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Detection of urban spot in the plain of Mina (Western Algeria)

Hartani Ahmed[1*], Baghdadi Djillali[1], Anteur Djamel[2] & Benaradj Abdelkrim[3]

[1]Department of Biology, Institute Of Exact Sciences And Sciences Of Nature And Lifes, Ahmed Zabana University Center, 48000 Relizane, Algeria - Biodiversity and Water and Soil Conservation Laboratory
[2]Department of Natural Sciences and Life, Institute of Sciences, Salhi Ahmed University Center, 20000 Saida, Algeria
[3]Laboratory of Geomatics and Sustainable Development (LGEO2D), University Ibn Khaldoun, Tiaret, Algeria
[*]Corresponding author, e-mail: hartani81@gmail.com

ABSTRACT During the last three decades, the plains of the Oued Cheliff watershed, have been affected by the decisions of the State which tried to change its development policy. This has put these plains in a state of transformation, whose rate of population has increased by causing greater worries such as consumption, employment, and housing needs. The latter has affected this environmental space and its agro systems by reducing the area of its most fertile lands and the pollution of the places that use its natural resources. In order to do our studies, we have chosen the Mina plain, which is part of a space that is in full change with regard to its physical environment, its demographic and economic aspect while acting on its agro systems. This study will develop a methodology, based on the integration of satellite images and cartographic data into a geographical information system (SIG) for the identification and mapping of urban extensions on agricultural land in the Mina Plain.

KEY WORDS Mina; plain; Detection; SIG; Urban; Algeria.

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INTRODUCTION

Urban growth in Algeria is developing in a brutal way, as it is continuing at a high pace (Bounouaet al., 2009; Tiliouine, 2009). This complex evolution of the sites to the sprawl of the city reacts on the urban landscape, both on the architectural plan, the habitat types, and on the organization of the fabric (Echenique et al., 2012; Jaeger et al., 2010). Urbanization has made an astonishing leap in recent years (Ma et al., 2018; Møller et al., 2011; Seto et al., 2011), not only because of the increase in the urban population, but also because of the abandonment of rural dwellings (Chen et al., 2018; Liu et al., 2010). The latter has affected all Algerian cities, as well as their communes; the latter have experienced an accelerated evolution of the urban fabric (Bellal, 2009; Lawless, 2015).

For a phenomenon that evolves rapidly over time such as the urban environment, the availability of recent and updated information for better urban space management is necessary (Burak et al., 2004; Zhang et al., 2003). This has encouraged the use of remote sensing space data (Krishnamurthy & Srinivas, 1995; Kustas & Norman, 1996). The possibility of acquiring time series of images, covering the same region several times in the year, makes this technique appear as a tool suitable for monitoring an area and studying significant changes (Butt et al., 2015; Haque et al., 2017;

Sinha & Ghosh, 2012). To choose a method of analysis adapted to the problem, it is important to know the type and nature of the information present in the image (Freire et al., 2014). The analysis of the thematic content of satellite images provides a better understanding of the interest and limitations of the methods traditionally used to extract the desired information (Xie et al., 2008; Hussain et al., 2013).

Urban sprawl alters land use and rural features, threatens peri-urban agriculture, and has environmental consequences. It disrupts ecosystems and poses a serious threat to biodiversity. Thus, the city destroys nature either directly, by the destruction of natural habitats, or indirectly, by the fragmentation and isolation of natural sites. The study of urban sprawl represents an important challenge for understanding the effects of urbanization on ecological processes, not only in large urban cities, but also in small and medium-sized urban areas, which play a major role in today's urban growth and, in so doing, urban sprawl. In the current context of accelerated and quasi-generalized land artificialization, the assessment and anticipation of the impacts of urban sprawl are of interest to both scientists and land managers. The latter has affected all Algerian cities without exception, among them the agglomeration of Relizane, which has experienced an accelerated evolution, concentrated in the peripheral areas, which has a profound impact on the overall structure of the city and its operation. This new dynamic, begins to pose huge problems of degradation of agro systems in the Mina plain, and in order to properly manage the urban spot we have proposed this study using the necessary remote sensing treatment for the extraction of spatiotemporal changes and agro system imbalances. The methods chosen for this study are the cuirass index method that helped us extract the urban envelope and quantify the extension of urban tissue, as well as the visual interpretation method for estimating degraded areas. At the end of this study, it appears that the cuirass index makes a contribution, quite efficient to the mapping in the case of these studies. In order to coordinate the research and applications of this new method, the main objective of our work is to show to what extent satellite images are suitable for the detection and mapping of the artificialized spot at the scale of our study area.

MATERIAL AND METHODS

Geographical location

The Mina plain is an agricultural plain located in the wilaya of Relizane in the northwest of the country (Fig. 1). The name of the plain comes from the wadi Mina, a river that descends from the massif of the Ouarsenis in the region of Tiaret to throw itself in the valley of the Oued Cheliff. It is bounded to the north by the Lower Cheliff plain, to the west by the Ghriss plain, to the east by the limestones of Zemmoura and the Saida plateau to the south. It is located in the continuity of the basin of the Oued Cheliff at its extreme west as a contiguous pocket of the plain of the Bas-Cheliff. It is separated from it in the northeast by the saline and the Benzian Sebkha Plateau is 1,600 hectares in size. It is separated to the west of the Macta-Habra plain by the Yellel bombement and circumscribed to the north by the djebel Belassel, to the south and to the south-west

