

Chapter

Ecological Characterization of Steppe Formations in the Naama Region (Western Algeria)

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Abstract

The steppe space of Naâma covers an appreciable pastoral area of 3 million ha (i.e., more than 74% of the area of the wilaya). It is essentially characterized by plant formations that are very diversified by the abundance of bunchgrasses, a shrub layer (chamephytes), and an herbaceous layer including therophytes (annual species). This space is mainly made up of alfa pastures (*Stipa tenacissima*), spartan pastures (*Lygeum spartum*), psammophytic pastures in Drinn (*Stipagrostis pungens*), and bushy steppe pastures with Remth (*Hammada scoparia*). This chapter consists of an ecological characterization of steppe groups in the South Oran region of Naama with the aim of better understanding the dynamics of vegetation and better understanding the ecological factors that govern these plant formations.

Keywords: steppe, formations, Naâma, vegetation, Algeria

1. Introduction

The Algerian steppe constitutes a particular agroecological zone, covering more than 20 million ha or 8.4% of the country's surface area. Geographically, it is located between the Tell Atlas in the North and the Saharan Atlas in the South. It is limited by the isohyet 400 mm to the north and 100 mm to the south. It constitutes an intermediate zone between the north of the country with a humid, subhumid, or semi-arid climate and the south of the country with an arid climate (pre-Saharan course) and Saharan climate (oases) [1–8]. It is made up of three very distinct geographical groups: the Algerian-Oranian high plains; the Saharan Atlas (Mountains of Ksour, Djebel Amour; Mount of Ouled Neil; Mount of M'Zab, and Nementcha) and the southern foothills of the Saharan Atlas (south of the mountains of M'Zab, Aurès, and Nementcha) [9]. Including eight pastoral steppe wilayas proper: El-Bayadh and Naâma in the western part (west), Laghouat, Djelfa, M'sila in the center, and the wilayas of Biskra, Tébessa, Khenchella in the eastern region. They cover 264,034 km², or nearly 12% of the national territory, and account for more than 25% of the Algerian population.

The approach followed in this study is based on a classic ecological approach, integrating the study of the physical factors of the environment (geomorphology, climate, pedology, hydrology) and the inventory of the biotic component by the flora (steppe formations).

The analysis of the natural environment must allow us to identify and characterize physical potential and constraints as well as their interaction and geographic variation. For this, the methodological approach followed for data collection was focused on two main sources of information: bibliographic data explanatory of existing information, namely (statistics agricultural, demographic, livestock, etc.), Studies, and theses, Cartography Knowledge of data from the physical environment in its different forms is essential in understanding the phenomena linked to different aspects of the environment and its components.

The approach to the natural environment will be based on the analysis of the following factors which characterize this steppe region:

- General presentation of the study area (wilaya of Naâma)
- Geomorphological framework
- Geological setting
- Soil framework
- Hydrographic and hydrogeological framework
- Floristic analysis: For the floristic analysis, the aim is to establish a quantitative and qualitative inventory with characteristics relating to stratification, abundance-dominance, biological type, vigor, and phenology... It consists of studying the floristic composition on a biological level, and systematic and phytogeographical analysis of a population in a given region [10]. According to Gounot [11], “it involves listing all the species encountered in a representative area with the aim of establishing the floristic list of homogeneous communities.” This part was carried out based on floristic surveys conducted during the spring period when perennial and annual plant species are in full development in the study region. The methodological approach adopted was based on the exploitation of work on steppe vegetation in the Naama region: [8, 12–27].

The steppe rangelands are characterized by a set of plant communities which owe their physiognomies, in spaced tufts of herbaceous and/or more or less shrubby nature, to the abundance of bunch grasses based on esparto*grass (*Stipa tenacissima*), esparto (*Lygeum spartum*), and Drinn (*Stipagrostis pungens*), or chamaephytes such as mugwort (*Artemisia herba-alba*) and Remth (*Hammada scoparia*) [14–20].

