Chapter 2

Changes in Land Management of Iberian Rangelands and Grasslands in the Last 60 Years and their Effect on Vegetation

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http://dx.doi.org/10.5772/intechopen.72490

Abstract

Rangelands and grasslands occupy now more than 3 million ha in the Iberian Peninsula representing one of the most valuable ecosystems. They are particularly interesting due to their great geographical spread and heterogeneity in land management. Significant changes have been undergone in the last 60 years affecting vegetation. The main goal in this study was to compile existing information about the changes in the Iberian rangelands and grasslands, their geographical distribution, typologies, main characteristics as well as past and recent land management based on a thorough bibliographical review and serious research. This has been subdivided into five large groups according to climate and human drivers: (1) Mediterranean rangelands and steppes, (2) oceanic grasslands, (3) mountainous meadows, (4) semi-arid steppes and (5) Portuguese rangelands and grasslands. Two milestones over the past 60 years were remarkable as main driving forces: rural exodus in the 1960s and 1970s and Spain and Portugal joining the European Union in 1986. They have provoked both processes of intensification and extensification at the same time on different scales. Many farms have been progressively fragmented using wire fences, and the numbers of livestock have been significantly increased. Land abandonment and grazing exclusion have provoked a large shrub encroachment of species such as *Retama sphaerocarpa* or *Cistus ladanifer*.

Keywords: EU subsidies, fencing, grazing, land abandonment, shrub encroachment

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1. Introduction

A long period of time has passed since the Latin geographer Strabo in his book *Geographiké* described how Roman Hispania could be crossed by a squirrel jumping from tree to tree from north to south [1]. Many centuries of intense human activity have led to the progressive reduction of this original dense forest converted into agricultural land, grazing areas or settlement of the current cities [2]. Of particular interest are those lands that have been progressively cleared aiming to obtain pastures, either by removing all the trees (grasslands) or by combining scattered trees with the management of a productive herbaceous layer (rangelands), to feed domestic animals [3].

These rangelands, called *dehesas* in Spanish and *montados* in Portuguese, occupy more than 2 million ha in the southwestern part of the Iberian Peninsula (this value can vary depending on the author consulted). They represent one of the most valuable ecosystems for both countries (Spain and Portugal) for different reasons: biodiversity, meat production, landscape, preservation of traditional values and rural population fixation [4]. Grasslands are also very important in terms of the area they occupy (more than 1 million ha in size), but above all they are particularly interesting due to their great geographical spread and heterogeneity in land management [5].

The origin of these grasslands is probably the same for the better-known rangelands (dehesas and montados): the clearing of the former Mediterranean forest in order to obtain pasture for livestock, dominated by Quercus genus species: holm and cork oak. López Sáez et al. [6] attribute a prehistoric origin to this type of practice, but it is not until the reconquest of the territory under Arab domination by the Christian kingdoms (Portugal, Leon, Castile and Aragon) in the Middle Ages (1212–1492) that the current landscape of the Iberian rangelands and grasslands begin to take shape [7]. However, Llorente Pinto [8] dates the origin of these land systems to the eighteenth century.

Although the northern part of the Iberian Peninsula, dominated by an oceanic climate type [9], and those regions located close to the Mediterranean Sea have experienced the same process of clearing of the original forest, land management has been historically different in these areas [10], and in Portugal as well [11], due to many factors such as climate, topography or land tenure. Nevertheless, the most significant changes in land management have been undergone over the past 60 years when some areas of Portugal and Spain began an economic process of industrialization [12] and the rules of the European Union (EU) Common Agricultural Policy (CAP) came into effect [13].

This study aims at compiling further much-needed information about Iberian rangelands and grasslands: geographical distribution, typologies and their main characteristics. Finally, past and recent land management has been analysed based on a thorough bibliographical review and serious research in order to better understand how these changes have affected vegetation (e.g., composition, structure or species) on a landscape scale.

