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Urban Natural Spaces as Laboratories for Learning and Social Awareness

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Abstract: Mediterranean areas contain a great diversity of flora and phytocenosis, due to the different substrates and the special Mediterranean climate, and it is in the Iberian Peninsula where the greatest diversity is concentrated. The need for didactic techniques that generate awareness and good learning results is considered of great relevance in order to obtain well-trained environmental managers. We proceed to the research on different phytosociological groups. The one with the largest number of associations or plant communities is the one located in nitrified environments near urban areas; the group of communities dominated by *Poa bulbosa* is of great interest for sheep farming, while, for equine and bovine farming, the communities rich in grasses and legumes that are located in rural environments rich in organic matter are of interest. The latter communities are also interesting because they act as a sink for CO_2. Due to the serious alterations in Mediterranean grasslands, we propose cultural, socio-educational, and socio-economic strategies to increase family income, thus avoiding the south–north migratory flow, as well as combining exploitation and conservation, and promoting sustainable development.

Keywords: botany; grazing; sustainability; teaching; environmental deterioration

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1. Introduction

Currently, within the teaching learning processes, active learning is being favored as the main focus, where the student researcher is responsible for the acquisition of knowledge [1]. However, the specific preparation of teachers on environmental matters at all levels should be a priority, taking into consideration the emergency caused by climate change. Unfortunately, in some countries, we are witnessing the elimination of botanical disciplines, with the consequent impoverishment of the basic preparation of future managers in the environmental field and of future natural science teachers and researchers from the last 20 years of the 20th century, there has been a decrease in the teaching of botany; in countries such as Spain, Portugal, Mexico, Cuba, and other countries in America, Asia, and Africa, the teaching of botany is somewhat diminished [2]. Another very important issue to take into consideration is local populations awareness of the biodiversity of their territories, which is in danger of being gradually lost due to neglect and ignorance [3].

This high floristic diversity of plant communities is a fundamental element in the differentiation between the Mediterranean and Central European temperate biogeographic regions, and has been highlighted in various types of ecological, phytosociological, agricultural, and livestock studies [4–7]. The main factors conditioning the diversity of both Mediterranean and Central European grasslands are soil type, bioclimate (thermoclimate

and ombroclimate), and anthropogenic and agricultural actions [8–11]. In Raunkiaer's classification, the dominant biotypes of grasslands and grass fields are therophytes, hemicryptophytes, and geophytes [12,13].

Taking into account the dominance of the biotypes, the substrate, and the anthropic and livestock activities, large groups of grassland communities have been described from the ecological and phytosociological perspectives.

In the Mediterranean, grasslands are dominated by annual terophytes, among which there are two groups: (1) those developed on soils lacking organic matter, which have a low biomass and consequently are of no interest for raising livestock; (2) those of a ruderal and anthropogenic character, which develop on soils rich in organic matter and subnitrophilic–nitrophilic grasslands with a high biomass, which can be used to rear livestock (bovine, equine).

High mountain pastures should also be taken into consideration for livestock or for conservation if the number of rare and/or endemic species is high.

All these groups present a great diversity of plant communities and have different points of interest for livestock [14]. The group of nitrophilic communities has a wide-ranging presence in ruderal environments. Due to the control mechanisms used for pastures, teaching on the management of the species that make up these communities has been established in universities, with studies on malerbology, their use, and their conservation [15]. Something similar occurred with the study and teaching of grasslands dominated by *Poa bulbosa*, which are of high socioeconomic interest in the Mediterranean as they can support sheep farming [16].

This work aims to propose methods for the use and conservation of grass diversity; To achieve this, several strategies are presented, such as the proposal to provide teaching on pastures in universities, and livestock planning regarding the use of Mediterranean pastures.

The grasslands of the Mediterranean region constitute habitats of interest for the EU. According to the Habitats Directive [17], these grasslands are included in territories containing open spaces, including holm oaks, cork oaks, gall oaks, and oaks, and even in agricultural crops. The diversity of substrates in the Mediterranean basin is a triggering factor for the diversity of species, substrates that range from poor soils of an oligotrophic siliceous nature, obtained from Paleozoic slates, quartzites, granites, and diorites, to rich eutrophic soils obtained from limestone rocks, marbles, dolomites, serpentines, and gypsum. This diversity of substrates, together with the presence of all ombroclimates (ranging from arid to hyperhumid) and thermoclimates (ranging from infra-Mediterranean to cryo-Mediterranean in high mountains), is the cause of the high floristic and phytocenotic diversity.

