Plant diversity in the coastal zone of Guerbes-Benazouz (Skikda) in northeastern Algeria

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Received : 01/02/2023; Accepted :18/07/2023; Published :18/08/2023

Abstract:

The land of Guerbes-Benazouz located in eastern Algeria is composed of the plain of Benazouz and the dune cord of Guerbes which is extends 13 km into the interior of the country from the coast. This area is protected by typical Mediterranean plant cover, including *Diotis maritima, Ammophila arenaria, Retama monosperma, Juniperaie-cocciferaie, Alnus glutinosa, Pistacia lentiscus,* and *Quercu ssuber*. Which form the following plant groups: *Diotis maritima group, Ammophila arenaria group, Retama monosperma group, Fixed sand dune vegetation groups, Alnus glutinosa vegetation group* and *Quercus suber vegetation group*. Currently, this vegetation is exposed to acts of anthropogenic degradation. Its protection is essential for the functioning of the Guerbes-Benazouz wetland and the stability of the local population.

Keywords: Guerbes-Benazouz, eastern Algeria, coastal dunes, dune vegetation, Plant diversity, Guerbes-Benazouz wetland.

Tob Regul Sci. ™ 2023;9(1): 4323-4342
DOI: doi.org/10.18001/TRS.9.1.302

1. Introduction

Coastal Algeria is a very diverse biogeographic space in terms of climate, soil and vegetation. It could reveal, potentially, a characteristic floristic biodiversity very adapted to drought (Oldache, 2021). Some authors such as Thomas (1975) and Aouadi (1989), have provided data concerning this floristic richness exposed to several anthropogenic degradation factors (Kamel eddine, 2022). However, the monitoring of the dynamics of the vegetation in the littoral zones, in Algeria, remains insufficient. These areas, which are mainly classified as wetlands by the RAMSAR convention, such as the dune complex of Guerbes-Benazouz in the far north east of Algeria, are home to a wealth of flora and fauna of great importance. These sites are real water reservoirs.

They are among the most valuable, fertile and productive aquatic ecosystems on earth. They offer immense possibilities for sustainable development and constitute important biological pools, rich in remarkable flora and fauna species (Ramsar,1997).They ensure the regulation of hydrological flows, protection against floods and droughts, groundwater recharge and water purification (Coates, 2010), as well as the maintenance of dune ecosystems through water supply (Gallet et al. 2017). With the aim of conserving and preserving these natural coastal environments exposed to different types of degradation, we have undertaken to present the physiognomy and floristic biodiversity in the Guerbes-Benazouz area which will serve as support for a research for the fixation of coastal dunes in northeastern Algeria.

2. Materials and methods

To achieve the objective of this study, we also performed a field survey in 2018 - 2019 to describe the vegetation types, plant groups, and their spatial distribution, and compare it with the declarations against the old data about the coastal dunes of eastern Algeria. Here, We carried out floristic samples, according to a NW - SE transect from the beach to the interior of the Benazouz plain with an estimate of the rate of vegetation cover in ten stations Aïn Ras El Oued (Dl1), Koudia Safra (Df1), Mrabet Aïcha (Df2), Kef Fatima (Dl2), Boukout Sisig (Df3), Machtat Ramdane (Df4), Chikh Ben Mokrane (Df5), Demnet attaoua (Al), Koudiat El Mroudj (Ch1) on the dune strip and seven stations in the surrounding area (Kef Siada (Ch2), Oued Dissia (Ch3), Aïn Berda (Ch4), Djebel Filfila1 (Ch5), Djebel Filfila2 (ch6), Dem Safsaf (Ch7), Dem El Bagrat (Ch8) as shown in Annex1, using the Braun-Blanquet (1951), scale based on the coefficient of abundance and dominance of plant species at the site studied.

The identification of the species was carried out according to several references (Quezel & Santa, 1962 and 1963 ; Ozenda, 1983). The data matrix is analyzed by the XLSTAT 2014 software.

3. Study area

3.1. Geographical location

The study area belongs to the Guerbes-Benazouz wetland complex in eastern Algeria, which is located approximately 30 km from the east of Skikda Province, between 36°N, 7°E and 37°N, 7°E (Fig.1). This area is dominated by the vast plain of Benazouz and is drained by the Kebir

West River, which extends for more than 20 km and is impeded from reaching the sea by gentle slopes that range from 0% to 4% over the entire terrain; this promotes the formation of local hydromorphic depressions called “garaats”. The study area is approximately 14,000 ha, 79.2% of which is plains and dune cordons (Bazri, 1999). A dune complex approximately 13 km long extends from the coast to the interior of the plain and has an elongated form owing to the prevailing NW winds. The width of the dune occupies the plain from east to west. Dune altitudes vary from 20 m to 110 m (at Boukout Sisig), and generally decrease from NW to SE (Fig.2).

