

# Contribution of Remote Sensing in the Analysis of Urban Dynamics and Economic Transformation in the Bordj Bou Arreridj City- Google Earth Approach

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## **Abstract :**

*This study examines urban dynamics and economic transformation in Bordj Bou Arreridj city, with emphasis on the impact of rapid urbanization on the socio-economic development of the region. Using a combination of quantitative and qualitative methods, we analyze demographic changes, employment trends, changes in urban infrastructure and economic development policies. Our results highlight rapid urban growth and significant economic transformations, with important implications for urban planning and sustainable city development.*

**Key words:** *urban dynamics, economic transformation, Bordj Bou Arreridj, economic development, urban growth.*

## 1. Introduction:

The current Algerian urban system mainly depends on intermediate cities<sup>[1]</sup>, while urban changes are occurring, this is mainly due to the market economy, the extension of its spheres of influence to different levels in hierarchical system. This phenomenon is typical of Bordj-Bou-Argeridj, where the administrative boundaries of the Wilaya seem to encompass more regional space.

To understand the recent historical development of these intermediate cities in our country, we need to study their formation process (Urban Transformation). It is a question of understanding the issues which caused the development of these urban centers, which now constitute an urban heritage with secure use value, despite continued degradation. In other words, think about their role in the overall urbanization of the country.

In recent years, enormous economic and social changes have led to the acceleration of urban development: it has rapidly changed the image and characteristics of the city and reshaped the space. Urban growth is accelerating at an uncontrolled pace, leading to a process of horizontal densification, continued expansion and development.

Transform agricultural land with a view to accelerating the process of urbanization of the entire territory. This tends to establish a new relationship<sup>[2]</sup>, namely the relationship between the center and the periphery, divided into two categories. Divided space; therefore, the old center is in its initial state, unable to cope with the new dimensions of the city.

Therefore, urban chaos has taken over our cities, the ugly concrete landscape, endless views of garages, endlessly built houses and a significant lack of urban spaces create the environment for our daily lives.

During the colonial period (1868), the current town of BBA was promoted to the headquarters of the mixed commune because it was located in the center of the crossroads at the junction of Algiers in Constantine and Bejaïa in M'sila, giving it the following function: Bordj-Bou-Argeridj city, an agricultural market, benefits this vast territory and continues to attract rural residents. Indeed, as PRENANT A said, in terms of population recruitment, Bordj-Bou-Argeridj is above all a rural town. These villagers are mainly from the outskirts of the city, with a radius of between 30 and 40 kilometers.

These changes have a clear impact on the spatial distribution of the population, the occupation and use of land and the organization of services. Urban sprawl and the specialization of functions and uses are all visible phenomena of these changes. As a result, urban planning for this urban growth that began in the 1970s has changed, leading to a dramatic expansion of the city's urban scope. Excessive land consumption has led to the artificialization of agricultural land and natural space. This therefore raises the question of the protection of agricultural land to ensure the sustainable development of the territorial system, in particular the local development of cities.

## 2. Urban dynamics

Urban dynamics refer to the various forces and processes that shape the growth, development, and transformation of cities over time<sup>[3]</sup>. These dynamics are influenced by a range of factors, including economic, social, political, and environmental forces.

## 3. Economic transformation

Economic transformation within urban areas involves changes in the structure, composition, and organization of economic activities<sup>[4]</sup>. This can include shifts in employment patterns, the emergence of new industries or sectors, changes in land use and property values, and the development of infrastructure and services.

Several key factors drive economic transformation in urban areas:

- **Globalization:** Urban economies are increasingly interconnected with global markets, leading to the expansion of trade, investment, and the flow of goods, services, and capital. This can result in the emergence of new industries and the decline of traditional ones as cities adapt to changing global economic conditions.<sup>[5]</sup>

- **Technological Innovation:** Advances in technology, particularly in areas such as information technology, biotechnology, and advanced manufacturing, can drive economic transformation by creating new opportunities for innovation, productivity growth, and the development of new products and services<sup>[6]</sup>.

- **Urbanization:** The concentration of people, businesses, and economic activities in urban areas can stimulate economic growth and innovation through agglomeration effects, knowledge spillovers, and economies of scale and scope<sup>[7]</sup>.

- **Demographic Changes:** Shifts in population size, age structure, and workforce composition can influence economic transformation by affecting consumer demand, labor supply, and the availability of skilled workers<sup>[8]</sup>.

- **Government Policies:** Policies and regulations implemented by local, regional, and national governments can have significant impacts on urban economies, shaping factors such as taxation, land use planning, transportation infrastructure, and investment incentives.

