Towards an integrated assessment of protected riparian forests using EO-based indicators

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1. Introduction

Protecting habitats and areas of high biodiversity is an international commitment. Within the European Union this is supported by the EU Habitats Directive and the Natura 2000 network, where regular reporting and monitoring is mandatory (European Commission 2005). To preserve and improve the conservation status of such habitats, regularly updated spatial information on their quality and condition, as well as on existing threats and trends need to be collected (Lang et al. 2013). This information is essential for the development of adaptive local management strategies and policy decisions (Noss 1999; Vanden Borre et al. 2011).

It was often proposed to include satellite-based Earth Observation (EO) data in this task (e.g. Noss 1999; Gillespie et al. 2008), as it presents considerable potential for regularly monitoring the status and change of habitats. Today very high spatial resolution (VHR) EO data are capable of providing detailed information and characteristics, which are necessary for assessing habitat conditions on a local scale and advanced analysis techniques facilitate the extraction of thematic information on habitat conditions (Strasser et al. 2014). The area-wide coverage of EO data allows for seamless analysis of trans-boundary protected sites (Riedler et al. 2013) and the transfer of harmonized assessment methods (Vanden Borre et al. 2011) between sites that functionally belong to one single ecosystem but are subject to different national management strategies (Lang et al. 2013).

This abstract presents a study on the assessment of habitat quality of a Natura 2000 protected riparian forest with the help of EO-based indicators. The method was developed within the framework of the FP7 project MS.MONINA (www.ms-monina.eu). The aim of the study was to identify a set of indicators that cover different aspects of riparian forest quality and to compile these individual indicators into a single index (Nardo et al. 2008). This index summarizes the different aspects to support local site managers in the choice of management strategies.

2. Methods

This study was conducted in the Natura 2000 site Salzachauen, Austria (view details at http://natura2000.eea.europa.eu; area codes: AT3209022, DE7744371), which is located along the regulated river Salzach in a densely populated area of the alpine foreland at the Austrian-German border (Figure 1). According to the EUNIS classification scheme (Davies et al. 2004), the primary vegetation are *Riparian and gallery woodlands* (G1.1) and *Mixed riparian floodplain and gallery woodlands* (G1.2).

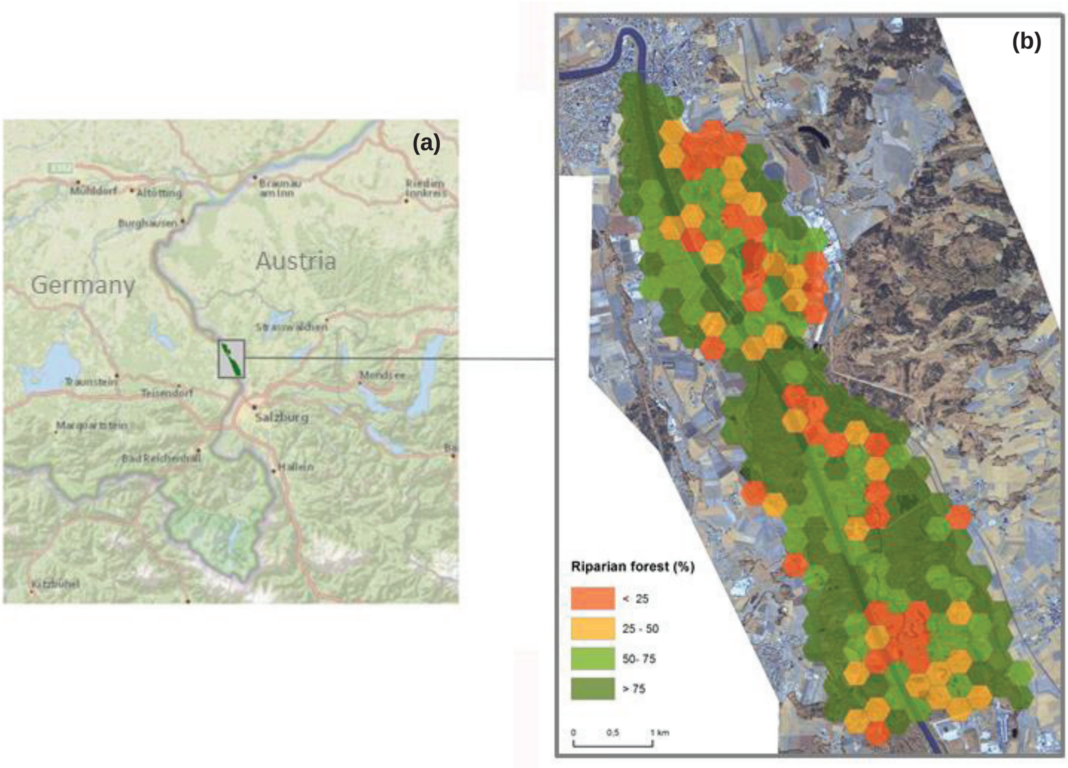

Figure 1: Location of trans-boundary flood plain Salzachauen (a), and coverage of riparian forest canopy (b).

VHR satellite imagery (WorldView-2, acquired in June 2012) along with a high spatial resolution digital terrain model (DTM) and digital surface model (DSM), both derived from airborne LiDAR data (acquired in April 2006), were used to derive a set of seven indicators. All indicators were summarised at the patch level of a semi-automated forest habitat delineation based on the WorldView-2 imagery (Strasser et al. 2014).

These indicators can be grouped to represent four different aspects of forest habitat quality: (1) the naturalness of tree species composition (Geburek et al. 2010), (2) the vertical forest structure (Noss 1999), (3) the horizontal forest structure (Noss 1999) and (4) the flood regime (Ellmauer 2005).