The classification established by Rivas-Martínez et al. [18] and other studies by these and other authors reveal the floristic diversity of the territories [19–22]. This has allowed for researchers to understand these habitats with some precision, with Professor Rivas Gooday being a pioneer in these studies, as well as Professor Rivas-Martínez [23,24]. Subsequently, a series of investigations emerged, focusing on both a description of the habitats and their management and conservation status. The interest aroused by knowledge of Mediterranean grasslands is due to their high socioeconomic and cultural value.

As a consequence of the different ecosystem services they provide, the diversity of plant associations or communities in each phytosociological group, their distribution, and their agricultural and livestock uses, as well as the conservation status of these associations, these grasslands were chosen for study. These are grasslands of interest for extensive and tabulated livestock farming due to their nutritional value [25–31] because they have a floristic composition rich in grasses and legumes.

Cano-Ortiz and collaborators [32] recently studied a section of grasslands dominated by *Hordeum leporinum* in the Mediterranean, and established the floristic differences between the associations studied in Spain, Portugal, and Italy.

Different communities were included by Rivas-Martínez in a broad phytosociological group of grasslands of the class *Stellarietea mediae*, with different edaphic characteristics. The holarctic distribution class group is very well-represented in the Mediterranean and represents a high number of subnitrophilic–nitrophilic grassland communities located in both basic and acidic pH soils.

The fundamental factor that determines the presence of this group are the nitrogen and organic matter content of the soil, which can obtained by studies related to livestock pressure. This group is also frequently found in agricultural environments, where cultivation techniques such as tillage and fertilization lead to the presence of different types of grasslands. However, pure or non-nitrified grasslands that develop in both basic and acid substrates have no organic matter or nitrogen requirements and are pioneer grasslands, from which the rest of the therophyte grasslands are obtained. Several grasslands of this group belong to habitats prioritized by the EU, with the codes 6220 and 2230 [20]. A priori, we can name two groups, one dominated by therophytes and the other by hemicryptophytes, which both have communities included in habitat 6220.

Communities dominated by hemicryptophytes are important to avoid erosive phenomena and contain rare and endemic species. However, those dominated by *Poa bulbosa*, have a strong representation in the Mediterranean, and especially in the Iberian Peninsula, where they are mainly of interest regarding livestock use. These grasslands are dominated by grasses and legumes, *Poa bulbosa*, and *Trifolium subterraneum*, which are included in habitat 6220 and widely distributed in Spanish dehesas and Portuguese montados on pastures that serve as food for sheep. This means that socioeconomic interest in these grasslands is high.

Festuca indigesta grasses frequently appear in the siliceous areas of high Mediterranean mountains. More rarely, in these same high mountain areas, due to specific environmental conditions, humid pastures of *Nardus stricta* can be found, whose southernmost distribution area in the Mediterranean reaches the Sierra Nevada (Spain). Both types of grasses have been used for grazing and sometimes still are; however, they are not suitable for grazing as the hard grasses of *Festuca indigesta* are not desired by livestock and the wet grasses have a high index of endemic species and therefore must be preserved.

The grasslands dominated by *Stipa gigantea* and *Agrostis castellana* appear relatively frequently on siliceous substrates; the reed–grasslands of wetlands present in streams and rivers are habitats of conservation interest, although in the summer season they are used for livestock feed.

Based on the importance of diverse grasslands as drivers of sustainable development, we proceed to investigate the high diversity of these Mediterranean grasslands using the phytosociological method. The objective of this work is to review the current status of some Mediterranean grasslands, along with their diversity, conservation status, and exploitation, as well as sustainability proposals and socio-educational and socio-economic strategies in Mediterranean countries to promote sustainability and development.

2. Materials and Methods

This work is based on the study of various Mediterranean grasslands in Andalusia (Spain). According to their biotype, we establish two large groups: therophytes and hemicryptophytes. Within the group of therophytes, we differentiate two subgroups according to the content of organic matter in the soil: those that are located in nitrified soils and those that are pure or non-nitrified. Although most achieve optimum growth in the Mediterranean region, some are found in European temperate zones.

In this study, ecological and phytosociological research is undertaken, as well as field practice by young researchers. The students constituted a heterogeneous group with little or no botanical knowledge, whose previous educational level was that of graduates and engineers. These students were young people who had studied the following subjects: Bioindicators and Vegetative Covers, and Plantation Design and Cultivation Techniques,

included in the double Master's Olive Tree and Olive Oil, and Secondary Education Teaching. Their age ranged between 22 and 25 years.

Using these methodologies, we proceeded to study groups of grassland and herbaceous communities, which have been studied by different authors and by our own research, and review the current status of the different types of grassland–herbaceous areas.