- **Social Dynamics:** Social factors, such as income inequality, social cohesion, and cultural diversity, can also influence economic transformation by affecting consumer behavior, business competitiveness, and the overall quality of life in urban areas.

Overall, economic transformation in urban areas is a complex and dynamic process that reflects the interplay of multiple factors and forces. Understanding these dynamics is essential for policymakers, urban planners, businesses, and other stakeholders seeking to promote sustainable economic development and prosperity in cities.

#### 4. Methodology and tools:

We used demographic data, employment data, geographic maps and interviews with local experts to analyze the urban and economic transformation of Bordj Bou Arreridj. Spatial and econometric analysis methods were used to assess trends and relationships between urbanization and economic development.

##### - **Google earth engine approach:**

The Google Earth Engine (GEE) approach can significantly contribute to understanding urban dynamics and economic transformation by providing access to vast amounts of satellite imagery and geospatial data. GEE is a cloud-based platform that allows users to analyze and visualize Earth observation data, making it particularly useful for studying urban areas and their changes over time. Here's how the Google Earth Engine approach can be applied to this context<sup>[9]</sup>:

- **Monitoring Urban Growth:** GEE enables the analysis of historical satellite imagery to track changes in urban land cover and land use over time. By using time-series data from satellites such as Landsat and Sentinel, researchers can quantify urban expansion, identify patterns of growth, and assess the spatial distribution of economic activities within cities.
- **Assessing Land Use Changes:** GEE provides tools for land cover classification and change detection, allowing researchers to identify shifts in land use patterns associated with economic transformation. For example, the conversion of agricultural land to urban development or the expansion of industrial zones can be monitored using remote sensing techniques and machine learning algorithms available in GEE.
- **Mapping Urban Infrastructure:** GEE facilitates the mapping and monitoring of urban infrastructure such as roads, buildings, and utilities using high-resolution satellite imagery. This information is valuable for understanding the spatial distribution of economic assets, transportation networks, and service provision within urban areas.
- **Land-Use Change in the Study Area**

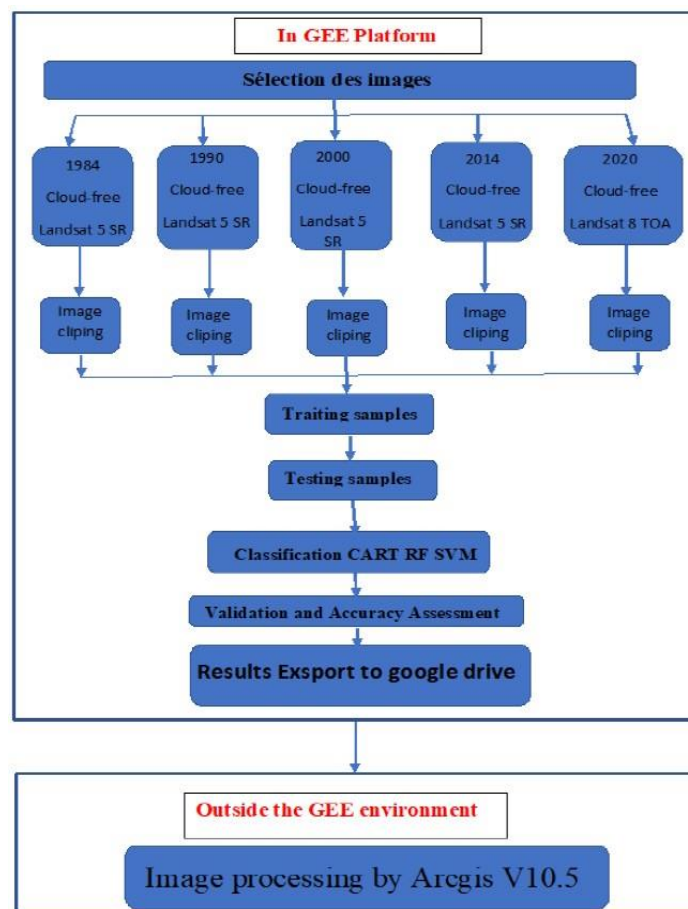
Various methods for measuring land-use change have been developed and introduced<sup>[10]</sup>. For our work, this was done using the supervised classification method<sup>[11]</sup>. Three categories that we need in our study were derived: lands, vegetation, and urban. This is done by a script that has a set of functions, the most important of which are<sup>[12]</sup>:

- The first steps in accessing and obtaining the data started with a recall function and the creation of a composite image of a series of images.

