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Energy Procedia 36 (2013) 349 – 357

Energy Procedia

TerraGreen 13 International Conference 2013 - Advancements in Renewable Energy and Clean Environment

Rehabilitation of the steppe *Lygeum spartum* in the region of Naama (western Algeria)

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Abstract

In the steppe south-Oranian of Naama (Algeria), clearing, overgrazing and overexploitation of vegetation expose the soil surface pastoral rangeland desertification intense. Intervention measures to this alarming situation are to promote the process of reverse degradation reconstruction, restoration and rehabilitation of degraded steppe by the technique of exclosure. This technique of fencing which is to put the grazing of degraded areas in order to promote the restoration and it may be sufficient to reconstruct the condition she still have the ability to correct itself degradation effects these pathways. She favors natural regeneration, the most appropriate to induce biological recovery of natural steppe. With a number of transects inside and outside the exclosure. These transects is a grid that can scan the entire site and put some grazing routes nearby free range. Along these transects, phytoecological are placed every 200 m in an area of 100 m². Following this assessment, remediation by technical exclosure the steppe of *Lygeum spartum* has a positive impact on biological recovery by a quantitative and qualitative increase in the rate of recovery of vegetation, floristic richness and of phytomass.

Keywords: Steppe, Naama, Algeria, Lygeum spartum, biological recovery, exclosure, desertification.

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Selection and/or peer-review under responsibility of the TerraGreen Academy
doi:10.1016/j.egypro.2013.07.040

1. Introduction

In in the Esparto steppe south Oranian, the degradation begins with an alteration of vegetation; changes in species composition, species with high grazing value are scarce and disappeared: these are the elements that characterize the steppe regressive evolution. Then, when the degradation becomes more intense, reproductive capacity and regeneration of the steppe vegetation and decrease in this vegetation is more reduced. The soil is less protected by the lack of cover, so the deterioration of soil properties, reducing its The ecology of restoration and rehabilitation are part of the possible actions more to limit the extension of these misdeeds than to erase or mitigate the consequences. First of all, it is necessary to know the steppe ecosystem performance [27]. The aim of restoration is the natural resources sustainable management in areas heavily damaged by desertification in order to safeguard the land courses.

To remedy the situation, the Algerian state "HCDS" (High Commission for the Development of Steppe) has undertaken various measures of restoration or rehabilitation that fit into the framework of a national strategy for improving pastoral of degraded steppe and the fight against silting to combat desertification.

The rehabilitation includes repair of damage that did not alter an ecosystem in depth with a minor operation, such as by removing the causes of deterioration and restoring the free way of natural processes. In this case, a simple exclosure (fencing) is sufficient for reconstitution of the media, with the proviso that the misdeeds of the disturbances are not very pronounced [29].

According to Le Houerou [28] ; the fencing is a natural technic that helps protect a territory or a plot against the man and/or pets, is a known technic which has been practiced for centuries by our ancestors like that of "Agdal" in North Africa or the system of "Hema" in the Middle East and Arabia.

water reserves and fertility, often reach its sterilization and regression of plant productivity.

These impact indicators induce a change in production systems inherent to increased needs and hence poor management courses leading to an overexploitation of the available natural resources [4].

To remedy the situation, the state has undertaken various measures of restoration or rehabilitation that fit within the framework of a national strategy for improving pastoral of degraded steppe, and the fight against the silting to combat desertification.

For over four decades, the esparto steppe (*Lygeum spartum*) is 2 million hectares, rarely homogeneous, occupying the encrusted erosion glacis covered with a thin sand layer over brown calcareous soils, halomorphic in the Chotts area. But now these steppe formations cover an area of less than 2 million hectares, because they are subject to a continuous decline.

