SUMMARY

Europe has a large diversity of agricultural landscapes ranging from traditional landscapes defined by extensive production methods, such as low-intensity grazing in upland and mountainous areas, to very intensive "industrial production" landscapes. While changes in land management have received less attention than land cover conversion, land management is one of the major influences on European agricultural landscapes and a dominant influence on future land use change. Land management has considerable impact on the appearance and functioning of agricultural landscapes, such as on biodiversity values, as well as a range of ecosystem functions and services.

The main research question of this dissertation is how land management differentiates agricultural landscapes and leads to changes in the functions and values assigned to these landscapes. As agricultural landscapes are at the interface of the biophysical environment and society, this thesis adopts an approach that accounts for both the natural and human factors that influence the landscape, and seeks to understand their relationship, feedbacks, and trade-offs.

A better understanding and assessment of the impact of land management and land use changes is necessary to anticipate future land use changes and their impact on society, such as the expected abandonment of marginal land in large areas of Europe. This is especially important as the demands for land-based goods and services are expected to continue increasing in the future. One of the necessary steps towards an improved assessment of the role of agricultural landscapes within global change processes is an improved representation of three critical elements of agricultural landscapes: landscape composition, structure and management.

The assessment and mapping of the spatial variability of landscape composition, structure and management of current agricultural landscapes is the focus of Chapter 2 and Chapter 3. Chapter 2 presents wall-to-wall maps of green lines, ditches and grass margins for the European Union, based on spatial modelling of ground observations of linear features from the 2009 LUCAS (land use/cover area frame statistical survey) database. Linear elements, such as hedgerows and tree lines, have important cultural, agricultural and ecological values within current agricultural landscapes. Chapter 2 has a methodological focus, comparing different spatial interpolation methods suitable to extend information beyond point observations. The resulting wall-to-wall maps of green lines, ditches and grass margins in Europe identified the main areas of occurrence of these landscape elements. In addition, the results confirmed the importance of both biophysical as well as socio-economic factors, such as elevation and accessibility, on the presence and abundance of linear landscape elements within Europe. Furthermore, the resulting maps have allowed other studies to include the

role of the spatial arrangement of landscape elements in their analysis. Currently, applications have been used to model the influence of support practices on water-induced soil erosion reduction and the demand and supply of pollination as an ecosystem service.

In Chapter 3, we integrated spatial datasets to develop a new typology of agricultural landscapes, which accounts for land cover, land management and landscape structure. Such a harmonized approach can help identify and characterize policy areas that need attention, e.g. to assess changes in cultural landscapes, landscape structure and biodiversity conservation. Included datasets in the typology include information on land cover, field size, nitrogen input intensity, and green linear elements (using the dataset developed in Chapter 2). This chapter had a methodological focus as well, comparing two common typology development techniques: an expert-based top-down methodology and a bottom-up approach using Self Organizing Maps (SOMs). A comparison with available national and European typologies showed that our typology clearly deviated from existing biophysical and anthropogenic typologies due to the inclusion of landscape management aspects.

Landscapes change over time and at different rates. The approaches in Chapter 2 and 3 focused on the assessment of the spatial variability of current agricultural landscapes and therefore did not indicate regions facing landscape change. While both maps offer a basis for landscape assessment and monitoring of change, provided that underlying databases are updated with regular intervals, Chapter 4 introduced an analysis with a dynamic component. This allows use to assess how changes in land management lead to changes in the functions and values assigned to these landscapes over different temporal and spatial scales. We used scenario-based land use simulations up to 2040 for Europe, to identify future areas under threat of land abandonment in the European Union - one of the dominant land use change processes and an important policy challenge in Europe. We assessed the impact of the possible future land abandonment, based on eight indicators, including carbon sequestration, mammal habitat suitability, nature recreation and cultural heritage. In this analysis we used the cultural heritage indicator based on the landscape typology developed in Chapter 3. Using a clustering approach, we developed a typology of four typical trade-off bundles. We further analyzed these bundles to distinguish potential desirable and undesirable outcomes of agricultural abandonment. Thus we were able to distinguish areas that face similar management challenges, which can provide a first guideline to target appropriate policies and 'optimal use'.

A limitation to our European scale trade-off analysis is that it does not include specific policy targets, values, norms and interests of the local population. To effectively address future management directions for rural areas in Europe, it is important to know the different perceptions of inhabitants and other user groups of the rural zone. Chapter 5 therefore

focused on the perception of land abandonment by different user groups in an area in Northern Portugal that has been undergoing large scale abandonment. Here, we combined statements, photograph rating exercises, and open questions to assess the overall impact of land abandonment as well as the preferences for different 'abandonment landscapes'. These 'abandonment landscapes' represent different possible trajectories following land abandonment. We argue that an understanding of local perceptions, opportunities, and tradeoffs associated with changing land management are crucial for landscape-related policies and planning measures. Furthermore, we argue that these can be used as input to find a common ground for landscape management, to reduce conflicts, and as starting point for a more spatially targeted and nuanced management approach.