Influence of Natural and Anthropogenic Factors on Plant Formations in A Steppe Region of the Wilaya of Saida, Algeria

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Abstract

In this study conducted in the steppe region of Saida, Algeria, we analyzed the relationships between biological richness and the environment at different scales and for different taxonomic groups. To do so, a multimodel inference was used to analyze the data, and power law species-area relationships were fitted using specific richness exponent as a measure of steppe biodiversity in our region.

The results showed that the biological richness in the region was intermediate compared to other similar lands in our region. The anthropic index was the most important factor for vascular plants and geophytes, with a negative relationship between specific richness and heat index. On the other hand, chamaephyte diversity depended mainly on stone and rock cover, with a positive relationship between specific richness and stone and rock cover.

The explanatory power of climate-related variables increased with increasing species size and coverage, while anthropic burning was the most important factor for richness patterns, with a positive effect on specific richness. Site coverage rates showed variation, but no significant difference in their means between temperature scales.

These results emphasize the importance of integrating scale in ecological analyses and nature conservation assessments to understand and manage biological diversity in steppe ecosystems. The results of this study may also help guide management and conservation practices in this region and other similar ecosystems around the world.

Keywords: desertification; phytodiversity, Steppe; Saida, Algeria.

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1. Introduction

In Algeria, the arid and semi-arid steppe ecosystems, like other Mediterranean arid regions, are characterized by a profound ecological imbalance, which leads inexorably to an increasingly marked pastoral ecosystems fragilisation and to an irreversible reduction of their production capacity and the protection of the physical environment. They are transformed by two major

processes: one corresponds to a natural evolution linked to drought and the nature of the edaphic environment and the other is linked to the anthropic factors.

All authors interested in the Algerian steppe highlands, mainly with pastoral vocation, highlight their strong deterioration resulting in the reduction of biological potential and the breakdown of ecological and socio-economic equilibrium Bensouiah (2003);Aidoud et al (2006);Nedjraoui&Bedrani (2008));Nedjimi&Guit (2012); Ikhlef (2013).

Diachronic studies carried out in southern Oranie have shown that the facies have completely disappeared and are replaced by other facies indicating degradation and silting stagesBouazza&Benabadji (2002); Bensaid (2006);Daoudi et al (2010);Hirche et al (2010); Khader et al (2014) The desertification risk increases and multiplies when anthropogenic factors act on ecosystems beyond their limit of resistance Nedjraoui&Bedrani (2008); Le Houérou (1985);Aidoud&Touffet (1996);Nedjraoui (2012).

The fight against the desertification in the steppe range, the preservation of their natural resources and the improvement of peoples living conditions is no longer a subject of debate for Algeria; it is a national priority.

The fight against desertification, an objective that the State has set it itself since the beginning of the 1970, should stopped, if not limited, the decline of steppe areas through actions affecting both the physical environment and the socio-economic. However, the assesses made over the past forty years shows that, apart from certain improvements, notably in terms of infrastructure, the Algerian steppe is much more degraded than in the aftermath of independence.

The lack of the quantitative and qualitative assessment of these actions wich are realized in the steppe area of the province of Saida has always been a major problem for the various actors in this space. To make an assessment based on a phytoecological and socio-economic approach represents an essential element in the development of a management strategy in this zone and constitutes an indispensable means that can guide the different operators, particularly in the field of the fight against desertification.

The results of these programs will allow us to better evaluate the constraintsand the role of each of the actors throughout this period, and to see their dysfunctions and discontinuities, why some have succeeded and others not? What are the causes?

Under these conditions, what are the strategies to be adopted for the development of these renewable but degraded resources? What would be the share of this population and especially the farmers and agropastors in this management?

To this end, an assessment of the actions carried out so far is imperative for this research work, actions that are often poorly conducted and uncoordinated. What has become of these developments and what are their present conditions? And what have they brought in terms of steppe development?

In fact, have these actions really created coordination between the various partners responsible for the implementation of development programs?

In the absence of a specific law governing pastoral activity capable of ensuring the protection and enhancement of natural resources, have these actions not been hindered?
And finally, what lessons can be drawn from this immense experimental field for the improvement of future programs in order to develop the steppe sustainably?
As far as we are concerned, and initially, we assume that the degradation is essentially linked to poverty in rural areas.

