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Measuring the long-term impact of peripheral drainage on the ecohydrology and net ecosystem carbon balance of an intact raised bog

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Raised bogs are typically considered ombrotrophic wetlands, in that rainfall acts as the dominant control on their hydrological and ecological functioning. However, long-term monitoring of a raised bog in Ireland has demonstrated that these wetlands can display a significant groundwater dependency, with an upward gradient in the underlying groundwater body acting as a supporting condition for the peatland above. When this equilibrium is disturbed, in this case by peripheral drainage impacting the groundwater body, it can have severe and lasting impacts on ecosystem function. In damaged systems, morphological changes due to drainage and consequent peat subsidence occur but the long term effects are rarely recorded or monitored. Detailed ecohydrological monitoring of Clara raised bog over a 25-year period shows continued peat subsidence long after initial drainage. The continual movement of surface catchment boundaries and progressive degradation of critical peat-forming communities has impacted on one key function of the habitat, as a carbon store.

To quantify the impact of drainage on the net ecosystem carbon balance (NECB) of the bog, a three year (2014-2017) intensive field monitoring programme measured the carbon dioxide (CO_2) and methane (CH4) gas exchange of the habitat and the export of dissolved organic carbon (DOC) from the bog's regional drainage system, in addition to the rate of CO_2 evasion from the drainage waters. Though this peatland is free of superficial drainage, results show that the overall NECB is one of carbon loss due to the impact of peripheral drainage and associated hydrogeological pressures, an underrepresented carbon flux pathway in peatland monitoring and modelling studies. The inclusion of regional carbon losses in fluvial aquatic pathways thereby reverts a seemingly intact bog system to an atmospheric carbon source. The capacity of degraded peatlands to sequester carbon with active management ensures they are prominent in the debate on the solutions needed to combat the effects of climate change. However, this study demonstrates the difficulty restoring a positive sequestration function following environmental damage where regional groundwater dependencies have been modified.