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- A function to select a group of satellite images (Landsat 5 and 8 SR)
- A filter function by date of interest (1984-2020), and another to mask clouds using the QA pixel cloud range value available in SR products.
- Transfer and export images to ArcMap 10.5 for analysis, processing, and final extraction. **(Fig 01)**.
- Conduct in-depth qualitative and quantitative analysis and discussion and conclusion.



**Figure 01.** Methodology adopted for the study of the Land-use change.

## 5. Geographical location of the wilaya of Bordj Bou Arreridj:

It is a part of the high plains of the East, between the two Tellian Atlas mountains represented by the El-biban mountain range, it is a homogeneous unit, ranging from 1200 to 1750 m altitude , In the south is the Al-hodna mountain range, which includes the northwest end of the Al-Maadid mass, which is the highest peak of 1885 m at Mount Chellige, Taglait commune, as well as the mountains of Al-ach and the mountain of Bordj Ghdir which separates the two groups and the valley of Oued Elksob. From the east, it is surrounded by the upper plains area towards the Sabia plains.

Administratively, the wilaya of Bordj Bou Arreridj is located approximately 250 km southeast of the capital. It is limited to the north by the wilaya of Bejaia, to the east by Sétif, to the south by Batna and M'Sila and finally to the west by Bouira. The Kef Azerou Seghir quarry is located 5 km as the crow flies north of the capital of the commune of El M'Hir.

### - Bordj-bou-arreridj city:

Bordj Bou Arreridj city is located in the center of the Wilaya, it is the eastern extension of the Sétifian high plains, which are part of the high plains of Eastern Algeria, at 916 meters above sea level; it is located 240 kilometers northwest of Algiers, 190 kilometers east of Constantine and 65 kilometers east of Sétif (RN 5).

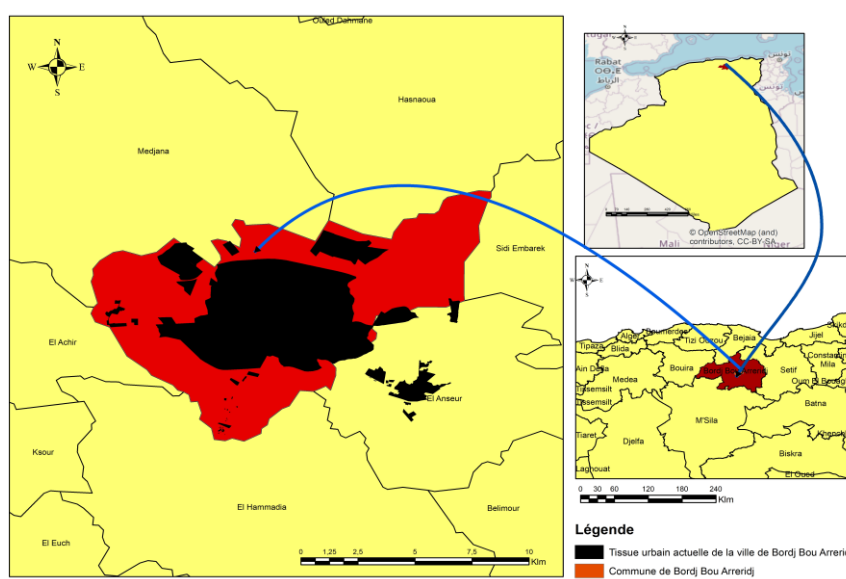


Figure 02: Geographical location of the city of Bordj Bou Arreridj

### - Genesis of Bordj Bou Arreridj city

The first core of Bordj Bou Arreridj city was formed in the center, as it dates back to the colonial era, which is characterized by its colonial architectural character and the rectilinear road network, which was a feature of most Algerian cities of the time. Then

the city experienced rapid urban expansion after independence in all directions (Fig No. 02), thus some chaotic neighborhoods appeared, such as Al-Jabbas, the market roundabout, Al-Faybour, La graf, Al-Batwar, the district of May 8, 1945 and the old garden district. Then the industrial zone appeared on the south side, then the first urban residential zone appeared on the east side. It consists of 400 housing units, then individual housing units began to appear in fragments on the west side, such as the Tayeb Khairah fragmentation (12 hectares). Subsequently, the city's urban growth stopped on the three eastern, southern and western sides, due to the presence of obstacles preventing urban sprawl, including:

- **Natural obstacles:** represented in the valley and the forest of Boumrkad on the east side.

- **Industrial obstacles:** medium voltage lines on the west side, and the industrial zone on the south side.

To understand the recent historical development of the city, we need to study their formation process (Urban Transformation). It is a question of understanding the issues which caused the development of these urban centers, which now constitute an urban heritage with secure use value, despite continued degradation. In other words, think about their role in the overall urbanization of the country.

