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**Kooperationspartnerin:** Sandra Lavorel

The objectives of the visit where:

- 1) To advance the analysis and writing of the results of BiodivERsA project VITAL, including through a two-day workshop (15-16 Feb.) with all project partners.
- 2) To prepare and submit a follow up project to the BiodivERsA Call 2012.

### **1) Advances on project VITAL - Ecosystem service provision from coupled plant and microbial functional diversity in managed grasslands**

2012 is the last year of this four-year project, consequently most of the work focuses on data analysis and writing.

Key results worked on during the visit include the following:

- The field measurements at the three project sites (Stubai valley, Lautaret in France and Yorkshire Dales in the UK) have produced a very rich data base on linkages between plant functional traits, soil microbial properties, and ecosystem functioning. Final modifications, including standardization of measurements across partners were made.

- We have developed advanced statistical methods for the inter-site analysis of this data set. These methods were successfully applied to demonstrate how plant and microbial functional characteristics control different ecosystem processes, and how this determines trade-offs among ecosystem services.

- Thus we have shown that increasing soil fertility is associated with fast-growing plants providing greater production, but poor carbon and nutrient retention, notably because they are associated with very active soil bacteria. Conversely, decreasing fertility promotes plants with slower metabolism, usually low production, but improved

carbon sequestration and soil nutrient retention by favouring soil fungi and bacteria with slow activities. Managing grasslands for selected or multiple ecosystem services will thus require balancing effects on plants and soil microbes. For instance, it is possible to promote biodiversity production and water quality in traditionally managed, lightly fertilised and mown grasslands or in summer pastures.

A first paper resulting from this work was submitted on the 2 April 2012 to the Journal of Ecology:

Grigulis, K., Lavorel, S., Krainer, U., Legay, N., Baxendale, C., Dumont, M., Kastl, E., Arnoldi, C., Bardgett, R., Poly, F., Pommier, T., Schloter, M., Tappeiner, U., Bahn, M. & Clément, J.-C. Combined influence of plant and microbial functional traits on ecosystem processes in mountain grasslands.

- These results have been used to develop statistical models of ecosystem services. These models are applied to scenarios of grassland management resulting from combined climatic and socio-economic drivers, developed jointly by the partners using participative methods with local stakeholders at both the French and Austrian sites. Ecosystem service models are then applied to project alternative future states for ecosystem services, and to analyse how trade-offs and synergies among ecosystem services may change in the future.

- Specifically the French team has been in charge of providing new models of soil-related ecosystem services such as nutrient retention, maintenance of water quality and soil carbon sequestration. Meanwhile, the Austrian team has been implementing a model of soil water balance for the Lautaret site, in tight connection with results from a previous collaborative project BIOATCH. Results from these modelling exercises are being analysed currently.

## **2) Project proposal REGARDS - REsilience of marginal GrAsslands and biodiveRsity management Decision Support**

Much of the work during the visit was dedicated to the preparation and final submission (including administrative elements) of the proposal REGARDS. The aim

of this proposal, in terms of the bi-lateral collaboration, is to follow up on the excellent work developed during VITAL and enhance it by additional expertise from within the two partner groups (e.g. use of isotope tracing and gas exchange measurements), or with new formal partners such as the Institute of Sociology of Innsbruck University, and the University of Louvain-la-Neuve in Belgium.

A summary of the key elements of the proposal is given below. If granted, this new project, coordinated by Sandra Lavorel, will start in December 2012.

European marginal grasslands are biodiversity hot spots owing to biophysical constraints and natural heterogeneity, and to centuries of agriculture. Currently it is not clear whether these unique systems are vulnerable to ongoing environmental and societal changes, or if they have developed a high resilience over their history of co-evolution between humans and ecosystems. If so, the limits to this resilience are unknown, and their prediction hazardous. This uncertainty lies largely in the poor knowledge of resilience mechanisms of both the ecological and human sub-systems, as well as those underpinning robustness or vulnerability of the entire system coupled through land use decisions and ecosystem services. Resolving this uncertainty is essential to guide coherent policy development, especially in the areas of biodiversity conservation, agri-environment and rural development, where different policies can result in conflicting objectives.

REGARDS aims to unravel the mechanisms underpinning resilience of marginal grassland human-environmental systems to global environmental and social change in order to enhance socio-ecological resilience from landscape to regional level.

REGARDS will address this general objective above and its relevance to local and regional development by producing an integrated, multi-scale analysis of ecological and human mechanisms influencing resilience to climate and societal changes. We will focus on mountains where traditional livelihoods relying on biodiverse and multifunctional grasslands face ongoing societal changes and the prospect of severe climate change. These changes have the potential to fundamentally shift the sets of ecosystem services that these agroecosystems can provide, and thereby the development potential for local economies.

REGARDS will address six specific questions:

(1) Can we identify safe parameter space vs. tipping points in the combined effects of changing climate, including extremes, and management on grassland ecosystems?

(2) How does coupled above-belowground functional diversity buffer or amplify grassland ecosystem responses to combined changes in climate and management?

(3) How do landscape structures enhance or decrease the resilience of ecosystem services?

(4) Can multi-level governance structures facilitate fast adaptation to socioeconomic changes that affect biodiversity and the related ecosystem services?

(5) Does regional integration and globalization enhance or threaten resilience through their effects on flows of goods and ecosystem services, people and information?

(6) How do ecological and human processes combine to determine resilience of ecosystem services?

Research will be conducted at two main long-term socio-ecological research sites in the French Alps (Lautaret) and Austria (Stubai Valley), thereby affording a historical perspective in the resilience analysis (39), and the benefits of participative research and scenario development (1, 40). These two contrasting human-environment systems are typical of western European mountain regions. The Austrian site typifies more productive and wealthier northern alpine regions, where since WW2 agriculture has gradually concentrated on more productive areas, while unproductive slopes were abandoned, and the local economy strongly depends on additional income from tourism and external activities within households. In contrast, the French site represents more marginal areas of the southern Alps, where in spite of adjustments of practices, structural changes of farm systems have been more minor, with self-sufficiency still as a main objective, resulting in low- to moderate intensity management over large areas, and a strong reliance on a variety of subsidies.