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Spatial distribution of lacunarity of voxelized airborne LiDAR point clouds in various forest assemblages

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Forest ecosystems have characteristic structure of features defined by various structural elements of different scales and vertical positions: shrub layers, understory vegetation, tree trunks, and branches. Furthermore in most of the cases there are superimposed structures in distributions (mosaic or island patterns) due to topography, soil variability, or even anthropogenic factors like past/present forest management activity. This multifaceted spatial context of the forests is relevant for many ecological issues, especially for maintaining forest biodiversity. Our aim in this study is twofold: (1) to quantify this structural variability laterally and vertically using lacunarity, and (2) to relate these results to relevant ecological features, i.e quantitatively described forest properties.
Airborne LiDAR data of various quality and point density have been used for our study including a number of forested sites in Central and East Europe (partly Natura 2000 sites). The point clouds have been converted to voxel format and then converted to horizontal layers as images. These images were processed further for the lacunarity calculation. Areas of interest (AOIs) have been selected based on evaluation of the forested areas and auxiliary field information. The calculation has been performed for the AOIs for all available vertical data slices.
The lacunarity function referring to a certain point and given vicinity varies horizontally and vertically, depending on the vegetation structure. Furthermore, the topography may also influence this property as the growth of plants, especially spacing and size of trees are influenced by the local topography and relief (e.g., slope, aspect). The comparisons of the flatland and hilly settings show interesting differences and the spatial patterns also vary differently. Because of the large amount of data resulting from these calculations, sophisticated methods are required to analyse the results.
The large data amount then has been structured according to AOIs and relevant AOI pairs or small groups have been formed for comparative purposes. Change detection techniques have been applied to reveal fine differences. The spatial variation can be related to ecologically relevant forest characteristics.
Data used in this study have been acquired in the framework of ChangeHabitat2 project (an IAPP Marie Curie Actions project of the European Union), in Hungarian-Slovakian Transnational Cooperation Programme 2007-2013, "Management of World Heritage Aggtelek Karst/Slovakian Karst Caves" (HUSK/1101/221/0180, Aggtelek NP). These studies were partly carried out in the project 'Multipurpose assessment serving forest biodiversity conservation in the Carpathian region of Hungary', Swiss-Hungarian Cooperation Programme (SH/4/13 Project). BS contributed as an Alexander von Humboldt Research Fellow.