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# Landsat time series allow for the quantification of forest management and patch size effects on post-disturbance recovery trajectories

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Natural forest disturbances are inherent components of forest ecosystem dynamics, yet they also impact important ecosystem services such as carbon sequestration and water purification. It is thus of upmost importance to understand whether forest ecosystems and related ecosystem services are resilient to natural forest disturbances and how resilience might change under current climate change. Forest recovery from forest disturbances is an important indicator of forest ecosystem resilience. However, effects of disturbance characteristics (e.g., size and severity) and post-disturbance management (i.e. salvage and sanitation logging) on recovery trajectories remain incompletely understood, especially at scales beyond the plot-scale. To test the influence of disturbance characteristics and post-disturbance management on forest recovery trajectories, we combine Landsat time series and lidar data for mapping forest recovery across a forested landscape on the border of Germany, the Czech Republic and Austria (the Bohemian Forest ecosystem). Our study area has experienced large-scale natural disturbances in recent decades and is characterized by different management regimes – ranging from strictly protected to conventional forestry – which allows for a direct comparison of recovery trajectories among management strategies. For mapping post-disturbance recovery, we developed a set of disturbance and recovery metrics from annual Landsat Tasseled Cap best-observation composites, and used those metrics to predict lidar-based estimates of vegetation cover and height. The models explained 74% and 66% of the variance in forest cover and height, respectively. Analyzing the Landsat-derived recovery maps using regression modeling, we found support for a significant effect of patch size and management on post-disturbance recovery trajectories. Recovery was slower and more variable in large disturbance patches (> 5 ha). This effect was especially pronounced in strictly protected areas, which indicates that large-scale natural disturbances increase forest heterogeneity, compared to regular harvest and managed natural disturbances (salvage and sanitation logging). However, variability decreased after approximately 15 years, irrespectively of the management regime. Hence, our results underline that both the characteristics of the disturbance itself and the management responses to it determine the first decades of forest recovery. We could also highlight the considerable resilience of Central European forest ecosystems, as all investigated disturbances reached >75% canopy cover 30 years after disturbance, regardless of patch size and management. Our novel approach combining Landsat time series and lidar data allowed us to explore the dynamics of Central European forest ecosystems at scales that are difficult and costly to tackle with field data alone, improving our understanding of the resilience of Central European forest ecosystems and related ecosystem services.