



Contribution to the study of the floristic diversity of steppe zone Tiaret (Algeria). Contribuição para o estudo da diversidade florística da zona estepária de Tiaret (Argélia).

[Houria Ouzzir](#)¹, [Yasmine Kadi Hanifi](#)²

¹- PhD student, Laboratory of Ecology and Environment, University of Science and Technology Houari Boumediene – USTHB, BP 32 Bab Ezzouar, 16111 – Algiers, Algeria. E-mail: houriabalegh6@gmail.com

²- Professor, Laboratory of Ecology and Environment, University of Science and Technology Houari Boumediene – USTHB, BP 32 Bab Ezzouar, 16111 – Algiers, Algeria. E-mail: hykadihanifi@yahoo.fr

Abstract

This study is devoted to steppe zone of the Tiaret region. Our work consists in highlighting the floristic biodiversity following a flora inventory, using subjective sampling - the simplest and most intuitive form of sampling - in order to obtain a database in which taxonomic, ecological and other characteristics are specified, revealing the importance of this biodiversity. The results of the flora analysis study led to the identification of 159 taxa divided into 28 botanical families and encompassing 101 genera. Endemic vegetation includes 15 taxa. As regards rarity, there are 08 fairly rare species, 01 rare species and 04 very rare species. Examination of the biological types of all the vegetation surveyed revealed that therophytes, numbering 71, dominate the scene with 45%. The Mediterranean phytochoric element is predominant with 63 species. The high perturbation index (62%) reflects a high degree of disturbance to the vegetation in this zone, which also reflects a more open environment (anthropozoic pressure). We recommend to the sustainable use of biodiversity, through the implementation of several integrated strategies.

Keywords: Subjective sampling. Flora analysis. Anthropozoic pressure. Preservation of biodiversity.

Resumo

Este estudo é dedicado à zona de estepe da região de Tiaret. Nosso trabalho consiste em destacar a biodiversidade florística seguindo um inventário da flora, utilizando amostragem subjetiva – a forma mais simples e intuitiva de amostragem – a fim de obter um banco de dados no qual características taxonômicas, ecológicas e outras são especificadas, revelando a importância dessa biodiversidade. Os resultados do estudo de análise da flora levaram à identificação de 159 táxons, divididos em 28 famílias botânicas e abrangendo 101 gêneros. A vegetação endêmica inclui 15 táxons. Em relação à raridade, há 8 espécies bastante raras, 1 espécie rara e 4 espécies muito raras. O exame dos tipos biológicos de toda a vegetação pesquisada revelou que terófitas, totalizando 71, dominam a cena com 45%. O elemento fitocórico mediterrâneo é predominante, com 63 espécies. O alto índice de perturbação (62%) reflete um alto grau de perturbação da vegetação nesta zona, o que também reflete um ambiente mais aberto (pressão antropozóica). Recomendamos o uso sustentável da biodiversidade por meio da implementação de diversas estratégias integradas.

Palavras-chave: Amostragem subjetiva. Análise da flora. Pressão antropozóica. Preservação da biodiversidade.



Introduction

Diversity is the most striking characteristic of this life (TILMAN, 2000). The diversity of life forms, so numerous that we have yet to identify most of them, is the greatest wonder of this period (WILSON, 1988).

Biodiversity refers to the variety of living species that inhabit the biosphere. It is also the total richness or number of living species that inhabit a given type of habitat, the whole of an ecosystem, a biogeographical region or the entire biosphere (RAMADE, 2008).

According to the United Nations Convention on Biological Diversity, held in Rio de Janeiro in 1992 (CBD, 1992), biological diversity is defined as the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part.

It was in 1992, at the Earth Summit, that the action plans for sustainable development were defined, and it was on the same date that the Convention on Biological Diversity was opened for signature with a view to the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of its genetic resources.

The Mediterranean basin is a biodiversity hot spot (MYERS et al., 2000), it is the second largest hot spot in the world and the largest of the five Mediterranean climate regions on the planet. It is also the third richest hot spot in the world in terms of plant diversity (MÉDAIL; MYERS, 2004).

Algeria's overlapping geographical location between two floral empires gives it a highly diverse flora, with species belonging to different biogeographical elements. Floristic diversity is the most visible element of biodiversity (DAJOZ, 2008).

The Algerian flora comprises around 4,000 taxa divided into 131 botanical families and 917 genera, of which 464 taxa are national endemics (387 species, 53 subspecies and 24 varieties) (YAHY; BENHOUGHOU, 2011).

The steppic zone occupies the southern part of the Wilaya; it corresponds to the high steppic plains that slope imperceptibly down towards Chott Chergui and the Oued Touil valley.

It covers an area of 1.380,401 ha, or 68.44% of the total area of the Wilaya Tiaret. For the most part, they are located in the average arid bioclimatic sub-stage which is characterized by purely steppe vegetation and varying rainfall between the 200 and 300 mm / year isohyets (PAWT, 2008) (FIGURE 1).

