Analysing the long term impact of landscape change on landscape structure and landscape functions in the national park region Saxon Switzerland

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Introduction and investigation area

Important tasks of today's landscape ecology are to monitor and assess natural resources, to examine impacts and effects of human intervention and – last but not least – to observe the state of the environment over long time periods. We focused on spatial analyses as well as indicators for the description of the environmental effects of land use changes concerning landscape structure and selected landscape functions.

The study is exemplified by the national park region Saxon Switzerland (398 km²), which consists of a national park (93.5 km²) and a surrounding landscape conservation area (287.5 km²). The region is situated in the east of the Federal Republic of Germany, south-east within the Free State of Saxony. Only some kilometres upstream the Elbe river from the state capital Dresden the area is bordering the Czech Republic in the south. The landscape unique in Central Europe represents the German part of the Elbe Sandstone Mountains which extend to Bohemia with a corresponding national park and landscape conservation area. The landscape of the region is characterised by forest and rock areas, including mesas, sandstone rock towers and u-shaped gorges, which are predominantly free of settlements, plateaus, which provide favourable conditions for agricultural use but also include most of the settlements, and canyons like the Elbe river valley with its scarps and vertical rock walls.

Analysing landscape change

The investigation is based on the analysis of historical maps from the last 200 years. The land use data of five time states was digitised and processed with a sufficient accuracy using a Geographic Information System (GIS). For the classification of all datasets the CORINE Land Cover nomenclature was used. It was adopted by additional classes in some cases (up to five levels instead of three). Up to 22 different polygon and line classes could be mapped at each point of time. The resulting digital land use database was used for the further GIS-based spatial analysis of landscape change, e.g. land use statistics, land use stability (number of land use changes), development of road and field path network or spatial changes of single land use classes. As a further result indicators for the description of the most important changes were developed (Neubert and Walz, 2006).

Effects of landscape change on landscape structure

The structural changes of the landscape were quantified by means of structural indices (landscape metrics). For the calculations of landscape metrics on class and landscape level ArcGIS 9.1 and the ArcGIS extension V-LATE 1.1 (LARG, 2005) were used. Self-developed calculation routines were applied for analyses based on 250 m grid cells, which are particularly suitable for spatial comparison over time periods, because the reference areas remain unchanged. The resulting values confirm trends of landscape development from the previous change analysis. Most of the developments are continuous in the period 1780 to 1940 and converse afterwards. This tendency can be found in all landscape metrics calculations of the investigation area. Reasons for this development can particularly be found in the following phase of farming collectivisation and reallocation of land in the GDR time. The aim was the homogeneous cultivation of both heterogeneous and extreme sites. The field path network was strongly decreased, and thus, a lot of land use boundaries were eliminated. In addition hedges, tree rows and bosks were removed and flowing waters became canalised and piped. These actions exerted a far-reaching influence on the structure and with that on the character of the landscape.

Furthermore, using a correlation analysis of the calculations based on grid cells the most significant landscape metrics were selected from the extensive overall set of structure measures. *Mean Patch Size*, *Patch Size Standard Deviation*, *Mean Patch Edge*, *Mean Perimeter-Area Ratio*, *Mean Fractal Dimension*, *Mean Shape Index* and *Dominance* turned out to be weakly correlated, while *Mesh*, *Proportion*, *Shannons' Diversity* and *Evenness indices* have a high relevance despite high correlation. Those metrics can therefore be considered as indicators of landscape structure development (Tröger, 2006; Neubert & Walz, 2006).

Impacts on landscape functions

For the further analyses the extensive land use database of different time states was used to model how these land use changes affect selected functions or potentials of landscapes. The effects of land use changes on the suitability of the landscape for a nature-oriented recreation, the impacts on soil erosion as well as on groundwater regeneration were examined. Another part of the case study focused on the correlations between land use change and biodiversity. An additional cross-border study has shown impressive results for the increase of landscape fragmentation in the Saxon-Bohemian Switzerland. The results of this analyses show that there have been negative impacts taken place to all of the functions analysed and a loss of landscape functionality could be shown. For example, the soil erosion of agricultural land has increased as a result of changed field structures, mainly the increase of erosion effective slope length due to the elimination of erosion barriers, like hedges, tree rows or field paths.

Conclusions

The information gathered by such analyses is helpful for the management of protected areas which are oftentimes tourist regions relying on their natural conditions. The resulting database of changes between historic and present landscape state contains quantitative-statistical information, which can be used for example for a continuous monitoring with comparable measure values. A set of indicators of landscape change is proposed to determine trends in landscape development and their consequences. Thus, problems of the impact of land use change can be counteracted in future. Furthermore, the results can be used to manage the changes of land use spatially in detail. Doing so, sensitive areas (e.g. for ground water recharge or as habitats) can be protected in a more efficient way.

For a more detailed description of project results and further publications see the project website under http://www.ioer.de/sistemaparc.

References

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