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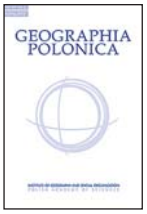
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WHAT STRATEGIES MAKE COMPATIBLE THE STAKES OF NATURE CONSERVATION AND THE STAKES OF ECONOMIC GROWTH IN PROTECTED AREA? EXAMPLE OF EL KALA NATIONAL PARK, ALGERIA

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Abstract

Public policies to protect natural environments are becoming increasingly integrated in many countries. However, in some countries, nature management policies do not pay much attention to issues raised by local populations, especially development issues. These seem often incompatible with the logic of protection of nature defended by the national administrations. Recent studies show that there are ways to make these issues compatible. The knowledge on this subject is still weak for the southern shore of the Mediterranean region. Our study focuses on the case of a natural park located in the northeast of Algeria: the sector of the El Kala National Park (EKNP). This territory faces a double strategic ambition: to strengthen the protection of nature but also to develop the agricultural economy and tourism. Our method relies on the analysis of 3 types of data: national statistics of Algeria, conservation and development strategy documents and satellite data. Our study shows an increase in the area of EKNP vegetation between 1995 and 2005.

Key words

conservation • tourism • protected areas • local development • El Kala National Park • Algeria

Introduction

The Mediterranean region is facing a growing population with an increasing demand for food and space (Malek et al. 2018). This evolution has an impact on one of the world's biodiversity hotspots. As indicated in Table 1, a large number of authors report the vulnerability of the natural environments of the Mediterranean region. This exceptional

Table 1. Table on taking into account threats to the biodiversity of the Mediterranean regions

The Mediterranean region is, nowadays, one of the most significantly altered hotspots in the world		Medail & Quezel 1997; Facucci et al. 2007; Kefi et al. 2007; Lefevre et al. 2013; Medail 2017; Malek et al. 2018
In the Mediterranean regions climate change causes significant impacts on biodiversity	Biodiversity loss	Klausmeyer & Shaw 2009; Lefevre et al. 2013
	Climatic changes have caused or contributed to tree mortality	Lefevre et al., 2013
	Climatic changes increase the frequency and intensity of extreme events	Quezel & Medail 2003; Lefevre et al. 2013
The Mediterranean region has been affected by anthropic disturbance for thousands of years and the pressure of human societies is, nowadays, responsible for the erosion of biodiversity, and natural resources		Brandt & Thornes 1996; Ribeiro et al. 2004; Facucci et al. 2007; Rudel 2011; Lefevre et al. 2013; Malek et al. 2018

biodiversity is highly threatened and is subject to the impacts of climate change (Malek et al. 2018), forest fires (Held and Montero Küpper 2001) and land clearance (Lefevre et al. 2013). Kefi et al. (2007) claim an imminent desertification.

Public policies to protect natural environments are initiated by international organizations and are increasingly integrated in many countries. At the country level and at local government level, there is a regulation for the protection of species (Abman 2018). As demonstrated by Joppa and Pfaff (2010) and Abman (2018), these nature protection policies are rooted in protected areas. IUCN defines categories of protected areas (Abman 2018) according to the intensity of protection. In parallel, some of the protected areas receive labels such as the MAB-UNESCO label. Then nationally, each country constitutes its methods of labeling, national and regional parks, reserves, etc. (Joppa & Pfaff 2010). However, as said by Joppa and Pfaff (2010) and Lefevre and al. (2013), they often focus on limited areas. However, as said by Venter et al. (2008), in some countries, nature management policies do not pay much attention to issues raised by local populations, especially development issues. These seem often incompatible with the logic of protection of nature defended by the national administrations. As presented by Pyke (2007), there is a frequent contradiction between development issues based on the growth of usual economic activities and nature conservation issues. Recent studies show that there are ways to make these issues compatible. It is not a question of giving priority to one or the other but of bringing the two together while moving towards an integrated management of the protected territories. This requires a shift in the economic approach and the nature conservation approach. Significant changes have been initiated since the early 2000s with the integration of sustainability strategies into protected areas, as shown for example by Venter et al. (2008). If the knowledge on this subject progresses for the countries of northern Europe and also for example in southern Africa where exemplary cases are described (Venter et al. 2008), the knowledge is weaker for the southern shore of the Mediterranean region (Held & Montero Küpper 2001; Malek et al. 2018). The question of erosion of biodiversity is well understood by most countries bordering the Mediterranean. But it faces other priorities.

