

# Modelling the influence of land use and land cover change on landscape functions

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Abstract: This paper provides an overview of the current challenges in land system modeling. One of the main challenges is go beyond an analysis of land cover change and include aspects of land function and management as well. The paper identifies potential modeling and scenario tools to address these challenges and provides examples of innovative research in this field.

Keywords: ecosystem services; scenarios; spatial models; land use and land cover

## Introduction

One of the main challenges in monitoring, modeling and communicating land change is the relation between land cover, land use and the provision of goods and services by the land system. The capacities of the land system to provide goods and services are often referred to as landscape functions (Verburg et al., 2009). Many studies have assessed the consequences of land use and land cover change on different socio-economic and environmental conditions as a post-analysis or impact assessment, e.g. by a series of indicators (Schröter et al., 2005; Helming et al., 2008). However, in reality the functionality of the land is intricately linked to the characteristics of the land system. A change in the provision of goods and services by the land is often not just a result of land cover change but an important driving factor of future land cover dynamics as well. The Millennium Ecosystem Assessment has requested specific attention for the way in which land cover change and ecosystem functioning are linked. Such assessments are difficult because there is no one-to-one relation between land cover and functionality. Functionality is often determined by both local and contextual factors synchronously. In addition, landscape function may not be observed and monitored by standard techniques used in land cover observation. In many cases landscape function may drastically change without any change in land cover and vice versa. Attempts to quantify landscape functions based on land cover information are often limited since land cover is not always a good indicator for the actual functions performed by the land at that location (Willemen et al., 2008). Therefore, impact assessments based on current monitoring and modeling techniques are often limited to landscape functions that can be quantified based on the land cover (change) map.

This presentation aims at providing an overview of the state of the art in methods and models for assessing land use and land cover change in relation to landscape functions. Based on this overview a number of promising pathways of further developing land change models will be discussed.

## **1. Dynamic models for land change analysis**

Land use and land cover change are one of the main drivers of changes in landscape functions. In many instances these changes lead to trade-offs between different functions. Local conditions and the spatial and social context of the study area influence the impacts of land use and cover change on the provision of ecosystem goods and services.

In order to target rural development and strengthen the multiple functionality of the landscape it is important to determine these context specific factors that influence the dynamics in landscape functions.

In this paper number of examples will be provided of studies carried out at different spatial scales that investigate the effect of land use change on landscape functions. These methods include:

-top-down, spatially explicit land change models linking global dynamics to regional level impact on land use followed by an assessment of impacts on landscape functions (Kienast et al., 2008; Verburg et al., 2008).

-agent-based simulations of local decision making leading to changes in landscape composition and structure (Valbuena et al., 2010; Valbuena et al., 2008)

-methods to map and model landscape function response to policy and planning at the regional scale (Willems et al. 2010).

Each of the methods has its own range of typical applications, data needs and potential outcomes. The choice of method is largely dependent on the scale of analysis and dominant processes of land change.

## **2. Tradeoffs and hotspots**

Based on assessments and models of land change and landscape functions hot-spots of changes in landscape functions can be identified. Such hot-spots analysis may be used to target interventions and more detailed assessments. At the same time, it is not the change in single landscape functions at a specific location but rather the trade-off between functions as result of these changes that is of importance. The costs of increasing production at a location may be large in terms of a range of other functions at the location itself or in other areas as result of teleconnections. Therefore, tradeoff analysis tools to analyze the effects on multiple functions need to be used, both on-site and off-site. The quantification of land use change impacts on landscape functions is not straightforward and different methods are

used depending on the scale of analysis and available data. A number of examples of such methods will be provided.

