EGU24-20580, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-20580
EGU General Assembly 2024

Small-scale spatial relationships between peat properties and surface microtopography in minerotrophic peatlands depend on management regimes

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Fens, in their natural states, are characterized by rich biodiversity and high carbon and water storage, playing a major role in providing several important ecosystem services. However, most fens in Europe were drained in the past for agriculture, leading to degradation and a reduction of their multifunctionality. While restoration, primarily through rewetting, is gaining prominence in Europe, there are substantial knowledge gaps in understanding spatial landscape and ecosystem processes in these environments, rendering successful restoration or rehabilitation of functions challenging. Determining peat properties and their relation to soil surface processes at small scales is key to revealing different pathways that ecosystem recovery may take, not only in terms of carbon storage but also hydrophysical functioning. In the absence of long-term monitoring of fen peatlands, both pre- and post-rewetting, drained and rewetted paired comparison studies are the next best approach to study the effects of drainage and rewetting and how degraded peatlands differ from their near-natural counterparts. Here, we compare the spatial structures of peat properties, such as soil moisture content, soil organic matter, and carbonate content, in a drained and a rewetted fen peatland in Ireland and investigate how surface microtopography influences such properties. This is done by constructing variograms and investigating the differences in range, partial sill, and nugget-to-sill ratio. Overall, soil properties in the near-natural fen show much lower spatial autocorrelation based on nugget-to-sill ratios, and these properties reach autocorrelation range at much shorter distances compared to those of the drained site. This indicates that the drained site is more homogeneous in terms of soil properties compared to the near-natural fen. The bivariate autocorrelation between the different soil properties and surface microtopography is much stronger in the drained site compared to the rewetted site, indicating that surface microtopography plays a larger role in controlling ecosystem processes in drained peatlands than in the near-natural fens. Our results highlight the importance of spatial peat sampling at short intervals for small-scale processes and for the identification of carbon storage hotspots and formulation of appropriate monitoring scale and plan.