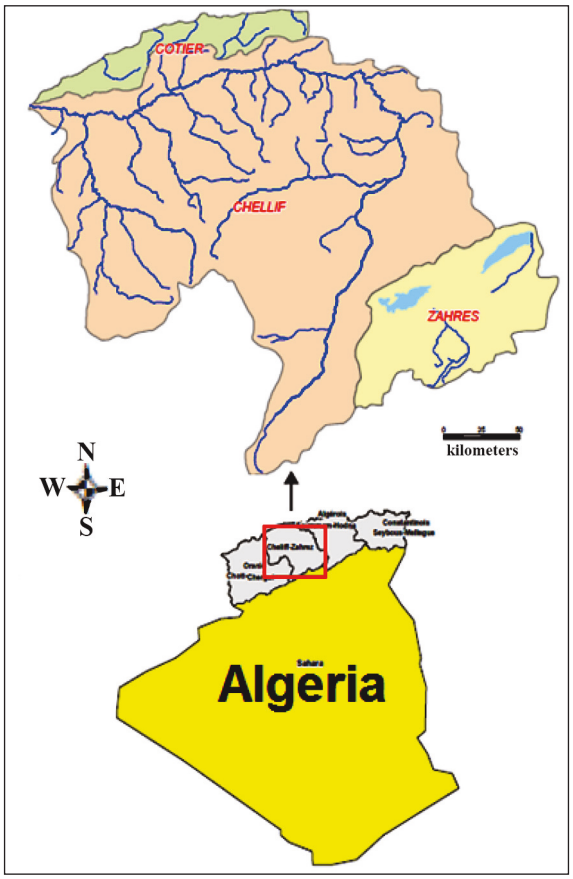


Figure 1. Geographical location of the study area.

by the foothills, the Ouarsenis and the Beni-Chougrane mountains. The plain of the Mina covers 6 communes of the wilaya of Relizane for an approximate area of 340 km^2 or nearly 7% of the area of the wilaya. The municipalities concerned are Yellel, El Matmar, Relizane, Belassel, Zemmora, Oued El Djemaa.

Climate Characteristics

Climate is a component of the physical environment. It is an essential factor in plant development, soil formation and evolution (Greco 1966; Kearney & Porter, 2004). The watershed of the Oued Mina is subject to a pronounced summer drought and suffers from a rainfall deficit which gives irrigation a mandatory character. This area enjoys a continental climate due to its position in a basin surrounded by mountains. The study area is characterized by an arid climate with a prolonged dry period (six to seven months) in which sirocco is felt. It is also characterized by the wind speed, which, despite being low, can present a threat, given the low vegetation cover and which exposes the plateau to the risk of evapotranspiration, which will require it to be reported and taken into account when selecting crops for climatic requirements (Baghdadi et al., 2016).

Population evolution between 1977 and 2008

The elements of characterization developed below illustrate a clear evolution of the population at the level of the wilaya and the plain of the Mina in particular during the different intercensal periods. Changes are recorded in terms of numbers and rate of increase; structure; and spatial distribution between municipalities, between agglomerated and sparsely populated areas and between main and secondary conurbations.

According to general population and housing census (GPHC) (Table 1), the population of the region has evolved strongly during the various population censuses of 368,512 inhabitants carried out since 1977 and reached the number of 754,505 inhabitants in 2018. During the period 1987-1998, the population of the Mina area increased at a higher rate compared to the wilaya average for the same period. Its population increased from 178,525 in 1987 to 233,139 in 1998 with an increase of general growth rate (GGR) of 2.39%. In the same period,

Parameters	Wilaya of Relizane	Mina plain	Algeria
GPHC1987	542577.00	178525.00	22714320.00
GPHC1998	642205.00	233139.00	29100867.00
GPHC2008	726180.00	271609.00	34080030.00
GGR between GPHC1987-1998 (%)	1.50	2.39	2.28
GGR between GPHC1998-2008 (%)	1.24	1.58	1.59
Surfaces (Km²)	4870.00	680.22	2381741.00
Population density (Hab/Km²)	149.11	399.29	14.31

Table 1. Population changes in the Mina plain 1987–2008 (National Statistics Office, 2013).

the wilaya of Relizane experienced an increase below the national average. The population rose from 545,061 in 1987 to 642,204 in 1998 with an increase of 1.50%, lower than the national rate of 2.28%. This rate of increase in wilaya (below the national average and the study area) is probably linked to the demographic characteristics of the North-West region (lifestyle influencing demographic behavior) conditioned by socio-changes and may also be linked to the security situation in mountainous areas forcing people to flee to the most secure areas (plains).

In the period 1998-2008, the trend of the population slowed down the increase in volume. The contribution was only 38,470 people. An annual contribution of 3,847 people per year compared to 54,614 people (an annual contribution of 5,416 people) for the previous period. The same rate of change was recorded at the wilaya and national level. The average rate of increase recorded in the Mina plain at that time was 1.58% against 1.24% for wilaya (still below the national rate) as well as the previous rate of wilaya. It should be noted, however, that the gap in terms of growth rate is starting to narrow between the wilaya and the national level.

The trend towards the decline recorded over the last decade shows that there has been a change in demographic behavior, through the decline in the birth rate, the fertility rate and the decline in marriage. On the other hand, the painful events that the mountainous areas experienced during the black decade, promptef some of these populations to emigrate to other regions, contributing to the decline in the rate of increase. The downward trend in the rate of increase over the last decade (1998 and 2008) is also observed in most municipalities in the study area and wilaya.

Economic characteristics

The main economy of the wilaya of Relizane is generated, in large part, by agricultural activities and the agro-food sector. The wilaya of Relizane has two industrial zones. The first in Relizane and the second in Oued Rhiou. As far as the areas of activity are concerned, about ten are recorded through the different communes of the wilaya. The main industrial activities are: the sanitary taps production complex of Oued Rhiou, the dairy complex of Sidi Saada, the manufacture of knitted and crocheted articles and the food canning plant in Relizane, the extraction, processing and packaging of salt in Oued Djemaa, the mills of Relizane (semolina) in Relizane, the manufacture of concrete channels in Oued Rhiou.

The Wilaya of Relizane, which is currently undergoing a demographic transition, translating into a rejuvenation of its population, whose age group representing the labour force aged 15-60 has reached 65%, or slightly above the national average, implies ever-increasing employment needs. This informs us about the importance of the economic stake, not only for job creation, but also to reposition the wilaya in the economic map of the region in order to prepare this territory for attractiveness.

The agriculture of the wilaya of Relizane is very diversified, as it includes field crops with an area of 40,000 ha including 120,000 ha cereals and 10,000 ha market gardening; perennial crops (arboriculture and viticulture) represent 7.05% or 19,900 ha including 2,128 ha of vine, fallow, covers an area of 1,119,751 ha (Director of agricultural services 2010). The total agricultural area (SAT) of the wilaya is 297,387 ha of which 281,875 ha of SAU, or 57.8% of the total area of the wilaya. These indicators tell us about the agricultural vocation par excellence. It ranks 12th at national level with 3.36% of the national UAA and 1.80% of the irrigated area.