Grasslands and grassland–herbaceous areas have been studied in several works by Rivas-Martínez [18,20–22]; some of these grasslands have been prioritized by the EU and granted a conservation status in order to maintain the sustainability of the habitat. We analyzed the greater or lesser diversity of the associations or communities in each of the large groups as a consequence of the abuse of herbicides and the use of diverse cultivation techniques. For this, we used the same plots that were sampled in 2005 and 2018 to see the human influence and establish which areas need protection measures.

To determine which species disappeared or decreased in abundance from 2005 to 2018, we used the phytosociological importance value, the Importance Value Index (IVI) = A% (relative abundance) + Dom% (relative dominance) + Frec% (relative frequency), an index that is widely used in forest ecosystems. In this context, we studied the plant covers belonging to the subnitrophilic–nitrophilic grasslands in terms of their floristic composition, the influence of chemical agents on species, the decline and loss of species, and proposed corrective measures.

In a similar way, we studied the grazing lands dominated by *Poa bulbosa*, *Trifolium subterraneum*, *Biserrula pelecinus*, and *Astragalus sesameus*, which are important in the feeding of sheep. The management proposals focus on different socio-educational and economic strategies that promote sustainable development. To achieve these research goals, we transferred our learning models to outside the classroom and used class time, together with the teacher's experience, to facilitate and promote other processes of acquiring and implementing knowledge [33–35].

Through this methodology, learning was transferred out of the classroom to the field. In this way, students were able to learn, through their own experience, not only how to recognize plant communities, but also the interrelationship between them and their conservation status.

In the months of April and May of the years 2005 and 2018, several experimental plots were selected, located in the Guadalquivir valley, Andalusia, Spain, used for olive grove cultivation. Some plots were subjected to the action of herbicides for 13 years, others had no herbicide application, and others were used as feed for livestock in Sierra Morena (Spain). The plots were studied for three years by a group of Geobotany researchers, together with the professor, who taught the students to carry out phytosociological inventories. In this way, the students learned, for example, how to select the minimum surface area in which there is maximum floristic diversity, calculate the vegetation cover in %, measure the average height of the dominant vegetation, measure the orientation and inclination of the plot, and obtain a list of the existing flora, along with the abundance–dominance of each species. These data can be used to study the floristic diversity and calculate the biovolume (Bv = S. hm. Cm) of the sampling plots and the amount of CO_2 that is absorbed, as well as to determine the area's importance in livestock farming and establish the livestock load.

Regarding the socioeconomic analysis, we used an ecosystem services valuation [36–40], which takes into account the value of pastures as CO_2 sinks, pastures that prevent erosion, and the valuation of pastures' ability to obtain a sustainable livestock herd.

3. Results

As a result of this learning through active methodologies, the students observed and interpreted different grassland communities, such as subnitrophilous–nitrophilous plant communities, distributed throughout the Mediterranean basin, which develop on both basic and acidic substrates. Taking into account the environmental factors that condition their presence, we established two groups: those communities that developed on soils whose organic content may be of animal origin, in which there is a predominance of grasses,

legumes, and composites, and a second group, found in rural environments and established due to cultivation techniques, such as tillage, semi-till, no tillage, fertilization, and the use of herbicides.

In the plots not treated with herbicides, we highlight the pastures dominated by *Taeniatherum caput-medusae*, *Aegilops geniculata*, *Aegilops neglecta*, *Medicago arabica*, and *Medicago polymorpha*, pastures in which 50% of grass species coexist with leguminous species. Accordingly, these pastures hold interest for horse and cattle breeding. On the other hand, pastures dominated by *Hordeum leporinum*, *Bromus rubens*, *Bromus diandrus*, *Bromus fasciculatus*, and *Bromus hordeaceus*, although still of interest for livestock farming, have a lower legume content than the previous pastures, which have been widely studied in the Mediterranean by Cano-Ortiz.

According to our research, *Hordeum leporinum* grasslands have a high biomass and a high biovolume (Bv), which is why they are of great interest as CO_2 sinks. Considering the degree of coverage, the incorporation of CO_2 is as follows: Bv100 = 0.35 = 3250 gr C/m^2; Bv75 = 0.26 = 2414.2 gr C/m^2; Bv50 = 0.17 = 1578.5 gr C/m^2; Bv25 = 0.08 = 812.5 gr C/m^2. For this reason, we maintain that *Hordeum leporinum* communities absorb 32.5 tons/hectare per year for 100% coverage (Table 1).