Our study focuses on the case of a natural park located in the northeast of Algeria: the sector of the El Kala National Park, also known as EKNP (Fig. 1). This territory faces a double strategic ambition: to strengthen the protection of nature but also to develop the agricultural economy and tourism. The question at stake is that of compatibility: how are the two issues compatible? What

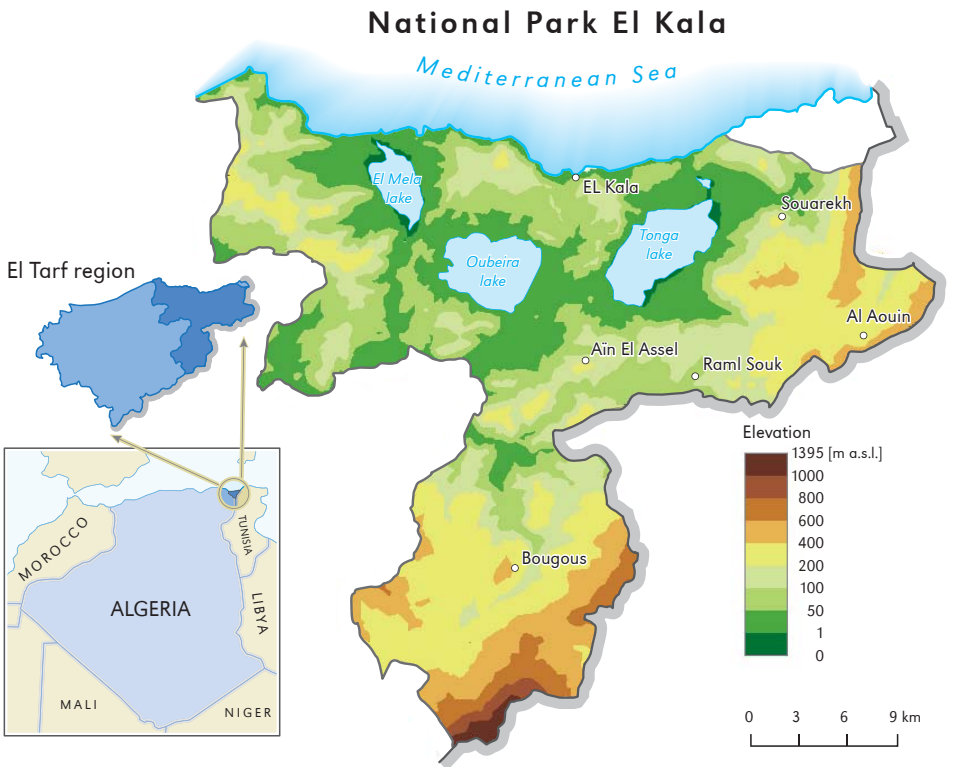


Figure 1. Location map: El Kala National Park, second largest park on the borders of eastern Algeria

elements make it possible to measure the efforts undertaken? What innovative solutions can be suggested based on experiences from other nearby or similar territories?

This paper proceeds as follows. Section 2 presents the area studied, the EKNP. Section 3 describes the method and the data used for estimation of the changes in the parameters studied for a little over a decade. Section 4 presents the results of these changes. Section 5 discuss them. The paper then concludes with final remarks and suggestions from the scientific literature and presenting integrated management practices in protected areas.

Study area

Created in July 1983, the El Kala National Park, located in the extreme northeast of Algeria, covers an area of about 800 km^2 spanning both the coastal plain and mountainous hinterland. The coastal plain corresponds to a low, sandy coast with dune cords insulating lagoons. The coastal plain is made up of alluvial deposits. It is occupied by 3 lakes (Lake Mellah, Lake Oubeira and Lake Tonga). The southern half consists of a mountain rising to 1395 m above sea level. It is a mountain consisting of sandstone/gray flysch generating leached brown soils. Some areas are covered with forests that protect the mountain against erosion. These are forests of Aleppo pines and Mediterranean oak. The rainfall varies from 900 to 1200 mm/year (Bouazouni, 2004). All contains a mosaic of ecosystems made up of forests and wetlands, and all of them constitute a complex that is considered unique in the Mediterranean basin. The flora is characterized by a particularly high rate of endemic, rare and very rare

species (De Belair 1990). Its faunal wealth is no less spectacular (Ouelmouhoub 2005): 189 species of birds, of which 21 are raptors have been documented there (Benyacoub & Chabi 2000). Most notable are the wetlands, which are internationally renown, with 5 featuring on the RAMSAR wetland convention list. These include Tonga Lake, Lake Oubeira and Lake El Mellah (Fig. 1). The EKNP represents the largest protected area in northern Algeria and also the richest in biodiversity. These features have earned it the international status of Biosphere Reserve by UNESCO in 1993.

