Chapter 4
Monitoring Biodiversity Using Remote Sensing and Field Surveys

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ABSTRACT

The world population has grown rapidly in conjunction with technological developments, especially in the last two centuries, which has led to a significant expansion of industrialisation, urbanisation, and agricultural intensification. As a result, land use and associated land cover have changed at an increasing rate, intensifying the pressures on habitats and landscapes, and biodiversity in general. The steady decline of habitats and landscapes demonstrates the need for protection. Monitoring the extent and quality is also required in a more comprehensive fashion across the countryside, ranging from regional to global scales. The Rio Declaration in 1992 confirmed the need to work towards international agreements to protect the integrity of the global environment. The associated Convention on Biological Diversity (CBD) draws attention to the need to identify and monitor ecosystems, habitats, species, communities, genomes, and genes. All CBD parties have committed themselves in achieving the 2010 Biodiversity Target: to protect and restore habitats and natural systems and halt the loss of biodiversity by 2010. All these policies require quantitative figures on the extent of habitats and their degree of fragmentation. Unfortunately 'hard' figures on the extent of landscapes and associated habitats (inside and outside protected areas) are currently not available. Therefore, the main objective is to develop quantitative methodologies for the spatial identification and monitoring of European landscapes and their habitats.

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This chapter concludes that, in combination with additional environmental data sets, it is now possible to model quantitatively the spatial extent of widespread habitats and landscapes on the basis of land cover information derived from satellite imagery. Although it is now possible to model the spatial extent of widespread European habitats, these patterns cannot be directly translated into area estimates. The retrieval of accurate land cover information is not only crucial for the spatial modelling of European landscapes and habitats, but also for their monitoring. Operational remote sensing enables land cover characterization at various scales but the classification accuracies are still insufficient at continental and global scales for monitoring purposes. Instead, the use of continuous thematic fraction layers, as derived from linear unmixing, provides a good basis for monitoring land cover changes of Europe's complex landscapes. However, gradual and small changes in habitats and their quality are not easily detected from space by satellite imagery, and therefore, additional information from field surveys is needed. Protocols for rapid field surveying of habitats have been developed that can provide a European baseline based on a sampling design across European landscapes. The information from the field samples (e.g. square kilometres) can be used for the validation and calibration of the obtained distribution maps of European habitats. The field surveying method is amongst others based on the estimation of the main plant life forms, which are highly correlated with vegetation structure. The latter has been shown to have a good relationship with satellite imagery. Field surveys are always limited to relatively small areas in Europe, and therefore, the spatial modelling of habitats and landscapes with the help of remotely sensed information remains important for providing a synoptic overview.

1. INTRODUCTION

During the last two centuries in particular, the world population grew rapidly, in conjunction with technological developments, which led to a significant expansion of industrialisation, urbanisation and agricultural activity (Stanners & Bordeaux, 1995; Moran *et al*., 2004; EEA, 2005). As a result, land use and associated land cover changed at an increasing rate, intensifying the pressures on landscapes, habitats and biodiversity in general. A global analysis by Klein Goldewijk & Ramankutty (2004) showed that between 1700 and 1990 the area of arable land increased by approximately 500%, from 3 million km^2 to 15 million km^2, and that of grassland by approximately 600%, from 5 million km^2 to 31 million km^2, both at the expense of semi-natural vegetation and forests. Over the same period, forest area decreased by approximately 17%, from 53 million km^2 to 44 million km^2. Types and rates of land cover change vary over time and space. Europe, for example, has experienced an opposite trend over the last 40 years, which included a net forest increase of approximately 10%, a net loss of arable land of about 11% and a net loss of permanent grassland of about 11% (source: FAO land use statistics). The EU project BIOPRESS showed, by analysis of historical aerial photographs over the period 1950-1990-2000, that of these land cover changes urbanisation was predominant. Alarmingly, the project showed that in the 59 transects across Europe the rate of land cover change remained almost constant; respectively, 15% and 14% per decade over the periods 1950-1990 and 1990-2000 (Köhler *et al*., 2006; Gerard *et al.*, 2010). In The Netherlands, between 1950-1990, in parallel with a net loss of agricultural land and a net increase of forest and urbanisation, there was a dramatic 44% decline of natural areas (Van Duuren *et al*., 2003). The amount of heathland was reduced by 68%, of salt marshes by 60%, of raised bogs (moors and peat-land) by 81% and of inland sand dunes by 52%. Only wetlands increased, by 9% (http://