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Assessment of the role of the protected land in the preservation of the steppe in Southwest Algeria (Case of the Rogassa Region)

Benyekhlef Benkaddour[1], Ahmed Megharbil[2], Réda Kechairi[3] & Kassim Boudjelal Safir[4]

[1]Institute TS/FSB, University of Ahmed Zabana Relizane, Relizane, Algeria; ORCID: BB https://orcid.org/0000-0002-2521-9602
[2]Laboratory of Plant and Ecology, USTHB – Algeria; ORCID: AM https://orcid.org/0000-0002-7056-2207
[3]Department of Ecology and Environment, Faculty of Sciences of Nature and Life, Earth Sciences and Universe, University of Abu-Bakr Bel Kaid, Tlemcen, Algeria; ORCID: RK https://orcid.org/0000-0002-3477-1132
[4]Department of English, Mustapha Stambouli University, Mascara, Algeria; ORCID: KBS https://orcid.org/0000-0001-8902-3679
* corresponding author (e-mail: benkaddoureco@yahoo.fr)

Abstract. In the Algerian steppe (Rogassa) overgrazing led to the reduction of the surface of the pasture land and its biodiversity. The objective of this work was to highlight the importance of the protected land in maintaining biodiversity and preserving the degraded areas. A mixed sampling for the two different sites was adopted, where fifty floristic surveys were conducted using the Braun-Blanquet method. The analysis of the real biological spectrum of the unprotected land was marked by the strong dominance of the therophytes. However, in the protected land the chamaephytes dominated all of the biological types. The analysis of the biogeographic spectra revealed the reappearance of the endemic species (+3%). The Shannon Index was very important in this matter (2.43). The Student's t-test of the biodiversity's index showed a highly significant difference between the two sites. The ascending hierarchical classification revealed that the protected land is subdivided into four groups dominated respectively by: *Macrochloa tenacissima*, *Lygeum spartum*, *Artemisia erba-alba* and *Hordeum murinum*. The results of the Jaccard dissimilarity index indicated a strong difference of the order of 80% between the two areas.

Keywords: Algeria, biodiversity, overgrazing, protected land, steppe, Rogassa

1. Introduction

The Algerian steppe plays a key role in the socio-economic maintenance of the local population and also in the environmental balance of the ecosystems (Benabdeli 1989). It forms a ribbon about 1000 km long and 150-300 km wide. It covers an area of 20 million hectares, including 15 million hectares of the rangelands (Houamel 2018). The Algerian steppe ecosystem is characterized by a parse plant cover, an arid climate with low, irregular rainfall, poor soil, and a large fauna (the sheep herds) (Nedjraoui & Bédrani 2008). According to Salemkour (2015), as a part of the fight against the desertification and the rational use of this fragile ecosystem, the Algerian government has created institutions for the implementation of programs for the restoration, rehabilitation (planting of the perennial species), reallocation and recreation of the agroecosystems.

The region of El Bayadh, for example, is one of the eight steppe wilayas (provinces). It is known for its extraordinary diversity of the medicinal flora, endemic species, and exceptional fauna (Aidoud 1989a). Since the 1970s several studies have been carried out (Djebaili 1978; Achour *et al.* 1983; Aidoud 1989a; Amgha 2012), but unfortunately the carried out developmental work remained weak in socio-economic and ecological dimensions. The objective of this study was to quantify the rate of the plant cover change on a spatio-temporal scale between the protected and unprotected lands to highlight the need for a sustainable management of the Algerian steppe.

2. Material and Methods

2.1. Presentation of the studied region

The studied region is located in Regassa, a marvelous steppe region situated in the north of the El Bayadh province, around the geographical point: y = 34.016596°N; x = 0.922465°E (Fig. 1). It was dominated by the Alfa type (*Stipa tenacissima*) before the study. Today, the degradation of these species (Alfa) can be noticed. The climate is characterized mainly by low precipitation (120 mm/year) with a great inter-monthly and inter-annual variability. The peak is estimated at 150 mm/year; relatively homogeneous but with very contrasting thermal regimes; characteristic for the continental type. The annual thermal amplitude exceeds 20°C (Le Houérou 1995). The soil is poor and fragile, with the dominance of thin soils and light gray, due to the depletion of the humus (Aidoud 1989a).

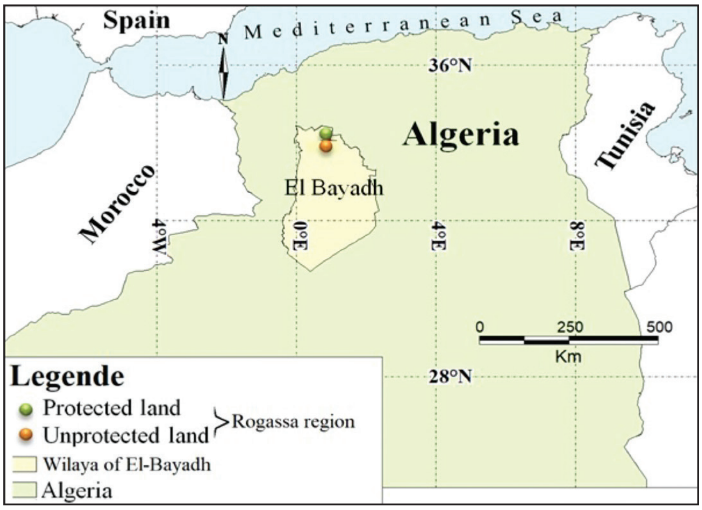

Fig. 1. Geographical location of the study region

2.2. Methodology

To achieve the objective a mixed, subjective and systematic sampling was adopted. The choice of the two sites (protected Fig. 2 and unprotected Fig. 3) was based subjectively on the knowledge of the land. The choice of the locations for the floristic surveys was done systematically along the north-south transect (about one kilometer between each plot). Fifty floristic surveys were carried out between March and June during the year 2020 (Appendix 1), within the area of around 200 m². Each species, noted on the sample surface, has been assigned a dominance abundance coefficient from 1 to 5 according to the Braun-Blanquet scale (1952).