2. Geographical distribution

Figure 1 shows the geographical distribution of grasslands throughout the Iberian Peninsula. They are distributed in soils developed on different rock types: siliceous (slate and granite),

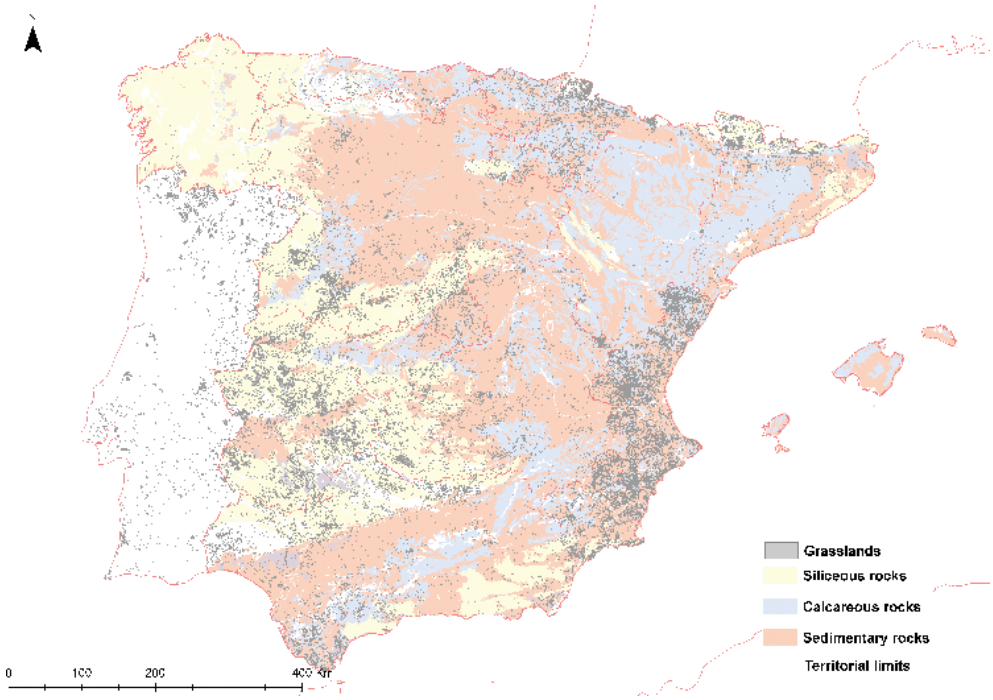

Figure 1. Distribution of grasslands in the Iberian peninsula. Data source: IGME [14], IGN [15] and CLC [16].

calcareous (limestone and dolomite) and tertiary sediments [14]. From a political point of view, the presence of grasslands is a common feature in most of the 15 autonomous regions into which peninsular Spain is divided, being particularly important in regions such as Valencia and Murcia (East) and Extremadura (West) [15]. In Portugal, around 175,000 ha of grasslands are disseminated throughout the country being mostly concentrated in the northern and western parts along the Spanish border [16].

3. Types of rangelands and grasslands

Iberian rangelands and grasslands are mostly represented by annual species, in areas thought to have been historically dominated by perennial forms, mainly as a consequence of the seasonality of rainfall [17]. The diversity of climate types (updated classification by Köppen-Geiger) is the first criterion that explains the existing differences between rangelands and grasslands in this region. Broadly speaking, the southern half of the Iberian Peninsula is dominated by a Mediterranean climate (Csa) with dry and warm summers, the northern half by a Mediterranean oceanic climate (Csb) with milder summers, mountainous areas with oceanic climate (Cfb) and SE Spain with a semi-arid climate (Bsh) [18] (**Figure 2**).

The description of Spanish rangelands and grasslands and their management is therefore divided into 4 groups: (3.1.) Mediterranean rangelands and steppes, (3.2.) oceanic grasslands,