Numerous phytoecological and pastoral studies have been undertaken in several areas of the Algerian steppe, among which we quote: [1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 21, 22, 24, 25, 26, 28, 30, 31, 32, 33 and 34]

These studies were used to assess and map the natural available resources, and focused on the acquisition of knowledge of natural ecosystems which provides an overview on the role of steppe areas in Algerian politics. Diachronic studies have been conducted to quantify the intensity of their degradation and to identify factors that are responsible.

The present work is part of the conservation of steppe courses in south of Oran. It aims to study the role and effect of the exclosure (fencing) and the rise of organic steppe vegetation protected in relation to climate and use of the environment. Our approach results in a floristic and ecological assessment and quantification of changes in the rate of recovery of vegetation after a exclosure period.

2. Materials end methods

2.1. Study area

The area corresponds to the conditions of the high plains Oranian whose evolution has been consistent over the geological periods and which is, over all, of the Tell Atlas and of the Saharan Atlas general transition. This is a Saharan interface area. It is located on quaternary glacis belonging to the sub-sector of the Saharan Atlas. It has experienced strong population and sheep flocks growth. This trend is the main cause of degradation of pastoral ecosystems.

2.2. Climate framework in the region of study

The geographical position of the Naama province is not conducive to good climatic conditions. Surrounded by the chain of the Tell Atlas to the north and the great Moroccan massifs (over 3000 m) to the west, the inland areas of western Algeria are deprived of rainfall. From a biogeographical point of view, the region belongs to the Mediterranean area, the highlands sector and the area under the Saharan Atlas according to Quezel and Santa subdivisions [33].

Knowing that the climate is a major factor in the spatial distribution of vegetation and especially in the area of study, we have considered, as a climate parameter, rainfall and temperature that are on one hand, the most recent data available and, on the other hand, the fact that they represent the most affecting variables on vegetation. Climatic factors (rainfall, temperature, sirocco wind, frost ...) and bioclimatic (arid, semi-arid level...) determine all human activity, especially the activities of animal and plant production. Thus, a cyclically repeated drought can cause significant losses in the process of agricultural production which depends, ultimately, in the steppe regions, of the surface or groundwater availability.

The study area does not benefit from favorable weather conditions. It receives an annual average of less than 300 mm of rainfall which explains its ranking in the arid bioclimatic level. In general, the climatic year in the area is divided into two main seasons, a relatively wet and cold one which extends from November to April and a hot dry season from May to October [9] .

2.3. Presentation of the study site

In the province of Naama the High Commission for the Development of Steppe “HCDS” is achieving 32 fencing sites or 18% of the department grazing courses. These fencings (deferred grazing or exclosures) showed a form of struggle against the degradation of rangelands. We have chosen two sites to achieve our research project in the most affected, by desertification and silting area.

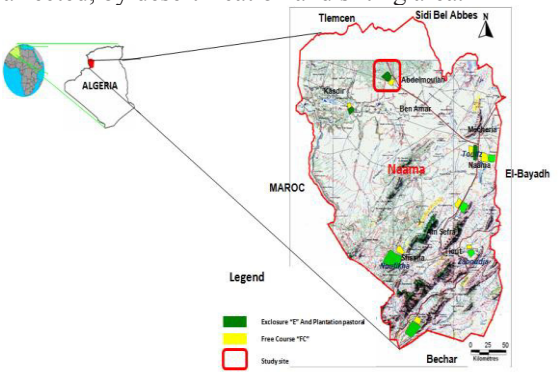

Fig. 1. Geographical location of the study site

The choice of study site of Abedelmoulah, (Fig.1) which correspond to the steppe has been done to assess the existing biodiversity in the Esparto group (*Lygeum spartum*). It was founded on the following criteria: the station must be accessible, identifiable and recognizable on maps and aerial photographs. The Table 1 below shows the different criteria study site.

