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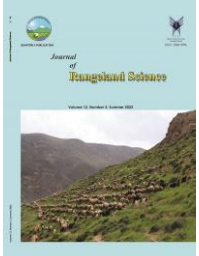

Research and Full Length Article:

The Effect of Pedo-Climatic Risks on the Evolution of Plant Cover and Soil Characteristics in Protected and Unprotected Areas in the Commune of Rogassa, Wilaya El Bayadh, Algeria

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Received on: 25/12/2020
Accepted on: 29/07/2021
DOI: 10.30495/RS.2022.683513

Abstract. Geographic techniques and soil analyses are widely used to identify the state of evolution of plant cover. In this article, we use cartography to identify the evolution of the vegetation and soil analyses in the commune of Rogasse; in the areas of El Mouwahdine, Sekine; and in unprotected sector. These areas are strongly affected by the degradation of soil and plant cover by sand advancement. In order to assess the reliability of our results, we used a map of the evolution of plant cover between 2006 and 2018. The results reveal changes in the composition of the successive colors of the surface of the study area, and the analysis of the soil demonstrated that this earth is completely sandy loam in nature, which is due to the desertification in the region. We maintain that between 2006 and 2018, the advancement of sand had a negative influence on the evolution of the plant cover in protected and unprotected areas. The phenomenon of desertification negatively influences in a rapid way on these protected and even unprotected areas is that it is necessary to introduce other species has greater faculty to face this climate change in this region and the adoption of " a long-term strategy for the protection of perennial plants.

Key words: Climatic hazards, Protected areas, Cartography, Vegetal cover, Soil analysis

Introduction

In Algeria, nearly 500,000 ha of land in steppe areas is in the process of desertification, and more than 7 million ha are directly threatened by the same process (Mate, 2002). Desertification currently affects 80% of the steppe area In Algeria. The rangelands representing 86% of the total area are also subject to degradation. The steppe region is most affected by wind erosion, due to the degradation of the plant cover. On fragile soil with an unstable structure, the wind carries fine and light particles, leaving skeletal soils with poor fertility. The Algerian steppe areas support pastoral livelihoods. Today, these regions are deteriorating, which is causing a reduction in their biological potential and ecological and socioeconomic imbalances. Desertification is a dual problem; it has both environmental and developmental characteristics. Human activity and land degradation are two of the consequences of poor development and major obstacles to the sustainable development of drylands. Several authors have identified the main causes of desertification in the Algerian steppe, such as drought, overgrazing, land clearing, the eradication of woody species, population growth, and other factors related to economic policies (Aidoud, 1996; Bedrani, 2008; El Zarev Wael 2012; Slimani, 1998).

The natural factors which are at the origin of the degradation of the steppe ranges are intimately linked to the fragility of the ecosystem of these areas. The combined action of hostile climatic factors, intensive development than perennial vegetation and edaphic factors linked to the structure and texture of the soils mean that the rangelands are subject to irreversible degradation accentuated by the phenomenon of erosion (Le Houerou, 1995).The degradation of the environment due to overgrazing and over cultivation has become irreversible, as the ecological disturbance has passed the stage of plant deterioration and reached the threshold of extensive soil degradation. We are in the presence, here, of a true desertification (Floch and Floret, 1973; Nahal, 2004).The process of desertification of arid and semi-arid rangelands causes transformations in their structure and functioning, at the level of vegetation (Aidoud-Lounis, 1997), attested by the disappearance of “keystone” species, the reduction of plant cover a change in the floristic composition (Slimani, 1998) and a decrease in fodder production (Aidoud, 1994). Le Houérou (2002), affirms that the balance of natural ecosystems has been strongly disturbed during recent decades in most arid and semi-arid regions under the effect of the modification of the systems of exploitation of the environment linked to the transformation of socio-economic conditions and changes in production techniques. In fact, following the demographic increase and the sedentarization of a growing part of the population, we are witnessing a rapid extension to agriculture to the detriment of the best pastoral areas whose natural vegetation is destroyed by mechanical means more power. This destruction is also aggravated by the increase in animal pressure on increasingly reduced pastoral areas and by the removal of wood products intended to meet fuel needs (Floret *et al.*, 1992). All these aridifying transformations of the environment are characteristic of the process of desertification of arid, semi-arid and even subhumid ecosystems and of the modifications of the energy balance resulting from the degradation of these ecosystems. Proportion of dust and aerosols in the lower atmosphere observed in particular during droughts in Africa and Asia, and the increase in the reflection of solar energy by barren arid surfaces (Nahal, 2004).