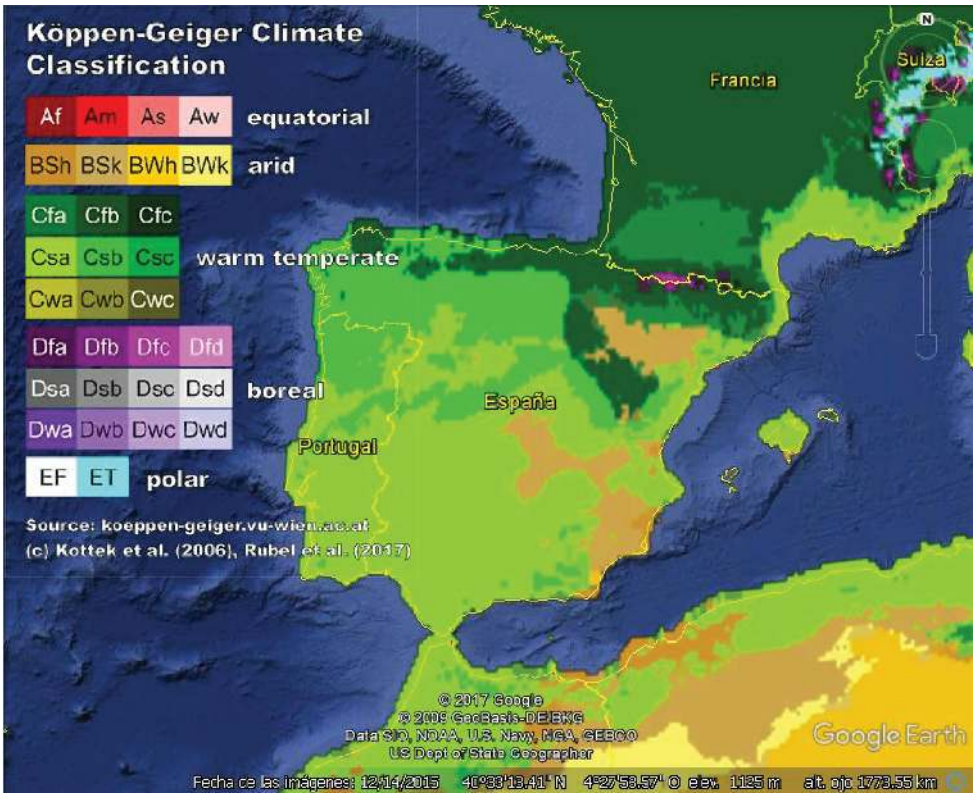

Figure 2. Köppen-Geiger's updated climate classification of the Iberian peninsula. Source: [18].

(3.3.) mountainous meadows and (3.4.) semi-arid steppes. (3.5.) Portuguese rangelands and grasslands are treated as a separated group. Relevant information of their land management (past and present) as well as of their vegetation features (including illustrative pictures) of each case is provided in the next sub-chapters.

3.1. Mediterranean rangelands and steppes

Mediterranean grasslands in Spain are a consequence of a more advanced state of tree degradation than in rangelands (dehesas). They have arisen due to a total deforestation in order to obtain croplands for cereal cultivation at some point in history. In Spain, tree clearing has been constant since the Middle Ages, but there is evidence that both the nineteenth and twentieth centuries were the periods of highest intensity. The confiscation of land owned by the Catholic Church (1798–1856), economic consequences of the Spanish Civil War (1936–1939) and a doubling in population (1860–1890) were the main driving forces [19].

Dehesas (**Figure 3** left) occupy more than two million ha in SW Spain [20] providing many ecosystem services [21]. Their landscape is characterised by the presence of scattered trees

Figure 3. Illustrative pictures of a dehesa (left) and a pastizal farm (right). Author: Javier Lozano-Parra.

belonging to the Quercus genus (holm and cork oak) used to obtain direct benefits such as fruit (acorn for feeding animals), wood or cork, and indirect benefits like protection against wind and sun (shadow in summer), soil erosion or nutrient pumping [22]. These trees enhance the landscape's heterogeneity increasing its complexity and biodiversity [23]. When most of the trees are removed (cultivation or lack of regeneration), these lands are converted into a treeless rangeland or grassland, commonly known in Spanish as *pastizales*, that could be actually considered as a steppe (**Figure 3** right).

The steppe is the most common landscape in Mediterranean and semi-arid grasslands. They are currently managed as grazing lands where annual species of legumes (*Ornithopus compressus L.* and several species of Trifolium), grasses (*Aira caryophyllea* L., *Bromus sp.,* etc.) and other families are dominant [24] (**Figure 4** left). In many cases, these grasslands are still rotationally cultivated every 3 or 4 years (traditional practice) with fodder species such as oats (*Avena sativa*) and vetch (*Vicia sativa*) [25]. Contrariwise, many of them are also abandoned giving rise to shrub encroachment (matorralization) of species such as *Cistus ladanifer*, *Lavandula stoechas* and *Retama sphaerocarpa* [26] (**Figure 4** right).