Fig.1. Location of the Guerbes - Benazouz dune cordon in Skikda Province, east Algeria (retrieved from Google Earth on 10/08/2021.

Fig.2. The width of the dune occupies the plain from NW to SE.

3.2. Ecological characteristics

According to Bazri (1999), secondary and tertiary geological systems dominate the terrain overlooking the Benazouz plain. The marine quaternary unit is predominantly dune formations. However, continental quaternary formations dominate the plains and valleys of the Kebir West River (Joleaud, 1912; Durand, 1952).

The soil units characterizing the study area are dominated by minimal evolution of undeveloped and poorly developed mineral soils (Bazri, 1999), which explains the fragility of the physical environment reported in several previous studies (Hilly, 1957; Villa, 1982).

As a coastal region, the study area receives annual rainfall of 800 - 1,000 mm; however, neighboring altitudes receive 1,000 to 1,200 mm of annual rainfall (Merniz, 2019).

4. Results

4.1. The composition and floristic richness of the studied site

76 species belonging to 34 families are listed in our study area: *Amaranthaceae, Anacardiaceae, Aplaceae, Arecaceae, Asphodelaceae, Asteraceae, Betulaceae, Boraginaceae, Caprifoliaceae, Caryophyllaceae, Cistaceae, Cupressaceae, Cyperaceae, Dennstaedtiaceae, Ephedraceae, Ericaceae, Euphorbiaceae, Fabaceae, Gentianaceae, Iridaceae, Lamiaceae, Lilaceae, Myrtaceae, Oleaceae, Papveraceae, Plantaginaceae, Poaceae, Polygonaceae, Primulaceae, Ramnaceae, Resedaceae, Rosaceae, Rubiaceae, Salicaceae, Smilacaceae* and *Thymeleaceae.* They are summarized in appendix 1.

For a better visualization of the distribution of the inventoried species, the Principal Correspondence Analysis (Fig. 3) shows us the following results:

The plane (F1xF2) expresses that stations Ch3 (r=0.87), Ch6 (r=0.86), Ch8 (r=0.79), Ch1 (r=0.79), Ch7 (r=78), Ch5 (r=78), Ch4 (r=0.77) and Ch2 (0.72) 2 contribute to the formation of the negative side of the factorial axis F1. However stations (r=0.07), Dl1 andt Dl2 (r=0.73 et r=075) form its positive side. However, stations Ch3 (r=0.87), Ch6 (r=0.86), Ch8 (r=0.79), Ch1 (r=0.79), Ch7 (r=78), Ch5 (r=78), Ch4 (r= 0.77), Ch2 (0.72) and Aln (r=0.07), form the

positive side of the factorial axis F2. They oppose the stations Df2 (r=0.75), Df1 (r=0.73), Df5 (r=0.68), Df4 (r=0.64) et Df3 (r=0.61), Dl1 (r=0.73) and Dl2 (r=0.75), participating in the development of the negative side of the F2 axis.

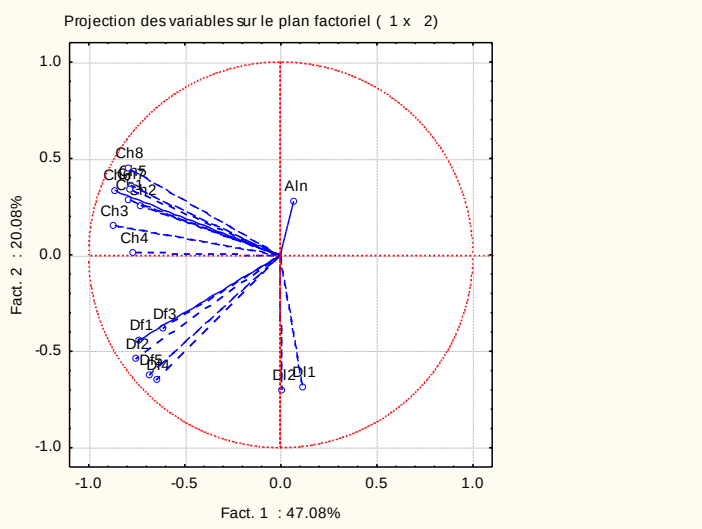

Fig.3. The Principal Correspondence Analysis on the plane F1 x F2

The projection of the individuals on the plane F1 x F2 (Fig. 4 (a) and (b)) reveals that the stations Ch1, Ch2, Ch3, Ch4, Ch5, Ch6, Ch7 and Ch8 are determined by the following species: *Quercus suber* (76), *Cistus monspeliensis* (54), *Myrtus communis* (53), *Cytisus triflorus* (55), *Cyclamen africanum* (58), *Erica scoparia* (24), *Arbutus unedo* (25), *Asphodelus microcarpus* (57), *Olea europea* (52), *Ampledesma mauritanicum* (56), *Cistus salvifolius*, Juniperus phoenicea (30), *Lavandula stoechas* (26), *Daphne gnidium* (27), *Calycotome villosa* (21), *Erica arborea* (23) et *Phyllirea angustifolia* (3). However, stations Df2, Df1, Df5, Df4 and Df3 are defined by the species *Pistacia lentiscus* (2), *Calycotome spinosa* (20), Halimium halimifolium (5) and *Quercus coccifera* (1).

