Landscape Management for Functional Biodiversity
IOBC-WPRS Bulletin Vol. 100, 2014
pp. 55-58

The QuESSA Project: Quantification of Ecological Services for Sustainable Agriculture

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Abstract: The vegetation in semi-natural habitats supports ecosystem services (ES) essential for the development of sustainable farming systems. QuESSA aims to quantify some of the key ES (e.g. pollination and biocontrol) derived from semi-natural habitats (SNH) for the main European cropping and farming systems. This will be achieved by identifying key SNH according to their potential to support selected ES based upon vegetation traits. The ES delivery will then be verified through field studies in 16 case studies covering the predominant European cropping systems. A case study is defined by a unique combination of region, crop species, and service. Data will parameterise spatially explicit models to determine how vegetation composition, management, shape, area, and placement of SNH in agricultural landscapes affect the distribution of ES from farm to landscape levels. To investigate synergies and trade-offs in ES, multi-criteria analysis will be developed to combine a suite of modules in an integrative modelling framework. The project will produce guidelines, make recommendations to local, national and EU stakeholders and provide a web-based tool for farmers to enhance exploitation of semi-natural habitats for ES provision.

Key words: biological control, agricultural policy, ecosystem services, IPM, semi-natural habitats

Introduction

Current conventional farming systems are heavily reliant on agrochemical inputs that cause pollution of semi-natural habitats and are implicated in declining biodiversity causing disruption of ecosystem services (ES) (Geiger *et al*., 2010). At the same time, the expected need to produce 70% more food by 2050 (UN, 2010) will require further intensification of agricultural practices and loss of semi-natural habitats that support ecosystem services. These developments call for bio-technical and social breakthroughs to improve the sustainability of farming systems (Foresight, 2011) and to escape from the vicious cycle of further intensification of external inputs and greater degradation of ES and European landscapes. More knowledge on and awareness of the role of semi-natural habitats may well be the way out of the current lock-in of many conventional farming systems. Such knowledge and awareness will help policy makers to further refine policy instruments already available in the CAP Pillar II, or planned in the CAP reform including the EU Green Infrastructure in agricultural areas and the Biodiversity Strategy, and will support farmers and other local stakeholders to adopt technologies based on eco-functional rather than external-input oriented intensification.

Approach

In the QuESSA project we will determine the levels of important ES (especially biocontrol and pollination) provided by the semi-natural habitats, how these levels are affected by the vegetation composition, management, shape, area and placement of the semi-natural habitats and establish what the degree of synergy or trade-off among various ES. The proposed research is structured around 16 case studies in 10 regions across the European continent chosen to represent highly divergent combinations of socio-economic and biophysical characteristics, including the main cropping systems (arable, orchards, vegetables and vines) and farming systems (conventional, innovative/organic) across four European agro-climatic regions (central; maritime; Mediterranean; North-east) (Bouma, 2005). This diversity enables us to combine local specificity in solutions with comparative analyses to establish the range of applicability of solutions and methods.

Case studies

In the case studies, which are each comprised of at least 18 independent 1-km radius landscape sectors, the vegetation in the predominant semi-natural habitat types was recorded in 2013 along with the abundance of natural enemies and pollinators. In order to make different types of vegetation comparable and link vegetation patches in the landscape to ES delivery in the studied fields, a trait-based approach will be applied (Lavorel & Garnier, 2002). The functional traits of the vegetation within these habitats will then be used to predict the likely level of each ES to enable a score to be generated per habitat type and thereby per landscape sector. Over the following two years we will quantify ES delivery per landscape sector using a series of simple sentinel systems that were developed and tested in 2013. For biocontrol these include measurements of predation and parasitism of the main crop pest in each case study and of generic prey items (*Calliphora* larvae, *Ephestia* eggs, weed seeds) common across all case studies. Measurements of natural enemy densities will be performed using standard sampling approaches (pitfall traps, sticky traps) within crops. Data from the measurements of actual ES delivery will be used to refine our scoring system. Farm management practices will be recorded that may impact on the potential and actual ES provision of semi-natural habitats. In the case study regions private and public economic benefits, and non-monetary value of selected ES will be assessed through qualitative methods including semi-structured or in-depth interviewing and focus groups among farmers and local residents.