Table 1. Biovolume values obtained from the minimum surface area of 1 m, with vegetation coverage of 100, 75, 50, and 25%, an average height of the dominant species of 35 cm, and CO_2 absorption values per year.

	Biovolume	**gr·CO_2/year**
Bv100	0.35	3250.0
Bv75	0.26	2414.2
Bv50	0.17	1578.5
Bv25	0.08	812.5

Some authors set the economic cost of planting grasses and legumes at 116 USD/ha, with a cost of 570 USD/ha for pasture fencing, and 225 USD/ha for meadows, although it is not specified which species constitute the plant community. The *Hordeum leporinum* and *Poa bulbosa* grasslands sampled by us have a minimum surface area of 1 m^2, with the abundance of the dominant species ranging between 60 and 100% coverage. The average height of the dominant species *Hordeum leporinum* is 35 cm, and that of *Poa bulbosa* is 15–20 cm. Field data are essential to evaluate ecosystem services.

Pure, non-nitrified grasslands, also called starvation grasslands, cannot be used by livestock due to their low nutritional value, with some such areas having conservation importance. A total of 102 grassland communities belong to the phytosociological group of humble therophytes, which shows the high diversity that exists in Mediterranean territories. Of the mentioned grasslands, there are only two large groups of interest, due to their capacity for transformation into other grasslands that are richer in species and of interest for livestock. These groups are those developed on siliceous and basic substrates.

The *Hordeum leporinum* communities that developed on basic substrates and on acid substrates have has a significant change in their abundance values. A characteristic species of the community, despite of being a generalist, edaphic, indifferent species, has been highly affected. The disappearance of *Malva neglecta*, abother species with a certain generalist character, but with greater edaphic requirements and a greater need for oxidizable organic matter (OOM), as well as the appearance of *Diplotaxis virgata* and *Papaver rhoeas*, suggests that the cultivation technique that most influenced this transformation is the loss of organic matter and the increase in tillage.

The *Hordeum leporinum* community that developed on siliceous substrates has undergone a smaller transformation as a consequence of the significant decrease in *Hordeum leporinum*; in this case, the decrease is more than 50%. The disappearance of *Cynara humilis*, a species whose optimal habitat is siliceous substrates and not disturbed soils, together with the significant increase in *Raphanus raphanistrum*, suggests that the cultivation technique

that most influenced the transformation is the loss of organic matter and the increase in tillage.

The *Taeniatherum caput-medusae* grassland has also suffered a slight decrease in abundance. However, no transformation is observed, since the species that disappeared are not important for this association, although the decrease in *Bromus hordeaceus* is of some importance, since it indicates a small decrease in the OOM. Pure, non-nitrified grassland has a tendency towards becoming subnitrophilic grassland containing *Trifolium cherleri* and *Taeniatherum caput-medusae* as the abundance of *Plantago bellardii* and *Xolantha guttata* decreases and the abundance of *Taeniatherum caput-medusae* increases. No anthropogenic influence was observed in this community.

The influence of humans and livestock has caused a change in the floristic diversity of the *Poa bulbosa* and *Hordeum leporinum* communities (Table 2). In the diversity analysis, according to the species importance value, all communities sampled in 2018 decreased by 52.69% compared to 2005, implying a loss of diversity mainly due to the use of different agricultural techniques. The most aggressive techniques are those using pre- and post-emergent herbicides.

Table 2. Changes in the Importance Value Index (IVI) of subnitrophilic–nitrophilic species and non-nitrified grasses.

Importance Value Index	**IVI-2005**	**IVI-2018**
Hordeum leprinum (basic substrates)	82	11
Plantago lagopus	4.92	11.26
Vulpia geniculata	1.56	6.05
Avena sterilis	2.27	6.63
Hordeum leporinum (acidic substrates)	79.78	31.58
Trifolium cherleri	10.24	20.91
Echium plantagineum	4.7	23.58
Bromus hordeaceus	30.31	4.68
Taeniatherum caput-medusae	30.91	25.60
Plantago bellardii	42.35	12.08
Xolantha guttata	27.89	23.61
Hypochaeris achyrophorus	12.19	2.58

Grasslands dominated by hemicryptophytes with a lower presence of therophytes are less abundant and have less livestock interest; however, within this group in Mediterranean areas, there are grasslands dominated by *Brachypodium phoenicoides,* which are of some interest, although to a lesser extent than the other groups. This large group of Hemicryptophytes includes temperate grasslands with abundant *Bromus erectus*, grasslands that support extensive livestock farming.

The high Mediterranean siliceous mountains are dominated by *Festuca* species. These communities are of no interest for livestock farming because they are not very palatable for cattle; however, they are of interest for conservation because of their high index of endemic species. All these communities are included in the group dominated by *Festuca indigesta,* which contains a total of 33 different communities (*Fetucetea indigestae*).