The calculation of the biological and the biogeographical spectra was chosen as an indicator of change. The matrix of the floristic records (Appendix 2) is subject to an ascending hierarchical classification in order to quantify the rate of dissimilarity on the one hand and on the other to identify the plant groups born in the rangelands and set aside.

The calculation of the biodiversity indices and the rank-frequency curve would be effective while focusing on the changes between the two sites. Student's t-test was used for the inter-site comparison. The environment used for the statistical processing is the R 4.0.0 software.

3. Results

3.1. Biological types

The real biological spectrum of the unprotected land is marked by the strong dominance of the therophytes (50%), but on the protected land the chamaephytes dominate all of the biological types (Fig. 4).

Fig. 2. Protected land (2020, photograph by B. Benkaddour)

Fig. 3. Unprotected land (2020, photograph by B. Benkaddour)

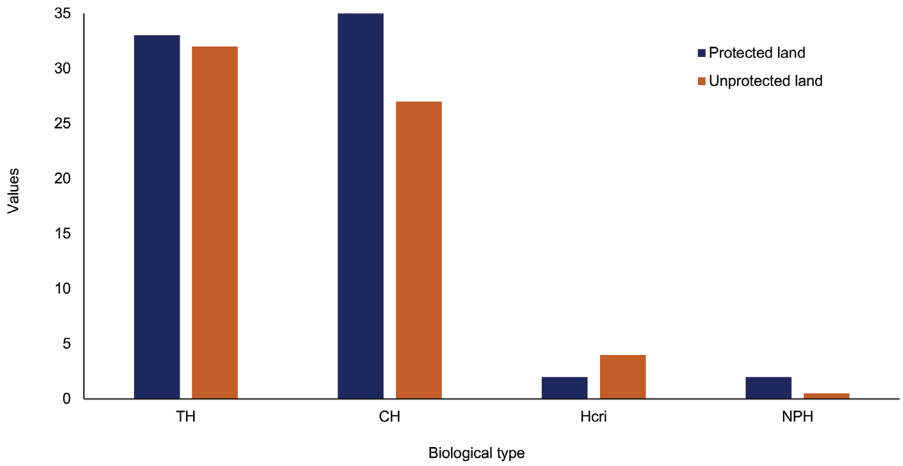

Fig. 4. Real biological spectrum
Explanations: TH – therophyte, CH – chamaephyte, Hcri – hemicryptophyte, NPH – nanophanerophyte

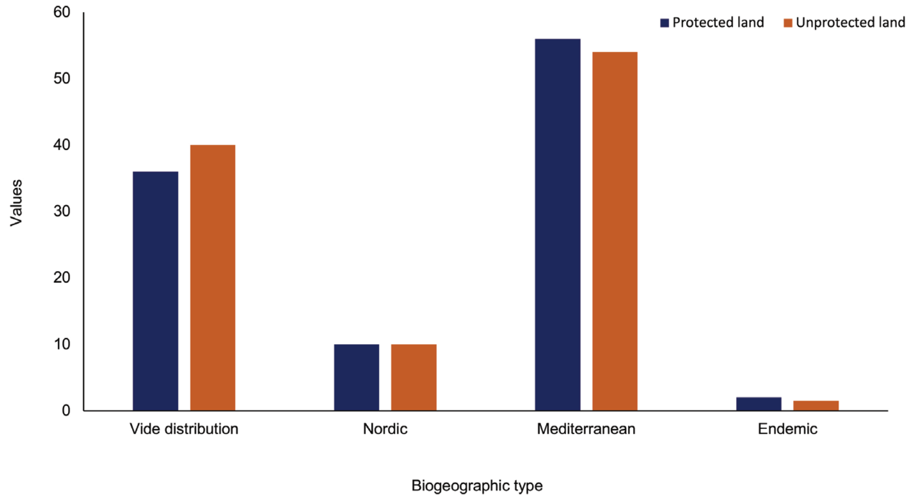

Fig. 5. Real spectrum of the biogeographic types

3.2. Biogeographic types

There were changes in the frequencies thanks to a biological rise, particularly in the percentage of the endemic species (+ 2%), cited: *Astragalus armatus*, *Thymelaea microphylla*, *Carduus arenarius* and *Anthemis monilicostata* (Fig. 5).

3.3. Rank-frequency curve

The unprotected lands are dominated by the two species with a high specific contribution (*Macrochloa tenacissima*, *Artemisia erba-alba*), however the protected lands are dominated by many species with low abundance (*Macrochloa tenacissima*, *Lygeum spartum*, *Artemisia erba-alba*) (Fig. 6). The curve established from the abundances of the taxa, collected in the protected land stations, moves away from the abscissa axis, spreads out more to the right and does not mark a significant break in slope. This reflected the presence of a more diverse, better structured and more homogeneous stand (Fig. 7).

3.4. Biodiversity indices

In order to understand the diversity of the vegetation several measures and indices were calculated for each survey. Shannon index values obtained in the protected land ranged from 0.366 to 2.343. In the unprotected land they fluctuated between the minima of 0.84 and the maxima of 2.03. The values of the Simpson's fairness (D) were different between the protected land and the unprotected land (Fig. 8).