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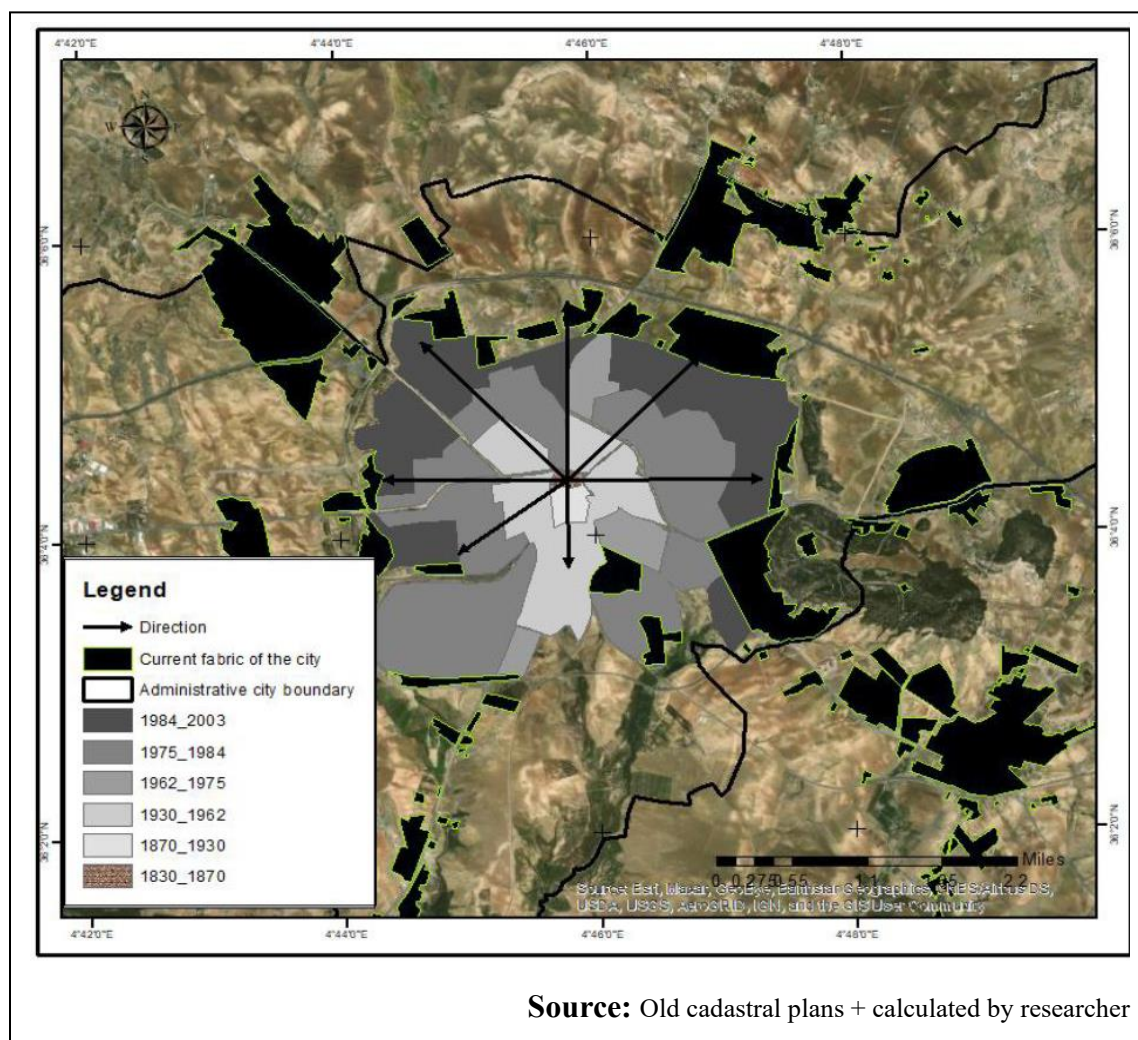
According to the result of the development of individual housing, housing programs, public, commercial and industrial services, the history of the urban expansion of Bordj Bou Arreridj can therefore be summarized in three phases:

- The development of the colonial city (1870-1962), the reconstruction of the fortress, the construction of the barracks to the north-east of the site, after the creation of the railway in 1871 which is considered a main axis in the direction of Zemmoura, Sétif and Algiers. Then the expansion continued to grow in different directions, establishing three communities to accommodate residents from neighboring suburbs, the east is El Djébbès, the south is Douar Souk.
- From 1963 to 1984, the city's expansion began relatively slowly. In 1975, it reached a total urban influence of 311.62 hectares. Subsequently, with the creation of the South-West Industrial Zone in 1976 and the formulation of the PUD, the agglomeration expanded from 126.67 ha to 438.29 ha (1978-1984).

