Ecosystem services provided by hay meadows in Iberian mountain areas: evolution and perspectives

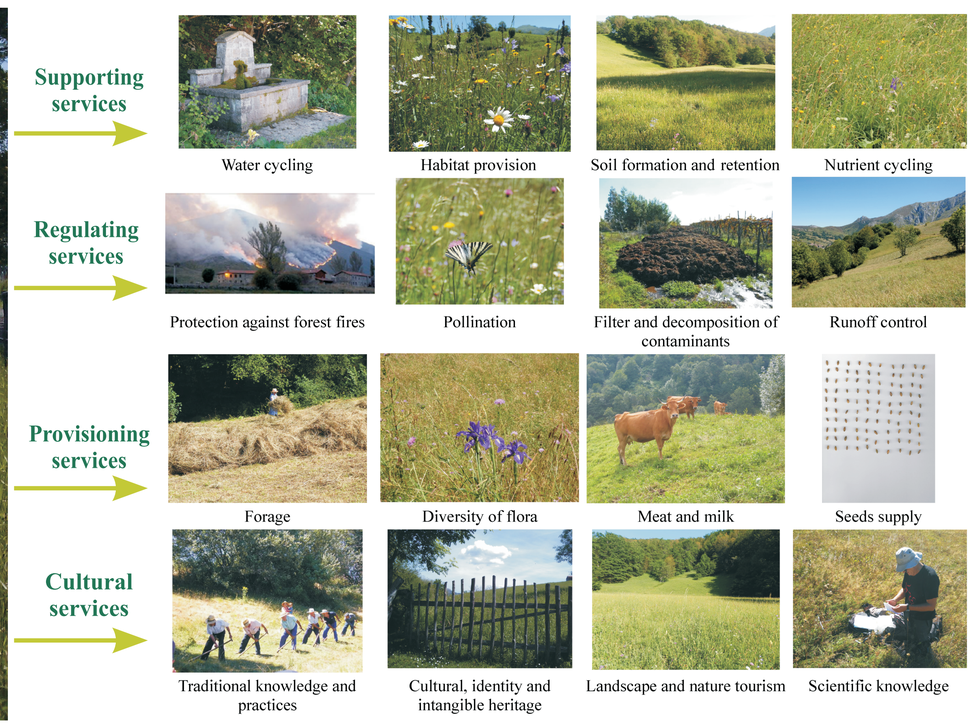
Laura García-de-la-Fuente [a,*], **João Azevedo** [b]

**, Corresponding author. Tel.: + 0034 985 45 81 27 ; fax: + 0034 985 45 81 10 ; E-mail address: laura.indurot@uniovi.es*
a, Universidad de Oviedo, INDUROT, Edificio de Investigación c/ Gonzalo Gutiérrez Quirós s/n, 33006 Mieres, Asturias, Spain
b, Instituto Politécnico de Bragança, Mountain Research Centre (CIMO), Campus de Santa Apolònia, 5300-253 Bragança, Portugal.

Abstract

Hay meadows represent agro-ecosystems maintained by secular extensive management of rural communities all over Europe. Nevertheless, their progressive disappearance (especially in mountain areas) represents a significant loss of biodiversity and ecosystem services. This study aimed at carrying out a general diagnosis of ecosystem services (ES) provided by hay meadows in the Iberian Peninsula, focusing on mountain areas located in the North of Spain and Portugal, most of which are currently protected areas or/and Natura 2000 sites.

The conceptual framework developed in the Millenium Ecosystem Assessment has been applied to characterize and assess the most relevant ES, as well as to analyse their evolution and driving forces in the last decades, based on published data and expert opinion. As the area of hay meadows has been decreasing notably over the last 60 years in this area, a general loss in the supply of fundamental ES for the well-being of our society is taking place. The study also discusses briefly possible responses to tackle this decline.



Introduction

Hay meadows are secular agro-ecosystems maintained by humans, indispensable for forage provision and European rural landscapes. Their traditional extensive management still survives in South-West European (SW EU) mountain areas, where grazing by livestock in autumn and spring is combined with mowing in summer (when livestock moves to rich grasslands in upper elevations).

Hay meadows are decreasing notably in this area mainly due to their conversion into grasslands or their abandonment and later conversion to forest or scrubland. Analyses carried out in pilot mountain areas in the North-West Iberian Peninsula show reductions of hay meadows surfaces about 68% (National Park of Picos de Europa) and 10% (Natural Parks of Alvão y Montesinho/Nogueira) between 1956 and 2017.