Poa bulbosa pastures developed on acid and basic substrates, although of little interest as CO_2 sinks due to their low biomass, have a high nutritional value for sheep farming., meaning that their socio-cultural and socio-economic importance is very high. However, the rest of the studied grasslands (Table 3) are of interest either as CO_2 sinks or as habitats of EU interest.

Table 3. Syntaxa of interest for livestock and ecosystem services.

	Dominant Species	**Type of Livestock**	**Endemic Species**	**Factors That Cause Transformation**	**Sustainability Proposals**
Cl. Stellarietea mediae					
All. Taeniathero-Aegilopion geniculatae	*Aegilops geniculata*, *A. neglecta*, *Aegilops triuncialis*, *Taeniatherum caput-medusae*	Equine and Bovine	Low rate of endemism	Excessive livestock pressure Anthropogenic action	Natural roof maintenance No use of herbicides Use of covers as an ecosystem service
All. Hordeion leporini	*Hordeum murinum* subsp. *leporinum*, *Anacyclus clavatus*, *A. radiatus*, *Bromus scoparius*, *Bromus diandrus*, *Plaantago lagopus*	Equine and Bovine	Low rate of endemism	Excessive livestock pressure Anthropogenic action Use of herbicides	Natural roof maintenance No use of herbicides Use of covers as an ecosystem service
Cl. Poetea bulbosae					
All. Periballio-Trifolion subterranei	*Trifolium subterraneum*, *T. gemelum*, *T. glomeratum*, *Poa bulbosa*	Ovine	Low rate of endemism	Excessive livestock pressure	Establish livestock load capacity
All. Astragalo sesamei-Poion bulbosae	*Astragalus echinatus*, *A. sesameus*, *A. stella*, *A. epiglotis*, *Poa bulbosa*	Ovine	Low rate of endemism	Excessive livestock pressure	Establish livestock load capacity
Cl. Molinio-Arrhenatheretea	*Arrhenatherum elatius* subsp. *bulbosum*, *Lotus corniculatus*, *Poa pratensis*, *Plantago lanceolata*, *Scirpus holoschoenus*	Equine and Bovine	Average rate of endemism	Excessive livestock pressure Anthropogenic action	Establish livestock load capacity
Cl. Stipo giganteae-Agrostietea castellanae	*Agrostis castellana*, *Stipa gigantea*, *Festuca ampla*, *Festuca elegans*, *Dactylis hispánica* subsp. *lusitanica*	Equine and Bovine	Average rate of endemism	Excessive livestock pressure	Establish livestock load capacity
Cl. Lygeo-Stipetea	*Macrochloa tenacissima*, *Lygeum spartum*, *Brachypodium retusum*, *Sipa capillata*, *Bituminaria bituminosa*, *Stipa barbata*, *Festuca scariosa*, *Hyparrhenia hirta*, *H. sinaica*	Without livestock interest	Average rate of endemism	Excessive livestock pressure Anthropogenic action	Habitats dedicated to preventing erosion
Cl. Festucetea indigestae	*Jurinea humilis*, *Koeleria caudata* subsp. *crassipes*, *Leucanthemopsis pallida* subsp. *alpina* and subsp. *pallida*, *Plantago radicata.*	Without livestock interest	High rate of endemism	Excessive livestock pressure Anthropogenic action	Habitats dedicated to conservation

4. Discussion

In the Iberian Peninsula, grasslands are represented by different types, of which the grasslands of *Poa bulbosa*, *Trifolium subterraneum*, and *Biserrula pelecinus*, located on siliceous soils, and the grasslands of *Poa bulbosa* and *Astragalus sesameus*, located on basic substrates, are the basis of the diet of sheep. In the case of communities dominated by *Poa bulbosa*, due to their lower biomass, the amount of CO_2 that is absorbed is lower, but they have a high ecosystem value for the population, since high-quality livestock products are obtained. In

the case of sheep, the coefficient of 0.15 is applied to transform the UGM; that is, 25 sheep are equivalent to 3.75 UGM/ha.

The grasses *Macrocholoa tenacissima*, *Lygeum spartum*, *Festuca scariosa*, *Brachypodium retusum*, *Hyparrhenia hirta*, and *Stipa parviflora* (*Lygeo-Stipetea tenacissimae*) constitute a large group of hemicryptophytes that undergo optimum development in the basic substrates and semi-arid–dry environments of the Iberian Peninsula and North Africa. Some of these species, such as *Macrocholoa tenacissima*, have not reached Italy, Greece, and the Mediterranean islands, since there have been no migratory routes for this purpose. This group dominates in arid, semi-arid, and dry environments of the Mediterranean basin, without livestock interest, and develops on basic substrates, limestone, dolomites, and gypsum. In some cases, the group is of interest, as it can prevent erosion and may also contain endemic elements.