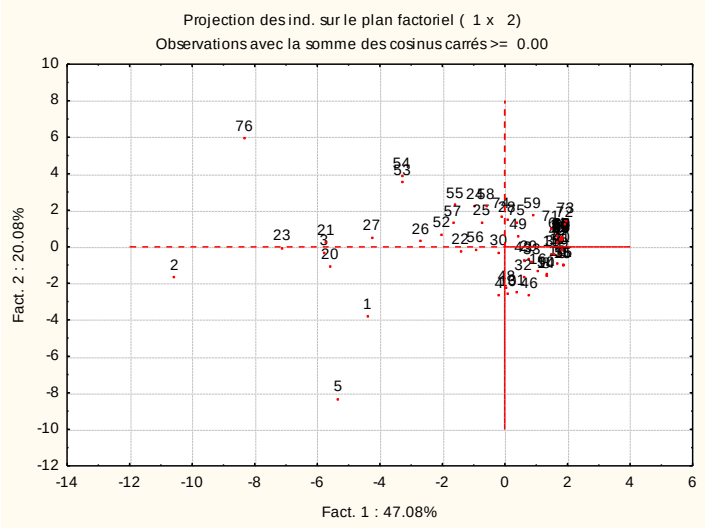

Fig.4 (a). The projection of the individuals on the plane F1 x F2.

The Dl1 and Dl2 sites are determined by the species *Silene colorada* (9), *Ononis diffusa* (15), *Pancratium maritimum* (51), *Ammophila arenaria* (37), *Diotis maritima* (35) *Centaurium umbellatum* (18), *Pragium majus* (19), *Agropyron junceum* (34), *Linaria flava* (14), *Scabiosa rutifolia* (13), *Cyperus kalli* (11) and *Salsola kali* (40). Note the contribution of the following species: *Rumex aristidis* (8), *Rhamnus alaternus* (16), *Echinophora spinosus* (33), *Juniperus oxycedrus* (29), *Reseda alba* (46), *Echium confusum* (43), *Euphorbia populus* (32), *Centaurea sphaerocephala* (10) and *Retama monosperma* (48).

Finally, the Aln site is represented by the species *Alnus glutinosa* (73), Populus alba (72) et *Pteridium aquilinum* (71) mais aussi la présence des espèces *Genista ulicina* (64), *Lotus creticus* (42), *Lagurus cystus ssp* (17), *Pancratium maritimum* (7), *Cutandia maritime* (12), *Sporobolus arenarius* (44), *Medicago marina* (36). *Rosa sempervirens* (59), *Ephedra fragilis* (49), *Acacia cyanophila* (75) and *Smilax aspera* (28).

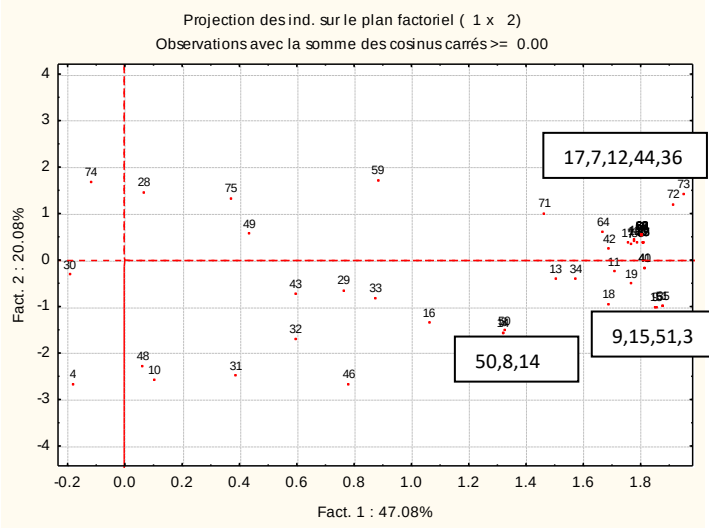

Fig.4 (b). The projection of the individuals on the plane F1 x F2

4.2. The distribution of vegetation in the different natural environments of Guerbes-Benazouz: The distribution of vegetation cover from NW to SE on the dune cordon is defined in the following subsections.