Materials and methods

As illustrated in Figure 2, our method relies on the analysis of 3 types of data: national statistics of Algeria according to its National Office of Statistics (NOS), conservation and development strategy documents and satellite data. Satellite data is used to measure the evolution of natural environments to measure the effectiveness of management measures. Then the results are confronted with the international scientific literature.

Analysis of socio-economic statistics

The Algerian National Office of Statistics make it possible to evoke the socioeconomic realities of the EKNP. We studied national statistics. These give little information on the territory of EKNP. In particular, tourism data are very poorly developed. We have therefore examined the data at our disposal, those relating to the modes of occupation of space, natural areas of forests and agriculture.

Analysis of conservation and local development strategy documents

Public documents concerning nature conservation and development strategies are studied using the TROPES software. We identify the words used to classify the documents by a notation system. Strategies for EKNP are compared to three other parks in three other countries. We studied strategies for tourism and agricultural development and nature protection strategies. The study of planning documents of the Algerian State (Tab. 2) allowed to take note of these strategies concerning the EKNP.

Then we wanted to compare them to documents that specify these strategies of other parks, taking two examples of natural parks in the Mediterranean region, the PNR Camargue, the Montsant Nature Park in Spain and the Kruger Park in South Africa. For these documents we have selected elements in the texts that allow to define notes for elements of strategies. These data are rated on a scale from -1 to +1, with negative ratings indicating a lack of a strategy for protecting nature and biodiversity. The two notes on development contrast strategies rated +1 when strategies are oriented towards the sustainable development of tourism and agricultural development and -1 when it is a question of productivist and intensive strategies giving little priority to sustainability. We add a note on the use of consultation process, +1 when the

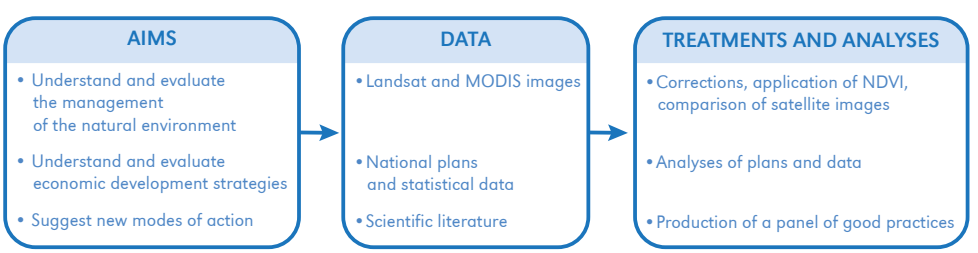


Figure 2. Working method

Table 2. List of documents related to nature conservation and economic development strategies

Number	Name in the text	Reference
1	CDP – Coastal Development Plan	Geosystem consulting, 2013. *Etude pour l'élaboration du plan d'aménagement cotier (Wilaya d'El Tark).* Ministère de l'Aménagement du Territoire et de l'Environnement, Alger.
2	Bouazouni	Bouazouni O., 2004. *Projet régional pour le développement d'aires marines et côtières protégées dans la région de la Méditerranée, Parc National d'El Kala, étude socio-économique du PNEK.* United Nations Environment Programme, Mediterranean Action Plan, Regional Activity Centre for Specially Protected Areas.
3	EKNP Zoning	Ministère de l'Aménagement et du Territoire et de l'Environnement, 2008. Zonage du parc national El Kala, Alger.
4	SDAT	Ministère de l'Aménagement du Territoire, de l'Environnement et du Tourisme, 2008. Schéma Directeur de l'Aménagement Touristique, "SDAT 2025", Alger, 5 volumes.
5	Kruger Park	Venter F.J., Naiman R.J., Biggs H.C., Et Al Pienaar D.J, 2008. *The evolution of conservation management philosophy: Science, environnemental change and social adjustements in Kruger National Park.* Ecosystems, vol. 11, no. 2, pp. 173-192.
6	Camargue PNR	Parc Naturel Régional de Camargue, 2010. *Charte. Objectif 2022. Rapport Vol. 1.* http://www.provence-plaisirs.com/pdf/charte_parc_naturel_camargue.pdf [28 Feb. 2019].
7	Montsant Agenda 21	Generalitat de Catalunya, 2009. Agenda 21, Parc Natural de la Serra de Montsant.

procedures are developed, -1 when they are absent. Intermediate scores are awarded: 0.75 when the trend is very good, 0.5 when it is acceptable, 0.25 when it is ok, 0 when it is average, -0.25 when the strategies are not very sustainable, -0.5 when they are insufficient, -0.75 when they are almost non-existent. These data are gathered in two columns which make it possible to constitute two axes in the figure representing each strategic document by a point: an axis of the intensity of the note with respect to the strategies of protection of the nature and an axis concerning the strategies of development more or less durable to which is added the note concerning the consultation. We have collected all the metadata in Table 3.