1.2 Presentation of the study area

Geographic location

The study area is located south of the city of Saida with an area of 3 301.9 km², spread over four communes (Moulay Larbi, Sidi Ahmed, Maâmora and Ain Skhouna) that correspond to the steppe part of this province.

Natural, physical and socio-economic description of the studied area

The study area belongs to the arid bioclimatic stage with a dry and hot summer characterized by a drought period of 7 months (April to October) and an average number of Sirocco of 31 days/year (ONM Saida; 2017).The terrain is generally flat and homogenous and slopes not exceeding 3%. The altitude varies between 1000 and 1339 meters. The dominant soils are brown limestone soils and soils fersialiques represented by hard limestones and dolomites (BNEDER; 2010).According to data from the(DSA Saida; 2017), the population of the studied area is about 57,945 inhabitants, or just over 16% of the total population of the province of Saida. The spatial distribution of the population is irregular, of which more than two thirds are concentrated in the agglomeration of the municipality capital. The remaining lives in secondary agglomeration and scattered areas. However, the nomadic population is reduced and represents 1.35% of the total population of the studied area.

3. Materials And Methods

3.1.The project data consultation

Before the evaluation, it was essential to study the literature and exploit all existing information on the draft of each management action like: technical specifications established by the concerned administration as HCDS or forest administration and the local communities regarding the terms of the structures; project data sheet and the final assessment of achievements.

3.2.Interview with executives

The interview was held with executives of the HCDS and CFS, including those responsible for monitoring the projects and has focused on the development of the various phases of an operation from its formulation to completion.

3.3.Implementation procedures

Among the programs advocated by the HCDS for the rehabilitation of degraded rangelands is the technique of resting and pastoral planting (*Atriplex canescens, Atriplex nummulariaand Atriplex halimus*)Henni&Mehdadi (2012).Three million hectares (on 20 million) have been preserved by exclosure, in collaboration with the Forests Conservation and 300,000 ha rehabilitated by pastoral planting (Nedjraoui&Bedrani; 2008).

This initiative involves intervening on rangelands by pastoral planting or simply by placing them in exclosure, depending on the degree of degradation of the target zone. The choice of these areas on which the pilot intervention is to be generalized to the rest of the altered zones meets certain conditions, in particular:

• The very advanced degradation of these lands, so as not to further restrict the environment to the herds;

• Ensuring that these lands are not subject to any litigation in order to avoid jeopardizing their rehabilitation by any covetousnesses.

Atriplex plants are first grown in the nursery for three months before being transplanted in the steppe zone. The plants before their transfer to the perimeters are essentially based on the height of the aerial part (15 to 20 cm), their vitality and their health status.

The plantations are made in holes settled along the furrows. The distance between furrows is 5 m. The spacing between two holes is 2.5 m. The plantations density is estimated at 800 plants/ha. After planting, three watering are made at a rate of 20 liters/plant over a period of two months.

According toBoudy (1952), the main restoration technique applied in the steppes was exclosure or deferred grazing of prohibiting grazing on a degraded area for a specified period.

This technique allows the land regeneration, provided that they are not completely naked, depending on the climate and soil quality. The minimum length for good regeneration according to the HCDS services is 03 years.

The word Reforestation is for performed work in order to reconstruct more or less disappeared forest or create new ones in bare land(Boudy; 1952). Reforestation operations has entirety touched bare land (non-woody) considered by the forests administration as forest land.

The different types of reforestation and plantations made by the forest administration are: the green belt; dune fixation; reforestation; the green band and pastoral plantation.

The reforestation main technical characteristics include:

• Objectives and Location: consist of identifying the objective assigned to the project, its location and the land legal nature;

• Soil preparation work: which type of plotting to use and the nature of the work carried out on the soil?

• Planting work: including the planting year, the chosen density and the species used;

• Other information related to the management arrangements.

Experimental stations

Given the diversity of actions and the multitude of projects, we chose for each type of action some station that will be the subject of a diagnosis. The "MapInfo" software enabled us to draw up the project distribution map (Fig.1).