4.2.1. Vegetation in the littoral part of the dune cordon

This vegetation zone exhibits poor edaphic environments, and is typically observed at Aïn Ras El Oued (Dl1), Koudiat Safra (Df1), and Kef Fatima (Dl2) stations. This zone is dominated by the following species : *Diotis maritima*, *Euphorbia paralios*, *Medicago marina*, *Agropyron junceum*, *Ammophila arenaria*, *Glocium flavum*, *Echinophora spinosa*, *Spergularia marginata*, *Salsola kali*, *Anthemis mariima*, *Lotus creticus*, *Echium confusum*, *Sporobolus arenarius*, and *Reichardia picroides*. These species represent 25 - 50% of ground cover and dominate the first line of major dunes facing the sea. *Reseda alba*, and *Scabiosa rutifolia* are also observed.

Slightly behind these littoral stations, *Crucianella maritima*, *Pancratium maritimum*, *Rumex aristidis*, *Silene colorada*, *Centaurea sphaerocephala*, *Cutandia maritima*, *Cyperus kalli*, *Reseda alba*, *Scabiosa rutifolia*, *Linaria flava*, *Pistacia lentiscus*, *Juniperus oxycedrus*, *Juniperus phoenicea*, and *Rhamnus alaternus* are observed. Notably, the species *Retama monsperma* widespread from the littoral stations toward the interior dunes, at AïnRas El Oued (Dl1), Koudiat Safra (Df1), Mrabet Aïcha (Df2), Kef Fatima (Dl2), Machtat Ramdane (Df4), Chikh Ben Mokrane (Df5), Koudiat El Mroudj (Ch1), and Aïn Berda (Ch4) stations.

4.2.2. **The vegetation on the dune cordon**

A. Vegetation in the northern part of the dune cordon: Here, the sandy substrate is fixed by vegetation dominated by *Quercus coccifera*, with a coverage rate of 50–75% at Boukout Sisig (Df3) and Koudiat Safra (Df1) stations. The species recorded at these stations include *Quercus coccifera*, *Juniperus oxycedrus*, *Juniperus phoenicea, Pistacia lentiscus*, *Chamaerops humilis*, *Halimium halimopholium*, *Calycotome spinosa*, *Calycotome villosa*, *Cistus salvifolius*, *Phyllirea angustifolia*, *Rhamnus alaternus*, *Genista ulicina*, *Erica arborea*, *Daphne gnidium,* and *Smilax aspera.*

B. Vegetation in the southern part of the dune cordon: At Chikh Ben Mokrane (Df5) and Machtat Ramdane (Df4) stations, located in the south of the dune cordon, the vegetation cover is less than 25%. *Halimium halimopholium* is the dominant species, and constitutes a real degradation facies on fixed dunes. *Pistacia lentiscus* and *Phyllirea angustifolia*are also observed, as well as *Chamaerops humilis*, *Halimium halimopholium*, *Calycotome spinosa*, *Calycotome villosa*, *Cistus salvifolius*, *Rhamnus alaternus*, *Genista ulicina*, *Erica arborea*, *Daphne gnidium, Smilax aspera, Quercus coccifera, Juniperus oxycedrus,* and *Juniperus phoenicea.*

4.3. Vegetation in the interlunar depressions

In the large interlunar depression of the dune cordon Demnet Ataoua (Aln), we witness wetland vegetation dominated by *Alnus glutinosa*, which reflects the wet climatic conditions of the Guerbes region. On the edges of this alder grove, we observe very old cork oak (*Quercus suber*) trees, which are evidence of old cork oak forests. The presence of *Pteris aquiline, Populus alba* and *Iris pseudo-acorus* species reflects the cool temperature conditions of this zone.

To the south of the dune cordon, an interlunar depression fed by springs from the water table, which is often water logged for long periods of the year, consists of *Heleocharis palustris*, *Callitriche palustris*, *Mentha rotundifolia*, *Mentha pulegium*, and *Rumex conglomeratus.* The following species occur adjacent to these lacustrine areas: *Erica scoparia*, *Genista ferox*, *Halimium halimofolium*, *Chamaerops humilis*, *Calycotome spinosa*, and *Rosa sempervirens.*

4.4. Mountains and foothills vegetation

Vegetation observed at stations in the mountains and foothills (i.e., Djebel Filfila : Ch5, Ch6), Dem El Bagrat (Ch8), Dem Esafsaf (Ch7), and Kef Siada (Ch2) is predominantly settled degraded forests comprising *Quercus suber* and other species such as *Cistus monspeliensis*, *Cistus salvifolius*, *Tuberaria vulgaris*, *Calycotome villosa*, *Calycotome spinosa*, *Genista ulicina*, *Erica arborea*, and *Lavandula stoechas*. *Pistacia lentiscus*, *Phillyrea angustifolia*, *Olea europea*, *and Quercus coccifera* are also observed. However, the mattoral vegetation observed at Aïn El Berda (Ch4), Oued Dissia (Ch3), Kef Siada (Ch2), and Koudiat El Mroudj (Ch1) stations includes the following species: *Pistacia lentiscus*, *Myrtus communis*, *Cistus salvifolius*, *Daphne gnidium*, *Bellis silvestris*, *Cyclamen africanum, Mentha pullegium* and *Genista ferox*.