Table 1
Characteristics of study site (Exclosure of Abedelmoulah)

Station	Abedelmoulah
Country	Algeria
Department	Naama
Daïra	Ben Ammar
Area (Ha)	50 000
Starting date	01/07/2003
Geomorphology	Glacis
Geology	Villafranchian
Altitude (m)	1127 – 1143 m.
Soil surface elements	Coarse element
Vegetation recovery (%)	8 – 45 %
Coordinates	**X** : 06°81’80,2” **Y:** 37°52’35,5”

Abedelmoulah station is located close to the village of Abedelmoulah, northwest of the town of Naama. The study area is administratively attached to the common Kasdir. Covering an area of 50,000 Ha made by the HCDS in 2003 to protect the village from the invasion sandy Abedelmoulah. It is part of the high steppe plains of *Lygeum spartum*. The topography is almost flat. This is an area of rangeland improvement, which is supported by a magnificent plantation of shrubs Atriplex forage. This is an exclosure which is supported by planting fodder shrubs namely Atriplex preceded by a remote line routing of 4 m and the distance between plants is 3m.

2.4. Methodology: Choice of transect and sampling structure

After the description of the vegetation and inventory and statement of state of the vegetal cover, we developed a survey about the vegetation inside and outside the fencing, corresponding to a plant survey and the measurements or estimates of ecological site types (geomorphology, topography, lithology and altitude).

We launched a sampling campaign in spring 2007 to determine the effect of that experimental practice on plant diversity and the soil surface condition at this station in the steppe south- Oranian of Naama.

To give this work a participatory approach, we went up to the indigenous populations for its views on the concept of natural resources fencing and, by showing the consequences of unsustainable exploitation of rangelands to maintain this ecosystem, made them react to that fact.

We selected by systematic sampling the transect method. This sampling technique, very suitable for our work, allows on one hand to relate the vegetation and the environment by using gradients of environmental sustainability such as micro-topography, substratum, etc.., and on the other hand to study the horizontal and vertical structure of vegetation. This method sets the size of the vegetation elements that could provide a working scale.

After detecting variability of vegetation (zoning), the methodology used includes a device consisting of a series of transects located in different topographic units of the study area. Thus the number of transects is a grid that can scan the whole fencing site and in some grazing courses nearby. These transects implanted with different orientations can overlap with more altitudinal and geomorphological gradients (tops, sides, flat terrain, troughs ...).

These transects are collected every 200 m depending on the variability of vegetation and ecological conditions (topography, exposure). The station, an area of $100m^2$, is delimited with a rope.

3. Results and discussion

This study was done by comparing the results obtained from the protection fencing "Ex", and, as witness, a neighboring free-range or free courses "FC" outside the latter. The comparative analysis is made by the calculus of variations of different recovery rate parameters, and systematic biological spectrum of inventoried species.

We found significant differences between the fencing and the open range as the uncontrolled anthropogenic fraction, and a bad management of the protected courses (fencing zone) after their opening, threatens the whole steppe ecosystem of Naama province despite all the HCDS efforts to preserve natural resources and to keep them for future generations.

This allowed us to obtain results from recovery plan, floristic richness, biological, systematic and characterizing phytomass the study sites.

Table 2
Comparison between parameters of the two situations (Ex and Fc)

Parameters	Exclosure (Ex)	Free courses (Fc)
Recovery %	45**%**	08**%**
Species number	56 espèces	21 espèces
biological types		
Phanerophytes (Ph)	1	0
Chamæphytes (Ch)	11	8
Hemicryptophytes (He)	11	3
Therophytes (Th)	31	9
Geophytes (Ge)	2	1
Biological spectrum	Th>Ch>He>Ge	Th>Ch>He>Ge
Systematics		
• *Families*	17	12
• *Genus*	45	21
• *Species*	56	21
Phytomass and pastoral production		
Phytomass (Kg/Ms/ha)	582	130
Pastoral value / 100	16,62	3,57
Pastoral production UF / ha	125,15	26,74
Densité floristique		
Number of individuals / 10m²	22,1	04,8