The hemicryptophyte grasslands located in the siliceous mountains are dominated by *Agrostis castellana* and *Stipa gigantea* (*Stipo giganteae-Agrostietea castellanae*); these are tall communities with a large biomass and are of interest both for equine and bovine livestock farming and their ability to act as a CO_2 sink.

The grassland–herbaceous–juncals (*Molinio-Arrhenatheretea*) of humid and waterlogged areas are very frequent in temperate climates, and in the Mediterranean they represent wetlands of interest for livestock farming; these are communities of high floristic diversity, which has led to the differentiation of up to 119 associations or plant communities. The pastoral value of temperate communities is high, and they help to maintain an important livestock population in Europe. In Mediterranean areas, these communities have less value but are important due to their use for nesting birds. Therefore, Mediterranean wetlands are protected by the EU and by the laws of different countries (Figure 1).

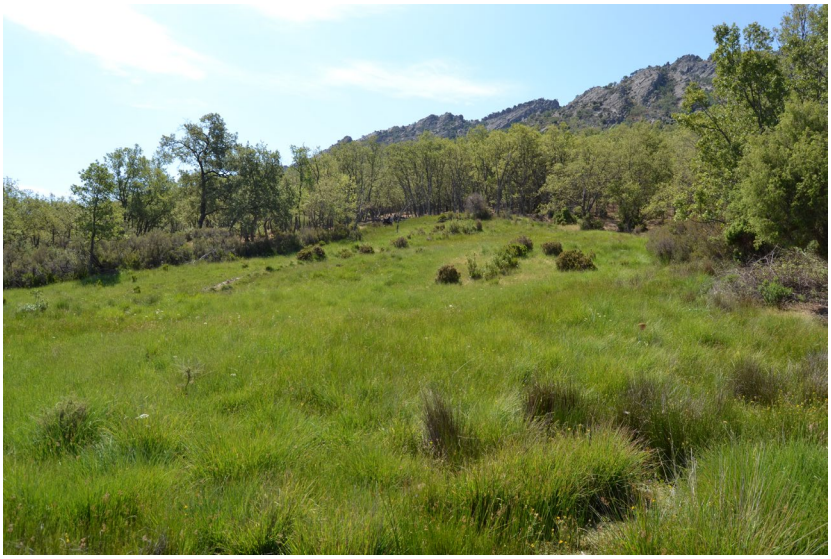

Figure 1. Grasslands–juncals of *Molinio-Arrhenateretea* (habitat located in Sierra Morena, Andalusia).

Finally, the borreguiles are high, mountainous, wet grasslands characterized by a dominance of *Nardus stricta*, in which 33 different types are included. Although they are grazed in both temperate and Mediterranean territories, they should not be subjected to livestock pressure as they are included in the habitats prioritized by the EU 6110 due to their rarity in Mediterranean areas, and the rare or endemic species included in their flora. In Spain, the southernmost area reached by this class is the Sierra Nevada, a temperate optimum area that reaches the Mediterranean. However, in the specific case of the Sierra Nevada, these communities are threatened by excessive tourism.

The diversity of Mediterranean grasslands and herbaceous environments is undeniable in scientific research, both from the ecological and phytosociological perspectives. The current state of knowledge regarding these areas is high, especially with regard to the

Iberian Peninsula [18]. Nitrified grass communities constitute a very diverse group with a wide distribution in the Holarctic territories, especially in the Mediterranean. To date, 15 large groups have been described, which include 164 plant communities were originally established due to the influence of urban areas.

However, at the institutional level, there is no favorable management for the sustainable development of these pastures, despite the existence of associations dedicated to this purpose, such as the Spanish Society for the Study of Pastures (SEEP). This is due to the lack of support from Governmental Institutions. Attention is only paid to pastures at the level of universities and research institutes.

Natural pastures provide food for livestock, which can represent a large part of a country's economy. There are essentially three types of livestock that are of interest: cattle, horses, and sheep.

Although there should be a correlation between the type of pasture and the type of livestock, this is not always the case. This is due to the loss of knowledge passed from parents to children and the lack of teaching of these concepts. In addition, variations in palatability, the nutritional value of the pasture, the structure of the constituent flora of the pasture, and the type of animal that grazes it are fundamental; for example, the biodiverse communities dominated by *Hordeum leporinum*, *Taeniatherum caput-medusae*, *Aegilops geniculata*, and *Aegilops negligencia*, with a notable biovolume, are suitable for cattle and horses, but not for sheep, due to their high biovolume (Figure 2).