The aim of our study participated in the fight against desertification by evaluating the vegetation cover and the use of mapping and soil analysis between 2006 and 2018. For this, we have chosen two dates 2006 and 2018 for the monitoring of changes in our study area. The investigation brings us back to a realization of a variation map of the vegetation cover between these two periods, this map allows to follow in long-term evaluation and combined effect of the means of combating desertification in these protected areas.

Material and Methods

Overview of the country of Rogassa

The county of Rogassa is located northeast of El Bayadh; it is 45 km from the capital (34°12′40″ N 0°48′40″ E). It covers an area of 240,830 ha (D.S.A, 2018) (Fig. 1). The commune is located in the daïra of Rogassa, and it is bordered by the following communities: In the North: the wilaya of Saida, in the West: the commune of Kef Lahmar, in the East: the Cheguieg commune and in the South: commune of El Mehara. According to the division carried out for the wilaya of El Bayadh, the commune of Rogassa is located in the homogeneous zone of the foothills and mountains of the Saharan Atlas. It is a pastoral community.

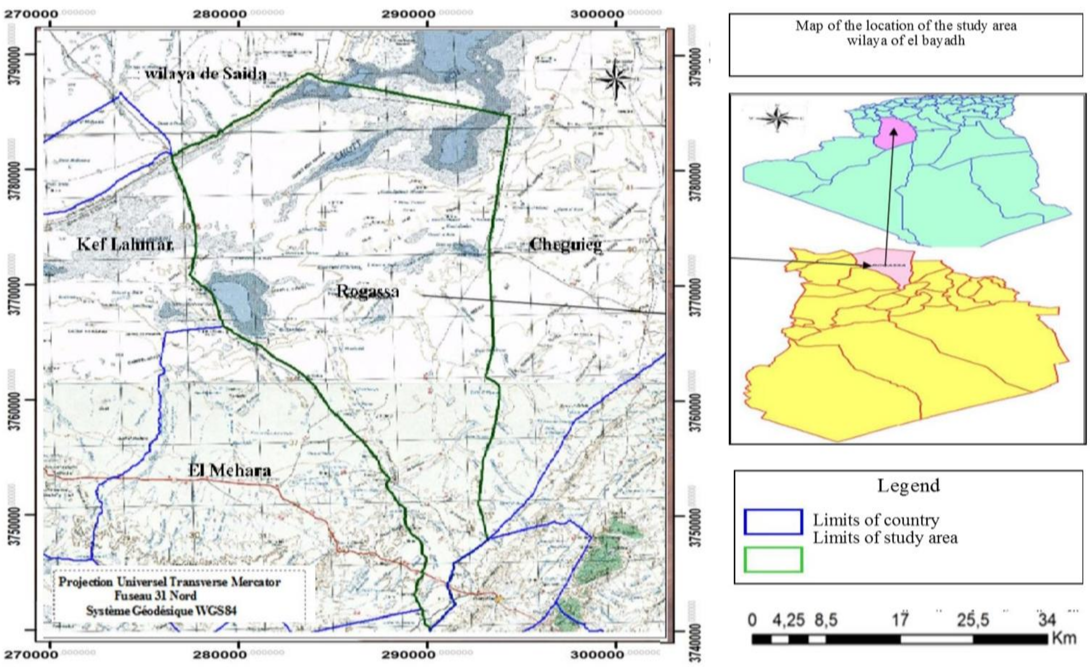


Fig. 1. Location of Rogassa

Climatic factors

The study area has an arid climate, which is characterized by cold winters with low annual precipitation (200 mm) and with great inter-monthly and inter-annual variability at relatively homogeneous and very contrasted thermal regimes of the continental type. This promotes the emergence of drought-resistant plants. From 1975 to 2018, October was, on average, the rainiest month, with a value of 36.46 mm. The wet period extends from October to February, while the months of June, July, and August have low rainfall; the irregularity and insufficiency of rainfall are unfavorable influences on the development and growth of vegetation.

Materials used

A digital camera for taking witness photos. Stakes and ropes to delimit the statements. A GPS to determine the stationary parameters (coordinates, altitude). Paper bags to bring back vegetation for unidentified species on site. Pruning shears for cutting vegetation at ground level. A tape measure for the measurements. Technical sheets to record the information related to each plot Plastic bags and numbered labels to put the soil sample An Auger for taking the soil readings the tools necessary for digging the soil: a small hammer and a chisel.