The study carried out in western Algeria on the ecological characterization of the steppe, entitled “Ecological characterization of steppe formations in the Naama region (western Algeria),” deals with the characterization of various plant formations, among which the authors make special reference to the communities of *Stipa tenacissima*, *Lygeum spartum*, *Stipagrostis pungens*, and *Hammada scoparia*. Communities of certain interest, especially those of a psammophilous character and for acting as soil protectors. The objective of this chapter is to establish an ecological diagnosis which

allowed us to identify the main existing steppe formations in interaction by ecological factors in the steppe region of Naama (western Algeria).

2. Presentation of the study area

2.1 Geographical location

The wilaya of Naâma has a large set of ecosystems and biological diversity. It is located between the Tell Atlas and the Saharan Atlas in its western part. It is limited:

- To the north by the wilayas of Tlemcen and Sidi Bel Abbès,
- To the east by the wilaya of El-Bayadh,
- To the south by the wilaya of Béchar,
- To the west by the Algerian-Moroccan border (**Figure 1**).

2.2 Biophysical characterization of the study area

It is dedicated to the presentation of the physical and natural characteristics of the wilaya of Naâma, aiming to provide overall knowledge of the South Oran steppe of Naâma and offering a situational scenario through an analytical approach, both on the biophysical and socioeconomic level with regard to the dynamics of societies and their activities.

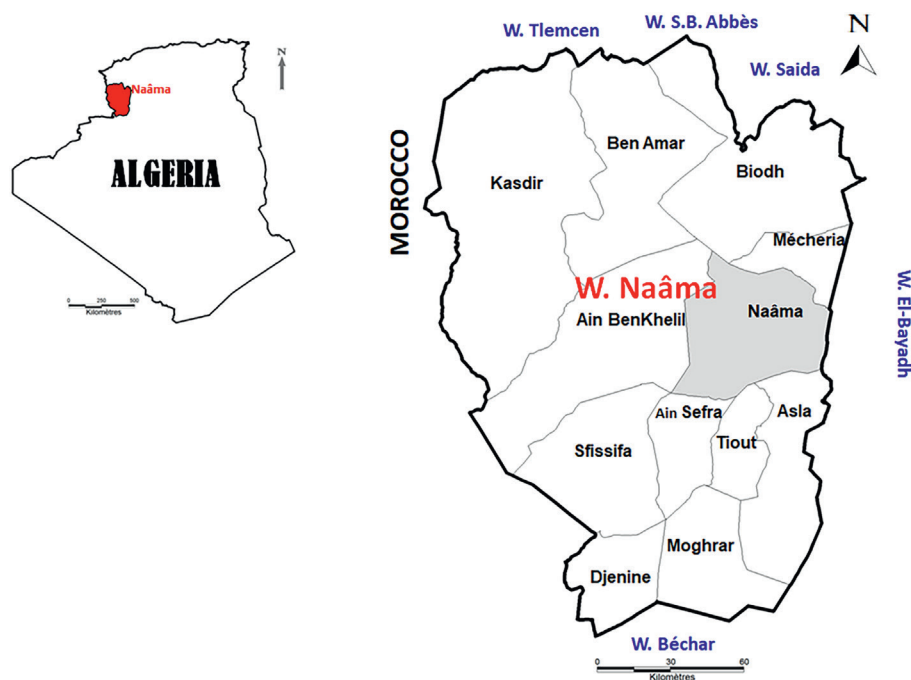


Figure 1.
 Geographic location of the study region (Naâma, Algeria).

2.2.1 Socioeconomic framework

The wilaya of Naâma is characterized by a low population density (6.85 inhabitants/km²). A population poorly distributed in space: Out of 303,843 inhabitants occupying the territory of the wilaya, a third (1/3) is concentrated in the municipalities of Mécheria and Ain-sefra whose surface area does not exceed 6% of the total surface area.