For the study area, the SAT is 71,298 ha, of which 68,022 ha are UAA (95% of SAT and 70% of the area), it represents 22% of the agricultural useful area of the wilaya and nearly 50% (12,776 ha) of the irrigated area, the main agricultural products are illustrated in the Table 2.

As the Table 2 shows, for field crops, artichokes and peas are the reference crop for this wilaya. The artichoke crop is irrigated while the peas are dried. Melon production is also important in this region. For the arboriculture, Relizane is known for its olive and citrus production. These two crops occupy most of the land on the Great Irrigation Perimeters (GPI). The total irrigated area for the 2012/2013 season is of the order of 25,930 ha including 12,000 ha in the 02 GPI (Mina and Bas Cheliff) and 13,930 ha in the Small and Medium Hydraulic (PMH), more than 12,900 ha are irrigated in the Mina plain.

Speculations	Artichoke	Peas	Citrus	Olives
Rank at the national level	1	4	6	6

Table 2. National Agricultural Position of the wilaya of Relizane (Ministry of Agriculture and Rural Development, 2013).

Agricultural employment is in the order of 70,000 permanent jobs for 2012/2013. In 2005, it accounted for 61,000 permanent jobs, an increase of 15%. The wilaya of Relizane is divided into four agricultural regions namely:

The massif of Ouarsenis, covering 47% of the territory of the wilaya with 22% of the population (156,136 hbts) and an UAA of 120,600 ha, has a ratio of 0.77 ha/hbt. However, with the practice of a biennial rotation, each year, nearly 50% of the UAA is left fallow.

The Massif des Béni Chougrane occupies 10% of the area where 4% of the population lives (30,254 hbts) and an UAA of 28,568 ha, a ratio of 0.94 ha/hbts. A region where cereal crop rotation is practiced – Fallow.

The Dahra Mountains occupies 9% of the territory and 14% of the population (103,528 hectares) and an UAA of 21,731 hectares or a ratio of 0.21 ha/hbts. This region develops more intensive agriculture than the two southern massifs with mixed grain farming, fodder, arboriculture, viticulture.

The Cheliff plain area (La Mina and Lower Cheliff plain) covers 34% of the territory with however 60% of the population (436,264 Hbts) and an UAA of 110,996 ha or a ratio of 0.25 ha/hbt. Much of the UAA in this area (80,000 ha) is reserved for herbaceous crops while only 12,000 ha is allocated for perennial crops. The practice of fallowing represents less than 17% of the UAA. The Mina Plain UAA is

68,022 ha or 60% of the Cheliff Plain area, with a population of (271,605 hbts) or a ratio of 0.25 ha/hbt. Only 12,905 ha has been irrigated for the 2012/2013 irrigation season, a ratio of 0.18 ha/hbt. Taking into account the landscapes mentioned above we can distinguish two types of agriculture, intensive agriculture at the level of the plain and the Dahra of low mountains and extensive agriculture in the rest of the country. The plain of the Mina, which includes 8 communes, counts 8,321 agricultural holdings with an area of 68,022 ha (Table 3).

The cultures practiced in the plain of Mina are diverse, often associated with the breeding. The main products are fruit, market gardening, cereals and fodder crops; livestock farming concerns sheep, goats, cattle and small livestock such as poultry and beekeeping and cuniculture. Our study space has a great cereal and arboreal vocation that extends over the high and medium plains, among them are the plains of Lower Cheliff and Mina which present the most fertile land and the most important irrigated perimeters in this region. The plain of the Mina enters the administrative area of the Wilaya of Relizane, which led us to present this Wilaya for the description of the characteristics of the physical environment in this region. The land in our study area is mostly agro-pastoral and agriculture is very diversified, as it includes field crops with an area of 40,000 ha including 120,000 ha cereals and 10,000 ha market gardening; perennial crops (arboriculture and viticulture) represent 7.05% or 19,900 ha including 2,128 ha of vines, the fallow covers an area of 1,119.751 ha.

In the study area, private sector land represents 82% of farms and they occupy more than 62% of the useful agricultural area, in second position, EAI and EAC (Individual and Collective Agricultural Exploitation) land represents 9% of farms and nearly 34% of land. Together, these two land statuses represent 91% of farms and 96% of land (Figs. 2, 3).

For sheep, too, the wilaya ranks in 20th place with nearly 2% and also 60% of the workforce in the plain. Over the years, livestock farming has become an activity that structures the rural world of the plain thanks to the programme of rural development and rehabilitation of livestock infrastructure on the one hand and the financial and technical support of livestock farming on the other hand, but its importance has not reached the level of the agro-pastoral region. Sheep breeding remains dominant. However, it shows a significant increase compared to previous years of 106,204 heads. Cattle breeding apparently followed the same trend, with 7,510 heads (Table 4). Finally, poultry and beekeeping remain activities to be developed, taking into account the environmental conditions (tree orchards, etc.), technical and financial support and their role in rural development. The economic bases of the Mina plain are currently crystallizing around agricultural activity and livestock (agro pastoralism) as the main levers of local rural development creating jobs.

Municipalities / Agricultural Regions	Surface (ha)	Useful Agricultural Area (U.A.A)		Pastures and courses	Unproductive lands	Total Agricultural Land (T.A.L)
		Total	Not irrigated			
Relizane	11047.00	8537.00	2148.00	400.00	144.00	9 081.00
Bendaoued	11553.00	7211.00	1128.00	59.00	200.00	7 470.00
Oued El Djemaa	18118.00	14450.00	1891.00	335.00	300.00	15 085.00
El-Matmar	5297.00	4977.00	1484.00	100.00	100.00	5 177.00
Yellel	11592.00	9824.00	3954.00	222.00	100.00	10146.00
Sidi Saada	7324.00	6593.00	551.00	26.00	140.00	6 759.00
Belaassel Bouzagza	13755.00	6722.00	1050.00	60.00	250.00	7032.00
Sidi Khatteb	18185.00	9708.00	700.00	140.00	700.00	10548.00
Mina plain	96871.00	68022.00	12905.00	1342.00	1934.00	71298.00

Table 3. General Land Distribution in the Mina Plain (Directorate of Agricultural Services-Relizane).

