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Landscape change and biodiversity values of floodplains along the River Vistula, Poland

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winner of the NCR-days
poster Award 2008

Abstract

This paper deals with the effects of landscape change on spatial distribution of ecotopes and the assessment of biodiversity values of the Middle Vistula river valley in the Kazimierski Landscape Park (Poland), using the BIO-SAFEv model. The actual biodiversity values of the river valley in are high in comparison with floodplains of other lowland rivers in Europe. GIS-analyses of remotely sensed ecotope maps show remarkable differences in number, acreage and patchiness of ecotopes for the years 1953 and 2003. Side channels and floodplain lakes became fragmented. The average and total surface area of bush, forest and arable land increased, but decreased for bare soil, pioneer vegetation and grassland. These changes in distribution of ecotopes indicate both natural vegetation succession and increase of human impacts (e.g., intensification of agriculture and progressive impacts of river regulation). Current landscape changes negatively affect biodiversity values.

Introduction

In spite of floodplain embankment for urbanisation, industrialisation and agriculture, the Middle Vistula River still shows rather natural hydro-morphological characteristics with sandy islands, braided-meandering channels and species rich vegetation (Kajak, 1993). Therefore, the Vistula River is often used as reference for other lowland rivers. This paper describes the impact of landscape changes on distribution of ecotopes and biodiversity values of the Middle Vistula river valley (Fig. 1). It aims to answer the following research questions:

1. What are the changes in the number, surface area and patch size of ecotopes over the period 1953-2003?
2. What are actual biodiversity values in comparison with floodplains along the rivers Rhine and Meuse?

Study area

The River Vistula is the largest river in Poland, crossing the whole country from the Carpathian Mountains in the south to the Baltic Sea in the north (Fig. 1). Our study areas are located in the Middle Vistula river valley. The subsoil of the river valley mostly consists of course-grained sandy-clay soils. Owing to historical data availability, two sites in the Kazimierski Landscape Park (Lubelski Province) were selected for our case studies:

1. The river valley between the villages Janowiec and Nasitow (rkm 357-363; 482 ha) for assessment of actual biodiversity values; and
2. The river valley between the villages Lucimia and Kazimierz Dolny (rkm 249-359; 1107 ha) for analysing effects of landscape change on biodiversity values.

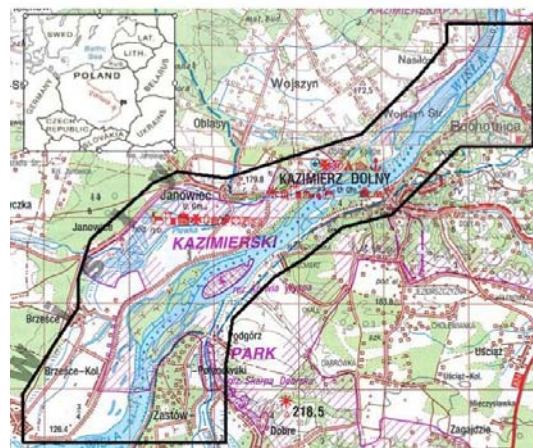


Figure 1. Location of the study area.

Methods

Actual biodiversity values are quantified using the Taxonomic Biodiversity Saturation (TBS) index in the Vistula version of BIO-SAFEv (Wozniak et al., 2009), a model meant to quantify biodiversity and to value ecotopes based on legally protected species (Lenders et al., 2001; De Nooij et al., 2004).

Biodiversity values were calculated using the actual distribution data of legally protected flora and fauna species. These data were obtained from several atlases and regional surveys. Landscape change was analysed using a retrospective method (Geerling et al., 2006). Ecotope maps were digitized using black- and white aerial photographs of the

years 1953 and 2003 with stereoscopic verification. The maps were validated by ground truth and comparisons with topographical maps. The number, acreage and patchiness of ecotopes were analysed using ArcGIS 9.0.

Results

- The study area shows remarkable landscape changes over the period 1953-2003 (Fig. 2). The total number of ecotope patches increased with 43.8 %. Side channels and floodplain lakes became fragmented. The average and total surface area of bush, forest and arable land increased, while that of natural pioneer vegetation and grassland decreased.
- In comparison with floodplains along lowland reaches of the rivers Rhine and Meuse, the Vistula river valley still represents high biodiversity values for higher plants, mammals, fish and herpetofauna (Fig. 3).

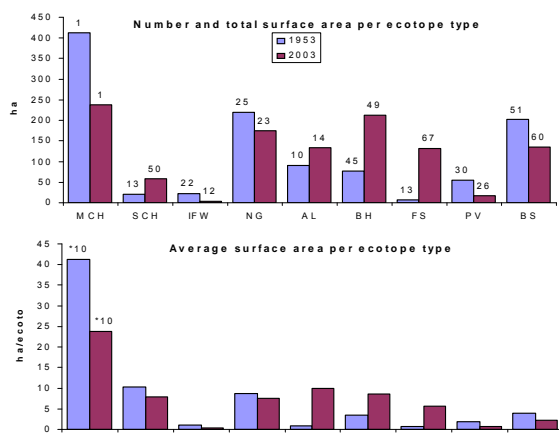


Figure 2. Changes in ecotope numbers, total surface area and average patch size (1953-2003). MCH: main channel; SCH: side channel; IFW: isolated floodplain water; NG: natural grassland; AL: arable land; BH: bush; FS: forest; PV: pioneer vegetation; BS: bare soil.

Discussion

The ecotope changes indicate both natural vegetation succession and increase in anthropogenic impact (intensification of agricultural land use and progressive river regulation by construction of embankments and groyes (Wozniak et al. 2009). In spite of several anthropogenic impacts, the Middle Vistula river valley still represents high biodiversity values. Many nationally and internationally protected species were recorded in recent field surveys. However, extensive analyses of recent landscape change with BIO-SAFEv show a decline of the potential values of the Middle Vistula river valley for several groups of protected and

endangered species (Wozniak et al. 2009). Assessments with policy-based valuation models for biodiversity and ecotopes, such as BIO-SAFEv, can help to balance biodiversity conservation, river management and landscape planning.

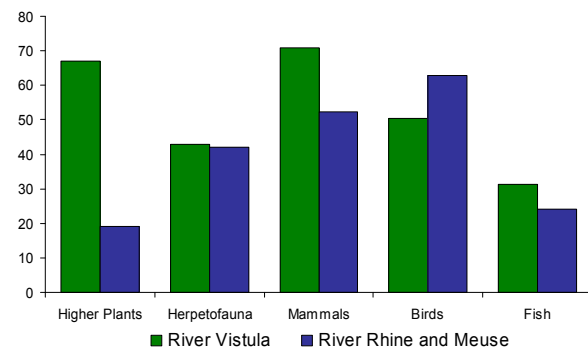


Figure 3. Taxonomic Biodiversity Saturation indices per taxonomic group in Poland and in the Netherlands (TBS, 0-100).

Conclusions

- The actual biodiversity values of the river valley in Kazimierski Landscape Park are high in comparison with floodplains of other lowland rivers in Europe (Rivers Rhine and Meuse).
- The landscape changes indicate both natural vegetation succession and increase in anthropogenic impact.
- The changes in riverine ecotope distribution are expected to affect biodiversity values of the river valley in the near future.

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