

EGU2020-9910

<https://doi.org/10.5194/egusphere-egu2020-9910>

EGU General Assembly 2020

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Exploring the long-term vegetation and fire-disturbance history of the Biogradska Gora old-growth forest (Montenegro)

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As disturbances are predicted to increase both in terms of frequency and severity due to global changes, it is important to improve our knowledge on their natural regimes in order to adopt an appropriate management to enhance the resilience of forest stands. In this context, the assessment of disturbance regimes in old-growth forests is becoming increasingly important because these ecosystems are considered as reference systems that developed without significant human impact for long periods of time. In the temperate zone of Europe only few fragments of mountain forests perhaps succeeded to persist despite millennia-long anthropogenic land-use pressure. However, few studies support their long-term stability and continuity in a changing landscape. Our study focuses on one of the largest and well-preserved old-growth forests in the Balkans. It is situated in the Biogradska Gora National Park reserve, whose extension (c. 6000 ha) is large enough to recognize the natural range of variability of disturbance processes. Under informal protection (hunting reserve) since 1878, the area became National Park in 1952. At present the forest is dominated by beech, silver fir and Norway spruce. We assume that the old-growth forest stands dominated by coniferous trees, which are currently confined to the inner part of the reserve, were more widespread in the past, and that their area was strongly reduced due natural disturbances and land-uses (e.g. grazing activities, fires, forest exploitation) that may have promoted the spread of beech. We used orthorectified high-resolution Pléiades satellite images (0.5-2 m) and field surveys of forest structures and composition to assess the spatial patterns of successional stages of forest development, thereby indirectly tracing the recent disturbance regime. However, such datasets are unable to unfold longer-term trends and to identify the type of disturbances. Moreover, carrying out dendrochronological research both on living and dead biomass is banned in the reserve area. Thus, we reconstructed longer-term changes in species composition, and disturbance and land use histories using pollen, plant-macrofossils, and charcoal analyses from sediments spanning the past 1000 years. Sediments were collected from a small forest hollow situated on the edge of the present old-growth forest reserve. We found that on the edges of the reserve forest cover dominated by conifers

(mainly *Abies*) was reduced due to land-use activities (agriculture, cattle grazing), as suggested by Cerealia-type pollen and *Sporormiella* spores. The expansion of beech populations, which are dominant around the forest hollow today, occurred very recently. What emerges with the current level of detail achieved in our study is that tree cover and composition changed substantially over time on the edge of the old-growth forest reserve. This suggests that the edges of the reserve were disturbed and consequently not characterized by long-term stability and continuity of vegetation. Expected results will advance awareness of the legacies of past environmental changes and forest-management on current ecosystems. This multidisciplinary study, in a poorly explored area as the Balkans, will permit to anticipate biotic responses of these important mountain ecosystems in front of future environmental changes, providing useful information for their management and conservation.