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ATTEMPT TO MEASURE AND ASSESS THE IMPACT OF GROWTH IN EL-KALA CITY USING GEOGRAPHICAL INFORMATION SYSTEMS

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ABSTRACT

This study aims to assess the urban growth dynamics of the city of El-Kala between 2008 and 2024, adopting a diachronic approach using geographic information systems (GIS) and remote sensing. The aim is to quantify and spatialize the city's expansion over this period, and identify its main causes.

Satellite images of the years between 2008 and 2024 will be processed using GIS to map land use at these different dates. Diachronic analysis will enable us to measure urban growth in terms of built-up areas gained between each date.

The results will make it possible to assess the sprawl dynamics of the city of El-Kala over the 2008-2024 period, both quantitatively and spatially. The main drivers of this expansion can be identified.

KEYWORDS

Urban Growth, El-Kala City, National Park of El-Kala, Geographical Information Systems (GIS)

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Introduction.

This study aims to evaluate the dynamics of urban growth in the city of El-Kala, Algeria between 2008 and 2024 using a diachronic approach based on geographic information systems (GIS) and remote sensing. The objective is to quantify and spatialize the city's expansion over this period, and identify the main drivers of this growth.

Urbanization is a phenomenon of increasing importance worldwide, as shown by the acceleration of urban growth rates at both the global and national scales. Since the Industrial Revolution in 19th century Europe, most cities have undergone rapid and successive urbanization that has induced various economic, political, social and environmental mutations.

In Algeria, urbanization intensified after independence in 1962 due to mass rural-urban migration flows towards major cities like Algiers, Annaba, Oran and Constantine seeking stability and security. This phenomenon was encouraged, directly or indirectly, by the state's industrialization and economic development policies at the time through the creation of regional development poles. Today, Algeria counts over 800 cities according to the 2008 census, up from just 209 cities in 1977. (O.N.S)

Historically, El-Kala remained a small rural town until the 1980s administrative reorganization that elevated it to the rank of district ("daira") capital, overseeing four municipalities. Its urban population doubled between 1987

(16,253 inhabitants) and current estimates of over 33,000 inhabitants, explained by strong natural growth and immigration from surrounding rural areas, secondary agglomerations and extra-municipal zones.

El-Kala and its environs now face rapid, unplanned urban sprawl to meet growing housing, equipment and infrastructure needs. However, the city encounters numerous development challenges, notably due to the presence of protected natural areas. Urbanization occurs through the spread towards lower priority zones established in the municipal development plan.

Methodology and Tools of the Study

1. Research Methodology

1.1 Research Approach

This study employs a descriptive research methodology, which involves observing, documenting and characterizing the key elements of the study area. A descriptive research approach is well-suited for capturing the current state of a phenomenon like urbanization.

1.2 Data Collection

Primary and secondary data sources were used. Field observations and surveys facilitated the collection of detailed geographical, demographic and socio-economic data on El-Kala municipality. Topographical maps, aerial photographs and satellite imagery from 2008 to 2024 were analyzed. Demographic statistics from the National Statistics Office were gathered. Interviews with local officials provided insights into drivers of urban growth.

1.3 Historical Context

Integrating the historical dimension was important to analyze the causes and consequences of urban sprawl in light of El-Kala's particular regional identity and local factors over time.

1.4 Spatial Analysis

A Geographic Information System (GIS) was used together with remote sensing technology. ArcGIS software facilitated the mapping and spatial analysis of urban expansion in El-Kala commune between 2008-2024 through a series of thematic maps. This enabled the visualization and measurement of changes to urbanized areas and their impacts on the natural environment over the study period.

1.5 Expected Outputs

The multi-method approach integrating descriptive research, GIS mapping, historical context and stakeholder consultations aims to provide a comprehensive understanding of the dynamics, patterns, determinants and impacts of urban growth in El-Kala municipality.

2. Study Area Presentation

2.1 Presentation of El-Kala city

El-Kala is a coastal city located in the extreme northeast of Algeria, with origins predating the French colonial presence established in 1830 like most Algerian cities. It existed well before under the name of Marssa El Kharaz in the 10th century with the Arab invasion of North Africa, then under the name of El-Kala, principally linked to fishing and coral commerce.