Agriculture and pastoralism are the two activities that still constitute the main economic vocation of the wilaya of Naâma. This sector has experienced several crises in the past, especially those linked to climatic factors and silting of the area. However, initiatives have been taken by local authorities to revitalize this sector in order to stabilize the local population.

This steppe region has a pastoral vocation with an area of 2,951,410 Ha, of which the useful agricultural area (UAA) experienced significant growth between 1983 and 2022 since it increased from 855 to 28,283 ha. While it constituted 0.65% of the total area of the wilaya in 1987, it reached 3% in 2022 [28].

2.2.2 Geographical framework

Geographically, the wilaya of Naâma is located in the western part of the High Plaines, a region with diverse relief (rocky plateaus, steppe, old mountain ranges of the western part of the Saharan Atlas, depressions, etc.). It is individualized by a fairly vast territory subdivided into three distinct spaces (steppe plains, Saharan Atlas, and Saharan space).

2.2.3 Climatic framework

The climate of the Naâma region is characterized by low and irregular rainfall (200 mm/year) and a fairly long dry period of 6–7 months, characterized by low temperatures generally falling below –4°C. This explains its belonging to the arid bioclimatic stage. The irregularity of precipitation from 1 year to the next, combined with prevailing dry winds, causes a degradation of the plant cover and accelerates the phenomenon of aridization [29–33].

2.2.4 Geological framework

The study area as a whole constitutes a transition zone of the geological formations of the Tell Atlas and that of the Saharan Atlas. It is characterized by the juxtaposition of two sedimentary series, marine and continental, following the phases of regression and transgression of the sea. The base of the deposits is made up of Jurassic marine series where sandstones predominate. Then come the Cretaceous continental series made up of sandstone and some dolomitic and limestone pasts in the Upper Cretaceous. In the tertiary, sedimentation ends with a continental formation, cemented by a limestone crust [34].

2.2.5 Hydrographic framework

The hydrographic network is poorly developed in the North, while in the South, it is denser with a significant interflow crossing the Atlas by successive reaches and locks. Surface water is temporary; it circulates toward three closed basins: Chott El

Rharbi to the West, Chott Ech Chergui to the north-east, and Sebkha de Naâma to the south-east. In the south, the existence of reliefs gives rise to denser flow and a more hierarchical hydrographic network, thus forming a few wadis whose flow takes a direction parallel to the structures. The El Breidj wadi has a southwest-northeast flow, while the Ed Douis and El Rhouiba wadis have a northeast-southwest flow [35].

For shallow and medium depths, the more or less coarse levels of the tertiary filling base can contain minor aquifer horizons. Also, the fractured formations of the Bajo-Bathonian may be likely to accumulate groundwater [34–36].

2.2.6 Pedological framework

Based on the work of Pouget [1], Halitim [37], Bensaid [38], Benaradj [14], and Boucherit [32], the soils of the wilaya of Naâma are generally thin and are classified as follows: raw mineral soils, poorly developed soils, calcimagnetic soils, and halomorphic soils.

3. Results and discussions

Floristic aspects and the main plant formations.

Numerous works have been carried out in this steppe space in the South Oranian region: Djebaili [39, 40], Pouget [1], Bouzenoune [12], Kaabèche [3], Le Houérou [4], Bouazza [41], Bouazza and Benabadji [42, 43], Benaradj [14], Haddouche [44], and Boucherit [32]...

The appearance of the steppe changes with the rainfall gradient and the nature of the soil. The steppe is dominated by the following plant formations (**Figure 2**):

- Espresso steppe (*Stipa tenacissima*);
- White sagebrush steppe (*Artemisia herba-alba*);
- Remth steppe (*Hammada scoparia*);
- Esparto steppe (*Lygeum spartum*);
- Halophyte steppe;
- Psammophyte steppe.