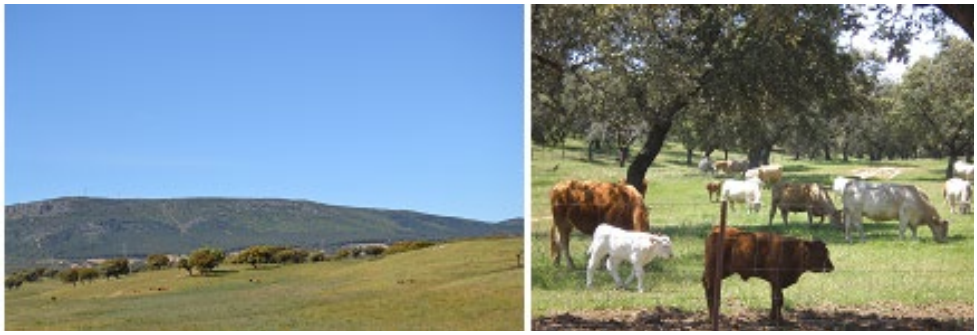

Figure 2. *Taeniathero-Aegilopion geniculatae* and *Hordeion leporini* grasslands with cattle (pastures located in eastern Sierra Morena, province of Ciudad Real).

On the other hand, *Poa bulbosa* pastures are suitable for sheep, but not for cattle and horses, since this type of livestock needs a pasture with a higher biomass and these animals destroy the *Poa bulbosa* communities due to their heavy weight. These communities are of extraordinary interest for sheep farming and are a source of various ecosystem services, including the dairy industry, with Spain and Portugal being leaders in this type of industry. *Poa bulbosa* communities are widespread throughout the Mediterranean; they are very suitable communities for sheep due to their palatability and nutritional richness, with a percentage of legumes higher than 50% [41]. Consequently, a form management in which each type of pasture corresponds to a type of livestock is necessary; this would allow for sustainable development.

This type of management is not usually in place; the most common form of management is rotational grazing and the planting of species to provide supplementary feed in unfavorable seasons.

In this practical study, the correlation between type of pasture and type of livestock was carefully observed, and the following form of livestock planning is proposed: (1) higher-biomass pastures should be used by cattle and horses; (2) low-biomass pastures (*Poetea bulbosae* community) should be used for sheep. The type of practical field work used in this study enables young people to acquire knowledge, which allows them to develop the competencies, skills, and abilities to sustainably manage pastures and livestock (Figure 3).

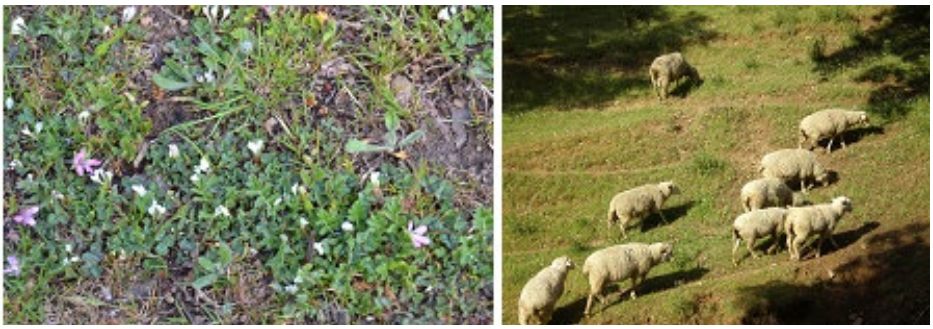

Figure 3. *Poetea bulbosae* grassland used for sheep grazing (pastures located in Sierra Morena, province of Ciudad Real).

Subnitrophilic–nitrophilic grasslands have a high ecosystemic value; however, they are rarely use or not used by the population, possibly due to a lack of knowledge or because communities have been taught that they are weeds. This has led to the use of herbicides in agriculture, and the application of inadequate cultivation techniques that damage the flora. However, there are studies on bioindicators of nutrients in the soil, which should guide the sustainable management of these grasslands [42–44].

The European Commission states in its communiqué 2021 that annual economic losses due to extreme events due to climate change are higher than 12 billion/year. This commission is committed to promoting local, individual, and equitable resilience, with this providing the cornerstone for adaptation to climate change. To achieve this goal, the EU has increased the European structural and investment funds [39]. Using this funding mechanism, action should be taken at the individual and local levels, noting the economic value of land covered with vegetation, and providing farmers with an economic incentive to maintain hectares covered with grass [40]. This could help farmers to avoid or reduce the herbicide bill, which has greatly increased between 2010 and 2019 [45].