The current El-Kala municipality occupies a strategic geographic position 86 km from Annaba, 20 km from the province capital El Taref, and 23 km from the Algerian-Tunisian border. The municipality lies along a trans-Maghreb and Mediterranean trade corridor centered around an east-west axis (RN 44 and CW 109) connecting Annaba province with Tunisia. It is also 10 km from the east-west highway A1.

El-Kala has a fishing port constructed in 1925 with 800m of usable dock, and a new fishing port delivered in 2019 with 780m of dock and a capacity of 142 slips, later extended to 166 slips. It opens onto the Mediterranean Sea along a 56.7 km coastline and covers 292 km², of which 69.12% or 20184 hectares are forested. El-Kala represents the largest municipality in El Tarf province, covering 8.75% of the total provincial area.

The forests in this region represent an undeniable asset with an area of 166,311 ha, including 20,184 ha in El-Kala municipality alone, home to numerous species such as cork oak, Zen oak and poplars.

El-Kala municipality is bounded by:

- The Mediterranean Sea to the north
- Souarekh and Raml Souk municipalities to the east
- Ain El Assel municipality to the southeast

- El-Taref and Bouteldja municipalities to the south
 - Berrihane municipality to the west and southwest
- The geographic location is presented in the map below

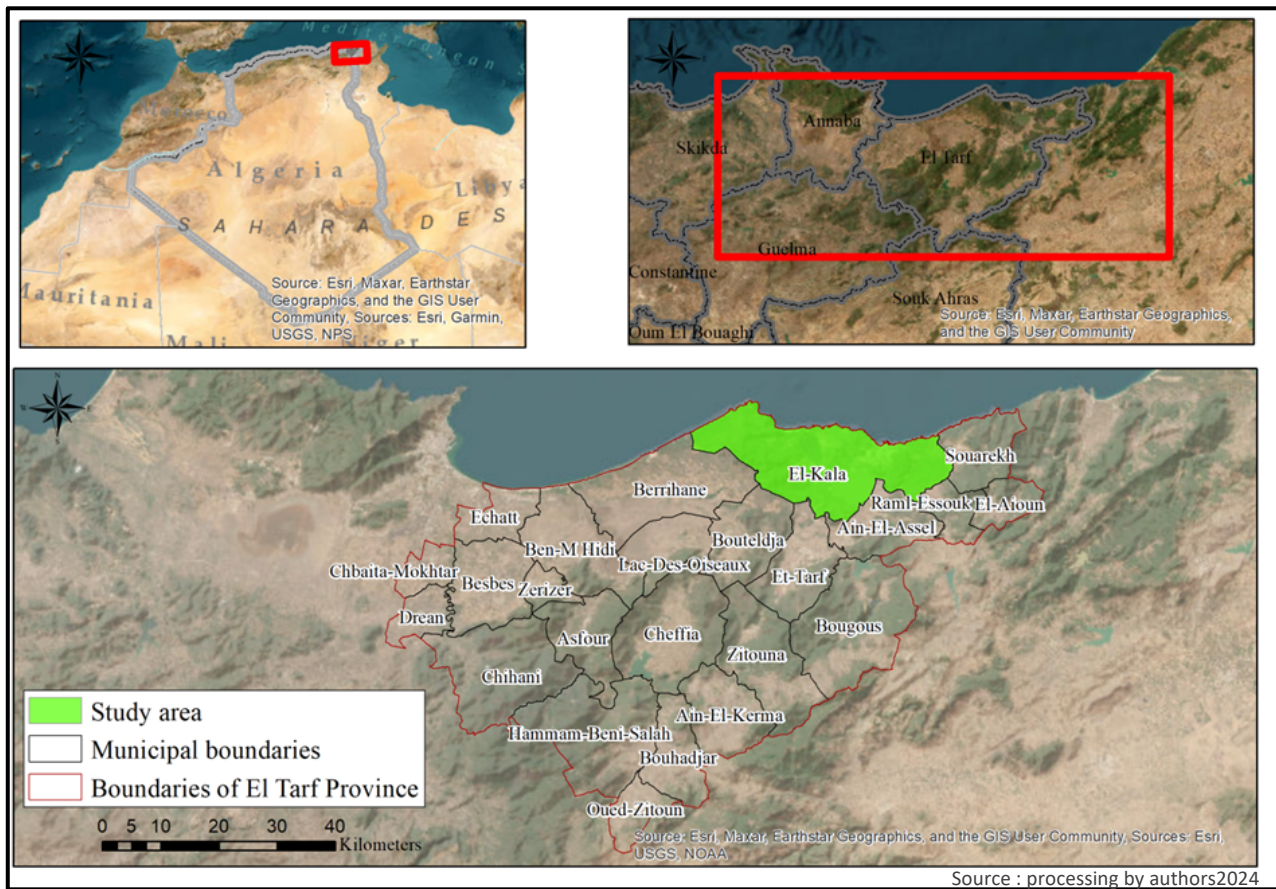


Fig. 1. Geographical Situation of El-Kala Municipality

It is important to point out that the town, which lies entirely within the El-Kala national park, is experiencing enormous difficulties in containing its urban expansion and economic development.