Methodology, collection and consultation of documentation

This stage takes place mainly on the consultation of basic documents and on gathering as much information as possible from different sources on the means of combating desertification. From the collection of information to be carried out in the study area of the commune of Rogassa at the HCDS level for diagnosis and to compare these data with those in the field, we have organized a schedule of outings in the various selected sites**.** In total, 15 vegetation and 15 auger surveys were completed. These surveys utilized a random sampling method based on the segregation of different geomorphological units and types of vegetation. Each survey covers 100 m^2 of surface (10 m on each side), inside each of them, we carried out floristic surveys and took a soil sample for physico-chemical analyses. We recorded the location (altitude and latitude) of the plots using GPS. The processing of the Landsat satellite images at 32m resolution was conducted on different dates. These images were used in order to show the evolution of the steppe plant cover. Two Landsat satellite images with medium spatial resolution (30×30m) were chosen to track the evolution of the steppe plant cover in Rogassa between 2006 and 2018. This step made it possible to map and compare the vegetation, surface from vegetation indices (NDVI) calculated using the images from the Landsat satellite. The methodology consists of collecting any type of information in the field and in fact calls for analysis in the laboratory to characterize the different types of soil sampled as well as the statistical analyzes applied to qualitative and quantitative data, the standardization of the data in the form of tables and processed by several software such as, EXCEL and SIG (ARCGIS 10.3) (Fig.2).

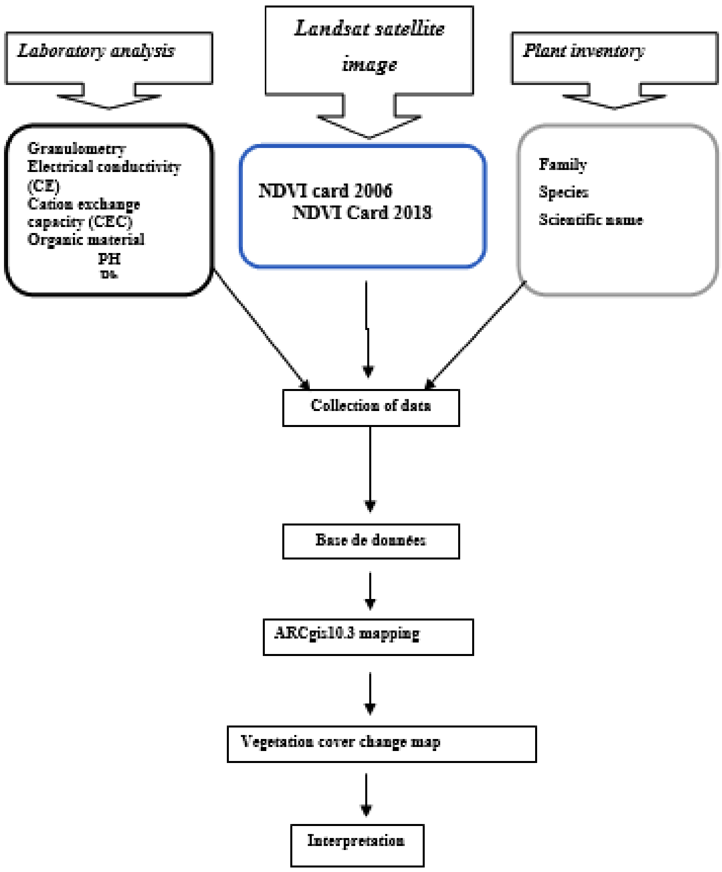


Fig. 2. Diagram of the methodological approach of our study

Results

Distribution of families in the study area showed that the protected aria A and B had more than 17 families (Table 1). However, there are three families dominant families (Poaceae, Brassicaceae, and Asteraceae) in sites (A) and (B). These three families represent more than 50% of the flora studied. The floristic study in the unprotected area (C) allowed us to highlight five families and the dominance of two families (Asteraceae 37% and Poaceae 18% (Table 1). According to the analysis of the vegetation inventory in the studied region, there was relatively a significant increase in the flora richness between 2006 and 2018 (Table 2). This increase was greater in exclosures (A) and (B) (more than 17 families and 48 species) than in the unprotected area (C), where there are only five families and six species. The setting in exclosures favors good condition of development of the species with the good management of exploitation of all fate of strategist adopted in favor of the breedings of the region.

Table 1. Distribution of families in the study area in (A) Protected aria of El Mouhdin, (B), Sekine, and (C) the unprotected area