URBAN SPOT DETECTION METHODOLOGY

The detection and identification of land use mutations in our study area is based on a combined use of data. It integrates procedures for image processing (satellite data), visual interpretation and exploitation of cartographic data using a geographical information system. This approach requires an urban spot detection technique. Classifying urban areas on satellite images is a complex task, as these images do not exhibit a unique and distinguishable spectral response (Tran et al., 2011). Many researchers have already presented methods to improve the classification of urban areas using remote sensing data. These pixel-based methods are very diverse and vary depending on the data used and the study areas on which they are applied. They are also difficult to categorize because they are a mixture of methods for extracting information from images (Cabral et al., 2007). These approaches include, in the classification process, incorporation auxiliary information such as spatial data (Harris & Ventura 1995; Zhang et al., 2012), population census data

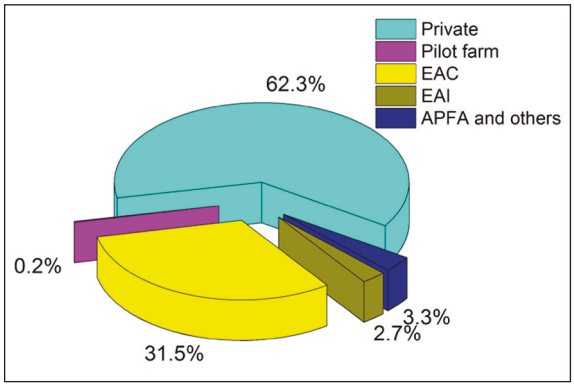


Figure 2. Legal distribution of agricultural land in the study area Mina plain.

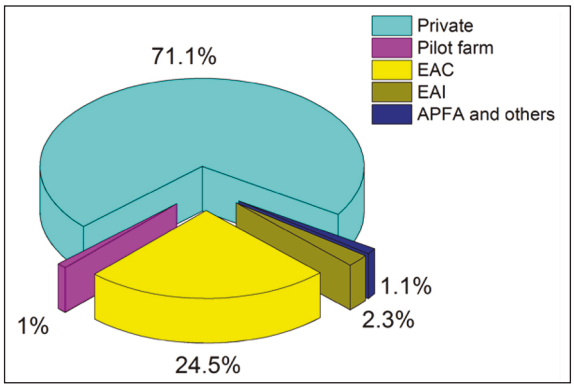


Figure 3. Legal distribution of agricultural land in the study area Wilaya of Relizane.

	Livestock (heads)							Small farms		
Communes	**Cattle**	**Dairy cows**	**Sheep**	**Female**	**Goats**	**Female**	**Equin**	**Pulped chicken**	**Hens**	**Beekeeping (Ruches)**
Relizane	1 374.00	997.00	17 858.00	7 610.00	205.00	94.00	275.00	106 875.00	11 815.00	1 472.00
Bendaoued	613.00	380.00	13 416.00	4 247.00	256.00	139.00	450.00	662 625.00	254769.00	221.00
Oued El Djemaa	876.00	319.00	20780.00	7 698.00	418.00	228.00	360.00	35625.00	0.00	1631.00
El-Matmar	741.00	436.00	6249.00	3761.00	353.00	250.00	107.00	71250.00	11815.00	54.00
Yellel	790.00	210.00	9588.00	5203.00	395.00	249.00	510.00	111488.00	17723.00	82.00
Sidi Saada	784.00	245.00	8486.00	4618.00	318.00	195.00	421.00	344375.00	0.00	57.00
Belaassel Bouzagza	1182.00	887.00	14244.00	13272.00	596.00	488.00	205.00	95000.00	66462.00	224.00
Sidi Khatteb	1150.00	873.00	15583.00	11857.00	708.00	610.00	196.00	106875.00	34462.00	354.00
Mina plain	7510.00	4347.00	106204.00	58266.00	3249.00	2253.00	2524.00	1534113.00	397046.00	4095.00

Table 4. Large and small farms.