Figure 4. Examples of a traditional grassland farm where rotational cultivation is still practiced (left) and another farm abandoned over the past 20 years. Author: Javier Lozano-Parra.

3.2. Oceanic grasslands

Grasslands both in northern Spain and in high mountainous areas are less abundant than in the southern half of the country (Mediterranean and semi-arid). It is quite usual to consider mountain meadows with evergreen grasses, grazed mainly by cattle, as the typical grassland of this geographical region, particularly in the Pyrenees [27] and in the Cantabrian Mountains [28]. In addition, some regions such as Galicia (NW Spain) are relatively densely populated (92 people km^{-2}), disperse settlements (a lower human habitat concentration) and micro-properties being the dominant features that have produced the complex mosaic that conforms this typical landscape [29] (**Figure 5**). Grasslands in the strictest sense (not to be confused with meadows) are mainly located in the Navarre region (western French border) although the dominance of Mediterranean climate in some areas (south) reduces its geographical distribution.

The Spanish region of Navarre (ca. 10,400 km^2) has an important rainfall gradient (350–2500 mm $yr.^{-1}$) that allows for the coexistence of dry [30] (**Figure 6**) and wet grasslands [31] (**Figure 7**) as well as mountain meadows (**Figure 8**), rangelands and rich agricultural fields. Berastegi et al. [32] classified its grasslands (and meadows) in 7 major groups, 37 subgroups and 69 different types (including associations). They gathered around 60% of the number of species found in the region and 27 out of 37 subgroups belong to the list of Habitats of Common Interest of the European Union. The main land-use is sheep grazing since Roman times [33] in the driest grasslands [34] and cattle as elevation rises [35].

3.3. Mountainous meadows

Iberian mountainous meadows can be included within the *nemoral forest* class (vegetation zone) by Mucina et al. [36] or as alpine grassland (phytosociological class) by Rivas Martínez et al. [37]. They are represented by acidophilous grasslands (*CT (TRI)—Juncetea trifidi Hadač in Klika et Hadač 1944*) in the Pyrenees and in the Cantabrian Mountains although the presence of calcicolous grasslands (*CU (SES)—Elyno-Seslerietea Br.-Bl. 1948*) is also noteworthy. Other

Figure 5. Illustrative picture of the typical fragmented landscape of Galicia. Place: Concello de Abegondo, A Coruña. Authors: Javier Pulido Fernández and Mónica Cortijo Blanco.

Figure 6. Shrub formations of *Lygeum spartum* and *Rosmarinus officinalis* in Bárdenas Reales region (southern Navarre). Author: Rosa María Canals Tresserras.

Figure 7. Atlantic meadows cultivated in a farm in Roncesvalles (northern Navarre). Fodder cultivation (ryegrass) is grazed by an autochthonous sheep breed named Latxa. Author: Rosa María Canals Tresserras.

Figure 8. Mountain meadow grazed by sheep (raso breed) located in the Salazar valley (northern Navarre). Author: Rosa María Canals Tresserras.

mountainous systems, such as *Sistema Central* (Madrid and Castilla y León), *Sierra Nevada* (Granada, Andalusia) and *Serra da Estrela* (Central Portugal), show differences only in regard to local species, but they could be included within the same phytosociological classes.

The Pyrenees are dominated by acidophilous species such as *Carex curvula subsp. curvula* and *Festuca airoides Lam.* and calcicolous species such as *Oxytropis halleri subsp. halleri* and *O. pyrenaica*. Their natural pastures are mainly grazed by local breeds of cattle (**Figure 9**) although a human process of land abandonment has been witnessed for many years [38]. In the Cantabrian Mountains, *Oreochloa disticha subsp. blanka* is one of the most representative species [39]. Other peninsular mountainous systems are remarkable for the presence of endemism, particularly of vascular flora [40]. Nevertheless, the abandonment of traditional activities linked to the mountains (grazing, agricultural, wood harvesting or forestry) due to emigration from rural areas to industrial regions is a common feature throughout Spain, particularly in the 1960s and 1970s [41].