3.1 The esparto steppes (*Stipa tenacissima* L.)

The steppes of *S. tenacissima*, whose potential area was 4 million ha having declined to only 2.1 million ha, present a strong ecological amplitude and colonize geological substrates from 400 to 1800 m altitude. The *S. tenacissima* is one of the xerophilous species that best characterizes arid Mediterranean environments, excluding desert areas. In Algeria, esparto steppes occupied approximately 70% of the surface of the high steppe plains [2]. The esparto steppes extended over 4 million ha in the 1970s and currently just 2 million ha, which shows that these steppes have been the most affected by degradation [13]. In Algeria, esparto is abundant in the Oran region, from the coast to the Ksour Mountains and on the high plateaus [46–48].

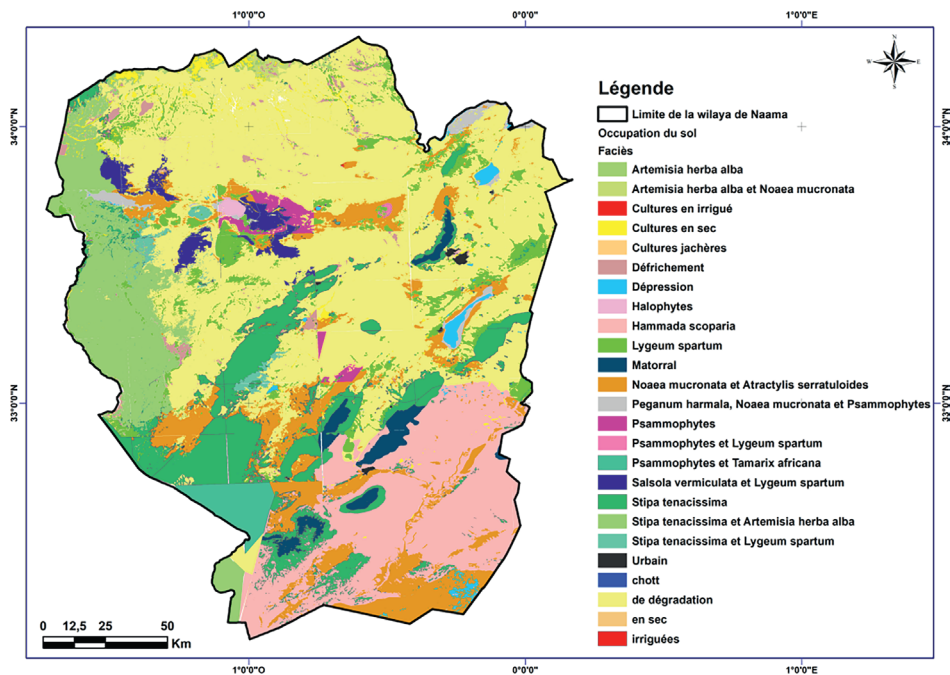


Figure 2.
Distribution map of steppe vegetation in the wilaya of Naama [45].

The esparto is a xerophilous plant, although its bioclimatic limit is between arid and semi-arid. It is located between the two 100 and 400 mm isohyets. The *S. tenacissima* formation constitutes a transition stage between Aleppo pine forests, holm oak, and chamaephytic steppe [49, 50].

In this Noufikha station, this group of esparto occupies the mid-slope and lower slopes of the djebels. Lithologically, the *S. tenacissima* group colonizes the encrusted glaciais of the Middle Quaternary with calcagnisic soil of the brown limestone type with crust and slab [49, 50]. In the enclosure of Noufikha, this group is found on the djebels, with shallow soil, covering an area of over 10,000 ha. This steppe facies presents with a coverage rate close to 40%. Among the species which make it possible to identify this grouping, a large majority are therophytic species that develop during the wet season and which colonize the space between the tufts: *Alyssum linifolium*, *Anthyllis vulneraria*, *Astragalus armatus*, *Atractylis humilis*, *Atractylis proliфера*, *Catanche arenaria*, *Echinaria capitata*, *Eryngium tricuspidatum*, *Helianthemum rubellum*, *Helianthemum hirtum*, *Launaea nudicaulis*, *Launea resedifolia*, *Leontodon hispanicum*, *hirtum*, *Hernaria fontanesii*, *Plantago albicans*, *Muricaria prostrata*, *Stipa parviflora* [16]. However, in the free range, the grouping of *S. tenacissima* can be recognized by a particular appearance (coverage less than 25%) and a floral procession characteristic of maximum exploitation of the group's resources. Among the indicator species of this overload are: *Astragalus armatus*, *Atractylis humilis*, *Atractylis serratuloides*, *Noaea mucronata*... [16].