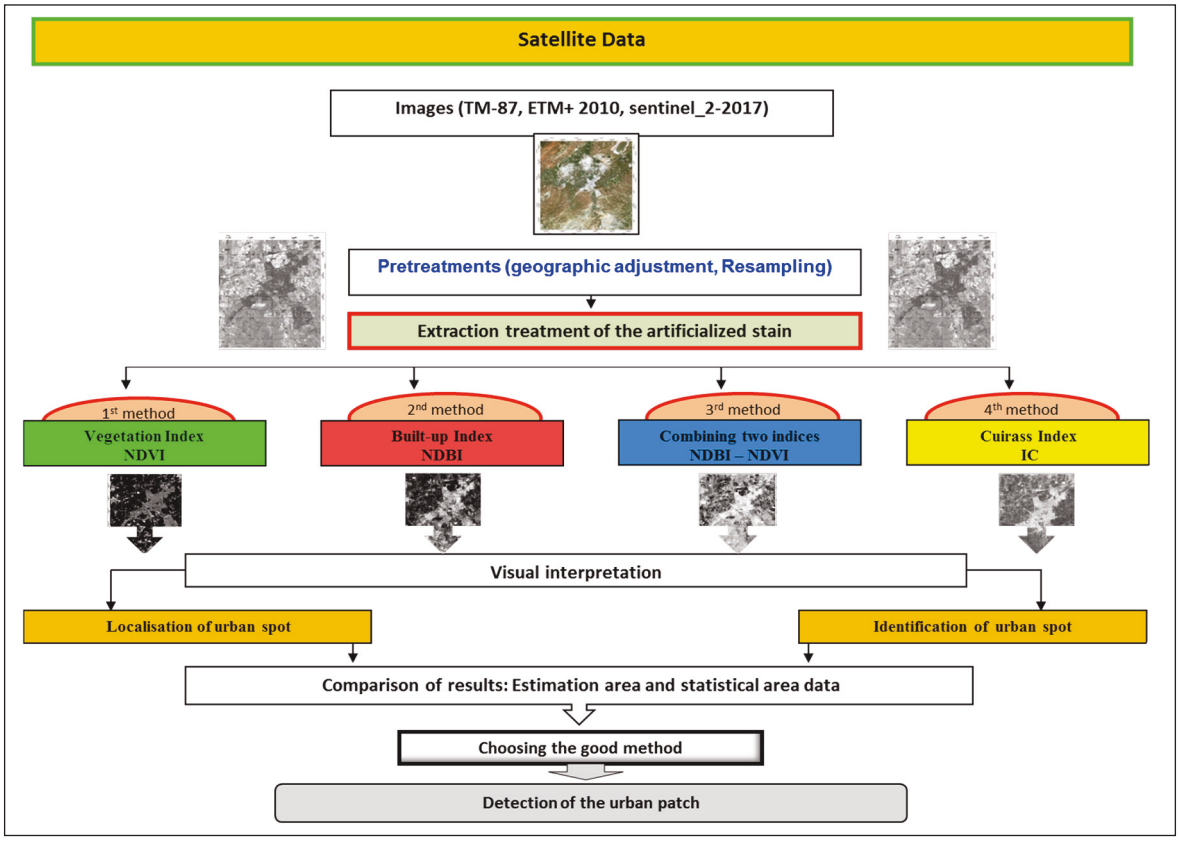


Figure 4. Methodological chart for urban spot detection.

(Mesev, 1998), and contextual data (Freedman et al., 2002; Gong & Howarth, 1990; Kolominsky-Rabas et al., 2001; Shaban & Dikshit, 2001; Wylie et al., 2005).

Other authors propose the use of indices (Angert et al., 2005; Sears & Zha, 2003), the analysis of mixed spectra (Phinn et al., 2002; Weng et al., 2004), and the use of expert systems (Stefanov et al., 2001) or the use of neural networks (Civco & Hurd, 1997; Zhang & Foody, 2001). In summary, there is no method considered the best method to delineate urban areas from the different types of urban landscapes that vary geographically and exhibit diverse material compositions (O'Connell et al., 2020). In this step, we will follow the different methods of identification of the urban spot mentioned in the Fig. 4.

Normalized Vegetation Index Reverse Mask

In this index method, we applied a reversed mask on the NDVI image where we keep the low value pixels (-1 to 0) which represent the non-vegetation areas, which are considered as the urban spot. NDVI consists of subtracting from the infrared channel (where the vegetation cover has strong reflectances) the red channel (where the mineralized surfaces have strong reflectances).

$$NDVI = PIR\text{-}R/PIR+R$$

Where *PIR* is the near infrared channel and *R* is the red channel.

Normalized Difference Built-up Index (NDBI)

Several building indices can also help in the extraction of buildings, such as the ISU index (Amiri et al., 2020) which is a built surface index and must be complementary to the *NDVI* (Normalized Difference Vegetation Index) and highlight buildings. In our case based on Landsat and Sentinel-2 images (Fig. 5) the use of the *NDBI* index is possible be-

cause it requires the *MIR* band that is available in these two satellites.

The Normalized Difference built-up Index (*NDBI*) (Fig. 6) is based on the fact that urban areas generally have a higher reflection in the MIR band than in the PIR band (Zha & Ni, 2003). The *NDBI* is an index used to map bare and artificialized lands. It was calculated using spectral bands of the Landsat satellite and sentinel-2, whose output values are between -1 and 1 (like *NDVI*). This index highlights urban areas where reflectance is generally higher in the short-wave infrared (*SWIR*) region than in the near-infrared (*NIR*) region. In our case, the *NDBI* was used to extract the urban or artificialized spot (Fig. 7).

NDBI = SWIR-NIR/SWIR+NIR

Where *SWIR* is the short wave infrared and *NIR* is near infrared.

The application of this index (*NDBI*) allowed us to determine the urban area by the combination of the spectral bands (Thematic Mapper *TM5* and *TM4*) of the Landsat images and by the combination of the Band *B12* and *B08* spectral bands of the sentinel-2.

Combination of indices (NDBI and NDVI)

The most commonly used index to examine vegetation distribution is *NDVI* (the normalized difference vegetation index). Other applied indices, which examine urban distribution, are the NIR and SWIR, that highlight built-up areas. In this study, we choose the NDBI (Normalized Difference Urbanization Index), which is useful for monitoring urban area distribution, reported that the accuracy of urban area extraction based on an earlier method that uses the difference of about 90% between NDVI and NDBI (Zha & Ni, 2003). Thus, two indices used in this method are the Normalized Difference Built-Up Index (NDBI) and the Normalized Difference Vegetation Index (NDVI). The first corresponds to the normalized difference for the frame and the second to the difference for the vegetation. Both are calculated from sentinel-2 satellite bands, the method is to subtract the vegetation index (NDVI) from the urbanization index (NDBI) given in the following formula:

Artificialized spot = NDBI – NDVI

The application of this index (NDBI) allowed us to determine the urban area by combining the B12 and B8 spectral bands of the sentinel-2 satellite (Fig. 8).

Cuirass index (CI)

This term comes from the cuirass, which is the surface crust of the soil, thick (up to several meters) strongly hardened by precipitation of iron and aluminum forming especially in inter-tropical climate with well-marked dry seasons. The cuirass index separates vegetated covers from mineral areas (including cuirasses). The vegetated and aquatic surfaces appear in black while the mineralized surfaces are coded in light grey or white. The cuirass index has the following formula:

IC = (3 X B3) –B4 – 100)

Where *B3* is the Band 3, the spectral band in the wavelength of the sentinel-2 satellite green and *B4* is the Band 4, the spectral band in the red wavelength of sentinel satellite-2.