3.5. Students t-test

The Students t-test of the biodiversity indices revealed a highly significant difference between the two sites with respect to the biodiversity indices (Table 1).

3.6. Jaccard dissimilarity index

The Jaccard index is an association coefficient used to study the similarity between the samples. The calculation of the Jaccard similarity between the two sites

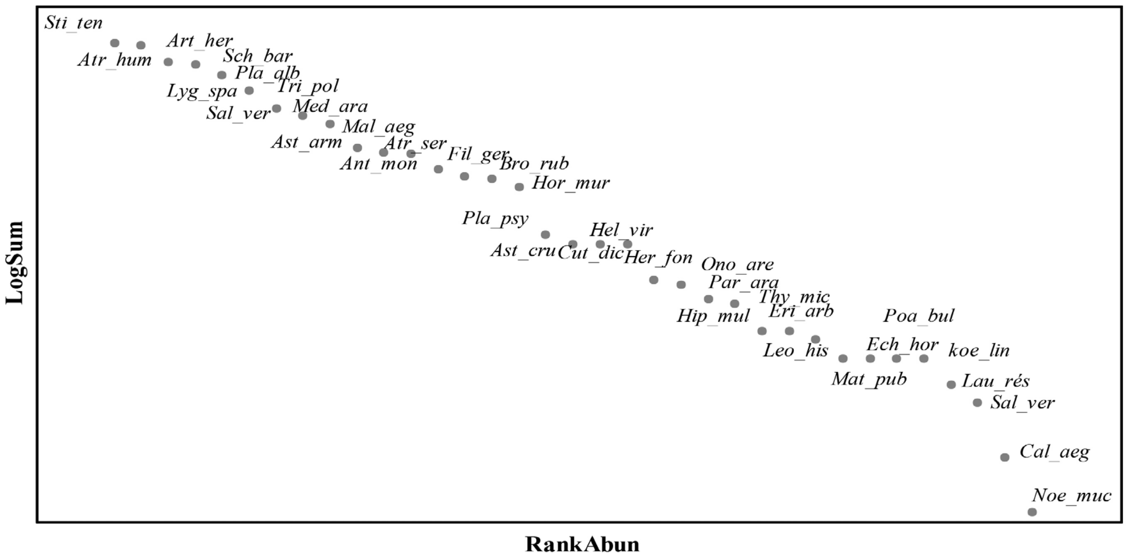

Fig. 6. Rank-abundance curve of the unprotected land

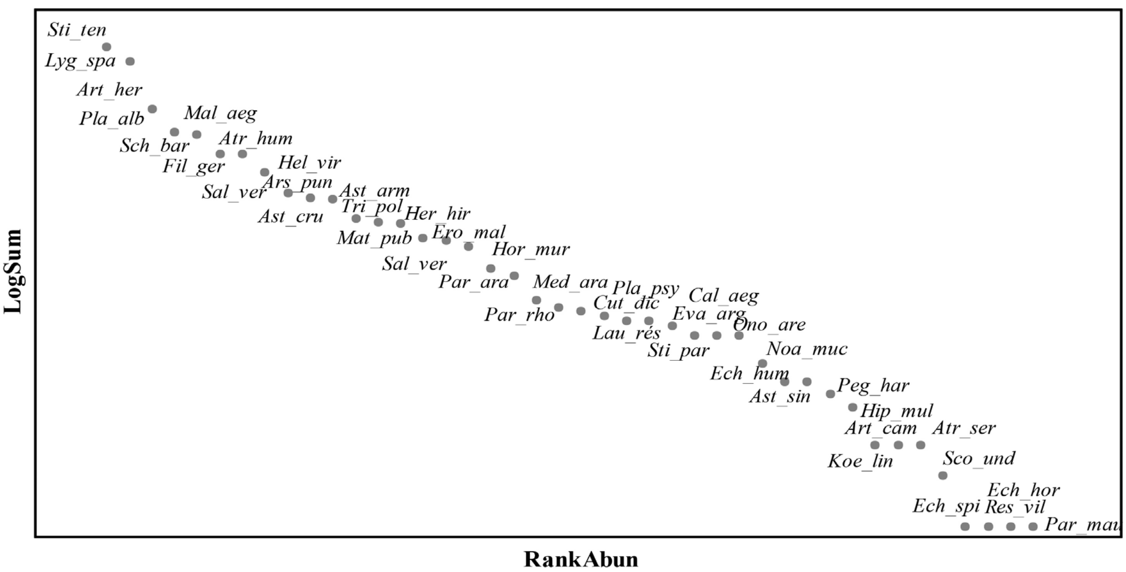

Fig. 7. Rank-frequency curve abundance of the protected land

revealed that J=0.19, which meant that the dissimilarity was very large, namely 81%.

The Jaccard index of the fifty relevés ranged from 0.10 to 1.00. This shows that the range was very large. So there was a significant heterogeneity between the two sites.

There were very few common species between the two areas, unlike R8 where this number reached its maximum value of 90%. This dissimilarity clearly explains the role of protection in the biological recovery of the steppe. It was observed that this dissimilarity reached 100% on several occasions (Fig. 9)

Table 1. T-test of the biodiversity indices of the two sites

	t (Student)	P (=0.05)
Richness	23.27	3.84^{E}-28
Shannon-Weaver	30.77	1.05^{E}-33
Simpson	27.54	1.78^{E}-31
Evenness	24.90	1.79^{E}-29

3.7. Hierarchical classification

The ascending hierarchical classification of the unprotected land highlighted two main groups. The latter were respectively dominated by *Macrochloa tenacissima* and *Lygeum spartum*. The ascending hierarchical classification of protected land highlighted two groups. The first was dominated by *Macrochloa tenacissima*. The second was subdivided into three subgroups, dominated respectively by: *Lygeum spartum*, *Artemisia herba-alba* and *Hordeum murinum* (Fig. 10).

