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EO-based habitat structure assessment in a trans-boundary Natura 2000 site

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Abstract

Rivers often demarcate the border line between adjacent countries, which also affects protected sites (e.g. Natura 2000 sites) along rivers. As a consequence, the same habitat omplex may underlie different regulations and management strategies of neighbouring Member States. The historical development and recent conservation policy on Member State level may result in different patterns of usage. This special situation requires a monitoring of protected areas independent from national boundaries to evaluate the effect of conservation measures on the whole biotope complex. Earth observation (EO) methods, and in particular the use of satellite images, support such a monitoring beyond boundaries, leading to a more harmonized assessment of riparian habitats. Habitat structure analysed on the basis of EO data can be used to determine habitat quality in general and to reveal different structural patterns and compositions of habitats. Here, we present a case study in the Salzach river floodplain, a trans-boundary Natura 2000 site in Austria/Germany, which is part of the continental biogeographical region. Forest and woody vegetation patches with homogenous tree species composition were visually delineated on a very high resolution (VHR) satellite image. Two form parameters (shape index and fractal dimension)and patch size were calculated to describe the habitat structure. The results showed that the forest patches on the German side are on average smaller and more complex than on the Austrian side. This significant difference reflects different usage pattern, which can be explained by historic development.

Keywords

Riparian forest, habitat quality monitoring, landscape metrics, shape index, fractal dimension, patch size, Salzachauen

Introduction

Riparian forests are known for their high biodiversity and importance to provide ecological services (NAIMAN & DECAMPS 1997, WANTZEN et al. 2008). The monitoring of these ecosystems is essential to protect them and stipulated within the Natura 2000 network of protected sites. Information services for monitoring such habitats with the help of Earth observation (EO) are currently developed within the FP7-project MS.MONINA (www.ms-monina.eu). These services are offered in a multi-scale approach on local site level, as well as on Member State and European level (LANG et al. 2012).

Satellite imagery provides key assets for monitoring nature protected areas, where terrain conditions hinder accessibility or political borders limit a harmonized evaluation outcome. Added value information on habitat quality can be provided by landscape metrics that quantify structural heterogeneity, habitat form, diversity or fragmentation(LANG et al. 2008).

Here, we present an illustrative example of a trans-boundary Natura 2000 site with protected riparian forest habitats (alluvial forest: 91E0* and riparian mixed forest: 91F0),which occur on both sites of the border river Salzach in Austria and Germany. About200 years ago, both countries agreed to regulate the river to better demarcate the border between them (WEISS, 1981). This process was finished in the 1930s and since then different national management strategies have been implemented, influencing today´s habitat structure.

Methods

For habitat structure assessment, we compared mean values of shape index, fractal dimension and patch size between Austria and Germany. In a first step, patches were visually delineated on a multi-spectral, VHR satellite image of the WorldView-2 sensor, which was acquired in June 2012. These homogenous forest patches with a similar tree species composition (Fig. 1) were then used to calculate the landscape metrics. The shape index (FORMAN & GODRON 1986) relates the patch area to its perimeter and characterises the deviation of the patch form from an optimal circular shape. Fractal dimension (MANDELBROT 1983) describes the irregularity of an object. Both form metrics are standardised measures (LANG & BLASCHKE 2007), which can be used to determine the spatial configuration of riparian vegetation patches in terms of complexity (FERNANDES et al. 2011). Higher values of form parameters reflect more complex forms, and are often found along water bodies indicating natural conditions, whereas low values reflect compact forms, which are in many cases the result of anthropogenic management (e.g. STRASSER et al. 2012).Patch size is one indicator used to detect structural heterogeneity (AQUIAR et al. 2011). More and thus smaller patches are considered to increase heterogeneity, which generally leads to a

positive assessment of habitat quality (LANG & BLASCHKE 2007). For the calculation of landscape metrics we used V-LATE, a vector-based analysis tools extension for ArcGIS (LANG & TIEDE 2003).Statistical analyses (Mann-Whitney U (MWU) as non-parametric test for two independent samples) were conducted using SPSS 21.0to validate the differences between the countries.