Kamel-eddine (2022), reports a very advanced loss of vegetation in in the natural environments of Guerbes-Benazouz due to intense anthropogenic action such as grazing, clearing and fires.

5. Discussion

Specifically, this region boasts high-yield farmland, significant water resources, remarkable vegetation cover (forests and scrub), a coastal landscape, mountainous environments, and a large dune cordon, as well as expanses of lakes and marshes. This area is also classified as a wetland by the Ramsar convention, where irrigation is provided by the Kebir West River and ground water.

The Principal Correspondence Analysis indicates that all vegetation species identified in our field survey coincide with following vegetation groups:

5.1. The vegetation groups of Mobile sand dune

a. **The group of *Diotis maritima*:** This group colonizes the poorly edaphic environment (Chergui, 2009), supports saline ground, and exhibits adaptations to fight silting. The relevant species are *Diotis maritima*, *Euphorbia paralios*, and *Medicago marina*. These geophytes are responsible for the formation of elongated sand mounds in the prevailing wind direction (Thomas, 1975). Rhizomes and stolons such as *Agropyron junceum* are considered to be anatomical structures best suited to silting and the colonization of bare ground, as they are efficient builders of small dunes, where the following species are established: *Ammophila arenaria*, *Diotis maritima*, *Medicago marina,* all of which are excellent sand-colonizing species

(Paskoff 2005). Hemicryptophytes with large vertical roots are also present in the *Ammophila arenaria* group, including *Glocium flavum*, *Echinophora spinosa*, and *Spergularia marginata*.

b. **The group *of Ammophila arenaria*:** This group occupies mobile sands where *Agropyron junceum* competes with *Ammophila arenaria*, a more powerful species that allows the formation and fixation of a larger sand surface. This grouping constitutes the dominant vegetation cover on the first line of the key dunes facing the sea. It contains the following species: *Salsola kali*, *Diotis maritima*, *Euphorbia paralios*, *Anthemis mariima, Lotus creticus*, *Echium confusum*, *Sporobolus arenarius*, *Reichardia picroides*, and *Medicago marina*.

Other species that tolerate a substantial thickness of dry sand include *Echiniphora spinosa*, *Reichardia picroides*, *Reseda alba*, and *Scabiosa rutifolia*. *Medicago marina* and *Lotus creticus* (papilionaceous species) appear to be better colonizers of dune sands, as indicated by kameleddine (2021).

c. **The group of *Retama monosperma*:** *Retama monosperma* dominates in locations where the sands are enriched in organic matter. This species is characterized by substantial resistance to silting and heaving according to Boulila and al. (2009), who also confirmed that *Retama* species grow in different ecological climatic areas of northeastern Algeria thanks to their ability to fix nitrogen and withstand poor environments. *Crucianella maritima*, *Pancratium maritimum, Rumex aristidis* (a species characteristic of fixed sands), *Silenecolorada*, *Centaureasphaerocephala*, *Cutandiamaritima*, Cyperus *kalli*, *Reseda alba*, *Scabiosa rutifolia*, *Linaria flava*, and *Ononis diffusa* (more continental species) occur in this group. In the oldest areas stabilized by *Retama monosperma*, several pioneer species of fixed dune groups are observed, including *Pistacia lentiscus*, *Juniperus oxycedrus*, *Juniperus phoenicea*, and *Rhamnus alaternus*.

5.2. The vegetation groups of Fixed sand dune

This xerothermic *Juniperaie-cocciferaie* species forms a very dense vegetation group on the dunes of Guerbes. Here, kermes oak (*Quercus coccifera*) can effectively adapt to deep sandy soils by participating in the fixation of sand and ensuring a transition between living dunes and dunes fixed by *Quercus suber*. *Halimium halimopholium* is dominant over other species and constitutes a degradation facies on fixed dunes. Jean-Pierre Hébrard (1977) and Guo Yu et al

(2004) stated that the morphology and physiology of this species allows it to colonize degraded dunes.

The phanerophytes encountered in fixed sand dunes are *Pistacia lentiscus*, *Chamaerops humilis*, *Halimium halimopholium*, *Calycotome spinosa*, *Calycotome villosa*, *Cistus salvifolius*, *Phyllirea angustifolia*, *Rhamnus alaternus*, *Genista ulicina*, *Erica arborea*, *Daphne gnidium, Smilax aspera* and also *Quercus coccifera*, *Juniperus oxycedrus*, and *Juniperus phoenicea.*Typical psammophiles found among this group include *Lotus creticus*, *Lagurus Cystus* ssp., *Centaurium umbellatum*, and *Pragium majus*.

The living dunes resulting from degradation of this vegetation group are colonized by *Retamaboveï*, *Ephedra fragilis*, *Cyperus kalli*, and *Pancratium maritimum*. Currently, the landscape dominated by this vegetation group takes the form of scrubland that has been strongly degraded by many years of detrimental anthropogenic activity.