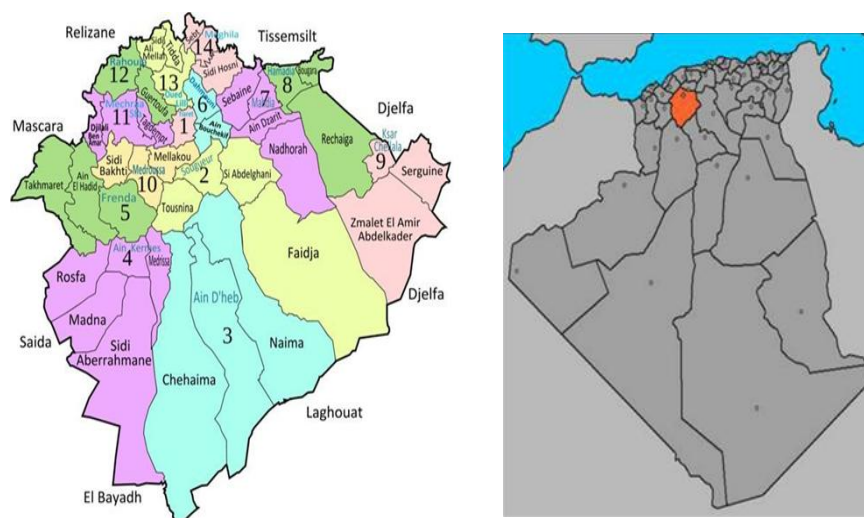


Figure 1 - Situation map of Tiaret's area.

The most dominant type of training vegetation in the region is steppe with a surface area of 974.967,65 ha, followed by herbaceous crops with 150.322,90 ha, located to the north of the communes of Madna, Sidi Abderahmane, Chehaima, Ain Deheb, Naïma, Faidja and Rechaiga, and practically the whole of the commune of Medrissa; another part of this formation is located to the south of the wilaya in the communes of Zmalet Emir Abdelkader and K'sar Chellala.

The region's steppe is degraded over an area of almost 438.224,98 ha and is marked by the presence of species indicative of this state of degradation, such as *Atractylis serratuloides*, *Peganum harmala*, *Astragalus armatus*, *Noaea mucronata* and *Salsola vermiculata*. The esparto steppe (*Stipa tenacissima*) covers an area of 214.388,54 ha, equivalent to 17%, while herbaceous crops account for only 149.727,33 ha, or 11.94% of the total (BNEDR, 2008).

This steppe formation is based on perennial grasses *Macrochloa tenacissima*, *Lygeum spartum*, *Aristida pungens* and perennial chamaephytes *Artemisia herba-alba*, *Artemisia compestre*, *Helianthemum hirtum*.

Its facies of degradation *Noaea mucronata*, *Peganum harmala*, *Thymelaea microphylla*, *Arthropytum scoparium*, *Astragalus armatus*, *Atractylis serratuloides*.

This research initiative aims to invent and analyze the floristic composition, the distribution of species according to their ecological affinities, and the structure of the vegetation in this semi-arid environment. It also enables us to assess species richness, the predominance of certain biological groups (such as therophytes and chamephytes). At the same time exploring the interactions between humans, biodiversity and ecosystems while identifying sustainable solutions for their preservation, to measure the impact of disturbances on the vegetation. The study thus contributes to a better understanding of ecological dynamics and provides a basis for the conservation and sustainable management of this steppe biodiversity.

Material and methods

Vegetation surveys are carried out using traditional methods, by drawing up a list of all the plant species present on a previously determined surface unit within a homogeneous station; this is the minimum area (HAMMADA, 2007); in our case, it is 100m².

The sampling used is subjective the simplest and most intuitive form, which consists in selecting as samples areas that appear particularly homogeneous and representative in accordance with the stigmatist method, the surveys were carried out on areas that were homogeneous in terms of physiognomy, flora and ecology (GOUNOT, 1969)

The linear survey is considered as an effective way to study the evolution of the vegetation cover when it is a permanent line (GOUNOT, 1969; AIDOU, 1983); 10 stations were sampled; 110 surveys were performed (TABLE 1).

The list of plant species can be easily identified by consulting a number of references:

- The flora of Algeria (QUEZEL; SANTA, 1962-1963);
- The flora of the Sahara (OZENDA, 1977);
- The Dobignard and Chatelain index (2010-2013);
- The website of the database of plants in Africa (CJBG, 2021);
- The new flora of Algeria and the southern desert regions (QUEZEL; SANTA, 1962-1963)

supported by the website (tela-botanica).

Table 1 - Distribution of surveys in the Tiaret steppe region.