3.4. Semi-arid steppes

In the semi-arid areas of SE Spain, steppes are a common feature as well. They are mainly characterised by the presence of species such as *Stipa tenacissima*, *Thymus vulgaris*, *Rosmarinus officinalis* or *Lavandula angustifolia*. Their grasses are usually little developed (low height), and it is very common to find areas of uncovered soil producing a desert-like landscape as a result [42] (**Figure 10**). It contrasts with Mediterranean steppes, where bare soil surfaces only occur under conditions of heavy grazing and dry grasses are regularly visible in the summertime, feeding domestic animals such as *merina* breed sheep [43]. This landscape is also a common feature in southern Portugal (Algarve region) where the climate is relatively drier than in the rest of Portugal [10].

These grasslands have historically been used to harvest esparto fibre up until the decade of the 1970s [10]. Their natural pastures have been mainly grazed by goats [44]. Overgrazing is addressed as a recurrent practice in the past [42], but nowadays this kind of grasslands are being abandoned provoking problems of matorralization and wildfires [45]. In dry regions such as Murcia, these grasslands have been rotationally cultivated with rainfed fodder cereal taking advantage of relatively deeper soil at the valley bottoms (**Figure 11**) although they are

Figure 9. Local cattle breed grazing in a mountain meadow located on the northern face of sierra Bernera (central Pyrenees). Author: Teodoro Lasanta Martínez.

Figure 10. Semi-arid grassland dominated by *Stipa tenacissima* in the Tabernas desert (Almería). Author: Isabel Miralles Mellado.

Figure 11. Typical rainfed cultivation of cereal in a grassland farm located in SE Spain. Place: Archivel, NW Murcia. Author: María Nieves García Marín.

Figure 12. Former tree orchards and croplands abandoned that are currently grazed by sheep in eastern Spain (Valencia region). Author: Artemi Cerdà.

being converted into a more intensive land-use [46]. Contrariwise, in the Valencia region, many tree orchards (citrus) are being progressively abandoned and consequently converted into grazing areas [47] (**Figure 12**).

3.5. Rangelands and grasslands in Portugal

Portugal and Spain are divided into two climate zones (Mediterranean and oceanic). The southern half of the country is also dominated by grasslands that are currently treeless rangelands (montados) and have a steppe-like landscape [48].

The main land-use in these rangelands and grasslands is obviously grazing combined with rotational crops of cereals or fodder species in some cases [49]. Grasslands dominated by *Stipa tenacissima* are also present in southern Portugal (The Algarve region) [10]. These facts guarantee a visual continuity of land systems on both sides of the Portuguese-Spanish border in spite of being land belonging to different countries [50] (**Figure 13**).

The northern half of Portugal has quite distinct grasslands as compared with Spanish grasslands than in the southern half of the country where the landscape between both countries presents a larger spatial continuity. An exception could be the mosaic landscape of Galicia (NW Spain) showing similarities with those of northern Portugal even in the inner provinces (e.g., Lugo). **Figure 14** shows the typical landscape of many parts of Northern Portugal and the region of Galicia. It is formed by a natural forest with differing degrees of human intervention, areas reforested by pine trees in the twentieth century and natural pastures. Nevertheless, some of them deserve to be highlighted due to their current situation.

The endangered system called in Portuguese 'campo-bouça' (**Figure 15**) is formed by a mosaic-like tapestry of grasslands surrounded by fruit orchards and forest (e.g., cork oak). It is grazed by cattle and typical of the northern region of Portugal close to the Minho and Douro rivers. Another important grassland type is called 'lameiros' in Portuguese (**Figure 16**). They are

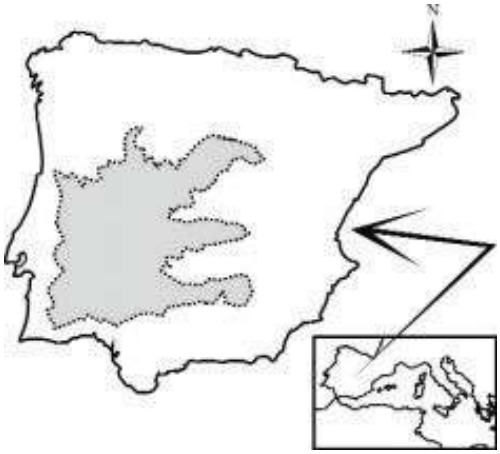

Figure 13. Broad distribution of dehesas and montados in the Iberian peninsula. Extracted from Gea-Izquierdo et al. [50], p. 342.