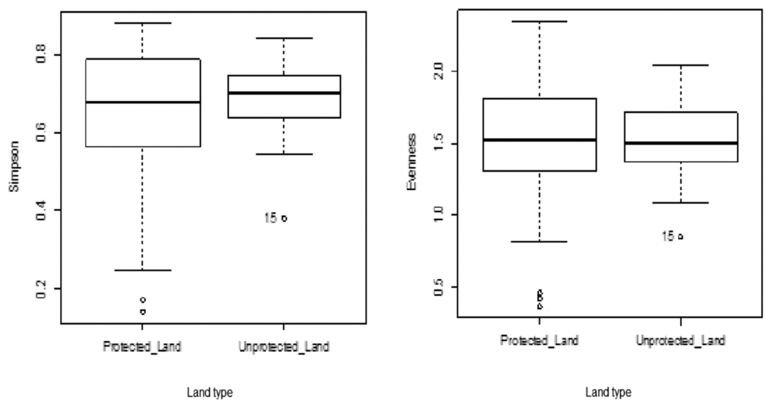

Fig. 8. Comparison of the biodiversity indices between the unprotected and protected land

Protected_Land (columns); Unprotected_Land (rows)

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25
R1	0.78	0.71	0.65	0.69	0.47	0.53	0.56	0.38	0.62	0.75	0.94	0.76	0.80	0.84	0.94	0.83	0.83	0.89	0.82	0.79	0.82	0.83	0.60	0.69	0.67
R2	0.69	0.58	0.62	0.55	0.43	0.57	0.69	0.26	0.74	0.75	0.92	0.86	0.92	0.87	0.91	0.93	0.86	0.93	0.93	0.88	0.93	0.93	0.77	0.86	0.85
R3	0.77	0.55	0.69	0.64	0.36	0.64	0.75	0.21	0.79	0.81	0.91	0.75	0.80	0.86	0.90	0.93	0.85	0.93	0.92	0.87	0.92	0.93	0.75	0.85	0.83
R4	0.60	0.50	0.63	0.57	0.60	0.40	0.75	0.33	0.67	0.74	0.87	0.75	0.79	0.83	0.86	0.75	0.75	0.82	0.73	0.71	0.81	0.82	0.67	0.75	0.73
R5	0.46	0.46	0.60	0.42	0.64	0.36	0.74	0.35	0.65	0.72	0.86	0.73	0.77	0.75	0.85	0.73	0.73	0.81	0.71	0.69	0.80	0.81	0.64	0.73	0.71
R6	0.69	0.87	0.71	0.77	0.25	0.75	0.69	0.26	0.74	0.57	0.82	0.86	0.92	0.94	0.80	0.86	0.77	0.86	0.93	0.80	0.85	0.86	0.77	0.86	0.85
R7	0.71	0.71	0.64	0.58	0.31	0.69	0.53	0.32	0.68	0.60	0.92	0.94	1.00	0.94	0.92	0.94	0.87	0.94	0.93	0.88	0.93	0.94	0.79	0.87	0.86
R8	0.62	0.62	0.54	0.58	0.40	0.60	0.63	0.32	0.68	0.60	0.83	0.87	0.92	0.88	0.82	0.94	0.87	0.94	0.93	0.88	0.86	0.87	0.79	0.87	0.86
R9	0.71	0.80	0.73	0.69	0.40	0.60	0.78	0.32	0.68	0.69	0.92	0.94	0.92	0.94	0.92	0.87	0.79	0.87	0.86	0.81	0.86	0.87	0.79	0.87	0.86
R10	0.75	0.82	0.76	0.64	0.28	0.72	0.59	0.35	0.65	0.47	0.93	0.94	1.00	0.95	0.93	0.94	0.88	0.94	0.94	0.89	0.88	0.88	0.81	0.88	0.88
R11	0.86	0.67	0.58	0.93	0.27	0.73	0.82	0.10	0.90	0.88	0.80	0.64	0.67	0.77	0.78	0.93	0.93	0.93	1.00	0.94	1.00	1.00	0.85	0.93	0.83
R12	0.86	0.67	0.69	0.85	0.36	0.64	0.82	0.15	0.85	0.94	0.91	0.75	0.67	0.67	0.90	0.93	0.93	0.93	0.92	0.94	1.00	1.00	0.85	0.93	0.83
R13	0.81	0.81	0.75	0.88	0.22	0.78	0.85	0.13	0.87	0.90	0.85	0.62	0.75	0.73	0.83	0.80	0.80	0.80	0.87	0.82	0.94	0.94	0.88	0.88	0.87
R14	0.75	0.75	0.69	0.88	0.28	0.72	0.86	0.13	0.88	0.90	0.77	0.54	0.67	0.67	0.75	0.81	0.81	0.81	0.88	0.83	0.94	0.94	0.88	0.88	0.88
R15	0.93	0.64	0.67	0.92	0.29	0.71	0.81	0.10	0.90	0.94	0.90	0.73	0.63	0.75	0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.92	0.82
R16	0.67	0.77	0.79	0.50	0.36	0.64	0.82	0.21	0.79	0.81	1.00	0.85	0.80	0.86	1.00	0.64	0.50	0.64	0.60	0.58	0.83	0.85	0.64	0.75	0.73
R17	0.73	0.73	0.93	0.70	0.21	0.79	1.00	0.11	0.89	0.94	1.00	0.82	0.75	0.83	1.00	0.56	0.70	0.70	0.50	0.64	0.80	0.82	0.82	0.82	0.80
R18	0.73	0.73	0.93	0.70	0.21	0.79	1.00	0.11	0.89	0.94	1.00	0.82	0.75	0.83	1.00	0.56	0.70	0.70	0.50	0.64	0.80	0.82	0.82	0.82	0.80
R19	0.73	0.92	0.93	0.70	0.21	0.79	0.94	0.17	0.83	0.94	1.00	0.92	0.89	0.92	1.00	0.56	0.38	0.56	0.50	0.50	0.91	0.92	0.82	0.82	0.91
R20	0.55	0.86	0.87	0.50	0.36	0.64	0.89	0.28	0.72	0.81	1.00	0.93	0.91	0.93	1.00	0.33	0.33	0.50	0.25	0.30	0.73	0.75	0.64	0.64	0.73
R21	0.75	0.82	0.76	0.64	0.28	0.72	0.80	0.23	0.77	0.79	1.00	0.88	0.86	0.95	1.00	0.73	0.73	0.81	0.71	0.69	0.71	0.73	0.27	0.64	0.36
R22	0.85	0.85	0.86	0.83	0.13	0.88	0.94	0.10	0.90	0.94	1.00	0.83	0.78	0.93	1.00	0.73	0.83	0.83	0.70	0.77	0.82	0.73	0.60	0.73	0.56
R23	0.81	0.81	0.75	0.71	0.22	0.78	0.85	0.18	0.82	0.78	1.00	0.88	0.85	0.94	1.00	0.71	0.80	0.80	0.69	0.75	0.69	0.71	0.36	0.71	0.30
R24	0.80	0.80	0.73	0.69	0.24	0.76	0.84	0.19	0.81	0.76	1.00	0.87	0.83	0.94	1.00	0.69	0.79	0.79	0.67	0.73	0.67	0.69	0.30	0.69	0.22
R25	0.94	0.94	0.81	0.87	0.17	0.83	0.84	0.14	0.86	0.83	1.00	0.87	0.83	0.94	1.00	0.87	0.87	0.87	0.86	0.88	0.77	0.79	0.45	0.79	0.40