3.2 Steppes at Sparta (*Lygeum spartum* L.)

Lygeum is a Mediterranean poaceae, whose large centers extend over the high plateaus of Algeria and Morocco [47, 48]. In Algeria, it is especially abundant in

the South-West, where it is found from the coast to the Ksour Mountains and on the high plateaus. In Algeria, esparto (*L. spartum*) constitutes a dominant element of the Algerian steppe and occupies second place after Alfa with an extensive area estimated at 2 million ha; it grows on sandy soils and saline soils in arid and semi-arid bioclimatic stages [49, 50].

In the Naama region, steppes with (*L. spartum*) mainly occupy erosion glacia on brown calcareous soils, halomorphic in the chotts zone. This Sparta facies appears in the form of a small enclave; it is found in the fresh lower bioclimatic level on glacia and especially in the spreading zones. In terms of soil, the soil is deep (>50 cm), rich in fine sandy-loamy elements. The floristic procession of this facies is as follows: *L. spartum*, *Eruca vesicaria*, *Hernaria fontanesii*, *Plantago albicans*, *Bromus rubens*, *Avena alba*, *Avena sterilis*, *Astragalus sinaicus*, *Helianthemum lipii*, *Artemisia herba-alba* ...

3.3 Steppe formation at Drinn (*Stipagrostis pungens*)

S. pungens is found in the dunes in clumps about 1 m high. Common throughout the Sahara, the Drinn is perfectly adapted to sandy habitats, represented by deep sandy piles (dunes, ergs). The sand sometimes accumulates at the foot of the tufts in an imposing manner. Extremely drought-tolerant, Drinn grows in areas where rainfall does not exceed 70 mm per year. The group colonizes sandy and sandy soils. This psammophilous vegetation occupies a larger area near the edges of the living dunes constituting dunes cords in Gaaloul (Ain Ben-Khellil region). The floristic composition of this group is characterized by a wealth of endemic grasses (Poaceae) (*S. plumosa*, *S. ciliata*, *S. obtusa*, etc.), which give the group a particular appearance (**Figure 3**) [16].

3.4 Steppe formation of *Artemisia herba-alba*

The white sagebrush steppes (*A. herba-alba*) cover almost 3 million ha and are located in the upper and middle arid levels with cool and cold winters, with precipitation varying from 120 to 300 mm [2]. This grouping presents clear seasonal variations which are expressed by the change in its floristic composition (*A. herba-alba*, *Astragalus mareoticus*, *Erodium glaucophyllum*, *Lygeum spartum*, *Marrubium deserti*, *Noaea mucronata*, *Medicago minima*, *Plantago albicans*, *Evax pygmaea*). From a synecological point of view, the *A. herba-alba* grouping is particularly linked to areas where rainwater is concentrated for more or less long periods of time (silty-clay basins and depressions and alluvial plains) where *S. tenacissima* is found, in contrast, eliminated [51]. The ecological characteristics of the habitats specific to the *A. herba-alba* grouping explain that this type of grouping corresponds, in arid territories, to the soils best



Figure 3.
 Steppe species (*Stipa tenacissima*, *Lygeum spartum*, *Stipagrostis pungens*).

suited to agricultural exploitation (better water retention capacities) and, therefore, where anthropogenic pressure is most accentuated. On the other hand, the *A. herba-alba* group subject to “controlled” grazing in the region of Aïn Ben-Khellil (Naâma) presents a remarkable density [51].