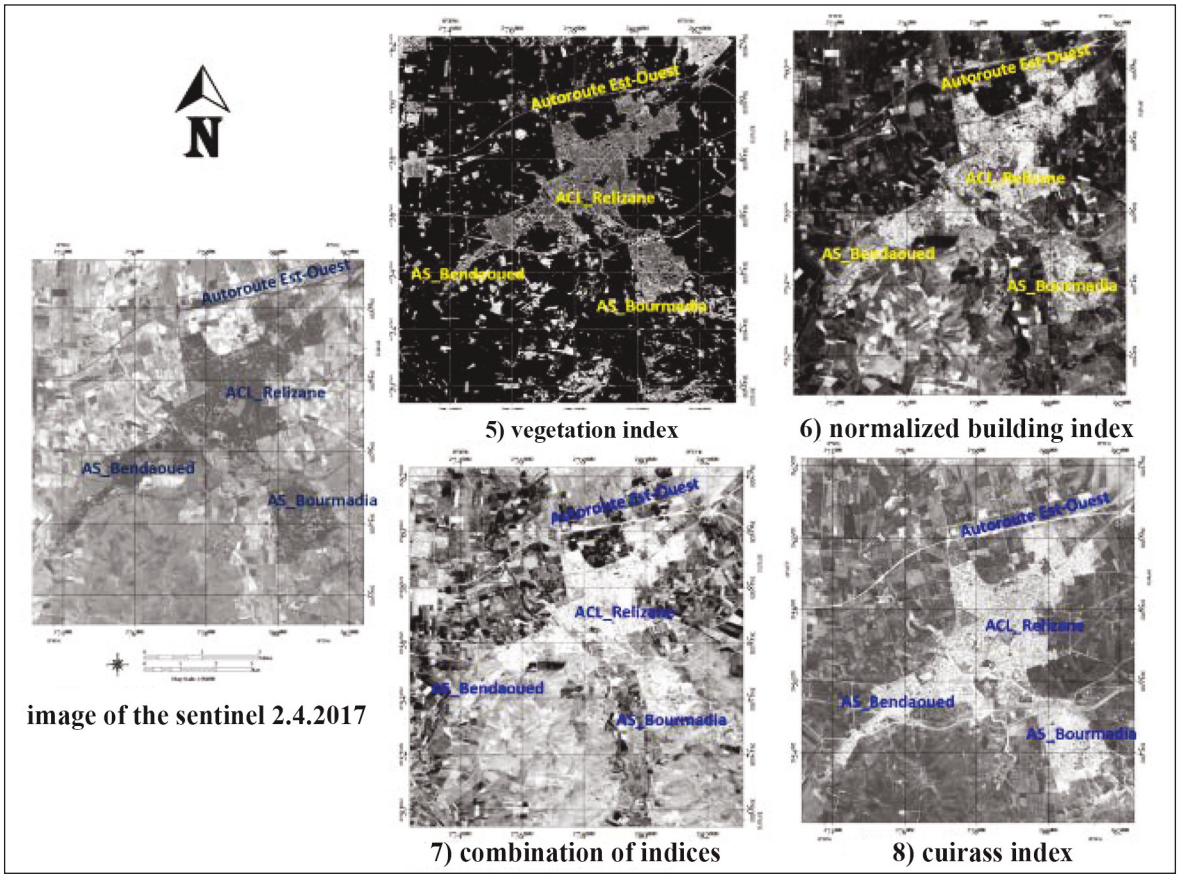
This index meets the same needs as the soil NDBI index, but has more performance for highlighting, and differentiation of built surfaces from bare soils. The vegetated and aquatic surfaces appear in black while the mineralized surfaces are coded in light grey or white. A calculation of the cuirass index applied to the images of the sentinel-2 satellite was made, as shown in Fig. 8.

RESULTS AND DISCUSSION

Urban spot detection

The result (Figs. 5–8) shows a growing gradient of plant activity ranging from black meaning no cover, to white which reflects a very high chlorophyll activity. The result of NDVI takes the form of a new image, the value of each pixel being between -1 (bare soil) and 1 (maximum plant cover). The method by applying the cuirass index (Fig. 8) gave a very good result on the urban fabric, by allowing us to discriminate the urban envelope, the latter appear in whitish color, and the other compositions appear in a gradient of gray.

In order to validate the results obtained, a com-



Figures 5–8. Automatic extraction of the urban spot from the study area by the 4 methods.

parison with the statistical data was made. The statistical information provided by the specialized services National Statistics Office (ONS) or by the field surveys at the level of the block, district, or urban area (population, employment, housing, etc.), allow the immediate comparison of the various results existing in the parts of the city and the apprehension of certain characteristics of the urban space studied.

The statistical data compiled are reported in the form of absolute values, percentages calculated over the last three decades (1990–2017). After the application of these methods, it is essential to choose the most efficient among them in order to take it as a source of information of the surface area of the building in our study area, knowing that the actual surface is estimated 837.60 ha (DUCH Relizane, 2017) and in order to be able to calculate the area of extensions made on agricultural land around the urban extensions. The plain of the Mina has undergone very great urban and agricultural changes, knowing that the urban extension was to the detriment of agricultural land, we will in this step evaluate this artificialized extension based on the images processed.

The rural population is defined by the status of the agglomeration and the proportion of agricultural workers at the level of each municipality. As a result, more than 36% of the Mina Plain population was classified as rural by the 2008 General Population and Habitat Census. This rural population is represented as follows (Table 5): 100% for the municipalities of Sidi khatteb, Belaacel Bouzagza and Sidi Saada, 73% for Yellel, 56% for Oued El Djemaa, less than 25% for Bendaoud and El-Djemaa-Matmar and 2% for the municipality of Relizane.

After a good study, we chose the main town (Relizane) which represents the largest artificialized mass in the Mina, and the two communes Oued El Djemaa and Yellel which have the high-

Agricultural Commune / Regions	Total	Rural	% Rural	Total labour force	Agricultural labour force	% agr. Labour force relative to total
Relizane	130092.00	2857.00	2.00	40322.00	3134.00	8.00
Bendaoued	17953.00	4520.00	25.00	5622.00	1285.00	23.00
Oued El Djemaa	23480.00	13116.00	56.00	7492.00	5532.00	74.00
El-Matmar	17442.00	4075.00	23.00	5362.00	2704.00	50.00
Yellel	38101.00	27821.00	73.00	11165.00	6830.00	61.00
Sidi Saada	17558.00	17558.00	100.00	5420.00	1963.00	36.00
BelaasselBouzagza	12905.00	12905.00	100.00	4210.00	2129.00	51.00
Sidi Khatteb	14074.00	14074.00	100.00	4362.00	2208.00	51.00
Mina plain	271605.00	96926.00	36.00	83955.00	25785.00	31.00

Table 5. Distribution of the rural population in the Mina plain (National Statistics Office, 2008).

est ratios of the rural working population in relation to its total working population (74% for Oued El Djemaa and 61% for Yellel) to monitor the evolution of artificialized spaces and to study the degradation of agro systems in the Mina plain.