Municipality	Number of surveys per station
Ain Dhab	10
Naima	10
Nadhoura	05
Serguine	05
Rosfa	08
Chehaima	04
Sar	11
Madena	08
Zaa	28
Elfaidja	21
Total	110

Socio-economic aspects

Nearly half of the population working in the various sectors of these communes is livestock farmers, practicing traditional agriculture represented mainly by cereal growing, with yields too low to meet their needs, and extensive livestock rearing.

Results and discussion

1. Floristic study

1.1 Floristic composition

Floristic composition varies according to climatic conditions (mainly rainfall and temperature), type of exploitation, soil and topography (AIDOU, 1989).

In all the stations studied, we recorded 159 species belonging to 28 families. It should be noted that of the 28 families recorded, 10 are represented by only one species. However, 04 families, respectively the Asteraceae (42 species), Poaceae (17 species), Fabaceae (15 species) and Amarantaceae (10 species), are the most dominant (FIGURE 2; TABLE 2).

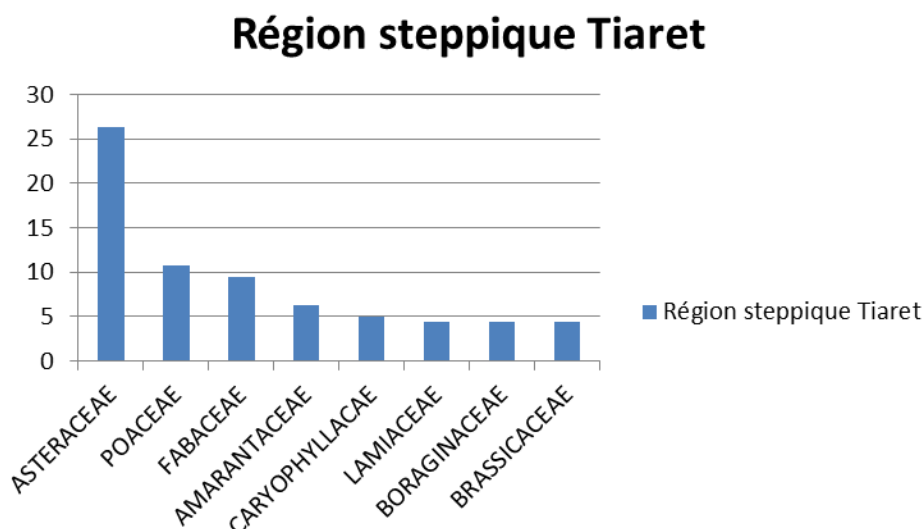


Figure 2 - Specific distribution of the most common families in the study area.

Table 2 - Flora recorded (generic and specific) by 28 botanical families in the study area.

Botanical family	Genre	Rate %	Species	Rate %
ASTERACEAE	26	25.74	42	26.41
POACEAE	12	11.88	17	10.69
FABACEAE	09	08.91	15	09.43
AMARANTACEAE	06	05.94	10	06.28
CARYOPHYLLACEAE	05	04.95	08	05.03
LAMIACEAE	05	04.95	07	04.40
BORAGINACEAE	04	03.96	07	04.40
BRASSICACEAE	06	05.94	07	04.40
CISTACEAE	01	0.99	05	03.14
APIACEAE	04	03.96	04	02.51
ASPARAGACEAE	02	01.98	04	02.51
EUPHORBIACEAE	01	0.99	04	02.51
MALVACEAE	02	01.98	04	02.51
PLANTAGINACEAE	01	0.99	04	02.51
LILACEAE	02	01.98	03	01.88
CRASSULACEAE	01	0.99	02	01.25
PAPAVERACEAE	01	0.99	02	01.25
RESEDACEAE	01	0.99	02	01.25
RARUNCULACEAE	02	01.98	02	01.25
CAPPARIDACEAE	01	0.99	01	0.62
GERANIACEAE	01	0.99	01	0.62
CONVOLVULACEAE	01	0.99	01	0.62
CAPRIFOLIACEAE	01	0.99	01	0.62
OROBANCHACEAE	01	0.99	01	0.62
AIZOACEAE	01	0.99	01	0.62
RHAMNACEAE	01	0.99	01	0.62
TAMARICACEAE	01	0.99	01	0.62
THYMELEACEAE	01	0.99	01	0.62
NITRARIACEAE	01	0.99	01	0.62
Total	101	100%	159	100%

1.2. The biological spectrum

Biological types are a combination of morphological characteristics resulting from the adaptation of species to environmental conditions (RAUNKIAER, 1934; BRAUN-BLANQUET, 1951; PIGNATTI, 1982; SIRVENT, 2020), especially during unfavorable periods.

As in most studies of steppe environments, therophytes are dominant, which is a particular feature of arid and semi-arid zones (FLORET; PONTANIER, 1982; LE HOUÉROU, 1986 and 1995). The dominance of species which complete their cycle in less than a year is only the consequence of various hazards combining climate and pressure on resources (AIDOU; TOUFFET, 1996; BOUCHAREB, 2012).