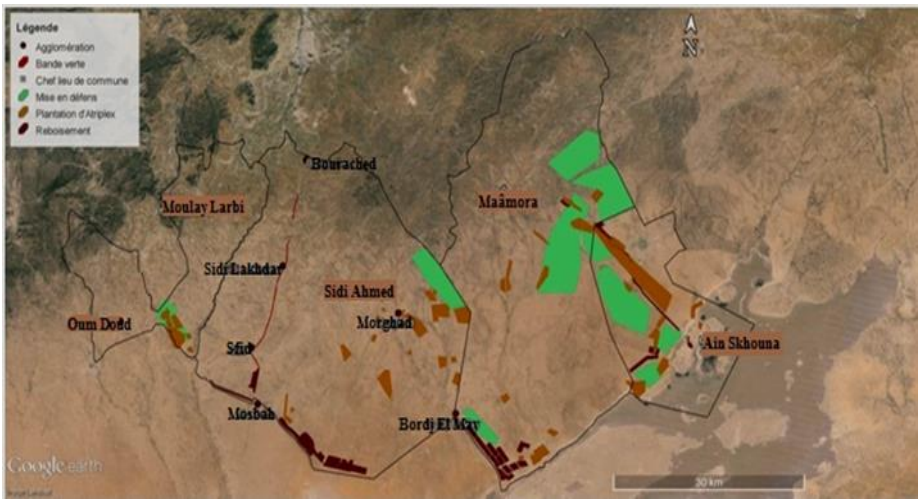

Fig. 1: The project distribution map in the studied area.

Using the GPS device, we recorded X, Y and Z coordinates for each plot. These coordinates allow the geo-referencing of stands for the possible establishment of cartography.

The following parameters are noted and appreciated or evaluated:

-The species used: As an important parameter we considered the main essence constituting the stand;

-Age: The age of the population remains an essential parameter to study. It was determined using the data sheets prepared on the basis of survey forms;

-The stand density: the plot density is the number of existing living subjects;

-Natural regeneration: It has been important to assess the ability of the stand to recover without human intervention. Given the multitude of types of planting, we merely report the absence or presence of natural regeneration with the degree of distribution as appropriate;

-Health status: Despite its variation over time, we thought that its useful to present the stand health status by recording the infestation or observing the physiological phenomenon

1. Results And Discussion

In analyzing the main technical characteristics of the different types of plantations, it emerges that:
• The location of plantations is linked to the objective assigned to the project, for the majority of cases that affect forest land.
Through the various diagnoses, we have established the summary table (Table I), which gives a numerical overview of projects realized across the province from 1995 to 2014, with the achievement and success rate and also the main species used.

Table 1. Global report of projects in the study area (1995-2014).

Project Type	Planned (Ha)	Performed Area (Ha)	Achievement Rate (%)	Success Rate (%)	SpeciesUsed
forage planting	26 000	25 000	96	10	*Atriplex canescens; Atriplex halimus and Atriplex nummularia.*
Exclosure	35 000	33 700	96	98	Degraded Steppe with Stipa degraded Steppe with Artemisia et Salsolaceae Steppe
Reforestation	3 500	3 350	95	60	Aleppo pine
Total	64 500	62 050	96.20	56	-

According to the table 1, the studied area recorded a total of 62,050 ha of operations spread over the steppic communes in province of Saida. The main types of operations are: reforestation; pastoral plantation based on Atriplex and Exclosure.

The global realization rate in the province is important, being 96.20%. Reforestation is the lowest share with 3 350 ha or 6% only; it's a novelty for the forests administration because it was launched only in 2006.

The exclosure area comes first with 55% of the total area of operations. The remaining 39% are occupied by forage planting generally based on *Atriplex canescens, Atriplex halimus and Atriplex nummularia.*

The commune of Maâmora represents the largest area of operations with almost half of the total area (49%). Followed by the commune of Ain Skhouna with 26%, close enough to the commune of Sidi Ahmed with 21%.

To succeed in a project is to achieve the objectives assigned to this action. Quantitatively, the success rate that corresponds to the percentage of live plants relative to the plants put in place should be calculated by a sampling method. However, it has been evaluated by the administration approximately for old plantations and by systematic counting in some plots for new plantations. Based on these figures, we can see that the average rate varies from one area to another depending on the type of plantation and the species used.

The average overall success rate for all actions is 56%. We see through that the highest success rates recorded in the exclosure where we observed an average of 98% of success.

For the reforestation, the success varies between 0% and 90% depending on the type and location of reforestation depending on the percentage of surviving plants. However, forage plantations have experienced lower rates from 0% to 47% depending on the type of the planted species, the age of the plantation and especially edaphologic location of the planting (soil type). For reasons that we try to identify them later(Chalaneet al;2019).

The province of Saida has made commendable efforts for the projects realization to fight against desertification whose magnitude is increasing at an alarming rate. Despite these enormous efforts many works are doomed to disappointment.

