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# Bibliometric analysis of the literature focusing on ecosystem services provided by grasslands

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## Abstract

We propose an original approach to reviewing the literature on the ecosystem services (ES) provided by grasslands. This review consists of a bibliometric analysis of the thematic fields of 1086 scientific articles published since 1995 and listed in ScienceDirect on the basis of a search for the keywords 'Ecosystem services' AND 'grasslands'. The textual analysis of the abstracts was carried out using Iramuteq, a software interface using R to study thematic fields in text corpora. We carried out a hierarchical descendant classification based on the proximity of words in the abstracts of the articles studied. This analysis revealed 5 recurring themes: (1) soil quality and life (nitrogen, phosphorus, biomass, fungi, bacteria, fertilisation); (2) water quality and regulation (retention, precipitation, plateau, etc.); (3) Biodiversity (species richness, pollinator, insect, habitat, flower, etc.); (4) dynamics of grassland areas (land, area, decline, crops, scenario, etc.); (5) perception of services by stakeholders (stakeholders, perception, interview, citizen, experts, etc.). These fields are often covered by thematic journals. The measures to support ES such as payments for environmental services still seem little studied. A better understanding of grassland ES, especially from the perspective of cross-disciplinary approach mixing ecology, agronomy, zootechnics and economics, is necessary for better operationally.

**Keywords:** grasslands, ecosystem services, bibliometric analysis, payment for services

## Introduction

The concept of Ecosystem Services (ES) first appeared in the 1970s, at the time of awareness of the impact of human activities on the environment and entered the scientific literature in the 1990s (Gomez-Baggethun *et al.*, 2009). Many texts introduce ES from a biodiversity perspective (e.g. Ehrlich and Wilson, 1991). Today, this concept is used more generally by economists, decision-makers and the private sector in the context of payments for environmental services (Capodaglio and Callegari, 2018). Bibliometric analyses give assess to research trends (Zhang *et al.*, 2016). Such analyses highlight unexplored fields of research that still have to be investigated (Mori and Nakayama, 2013). This bibliometric study aims to find out when, how and to what extent researchers have focused on ES provided by grasslands.

## Materials and methods

The bibliographical search was carried out *via* the ScienceDirect database (DB), taking into account titles, abstracts and keywords by using four sets of keywords: (i) 'Ecosystem services' AND 'grassland', (ii) 'Ecosystem services' AND 'grassland' AND 'payment', (iii) 'Ecosystem services' AND 'meadow', (iv) 'Ecosystem services' AND 'prairie'. A DB was then created in Zotero from a BibTeX file including the title, the year, the abstract and keywords. The data were formatted for analysis in IRaMuTeQ, a software package designed to mobilise R for multidimensional text analysis.

Only abstracts were used for the next analyses in which the text corpus was lemmatized, i.e. words were reduced to their dictionary forms. Only adjectives, adverbs, common names and verbs were taken into account in the analyses. A classification of the abstracts was then achieved on the basis of the frequency of association between words in the abstracts, in order to identify groups of articles according to topics.

The chosen keywords are common to all abstracts, so they weren't discriminants for the classification's construction.

## Results and discussion

Although the field of ES research is relatively young, there is a substantial and rapidly growing body of literature on the topic (Zhang *et al.*, 2019). The first DB contained 1086 articles and books. The first article was published in 1995 (Gren *et al.*, 1995) and it would be another 10 years before subsequent papers were published. However, the first works to mention term 'ES' appeared systematically in the 1980s, notably in the works of Ehrlich and Ehrlich (1981), Ehrlich and Mooney (1983) and Costanza *et al.* (2017). In 2005 interest for ES begins its expansion.

The hierarchic classification has highlighted five main abstract thematic areas (Figure 1). Class 1 which brings together the greatest number of articles (24.1%) is represented by words on indices of ES linked to biodiversity (species, diversity, pollinator, forage). Then, in decreasing percentage of papers, class 2 corresponds to public policy, class 3 to water quality and climatic regulation (retention, precipitation, fixation), class 4 to grassland area dynamics and class 5 is devoted to soil.

The bibliometric analysis makes it possible to identify the main ES associated with grasslands. They are linked to biodiversity, soil and water quality, but production (fodder, meat, milk and their quality), animal welfare and health are less addressed. Cultural services, more difficult to evaluate, are also largely

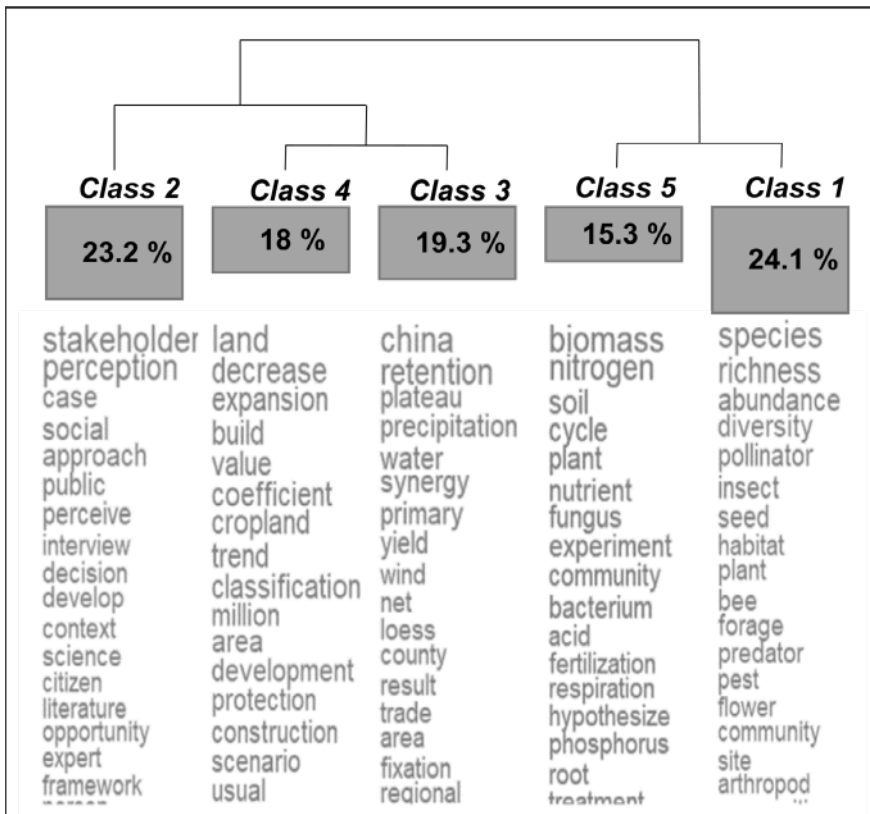


Figure 1. Classification of abstracts based on word proximity to identify thematic groups of articles. The percentages in the grey boxes indicate the percentage of articles involved in each class.

missing in these studies (Hirons *et al.*, 2016). Payments for services, currently at the forefront of public policies (Capodaglio and Callegari, 2018), does not yet appear as a major theme in the literature focusing on grasslands. However, our ScienceDirect DB does not cover all scientific literature and should be completed with other scientific publishing website searches.

## Conclusion

Even if the scientific literature on the ES provided by grasslands is abundant, it is recent and doesn't integrate all the ES. This bibliometric analysis allows us to realise that the services of water quality, biodiversity and soil are majoritarian studied, while other equally important services exist, such as fodder production and its quality. To have a better understanding about the ES provided by grasslands, it is important to conciliate approaches in ecology, zootechnics, agronomy and economy, in order not only to integrate all the ES into the scientific literature, but also to balance the ESs with each other and reconcile economic profitability and environmental preservation.

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