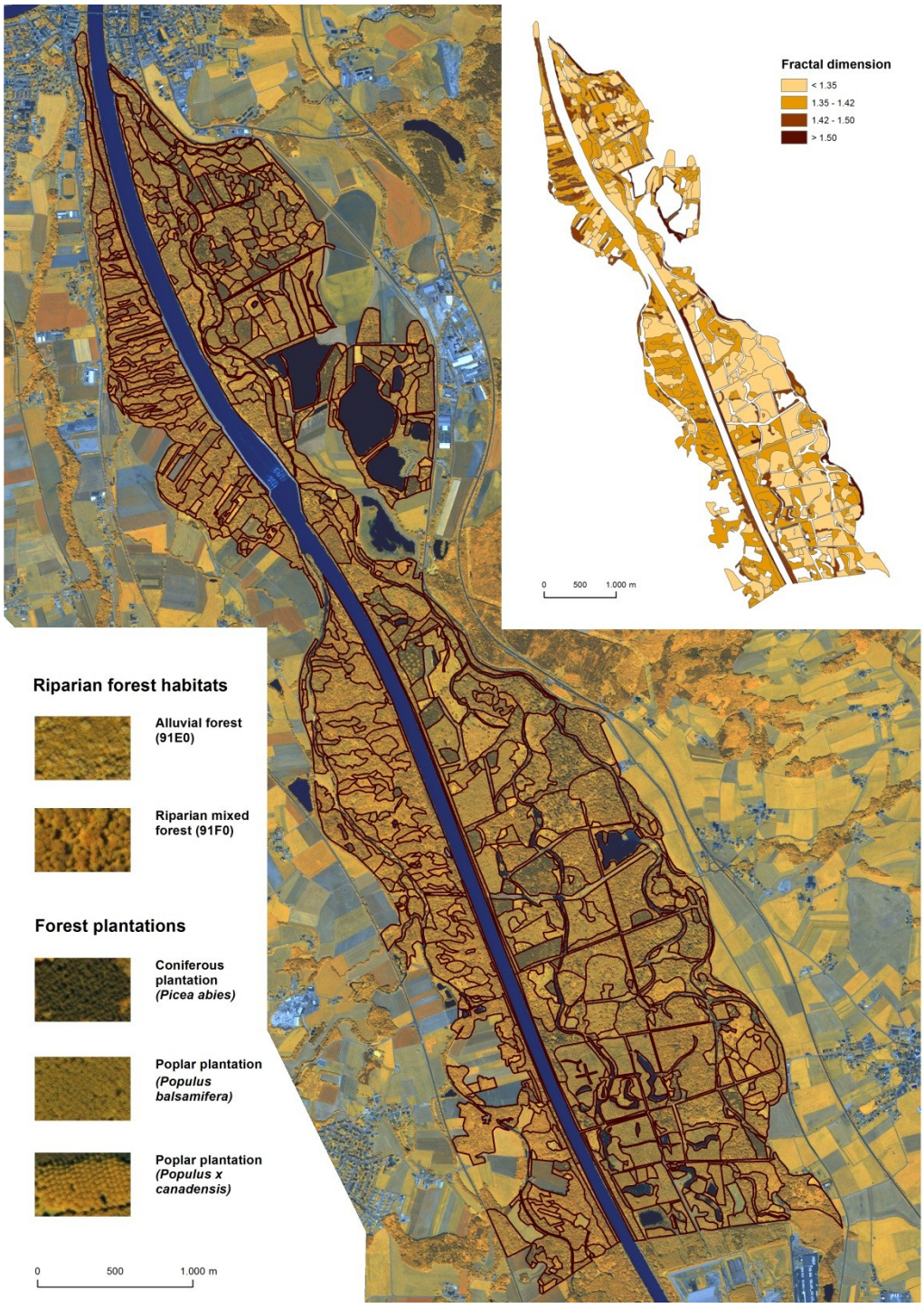

Figure 1: Forest patches and fractal dimension values describing patch form.

Results

The visual delineation of homogenous forest areas resulted in 770 patches in total. Different tree species were identified that can be assigned to different habitat types like alluvial forest (91E0), riparian mixed forest (91F0) or forest plantations (Fig. 1).

By comparing forest patches of the Austrian side to those of the German side, highly significant differences were found (mean patch size: MWU, $p<0.010$; shape index and fractal dimension: MWU, $p<0.000$).The mean patch size is significantly higher on the Austrian side, which indicates bigger, coherent forest areas. On contrary, the higher mean shape index and fractal dimension values on the German side reflect more complex forms of forest patches (Tab. 1; Fig.1).

Table 1: Landscape metrics calculated for riparian forest patches.

MEMBER STATE	Total number of patches	AREA		FORM			
		Patch size (m²)		Shape index		Fractal dimension	
		Mean	STD	Mean	STD	Mean	STD
Austria	485	13 179	16 870	1.60	0.67	1.38	0.07
Germany	285	10 311	13 474	1.67	0.49	1.41	0.11

Discussion and Conclusion

Although the riparian forest of the Salzachauen can be considered as one biotope complex, the differences between the Austrian and German side are significant. While the German part, as a general trend, is characterised by smaller forest patches with more complex forms, the Austrian part has bigger patches with simpler forms. These differences reveal a difference in usage structure of the riparian forest in the two countries. For example the northern part within the German territory is divided into private parcels with individual silvicultural usage. The historical development of ownership has led to rather small, elongated parcels. The form of these parcels results in high form index values. Thus, the chosen indicators mainly reflect structural differences that are a result of historical development. More detailed inference on habitat quality can be obtained by also taking tree species distribution and additional landscape indicators into consideration.

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