Changes in area and distribution of these systems, which are expected to reduce the supply of certain strategic ES to society have been only partially analysed. In this study we carried out a qualitative assessment of ES relevance provided by hay meadows in mountain areas in SW EU and trends in their supply, as well as the driving forces causing such changes and future perspectives to guide possible responses and management measures for these areas.

Methods

The study is focused on mesophile hay meadows at 700-1,300 meters in altitude, located in three pilot mountain zones included in protected areas and/or Natura 2000 sites: the National Park of Picos de Europa (Cantabrian mountains, NW Spain) and the Natural Parks of Alvão and Montesinho/Nogueira (N Portugal).

Adopting the conceptual framework of the Millenium Ecosystem Assessment (MA, 2003), we analysed ES in these sites based on the assessment of their Importance (ordinal scale classes “Very high”, “High”, “Moderate” and “Low”) and trends (“Fast growth”, “Growth”, “Steady, mixed or non-defined trend”, “Decrease” and “Fast decrease”) over the last 60 years (1956-2017). Previous results from Spanish and Portuguese national assessments (EME, 2011; Aguiar et al., 2009) were taken as starting points for the assessment, which was completed with authors´ prior knowledge and information from phytosociological and socioeconomic sampling and evolutionary analyses in these areas (García Manteca et al., 2017; Honrado et al., 2017; Aguiar & Azevedo, 2011; Pires et al., 1994) as well as expert opinion (3 experts in Portugal, 3 experts in Spain).

Direct and indirect drivers of changes in ES provision corresponding to categories set by the MA (2003) and EME (2011) conceptual frameworks and their importance and trends were assessed by using the aforementioned ordinal scales. Results were organized in matrices of "Importance" and "Trend" from which final scores for each ES class were calculated.

Results & Discussion

Supporting ES

Supporting ES are in a clear decreasing trend (very strong in the Spanish case study) due to a fast reduction of their area over the last 60 years. Forage production tends also to decrease, associated to higher grazing and changes in traditional fertilization. The transformation of these open, permanent herbaceous systems interconnected in the landscape contributes to loose unique habitats in some of the species richest sites in Europe. Loss of surfaces in Spanish mountains leads to a strong decrease of regulating ES concerning climate, hydrology, water quality and soil. In Portuguese mountains, the trend is less clear. Forest risk control and pollination, of high importance and irreplaceable in these areas, tend to decrease.

Provisioning ES

Hay meadows genetic resources are fundamental provisioning ES currently threatened by loss of agrobiodiversity. Traditional use of seeds has practically disappeared in favor of a growing use of commercial and non native varieties. Although populations of local autochthonous cattle and sheep breeds have suffered from a strong decrease, diversity of plant and animal species (e.g. insects) typical of hay meadows remain steady for the moment. Other threatened provisioning ES are animal products (meat, milk, cheese, honey), with high economic and cultural local value; nevertheless, their decline has been alleviated (particularly in Picos de Europa, Spain) by using geographical eco-labels and economic support to autochthonous breeds.

Cultural ES

With the exception of traditional knowledge, the majority of cultural ES associated to mountain hay meadows has improved in the last 60 years, particularly scientific knowledge and educational values, aesthetics and inspiration, sense of identity and place, and cultural heritage, as a result of an expanding urban society increasingly demanding culturally (tangible and intangible) and visually appealing environments where hay meadows are seen as identitary symbols of the rural landscape.

Drivers of changes

Land use change and over and under exploitation (mainly abandonment) have been identified as major direct drivers (pressures) of these changes, under the influence of indirect drivers such as socio-demographic changes (depopulation, aging), the Common Agricultural Policy (CAP), mechanization, and urbanization of rural communities. All drivers show a growing trend in the studied areas.

Responses and management

CAP and national Rural Development Programmes, risk prevention and climate change mitigation plans, environmental education and R&D&I programmes, are examples of policy and planning instruments that can contribute to maintain these systems. Hay meadows are strategic for mountain areas, where they provide safe and healthy food products, contribute to reduce fire hazard, to the development of new products and the establishment of new industries allowing the preservation and recovery of traditional knowledge. Raising the profitability of meadows through increasing support from existing policies (e.g. agri-environmental subsidies), and institutions (e.g. protected areas), better access to markets of bio-based agricultural products, and the development of new ecosystem services´ payment schemes, is an essential step for their maintenance.

