



How does ecosystem rehabilitation and inter-annual climatic variability impact the carbon dynamics of raised bogs in Ireland?

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In Ireland, peatland ecosystems cover ~20% of the land area and hold up to 75% of the soil organic carbon stock, however over 90% of these systems have been degraded due to drainage for agriculture, forestry and extraction for horticulture or energy. Due to their climate mitigation potential the conservation and rehabilitation of peatlands through rewetting forms an integral part of the national climate mitigation strategy in Ireland. The hydrological integrity of these sites is key to the success of both conservation and rehabilitation activities, both of which are susceptible to inter-annual variation in climate, such as changes in precipitation and temperature.

This study utilised eddy covariance techniques to assess Net Ecosystem Exchange (NEE) of carbon dioxide (CO₂) at two sites, a near-natural remnant raised bog ecosystem with six site years of data that captured two exceptionally dry climatic years (2018 and 2021), and two years of site data from a former industrial cutaway site where the drains were blocked, and the water table raised in 2015. The study area at the remnant bog acted as both a net C source and sink over the study period, with NEE ranging from 53.5 to -135.9 g C m⁻² yr⁻¹, respectively. Net C losses were observed in 2018 and were driven by a 16% increase in ecosystem respiration due to a prolonged reduction in water table height, highlighting the vulnerability of raised bog systems to inter-annual climatic variability. The rehabilitation site was effectively C neutral over the study period with NEE ranging from 18.3 to -0.34 g C m⁻² yr⁻¹ and provides further insight into the time dependent impacts and potential emissions savings of peatland rehabilitation as the former cutaway sites undergo both hydrological and ecological transitions.