Consequently, grasslands are of great interest as CO_2 sinks [46–51], as erosion-preventive elements, and as edaphic indicators of nutrients. Therefore, their protection and development are important, and the research and learning of university students, who serve as their future managers, is essential.

Hordeum leporinum grasses with 100% cover have a CO_2 absorption$_2$ of 32.5 tons/ha. This type of natural pasture is similar to the sowing of grasses and legumes, so an economic incentive of 170.5 USD/ha could be granted to the landowner. In addition, these pastures have a high livestock value, hence their ecosystemic character. According to the latest European regulation (EC Regulation No. 1200/2009), the LU livestock units are established on the basis of a dairy cow, with the following equivalence: 1 dairy cow = 1.25 non-dairy cows = 1.25 horses = 10 sheep = 10 goats.

However, this regulation does not take into account the type of pasture. The Ministry of Agriculture in Spain sets the stocking rate at 1.8 cows/ha, and to obtain a balanced development it is mandatory to maintain a minimum stocking rate equal to or greater than 0.1 Major Load Unit (MLU)/ha, except in cases of slopes greater than 20%, where lower stocking rates can be established.

The field study shows that Mediterranean grasslands are dominated by annual and perennial plants (therophytes and hemicryptophytes) [52–54], in which species of the families Poaceae, Fabaceae, Brassicaceae, and Asteraceae dominate. The nutritional value of the grasses lies in the first two botanical families. Therefore, we propose a strategy to encourage extensive grazing. If this is not possible, it is essential to practice mowing and transform grasses into hay for tabulated cattle. To achieve this, it is essential not to eliminate the vegetation cover using herbicides. These vegetation covers provide various ecosystem services, as they act as CO_2 sinks.

Another strategy is to raise social awareness of the usefulness of vegetation covers; to this end, it is necessary to promote public knowledge about grasslands. It is of interest to

transmit knowledge from parents to children, and to modify the contents of training centers and universities. In the specific case of Spain, only in some Higher Schools of University Education is the subject of Malerbology taught, which aims to teach students about what have been called crop weeds.

In view of this situation, it is necessary for governmental institutions to promote environmental issues in educational centers [55]. In the case of Spain, the BOE No. 5 of 5 January 2007, includes the Royal Decree 1631/2006 of 29 December 2006, which establishes the minimum teachings. This Royal Decree mentions the need for teaching to include content regarding the environment, pollution, and water resources, providing students with competences in their knowledge of and interactions with the physical environment, as well as in mathematics and linguistics. These are clearly insufficient regulations, since linguistic competence refers to the Spanish language, without taking into account scientific terminology, meaning that students do not acquire competences with respect to the current profound environmental changes.

More recently, the BOE No. 3 of 3 January 2015, established the basic teachings in Compulsory Secondary Education (ESO) and the Baccalaureate. Although the contents of Biology and Geology lessons are dealt with in some depth, no reference is made to serious environmental problems, such as climate change and biodiversity losses [56,57]. It is essential that all institutions, both public and private, undertake education and teaching on extreme natural phenomena, such as climate change, its causes and consequences, and the loss of biological diversity due to the excessive use of chemicals.

5. Conclusions

The current analysis of pastures and herbaceous lands allows us to affirm that there is a deterioration in these areas due to the excessive use of herbicides, whose use has multiplied in the last 10 years. The loss of floristic diversity and plant cover is worrying, since it entails losses of soil and water, causing strong economic losses due to low levels agricultural production, and leading social conflicts that are difficult to solve and consequent the increases in the migration of people from the areas most affected by climate change to the least affected areas. A chain of events is thus established, which begins with environmental pollution, the increase in CO_2, and the loss of vegetation cover that could act as a CO_2 sink. Climate change could be alleviated by reducing the decrease in water and soil resources, and these economic resources would consequently be maintained. The population's lack of training in this area is promoting these phenomena, so teaching on up-to-date environmental issues is essential. This situation can be mitigated through the training and increased awareness of rural populations. This implies the cultural, economic, and social development of said populations and positive valuation of rural environments instead of undervaluing them, in addition to environments close to urban areas that offer positive services for the population.

The use of active methodologies to teach complex concepts generates a better assimilation and understanding of these concepts. To this end, it is useful to use urban peripheral areas as laboratories to improve social knowledge about natural resources.

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