Species	Families	Exclosures area (A) El Mowahdin					Exclosures area (B) Sekine					Zone (C) unprotected				
		A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
Salsola vermiculata	Amaranthaceae	×	×	×		×	×	×	×			×	×	×	×	×
Helianthemum pilosum	Cistaceae	×							×	×	×					
Astragalus stella	Fabaceae	×							×							
Eruca sativa	Brassicaceae	×				×	×	×								
Scorzonera laciniata	Asteraceae	×	×	×	×											
Sinapis alba	Brassicaceae	×	×	×	×			×	×	×						
Matthiola longipetala	Brassicaceae	×														
Hordeum murinum	Poaceae		×		×	×	×	×	×	×	×	×		×		×
Buglossoides arvensis	Boraginaceae		×		×	×			×							
Scorzonera laciniata	Asteraceae		×					×		×	×					
Malva aegyptiaca	Malvaceae		×					×	×	×	×					
Lygeum spartum	Poaceae	×		×	×	×	×	×	×	×						
Scolymus hispanicus	Asteraceae			×	×											
Gynandriris sisyrinchium	Iridaceae			×	×			×		×						
Filago pyramidata	Asteraceae			×	×		×		×		×					
Buglossoides arvensis	Boraginaceae			×	×			×	×							
Isatis tinctoria	Brassicaceae					×										
Allium cepa	Amaryllidaceae					×										
Onopordum acanthium	Asteraceae					×		×	×	×		×		×	×	×
Tribulus terrestris	Zygophyllaceae						×									
Astragalus stella	Fabaceae							×	×							
Calendula arvensis	Asteraceae							×								
Calendula officinalis	Asteraceae							×								
Bromus garamas	Poaceae							×	×							
Plantago albicans	Plantaginaceae								×							
Buglossoides arvensis	Boraginaceae	×							×							
Helianthemum nummularium	Cistaceae								×		×					
Reseda alba	Resedaceae								×		×					
Echium pycnanthum	Boraginaceae								×							
Herniaria hirsuta	Caryophyllaceae								×	×	×	×				×
Scorzonera undulata	Asteraceae								×		×					
Taraxacum obovatum	Asteraceae								×	×	×					
Stipa barbata	Poaceae								×							
Avena sativa	Poaceae															
Bromus rubens	Poaceae								×							
Bromus mollis	Poaceae								×		×					
Artemisia herba-alba	Asteraceae								×	×	×					
Peganum harmala	Zygophyllaceae			×				×	×							
Stipa tenacissima	Poaceae			×				×	×	×						
Sinapis alba	Brassicaceae										×					
Pentzia incana	Asteraceae									×	×					
Asphodelus tenuifolius	Xanthorrhoeaceae										×					
Papaver rhoeas	Papaveraceae								×		×					
Centaurea maroccana	Asteraceae										×		×			
Brassica oleracea	Brassicaceae							×		×	×					
Clypeola jonthlaspi	Brassicaceae							×	×		×					
Brome inerme	Poaceae										×					
Brassica oleracea sub. robertiana	Brassicaceae											×			×	

Families distribution

In Table 2, there are more than 17 families and dominating by three families (the Poaceae, the Brassicaceae and the Asteraceae) in the site (A) and (B). These species represent more than 50% of the flora studied and the other families (Dipsaceae, Euphorbiaceae, Iridaceae, Amaranthaceae, and Cistaceae) present a low dominance compared to the whole. Distribution of families and species recorded in 2018 in protected and unprotected area aria is presented in Fig.3. The floristic study in the unprotected zone (C), allowed us to highlight the dominance of two families (Asteraceae 37% and Poaceae 18%), the other families record a low presence in this zone 13% for Amaranthaceae, Brassicaceae 13% and Caryophyllaceae 12% (Fig. 3).

Table 2. The species inventoried in 2006 (17 species, 8 family) (Slimani *et al*., 2010)

Number	Species	Families
1	*Salsola vermiculata*	Amaranthaceae
2	*Helianthemum pilosum*	Cistaceae
3	*Astragalus serratuloides*	Fabaceae
4	*Hordeum murinum*	Poaceae
5	*Lygeum spartum*	Poaceae
6	*Echinops spinosissimus*	Asteraceae
7	*Artemisia herba-alba*	Asteraceae
8	*Peganum harmala*	Zygophyllaceae
9	*Stipa tenacissima*	Poaceae
10	*Brome inerme*	Poaceae
11	*Brassica oleracea sub. robertiana*	Brassicaceae
12	*Aristida pungens*	Poaceae
13	*Cutandia dichotoma*	Poaceae
14	*Eruca vesicaria*	Brassicaceae
15	*Noaea mucronata*	Brassicaceae
16	*Onopordum arenarium*	Asteraceae
17	*Thymelaea microphylla*	Thymeliacées