2.2 Presentation of El-Kala National Park

The El-Kala National Park (PNEK) is one of the world's unique parks in terms of its diversity, fragility and ecological richness. It comprises four ecosystems: forest, marine, dune and lake, with a total surface area of 76,438 hectares and a coastline of around 45 km.

The PNEK falls entirely within the Wilaya of El-Taref, i.e. 26% of the total surface area, and includes 09 communes (El-Tarf, El-Kala, Ain El-Assel, Souarekh, El-Aioune, Berrihane, Raml Souk, Bougous and Bouteldja), six of which are fully integrated into the PNEK.

The park is located in the extreme north-east of the country, bordered to the north by the Mediterranean Sea and to the east by the Algerian border.

- To the east by the Algerian-Tunisian border
- To the south, the Medjrda mountain range
- To the west, the Oued Bougous watershed and the commune of Taref.

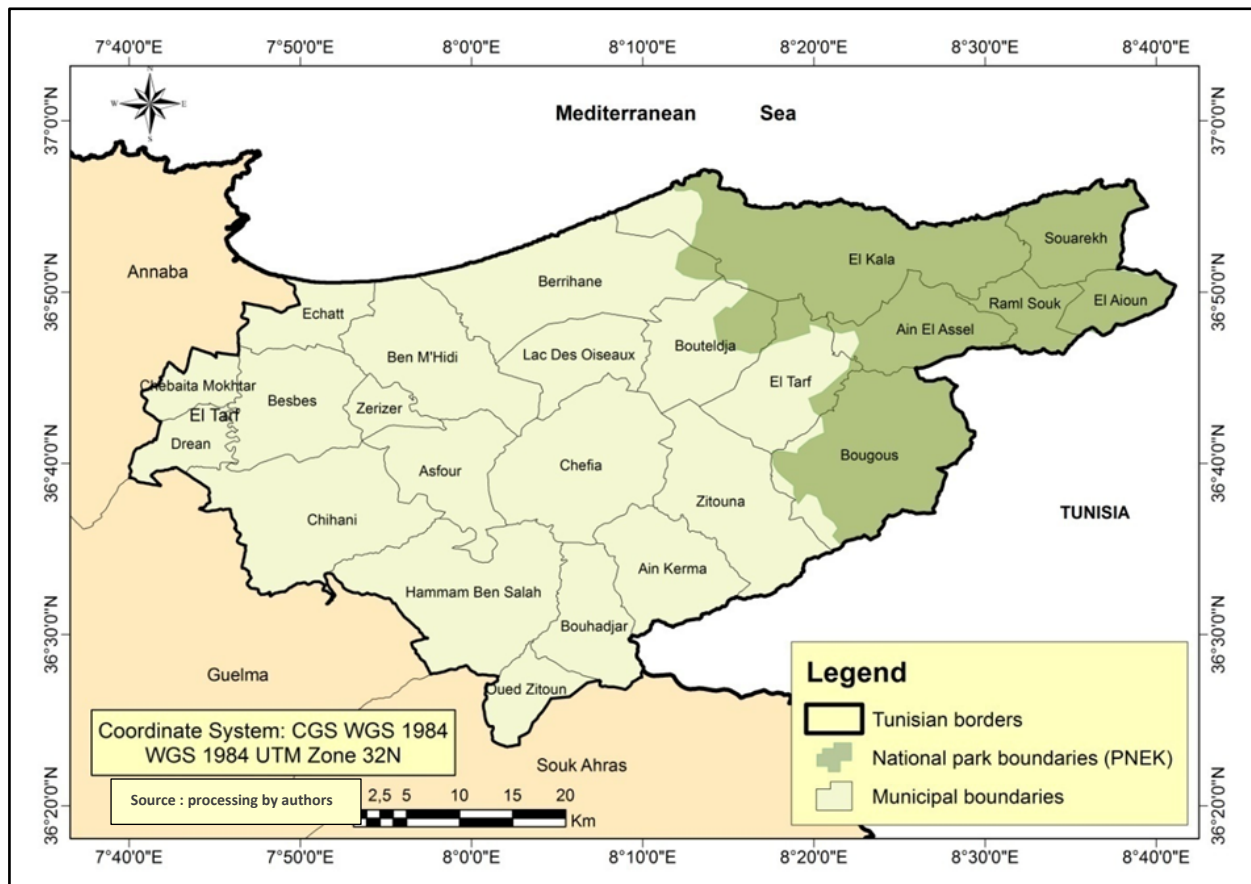


Fig. 2. Geographical Situation of the National Park of El-Kala

Results and Discussion

1. The PNEK in the legislative context

To protect this natural mosaic, the PNEK has undergone a succession of national and even international classifications, starting with the creation of the El Kala National Park under Decree N°83-462 of July 23, 1983, under the supervision of the Ministry of Agriculture and Fisheries.

Two of the park's numerous wetland sites have been included in the Ramsar list of Wetlands of International Importance as waterfowl habitat:

- On April 11, 1983; the integral reserve of Lake Tonga with a surface area of 2700 hectares.
- November 04, 1983; the Lake Oubeira integral reserve with a surface area of 2200 hectares (Ramsar data sheet, 2018).

The park was classified as a National and Cultural Heritage Site and World Biosphere Reserve by UNESCO on December 17, 1990, with the aim of preserving biodiversity by drawing on scientific knowledge, local skills and governance to achieve sustainable development.

A number of sites have subsequently been included on the Ramsar list:

Table 1. List of Ramsar sites in El-Kala National Park (PNEK)

Sites	Classification date	Area (Hectare)
Black lake bog	06 April 2003	 <i>Fig. 3. Black lake bog (05ha).</i>
Alder Ain Khia	04 June 2004	 <i>Fig. 4. Alder Ain Khia (180ha).</i>
Integral reserve lake El Mellah + Lake blue	12 December 2004	 <i>Fig. 5. Lake El Mellah+Lake blue (2257ha).</i>

Source: Ramsar fact sheet published on May 09, 2019, updated version+ Pictures from El-Taref Environment Department.