Satellite data analysis

The issue here is to understand how vegetation cover evolved over the 20-year period 1995-2015 using data from satellite imagery. The evolution of vegetation cover is analyzed by processing LANDSAT images from 1995, 2000, 2005, 2010, 2015 and MODIS images for the years 2000, 2005, 2010, 2015. The objective is to evaluate successive states of vegetation cover from cartographic data (Pech et al. 2007; Matuszkiewicz et al. 2013) and to question the impacts of management methods.

The metadata displayed in Table 4 is complementary and indispensable digital information for the interpretation, comparison and processing of satellite images. Other information, such as the elevation and the azimuth of the sun, makes it possible to provide radiometric corrections and thus to improve the reflectance of certain themes of the surface of the earth. Indeed, the images here selected have a very good quality with a minimum of estimated cloud cover close to 0%.

The choice of LANDSAT images was based primarily on their availability on NASA websites. Satellite sensors are usually exposed

Table 3. Metadata and interpretive data from strategic documents

Metadata	Nature protection strategy, nature management methods in general and integration of environmental concerns	Strategy for protecting biodiversity, ways of managing biodiversity	There are two types of tourism approaches and management. To +1, the recommended and regulated practices in the protected area are sustainable, respectful of the environment, using environmentally friendly accommodation and conversely intensive tourism development strategies are noted -1	There are two types of agricultural development. If the practices recommended and regulated in the protected area are sustainable, using few fertilizers and chemical weed killers, with organic farming and valorization of the local productions, we note +1, and opposite – the intensive agricultural practices and productivism are rated -1	The practices of citizen participation in the development of management plans are noted +1 and their complete absence is noted -1	The average score is calculated for nature and biodiversity protection strategies	The average of agricultural and tourist development modes and concertation practices are calculated
	nature protection	protection of biodiversity	development of the tourist industry, tourist complexes vs sustainable tourism	sustainable agriculture vs Growth of intensive agricultural production	participation of local actors	nature protection issue	local development
Number (Tab. 2)							
1	-0.75	-0.75	-0.75	-0.75	-0.75	-0.750	-0.75
2	-0.25	-0.50	-0.50	-0.75	-0.75	-0.375	-0.67
3	0.75	0.75	-0.75	-0.75	-1.00	0.750	-0.83
4	-0.75	-1.00	-0.75	-0.75	-1.00	-0.875	-0.83
5	0.75	0.50	0.75	0.75	0.75	0.625	0.75
6	0.75	0.75	0.75	1.00	0.75	0.750	0.83
7	0.75	0.75	0.75	0.75	0.75	0.750	0,75

Table 4. Main Landsat image metadata used (all scenes are diurnal; map projection: UTM)

Metadata	Date 1	Date 2	Date 3	Date 4	Date 5
Landsat chosen scene	LT519203519951 98MPS00	LE71920352000 188FUI00	LE71920352005 185EDC00	LT51920352010 191MPS00	LC81920352015 189LGN00
Sensor	Landsat 4-5 TM	Landsat 4-5 TM	Landsat 4-5 TM	Landsat 4-5 TM	Landsat 8 OLI
Acquisition date	17 July 1995	6 July 2000	4 July 2005	10 July 2010	8 July 2015
Quality of acquisition	7	9	9	9	9
Sun height	55.1625227	65.05884552	64.8292847	64.53377498	66.38993346
Sun azimut	105.135257	115.85044861	114.7677917	116.13576737	118.9491555
Datum	WGS84	WGS84	WGS84	WGS84	WGS84

to atmospheric effects (clouds, dust and other meteors) which makes vision and image interpretation sometimes difficult. We selected images that were almost undisturbed by cloudiness. In addition, we chose to focus on images of identical months to make our comparison more robust. This is why we have chosen the month of July for the available years of our study period. The aim is to focus on the state of vegetation in the Mediterranean region just at the time of summer hydric stress. Our goal is to measure whether there has been a positive evolution of forest cover over the last decades. With the selected images, our study takes into account variations in inter-annual weather conditions. These conditions have an impact on the state of water availability in soils for plants. However, according to the scientific literature, forest cover, and the mosaics of natural landscapes that accompany it, in regions with a dry season climate are less affected by variations in inter-annual climatic conditions than by local soil conditions, especially soil water holding capacity (Gergel et al. 2007; Pueyo et al. 2012). In this study, images of the Moderate Resolution Imaging Spectroradiometer (MODIS) were also used on the NASA TERRA satellites designed for the study and monitoring of the broadscale environment (biosphere, hydrosphere, atmosphere) with a spatial resolution of 250 m (for red and infrared from 0.6 to 0.9 μm). MODIS has a very good radiometric resolution (12bits) and captures images of the surface of the globe in 36 spectral bands ranging from visible (405 nm) to thermal infrared (14.385 μm). Normalized Difference Vegetation Index (NDVI) data is usually used to track ecosystem states and changes, with an analysis of the relationship between precipitation and the temporal evolution of this indicator (Kozuchowski & Zmudzka 2001; Vagen 2006; Williamson et al 2012).