Fig. 9. Jaccard dissimilarity index (the unprotected land and the protected land)

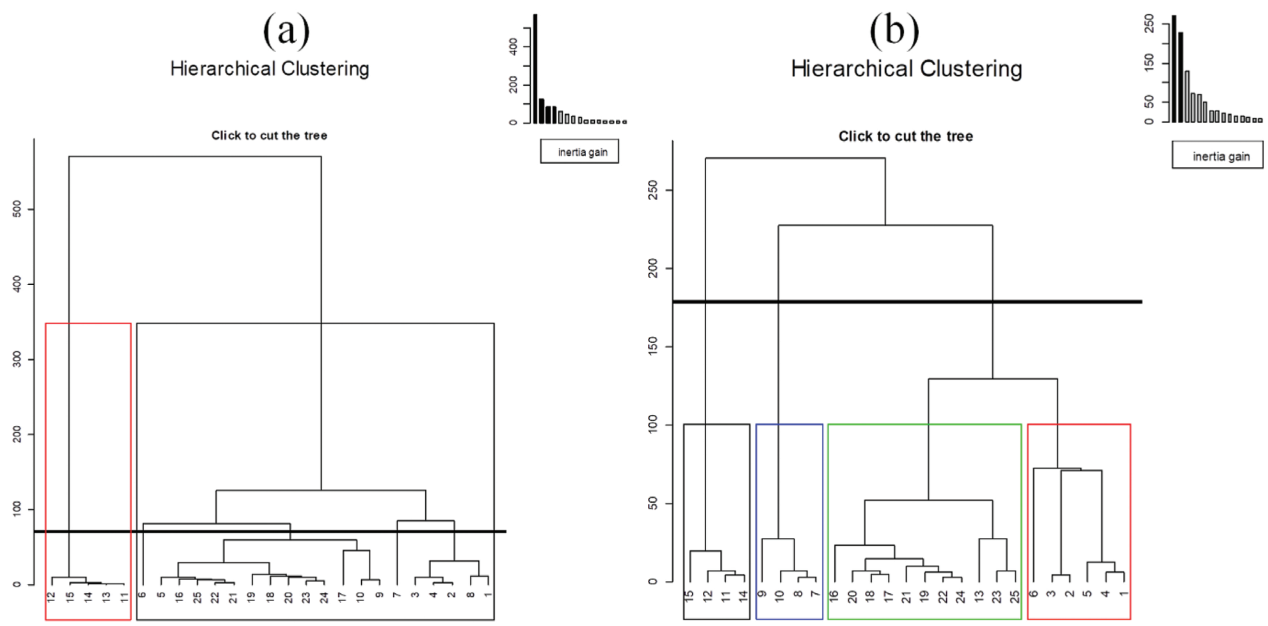

Fig. 10. Ascending Hierarchical Classification (CAH) the unprotected land (a), the protected land (b)

4. Discussion

According to the statistical tests, applied to the two matrices in the study region on a finding, the protected land promotes biological recovery. On the other hand, the unprotected land presents an obstacle to this natural phenomenon and gives rise to a more therophytic vegetation.