5.3. The vegetation group of *Alnus glutinosa*

This group is well represented in the interdunal depression of Demnet Ataoua, and is a clear indication of the wet climatic characteristics of the study area (Maurizio Cutini *et al.*2010). Here, the clay soils are regularly supplied with groundwater from the neighboring dunes, leading to optimal growth conditions for *Alnus glitinosa*. The acidity of the soil results in energetic development of *Pteris aquilina*, as reported by Marchetti (2004) and Samraoui and De Belair (1997).

5.4. The vegetation group of *Oleo-lentisque*

This vegetation group is closely associated with *Pistacia lentiscus* and *Myrtus communis*. It contains the following species: *Cistus salvifolius*, *Daphne gnidium*, *Quercus coccifera*, *Halimium halimofolium*, and *Chamaerops humilis*. This group grows on argilous soils in the degraded foothills; it is not very demanding and occupies the thermophilic positions unfavorable to other species. The herbaceous layer comprises *Bellis silvestris* and *Cyclamen africanum.*The humidity of the environment of this group is reflected by the presence of *Mentha pullegium* and *Genista ferox*.

5.5. The vegetation group of *Quercus suber*

This vegetation group occupies most of the quaternary terraces and is often degraded by cork exploitation, fires, and grazing. From a physiognomic point of view, the vegetation is typically matorral or scrub. Important species include *Cistus monspeliensis*, *Cistus salvifolius*, *Tuberaria vulgaris*, *Calycotome villosa*, *Calycotome spinosa*, *Genista ulicina*, and *Erica arborea* in dry areas, *Erica scoparia* in wetlands, *Lavandula stoechas,* and *Halimium halimifolium*, which are clearly dominant over other phanerophytes. *Pistacia lentiscus*, *Phillyrea angustifolia*, *Olea europea*, and *Quercus coccifera* are also observed.

6. Conclusion

The coastal dunes in Algeria constitute ecosystems of great importance, given the length of the coastline which extends over 1,622 kilometers from West to East.These natural environments are home to a very rich and diversified plant cover, particularly the areas classified as RAMSAR sites such as the wetland of the Guerbes-Benazouz complex in eastern Algeria.

Five natural environments are distinguished: Matorrals composed of *Cistus monspeliensis* or *Pistatcia lentiscus* and *Olea europea*, with a typical coverage rate of less than 75; scrubland composed of *Quercus coccifera* and *Pistacia lentiscus*, with a coverage rate of 25 - 50%; scrubland composed of *Halimium halimifolium* and *Calycotome spinosa*, with a coverage rate of less than 25%; erme of *Euphorbia paralios* and bare soil, with significantly degraded vegetation cover; the forest itself is composed of *Quercus suber*, which is almost completely degraded and burned. The plant cover of our study area contains the following plant groups:

a. Diotis maritima group

b. Ammophila arenaria group

c. Retama monosperma group

d. Fixed sand dune vegetation groups

e. Alnusglutinosa vegetation group

f. Quercussuber vegetation group

Currently the vegetation of the different natural environments of this area is exposed to intense degradation; it requires repopulation and regeneration programs with the aim of fixing and stabilizing the dunes and protecting this RAMSAR site.

7. Acknowledgments;

We would like to thank the Forest District of Benazouz (Skikda) for the support on the ground in the study area.

8. Declaration of interest statement;

I declare that the data of this work are our own research work on the Guerbes-Benazouz area which aims at the development of natural environments and the fixing of coastal dunes in this area classified as a wetland by the RAMSAR convention.
I also declare to commit myself to pay all the expenses of the publication of my article.
we have no conflicts of interest to declare. we have seen and agree with the contents of the manuscript and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

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10. Appendices

Annex 1. Main vegetation formations in the Guerbes region (2018-2019)

t	Type of vegetation formation			Altitude (m)	Slope (%)	Exposure	Density of vegetationcover (%)	Soil type	Locality	Lamb coord s
	Forest	Clear	Degraded Suberaie	500	12–24	North	25–50	Acidic Unsaturated soils	Dem El Bagrat (Ch8)	x 904); (403,
0	Forest	Clear		150	0–4	Flat surface	25–50	Acidleachedsoils	Dem Safsaf (Ch7)	x 905); (404,
	Forest	Dense	Aulnaie	12	0–4	Interdunal depression	>75	Hydro morphe soils with gley	Demnet El Ataoua (A1)	x 906); (413,
	Matorral	Dense	Cistaie	320	12–24	North	> 75	Insaturé acide acidicUnsaturatedsoils	Djebel Filfila (Ch5)	x 998); (409,
s	Matorral	Clear		190	12–24	South	25–50		Djebel Filfila (Ch6)	x 998); (408,
	Matorral	Clear	Oleo-lenticetum	140	12–24	East	25–50		Aïn El Berda (Ch4)	x 899); (409,
	Matorral	Dense	Artificial Suberaie	90	12–24	East	50–75	Colluvions	Oued Dissia (Ch3)	x 901); (409,
	Matorral	Dense		60	12–24	East	50–75		Kef Siada (Ch2)	x 901); (406,
	Matorral	Clear	Oleo-lenticet	84	12–24	North	25–50		Koudiat El Mroudj	x 902);