In light of our analysis and field observations, it appears that the actions done in the steppe zones based on forage species planting (*Atriplex canescens, Atriplex nummularia and A. halimus*), has a good success in some places and a failure in most places [plate.2].

Indeed, our analysis is entirely consistent with that made by a group of researchers on Atriplex plantation done in other steppe wilayas. For example: the province of DjelfaKaba (1996);Mesbahi (2002);Berno et al (2006); the province of M'SilaBouhroud et al (2006); the province of Laghouat Benahmed&Bensaha (2007); the province of Saida Merzougui&Bounif (2008); Henni&Mehdadi (2012) et Yahiaoui et al (2014);in the provinces of South Oran Boularak et al (2009).

During our missions on reforested and planted land, we have found that the results are below expectations. This state has questioned the factors of these failures, which led us to make the following observations:

- The health status of stands is an essential criterion for reforestation. The average state of the old plantations testifies to the presence of the processionary caterpillar, a redoubtable parasitic of Aleppo pine.

- Parasitic attacks due to monoculture reforestation (with *Pinus halepensis*) [plate.4];

- Absence of the terminal bud in some plants due to overgrazing, due to the lack of legal framework regulating;

- The exploitation of young Atriplex plantations of (age<2 years), might disrupt the plant growth, leading to their elimination;

- The death of seedlings *(Pinus halepensis*) because of drought and water shortage;

- In limestone depressions and Aeolian deposits, planting Atriplex causes degradation of the soil and vegetation cover under the influence of the scarification technique;

- Forage shrubs subject to full protection and for long-term (> 2 years), undergoing the natural phenomenon of lignifications inducing decrease in forage value;

- Older age (over 6 years) of the plantation, had a much larger timber production as fodder, he then distinguishes the effect of age on the production of *Atriplex canescens*, which suffered the woodiness natural phenomenon over time, therefore, a decrease in feed value;

- The Atriplex great adaptation to soils (salt, dunes and Oued); Case Moulay Smail commune of Ain Skhouna, Oued Hasba commune of Moulay Larbi;

- The formation of a layer of hardpan, real obstacle to the seeds germination of annuals of good feed values Mesbahi (2002); Bouhroud et al (2006);Yahiaoui et al (2014);

- Abandonment of several projects by enterprises;

- The forage plantations success is related first to their protection, always denied by breeders, which are rarely respected;

- Natural regeneration is almost absent in Atriplex and pine forests, however it is abundant in the exclosure [plate.2].

In the light of those obtained results, it appears the favorable effect of exclosure on the preservation of the steppes. These exclosure, significantly improve the production of fodder units, from 60 to 350 UF/h/year. This technique is very simple and has proved its effectiveness by, it's extremely low cost and the output gains are estimated at 350 UF/ha compared to the same course opened for grazing(Boularak et al; 2009).

Various studies have shown the effectiveness of the exclosure which offers, in a degraded steppe after a period of time, the reconstruction of the major characteristics (covered, composition, production) of the existing vegetation Aidoud et al (2006); Benaredj et al (2010); Henni&Mehdadi (2012); Boularak et al; 2009; Arabi et al (2015); Chalane et al (2015); Chalane et al (2016).

However(Kherief et al; 2013), considered that the beneficial effect of the exclosure is not proportional to its duration. He noted that in a normally grazed steppe and deferred grazing for long, woody plants have a tendency to produce "wood" in reducing the green matter production often accompanied by decrease palatability vegetation.

For this purpose, permanent exclosure performed by the HCDS, has to be reconsidered by providing periodic pasture openings that must be regulated and controlled (Amghar et al; 2016).

Exclosure would be a way to fight against the steppe ecosystem degradation and to protect the soil against water and wind erosion and silting phenomenon Aidoud et al (2006);;Henni&Mehdadi (2012); Saidi &Mehdadi (2015);Arabi et al (2015); Chalane et al (2015); Chalane et al (2016), Bekkouche et al (2019).