For the biological types it is known that overgrazing profoundly modifies the steppe ecosystem (Salemkour 2015) – this was confirmed by the research work of (Houamel 2018; Taibaoui *et al.* 2020). The extension of this species category (the therophytes) is favored by anthropization.

The real biological spectrum of the unprotected land is marked by the strong dominance of the therophytes (50%), but within the protected land the chamaephytes replace the therophytes (+10%). Therophytization is characteristic to the arid zones. Therophytes are a form of resistance to the climatic rigors (Barbero *et al.* 1990; Boucherit *et al.* 2017). In terms of the biogeographic aspect of the two sites the types are: Mediterranean > Wide distribution > Nordic > Endemic.

However, the Mediterranean steppe region and particularly the Algerian southeast are dominated by the Mediterranean species (Daget 1980; Benabadji *et al.* 2009; Taibaoui *et al.* 2020). Indeed, the Mediterranean affinity of the study region is marked by the abundance of several species which represent 35 to 40% of the flora in the Saharan sector (Ozenda 1977). In terms of dominance an unbalanced facies is characterized by the dominance of two species, namely *Stipa tenassicima* and *Artemisia erba alba*. This phenomenon was explained by Aidoud (Aidoud 1989a, 1989b).

The Shannon index clearly explains the differences in the floristic composition of the two areas. Taibaoui *et al.* (2020) explained the difference between the protected sites compared to the unprotected land. Simpson's fairness gives a picture of an increase in the regularity of the protected land. This allows us to highlight the role of the restoration in maintaining the ecosystem balance of the steppe. Aidoud (1989a) shows that the setting in the protected land has a definite beneficial effect on the vegetal resulting in the improvement of the vegetation cover. Furthermore, it guarantees protection in conditions of drought and pressure. This technique is recommended for the regeneration of the degraded land. Also, the dissimilarity clearly explains the role of rangleland protection in the biological recovery of the steppe. The “Biological recovery”, as a parameter of reconstitution, is threatened with destruction by the degradation factors (Emberger 1930; Daget 1980; Amgha 2012).

The ascending hierarchical classification of the unprotected land highlights two groups. On the other hand, the protected site is divided into several groups, which are dominated respectively by *Macrochloa tenacissima*, *Lygeum spartum*, *Artemisia erba-alba* and *Hordeum murinum*. Several studies (Le Houerou 1969; Djebaili 1978; Aidoud 1983) confirm, that in the Algerian steppe the reduction of the floristic diversity is not only due to the climatic factors (drought and increased aridity), but it is also the anthropic factors (mainly fires and overgrazing). These factors are also caused by irrational use of land, such as clearing.

In fact, in this study we clearly see that the protected land has a significant role in biodiversity. This is a testimony to what Aidoud and Adioud (1987), Aidoud (1989a, 1989b), Aidoud *et al.* (1998, 2006) and Haddouche *et al.* (2008) have done in their studies about the phytoecology and phytosociology.

5. Conclusion

The study area is characterized by an arid climate, poor soil and degrading biological diversity. In addition to this, it is subjected to an anthropogenic pressure. The quantification of the qualitative changes in the floristic diversity is an important element for the modeling of the rational management of the Algerian steppe. The appearance of the endemic species is a positive indication for the preservation of the flora heritage. Through our results the protected land is among the best solutions for a better preservation of the biodiversity against the climate and the strong demands of the local population. The state of degradation by overgrazing is in fact the determining factor, which necessitates a rigorous reaction to limit the harmful effect of this phenomenon. With this in mind, the following suggestions are highlighted: (*i*) scientific evaluation of the restoration work established before, (*ii*) updating of the actual state of the steppe rangelands and (*iii*) integration of the local population in the models and projects for the sustainable management of this fragile environment.

Author Contributions:
Research concept and design: B. Benkaddour
Collection and/or assembly of data: B. Benkaddour
Data analysis and interpretation: B. Benkaddour, A. Megharbi
Writing the article: B. Benkaddour
Critical revision of the article: R. Kechairi, K. B. Safir
Final approval of article: B. Benkaddour

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Appendix 1. Floristic list of species encountered in the two sites