Kadi Hanifi (2003) confirmed that the regression of steppe formations generally results in the chamaephytisation of thorny species of no economic interest, which are abandoned and pushed aside by the livestock.

The distribution of the species in the study according to biological type is shown in Figure 3.

Région steppique Tiaret

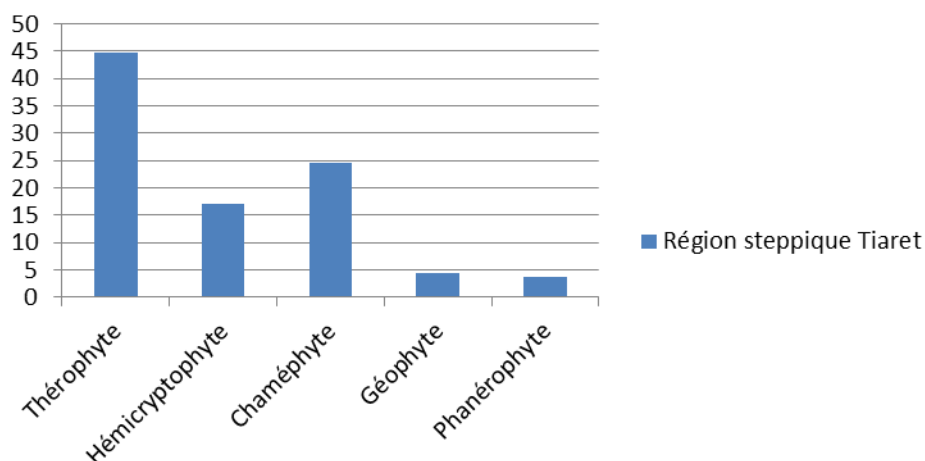


Figure 3 - Species distribution by biological type.

In our station, the Therophytes are the most represented (45%) of the total inventoried before the Chamephytes (25%), the Hemicryptophytes (17%) and apart respectively Geophyte (05%) and Phanerophytes (04%).

The abundance of therophytes is related to the aridity of the environment (NEGADI et al. 2014). Chamephytisation is also closely linked to the degradation of the environment by human activity, with the proliferation of hardy species.

1.3. The phytogeographical spectrum

According to Quezel (1983), the biogeographical diversity of Africa is due to the various climatic changes it has undergone since the Miocene, which have led to the migration of tropical flora.

Région steppique Tiaret

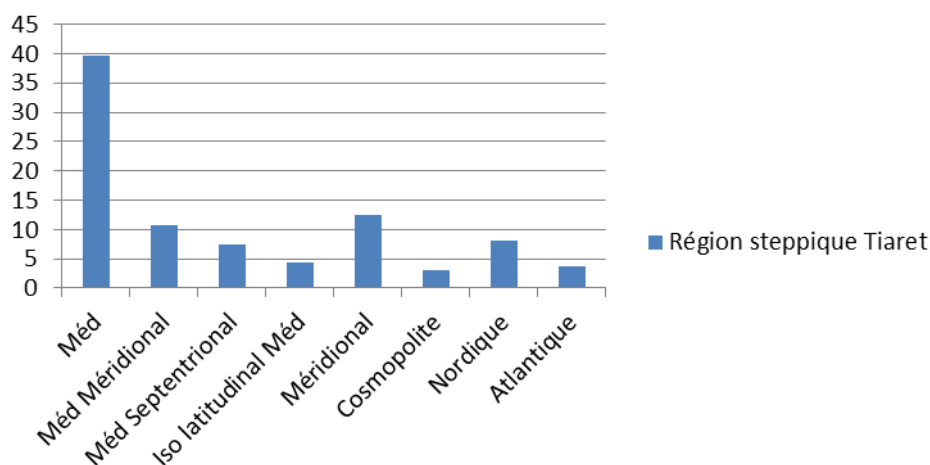


Figure 4 - Distribution of species by chorological type.

The analysis of the overall phytochoristic spectrum reveals the predominance of the Mediterranean element, with a high rate of 40%, i.e. 63 species, followed by the Southern element

(13%), Southern-Mediterranean (11%) and Nordic (08.5%). Mediterranean-Septentrional (08%). As for the other elements, they contribute little to floristic richness. Iso-latitudinal-Mediterranean (04.5%), Atlantic (04%), Cosmopolitan (03.5%) (FIGURE 4).

1.4. Endemism and rarity

We note that the highest proportion of species are North African (66,66%), followed by Algerian (20%). The endemic Algerian-Moroccan (06,66%) and Saharan (06,66%) species are poorly represented (TABLE 3).

Table 3 - endemic species to the study area.

