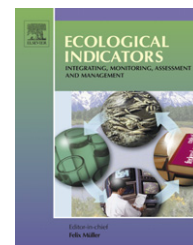


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Monitoring of landscape change and functions in Saxony (Eastern Germany)—Methods and indicators

Ulrich Walz

Leibniz Institute of Ecological and Regional Development (IOER), Weberplatz 1, D-01217 Dresden, Germany

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ABSTRACT

Important tasks of modern landscape ecology are to monitor and assess natural resources, to examine the impacts and effects of human intervention and, last but not least, to observe the state of the environment over long periods of time. Substantial goals of research at the Leibniz Institute of Ecological and Regional Development (IOER) are the development of methods for the detection of land use changes and for the description of this development by indicators, as well as the analysis and evaluation of the effects of such processes on selected environmental protection assets. GIS technologies were developed for the digital preparation and analysis of historical maps, and subsequent digital land use mapping.

This contribution focuses on spatial indicators to describe the environmental effects of land use change. The results from a long-term monitoring project will be presented: the structural changes of land use and their impact on landscape functions in a rural area within the national park region Saxon-Bohemian Switzerland, and the development of landscape fragmentation by transport infrastructure over the whole Federal State of Saxony. The analysis of the structural landscape changes proved to be an important aspect.

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1. Introduction

In Germany and other European states there is a high constant demand (growing in some areas) for land to construct settlements and new roadways. Today, landscape development in Central Europe is primarily a result of anthropogenic processes, affecting almost the entire landscape. Changing landscapes, especially changes to the way in which land is used, result in alterations to the landscape structure—and hence also to the abiotic and biotic functions and potentials of a landscape. Changes in land use often take place as small-scale individual measures, insignificant in themselves. However, over the long-term, the accumulation of such minor changes can lead to significant shifts in regional structures and environmental conditions. For analysing the effects of land use, it is fundamental to realise that ecological processes

occur within a temporal setting and change over time (Dale et al., 2000; Turner et al., 2001). Therefore, some important current tasks of landscape ecology are to monitor and assess natural resources, to examine the impacts and effects of human intervention and, equally vital, to observe the condition of the environment over long periods of time.

Central Europe is a region dominated by anthropogenic developments in housing, trade, industry and intensive agriculture. Human exploitation of natural resources such as soil, water, flora and fauna as well as space itself (due to urban expansion), has, over the past 60 years, been on a far greater scale than ever before (Bastian and Schreiber, 1999). Although population increase, as the major driving force for land use and landscape change over centuries, has now stabilised in Central Europe, expanding settlements and new infrastructure place ever greater demands on the land

E-mail address: u.walz@ioer.de.

URL: <http://www.ioer.de>.

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(European Environment Agency, 2006a, p. 11). The improved mobility of modern society is associated with intensive road construction and associated infrastructure. Unfortunately, this new technical infrastructure leads to a greater fragmentation of open space (Jaeger, 2002; Walz, 2005b).

Land consolidation and drainage projects have allowed an intensification of farming, increasing the average size of individual plots used for agriculture at the same time as structural elements of the landscape are obliterated. Thus, the general trend of landscape development in Central Europe is towards more monotonous, less diverse landscapes, combined with the impairment of landscape functions over large areas. Economic planning by former socialist regimes has left a legacy of extremely large management units, especially in the eastern part of Europe (Fig. 1). On the other hand, the economic development and agrienvironmental policies of the European Union have led to a decline in the total area of land devoted to agriculture (European Environment Agency, 2005, 2006b).

One of the main themes of landscape ecology in the coming decades will certainly be the close study of such processes, as well as integration of the knowledge obtained into relevant instruments of control, e.g., landscape monitoring and information systems (Walz, 2002; Lang and Blaschke, 2007, pp. 309–323).

1.1. Research goals

Substantial goals of research at the Leibniz Institute of Ecological and Regional Development (IOER) are the development of methods for the detection of land use changes and for description of these trends by indicators, as well as the analysis and evaluation of the effects of such processes on selected environmental protection assets. Environmental information systems and GIS technologies provide tools and methods which help to quickly assess the consequences of particular actions and decisions. Our investigations combine the classic approach of landscape analysis with methods from geoinformatics. GIS procedures were developed for the digital preparation and analysis of historical maps and subsequent digital land use mapping. This technique allows the spatial appraisal of time series and the inclusion of natural-spatial data. It includes the statistical analysis of the configuration of landscape elements with landscape indices.

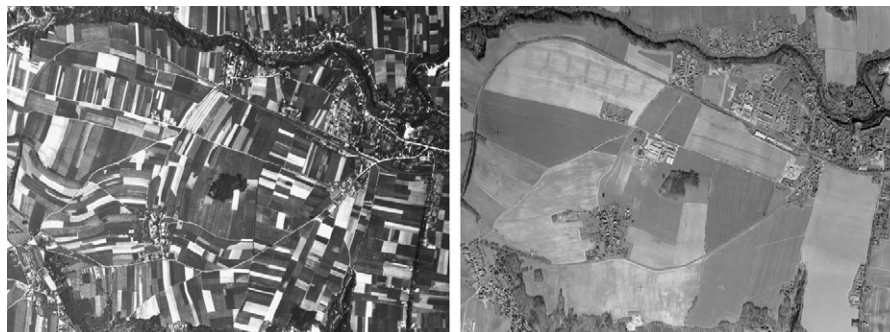


Fig. 1 – Typical change of landscape structure in the agricultural landscape of Saxony (1953–2002). Source: Aerial Photos © LVA Sachsen.

The main objectives and aims of the research work are:

- development of methods for data preparation and analysis of land use changes and landscape structure as a basis for a long-term monitoring;
- comparative survey and analysis of historical and current land use and structure;
- evaluation of the effects of landscape change on the environment and on landscape's ecological functions;
- formation of indicators and indices for land use or landscape change;
- shaping and visualisation of the results for the public and decision-makers.

The focus in this contribution is on spatial indicators for the description of the environmental effects of changes in land use. Special attention is given to the analysis of changes to structural landscapes.

2. Methods

2.1. Investigation area

The study examined areas on two spatial scales (Fig. 2). At the higher level we considered the whole Free State of Saxony, as well as the surrounding cross-border areas along the borders to other federal states of Germany and neighbouring countries, i.e., the Czech Republic and Poland. Saxony is located in the south of Eastern Germany. Formerly a part of the German Democratic Republic, the area's infrastructure and settlements have undergone intensive development since the political changes of 1989. At a more detailed level we focused on the "Saxon Switzerland" national park, located in the south-eastern part of Saxony. This national park is delineated by the border of the national parks and its surrounding landscape conservation areas. The area covers 398 km², of which 93.5 km² is protected as a national park and 287.5 km² is a designated landscape protection area. This unique central European landscape is the German part of the Elbe Sandstone Mountains, which extend into Bohemia (Czech Republic). Saxon Switzerland is one of the oldest and best-known tourist areas in Central Europe. Its long tradition as a beauty spot goes back to the Romantic era, when Swiss and German painters

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