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Comparison of input data with different spatial resolution in landscape pattern analysis – A case study from northern Latvia

Zigmārs Rendenieks [a,*], Aivars Tērauds [a], Oļģerts Nikodemus [a], Guntis Brūmelis [b]

[a] University of Latvia, Faculty of Geography and Earth Sciences, Jelgavas iela 1, Riga, LV-1004, Latvia
[b] University of Latvia, Faculty of Biology, Jelgavas iela 1, Riga, LV-1004, Latvia

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ABSTRACT

A suitable spatial scale needs to be selected in geographical and landscape ecological research, and this requires great consideration as different scales have profound effect on derived landscape spatial patterns. Numerous studies have investigated the effects of different scales on landscape metrics using simulated patterns, but few have been conducted to compare different data sources with variable scale for regional- and landscape-scale assessments. Possibly this has occurred because researchers have been prone to use the best available source, a well-known standard, and easiest to use. This study was conducted to assess the impact of input data resolution on values of landscape pattern metrics in four landscapes at scales 1:10 000, 1:50 000 and 1:100 000. The aim was to determine the applicability of three data sources for thematic models in landscape pattern analyses in the Eastern Baltic region. We found that the utility of CORINE Land Cover data for comprehensive structural assessment in mosaic-type landscapes was very limited, as the level of cartographic generalization excluded many small and linear landscape structure elements with potentially high importance for landscape functioning, such as habitat continuity. We also found that actual area harvested using clearcuts was considerably higher than shown in CORINE data, due to clearcuts size being much smaller than the minimum mapping unit. In the light of this, we suggest using data with spatial resolution corresponding to a cartographic scale of at least 1:50 000, in cases when spatial patches have size up to 25 ha.

1. Introduction

With the proliferation of remote sensing and GIS technologies, the significance of spatial scale in landscape ecology has gained more attention (Lausch & Herzog, 2002; Turner, O'Neill, Gardner, & Milne, 1989; Wu, 2004). Scale is significant in every phase of scientific research, but most notably in sampling, spatial analysis and also in the synthesis of the results. The theory of landscape ecology defines spatial extent and resolution as two core components of spatial scale (Turner, Gardner, & O'Neill, 2001). Thematic (categorical) data has been the dominant choice of input data in the majority of landscape pattern analyses, and in these cases thematic resolution has a profound effect on obtained results (see Bailey, Billeter, Aviron, Schweiger, & Herzog, 2007; Buyantuyev & Wu, 2007).

Quantification of landscape structure by calculating pattern indices (metrics) is crucial to determine function and dynamics of landscapes (Kupfer, 2012; Walz, 2011).

Landscape metrics are useful tool for rapid characterization of landscape background for real and simulated landscapes, as well as monitoring of landscape structure (Schindler, von Wehrden, Poirazidis, Wrbka, & Kati, 2013; Uuemaa, Mander, & Marja, 2013). A set of 5–6 relevant metrics is sufficient to characterize landscape patterns (Baldwin, Weaver, Schnekenburger, & Perera, 2004; Turner et al., 1989; Wu, Shen, Sun, & Tueller, 2002). However, the dependence of observed patterns on scale is noted as a major drawback in the use of pattern metrics (Gustafson, 1998; Uuemaa et al., 2013).

A number of studies have used real or simulated patterns in landscape pattern analysis to test the reliability of landscape metrics with regard to scaling (Argañaraz & Entraigas, 2014; Frate et al., 2014; Hargis, Bissonette, & David, 1998). Peng et al. (2010) notes

* Corresponding author. Tel.: +371 26649450.
E-mail addresses: zigmars.rendenieks@lu.lv (Z. Rendenieks), aivars@gis.lv (A. Tērauds), olgerts.nikodemus@lu.lv (O. Nikodemus), guntis.brumelis@lu.lv (G. Brūmelis).

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that landscape pattern analyses show distinct inconsistency between real and simulated landscapes.

Few studies have addressed the suitability of various data sources for landscape pattern analysis at multiple scales (see Frate et al., 2014; Giraldo, 2012). A study by Giraldo (2012) in Central Colombia demonstrated that coarse-scale thematic maps were unsuitable for the characterization of fragmented and complex mosaic-type landscapes due to oversimplification of landscape pattern. Thus, the general conclusion is that datasets with finer resolution provide more accurate quantitative assessments and allow to capture small habitat patches (Grafius et al., 2016).

Popular and freely available data sources like Corine Land Cover (CLC) are used extensively as representations of real landscapes (see Gimona, Messager, & Occhi, 2009; Kallimanis & Koutsias, 2012). This dataset was created under the program to coordinate comprehensive environmental information at the Pan-European level. As an example of its application, CLC data was used in a wide European study (Feranec, Jaffrain, Soukup, & Hazeu, 2010) to estimate deforestation rates for 1990–2000 for individual countries. In that study Portugal, Latvia and Slovakia were found to have the highest levels of timber harvesting activity in Europe. In Latvia CLC is used in municipal-level planning documents, research and policy development, due to seemingly lack of more detailed information on land cover. However, the crude scale of CLC may strongly limit application of this type of data for pattern analysis in smaller spatial extents. We were haunted by the question: has the past widespread use of CLC data created misinterpretation of real landscape patterns?