Endemic species	Botanical family	Endemism
<i>Thymelaea microphylla</i> Coss & Durieu	Thymelaeaceae	North African
<i>Thymus algeriensis</i> Boiss & Reut	Lamiaceae	North African
<i>Anacyclus cyrtolepidioides</i> Pomel	Asteraceae	North African
<i>Ebenus pinnata</i> Aiton	Fabaceae	North African
<i>Enarthrocarpus clavatus</i> Delile ex Godr	Brassicaceae	North African
<i>Euphorbia calypttrata</i> Coss. & Kralik	Euphorbiaceae	Algerian
<i>Euphorbia spinosa</i> L	Euphorbiaceae	Saharan
<i>Evax discolor</i> DC	Asteraceae	Algerian-Moroccan
<i>Hernaria mauritanica</i> Murb	Caryophyllaceae	Algerian
<i>Marrubium deserti</i> Coss	Lamiaceae	Algerian
<i>Muricaria prostrata</i> (Desf) Desv	Brassicaceae	North African
<i>Pituranthos scoparius</i> Coss & Durieu	Apiaceae	North African
<i>Telephium sphaerospermum</i> Boiss	Crassulaceae	North African
<i>Gymnocarpos decander</i> Forssk	Caryophyllaceae	North African
<i>Helianthemum hirtum</i> (L) Mill	Cistaceae	North African

Two non-endemic taxa present in our study area are protected at national level by executive Decree No. 12-03 of 04 January 2012 establishing the list of protected non-cultivated plant species in Algeria. These are *Hélianthemum Lippii* (L.) Pers. (Cistaceae) and *Ononis natrix* L. (Fabaceae).

The distribution of taxa by degree of rarity is as follows: 08 taxa fairly rare; 01 taxa rares; 04 taxa very rare (TABLE 4):

Table 4 - Rare species in the study area.

Species	Botanical Family	Rarity
<i>Arnebia decumbens</i> (Vent) Coss & Kralik	Boraginaceae	R
<i>Astragalus mareoticus</i> Delile	Fabaceae	RR
<i>Cutandia dichotoma</i> Trab	Poaceae	AR
<i>Scorzonera laciniata</i> (L) DC	Asteraceae	AR
<i>Astragalus sinicus</i> L	Fabaceae	AR
<i>Bassia muricata</i> (L) Asch	Amaranthaceae	AR
<i>Helianthemum hirtum</i> (L) Mill	Cistaceae	AR
<i>Helianthemum lippii</i> (L) Pers	Cistaceae	RR
<i>Cotula anthemoides</i> L	Asteraceae	RR
<i>Tamarix gallica</i> L	Tamaricaceae	AR
<i>Ononis natrix</i> L	Fabaceae	RR
<i>Stipa parviflora</i> Desf	Poaceae	AR
<i>Aristida pungens</i> Desf	Poaceae	AR

AR: fairly rare; R: rare; RR: very rare.

1.5. Disturbance index (LOISEL; GOMILA, 1993)

$$IP = \frac{\text{Number of Chamephytes} + \text{number of Therophytes}}{\text{Total number of species}} \times 100$$

IP = 62%, shows that the richness of therophytes and Chamephytes in the study area indicates a high degree of disturbance, which also reflects a more open environment. It also reveals a degradation of the plant cover due to human activity.

Discussion

The 110 surveys carried out enabled 159 species belonging to 101 genera and 28 botanical families to be recorded and identified. The biological types show a predominance of therophytes (71 species). In the Mediterranean as a whole, the Mediterranean phytochoric element is predominant with 63 species. Endemics are represented by 15 species. Rare species in the study area are 13 species.

The biological types of flora recorded for our study area can be summarised as follows: Th > Ch > He > Ge > Ph.

Plant regression is evidenced by the high number of therophytes (45%), as well as a sharp increase in thorny and toxic species (*Astragalu*, *Atractylis serratuloides*, *Carthamus lanatus*, *Thymelaea microphylla*, *Noaea mucronata*, *Onopordun arenarium*, *Thapsia garganica*, *Euphorbia* and *Peganum harmala*) and a few psammophilous species (*Stipagrostis pungens*, *Filago spathulata*, *Helianthemum lippii*) to the detriment of palatable species, especially those of the Fabaceae and Poaceae families:

- The therophytization observed in our area is linked to the harshness of the climate and to anthropogenic actions that are increasingly degrading the conditions for the installation of new species. Emberger (1955) claim that the rate of therophytes increases with the aridity of the medium. This wealth is due to the process of "biological recovery" of the reconstitution, regeneration and reappearance of species threatened with destruction by degradation factors.

- As our area is agro-pastoral, we found that the most palatable species (*Asteriscus pygmeus*, *Astragalus mareoticus*, *Astragalus sinaicus*, *Hippocrepis multiciliquosa*, *Atractylis cancellata*, *Cutandia dichotoma*, *Evax pygmea*, *Malva aegyptiaca*, *Medicago laciniata*, *Medicago minima*, *Muricaria prostrata*, *Nonnea micrantha*, *Plantago albicans*, *Stipa* and *Vicia monantha subsp cinerea*) are becoming rarer.

