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Predicting the Forest Development after Natural Disturbance in the Bavarian Forest National Park using Airborne LiDAR

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Abstract

Forests are highly dynamic ecosystems, driven by natural and anthropogenic changes. Increased public demands of various ecosystem services provided by forests as well as the environmental changes related to climate change are new challenging tasks in sustainable ecosystem management. In order to preserve the functionality of these vulnerable ecosystems, threaten by several biotic and abiotic factors, forest managers have to develop appropriate measures based on profound knowledge. This includes inter alia recognition of the current forest structures, a clearer understanding of the underlying processes and the early detection of change processes. Natural disturbances belong to the main drivers of changes in forest ecosystems. They play a key role in the ecological system, influencing forest health, regeneration and biodiversity. These ecological “catastrophes” strongly influence the spatial and temporal patterns in forest ecosystems by altering forest structure, composition and functions. Unfortunately most researches on forest rejuvenation in middle Europe were conducted in commercial timberland. Thus forest regeneration under natural conditions is only insufficiently documented. The European bark beetle *Ips typographus* is one of the main causes of disturbance in spruce dominated forests in Europe. In the Bavarian Forest National Park the interplay between windthrow and bark beetle infestation lead to the destruction of huge parts of the forest, but simultaneously initialized natural succession. Until recently it was assumed that the up growing trees on post-disturbed areas initially form a homogeneous forest structure, while structural complexity only occurs in the late growth stages. But current studies enhance the evidences that structural complexity may arise much sooner in stand development and persists through the growing process. Owing to the longevity of forest stands, today forest growth models have become a important tool in forest management, which is currently used for the estimation of future forest development. The goodness of these models often depends on the availability and accuracy of the used data. While traditional field surveys are often time consuming and expensive, remote sensing provides promising alternatives for data collection. Airborne Laser Scanning (ALS) is capable of providing both horizontal and vertical information from the earth surface and has been already successfully validated for studying forest structure. Aim of this project was the investigation of the current forest structure and the future development on post-disturbed

areas in the upper montane regions of the Bavarian Forest National Park. Therefore an approach was presented combining LiDAR remote sensing and individual tree based forest growth modelling in order to simulate a possible future forest development. For the investigation of both, current and future forest structure on the test sites, spatial point pattern analyses where conducted, including nearest-neighbor statistics and second-order statistics. The results showed that natural regenerating forests at post disturbed sites can reveal important structures of complexity and that a significant portion of eventual old-growth structural complexity may already be determined in this early successional stage.

Keywords: LiDAR, forest structure, natural disturbances, forest growth modelling, spatial point pattern analysis