Modelling and scaling up

We also recognise that the resources provided by vegetation (food, shelter, overwintering and oviposition sites) for beneficial invertebrates may have an influence beyond the immediate field and even up to several km. Therefore, the more mobile the beneficials, the higher the need for spatially explicit modelling. State-of-the-art spatial modelling will be used to better understand ES provided by natural enemies of crop pests and pollinators and to generate heat maps that depict the level of ES provided in each landscape sector, by integrating information on vegetation types, functional traits of plant species and dispersal abilities of ecosystem service providing insects, supported by the different vegetations in the landscape (Bianchi & van der Werf, 2003; 2004). An innovative spatially explicit prototype framework (Landscape IMAGES) will be used to synthesize knowledge on ES that are relevant in the case studies, such as natural pest control, pollination, erosion control, landscape quality, and investigate their synergies and trade-offs (Groot *et al*., 2007, 2010). In addition, modelling will be used to scale up the findings from the case study regions to European level, based on Europe-wide data and indicators. This will facilitate rapid evaluation of the current state of landscapes as well as exploration of alternative landscapes and their performance.

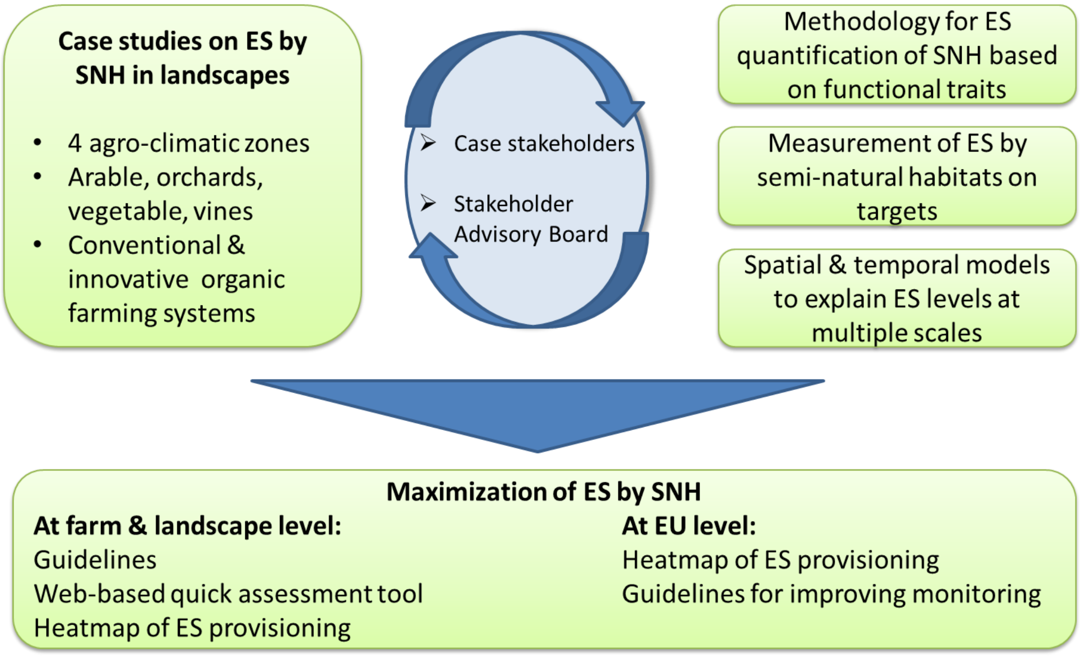

Figure 1. Conceptual scheme proposed for the project: relations between case studies, scientific analyses and outputs. Abbreviations: ES: ecosystem services; SNH: semi-natural habitats.

Stakeholder interactions and dissemination

Two levels of stakeholder interaction are planned to ensure that the project evolves with the input from local stakeholders and national/EU policy makers to generate desirable outcomes. The case study partners will interact with local stakeholders throughout the project whilst a Stakeholder Advisory Board will advise on the needs at national and EU level. The outcomes will be communicated using a range of modern media and approaches. This will include the production of practical guidelines for farmers from the main European cropping systems (arable, fruit, olive, vineyard and horticulture). Local stakeholders will be informed though the use of on-farm demonstrations and guidelines about the potential contribution to ES from SNH and information on best management practices. A key output will be the production of a web-based tool for use by the farmers, their advisors and policy makers to optimise management of semi-natural habitats for maximisation of ES provision. This will utilise the scoring system of semi-natural habitats and mathematical models to allow users to calculate "heat maps" maps for their own landscapes and manipulate these to explore opportunities for improvement of ES delivery. It is hoped that by engaging with policy makers we will be able to formulate recommendations for measures and policies that can support a more optimal development and exploitation of semi-natural habitats in agricultural landscapes across Europe.

Acknowledgements

QuESSA is funded by the European Union's Framework 7 programme. For further information see www.quessa.eu.

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