- On the other hand, unpalatable species such as *Atractylis serratuloides*, *Noaea mucronata* and *Thymelaea microphylla* are increasingly colonising rangelands used for summer and autumn grazing.

- Most of the species on the list of flora in undeveloped rangelands compiled by HCDS, DGF.... are poor species, such as: *Atractylis humilis*, *Noaea mucronate*, *Echinops spinosus*, *Thapsia garganica*, *Peganum harmala*.

- Grazing also favors the chamephytes repelled by herds such as *Thymelaea microphylla* and *Astragalus armatus*.

The high disturbance index (62%) in this study influences plant composition, favoring species adapted to environmental and anthropogenic stress, the main impacts observed are as follows:

- Dominance of therophytes and chamephytes, typically, this dominance is due to overgrazed environments. overgrazing reduces the biomass of perennial species such as *Stipa tenacissima* and favours thorny and toxic plants (MEKIDECHE et al., 2018).

- Impoverishment of biodiversity: anthropogenic disturbances lead to a reduction in endemic and Mediterranean species replaced by multi-regional or ubiquitous taxa (BENKHETTOU et al., 2015).

Soil degradation and limited resilience increased erosion due to reduced perennial plant cover effects:

- Water retention: limiting the growth of deep-rooted species.

- Soil fertility: favoring species tolerant of impoverished soils (TRÉMOLIÈRES et al., 2008).

Impacts on ecosystem services: the dominance of ruderal species reduces:

- Fodder productivity, crucial for local livestock

- Farming Carbon sequestration capacity, linked to the limited above-ground and root biomass of therophytes.

The high disturbance index reflects a profound transformation of steppe ecosystems, marked by forced adaptation of the flora to human and climatic pressures, while weakening natural resilience mechanisms (BENKHETTOU et al., 2015).

Recommendations

To better preserve floral biodiversity in the semi-arid steppe region of Tiaret, several integrated strategies can be implemented, drawing on lessons learned from local studies and international best practice:

Sustainable land management and ecological restoration. Adopting appropriate agro-pastoral techniques, such as rotational grazing and regulating overgrazing, would reduce pressure on key species (*Stipa tenacissima*, *Artemisia herba-alba*). The reintroduction of native species through targeted reforestation programs would strengthen ecosystem resilience. Combating soil erosion by mechanical means (benching) or biological means (stabilizing vegetation) is also crucial (DGF/GEF/PNUD-ALG/00/G35/2005, 2014).

Involving local communities. Developing economic alternatives (crafts based on aromatic plants, ecotourism centered on steppe landscapes) would reduce dependence on natural resources. Training in sustainable agriculture and water management could improve farming practices while preserving the flora. The example of the GEF project in Algeria shows that the involvement of local NGOs (Association de Protection de la Steppe de Mecheria) increases the effectiveness of measures (DGF/GEF/PNUD-ALG/00/G35/2005, 2014).

Strengthening protected areas. Extending and connecting existing protected areas with ecological corridors would encourage genetic exchange between plant populations. The implementation of adaptive management plans, incorporating regular monitoring of floristic diversity (Shannon-Weaver index, disturbance rate), would enable strategies to be adjusted.

Institutional framework and international cooperation. Harmonizing agricultural, forestry and conservation policies would avoid contradictions between development and preservation. Programs such as those of the GEF (Global Environment Facility) have demonstrated the importance of international funding to support local initiatives (DGF/GEF/PNUD-ALG/00/G35/2005, 2014).

Research and monitoring. A strengthening of long-term phyto-ecological studies, coupled with satellite monitoring systems, would provide a better understanding of the climatic and

anthropogenic dynamics affecting the region. The creation of a digitized regional herbarium would facilitate the monitoring of endangered species (DGF/GEF/PNUD-ALG/00/G35/2005, 2014).

The sustainable use of biodiversity and preserving plant biodiversity: a global challenge. Every year, a large number of plant species disappear without new ones being born. This impoverishment of species is due to a number of factors, including natural factors (climatic aridity, silting up), not forgetting anthropogenic factors (overexploitation of natural resources, overgrazing and overcrowding, modification of landscapes and land use, intensive agriculture, pollution. If human activities are the immediate causes of the erosion of biological diversity, the solutions and remedies must be sought in the behavior of societies.

In other words, the conservation of biodiversity depends on the development choices made at both national and international level.

Conclusion

Based on field work and data processing, the steppe region of Tiaret presents a rich diversity of flora, but is exposed to disturbance, with vegetation dominated by species adapted to semi-arid Mediterranean conditions.

The results of the flora analysis yielded 159 taxa divided into 28 botanical families and encompassing 101 genera. Endemic vegetation includes 15 taxa. As regards rarity, there are 08 fairly rare species, 01 rare species and 04 very rare species. Examination of the biological types of all the vegetation surveyed revealed that therophytes, numbering 71, dominate the scene with 45%. The remaining types are respectively: chamaephytes, hemicryptophytes, geophytes and phanerophytes. Examination of the phytochoric types of all the vegetation surveyed revealed that the Mediterranean element dominates over the other types of presents.