To maximize the benefits of satellite imagery, it is necessary to reduce or eliminate errors embedded in sensor data, atmospheric and lighting effects, and improper image overlay. For the present study, the radiometric and geometric corrections were applied to the LANDSAT TM and OLI images used, for useful predictive parameters.

Defined by Tucker (1979), NDVI is a vegetation index commonly used in vegetation monitoring studies. There are many applications of NDVI, Normalized Difference Vegetation Index (Pettorelli et al., 2005): deforestation assessments, forest fire monitoring, desertification monitoring, and even insect damage (Jepsen et al 2009). The NDVI is used to detect vegetation cover. It is calculated from spectral reflectance measurements in the red band in combination with near-infrared regions and is derivable with the equation:

$NDVI = ((IR - R) / (IR + R))$
(Tucker 1979; Myneni et al. 1995)

Where *IR* is the pixel values of the infrared channel, between 0.55 and 068 μm, and *R* is the pixel values of the red channel, between 0.73 and 1.1 μm. The theoretical values of *NDVI* are between -1 and 1 (between 0.1 and 0.9 for vegetation) (Doll 2010). Huete et al. (2002) consider that this index is sufficiently stable enough to allow comparisons of plant activity at seasonal or inter-annual time steps.

Change detection is the process of identifying the variation of an object or phenomenon over time, observing it at different times. It involves the ability to quantify temporal effects using multi-temporal datasets (Kożuchowski & Żmudzka 2001). The 'change detection' operation consists of subtracting the NDVI values from a first image (or anterior image) to the next (or posterior image), pixel by pixel, then determining the comparison classes according to the degree of change between the two (Mariotto 2010).

NDVI (*Xi*) – *NDVI* (*Xj*) =
= Change detection (*Xij*) (Mariotto 2010)

Where *Xi* are the pixels of the previous date; *Xj* are the pixels of the following date; *Xij* is the difference in pixels between dates *i* and *j*.

There are generally three classes:
- Pixels with a value greater than 0 reflect areas that have experienced vegetation enrichment from date *I*;
- Pixels whose value is 0 are the areas that have not changed during the period *i-j*;
- Pixels with a negative value correspond to places where the vegetation cover has regressed.

Results and discussion

Analysis of socio-economic statistics

The study focuses on the socio-economic evolution of the EKNP. According to the statistical data, the EKNP experienced a population growth from 126,781 inhabitants in 2008 to 141,920 inhabitants in 2015. This growth (12%) is part of a general growth for decades in Algeria. This protected area is not an empty rural area. The human density is high with a rate of 128 inhabitants/km^2 in 2015. However, population growth is concentrated in the areas of the coastal plain. Agricultural activity has grown strongly for several decades. Algeria entered the agricultural revolution early, with widespread modernization of crops and some forms of livestock farming, including cattle breeding for milk and meat production. The EKNP is characterized by a development of a productivist agriculture essentially in the north, in the coastal plain. There is, however, extensive livestock rearing of sheep grazing pastures in the mountains. Yet, there is no agriculture oriented toward organic or rational production.

However, the EKNP is a heavily forested area for Algeria with 69% of its area. The cork oak forest with 36% of this area and the eucalyptus forest with 37% dominate in the mountainous regions, to the south. The forest is old but it does not give rise to any productive management. On the other hand, forest fires represent a destruction that affects on average 10% of the forest area of EKNP per year (Bouazouni 2004).

Tourism activities are mainly concentrated on the coast. All of the current accommodation structures are located in the north. Statistics are failing on this sector. Yet a mass of tourists come in summer on the beaches of the coast. They are essentially nationals. Algeria has developed tourism but major development plans concern an industrial tourism activity (SDAT – see Tab. 2). This is reflected in the projects of seaside resorts. The goal is to enable the employment in tourist economy and development of the construction industries. However, since the SDAT (2008), the projects of creation of tourist resorts on the coast of the EKNP did not succeed. This reflects the important contradiction between tourism potential and investment capacity. Public policies aim at the creation of large seaside resorts. On the other

hand, no strategy is developed towards sustainable tourism in relation to the potential of the protected area.