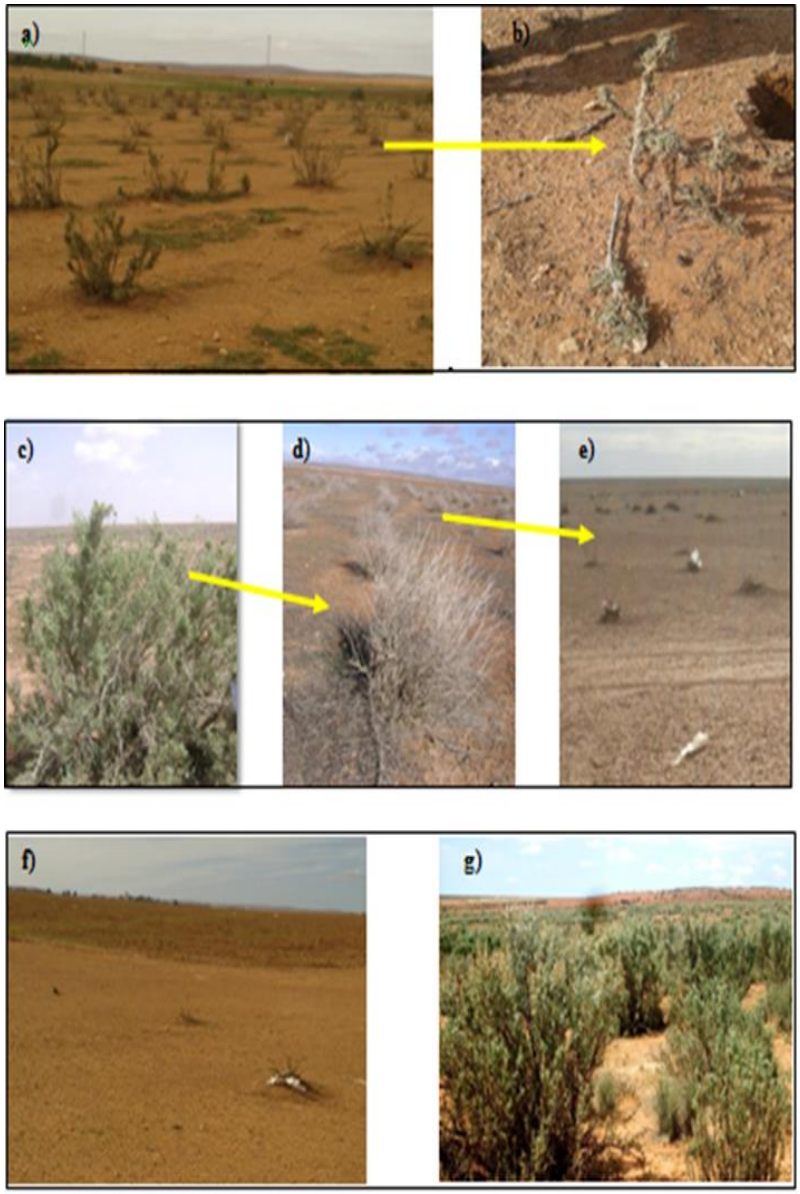

Fig. 2: The status planting of Atriplex in some stations in the study area.

a) and b) Lignification of *Atriplex canescens* after 10 years of planting, "Morghad" station in the commune of Sidi Ahmed; c) Tuft of Atriplex canescens after 7 years of plantation, station "Horchaia" commune of Sidi Ahmed; d) Lignification of the tuft of Atriplex after 10 years of planting; e) and f) Deaths of the plants of *Atriplex canescens* and the total absence of the plant cover in the "Horchaia" after 15 years of planting; g) Planting of *Atriplex Nummularia*, coming from 19 years old, joint Moulay Smail station Ain Skhouna.