Code	Species	Family	Biological types	Biogeographical types
Mac_ten	*Macrochloa tenacissima* (L.) Kunth	Poaceae	Chamaephyte	Iber-Mauritania
Lyg_spa	*Lygeum spartum* L.	Poaceae	Chamaephyte	West Mediterranean
Hel_vir	*Helianthemum virgatum* (Desf.)Pers.	Cistaceae	Hemicryptophyte	lbéro-Mauritania
Pla_alb	*Plantago albicans* L.	Plantaginaceae	Therophyte	Mediterranean
Med_ara	*Medicago arabica* (L.) Huds.	Fabaceae	Therophyte	Mediterranean
Peg_har	*Peganum harmala* L.	Nitrariaceae	Chamaephyte	Iranian-Tour.-Europe
Hor_mur	*Hordeum murinum* L.	Poaceae	Therophyte	Circum-boréal
Ani_rub	*Anisantha rubens* (L.) Nevski	Poaceae	Therophyte	Paleo-subtropical
Mal_aeg	*Malva aegyptia* L.	Malvaceae	Therophyte	Saharan. Sindian. Mediterranean
Sal_ver	*Salvia verbenaca* L.	Lamiaceae	Chamaephyte	Mediterranean atlantic
Atr_cae	*Atractylis caespitosa* Desf.	Asteraceae	Therophyte	Ibero.-Mauritania.
Ast_arm	*Astragalus armatus* Willd	Fabaceae	Chamaephyte	Endemic north Africa
Par_ara	*Paronychia arabica* (L.) DC.	Caryophyllaceae	Therophyte	Europe. Mediterranean
Cen_pub	*Centaurea pubescens* Willd.	Asteraceae	Therophyte	Ibéro-Mauritania.
Xer_ina	*Xeranthemum inapertum* (L.) Mill.	Asteraceae	Therophyte	Eurasiatic. North.Africa
Bom_dis	*Bombycilaena discolor* (Pers.) M. Laínz	Asteraceae	Therophyte	Eurasiatic. N.A.
Lau_res	*Launaea resedifolia* (L.) Kuntze	Asteraceae	Therophyte	Med.- Saharan. Sindian
Car_eri	*Carthamus eriocephalus* (Boiss.) Greuter	Cynareae	Therophyte	Saharian.
Ast_set	*Astragalus stella* L.	Fabaceae	Therophyte	Med.-Irano.Touranian
Koe_lin	*Koelpinia linearis* Pallas	Asteraceae	Therophyte	Mediterranean. Saharan.-Irano. Touraninan
Ery_cam	*Eryngium campestre* L.	Apiaceae	Therophyte	Europe. Mediterranean
Koe_pub	*Koeleria pubescens* (Lamk.) P. B.	Poaceae	Therophyte	West. Mediterranean
Sco_his	*Scorzoneroides hispidula* (Delile) Greuter	Asteraceae	Therophyte	Mediterranean
Sti_par	*Stipa parviflora* Desf.	Poaceae	Therophyte	Mediterranean
Sti_bar	*Stipa barbata* Desf.	Poaceae	Therophyte	West. Mediterranean
Art_her	*Artemisia herba-alba* Asso	Asteraceae	Chamaephyte	Sp from Canaries to Egypte, W.Asia
Art_cam	*Artemisia campestris* L.	Asteraceae	Chamaephyte	Circumboreal.
Noe_muc	*Noeae mucronata* (Forssk) Asch.	Amaranthaceae	Nanophanerphyte	North Africa, West. Asia
Car_ver	*Caroxylon vermiculatum* (L.) Akhani & Roalson	Chenopodiaceae	Chamaephyte	Saharan Mediterranean
Stp_pun	*Stipagrostis pungens* (Desf.) De Winter	Poaceae	Therophyte	Saharan. South.Africa.
Sch_bar	*Schismus barbatus* (L.) Thell.	Poaceae	Therophyte	Macar-Med
Atr_ser	*Atractylis serratuloides* Sieb. ex Cass.	Asteraceae	Therophyte	Saharan
Thy_mic	*Thymelaea microphylla* Coss. et Dur.	Thymelaeaceae	Therophyte	Endemic. North.Africa
Oto_pub	*Otoglyphis pubescens* (Desf.) Pomel	Asteraceae	Therophyte	Saharan
Poa_bul	*Poa bulbosa* L. *subsp. bulbosa*	Poaceae	Hemicryptophyte	Macar- Mediterranean
Bor_off	*Borago officinalis* L.	Boraginaceae	Therophyte	Mar Alg Tun Lib
Car_are	*Cardus arenaria* Coss. et Dur.	Asteraceae	Therophyte	Endemic. North. africa
Cut_dic	*Cutandia dichotoma* (Forssk.) Trab.	Poaceae	Therophyte	Mediterranean
Ast_cre	*Astragalus crenatus* Schult.	Fabaceae	Therophyte	Mediterranean. Saharan
Ech_hor	*Echium horridum* Batt.	Boraginaceae	Therophyte	South. Mediterranean
Ant_mon	*Anthemis monilicostata* Pomel	Asteraceae	Therophyte	Endemic-Alg.-Mar
Cal_arv	*Calendula arvensis* (Vaill.) L.	Asteraceae	Therophyte	Sub. Mediterranean
Hip_mul	*Hippocrepis multisiliquosa* L.	Fabaceae	Therophyte	Mediterranean
Pla_ova	*Plantago ovata* Forssk.	Plantaginaceae	Therophyte	Mediterranean
Tri_pol	*Trigonella polyceratia* L.	Fabaceae	Therophyte	Ibero-Mauritanica.
Eri_arb	*Erica arborea* L.	Ericaceae	Hemicryptophyte	Sub. Mediterranean
Her_fon	*Herniaria fontanesii* J. Gay	Caryophyllaceae	Therophyte	Ibero.-Maur.-Cen.
Stp_pun	*Stipagrostis pungens* (Desf.) De Winter	Poaceae	Chamaephyte	Saharan Africa
Her_hir	*Herniaria hirsuta* L.	Caryophyllaceae	Therophyte	Paleo-Temp

Mat_par	*Matthiola parviflora* (Schousb.) R. Br.	Brassicaceae	Therophyte	Ibero-Mauritanica
Pap_rho	*Papaver rhoeas* L.	Papaveraceae	Therophyte	Paleo-Temp
Res_vil	*Reseda villosa* Coss.	Resedaceae	Therophyte	Saharan. Tropical.
Sco_und	*Scorzonera undulata* Vahl	Asteraceae	Hemicryptophyte	Mediterranean
Par_arg	*Paronychia argentea* Lam	Caryophyllaceae	Therophyte	Mediterranean
Fil_arg	*Filago argentea* (Pomel) Chrtek & Holub	Asteraceae	Therophyte	Tropical
Ech_spi	*Echinops spinosissimus subsp. spinosus*	Greuter	Asteraceae	Therophyte Mediterranean. Saharan
Ech_pyc	*Echium pycnanthum* Pomel	Boraginaceae	Therophyte	Mediterranean. Saharan
Ero_mal	*Erodium malacoides* (L.) L'Hér.	Geraniaceae	Therophyte	Mediterranean

