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Investigating ecological baselines and critical thresholds in ombrotrophic nemoral peatlands: implications for ecological restoration

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Peatlands are increasingly prone to climate extremes, such as drought, with long-lasting effects on plant and soil communities and, thus, on C cycling. Unveiling past tipping points is a prerequisite for understanding how individual plant species and entire ecosystems respond to future climate changes. Across Europe, however, vast areas of peatlands have been degraded or destroyed, mainly by drainage, peat extraction or agricultural cultivation. Consequently, degraded peatlands have turned from sinks into sources of atmospheric C, which pivots to restoring ecosystem functions to mitigate climate warming. Our main objective is to develop a spatiotemporally explicit indicator framework for restoration success across peatland sites affected by drainage and/or extraction, as peatlands are increasingly designated as priority areas for conservation/restoration. Yet, knowledge of how management actions play out in the long-term development of protected ombrotrophic peatlands and their response to human activity and climatic changes is often limited. However, palaeoecological high-resolution data can provide such information, reconstructing past vegetation, hydrology, climate, and ecosystem resilience. Palaeoecological investigations on site succession and development can also provide a basis for setting restoration goals regarding the target water table depth for rewetting. Our research evaluates baselines and restoration pathways based on paleoecological proxies and by evaluating the historical

development of the site. The project objectives target representative peatland ecosystems in the nemoral zone from Western (Netherlands, Northwest Germany) to Eastern (Poland), and Northern (Southern-Sweden) to Southern (Austria) Europe. The sites are affected by various degradation factors, including drainage, climate change, intensive land use or different management techniques, and different approaches for restoration have been (partly) applied. We analysed testate amoebae and plant macrofossils from the peat. Furthermore, we reconstructed water table depth using a testate amoebae calibration data set. Then, we used broken-line regression models to identify whether plant community composition experienced different states over time. We also analysed patterns in plant species along the hydrological gradient (all sites were pooled) using a threshold indicator taxa analysis. New high-resolution data on testate amoebae and plant macrofossils show that the six peatland ecosystems experienced different disturbances. All sites experienced noticeable anthropogenic pressure (expressed in vegetation transitions and water table) during the drainage and peat harvesting time. We provide novel data about peatland states before the disturbance and their different resilience potential that may help to set the restoration goals. According to former results, we hypothesised that the critical transition was ca 12 cm. However, in our calculations, the tipping point appeared to be higher at DWT of ca 5 cm, which suggests a range of the ideal wetness for healthy peatlands in various biogeographical and climatic settings. The palaeoecological results provide the critical baseline for the future rewetting scenarios in Sphagnum-dominated peatlands in Europe.

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