- The third phase lasted 16 years (1984-2020), marking the exponential expansion of the city after being transformed into the capital of the Wilaya. It spreads in all directions (housing and public facilities and services). The agglomeration area has expanded by more than 75% to 1,330 hectares.

**Table 01:** Evolution of the urbanized surface area of the city of BBA since 1830/2020

Year	1830-1870	1870-1930	1930-1962	1962-1975	1975-1984	1984-2003	2003-2020
Area in ha	6,87	19,55	8,30	41	197,50	45,02	1285,42



**Figure 03.** The historical development of the urban fabric of the city of Bordj Bou Arreridj (1830-2003) according to urban plans<sup>[13]</sup>.



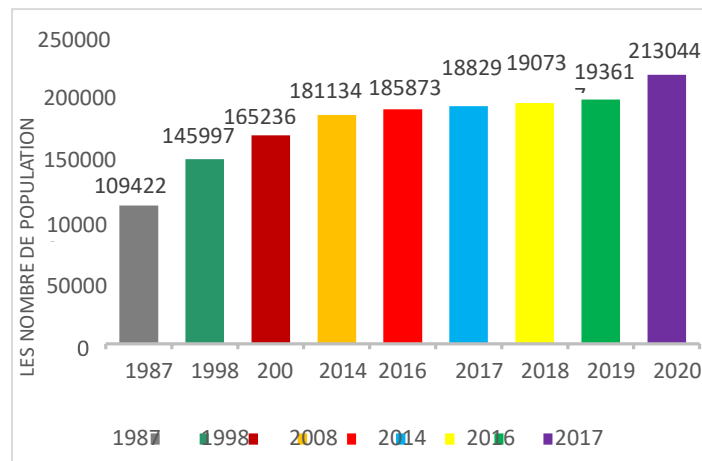
## - Population development in Bordj Bou Arreridj

Increasing urban fabric results from accelerated demographic growth on the one hand and economic development on the other.

**Table 02.** Population development in Bordj Bou Arreridj from 1987-2020.

Year	1987	1998	2008	2014	2016	2017	2018	2019	2020
Habitants	109422	145997	165236	181134	185873	188290	190737	193617	213044

Source : Local Administration Bordj Bou Arreridj



**Figure 04 :** Représentation graphique évolution de la population de commune de Bordj Bou Arreridj 1987-2020.

- According to the graph (Fig .04), we see that demographic growth is constantly increasing, and the period between 1987-1998 witnessed the largest demographic growth, as the population increased from 109,422 people to 165,236 people. As for the period between 1998-2008, it witnessed a decline due to the decline in the standard of living, but during the period between 2008-2020 the population reached 213,044 people, thanks to the establishment of the Electronics and Home Appliances Corporation. A strong and dynamic industry, which is concentrated in the municipality of Bordj Bou Arreridj, where there are twelve sites for industrial activity. The industrial zone of Bordj Bou Arreridj is considered the most important industrial center in the state, where we notice the presence of factories of national and regional importance, as well as the presence of small private industrial units, which has led to population overcrowding in the area of this region. Industrial and thus had to expand it by creating a new industrial area. This dynamism of the electronics and home appliances industry has helped improve the standard of living of Bordj Bou Arreridj residents, which has translated into the availability of services that attract residents in order to improve their health as well as cultural conditions.

- This graph (Fig. 05) shows that the urban area is constantly growing. In the period from 1962 to 1988, the growth was significant in a large urban area, increasing from 94,184 hectares to 1,810 hectares, due to the natural increase in population. Regarding the period between 1988-2008, we note that the urban area decreased due to the slight increase in population during this period, 2008-2017, the urban area.
- There is a direct relationship between population and urban expansion, which means that as the population increases, urban areas also increase, and thus the areas of agricultural land (arable) decrease.

## **6. Economic transition in the city of Borj Bou Arreridj:**

From the first ten years of independence, to achieve territorial balance, land use planning programs tended to promote the Eastern High Plains, according to M. C MTE (1988), this area was favored due to cereal crops and a population density of 60 inhabitants/km<sup>2</sup>.

All cities in the region, in particular Sétif, have industrial zones, airports, social services and administrative foundations necessary for the territorial framework, and strengthening of road and railway infrastructure.