SUPPORTING ECOSYSTEM SERVICES

Categories	Portugal Importance	Portugal Trend	Spain Importance	Spain Trend
Primary production		↘		↓
Atmospheric oxygen production		↔		↓
Soil formation and retention		↗		↓
Nutrient cycling (nutrient retention and soil fertility)		↘		
Water cycling		↘		↓
Habitat provision		↘		↓

PROVISIONING ECOSYSTEM SERVICES

Categories	Subcategories	Portugal Importance	Portugal Trend	Spain Importance	Spain Trend
Food	Mushrooms		↔		↔
	Animals that provide meat, milk and cheese		↘		
	Hunting species		↘		
	Beekeeping products		↔		
Freshwater	Fresh water of sufficient quality and quantity		↘		↘
Wood and fibers	Vegetable fibers		↔		↓
	Animal fibres		↘		
Fuels	Plant fuels		↔		↘
Genetic resources	Seed supply		↘		↓
	Diversity of flora		↘		↔
	Diversity of fauna		↘		↔
	Livestock breeds		↓		↘
Biochemical substances	Medicinal plants		↘		↘

REGULATING ECOSYSTEM SERVICES

Categories	Subcategories	Portugal Importance	Portugal Trend	Spain Importance	Spain Trend
Climate regulation	Favourable climate		↔		↓
	Carbon sequestration and storage		↘		
	Regulation of other greenhouse gases		↔		
Maintenance of air quality	Adequate air quality		↘		↓
	Assimilation and detoxification of solid waste		↘		
Water regulation	Protection against natural disasters		↘		↓
	Runoff control		↘		
	Aquifer recharge, soil moisture retention		↘		
Water purification	Filter and decomposition of contaminants		↔		↓
	Self-purification and wastewater treatment		↔		
Erosion control	Soil retention due to vegetation		↔		↓
	Landslide prevention		↗		
Protection against natural hazards	Mitigation of the effects of natural hazards		↓		↓
Biological control	Prevention of pests and damage to crops and livestock		↔		↓
	Control of invasive alien species		↓		
Disease management	Control of pathogens and infectious diseases		↔		↓
	Regulation of transmitting vectors (mosquitoes, flies)		↔		
Pollination	Pollination of wild species		↔		↓
	Pollination of crops and plantations		↔		

CULTURAL ECOSYSTEM SERVICES

Categories	Subcategories	Portugal Importance	Portugal Trend	Spain Importance	Spain Trend
Knowledge	Scientific knowledge		↔		↗
	Traditional knowledge		↓		↘
Recreation and ecotourism	Recreational activities		↘		↔
	Nature tourism		↗		
Aesthetic appreciation	Landscape/psychological well-being		↗		↑
	Relaxation/mental and physical health		↔		
Inspiration	Expression of nature in books, film and audiovisual production.		↔		
	Source of inspiration for culture, folklore, art, design, etc.		↔		
Spiritual and religious values	Sacred aspects of religious beliefs and spiritual enjoyment		↘		↘
Sense of identity and belonging	Feeling of belonging to a place (rooting)		↔		↗
	Sense and community values associated with place, traditions, etc.		↔		
Cultural heritage	Relevant cultural landscapes in the history of a community		↗		↗
	Cultural importance of certain species		↗		
	Cultural, identity and intangible heritage		↗		
Educational values	Environmental education		↗		↗
	Informal education/learning		↔		

LEGEND

IMPORTANCE	Very high	
	High	
	Moderate	
	Low	
TREND SINCE THE 1960S	Fast growth	↑
	Growth	↗
	Steady, mixed or non-defined trend	↔
	Decrease	↘
	Fast decrease	↓

DIRECT DRIVERS OF CHANGE	Portugal Importance	Portugal Trend	Spain Importance	Spain Trend
Changes in land use		↗		↑
Climate change		↗		↔
Pollution and fires		↗		↔
Invasive alien species		↗		↔
Changes in biogeochemical cycles		↗		↔
Over-exploitation or under-exploitation		↑		↑

INDIRECT DRIVERS OF CHANGE	Portugal Importance	Portugal Trend	Spain Importance	Spain Trend
Changes in policy processes		↗		↔
Economic changes		↗		↗
Changes in socio-demographic processes		↗		↑
Public policies / Agricultural policy		↔		↗
Science and technology (agricultural technology)		↗		↗
Cultural processes		↔		↑

Conclusions

The identification and assessment of ecosystem services provided by mesophile hay meadows in mountain pilot areas in the North-West Iberian Peninsula, based on published data and expert opinion, indicates that:

i) Meadows have decreased considerably in area over the last 60 years;

ii) This reduction has been caused mainly by land-use change and socio-demographic dynamics;

iii) Loss of meadows is leading to a loss of biodiversity (domesticated species) and a decrease in the supply of strategic ecosystem services such as genetic resources, safe and healthy food products, traditional knowledge or fire risk protection.

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