			um						(Ch1)	(404,
	Maquis	Dense	Coccifér aie dunaire	100	0–4		> 75		Aïn Ras El Oued (Dl1)	x 905) (412,
	Maquis	Dense		70	0–4	Dunesummit	50–75		Boukout Sisig (Df3)	x 902); (412,
	Maquis	Clear		45	0–4		25–50	Dunesoils	Mrabet Aïcha (Df2)	x 909); (411,
	Maquis	Clear		30	0–4		25–50		Kef Fatima (Dl2)	x 904); (412,
	Maquis	Veryclear		40	0–4		< 25		Mechtat Ramdane (Df4)	x 906); (412,
	Bushes	Very degraded		50	0–4		< 25		Chikh Ben Mokrane (Df5)	x 912); (408,
s	Dense		70	0–4	Dunesummit	50–75		Koudiat Safra (Df1)	x (901, 902); y (412, 413)	Maqu

Annex 2. Phytosociological results for different stations in the Guerbes region (2018-2019)

	Sampling stations												
Plant Species	Aïn Ras El Oued	KoudiatSafra	Mrabet Aïcha	Kef Fatima	BoukoutSisig	MachtatRamdane	Chikh Ben Mokrane	Koudiat El Mroudj	Kef Siada	Oued Dissia	AïnBerda	Djebel Filfila	Djebel Filfila
Quercus coccifera	.	4.3	3.4	.	4.4	2.2	2.2	1.r	.	1.1	2.2	1.1	1.+
Pistacia lentiscus	.	4.2	4.3	.	4.3	3.+	3.2	2.2	3.2	3.2	3.3	3.1	3.2
Phyllirea angustifolia	.	2.2	2.1	.	2.2	2.+	2.1	2.1	2.1	2.2	1.1	2.2	2.2
Chamaerops humilis	1.+	+	1.1	1.1	.	3.1	1.1	1.1	.	.	+	.	.
Halimium halimifolium	2.1	3.1	4.3	4.4	1.1	4.3	4.4	.	2.1	2.2	1.1	1.1	1.1
Crucianella maritima,	+	.	.	+	.	.	.	.	.	.	.	.	.
Pancratium maritimum	+	+	+	+	.	.	.	.	.	.	.	.	.
Rumex aristidis	1.1	1.1	1.r	1.1	+	1.r	+	+	.	.	.	.	.
Silene colorada	1.1	.	+	1.1	+	.	.						
Centaurea sphaerocephala	1.1	1.1	1.1	+	1.1	2.1	1.1	+	.	.	.	.	.
Cyperus kalli	+	.	+	1.1	.	+	+	+	.	.	.	.	.
Cutandia maritima	+	.	.	+	.	.	.	+	.	.	.	.	.
Scabiosa rutifolia	+	1.1	+	1.1	.			+					
Linaria flava	1.1	1.1	1.1	1.1	.	+	.	.	.	.	.	.	.
Ononis diffusa	1.1	+	+	1.1	.	.	.	.	.	.	.	.	.