Analysis of conservation and local development strategy documents

Strategic documents concerning nature protection and local development have been studied and a representation of the data in Table 3 is given in Figure 3.

According to Table 3 and Figure 3, the four documents corresponding to the public policies of Algeria and EKNP do not integrate the sustainable development approach. In circle A, 3 documents corresponding to the three protected areas are represented: the Kruger Park in South Africa, the Montsant Park in Spain and the Camargue Regional Nature Park in France. Circle B is the document describing the nature conservation strategy of the EKNP. It aims at the protection of biodiversity but it incorporates few concerns about economic development and not at all the local consultation of the populations concerned. Circle C brings together the EKNP documents and the SDAT that specify public policies in development. The solutions are exclusively unsustainable, neither for agriculture nor for tourism. In addition, no policy of consultation of the local populations is envisaged.

Satellite data analysis

The analysis that has been conducted on annual average rainfall for each year of satellite image observations demonstrates a good linear relationship between the variability of rainfall and that of the area of vegetation. In addition, a monthly treatment of these rainfall values demonstrates that soil moisture conditions follow the same variability of rainfall and that they are the ones that also determine changes in vegetation cover. However, if the precipitation curve shows significant variations (Fig. 4), the vegetation cover follows a more stable progression between 1995-2015.

This was not without positive consequences for the hydrology of the lakes, the dynamics of aquatic vegetation, agriculture and rangeland management in recent years (Boumaraf 2010). It should be noted that this change in vegetation area is not solely due to climatic conditions and that there are other factors that have contributed to the increase in vegetation cover, in particular the effects of conservation policies.

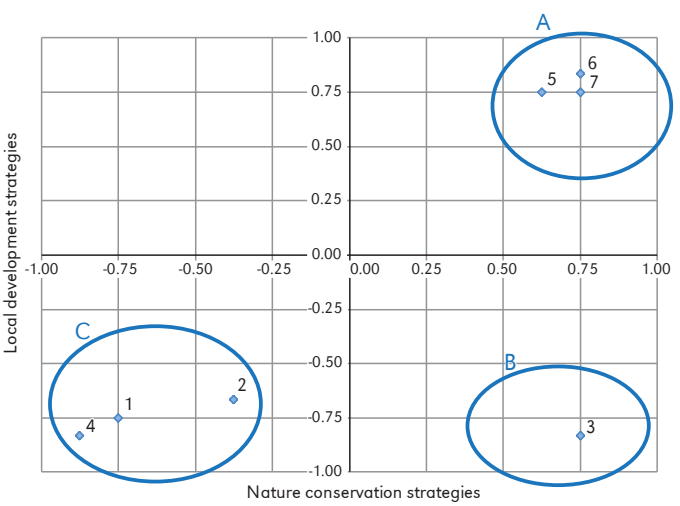
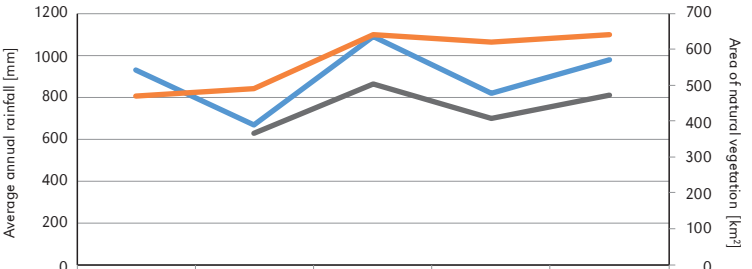


Figure 3. Representation of data corresponding to nature conservation and local development strategies (see Tab. 3)



	1995	2000	2005	2010	2015
precipitation	929	666	1088	820	980
Landsat	469.7114	490.6756	640.85	620.427	639.9747
MODIS		365	503	406	471

Figure 4. Average annual precipitation and vegetation cover curves calculated from Landsat and MODIS imagery in El Kala National Park between 1995-2015

The calculation of the NDVI index allowed us to observe and quantify the state of the vegetation in the EKNP over a period of 25 years. This analysis was applied to LANDSAT 4-5 TM and 8OLI LANDSAT images with 30m resolution. In addition, we used 250m resolution MODIS images, taken during the same periods as LANDSAT, to help us confirm the evolution of the vegetation. The results obtained by calculating the NDVI index on the LANDSAT images allowed us to observe a significant increase in the plant cover of the EKNP between 1995-2005, whereas the period 2005-2010 appears quite stable. A majority of the positive changes were located around the EKNP lakes (Lake Oubeira, Lake El Mellah and Lake Tonga). The study area is a rural area and agriculture is the dominant sector of activity, so the presence of a large number of lakes allows for a paradoxical evolution. Indeed, the lakes, and more particularly that of Oubeira, is the source of irrigation for the main crops in the region. The development of agriculture in the vicinity of Lake Oubeira has the effect of reducing lawn and forest areas (Hamouda & Tahar 2012). Vegetation outside wetlands is essentially xerophile. Rainfall variations, especially during the most abundant years, have little impact on overall vegetation. The lake area increases during the wetter period, but paradoxically this leads to a decrease in the natural vegetation due to the increase in pastoral routes increase.