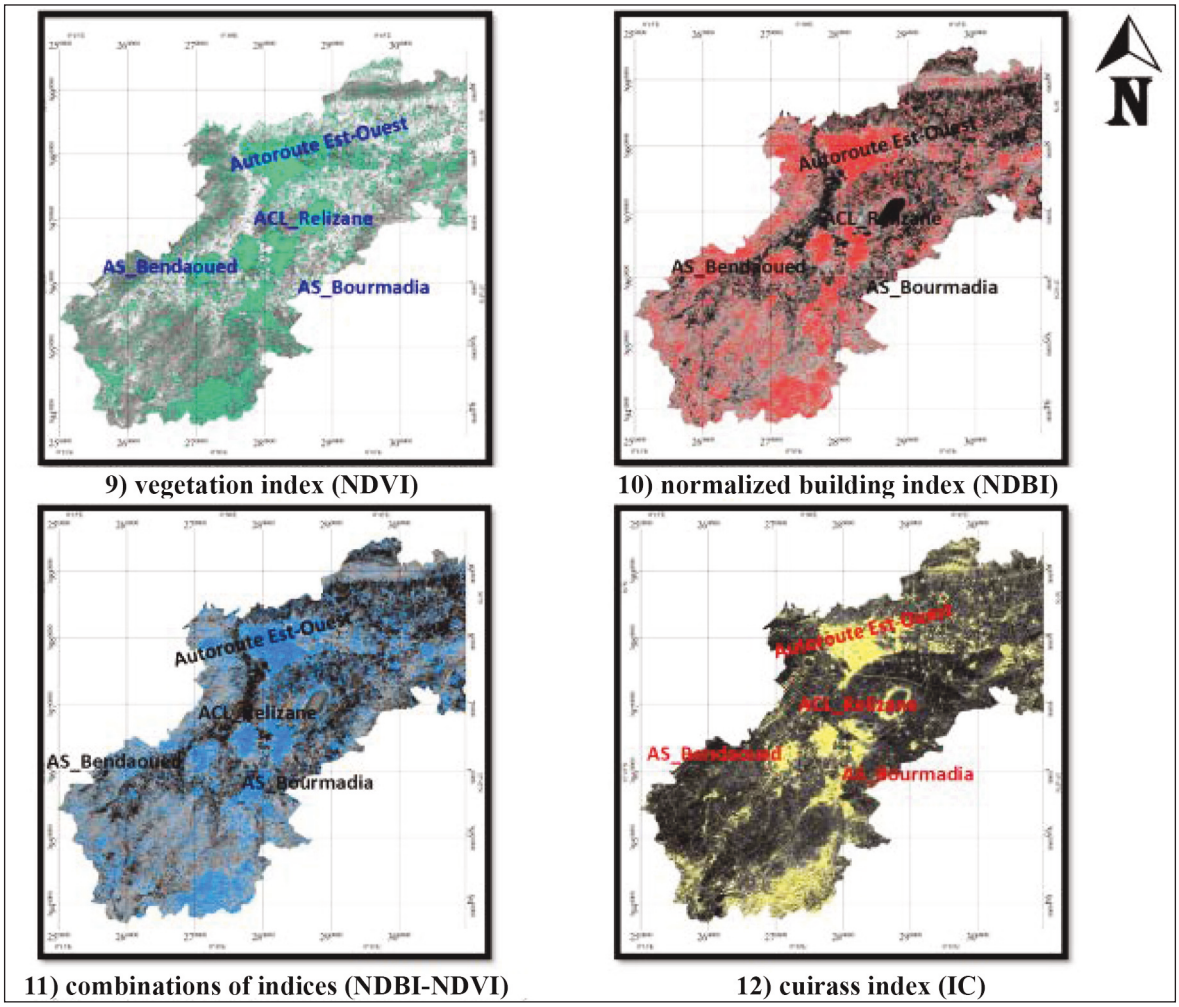
The indices are multivariate analyses, namely, treatments developed from several channels**,** more or less simple, aimed either to reduce the amount of information, or to highlight particular themes (vegetation, soils, etc.). Following the application of the four methods, we were able to make our surface estimation to digitalize the urban expansion from the resulting image by comparing the different surface estimates. We can conclude that the results obtained are reliable. To identify and track the urban expansion in the three communes (ACL de Relizane, commune of Oued El Djemaa and commune of Yellel) on the image of the sentinel-2 of the month of April 2017, this image has a fine spatial resolution (10 m), which helps us to better identify urban contours and to quantify urban extensions. The areas estimated in each method are shown in the Figs. 9–12.

In order to measure this extension, it was deduced that it is necessary to make a classification from the radiometric values to extract the urban envelope and mask the other objects from the image. After the extraction of the urban extensions, several steps will be performed on the already classified image and on the index image (*NDVI*, *NDBI*, *NDBI-NDVI*, *CI*) in order to locate and calculate the area of the extension areas. Filtering is one of the simple treatments to implement and works on most of the observed environments. The method of applying the cuirass index gave us a very good result on the urban fabric, allowing us to discriminate the urban envelope, as the latter appear in whitish color and the other compositions appear in a gradient of gray. Table 6 shows a comparison of the real and estimated area with the four methods.

Today, almost 57.5% of the population lives in urban areas, compared to 52.15% in 1998 and 33.63% in 1987. This shows the scale of the urbanization process. This phenomenon of urbanization is still more acute; especially in recent years with the emergence of several urban agglomerations and the accentuation of the phenomenon of per urbanization around major cities. The different censuses make it possible to assess the urban fact. For practical reasons, we will deal with this aspect in two periods, the first concerns the evolution of the urban population between 1987 and 1998, the second concerns the level of urbanization in the 2008 census.

Evolution of the urban population between 1987 and 1998

The decade between 1987 and 1998 has seen a dramatic change in the urban population, characterized by a demographic increase in agglomerations often lacking an economic base and urban management functions. The most edifying case was the commune of Moussa Ami which saw its rate of urbanization increased from 54% to 92% since it drained all its rural population in addition to the population of the communes in difficulty of the



Figures 9–12. Automatic results of the urban spot in the study area by the 4 methods.