3.5 Steppe formation at Remth (*Hammada scoparia*)

In North Africa, it covers vast areas in the form of an elongated strip from the Zemmour region in Mauritania to Tunisia. In Algeria, the *H. scoparia* group ensures the transition between, on the one hand, the steppes with esparto, esparto, and white mugwort, vegetation typical of the steppe high plains where the Mediterranean floristic element predominates, and on the other hand, the vegetation of the Sahara where the Saharo-Arabian taxa become the majority. Colonizing various types of habitats (hamadas and regs) on the borders of the northern and north-western Sahara, this steppe also infiltrates into the high steppe plains where it covers areas limited to the Hodhna Basin and the Atlas Saharan Oranian (Béchar, Naâma and El-Bayadh).

Remth steppes (*H. scoparia*) form chamaephytic bushy steppes with very little coverage. The *H. scoparia* steppe occupies 3 million ha and represents 15% of the Algerian steppe (20 million ha). It is a fairly common and characteristic steppe species of the Saharan Atlas of western Algeria. It develops at an altitude of 800–1400 m on average slopes of 10–15% and occupies loamy-sandy soils, the southern foothills of the Saharan Atlas, the glacis and hamadas of the northern part of the Sahara [32]. Like all steppe vegetation, the *H. scoparia* steppe brings together a very diverse floristic procession which develops during the humid period and constitutes spring rangeland with the main characteristic species: *Anvillea radiata*, *Gymnocarpos decander*, *Hammada schmittiana*, *Fagonia glutinosa*, *Saccocolyx satureoides*, *Wariona saharea*, *Rhus tripartita*, *Anabasis aetnoides* ...

From North to South of the Naâma region, the distribution of *H. scoparia* in the Saharan Atlas extends over an area of 800,000 ha, with an altitudinal barycenter that follows a progressive layering. However, their amplitudes are more reduced at altitude (800–1400 m), in south-east exposure. On an average slope of (15–20%). groups in *H. scoparia* and adapt well when the average annual precipitation is between 150 and 200 mm in the study area (case of Ain Séfra) and tolerates precipitation of less than 100 mm in the southern part of the Saharan Atlas (case of the Béchar region) [31]. Climatically, its northern limit fairly faithfully follows the 150 mm isohyet in Algeria; its southern limit only rarely transgresses the 100 mm isohyet [32]. According to Emberger et al. [52], this grouping characterizes the lower arid and Saharan bioclimatic stages with a cold variant corresponding to a desert and sub-desert climate. Thus, it initiates the transition between the arid stage and the Saharan stage [40].

This grouping has been described by several authors including Pouget [1] in southern Algeria and Bouzenoune [12] in southern Oranian. This grouping is linked to an arid lower than Saharan bioclimate (warm to cool variant) with annual precipitation between 100 and 200 mm with very high variability. From a geomorphological and edaphic point of view, the *H. scoparia* group develops on medium-textured xeric calcimagnesian soils. These soils correspond to habitats characterized by development on limestone crusts often in the form of slabs and on flat, stony, and rocky erosion glacis, often crusted on the surface, on stony regs, and on hamadas [51].

The *H. scoparia* occupies the southern foothills of the Saharan Atlas, the glacis, and the hamadas of the northern part of the Sahara where it seems to find optimum development [49, 50]. This group colonizes the entire Chekika station; it develops on

regs, denudation glakis, on erosion glakis covered by silting with shallow soil, mostly with a loamy-sandy texture.

Physiognomically and floristically [40], the variation in the floristic composition of this group depends on the nature of the lithological substrate. When it develops on heavily silted erosion glakis, this group forms facies with psammophytic species such as *Thymelaea microphylla*, while on denudated glakis with poor soil, it forms a facies with *Anabasis aretioides* etc. The physiognomy of the group in the sense of Bouzenoune [12] and Le Hou  rou [53], is characterized by diffuse bushy steppes.

