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# Sustainable meat and milk production from grasslands

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

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## Abstract

Hay meadows represents agro-ecosystems maintained by secular extensive management of rural communities throughout Europe. 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 characterise 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 briefly discusses possible responses to tackle this decline.

**Keywords:** ecosystem services, mesophile hay meadows, mountains, South-West Europe

## 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, however, 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.

## Materials and methods

The study is focused on mesophile hay meadows at 700 - 1,300 metres 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 and Azevedo, 2011; Pires *et al.*, 1994) as well as expert opinion (three experts in Portugal, three 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 organised in ES/Importance and ES/Trend matrices from which final scores for each ES class were calculated.

## Results and discussion

According to published information and the opinion of experts, mesophile hay meadows agro systems are essential in the provision of supporting ES (primary production, soil formation-retention-fertility, habitat), but these services 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 fertilisation. The transformation of these open, permanent herbaceous systems interconnected in the landscape contributes to permanent loss of unique habitats in some of the species richest sites in Europe. Simultaneously, the reduction in area of meadows in Spanish mountains leads to a strong decrease in the supply of important regulating ES such as climate regulation (C sequestration and storage), hydrological regulation (flooding and drought control, runoff control, maintenance of soil moisture in steep slopes), water quality regulation (filtering and degradation of contaminants), and soil loss regulation (soil retention and control of landslides). In Portuguese mountains, the trend is less clear. In fact, due to the replacement of meadows by shrub communities and young forest stands, globally these northern mountain areas in Portugal show an increasing supply of these ES (Sil *et al.*, 2016). Other regulating ES such as risk control (forest fires) and pollination, of high importance and irreplaceable in these areas, tend to decrease in supply.

Hay meadows genetic resources are fundamental provisioning ES currently threatened by loss of agrobiodiversity. Traditional use of seeds has practically disappeared in favour 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 in hay meadows are animal products (meat, milk, cheese, honey), with very high economic importance for local economies and cultural value; nevertheless, their decline has been alleviated (particularly in *Picos de Europa*, Spain) by using geographical and traditional indications and economic support for the conservation of autochthonous breeds.

With the exception of traditional knowledge, the majority of cultural ES associated with 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 identity symbols of the rural landscape.

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), mechanisation, and urbanisation of rural communities. All drivers show a growing trend in the studied areas. Conservation of hay meadows is a way of assuring the supply of diverse and fundamental ES to the society. 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 the maintenance of these systems. Hay meadows are strategic in rural areas, in particular in mountain areas, where they provide safe and healthy food products, contribute to the

reduction of fire hazard in the landscape, 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.

## Conclusion

The identification and assessment of ecosystem services provided by mesophile hay meadows in mountain pilot areas in the northwest Iberian Peninsula, based on published data and expert opinion, indicates that: (1) meadows have decreased considerably in area over the last 60 years; (2) this reduction has been caused mainly by land-use change and socio-demographic dynamics; (3) 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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