Communes	Index	Actual surface (ha)	Estimated surface (ha)	Difference (ha)	Error ratio %
Yellel	NDVI	837.60	867.84	30.24	3.6
	NDBI		901.20	63.60	7.6
	NDBI – NDVI		883.15	45.55	5.4
	CI		838.90	1.30	0.15
Relizane	NDVI	262.00	266.11	4.11	1.6
	NDBI		271.35	9.35	3.6
	NDBI – NDVI		267.77	5.77	2.2
	CI		262.41	0.41	0.15
Oued El Djemaa	NDVI	174.73	177.22	2.49	1.4
	NDBI		179.08	4.35	2.5
	NDBI – NDVI		177.01	2.28	1.3
	CI		175.01	0.28	0.16

Table 6. Actual and estimated area in the three communes (Relizane, Yellel and Oued El Djemaa).

South East of Ouarsenis (Souk El Had, Remka, Had Chekkal). The increase in the rate of urbanization is also linked to the conurbation of some secondary agglomerations with their ACL. This is the case of Ben Ziane with Oued Rhiou and Meriama With Ben Daoud. At the wilaya level the rate of urbanisation increased from 33.6% in 1987 to 52.15% in 1998.

In 1987, only 10 agglomerations were classified as urban with an estimated population of 183,304.

In 1998, the number increased to 19 urban agglomerations totaling a population of 334,942, the most important of which are Relizane, Oued Rhiou, Zemmoura, Ami Moussa and Djidiouia. However, despite the evolution of the rate of urbanization the wilaya of Relizane remains strongly marked by rural and agricultural life during this period.

In 2008, urbanization is very strong at the level of the plains, along the RN04 where the rate of urbanization exceeds 70%. On the other hand, mountain areas and landlocked areas remain more rural. The urban population of the wilaya according to the GPHC 2008 has increased to 417,084 inhabitants, who live in 22 agglomerations, 17 of which do not exceed 20,000 inhabitants. The wilaya has experienced a strong urban growth, in fact the urban population has doubled since 1987 with an urbanization rate that has risen to 57.40%, or more than 24 points compared to 1987 but it is stabilizing compared to 1998. This urbanization is the product of two factors that interact with each other: the emergence of new urban agglomerations and the continuation of the process of urbanization of former urban centres. In addition to the 10 cities already considered urban in 1987, other agglomerations integrated the urban framework of the wilaya, namely: Lahlef, Ain Tarek, El Guettar, Beni Dergoun, etc. The rate of urbanization in Relizane increased to 97.8%, Oued Rhiou to 85%, Zemmoura to 76% and for Mazouna to 72%. These cities continue to strongly polarize their hinterland.

Urban expansion to the detriment of agricultural land

Urban growth can be defined as a process of population growth (urban population growth) and/or spatial growth (extension, spreading) of urban units (ONS 2008) (Table 7).

According to Table 8, the total area cleared by the PDAU is 3741.04 ha for the whole wilaya. In the short and medium term, more than 85% of the open land has been consumed, while 38.74% of the open land in the long term is consumed. More than 1/3 of the land remains open all areas.

The unfavorable economic and security conditions experienced by Relizane, and Algeria in general, during the period 1987–2001 encouraged the population to confine themselves to the most secure agglomerations like the place of wilaya and the agglomerations located on axis RN 04, on the one hand, such as Relizane, Oued Rhiou, Matmar, Yellel, M/S/Abed and the urban centres closest to the countryside such as Ammi Moussa, Mendes, Zemmoura, O/Essalem on the other hand (Table 9).

The visual interpretation of the images is an indispensable step that follows us during all the treatments carried out on the images and above all locate the areas of urban evolution, after having geometrically corrected our images, to make it conform to a known type of map projection (UTM, fuseau 31), to facilitate the manipulations between the software.

Among these treatments we cite the superposition of the common boundary file on the index images and the colored composition, the delimitation by visual interpretation of the urban evolution zones on each image based on the vector files of the Mapinfo8.5 software to position the communes.

Following the treatments carried out above, four index images were established characterizing the urban tissue representing the three common wilaya of Relizane chosen for the study. The Figs. 9–12 show the four methods applied in our treatments.

For a cost effective use of the information it is necessary to know its reliability. The expected level

Urbanisation sector	Exposed surface (ha)
Urbain (U)	184.99
A Urbaniser (AU)	1961.81
Urbanisation Future (UF)	1594.24
Total	3741.04

7

Farmland (ha)	3558.32	95.12
Other (ha)	182.72	4.88
Total (ha)	3741.04	100%

8

Table 7. Land status of approved (DUAC, 2013).
Table 8. Land Use Identified by Approved (DUAC, 2013).

Communes	Urban planning Sector (HA)			Sector for urban development (HA)			Sectors for future urbanization		
	Total surface (ha)	Available surface		Total Surface (ha)	Available surface		Total surface (ha)	Available surface	
		Moment APP	Todate		Moment APP	To date		Moment APP	To date
Commune Relizane	838	00,00	00,00	199.83	201.96	567.71	467.24	456.06	456.06
Total Wilaya	3518.68	35.97	35.48	1233,62	1135.56	1257.15	1544.70	1466.34	1161.08

Table 9. Land availability by municipality and by urbanization sector (DUC Relizane 2013).

of information should be known and taken into account when using the data. The results of remote sensing analysis and any other type of spatial information should be complemented by field visits and investigations. This phase involves verification of the products from the previous phase. A conventional precision test is carried out in which sampling points are selected and measured on the remote sensing information medium and compared to data from independent field surveys.

CONCLUSIONS

These results highlight the value of using remote sensing and GIS for the quantification and monitoring of artificialization. The approach implemented in this work has favored the application of already proven and easily reproducible indices. They showed that urban sprawl leads to major changes in landscape structures that in turn impact agro systems and the rural world. We can stress that this study should make it possible to manage urban space and control its dynamics, and to draw up prospective scenarios for urban land use planning.

The integration of remote sensing data with other data through GIS remains a very definite research, for the development of an information system on urban components. Secondly, the creation of a soil map, which serves to identify all types of existing land, in order to make a good classification of agricultural land instead of a decommissioning of this land for reasons of urbanization and the fight against demographic explosions.

In perspective, these elaborated cartographic documents can help us to criticize the orientations of the PDAU, and to propose a future direction that takes into account the perspectives of the preservation of agricultural land, of the agro systems maintained and of the rural world in general.

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