From table 2, we find that the application of the exclosure has an effect on:
- Improving the recovery rate
- Improving the rich flora
- A richness of floristic composition (biological and systematic)
- Effect of exclosure on floristic density
-Effect of exclosure on phytomass production and pastoral
- Regeneration and reappearance of vegetation

3.1. Improving the recovery rate

We find that the recovery is higher in the fencing situation (Ex); it is twice that of the free courses. Thus we can say that the exclosure has improved the recovery rate of vegetation. In this latter, the recovery is between 30 and 45%, but varies in space. Indeed, it is different in Free courses (Fc), where it does not exceed 8%.
This improvement in recovery rate is due to the process of biological recovery. According to Le-Houérou [30] "the rise is the set of biological processes inverse to those of the steppe and desertification. The biological recovery is characterized by an increase in the continuous recovery rate of the sustainable perennial biomass, the organic matter rate in the soil, structural stability, permeability and water balance, biological activity and primary productivity, while the variability of annual declines".

3.2. Improving the rich flora

We can see a clear pastoral flora diversification. Indeed, the species recorded within the deferred grazing are more important than outside (free courses). The difference shows the beneficial effect of the exclosure on the floristic richness.
The deferred grazing favored several species by the process of biological recovery: *Stipa parviflora, Salsola vermiculata, Anabasis articulata, Helianthemum lippii, Launaea nudicaullis ...*
In the free range (FC) species such as *Atractylis serratuloïdes, Peganum harmala, Thymelaea microphylla*….., and while other species decrease or even disappear among them: *Stipa parviflora, Artemisia herba alba, Salsola vermiculata ...*

3.3. The floristic composition (biological and systematic)

In terms of floristic composition, the fencing allowed a richness of flora from more than 50%. Several pasture species have reappeared in the deferred grazing, such as: *Lygeum spartum*, *Stipa parviflora, Artemisia herba-alba...*
This Therophytisation is related, on one hand, to the harsh climate and, on the other hand, to the anthropogenic actions that degrade more the conditions of new species settlement [9]. Emberger [23] said that the rate of therophytes increases with the environment aridity. For Daget [17], the therophytisation is a characteristic of arid zones; it expresses a coping strategy toward the unfavorable conditions and a form of resistance to harsh climate conditions.
The figure 2 describes a difference between the two situations (exclosure and free courses grazing). They are characterized by a strong presence of the herbaceous layer predominates. So the biological spectrum type (Th>Ch>He>Ge>Ph) is the same in both situations. So the difference lies in the number of species per spectrum.

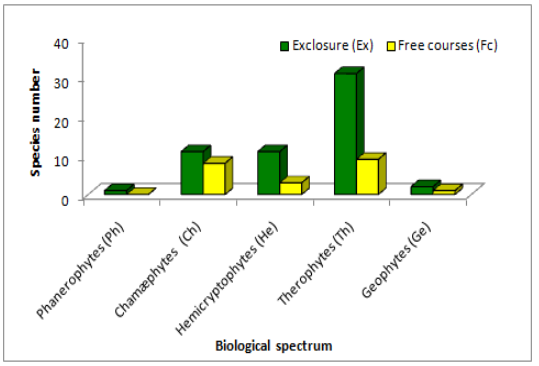

Fig 2. Spectrum of crude biological study sites (Ex and Fc)

We also note that this station is characterized systematically by two scenarios, being in the free courses (FC) or in the exclosure part (Ex). From Figure 3, we find that first situation (Ex) is represented by 24 families, 55 genera and 75 species, and in the second situation (FC), we find only 14 families, 25 genera and 28 species.
From these systematic reviews, we see families and genera diversity more nuanced in deferred grazing compared to the free courses (outside of the exclosure).

