

Ecosystem service provision from coupled plant and microbial functional diversity in grasslands: current status and scenarios under changed climate and management

OBJECTIVES

Extensively managed or restored grasslands (hereafter semi-natural) are key elements of European landscapes and provide multiple services central in supporting local livelihoods. In a context of environmental change and search for better sustainability, European agriculture is increasingly required to provide multiple ecosystem services ranging from economically viable production levels to carbon storage and water quality preservation. However, basic understanding of the ecological opportunities and constraints underlying this multifunctionality is still missing. The VITAL project aimed at testing the hypothesis that the delivery of multiple ecosystem services in semi-natural grasslands, including their vulnerability to climate and social change, largely relies on plant and soil microbial diversity and their coupled impacts on carbon and nitrogen cycles.



APPROACHES

The VITAL team gathered researchers from five countries in a collaborative project with testing at three mountain sites (France, UK and Austria). Their approach was to:

1. Identify key ecosystem services associated with fertility of semi-natural grasslands, and how these are influenced by management and the needs of local and regional stakeholders;
2. Develop a model linking plant responses to management practices, associated effects on microbial soil diversity and functioning, and cascading effects on ecosystem services. Model results were validated at test sites;
3. Develop scenarios of land use, management and climate with local and regional stakeholders, and model, under these scenarios, the coupled biodiversity and functioning of plants and soil microorganisms, and their effects on a range of ecosystem services. Results were used to understand how to meet the identified needs of the stakeholders and preserve multifunctionality of grasslands and local livelihoods.

MAIN ACADEMIC FINDINGS

- Drawing from experiments at individual plant and community level, the VITAL team demonstrated the key role of combined plant and microbial functional diversity on carbon and nitrogen cycles and linked ecosystem services, identifying key functional traits associated to processes and services like biomass production, nitrogen retention and carbon sequestration ⁽⁹³⁾.
- The project observed that the extensification of management promotes plant and microbial communities favouring nitrogen retention and carbon sequestration ⁽⁹³⁾.
- Using co-designed scenarios of future change, the VITAL team identified a number of trade-offs between services at landscape scale that originate from ecological functional trade-offs linked to coupled plant and soil microbial communities (e.g. nitrogen retention and carbon sequestration versus fodder production) ^(94, 95).

By highlighting the key roles of plant functioning diversity and soil microbial diversity in the provision of essential ecosystem services of local and regional interest, VITAL drew the attention to the “hidden” side of biodiversity in sustaining benefits of ecosystems to society.

Consortium partners:

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Institute of Ecology, University of Innsbruck, Austria
Lancaster Environment Centre, Lancaster University, UK
Gezrman Research Centre for Environmental Health, Germany

Dept. of Vegetal Biology, Universitat de Barcelona, Spain

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ACADEMIC RESULT HIGHLIGHT

Using plant trait-based models, the VITAL team disentangled the effects of climate change and land management change on grassland ecosystem functioning and bundles of ecosystem services*, applying different scenarios of global change (see Figure). Overall, the supply of services was more sensitive to climate than management changes because of farmers limited adaptation capacity.

* Lamarque *et al.* (2014) Plant trait-based models identify direct and indirect effects of climate change on bundles of grassland ecosystem services, *Proceedings of the National Academy of Sciences of the USA* 111: 13751-13756

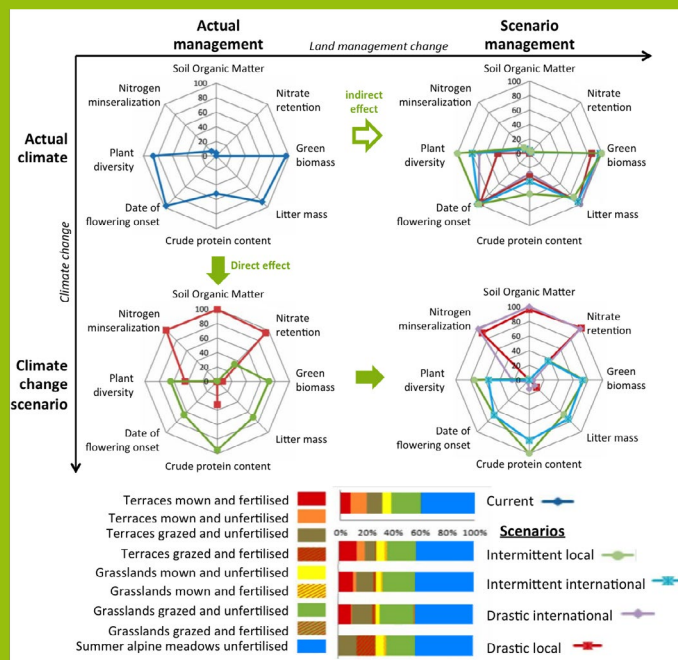
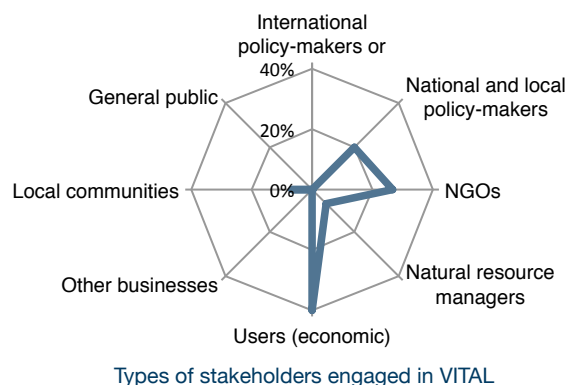


Illustration of ecosystem properties and services predicted by trait-based models under (top) current climate or (bottom) climate change scenarios, and under (left) current land management or (right) co-designed land management scenarios. After Lamarque *et al.* 2014 (PNAS)

STAKEHOLDER ENGAGEMENT AND PRODUCTS RELEVANT TO SOCIETY/POLICY

- The VITAL team worked closely with local farmers, regional and local NGOs, and policy advisors (see Figure) to identify their perceived most important ecosystem services in semi-natural grasslands, and to develop scenarios for land management change and associated storylines. Local farmers at study sites took part in a role-playing game to assess their responses to different scenarios and their resulting management decisions
- The VITAL team organised a number of field days involving local authorities, protected area managers, and technical advisors in charge of implementing agri-environmental schemes
- The close interaction with Natural England in the UK lead to the funding of new projects by BBSRC on optimal grazing management and on the impacts of restoration management on ecosystem services provision by grasslands



Overall, VITAL provided essential knowledge to guide the development of feasible, multi-sectoral policies and management plans while considering the socio-economic context of mountain livestock farming and the need for technical and active learning support for farming communities.

HIGHLIGHTS ON SOCIETY/POLICY-RELEVANT PRODUCTS

- "Meadows matter"**: this toolkit for managers of mountain grasslands and students is based on several learning activities, card games and outdoor (optional indoor) activities. It has been successfully tested in a secondary school (http://ftp.uibk.ac.at/private/c7701026_20160518_226d60a4afcac7b43901ecea75488cdb).
- Stakeholder perceptions of ecosystem services**: list of services that stakeholders associate with fertility for each site, perceived relationships between these services, and associated indicators (Lamarque *et al.* (2011) Stakeholder perceptions of grassland ecosystem services in relation to knowledge on soil fertility and biodiversity. *Regional Environmental Change* 11(4): 791-804).
- Stakeholder-based report on options for policy measures to be taken at national and/or EU level**: intended for policy-makers, this report focuses on implications for sustainable management of ecosystem services in grasslands (http://www.project-regards.org/VITAL/VITAL%20policy_report_final.pdf)