The period between 1995 and 2005 was marked by an increase in the total area of vegetation from 469 km^2 to 640 km^2, an evolution of 36.46%. It is noted that shrub vegetation is the most advanced class compared to dense vegetation; this is explained by the highly developed agricultural activity in this period as a dominant sector for the local population. In addition, the regression of the class of bare ground of 280 km^2 to 101 km ^{2} (or -63%) confirms the progression of the natural and agricultural vegetation cover.

The last 10 years have been marked by a stable vegetation cover that has not undergone any major changes, apart from a significant increase in dense forest vegetation from 185.771 to 267.435 km^2. On the other hand, a small regression between 2005 and 2010 affected the shrub vegetation from 455.079 km^2 to 352.9918 km^2. This is due to various factors such as fires, and overgrazing, which affect the landscape and biodiversity of the EKNP. These facts can lead to significant degradation of some ecosystems (Bougherara 2011). Contraction of forests and extension of agricultural land are the main changes that mark the evolution of the park's landscapes or wetlands in recent decades.

The use of MODIS images was incorporated into this study to help us confirm the EKNP vegetation cover for the selected period. According to our results from the MODIS image study, there are significant positive changes between 2000 and 2005, particularly in the northern part, around the lakes where the vegetation area has increased by more than 37%, from 365 km² to 503 km² between 2000-2005.

Table 5 shows the area variations for both types of images. Since 2005, the rate of evolution of vegetation varies between regression and progression, from 503 km²

Table 5. Area of vegetation during the period selected for LANDSAT images

	Area in km² (Landsat images)				
	NDVI 1995	NDVI 2000	NDVI 2005	NDVI 2010	NDVI 2015
Dense vegetation, forest	170.6462	180.4621	185.771	267.435	171.9631
Shrub vegetation	298.7483	310.2135	455.079	352.9918	468.0116
Bare ground	280.467	253.137	101.481	121.819	105.1043
Wet area	21.24	27.76	29.19	29.46	26.63
Total	771.42	771.57	771.51	771.70	771.70

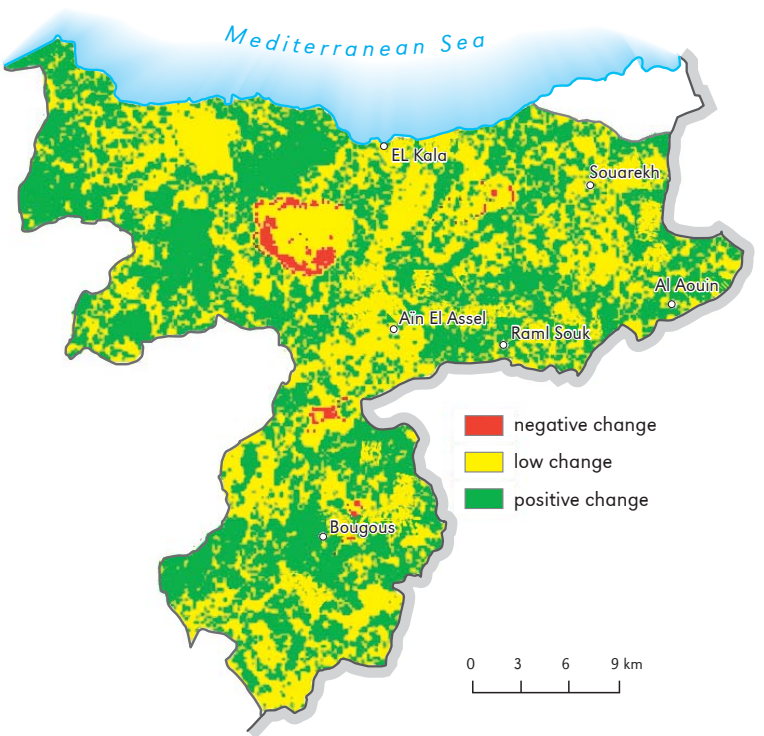


Figure 5. Vegetation changes based on Landsaet images between 1995 and 2015 from the processing of data taken from LANDSAT images