Borj Bou Arreridj city should become a dynamic center of the region like other neighboring areas (Sétif and El Alama), where the population is growing rapidly, is being promoted to the capital, and offers 173 hectares of industrial space. from the first stage of the organization of equipment and national industrial policy.

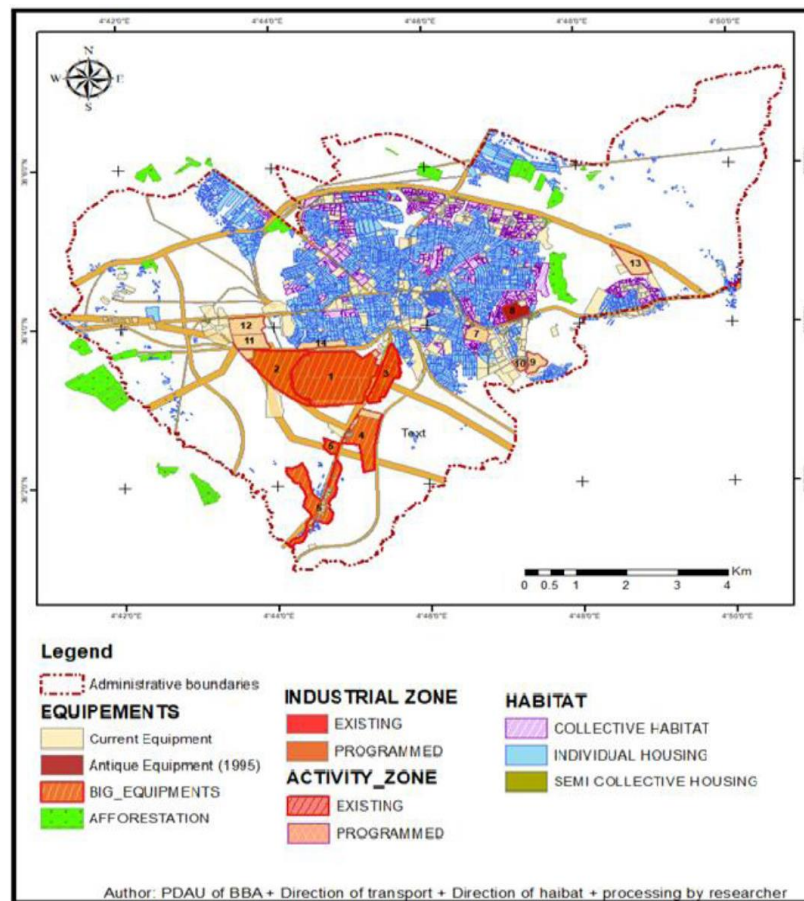
The adoption of the capitalist system and the free market and the transition of the role of the state in the development process from the role of manager to the role of supervisor (1987-1988) have no effect on the economic dynamics of the city, quite the opposite. It particularly attracted private investors oriented towards the industrial sector. Through the establishment of small and medium-sized businesses, it experienced the intensification of the industrial structure and the diversification of products, and was accompanied by a significant exodus of the rural population, mainly absorbed mainly by the city.

## **7. Bordj Bou Arreridj: Industrial and commercial center**

Given the state policy to develop the industrial sector in the city Bordj Bou Arreridj dates back to the 1970s, an industrial zone was created in 1976. Several relatively important public sectors (ERCE, EMBAG, ANABIB) were initially there. established, then other construction and public works services (ESTB, ENITRO) set up there. Since the early 1990s, we have witnessed the creation of various industrial sectors, most of which belong to private investment.

Currently, the industrial zone brings together 48 units, located in various sectors of activity; Agri-food, I.S.M.M.E, Electronics, Electricity, Textiles, Wood, Services and

construction materials. The area covers 1795 km 2 and almost entirely consumed (Fig No. 05, Table .04).



**Figure 05:** Land use plan for the Bordj Bou Arreridj city<sup>[14]</sup>

From the location of industrial units, for example Compared to other regions of the Wilaya, is concentrated in Bordj Bou Arreridj city. We are witnessing excessive polarization. With the saturation of industrial zones, industrial units are clearly visible throughout the city (in the city center, east, west or south) or outside the city limits in the form of encroachment on the territory of neighboring municipalities (Exit towards El Achir).

Firstly, the construction industry (BTP) is considered the largest employment opportunity in the entire Wilaya region. Thanks to the dynamics of the city and the distribution of known facilities in the city, it has made considerable progress. This department participates directly or indirectly in the flow of local labor, first after the implementation of the project, then to promote the daily flow of local labor, the rural population in search of a job. For construction materials, they mainly come from the extraction of sediments distributed in many towns in the Wilaya (23 in total), but raw materials can also be brought from all over the country.