Contrary to the objectives set by the State for the protection and safeguarding of national parks, the East-West freeway linking the Tunisian border to the Moroccan border, which stretches over a distance of 1216 km, crosses the PNEK over a length of around 20 Km, posing a threat to the park and its biodiversity.

The passage of the latter is superimposed on Zone III, now a low-growth zone for animal and plant species, where all human intervention is prohibited.

A hard-fought debate ensued between the various stakeholders, on the one hand for the preservation of the PNEK and on the other for the realization of the route, which would contribute to the development of the region, given the importance of such a project for the regional economy.

Since 2008, construction of the 80 km section linking the Dréan commune to El-Aïoun in the same wilaya has encountered a number of technical, financial and management problems. It was only in August 2023 that this section was completed and inaugurated by Prime Minister Aïmne Benabderrahmane (press, 2023).

2. Assessment of Growth in El-Kala city (2008-2024)

2.1 Demographic process

The distribution of the population of the El-Kala region between rural and urban areas was reconfigured between 1962 and 1970. A migratory flow took place from agricultural areas towards the regional urban center, the town of El-Kala. This demographic dynamic, reflected in an exodus from rural to urban areas, helped to increase the demographic weight of the municipality of El-Kala over this period. In this way, the displacement of the population that used to live in the countryside, particularly those from the agricultural sector, has contributed to the quantitative development of the urban component at the expense of the rural environment in this region.

Indeed, migration is seen as one of the main drivers of urban growth, with people moving from rural areas to cities in search of better economic, educational and social opportunities.

Statistical data released by the National Statistics Office also reveals an exceptional demographic trend concerning the municipality of El-Kala over the period 2008-2024. Population trends in this urban area show a relatively moderate rate of natural increase over the years, in contrast to the dynamic observed in many Algerian urban centers in the decade following the country's accession to international sovereignty in 1962.

Unlike these other localized entities, where the demographic masses were marked by substantial growth, the town of El-Kala seems to have maintained a more measured and constant demographic progression over the long term, as shown by the differences in the curves presented by the demographic distribution graph over the period under consideration.

