Chapter 6
Simulating Land Use Policies Targeted to Protect Biodiversity with the CLUE-Scanner Model

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ABSTRACT

This chapter presents an integrated modelling approach for assessing land use changes and its effects on biodiversity. A modelling framework consisting of a macro-economic model, a land use change model, and biodiversity indicator models is described and illustrated with a scenario study for the European Union. A reference scenario is compared to a scenario in which a number of possible policies for conservation and protection of biodiversity are assumed to have been implemented. The results are evaluated by an indicator of the habitat quality for biodiversity and an indicator of landscape connectivity. The results illustrate that land use change has spatially diverse impacts on biodiversity. The effectiveness of the assumed policies is region and context dependent. The modelling framework can thus provide ex-ante assessments of policies and identify critical regions for biodiversity conservation and assist in targeting policies and incentives to protect biodiversity in vulnerable areas.

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1. INTRODUCTION

Land use change is an important determinant of biodiversity loss and changes in the availability of natural resources. Many studies have indicated the importance of land use change research to assess the impacts on biodiversity and other environmental and social consequences of land use change (Reidsma *et al.*, 2006; Verboom *et al.*, 2007; Trisurat *et al.*, 2010; DeFries *et al.*, 2004). These studies have indicated that not only the total area of the ecosystem converted, but also the spatial pattern and the location of change, are important factors determining the impact of land use changes on biodiversity. Fragmentation of habitats, the conversion of critical locations for threatened species and the blocking of migration routes are important processes that make the effects of land use change on biodiversity more important than the conversion of the habitat by itself. Therefore, the relation between land use change and biodiversity can only be adequately assessed when a spatial perspective is taken. Measures taken to avoid or reduce biodiversity loss are, in many cases, also related to specific locations, e.g. the establishment of natural parks, ecological corridors, buffer zones etc. Planning of such measures needs to consider not only the types of pressure that the anticipated land use changes will cause, but also where they will happen, as well as the spatial determinants of biodiversity.

Land use modelling in scenario studies has become an important tool in ex-ante evaluation of policy and spatial planning (Koomen *et al.*, 2008b). Land use modelling facilitates the identification of the possible consequences of different types of development and helps to evaluate the effectiveness of policies. In addition, integrated land use modelling can identify the trade-offs of policies in other sectors on biodiversity. Examples of such ex-ante assessments of land use change are available for different regions in the world (Verburg *et al.*, 2006; Hellmann & Verburg, 2010; Voinov *et al.*, 1999). In such studies a range of different land use models are used, often adapted to the local situation and its specific conditions. Also, the scale of analysis is an important determinant of the type of modelling chosen. A major challenge in such studies is to consistently link the methods of land use analysis with methods to derive the scenarios and assessments of the impacts on biodiversity indicators. Often the amount of information on ecosystem changes provided by land use models is limited by data availability and the abstractions made during the modelling process. The biodiversity assessment methods need to make best use of the limited information available on the specific ecosystem conditions, while the land use modelling needs to be tailored towards an output that makes an evaluation of the possible consequences of policies related to biodiversity conservation possible.

The objective of this chapter is to present a consistent method for evaluating the effects of policy scenarios affecting land use for the complete European Union (EU27), using as illustration a scenario aimed at conserving and protecting biodiversity.

2. METHODS

2.1 The CLUE-Scanner Model

The overall methodology for assessment is based on a multi-scale, multi-model approach that integrates the economic, demographic and environmental drivers of land change in a consistent modelling framework as described by Verburg *et al*. (2008). Figure 1 provides an overview of the modelling methodology. Global scale drivers of land use change originating from changes in demography, consumption patterns, economic development, trade and climate change are analyzed with the combined application of the global economy model LEITAP and the global integrated assessment model IMAGE. A detailed description of the interaction between these two