(1) The naturalness of tree species composition is approximated by

- the proportion of native key tree species (here *Alnus incana*, *Salix alba*, *Fraxinus excelsior*, *Quercus robur* and *Acer pseudoplatanus* derived from a semi-automated habitat model (Strasser et al. 2014) and
- the proportion of allochthonous tree species (here *Picea abies* derived from a semi-automated habitat model (Strasser et al. 2014).

(2) Vertical forest structure is described by

- the variance of the canopy surface model as approximation of the height structure, calculated by the standard deviation of height information of the DSM, and
- the number of old trees (heigher than 26 m), here extracted by calculating local maxima of the normalized DSM.

(3) Horizontal forest structure is indicated by

- the within-patch heterogeneity, using the spectral heterogeneity as an approximation for plant species diversity (Rocchini et al. 2004), here estimated from a measure of relative entropy (Dean and Smith 2003) and summarized as proportion per patch, and
- the shape index, describing the patch form complexity as an approximation for the occurrence of structural features (Riedler et al. 2013).

(4) The flood regime is described by

- the terrain roughness as an approximation for the soil wetness induced by perennial streams or channels that are activated through flooding, here calculated as the standard deviation of slope based on the DTM.

These indicators were aggregated into a composite index using geometric aggregation and expert-based weighting of the single factors (Nardo et al. 2008) The result of the composite index was compared to an existing conservation status map (REVITAL, 2014).

3. Results and Conclusions

The composite indicator provides an overview of the forest conservation status on local scale and thus allows the detection of hot-spots where management actions are needed to improve the conservation status (Figure 2a).

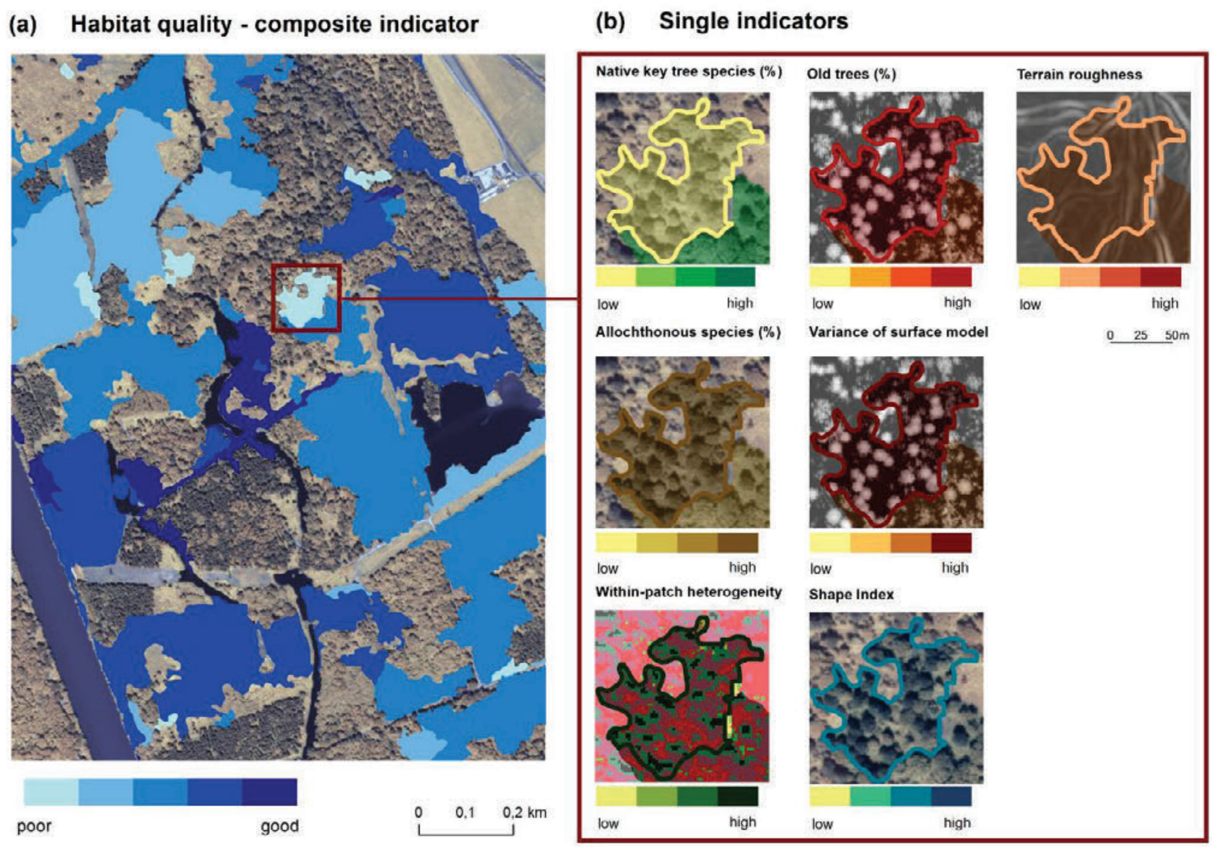

Figure 2: Composite indicator for describing the riparian forest quality (a). Seven single indicators were used for the calculation of the composite indicator (b).

This index can also be decomposed into its single indicators to identify aspects that need improvement in areas with poor quality. The poor conservation status in the chosen example can mainly be explained by a high proportion of allochthonous tree species and a low variance in terrain roughness (Figure 2b). A selective logging of *Picea abies* in addition to measures that increase soil wetness (e.g. the re-connection of dry channels to existing river branches), may be the most promising conservation measures here. Comparison of this patch with the conservation status map reveals that the overlapping area was also there graded as unfavorable-bad.

The use of the presented EO-based indicator approach complements classical field survey to assess the habitat quality status and to develop adaptive local management strategies and policy decisions independent of national and international borders.

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