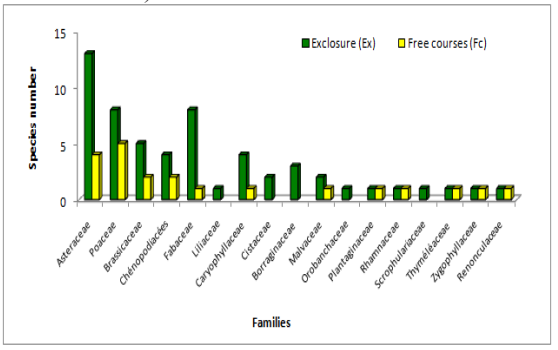

Fig. 3. Systematic characterization by families between the situations (Ex and FC)

The Asteraceae, Poaceae and Fabaceae are three families common to both situations with predominance in both floristic lists. These three families represent 35 to 40% of the flora in each Saharan sector [32]. This dominance is justified because there are cosmopolitan families widespread throughout the globe.

3.4. Effect of exclosure on floristic density

It was found that the highest mean total density (all age groups combined) was higher within the exclosure (Ex) compared to free courses. Within the exclosure, this density is only 22.1 individuals/10m^2, followed always by free range where the density is 4.8 individuals/10m^2. This difference can be explained by grazing and drought. Indeed, this ephemeral vegetation is closely related to the amount and timing of precipitation.
This density has increased significantly compared to free range can be explained by the abundance of seedlings of certain herbaceous perennials highly dynamic as *Plantago albicans* and *Helianthemum lippii* outside the exclosure. Within the exclosure, however, the presence of a hardpan could limit the dynamics of these species in opposing the penetration of seeds and their germination.
These differences can be explained mainly by grazing intensity acting on intraspecific competition, but also by interspecific competition against perennial grasses which have a high density in the exclosure. Indeed, these grasses (*Stipa parviflora, Lygeum spartum*) are highly coveted by animals. Which impairs their regenerative capacity by preventing the installation of seedlings, especially as these grasses reproduces only by seed. Thus, in the free courses grazing intensity because of its lower density, and tuft reduced to the ground. However, the protection has promoted the regeneration of these grasses, which results in a high density.
Indeed, in the exclosure stop grazing led to the emergence of large vigorous individuals. These prevent the establishment of seedlings in competition towards the limiting factor in this case, water-and nutrient.

3.5.-Effect of exclosure on phytomass production and pastoral

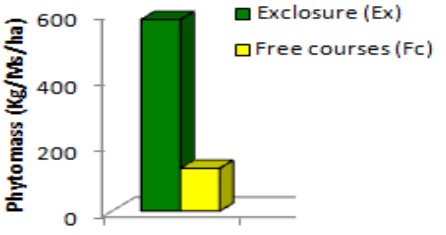

Fig. 4. Variations phyotomass between the situations (Ex and FC)

It is seen from Figure 4, the phytomass was higher in the exclosure (582 Kg / Ms / ha) contribution to the free range (130 Kg / Ms / ha). This abundance of phytomass in situations (Ex) is dominated mainly by species great pastoral value. This situation can be explained by the grazing intensity of human activity and drought. This last factor has not a great effect in the exclosure, where phytomass perennial grasses is important despite the dry conditions this year, the opening and location of exclosure by municipalities. In addition, the combination of free range grazing intense grubbing of trees down and drought makes the low biomass. Indeed, in the exclosure, the contribution of woody biomass is high. This is slightly lower in the free course...

3.6. Regeneration and reappearance of vegetation after a period of exclosure

In Table 3, we see that the protection by the technique of exclosure has a positive impact on the wealth of flora and the return of endangered vegetation.