We compared landscape patterns obtained by several data sources (including CLC) that operate using different scales. The landscapes selected represented different types of spatial patterns varying from mosaic-type character to simpler, more contiguous spatial arrangements. The main aim of this study was to assess the effect of input data resolution of different data sources on values of landscape pattern metrics in four landscape at scales 1:10 000, 1:50 000 and 1:100 000. This would allow to identify the optimal spatial scale for comprehensive landscape pattern analysis in the Eastern Baltic region. We hypothesized that the use of land cover data at scale coarser than 1:50 000 would be inadequate for pattern analysis in mosaic-type landscapes (areas without a single dominant land cover type). Map data at this scale is often used in quantitative analyses; CORINE data at 1:100 000 scale is also popular but much more generalized by design. In this context, we closer examined the issues and potential errors for the use of CORINE Land Cover datasets as a potential source for the analysis of changes in forest cover. We also estimated the ability of CLC data to model deforestation rates, as a reference using precise operational stand level data from the State Forest Register of the Latvian State Forest service.

2. Material and methods

2.1. Study areas

The four studied landscapes (Fig. 1) are located in northern Latvia, within the North Vidzeme Biosphere Reserve (NVBR). The area of the NVBR is 457 600 ha, consisting of mostly flat or hilly terrain with elevation ranging from 4 to 100 m above sea level. Forest area is 45% of the terrestrial area, slightly less than the national forest area (52%). The NVBR includes diverse landscapes ranging from extensive contiguous forest tracts with patches of agricultural lands and swamps (W and NE parts) to mosaic-type patterns with similar proportions of forest and open areas (central part). The NVBR is intended to serve as model area for sustainable development, balancing economic, ecologic and social interests (Urtans & Seilis, 2009). The forest area is mostly managed without harvest restrictions for conservation of biological diversity, but includes some protection zones (some level of felling restrictions applies to 5.9% of the forested area).

The selected study areas (landscapes) had identical size (8236 ha each). These areas were selected to represent the variation of land cover patterns characteristic of Latvia, generally focusing on

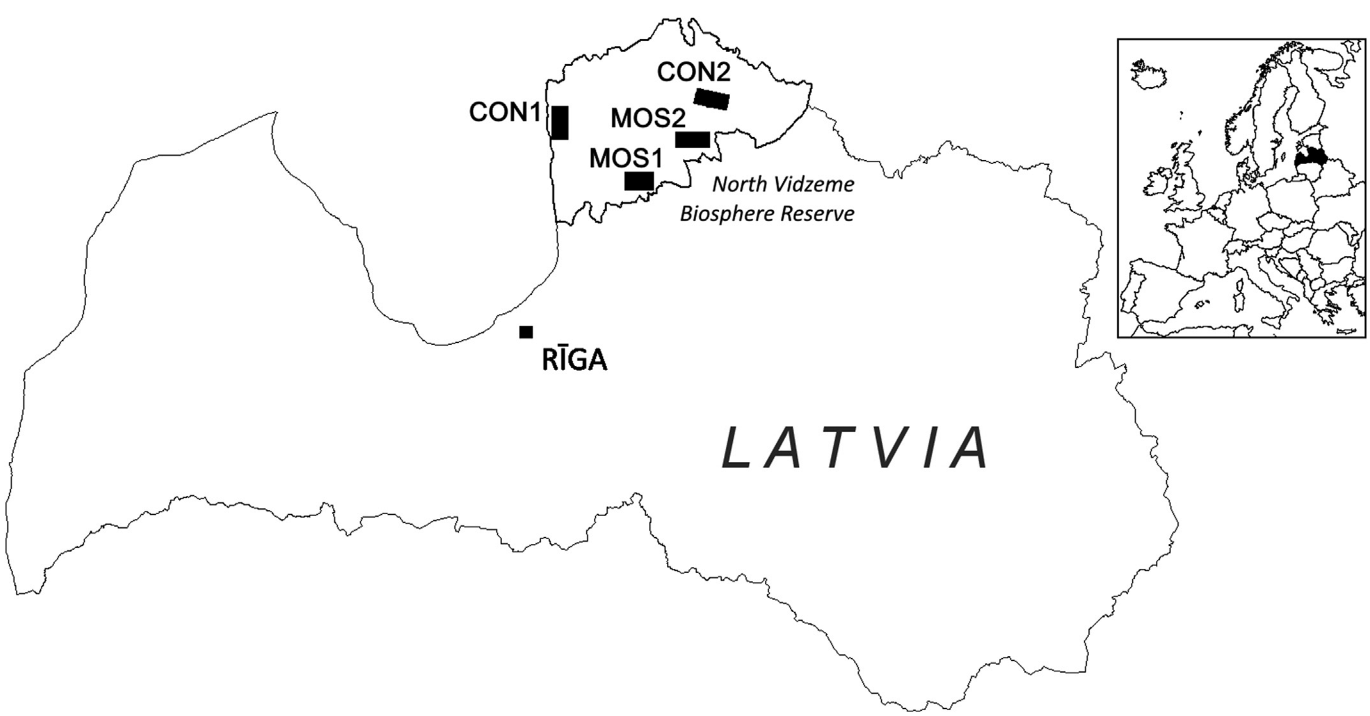

Fig. 1. The location of study areas (CON1, CON2, MOS1, MOS2) within the North Vidzeme Biosphere Reserve.