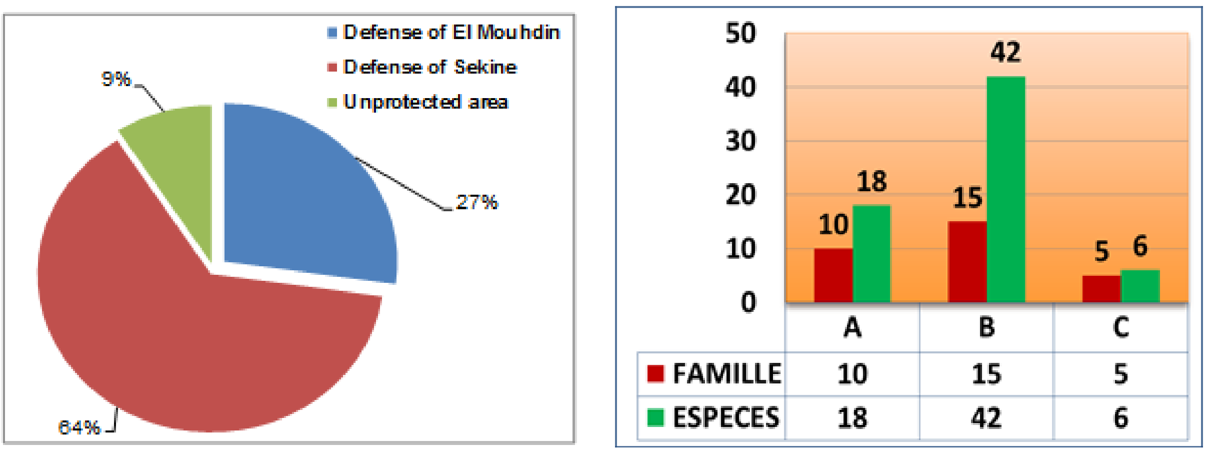


Fig. 3. Distribution of families and species recorded in 2018 in (A) Protected aria of El Mouhdin, (B), Sekine, and (C) the unprotected area

Cartography

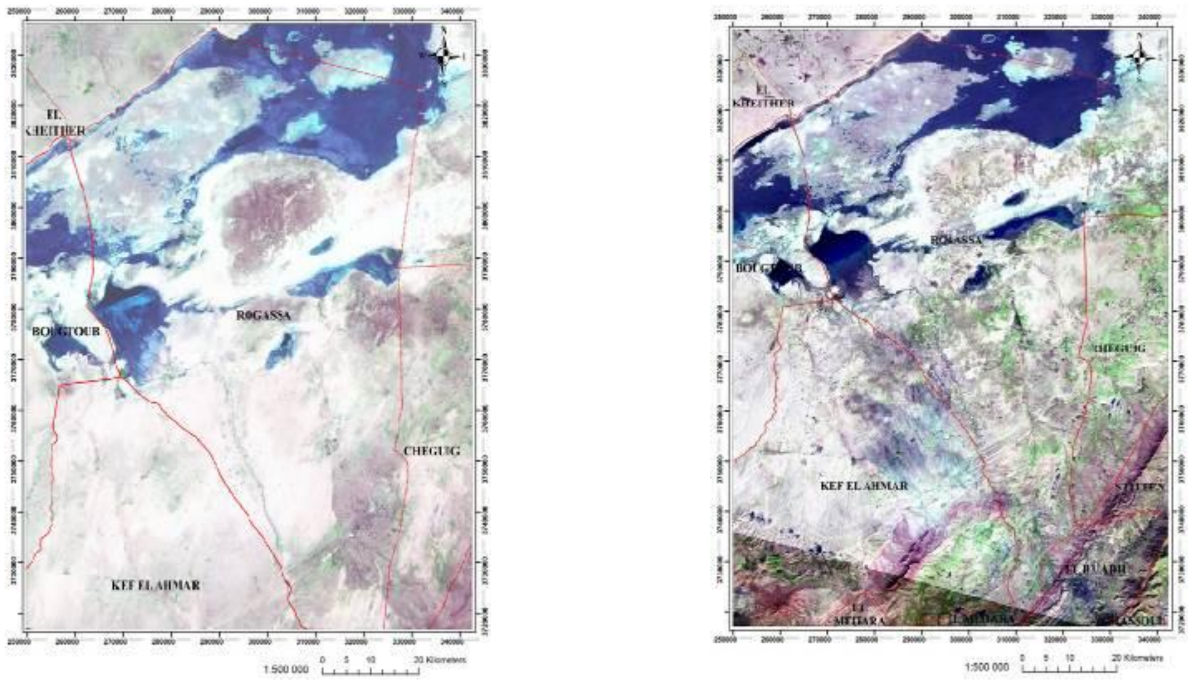
Several approaches are available to classify remote sensing images. Supervised or unsupervised approaches based on pixels can be performed with image analysis software, such as Erdas IMAGINE and ENVI (Lassieur, 2006). The unsupervised approach was applied using the ENVI software (4.7.01), which uses the ISODATA algorithm of multispectral images with a resolution of 30m. With this method, the pixels are automatically separated according to their spectral properties. In our study, we used a methodology based on the calculation of the NDVI from the satellite images.