So the plant species of this purely desert grouping: *H. scoparia*, *Anabasis articulata*, *Anabasis aretioides*, *Ephedra alata*, *Anvillea radiata*, *Asphodelus tenuifolius*, *Bassia muricata*, *Bubonium graveolens*, *Cleome arabica*, *Cotula cinerea*, *Daucus biseriantus*, *Echium pycnanthum*, *Euphorbia retusa*, *Fagonia glutinosa*, *Globularia alypum*, *Gymnocarpus decander*, *Launaea arborescens*, *Launaea nudicaulis*, *Launea acanthoclada*, *Limoniastrum fei*, *Moricandia suffruticosa*, *Neuroda procumbens*, *Plantago ciliata*, *Teucrium polium*, *Zilla macroptera*, *Zilla spinosa* (Figure 4).

3.6 Steppe formation of Baguel (*Hammada schmittiana*)

This grouping forms steppes with fine sand, on more or less crusted, slightly gypsum soil [53]. *H. schmittiana* is an indicator of the hot variant of the Saharan stage and of the mild variant of the arid stage [54]. According to Djebaili [40], it is a psammophyte. This *H. schmittiana* group is found in environments with a lower arid bioclimate [54]. This facies is very rare in the study station, it is located on the alluvial terraces, with deep sandy-loamy soil, with a silting coverage of between 30 and 50% [55], allowing the development of the following floristic procession: *H. schmittiana*, *Salsola vermiculata*, *Thymelaea microphylla*, *Zilla spinosa*, *Marrubium desertii*, *Atractylis serratuloides*, *Launaea nudicaulis*, *Erodium triangulare*, *Plantago ciliata* (Figure 5).

3.7 Steppes grouping of the chobrog (*Noaea mucronata*)

This group of chobrog grows on a low slope with sandy-loamy soil texture. The floristic procession of this grouping: *N. mucronata*, *Atractylis serratuloides*, *Thymelaea microphylla*, *Anabasis articulata*, *Salsola vermiculata*, *Scorzonera undulata*, *Plantago albicans*.....



Figure 4.
 Steppe formation of Remth (*H. scoparia*).



Figure 5.
Steppe formation of Baguel (*Hammada schmittiana*).

3.8 Steppes grouping of Serr (*Atractylis serratuloides*)

This grouping of *A. serratuloides* is replaced by the esparto that has disappeared and been degraded by the concentrated overgrazing of livestock. This grouping dominates free rangelands, which are strongly disturbed and degraded by anthropozoic factors; it is gradually replaced by unpalatable species such as *Atractylis serratuloides*, *Peganum harmala*, which can, depending on the stations, dominate. Among the species in this group: *Atractylis serratuloides*, *Thymelaea microphylla*, *Bassia muricata*, *Salsola vermiculata*, *Anabasis articulata*, *Ferula cossoniana*, *Atractylis humilis*, *Peganum harmala*, *Plantago albicans*.....

4. Conclusion

Pastoral areas have always constituted a determining component in the stability of the economic and social balance of the rural world. Indeed, rangelands constitute a natural resource for grazing animals, provide habitat for wildlife, shelter groundwater reserves, protect watersheds, and contribute to the fight against desertification.

The wilaya of Nâama is characterized by its agropastoral character because it is exposed to certain problems and obstacles, which manifest themselves in the reduction of biological potentials and the degradation of ecological balances such as the deterioration of pastoral lands and the absence of plant cover, as well as the phenomenon of desertification and overgrazing. Faced with this alarming situation, the state has undertaken several biological rehabilitation measures: creating defenses that give the plant a chance to regenerate, as well as pastoral agriculture to provide feed for livestock, and the major green dam project to reduce the phenomenon of desertification. To achieve pastoral development, the efforts adopted by relevant segments of society should be combined.

Acronyms and abbreviations

BNEDER	National Bureau of Studies for Rural Development
CRBT	Biotechnology Research Center
DBPM	Directorate of Budget Programming and Monitoring
HCDS	High Commission for the Development of the Steppe
UAA	Useful Agricultural Area

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