Figure 14. Typical landscape of inner Galicia. Place: Friol, Lugo. Author: Urbano Fra Paleo.

Figure 15. Image of a 'campo-bouça' located in Ponte de lima, Portugal. Author: Bruno Mateus.

Figure 16. Image of a 'lameiro' located in Rio de Onor, Bragança. Author: Carlos Aguiar.

traditional grasslands (even meadows) located in the high mountains in NE Portugal. Some autochthonous breeds of cows graze permanently on their evergreen grasses. These grasslands and their traditional management are a feature of the idiosyncrasy of local people, and they are at risk of disappearing [51].

4. Changes in land management

Spain and Portugal have undergone similar political and socioeconomic processes during the twentieth century. Both countries were governed by a dictatorial system: the dictatorships of General Franco in Spain (1936–1975) and Oliveira Salazar in Portugal (Estado Novo: 1933–1974). Their economic take-off happened in the 1960s and 1970s involving a strong emigration from little developed rural areas to the more developed industrial areas located within their own countries (Madrid, Catalonia, The Basque Country, Porto or Lisbon) or in other European countries (France, Germany, Switzerland, Luxembourg, The United Kingdom or The Netherlands) [52].

Figure 17 shows the evolution of the percentage of active workers for each economic sector in Spain during the twentieth century. Agricultural activities ceased to be dominant in the decade of the 1960s when a strong industrial development occurred along with a higher demand for services in the increasingly more populated cities [53]. This fact was responsible for the current depopulation of rural areas dominated by agriculture and the subsequent land abandonment or land-use intensification brought about by the introduction of agricultural machinery [54]. Parallel to this geographical process, national conversion plans for large-size rainfed croplands to irrigation [55] and national forestry policies for reforestation using eucalyptus and pine trees were prevalent in these rural areas [56].

Rangelands and grasslands have passed through different phases of land-use intensification induced by many diverse driving forces. After the Spanish Civil War (1936–1939), Spain went through a period of re-ruralisation, which resulted in the current conversion into croplands of thousands of hectares of land [57]. Trees and shrubs were increasingly cleared, and 4-year rotational cultivations of rye, wheat or barley were common throughout these years. Wood harvesting of holm and cork oak for heating (e.g., *picón*) and heavy grazing in many areas lead to processes of land degradation and soil erosion [58].

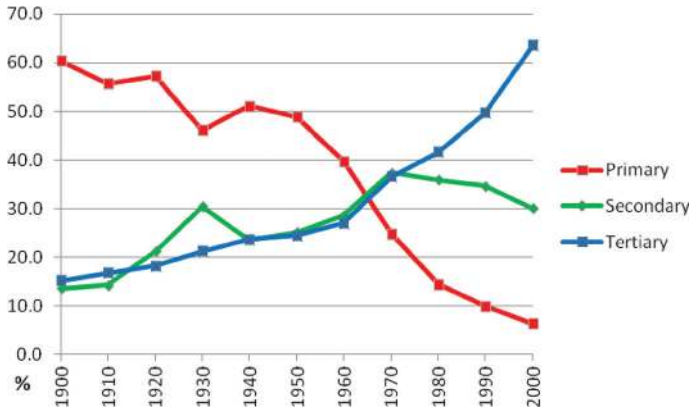

Figure 17. Evolution of the percentage of active workers by economic sector in Spain in the twentieth century. Data source: Spanish Statistical Institute (www.ine.es).

The decades of the 1960s and 1970s are key for understanding the period of decadence of many rangelands. Labour workers moved from rural settlements to industrial areas and those who remained in the rural areas began to demand higher salaries. The response of many owners was to buy some machinery (e.g., tractors or mowers) for agricultural labours and farms began to be fragmented using wire fences in order to reduce costs in shepherding and animal caring. In addition, African swine fever considerably reduced the income produced by the selling of Iberian pigs and their products [59].