Anthropogenic pressure on environments through overgrazing generates not only the loss of global and endemic floral biodiversity but also the proliferation of toxic and non-pastoral plants.

For sustainable development and effective protection of the existing flora, action must focus on preserving the environment and on the socio-economic aspect by involving the local population.

These combined actions (limit overgrazing, protecting soils, restore natural habitats, setting up protected areas or nature reserves, raising people's awareness) integrated into a national policy of conservation and sustainable management, will reduce the pressure on this fragile ecosystem and ensure its long-term survival.

These results show that steppe development projects and the introduction of forage species are effective solutions for combating silting and restoring degraded rangelands.

References

AIDOUD, A. **Contribution à l'étude des écosystèmes steppiques du sud oranais**. Thèse Doct. University of Science and Technology Houari Boumediene – USTHB, Alger, 1983.

AIDOUD, A. **Contribution à l'étude des écosystèmes steppiques du sud oranais: phytomasse, productivité primaire et application pastorales**. Thèse Doct. University of Science and Technology Houari Boumediene – USTHB, Alger, 1989.

AIDOUD, A.; TOUFFET, J. La régression de l'alfa (*Stipa tenacissima* L.) graminée pérenne, un indicateur de désertification des steppes algériennes. **Sècheresse**, n. 3, v. 7, p. 187-193, 1996. <https://www.jle.com/fr/revues/sec/e-docs/270777/article.phtml>

- BENKHETTOU, A.; AZOUZI, B.; DJILI, K.; MOHAMED, B.; ZEDEK, M. ; SAADI, R. Diversité floristique du massif du Nador en zone steppique (Tiaret, Algérie). **European Scientific Journal**, v. 11, n. 21, p. 401-419, 2015. <https://eujournal.org/index.php/esj/article/view/6008>
- BNEDR. Bureau National d'Études pour le Développement Rural. **Dernières Actualités du BNEDER**. 2008. <https://bneder.dz/#home>
- BOUCHAREB, B. **Suivi des actions de lutte contre la désertification: étude expérimentale et diachronique dans la commune de Hadj Mécheri (W. Laghouat)**. Thèse Doct. University of Science and Technology Houari Boumediene – USTHB, Alger, 2012.
- BRAUN-BLANQUET, J. **The plant communities of Mediterranean France**. Paris: C.N.R.S., 1951.
- CBD. Convention des Nations Unies sur La Diversité Biologique. **Sommet de la Terre à Rio de Janeiro (Brésil)**. 1992. <https://www.cbd.int/doc/legal/cbd-fr.pdf>
- CJBG. Conservatoire et Jardin Botaniques de Genève. **L'African Plant Database**. 2021. <https://www.cjbg.ch/science/nos-activites-scientifiques/flores-catalogues/flore-dafrique/africanplantdatabase>
- DAJOZ, R. **La biodiversité, l'avenir de la planète et de l'homme**. Paris: Ellipses, 2008, 269p.
- DGF/GEF/PNUD-ALG/00/G35/2005. **Conservation de la biodiversité et gestion durable des ressources naturelles en zones arides et semi-arides Algérie PNUD/FEM**. Agence d'Exécution et Supervision Générale par le Ministère de l'Agriculture et Mise en œuvre par les Organisations Non Gouvernementales, 2014
- DOBIGNARD, A.; CHATELAIN, C. **Index synonymique de la flore de l'Afrique du Nord**. 4th edition. Conservatoire et Jardin Botaniques de Genève, 2010-2013.
- EMBERGER, L. Une classification biogéographique des climats. **Recueil des Travaux de Botanique**, n. 7, p. 3-43, 1945.
- FLORET, C. PONTANIER, R. **L'aridité en Tunisie présaharienne. Climat, sol, végétation et aménagement**. Paris: Travaux et documents de l'O.R.S.T.O.M., 1982.
- GOUNOT, M. **Méthodes d'études quantitatives de la végétation**. Paris: Masson et Cie, 1969, 314p.
- HAMMADA, S. **Etudes sur la végétation des zones humides du Maroc - catalogue et analyse de la biodiversité floristique et identification des principaux groupements végétaux**. Thèse Doct. Université Mohammed, 2007.
- KADI HANIFI, H. **Diversité biologique et phytogéographique des formations à *Stipa Tenacissima* L. en Algérie**. Thèse Doct. University of Science and Technology Houari Boumediene – USTHB, Alger, 2003.
- LE HOUÉROU, H. N. **Bioclimatologie et biogéographie des steppes arides du Nord de l'Afrique: diversité biologique, développement durable et désertisation**. Montpellier, Paris. CIHEAM, 1995, 396p. (Options méditerranéennes. Série B, n. 10).
- LE HOUÉROU, H. N. The desert and arid zones of Northern Africa. In: EVENARI, M.; NOY-MEIR, E.; GOODALL, D. W. (Eds.). **Hot Deserts and Arid Shrublands, Ecosystems of the World**. Amsterdam: Elsevier, v. 11B, p. 101-147, 1986.
- LOISEL, R.; GOMILA, H. Traduction des effets du débroussaillage sur les écosystèmes forestiers et préforestiers par un indice de perturbation. **Annales de la Société des Sciences Naturelles et d'Archéologie de Toulon et du Var**, v. 45, n. 2, p. 123-132, 1993.
- MÉDAIL, F.; MYERS, N. Mediterranean Basin. In: MITTERMEIER, R. A.; GIL, P. R.; HOFFMANN, M.; PILGRIM, J.; BROOKS, T.; MITTERMEIER, C. G.; LAMOREUX, J.; FONSECA, G. A. B. (eds.). **Hotspots**

