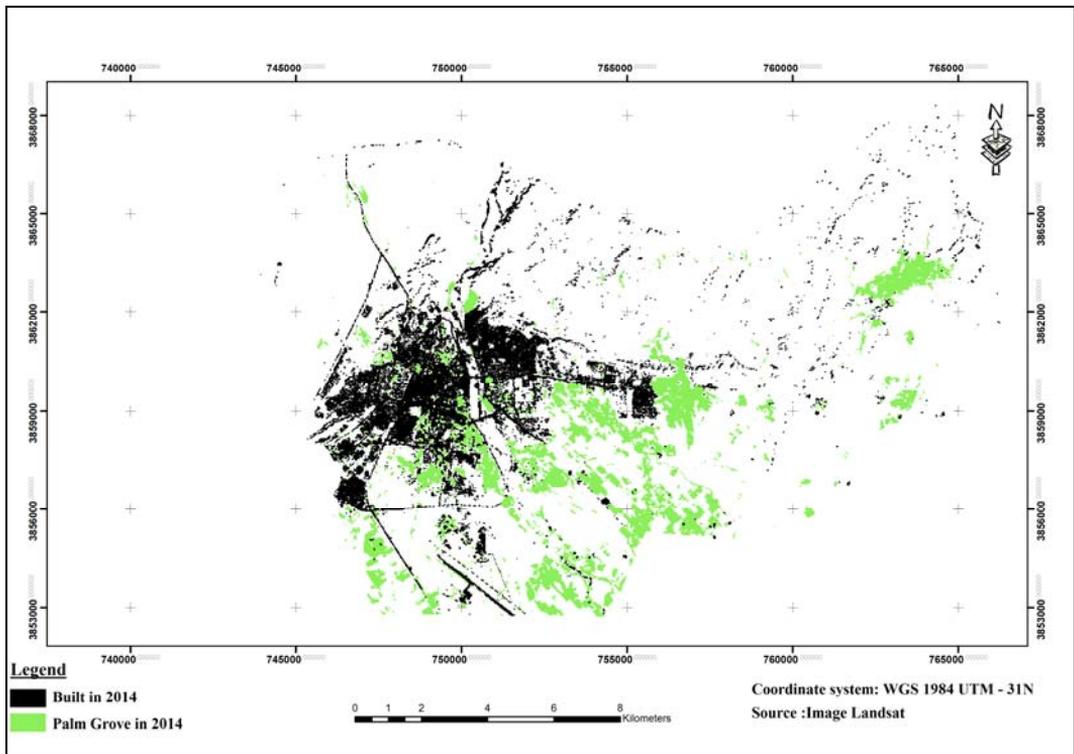


Figure 4. Thematic map of land occupancy in Biskra city in 2014

The area of the city of Biskra increased from 1080,03 ha in 1987 to 1311,31 ha in 2000 and over 1655,97 ha in 2014; that makes it of 38,71% of rate. This means that there is an increase in land demand each year, the Biskra city is in need of 24,5 ha each year for its extension. This expansion and urban growth is a logical response of a population growth that is marked in both periods (from 129,611 inhabitants in 1987, 172 905 inhabitants in 1998 to 223 492 inhabitants in 2011). It was accompanied by a national policy mainly based on the principle of "*planned economy*" and "*industrialization*". Security conditions that Algeria had known in the 90s led to record 60% of migratory entries came from the northern provinces of Algeria, 28% from internal (municipalities and towns of the Wilaya), and 15 % entries from Sahara, which implies a considerable increase of the urban system of the city. The change detection approach helps to better assess the socio-spatial changes that occur over a territory. To do this, vectorization and layering Multi dates builds (figure 5) are an excellent source of information for determining the size and trend of urban dynamics of Biskra city.