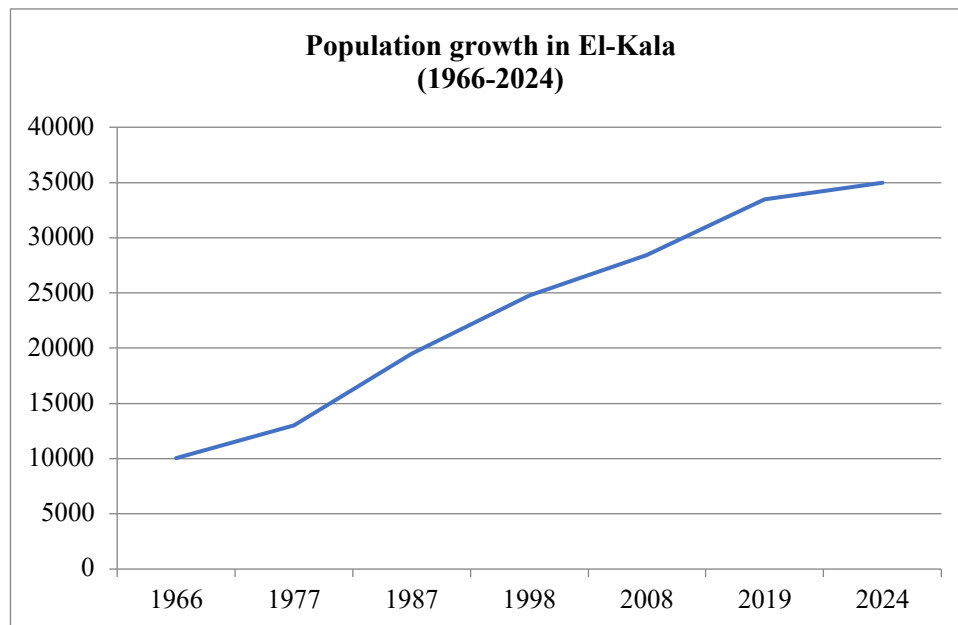


Fig. 6. Demographic evolution of El-Kala city 1966-2024

Source: Researcher's treatment based on data from the municipality of EL-Kala, 2024

2.2 Economic growth process

The economic sector in the wilaya of El Tarf appears underdeveloped, given the latent potential of certain key sectors such as fishing and tourism.

In fact, these strategic activities are mainly exploited informally in a poorly structured economy, where unregistered activities account for about half of all productive activities in this part of the country.

Furthermore, the dominance of the tertiary sector, which employs almost 80% of the working population, is dictated by the prominent role of the public sector, particularly through the number of employees in government departments and public enterprises.

Private companies, for their part, continue to focus mainly on trade and services, while industry is still in its infancy, limited to a few small-scale activities involving the processing of the region's natural resources, such as wood and coral.

The socio-economic diagnosis of this coastal region therefore highlights the incompleteness of its development, the apparent dependence on the public sector and the lack of optimal development of the sources of economic opportunity that would promote a diversified structure generating sustainable growth.

2.3 Spatial growth of the town of El-Kala

In order to delimit the spatial evolution of the city of el-kala between 2008 and 2024, we used a digital cartographic support, geo-referenced satellite images which show the expansion of the city in the two dates mentioned above, allowing us to define the urban limits of the city in each given period.

Using the ArcGis software package, we were able to superimpose the urban boundaries of the two dates, one on top of the other, to give a synthetic view of the spatial changes observed. Between these two dates, different colored zones highlight the transformation of land use, which represents an extension of built-up areas outside the pre-existing urban boundaries of 2008, confirming a trend towards urban expansion accompanied by a densification of the inner areas of the city.