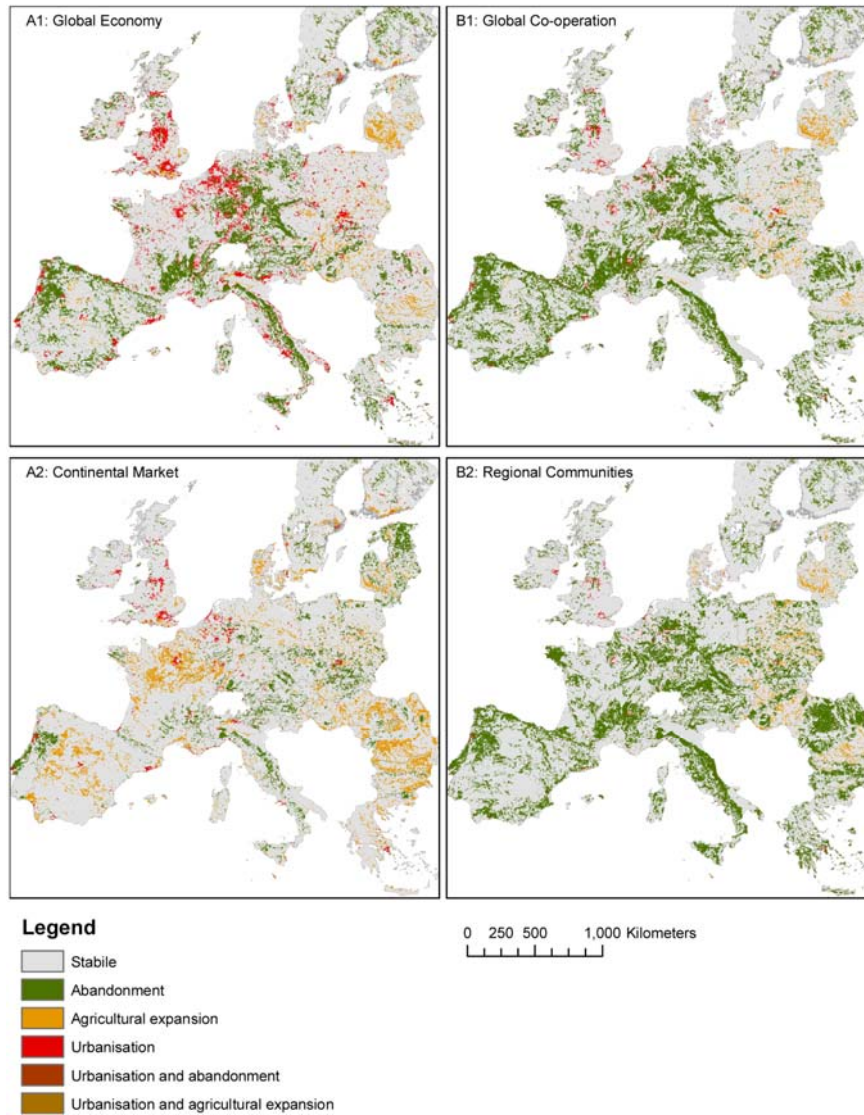


Figure 1. Example of the identification of hot-spots of land change using a multi-scale, multi-model approach (based on: (Verburg et al., 2010))

### 3. Scenario assessments: visions and opportunities

In order to be able to target policies to make best use of regional potentials of landscape functions methods are proposed that quantify the region-specific potentials of the landscape to support different landscape functions. The identification and simulation of the potentials of a location to provide landscape functions provides an additional layer of information complementary to the assessment of actual landscape functions and their change. At local level participatory scenarios may be used to identify the local potentials by confronting stakeholders with possible scenarios and visualisations (van Berkel et al., in prep). At larger scales simulation methods and indicator assessments are needed to quantify these potentials. Most critical is the assessment of pathways towards better using these potentials. Therefore, confronting explorative scenarios with visions on regional potentials may help to identify the region specific assets and constraints towards moving into sustainable development pathways.



Landscape in 2009



Visualisation of scenario with multi-functional landscape development

*Figure 2 Example of visualisation of participatory vision development for a case study area in Northern Portugal (van Berkel, Ribeiro, Verburg, Lovett, in preparation)*

## Conclusions

The research approaches presented are a series of complementary methods to better identify, map and simulate the relations between land cover, land use and landscape functions. Each of the approaches has its own specific strengths and weaknesses in addressing the different dimensions of land change. When used in a complementary manner they contribute to the portfolio of methods available for better understanding the earth system.

The examples illustrate the importance of accounting for the spatial variation in landscape, environment and society in assessments of landscape functions across different scales. A good combination of such will help to better design and target rural development policies, investments and land management in order to retain and improve the capacity of the landscape to provide goods and services to society.

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