Rhamnu salaternus	1.1	.	.	1.1	.	1.1	+		+	1.1	1.r		
Lagurus cystus ssp.	+	.	.	+	.	+	.	+	.	.	.	.	.
Centaurium umbellatum	1.1	.	+	1.1	.	.	+	1.r	.	.	.	.	.
Pragium majus	1.1	+	+	+	.	+	+	+					
Calycotome spinosa	.	4.2	2.1	.	1.1	2.2	2.2	1.1	2.2	2.2	2.1	2.1	2.1
Calycotome villosa	.	4.1	3.3	.	+	1.1	1.1	1.2	2.1	3.2	2.2	1.1	2.1
Cistus salvifolius	.	1.1	1.+	.	1.1	1.+	1.1	1.1	1.r	.	1.+	1.r	1.r
Erica arborea	.	4.3	3.3	.	1.1	2.2	1.1	3.2	2.2	2.2	2.2	2.1	2.2
Erica scoparia	.	.	.	.	.	.	.	1.+	.	1.1	.	2.1	2.2
Arbutus unedo	.	1.1	+	.	.	.	+	1.1	1.1	1.+	1.+	2.1	1.1
Lavandula stoechas	.	1.r	1.1	.	1.1	1.2	1.2	1.1	1.1	2.1	1.2	.	1.+
Daphne gnidium	+	2.1	2.1	+	1.1	1.1	1.1	1.1	1.2	1.1	1.1	2.1	2.2
Smilax aspera	+	+	+	+	+	.	.	.	1.1	.	.	1.2	1.1
Juniperus oxycedrus	.	1.1	1.r	.	1.1	+	1.1	.	.	.	.	.	.
Juniperus phoenicea	+	+	+	+	+	1.1	1.1	.	.	1.1	2.1	.	1.+
Euphorbia paralios	1.1	1.1	1.1	1.1	.	1.2	1.1	.	.	.	1.+	.	.
Euphorbia populus	1.r	+	1.1	1.1	+	1.+	1.1	.	.	.	1.+	.	.
Echinophora spinosus	+	.	1.+	.	+	1.1	1.1	.	.	.	.	.	.
Agropyron junceum	1.1	.	.	+	.	.	.	.	.	.	1.1	.	.
Diotis maritima	1.1	+	.	1.1	.	.	.	.	.	.	.	.	.
Medicago marina	+	+	.	+	.	.	.	.	.	.	.	.	.
Ammophila arenaria	+	.	.	+	.	.	.	.	.	.	.	.	.
Glaucium flavum	+	.	.	+		.	.	.	.	.	.	.	.
Spergularia marginata	+	.	.	+	.	.	.	.	.	.	.	.	.
Salsola kali	+	.	.	1.1	.	.	.	.	.	.	.	.	.
Anthemis maritima,	+	.	.	1.1	.	.	.	.	.	.	.	.	.

Lotus creticus	+	+	+	+	+	+	+						
Echium confusum	+	2.2	+	+	2.2	+	+	+	.	.	.	.	.
Sporobolus arenarius	.	.	.	+	+	.	.	.	.	.	.	.	.
Scabiosa rutifolia	+	.	.	+	.	.	.	.	.	.	.	.	.
Reseda alba	1.1	1.1	1.r	2.1	+	1.+	1.+	+	1.r	.	.	.	.
Reichardia picroides	+	.	.	+	.	.	.	.	.	.	.	.	.
Retama monosperam	1.1	1.r	+	2.+	1.1	1.1	1.r	1.1	.	.	2.+	.	.
Ephedra fragilis	+	.	.	.	.	1.1	+	1.1	1.1	.	.	.	.
Cyperus kalli	1.1	1.1	1.r	1.1	.	1.r	+	+	+				
Pancratium maritimum	1.1	.	+	1.1	.	.	.						
Olea europea	+	1.1	.	1.+	.	1.r	+	3.2	1.+	1.1	4.3	.	+
Myrtus communis	.	.	+	.	+	+	.	2.2	2.1	2.2	1.1	2.2	2.2
Cistus monspeliensis	.	.	.	.	.	.	.	1.1	1.1	1.r	.	4.2	4.3
Cytisus triflorus	.	.	.	.	.	.	.	1.1	2.1	3.2	.	1.1	1.2
Ampledesma mauritanicum	1.r	1.1	+	1.1	.	1.1	1.r	1.1	1.r	.	1.+	2.1	1.1
Asphodelus microcarpus	.	.	.	.	.	1.1	1.2	1.2	1.1	1.1	1.1	1.1	1.1
Cyclamen africanum	.	.	.	.	.	.	.	1.1	1.1	1.1	.	1.2	1.1
Rosa sempervirens	.	.	.	.	.	.	.	+	.	+	1.1	.	.
Bellis silvestris	.	.	.	.	.	.	.	.	.	.	.	.	.
Mentha pullegium	.	.	.	.	.	.	.	.	.	.	.	.	.
Genista ferox	.	.	.	.	.	.	.	.	.	.	.	.	.
Tuberaria vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	.
Genista ulicina	.	.	.	.	.	.	.	.	.	.	+	+	+
Iris pseudo-acorus	.	.	.	.	.	.	.	.	.	.	.	.	.

Heleocharis palustris	.	.	.	.	.	.	.	.	.	.	.	.	.
Callitriche palustris	.	.	.	.	.	.	.	.	.	.	.	.	.
Mentha rotundifolia	.	.	.	.	.	.	.	.	.	.	.	.	.
Mentha pulegium	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex conglomeratus	.	.	.	.	.	.	.	.	.	.	.	.	.
Pteridium aquilinum	.	.	.	.	.	.	.	.	.	.	.	.	.
Populus alba	.	.	.	.	.	.	.	.	.	.	.	.	.
Alnus glutinosa	.	.	.	.	.	.	.	.	.	.	.	.	.
Eucalyptus globulus	.	.	.	.	.	.	.	.	4.2	.	.	3.1	.
Acacia cyanophila	.	.	.	.	.	.	.	.	4.2	.	.	.	.
Quercus suber	.	.	.	.	.	.	.	3.2	4.+	4.2	4.+	4.2	4.2