This technique, which aims to reactivate the biological recovery of endemic species (pastoral and Saharan), will be applied primarily to the grazing courses types showing regeneration capacities and the rapid return of species of great pastoral value.

a- Grouping of *Lygeum spartum*

After a period of exclosure, the Spartans experienced a return with other vegetation through the process of biological recovery, so Sparta regenerates and grows naturally. It also grows on soil texture sandy loam. The floristic composition of this grouping: *Lygeum spartum, Stipa parviflora, Bromus rubens, Plantago albicans, Schimus barbatus, Malva aegyptiaca, Medicago laciniata, Noaea mucronata, Hordeum murinum, Hernaria fontanesii, Helianthemum lipii, Helianthemum hirtum,.....*

b- Grouping artificial of *Atriplex numularia*

This is an exclosure which is supported by planting fodder shrubs namely Atriplex preceded by a remote line routing of 4 m and the distance between plants is 3 m. Atriplex is purchased private nurseries are planted with a density of 800 plants per ha. The plants of this group *Atriplex numularia* artificial form of shrubs with an average of two meters in height. The floristic this group: *Atriplex numularia, Cistanche tinctoria, Salsola vermiculata, Lygeum spartum, macrocarpum Chrysanthemum, Matricaria pubescens, Launaea nudicaulis, Hernaria fontanesii.....*

C-Grouping of *Atractylis serratuloides*

This group is replaced esparto lost and degraded by overgrazing of livestock concentrated. This group is dominated by free range, which are highly disturbed and degraded by factors anthropogenic; it is gradually replaced by species that are not palatable as *Atractylis serratuloides, Peganum harmala,* which may, depending on the stations dominate. Among the species of this group: *Atractylis serratuloides, Thymelaea microphylla, Bassia muricata, Salsola vermiculata, Anabasis articulata, Ferula cossoniana, Atractylis humilis, Peganum harmala, Plantago albicans.....*

Table 3.
Comparison of floristic lists between the two situations (Ex and Fc).

N°	Families	*Exclosure (Ex)*		*Free courses (Fc)*	
		Sp	G	Sp	G
01	Asteraceae	13	13	4	4
02	Poaceae	7	8	5	5
03	Brassicaceae	4	5	2	2
04	Chenopodiaceae	3	4	2	2
05	Fabaceae	3	8	1	1
06	Liliaceae	1	1	-	-
07	Caryophyllaceae	2	4	1	1
08	Cistaceae	1	2	-	-
09	Borraginaceae	3	3		
10	Malvaceae	1	2	1	1
11	Orobanchaceae	1	1	-	-
12	Plantaginaceae	1	1	1	1
13	Rhamnaceae	1	1	1	1
14	Scrophulariaceae	1	1	-	
15	Thyméléaceae	1	1	1	1
16	Zygophyllaceae	1	1	1	1
17	Renonculaceae	1	1	1	1
Total		45	56	21	21

** G: Genus, Sp: Species*

4. Conclusion

This article was produced in the breeding station pastoral esparto steppe *Lygeum spartum* in the area of Naama. The objective of this study is to highlight the technical improvement Pastoral (exclosure) to attend and promote natural regeneration.

After this comparative study phytoecological certain parameters of vegetation (recovery and number of species per plot) in the esparto steppe (*Lygeum spartum*) at different sites (exclosure and free courses), compared to the free course vegetation is more productive and diversified into exclosure. There is an average recovery of 45% of the vegetation in the exclosure against 8% in free-range. In terms of floristic diversity found 56 species against 21 species respectively inside and outside exclosures.

The exclosure allows a quantitative and qualitative increase in floristic richness, development of pastoral species including therophytes. This results in a significant phytomass, and vegetation cover is relatively high. The floristic composition is very diverse. She encouraged the resettlement and reappearance of endangered species.

In light of this, it is imperative to put in place a comprehensive program to establish protected areas (exclosure) to organize a rational conservation, rehabilitation of natural resources at local and national level. To better understand, protect these wild resources. Management of our natural resources must necessarily pass through a development strategy that will allow the preservation of ecological balance. These are invaluable resources potential, but should preserve these natural resources against all loss factors, to integrate these resources in the list of protected species.

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Acronyms

HCDS: High Commission for the Development of Steppe
G: Genus
Sp: Species
Fc: Free courses
Ex: Exclosure
Ph: Phanerophytes
Ch:Chamæphytes
He:Hemicryptophytes
Th:Therophytes
Ge:Geophytes
Ha: Hectares