This period of rangeland crisis was an influential factor in the advent of large-surface commercial fodder cultivations and in processes of land abandonment followed by shrub encroachment (matorralization). Many of these rangelands and grasslands were afforested by pine or eucalyptus trees following national programmes and others were converted into irrigation croplands for tomatoes, corn or cotton. Campos Palacín [60] counted a disappearance of more than 700,000 ha of rangelands between 1955 and 1981 converted into reforestations of croplands.

Spain and Portugal's joining the European Union meant their acceptance of the Common Agricultural Policy (CAP) rules and their subsidies promoting a higher number of animals. From 1986 to 2000, average animal stocking rates increased from 0.40 AU ha^{-1} to 0.70 AU ha^{-1} [61]. This increase in the number of animals was one of the main causes for the increase in the number of fenced areas in farms, subsequently reducing the connectivity between vegetation patches [62]. Another little-studied influential factor on vegetation was the progressive replacement of cattle for sheep [63].

Many grasslands and rangelands are being progressively occupied by shrub species such as *Retama sphaerocarpa* and *Cistus ladanifer* as a consequence of undergrazing and the lack of influence of goats within the grazing system (**Figure 18**). Nevertheless, Moreno and Rolo [64] concluded that this natural process of shrub encroachment is necessary to facilitate tree regeneration since the lack of trees is becoming a serious problem in rangelands of many parts of the Iberian Peninsula [65]. CAP agri-environmental subsidies are also promoting the seeding of different species or the exclusion of grazing in some areas in order to favour bird habitat protection [66].

Figure 18. Undergrazed fenced areas within a rangeland farm colonised by *Retama sphaerocarpa* over the past 20 years. Place: Monroy, Cáceres, Spain. Author: Javier Lozano-Parra.

Figure 19. Southern face of the sierra de las Corchuelas in Monfragüe National Park (Extremadura, Spain). The Tagus River splits a typical landscape of dehesa and a eucalyptus reforestation from the 1960s. Author: María José Mena Martín de Prado.

Finally, one of the most important changes in terms of vegetation has been the introduction of exotic tree species such as *Eucalyptus globulus*, *E. camaldulensis* or *Pinus halepensis* during the twentieth century, particularly in the northern part of the Iberian Peninsula and in Portugal as well (**Figure 19**). From 1941 to 1959, more than 1.3 million ha of land were reforested in order to reduce the wood imports following the instruction given by the National Plan for Reforestation of 1939 [67]. Madrigal [68] provided values of 3.7 million ha of reforested land up until 1986 in Spain, the 1970s showing particular importance after the reform of the former Spanish Ministry of Agriculture in 1971. Many of these eucalypti were planted for cellulose extraction [69].

5. Conclusions

The Iberian Peninsula is a territory that has been strongly intervened by human land-use since before Roman colonisation. This historical landscape modelling by human activities has shaped original land systems such as *dehesas* or *montados* (rangelands), steppes, micro-properties or endangered systems such as *campo-bouça* or *lameiros* in Portugal. Nevertheless, changes promoted by national governments (plans for reforestation or conversion into irrigated cropland), a significant increase in the secondary and tertiary economic sectors (rural exodus, land abandonment, mechanisation, etc.) in the 1960s or the application of the European Union Common Agricultural Policy, have motivated different types of vegetation. Traditional cereal fodder

crops have been progressively replaced by natural pastures or commercial crops. Vegetation habitats have been increasingly fragmented, and processes of intensification and extensification have provoked changes on a farm scale (shrub encroachment, nitrophilous plants, etc.). Finally, this study is just a *bouquet* of the many land systems distributed throughout the Iberian Peninsula. Further, specific and empirical studies are still needed on this matter.

Acknowledgements

This work has been financed by the research projects CGL2014-54822R and IB16052 funded by the Spanish Ministry of Economy and Competitiveness and the Government of Extremadura, respectively. The payment of the chapter-processing charge has been made using economic funds from the CGL2014-54822R research project. Financial support was also offered by the Government of Extremadura and the European Regional Development Fund (Reference GR15032). We wish to thank Prof. João Azevedo and the authors of each illustrative picture.

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