The food industry attracted private investors, who established their first branch (for soft drinks) in the Bordj Bou Arreridj branch in the 1980s. Then the industry underwent enormous diversification, and now it has brought together three main branches: flour mills and pasta factories, biscuit, chocolate and confectionery factories, and beverage and juice factories.

Finally, electronics is the most recent industry in the region, its history dates back to the 1990s. It started with simple assembly and then attracted local and national leaders (Condor, Sentrax) in the field. This department has succeeded in establishing a new business for Bordj Bou Arreridj, and the manufacturing department continues to expand: in terms of departments of activity (only 8 manufacturing departments in 2018), it is just behind the agri-food department. As for the construction and building materials sector, the level of units under construction (8 units).

**Table 03:** Industrial units operational and under construction (year 2018)

Sector	In activity	In progress
Agri-food	11	03
Electronics and electricity	08	08
Construction materials and BTP	17	09
Plastic	05	04
Chemistry	00	02
Paper processing	03	03
Metal industries	02	03
Services	03	00
Others (wood, textiles, etc.)	05	02
<b>Total</b>	<b>54</b>	<b>34</b>

**Source:** technical service of the BBA industrial zone

If the industry is an emerging fact, then the trade of Bordj Bou Arreridj is a tradition. Due to its strategic position and its integration on a double trajectory: El Hodna Soummam and Plaine Sud, trade and services have deepened. Since the colonial period, it is in the development of this central city. Therefore, during this period it was promoted to administrative center to ensure the functioning of the agricultural products market. In fact, the whole area was organized around grain and the colonial government as a sampling site (around Tixter and other railways), agricultural produce markets (Medjana, Zemmourah, Bir Kasdali) and administrative command centers (Mansoura case).

Today, like the entire Hauts Plateaux region, Bordj Bou Arreridj is also quite representative at this level and is developing undisputed vitality in the field of commerce. According to the economic census (2011), commerce and related services accounted for 88% of all economic institutions in 2011. Like the industrial sector, the distribution of various commercial activities carried out by the municipality also shows a strong concentration in the city. Concentrated 80% of retail trade (i.e. 10,356 units), 88% of wholesale trade (559 units) and almost all import trade (96%).

## **8. Characterization of the urban changes occurring in Bordj-Bou-Arreridj:**

The concept of mutation has recently been introduced into urban planning and architecture. It's about the ability to do things that can be changed and transformed, things that can adapt and change the occupants. The variability seems linked to the so-called sustainable development process: a sustainable city is a city that saves space and rebuilds itself. The forms, functions and uses of cities are evolving. Taking into account the variability of urban and architectural spaces, not models when the question of the era becomes the heart of urban reflection, current production seems to take over.

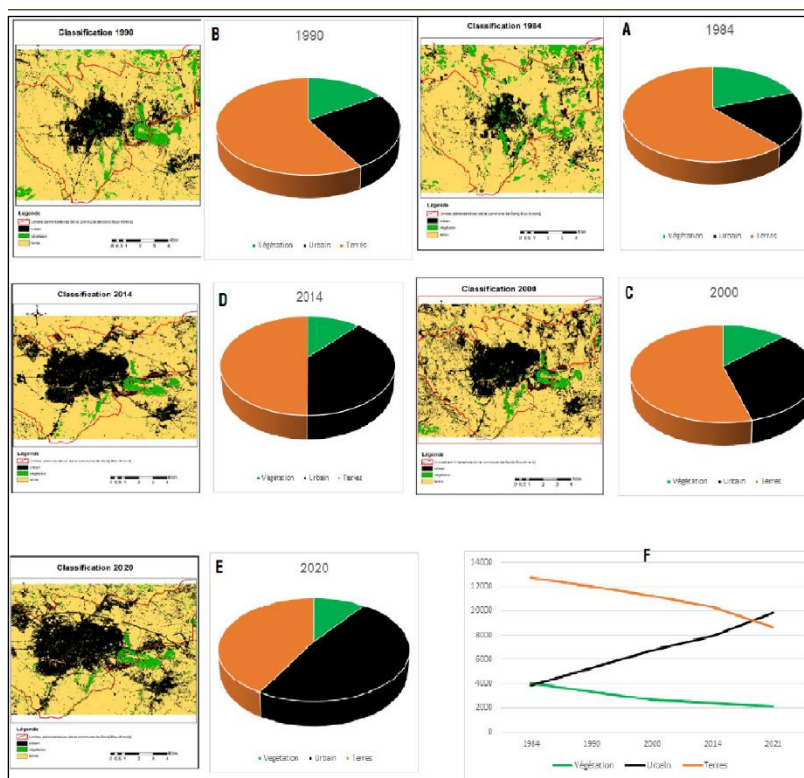
The spatial dynamics of Bordj Bou Arreridj reveals the high consumption of space. If the size of the city in 1992 was relatively small and many undeveloped spaces were within the city limits (See Fig No. 04), the city in 2002 would show strong growth, especially throughout the northern part from the city. These new buildings correspond to new buildings, residential neighborhoods which are accompanied by an urban population and economic growth. In Bordj Bou Arreridj, this does not seem to be the case, as the city is more prone to urban sprawl, as shown in Figure 04.

