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Using plot-scale greenness and plant height to monitor vegetation development and model CO_2 exchange in peatland restoration trials

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Vegetation development is a major yardstick for successful peatland restoration and is tightly linked to the potential of peatlands to sequester carbon. Hence, a quantitative assessment of vegetation development is required to evaluate peatland restoration practices regarding the re-colonization of target species and implications for the C sink function. Continuous, non-destructive canopy metrics obtained from digital RGB imagery become increasingly popular in observational ecosystem studies. In contrast, existing vegetation proxies commonly used on the plot-scale are either labor-intensive (e.g. vascular green area index), cannot account for management measures such as harvest events (e.g. effective temperature index), or would alter field plots (e.g. intermittent biomass sampling). Plot-scale metrics derived from RGB photography could therefore be a promising tool to quantify vegetation development.

Here, we evaluate the applicability of plot-scale vegetation metrics, namely vegetation height and greenness, as proxies for succession and treatment effects in a peatland restoration study. The experiment comprised a reference plot with intensive grassland species and six restoration plots. During the course of our study, the plots were covered to a different degree with graminoid species and peat mosses. In a second step, we evaluated the suitability of these plot-based vegetation indices as predictors for CO_2 exchange dynamics using artificial neural networks. Accurate prediction of CO_2 exchange dynamics is of special concern in plot-scale field trials, where greenhouse gas budgets are commonly obtained from modelled flux time series based on biweekly to monthly closed-chamber measurements.

Our results show, that both greenness and vegetation height can quantitatively track restoration-induced vegetation dynamics and harvest effects on the plot scale. Vegetation height was more sensitive to harvest events, whilst plot greenness better represented the lateral spread of peat mosses. Implementing these vegetation indices as predictor variables in artificial neural networks improved the plausibility of gap-filled CO_2 flux time series, which ultimately leads to more accurate budgets. This suggests that vegetation indices derived from RGB photography and vegetation height measurements are simple and effective tools for tracking the success of plot-scale restoration projects.