The most interesting extensions are made by building ZHUN (new urban habitat area) to the east of the city and ZHUN to the west of the city. In the mid-1980, the city has seen an expansion in the planned tissue of which the most important equipments are: parks area at the ZHUN East, the industrial area at the ZHUN West and the equipment areas to the North of the city. The important event of this phase is undoubtedly the appearance of the planning land. In 1981 there's been the creation of the National Agency for Planning (ANAT), which deals with the development of the national plan of land use plan in particular, and in 1990 there was an enactment of 03 important laws: the Law 90/25 of 11/18/1990 carrying the land orientation, the law 90/29 of 01/12/1990 relating to planning and development, and the 90/30 law of 01/12/1990 relating estate law. The constitution of the municipal property portfolio must be in accordance with urban planning instruments and determining the scope of reserve requirements as a first condition.

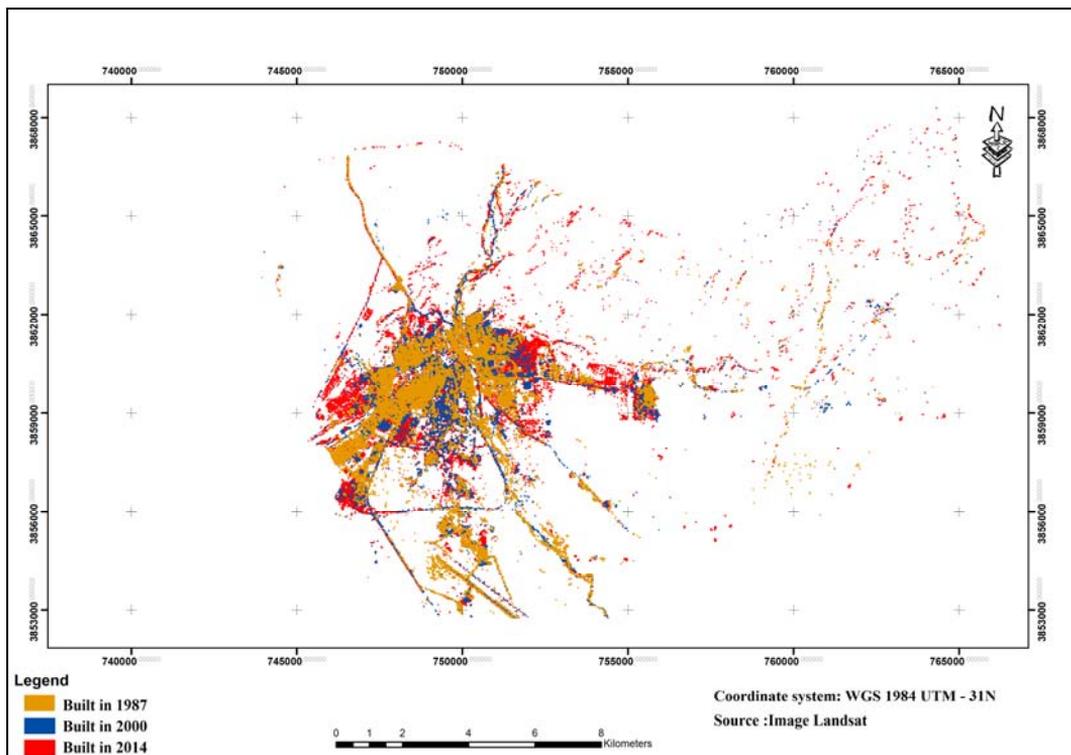


Figure 5. Map synthesis of urban sprawl in Biskra City between 1987, 2000 and 2014



Figure 6. Highlighting the increased surfaces built in the northern part of the city of Biskra, in 2013 and 2016

CONCLUSION

The main objective of this study is to test the ability of this type of multi-date images from the Landsat satellite to identify the contours of the urban fabric, which led us to evaluate the spatial and temporal spread of the city.

The spatio-temporal analysis of urban expansion of the city of Biskra for the period from 1987 to 2014, using space imagery and GIS reveals a major spatial growth. This extension and the new urbanization of Biskra urban group is manifested by the excessive extensions of peripheral settlements in one hand and in the other hand by the proliferation of informal habitats.

This study illustrates concretely the operational advantages offered by the processing of satellite images, combined with the use of GIS in the approach and analysis of urban areas. Thus, these techniques are very useful in the absence of updated mapping or rare or unreliable statistics, especially in many developing countries.

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