The vegetation indices (NDVI was calculated as:

$$\mathbf{NDVI} = (\mathbf{PIR} - \mathbf{R})/(\mathbf{PIR} + \mathbf{R})$$

Where: PIR is the near infrared channel and R is the red channel. In contrast to quantitative overviews of the use of NDVI,

Users tend to estimate a large number of vegetation properties, such as leaf area index, biomass, chlorophyll concentration in leaves, plant productivity, partial coverage of vegetation, precipitation accumulated from the value of this index, and the correlation of space-derived values of NDVI with earth-measured values of these variables (Escadafal, 1994).Our experiments were conducted at three sites to ensure our results were representative of the entire study area; the sites consisted of two exclosures (A and B) and an unprotected area (area C). The superposition of the different layers of information obtained by the automatic processing of satellite images (colored composition and unsupervised classifications) and the field surveys enabled the creation of a map of plant changes for 2006 and 2018 (Fig.4 and 5). The comparison of satellite images shows changes in the successive color composition of the city's surface. These images show two colored compositions: the color light green in 2006 and the color red in 2018. This difference of color between the two images shows a clear decrease in the vegetation cover between the two periods. The areas affected by desertification, embodying the ephemeral, bare land and advancing sand with percentages of 4% (40-36), 5% (28-23), and 6% (17-11), respectively (Table 3). At the same time, there was a 11% drop in the plant cover of perennials. In addition, the wetland was influenced by drought, with a considerable drop in area of 4%. These results confirm the importance of silt produced in the Rogassa region during this decade, which amplifies by the region's harsh climatic factors.



Colorful composition card 2006 image Colorful composition card 2018 image

Fig. 4. Map of vegetation cover change in the municipality of Rogassa between 2006 and 2018