### 9. Land-Use Change

All results are summarized in Table 10, Graph 01, Figure 05, A, B, C, D, and E which includes all periods studied:

**Table 10.** La superficie de chaque classe qui convient à chaque année

Classes (Ha)	1984		1990		2000		2014		2021	
<b>Vegetation</b>	4043,48	19.6	3286,35	15.93	2659,20	12.89	2384,82	11.56	2137.26	10.36
<b>Urban</b>	3837,18	18.6	5287,46	25.63	6766,64	32.80	7942,55	38.50	9861.14	47.80
<b>Lands</b>	12749,34	61.8	12056,17	58.44	11204,15	54.31	10302,62	49.94	8631.59	41.84
<b>Total</b>	20630	100	20630	100	20630	100	20630	100	20630	100



**Figure 06:** The development of urban, vegetative and agricultural character of Bordj Bou Arreridj city from (1984-2020)

## 10. Interpretation

- Referring to the result (Fig. 04, classifications from 1984 to 2020 and graph for each period) classification gain for 36 years, it can be seen that the vegetation cover species show a relatively decreasing trend. All vegetation types showed a decrease, especially between 1984 and 1990 (19.6, 15.93, 12.89, 11.56, 10.36%) with an area of (4043.48, 3286.359, 2659.207, 2384.828, 2137.26 ha).
- The urban fabric: it can be seen from the previous maps that it has doubled over the 36 years studied, but the rate of development is constant between the different periods, except the period between 2014 and 2020. This is the most important in terms of the surface area of the built-up area, as it went beyond the administrative boundaries of the municipality and the beginning of its integration into the rural areas surrounding the agglomeration.
- As for the land, as mentioned earlier, most of it is agricultural land, and the cultivation of cereals is the most important, but due to recurrent periods of drought, the lack of its yields, and the increase in demographic pressure, the main cause of which is a large migration of the population from neighboring regions and from outside the state, forcing its owners to change their activities from agricultural to commercial and industrial activities on the one hand, and on the other hand, the high price of real estate compared to agricultural real estate.

## 11. Results and recommendations:

Through the above, and taking into account the particularity of the region and its weight in the province, we can summarize our recommendations as follows:

- Reorganize the urban framework in a logic of complementarity within the wilaya on the one hand, and the High Plains imperative which makes the wilaya of Bordj Bou Arreridj a space for redeployment of populations as part of the coastal/inland rebalancing.
- The development strategies of the different spatial entities must be adjusted according to their specific dynamics. Therefore, we need to take different actions in urban space and rural space.
- Mountain areas must become the target of targeted actions, not only to diversify and develop activities, but also to take into account their economic, social and environmental specificities.
- The unbalanced urban framework of the wilaya with primacy at the top of the wilaya capital city and a fairly diffuse base of small towns, does not make it possible to develop urban dynamics and organize the territory of the wilaya.

- It is therefore a question of organizing the urban framework to alleviate the pressure on the city Bordj Bou Arreridj and enable it to begin its urban renovation within the framework of the economic ambitions of the Wilaya and promote coherent and integrated development. Medium-sized relay cities in the respective urban subsystems to better distribute spatial structure and development.
- These poles constitute the anchor and balance point for the planning and territorial development of the Wilaya. It will be possible for them to organize the territory with a complementary logic, which is based on the organization of different levels of territorial command to control the entire territory of the Wilaya and allow the development of activities and services necessary for rebalancing.
- For this reason, land use planning strategies must be based on the diversity of spatial entities, in particular their characteristics and development dynamics.
- Territorial diversity is a strong reality in the wilaya of BBA which must be promoted by ensuring a certain balance not only between spatial entities but also within these different entities.
- The objective of highlighting this geographical diversity is to achieve a grassroots development method, in which the interurban level will become a privileged framework for public action and intervention.
- The coherence of local professions and the relevance of spatial scales will ultimately determine the overall development and competitiveness of Wilaya



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