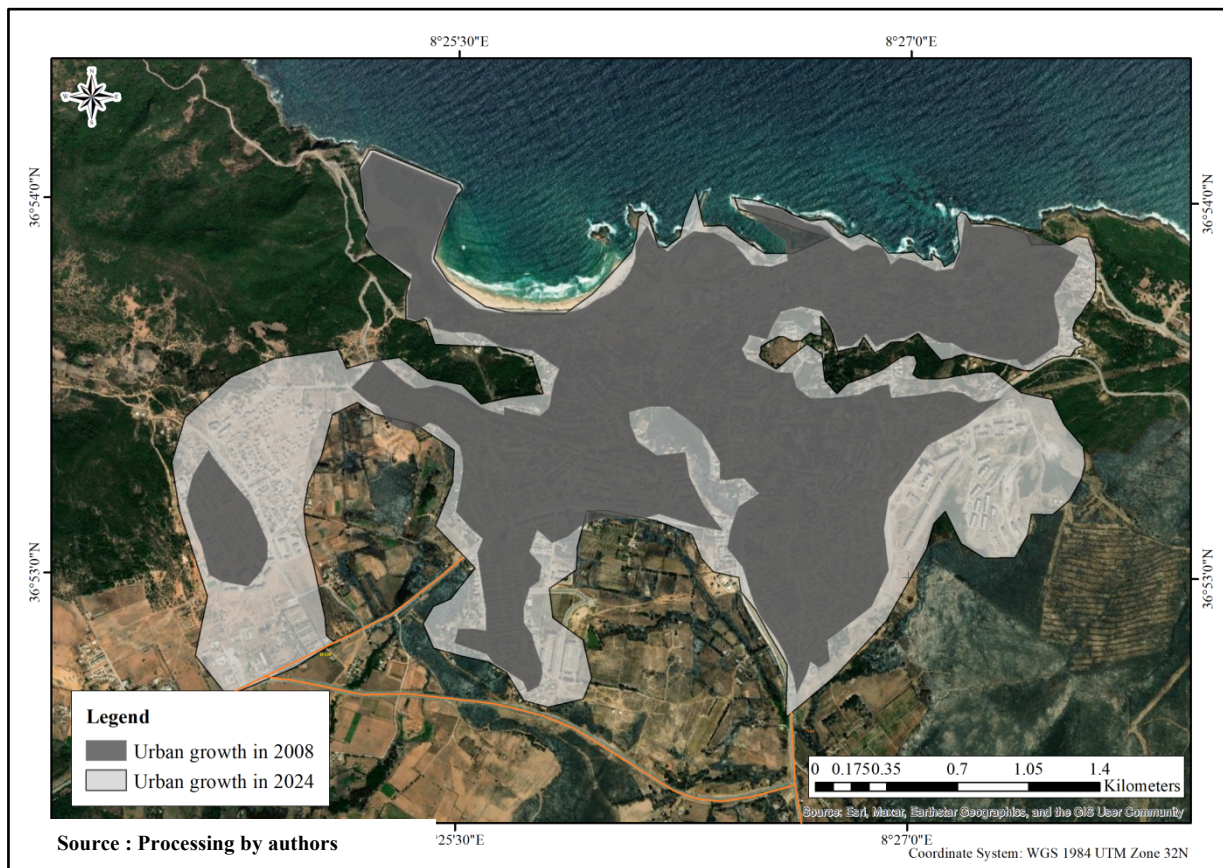


Fig. 7. Urban Growth in El-Kala City, 2008-2024.

This phenomenon reflects the continuing urbanization process, which is taking place in a south-westerly (road W109) and south-easterly (road N44) direction, essentially along the main roads.

Many factors have contributed to driving and sustaining this expansion over the period under consideration. Above all, the city's constant demographic growth has mechanically increased the need for housing, and the government's housing policy has encouraged this growth.

In addition, a local economic boost through the creation of small businesses and the new fishing port has been able to boost the attractiveness of El-Kala and generate moderate new employment opportunities.

Conclusions

The study shows that, we can see that, despite a low and constant population and limited economic development, there is a significant waste of space in certain areas. The map (Fig.7) above also highlights this

problem, showing that urban sprawl on the outskirts of agricultural land poses a real problem, especially in a region where the majority of the population depends on agriculture, fishing and craft industries for their livelihood.

This situation is exacerbated by the expansion of urban areas towards the PNEK national park, a world-renowned nature reserve classified and protected by Algerian law.

Although numerous urban planning programs are planned by the State to control development, they appear to be ineffective in the face of the pressure exerted on these fragile areas. Urban planning laws and instruments, although abundant, struggle to protect this precious territory effectively. The fragility of ecosystems and the importance of preserving these lands for ecological and economic purposes are crucial issues. It is vital to strengthen protection policies and allocate adequate resources to monitor and enforce existing laws.

In addition, it is crucial to raise public awareness of the importance of keeping these nature reserves intact, and to develop sustainable development strategies that take into account both human and environmental needs.

In conclusion, this study underlines the importance of careful management of territorial resources, in order to remedy this waste of space, encourage more harmonious development and respond to current demographic and economic challenges.

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