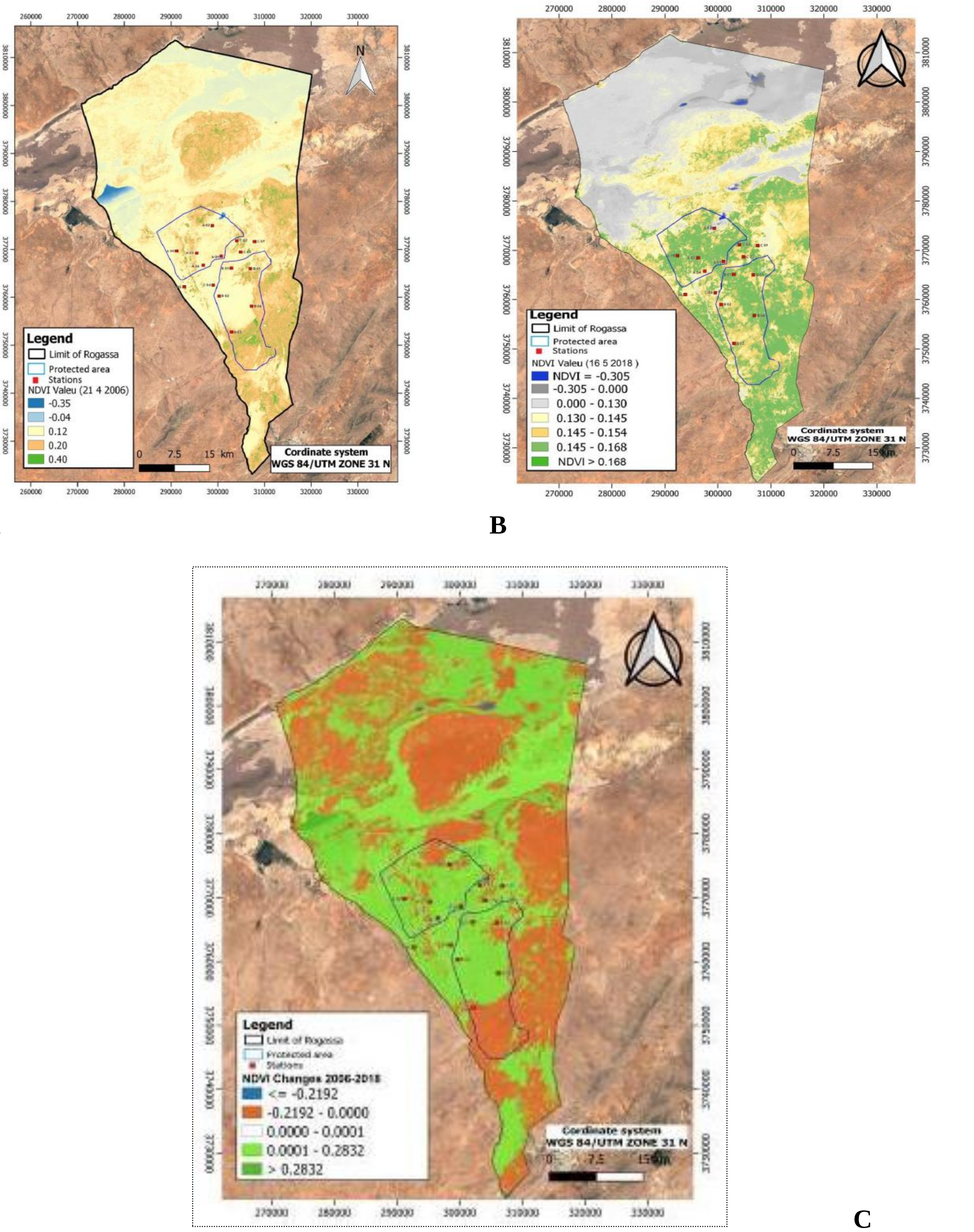


Fig. 5. Map of the vegetation index of the commune of Rogassa 2006(A), 2018(B) and NDVI change 2006-2018 (C)

Our results reveal the vegetation in the region had entered an important phase in its evolution where categories of ephemeral species are widely distributed (Table 3). Furthermore, perennial species are only represented in the southern Exclosures area of Sekin (B). The sanding process is frequent in the study area and more affects the unprotected area (C). Sand deposit revenue decreased by 80% over the period, and light stability sand increased by 2%. A very high salinity with a light soil that has an average light chemical fertility. The texture is sandy to silty/sandy. However, more than 70% of the amount of sand is in the soil. The MO (Organic Matter) content is low in the soil (Table 4) (annex). The pH in the study area is 8.5. The type of soil in this area is purely alkaline. Very high salinity was also identified in the study area, especially during the drought period.

Table 3. Vegetation index results (NDVI) between 2006 and 2018

Color code		Vegetation	2006		2018	
			Area (ha)	(%)	Area (m^2)	(%)
Green	1	Perennial (*Stipa tenacissima*)	48,166	20	21,674	9
Light green	2	Ephemera (annual)	86,698	36	96,332	40
Red	3	Bare ground	55,390	23	67,432	28
Yellow	4	Sand	26,491	11	40,941	17
Blue	5	Wet area	24,083	10	14,449	6
Total			240,830	100	240,830	100

Table 4. Physico-chemical analysis of the soil in the study area in 2018

Soil Physico-chemical traits	Enclosures area (A) El Mowahdin	Enclosures area (B) Sekine	Zone (C) unprotected
Surface sand (%)	80.4	79.67	85.35
Sand in the ground (%)	70.86	68.16	84.34
Clays (%)	07.56	08.5	04.21
Fraction Fine (A + L)	29.26	30.55	15.35
Organic material (%)	1.2	1.2	0.67
pH	8.75	8.58	8.59
CEC (meq/100g.sol)	7.5	7.87	6.75
CE (mmho/cm)	0.7	0.6	0.8

Discussion

The Exclosures area is one of the effective means for the rehabilitation of disturbed spaces. The results obtained in the study confirm that the improvements which have resulted from this technique are numerous and diverse. The difference observed in the number of species in the different zones shows the beneficial effect of the protection on the richness of the flora. This improvement has also been demonstrated by several authors who recognize that grazing and pastoral overload have a considerable effect on the structure of the community and the floristic composition (Floret and Pontanier, 1982, Waechter, 1982, Le Houérou, 1995, Ouled Belgacem and Neffati, 1996, Le Floc'h, 2001, Amghar *et al*., 2012; Gamoun *et al*., 2012). In the Exclosures area of El Mouhdin (A), more than 10 families are present, the best known of which are Poaceae, Brassicaceae and Asteraceae, with some tufts of dried alfa (*Stipa tenacissima*). In increasingly degraded states, however, the unprotected area contains only five families, which are Poaceae, Asteraceae, Brassicaceae, Amaranthaceae, and Caryophyllaceae; there was an absence of *Stipa tenacissima*. The poor vegetation recoveries observed at the level of the defensive ranges can be explained by the samples taken by the animals (grazing and defoliation). Trampling by herds is also a major cause of the degradation of the vegetation cover

(Daget and Godron, 1995; Le Floc'h, 2001). The loss of species in an already rich community would have a relatively small impact on the community, compared to the loss of species in a particularly poor community. This idea is linked to the notion of species redundancy different species can share similar community functions (Collins, 1995). In addition, species richness could also guarantee greater stability in the face of usual or catastrophic variations in the environment (Pim, 1991). Low levels of organic matter directly influence soil characteristics critical for seedling establishment, water infiltration and root penetration in arid and semi-arid areas (Aronson et al., 1995). As Jauffret (2001) has already noted, soil surface conditions in drylands reflect the "state of health" of ecological systems. In the three stations studied, the surfaces covered with bare soil and sand always remain high on the outside compared to the inside of the defenses. Su *et al.* (2005) noted that due to frequent trampling on sheep and cattle, the soil surface becomes bare and exposed to wind erosion.

