Multi-scale integrated analysis of land use change

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Introduction

Human induced land use changes can have major effects on landscape pattern, biodiversity and the functioning of the water and climate systems, either through a complete change of vegetation or crop type or through changes in the spatial configuration of the landscape. The simulation and exploration of future scenarios of land use change is a useful tool to assess impacts of land use change and discuss the role of land use policies and autonomous developments between scientists and policy makers. Depending on the purpose of the study and the stakeholders addressed different, scale-specific methods are available to assess such changes in land use. This presentation will illustrate the use of such scenario-based simulations for two case studies at different scales. We will argue that the analysis at multiple scales is complementary and necessarily to adequately address the multi-scale structure of the land use system.

European scale case study

The first study concerns a high-resolution analysis of land use change and environmental impacts for the full territory of the European Union based on the EURURALIS and SENSOR projects (http://www.eururalis.eu; http://www.sensor-ip.org). This continental study aims at assessing the effects on landscape change for Europe's rural areas due to changes in demography, global trade, technology and enlargement of the European Union (Verburg et al. 2006; Verburg et al. 2008). Changes in demand for agricultural products and agrarian structure are likely to have a large impact on landscape quality and the value of natural areas. In addition, several European policies to counteract the adverse effects of such changes in landscape are evaluated on their effects. A spatially explicit, dynamic, land use change model was used to translate European level scenarios into a high resolution assessment of changes in land use for the 27 countries of the European Union. Simulated scenarios differ in world view, ranging from enhanced global cooperation towards strong regionalization on one hand and strong to weak government intervention on the other. Global economic and integrated assessment models were used to calculate changes in demand for agricultural area at country level while a spatially explicit land use change model was used to downscale these demands to land use patterns at 1 km2 resolution. The land use model explicitly accounts for the variation in driving factors among countries and the path dependence in land use change trajectories. Results indicate the large impact abandonment of agricultural land and urbanization has on European landscapes and the different scenarios indicate that spatial policies can make an important contribution to preserve landscapes containing high natural and/or historic values.

Furthermore, the dynamic simulations indicate that the trajectory of land use change has an important impact on resulting landscape patterns as a result of the path-dependence in land use change processes. The results are intended to support discussions on the future of the rural area and identify hot-spots of landscape change that need specific consideration. One of the specific European scale policies that were evaluated it the so-called 'less favored areas' policy aimed at reducing land abandonment in marginal areas in order to preserve rural livelihood conditions, cultural heritage and valuable landscapes. Many of these areas coincide with the so-called 'high nature value farmland' areas that are important in terms of agro-biodiversity. The simulations clearly show the trade-offs of compensating farmers in such areas and can be used to identify areas where such policies may be most efficient and successful.
The results of the downscaling of macro-economic trends to landscape changes at the European scale indicate that large changes in land cover are to be expected in the peri-urban areas. Further urbanization and claims on land for recreational uses and leisure related activities will cause an increased pressure on these areas. The results of this study do, however, not clearly indicate the change in land use functionality since the macro-economic models focus on the agricultural production characteristics and the spatial models solely indicate changes in land cover.

Regional scale study

The second case study focuses on a small region within Europe, the Gelderse Vallei region of the Netherlands. The consequences of peri-urban development and structural change in agriculture are analyzed at a high level of detail with special attention to the landscape functionality. At this scale specific attention is given to the capacity to provide landscape good and services. So, instead of focusing on land cover types, functioning of the landscape is addressed.
In addition to agricultural production, most rural regions in Europe provide a range of other landscape goods and services, including non-commodity outputs such as favorable conditions for tourism, protection of cultural heritage or nature conservation. The various landscape functions are not equally distributed over the landscape as their spatial variability depends on the local processes and the different components of the landscape.
The presented study aimed to quantify the spatial variability and multifunctionality of selected landscape functions in relation to their surrounding social and biophysical processes and conditions. Determining the delineation of landscape functions is not straightforward as not all functions can be observed directly from the landscape. By solely observing land cover, identifying the 'agricultural production function' is less complicated than detecting a 'tourism' function, because 'tourism' is not related to one single land cover type. In this study spatial indicators related to social and biophysical characteristics of the landscape were used to assess the delineation of functions and their capacity to provide goods and services. Depending on the available information on the location of current landscape functions different function assessment methods were used to come to landscape function maps.
In relation to the European policy focus on multifunctional landscapes, interactions between landscape functions can be studied by overlaying function maps and comparing spatial indicators, providing policy makers the opportunity to optimize their land use

strategies. Especially in areas with a high pressure on land resources, like in the Netherlands, a good management of interacting functions of a multifunctional landscape promotes sustainable land use.

Within such a more detailed study the changes in landscape functionality in response to European level and global processes of change can be explored and region specific policies and adaptations evaluated.

References

Verburg, P.H., Rounsevell, M.D.A. and Veldkamp, A. (2006). Scenario-based studies of future land use in Europe. *Agriculture, Ecosystems & Environment*, 114(1): 1-6.

Verburg, P.H., Eickhoudt, B. and Meijl, H.v. (2008). A multi-scale, multi-model approach for analyzing the future dynamics of European land use. *Annals of Regional Science*, doi:10.1007/s00168-007-0136-4.