Appendix 2. The matrix of the floristic records

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17
Mac_ten	2	+	+		2	4.5					4	3	4	4	4		
Lyg_spa	1	2		2	3			2		1						1	
Ars_pun									2	2							
Art_cam									1								
Art_her	2	3	3	3	1			2									
Atr_hum	2	1	1	2								1	1	1		1	3
Sal_ver	2			1	2	2	1	2	1	+							1
Peg_har							1										
Atr_ser						1				+							
Ast_arm			2	1	1		1	+									
Ast_cru						1	1	1	2	1		1					
Ast_sin						1	1	1									
Cal_aeg			+		+	1	1	1									
Ech_hor						+											
Her_hir						1		2				1					
Fil_ger	1			+	+	1		1						+		1	1
Hel_vir	2		2							2	1	2			2		1
Hor_mur		1			2							+	1	2			
Hip_mul						1				1							
Koe_lin									+								
Lau_rés					+			1	+							+	+
Mal_aeg	1		1	1	2	1	2	2	1	2						1	1
Mat_pub						5	2	7.5	6	3.5							
Med_ara		2	1			1	+										
Noa_muc									1								
Par_ara						1	+		2	1							
Sti_par		+									1			1			
Pla_alb	2	1	1	+	+		3	2		2	1	+		+	+		
Pla_psy									2								
Sal_ver						+	2	+	+								
Tri_pol		+	1	1	+	+	+	+		+							
Sch_bar												1	+			+	2
Par_rho											+	+	+	+	+		
Res_vil														+			
Sco_und														+			
Ono_are																	
Par_mau																	
Cut_dic																	
Eva_arg																	
Ech_spi																	
Ech_hum																	
Ero_mal																1	+
Ant_mon																	
Bro_rub																	
Eri_arb																	
Noe_muc																	
Leo_his																	
Poa_bul																	
Thy_mic																	
Her_fon																	

	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27	R28	R29	R30	R31	R32	R33	R34
Mac_ten												2	2	2		4.5	2
Lyg_spa		2	2	3	3	2	1	3	3			1	3				
Ars_pun																	
Art_cam																	
Art_her										2	2	+	1		1	3	3
Atr_hum	2	1	2														
Sal_ver			+				1		2	2	2	2	1	1	2	1	2
Peg_har																	
Atr_ser																	
Ast_arm						1	1	1	2								
Ast_cru				2	2									1		1	1
Ast_sin																	
Cal_aeg									1								
Ech_hor									+								
Her_hir				1	1		2										
Fil_ger	1	1	2										1				
Hel_vir	1		1											1			
Hor_mur									1	2	1	2	1				
Hip_mul																1	
Koe_lin															1		
Lau_rés	+	+	1									+					
Mal_aeg	2	2	1	1	2	1	1	1	1	+		2	1	2	2	2	2
Mat_pub														3	+		
Med_ara									1	1	1	+	1		1	1	
Noa_muc																	
Par_ara															1.5		
Sti_par																	
Pla_alb									2	3	3	+	1		1	1	
Pla_psy																	2
Sal_ver									+								
Tri_pol						+		+	1	+	1	+	1	1	2	1	+
Sch_bar	1	2	2	+	2	2	1	+	+		+	+	+				
Par_rho																	
Res_vil																	
Sco_und																	
Ono_are				+		+		+									
Par_mau					+												
Cut_dic					+	+	+	+									
Eva_arg				+	+		+										
Ech_spi	+						+										
Ech_hum			+														
Ero_mal	+	1	+														
Ant_mon														2			
Bro_rub												+					
Eri_arb										1							
Noe_muc									+								
Leo_his																	
Poa_bul																	
Thy_mic																	
Her_fon																	

	R35	R36	R37	R38	R39	R40	R41	R42	R43	R44	R45	R46	R47	R48	R49	R50
Mac_ten		3	3		3	4										
Lyg_spa								1	2		+	2	2	2	1	
Ars_pun																
Art_cam																
Art_her	3															
Atr_hum							3	3	2	2	2	1	2	1	2	
Sal_ver	1						1			1	2	+				
Peg_har																
Atr_ser	1													3	1	2
Ast_arm		1	2	1	1	1						2	1	2	2	2
Ast_cru	1															
Ast_sin																
Cal_aeg																
Ech_hor					1											1
Her_hir																
Fil_ger			+	1	1		2	2	1	1	1					
Hel_vir		1		2	2											
Hor_mur		2	1	1	1	1	1	+	+							
Hip_mul	1															
Koe_lin	1									1	+					
Lau_rés											+	+		1	1	1
Mal_aeg	1						+									
Mat_pub																
Med_ara		2	2	2	2	1										
Noa_muc																
Par_ara	6															
Sti_par																
Pla_alb	2			1	+											
Pla_psy																
Sal_ver	+															
Tri_pol	1	+	1			1	+					1		3	+	4
Sch_bar				+	+		1	1	+	1	3	1	1	1	2	1
Par_rho																
Res_vil																
Sco_und																
Ono_are												+		+	+	+
Par_mau																
Cut_dic												+	+	+	+	1
Eva_arg																
Ech_spi																
Ech_hum																
Ero_mal																
Ant_mon																
Bro_rub		1	1	2	1	+									+	
Eri_arb																
Noe_muc																
Leo_his				+												
Poa_bul				+	+											
Thy_mic												+				+
Her_fon												1	+			