- revisited: Earth's biologically richest and most endangered terrestrial ecoregions.** CEMEX (Monterrey), Conservation International (Washington) & Agrupación Sierra Madre (Mexico), p. 144-147, 2004.
- MEKIDECHE, S.; BRAKCHI-OUAKOUR, L.; KADIK, L. Impact des perturbations anthropiques sur la diversité végétale de la subéraie de Chr  a, au nord de l'Alg  rie. **Bois & For  ts des Tropiques**, v. 337, p. 53-66, 2018. <https://doi.org/10.19182/bft2018.337.a31633>
- MYERS, N.; MITTERMEIER, R. A.; MITTERMEIER, C. G.; FONSECA, G. A. B.; KENT, J. Biodiversity hotspots for conservation priorities. **Nature**, v. 403, p. 853-858, 2000. <https://doi.org/10.1038/35002501>
- NEGADI, M.; HASSANI, A.; BOUNACUER, F.; AZZAOU, M. E. Etude de la diversit   floristique de la r  gion d'El Bayadh (Alg  rie): flore rare et menac  e. **Revue Ecologie-Environnement**, v. 10, p. 50-55, 2014. <https://www.researchgate.net/publication/344831665>
- OZENDA, P. **Botany**. Paris: CNRS, 1977, 622p.
- PAWT. Plan d'Am  nagement de la Wilaya Tiaret. **Pr  sentation du projet**. 2008.
- PIGNATTI, S. **Flora d'Italia**. Bologna: Edagricole, 1982.
- QUEZEL, P. Flore et v  g  tation actuelles de l'Afrique du nord, leur signification en fonction de l'origine, de l'involution et des migrations des flores et structures de v  g  tation pass  es. **Bothalia**, v. 14, n. 3-4, p. 411-416, 1983. <https://doi.org/10.4102/abc.v14i3/4.1186>
- QUEZEL, P.; SANTA, S. **Nouvelle flore de l'Alg  rie et des r  gions d  sertiques m  ridionales**. Paris: CNRS, v. 2, 1962-1963, 1170p.
- RAMADE, F. **Dictionnaire encyclop  dique des sciences de la nature et de la biodiversit  **. Paris: Ed. Dunod, 2008, 727p.
- RAUNKIAER, C. **The life form of plants and statistical plant geography**. Oxford: Clarendon Press, 1934, 632p.
- SIRVENT, L. **Les types biologiques: Etat de l'art, actualisation des d  finitions et mise en place d'un r  f  rentiel**. Conservatoire Botanique National M  diterran  en de Porquerolles, 2020, 64p.
- TILMAN, D. Causes, consequences and ethics of biodiversity. **Nature**, v. 405, p. 208-211, 2000. <https://doi.org/10.1038/35012217>
- TR  MOLIERES, M.; COMBROUX, I.; THI  BAUT, G.; HAURY, J. R  ponse des communaut  s v  g  tales aux conditions environnementales: perturbations ou contraintes. **Sciences Eaux & Territoires**, (Sp  cial Ing  nieries-EAT-25), p. 63-77, 2008. <https://revue-set.fr/article/view/6256>
- WILSON, E. O. **Biodiversity**. Washington, DC: The National Academy Press, 1988, 538p. <https://doi.org/10.17226/989>
- YAH, N.; BENHOUEH, S. Country reports (Algeria). In: RADFORD, E. A.; CATULLO, G.; MONTMOLLIN, B. (Eds.). **Important Plant Areas of the south and east Mediterranean region. Priority sites for conservation**. Gland, Switzerland and M  laga, Spain: IUCN, p. 27-30, 2011. <https://portals.iucn.org/library/sites/library/files/documents/2011-014.pdf>

Received on November 29, 2024

Returned for adjustments on May 26, 2025

Received with adjustments on June 18, 2025

Accepted on August 2, 2025