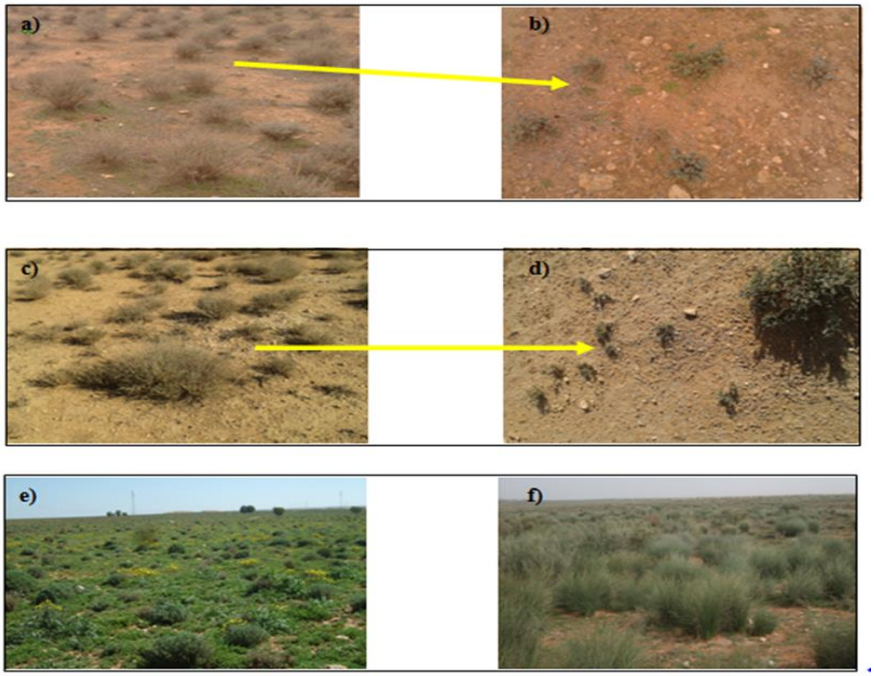

Fig.3: Some representative Photos of exclosure station in the study area.

a)Put in defense of white Armoise, station "Hassi ben Aoulai" commune of Maâmora;b) Natural regeneration of white wormwood, "Hassi ben Aoulai" station; c)Defence of White Armoise, "Hasba" station commune Moulay Larbi; d) Natural regeneration of white wormwood, Hasba station; e) Defend the Salsolaceae, commune "Benhaouar" station Ain Skhouna; f) Defenses of Sparte, "Labter" station commune Maâmora.

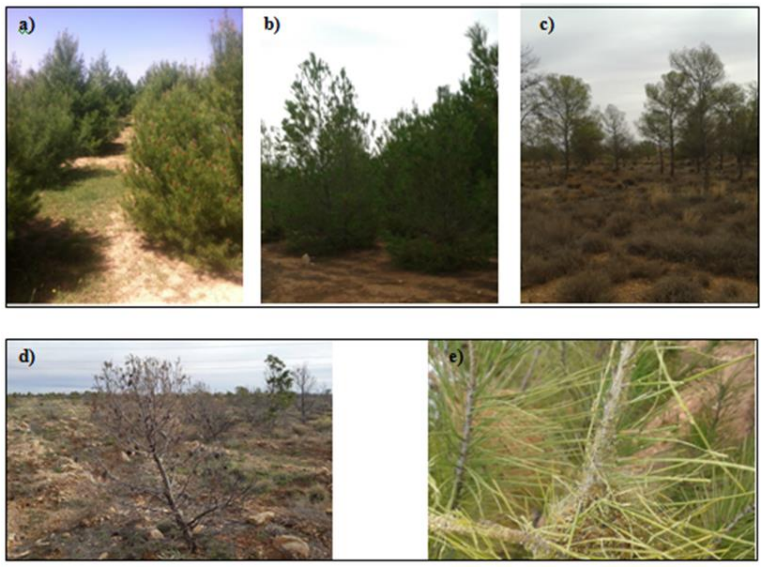

Fig. 4: reforestation project Photos in the study area.

a) Reforestation of 10 years old, station "Bordj El May" commune of Maâmora;
b) Reforestation of Aleppo Pine since 2006, "Lekherab" station in Sidi Ahmed commune;
c) Reforestation of Aleppo Pine since 1974, Sidi Sidi Station, Sidi Ahmed;

d) Attack of the pine processionary caterpillar, joint RejemOgab station of Maâmora;
e) Attack of the Pineprocessionary caterpillar, "Lekherab" common station of Sidi Ahmed.

Conclusion

The management and the steppe development remain one of the main concerns of local authorities in the province of Saida.

Atriplex crops represent an erosion control strategy and forage production. We encourage its plantation on saline soils, on silted and heavily degraded environments and the exclosure on low degraded environments.

The health status of populations is a critical evaluation criterion for reforestation. The average condition of the old plantations indicates the presence of the processionary caterpillar, harmful pest of Aleppo pine, the struggle for forest administration must be continuous and regular.

Parallel to the reforestation and forage planting, the exclosure action as a measure against land degradation remains the least expensive (compared to plantations), the most effective (feasible for large areas) and most profitable (very interesting results).

The exclosure conducted in the province of Saida, has always succeeded. But the lack of laws that protect regulates these gazing areas and overruns of agro-pastoralists in these lands after regeneration, make these operations still idle.

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