to 406 km², a regression of -23%, and then a slight increase until 2015 of 16%. Despite the spatial resolution of MODIS 250 m images, the same vegetation evolution results were observed between 2000-2015. This period was marked by an increase in vegetation area from 469 km² to 640 km², an evolution of 36.46%. On the other hand, over the last 10 years, this was a period of stability for vegetation. It has not undergone any major changes, apart from a small regression of about 2 km² between 2005 and 2010, due to the same factors as in the previous analysis. The reduction of forests and the extension of agricultural land are the main changes that mark the evolution of the landscape or wetlands of the park in recent decades. Map obtained after NDVI treatment (Fig. 5) shows changes within EKNP from 1995 to 2015. Limited negative changes have occurred in the hygrophilous vegetation cover of Tonga Lake (northeast of the park). In the same Figure, we notice that the region of Lake Oubeira (located north of the park) has experienced major negative changes. This sector has been exploited since the end of the 1970s, because of its attractiveness for agricultural activities. This increased exploitation in wetlands has led to significant degradation of its ecosystem.

In contrast, the El Mellah Lake area (northwest of the park) has had much more positive changes. These results are due to the fact that it has been spared from human activity. This evolution can be explained on the one hand by the nature of the soils, which include marine sands. On the other hand, the proximity of Lake El Mellah to the coastline, which increases the salinity of its water (Hamouda & Tahar 2012).

Conclusion

In our study, it is shown that there are two contradictory public policies concerning the case of the El Kala National Park. However, public policies of nature conservation are effective. Indeed, our study, resulting from the processing of LANDSAT images, shows an increase in the area of EKNP vegetation between 1995 and 2005 by more than 36%, or an area of 171 km². On the other hand, the observations from 2005 of the variations up to 2015 show that the vegetation did not have any significant positive changes. Indeed, an increase in the rural population has generated a radical transformation of the use of the environment: deforestation, overgrazing, urbanization and fires. Locally, the extension of irrigated crops takes place at the expense of wetlands. These phenomena profoundly disturb natural ecosystems. Safeguarding them requires the development of policies that conserve biodiversity and endangered habitats.

An important part of the EKNP has had a significant increase in its vegetation and this testifies to the effectiveness of the Algerian State's policies for the conservation of nature. Nature conservation issues concern the contribution to the preservation of the fauna and flora richness of the Mediterranean region. As has been demonstrated by Rykowski (1999), forests play an important role in reducing climate change, particularly through their carbon sequestration activity (Rykowski 1999). They also make it possible to fight against soil erosion and floods (Lefevre et al. 2013). As more and more scientists point out, the management of protected areas now involves a desire to reconcile multiple and varied issues by integrating the concerns of sustainable development, for example by promoting controlled and accepted agricultural and tourism activities by local populations (Balmford et al. 2002; Kalamandeen & Gillson 2007; Rudel 2011; Pfueller et al. 2011; Tomicevic et al. 2011). All this implies the cohabitation of areas, natural environments, wild fauna and flora, with a certain presence and attendance of temporary populations, guided or demarcated visits, or even for permanent populations occupying the area protected to practice agricultural activities in harmony with the conservation of nature (Mathevet & Mauchamp 2005; Pfueller et al. 2011; Mathevet et al. 2016).

Created in the 1970s, the global network of Man and Biosphere (MAB) reserves, led

by the United Nations, is a witness to this evolution and even the International Union for the Conservation of Nature (IUCN), International Union for the Conservation of Nature, agrees favorably, within the protected areas, for the association of nature conservation and development objectives, especially since the current approaches include the protection of the natural and cultural heritage, with the aim of safeguarding rural traditions and activities (Tomicevic et al. 2011; Mathevet et al. 2016). Particularly in Africa, such as in South African Kruger Park (Venter et al. 2008), development efforts are integrated with sustainability goals. Agricultural activities rely on traditional or non-intensive practices. Tourism practices are activities of nature tourism, such as hiking that may include insertion into the landscape, accommodation built using local materials. In some cases, as shown for Sahara by Santarem et al. (2019), innovative tools are developed to integrate biodiversity conservation dynamics with collaborative practices involving a plurality of actors (Weiss et al. 2007; Pfueller et al. 2011; Tomicevic et al. 2011; Rykowski 2012; Muhumuza et al. 2013): what Weber et al. (2012) expresses in the form of cumulative effects. Many examples exist and Algeria can follow suit according to an integrated approach of its socio-ecological systems (Balmford et al. 2002; Ostrom 2009; Tomicevic et al. 2011).

Editors' note:
Unless otherwise stated, the sources of tables and figures are the authors', on the basis of their own research.

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