Floret and Pontanier (1982) add that by inducing a very strong regression of the plant cover, the pasture leaves the soil exposed to the wind causing the mobility of the sand. On the other hand, the resumption of the relatively low sand in the defenses reflects a good fixation of the soil by the vegetation. The study clearly shows the insufficiency in organic matter levels, ranging from 1.8 to 1.2%, the first period recorded a slow decrease in this matter 0.4% over almost 30 years, from 2006 the decrease proved to be more rapid on a period of almost 12 years or 0.2%. The study also notes that all samples indicate a salinity for all profiles of 0.6 to 0.8 m S / cm. The salinity is higher in the surface horizons. This increase in salinity is explained by the release and rise of salts to the surface of ground water at alkaline pH. It should be noted that in halophytic plants, too much salt-containing tissue darkens, falls off and eventually increases the salt level in the soil (Halitim, 1988). The texture of a soil rich in fine elements is positively correlated with salinity (Le Brusq and Loyer, 1982; Attia, 2013). These factors affect the water balance and therefore the accumulation of salts in the soil. This is the case in our study. Regional values range from 8.5 to 8.75 in most stations. These high salinity levels are a negative development in the evolution of vegetative strata and hamper soil conservation in the region. After the analysis of the soil and the comparison with the data of their classification of references, by deducing the cation exchange capacity in the samples, the results show that the study area is characterized by light soils (6.75 and 7.87 meq / 100g.sol). Analysis of satellite imagery reveals a clear difference between NDVI values April 21, 2006(-0357) and May 16, 2018 of the order of (-0.305). It is about the establishment and development of vegetation. However, the Landsat_5 NDVI swallows negative (absence or little vegetation cover) between them period.

These conclusive results highlight the development of significant coverage for such a short period of 12 years. Our results are consistent with those of many authors who have studied the spatiotemporal evolution of vegetation, especially using vegetation indices (Toby and Ripley, 1997; Paruelo and Lauenroth, 1998; Lukasová *et al.*, 2014). According to El Halimi (2015), healthy vegetation absorbs much of the visible light in the red thanks to chlorophyll pigments and strongly reflected in the NIR. The choice of the date for the series of images was not sudden; on the contrary, it turns out that the processing of images taken during the month of April offers multiple advantages for the detection of chlorophyll (photosynthetic activity). When a vegetation index is high, this usually indicates an increase of the region's vegetation. (Eklundh, 1998; Girard and Girard, 1999). The development of perennial and annual species allows both the protection of the soil against the risk of erosion and the revitalization of the organic matter cycle. This improvement would also guarantee better use of abiotic resources and greater stability in the face of fluctuations in the conditions of the fragile environment. However, this improvement is not correlated with the duration of protection because the old defenses have certain negative aspects, namely a low floristic diversity compared to plots placed in defenses for an average duration of protection.

The search for appropriate solutions for ecosystems in reproduction difficulties requires a sufficiently in-depth knowledge of all the constituents and factors which govern their dynamism (Tbib and Ouled Belgacem, 2001). The constitution of multidisciplinary research teams, with well-targeted objectives and rigorous coordination could detect solutions that are able to mitigate the degradation of the environment while preserving an adequate threshold for the social and economic development of rural populations.

Conclusion

In our work, we have identified the effects of desertification on the evolution of the vegetation of the area. The results show that, in the study area, this progression is based on the results obtained from the various parameters studied over this period, such as vegetation cover and soil composition. Major changes in soil properties were observed between 2006 and 2018 in the study area (results in 2006 data). The analysis of the studied parameters revealed that the texture is high in amounts of sand, which vary from 68% to 84% in all the stations. The texture triangle places the station samples in the sandy to silty/ sandy area by increasing the amount of sand in the unprotected area. There was a significant reduction in fine particles (silts and clays) and organic matter, especially in the unprotected area. The use of enclosures as a means of combating desertification and increasing the productivity of these areas help to preserve these species and protect the soil against erosion and siltation. In this context and on the basis of the results obtained, we recommend the creation of multidisciplinary establishments specializing in the observation of these phenomena, which increasingly affect the steppe areas by their accentuated effect.

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