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Towards a better understanding aquatic carbon losses from lowland peatlands across England and Wales

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Hydrological fluxes in lowland peatlands can be challenging to measure but they drive poorly understood aquatic carbon fluxes which may form an important part of the overall carbon budget for peatlands. In this study we examined 11 lowland peatland sites across some of the most important fen and raised bog complexes in England and Wales including agricultural peatlands, mining sites and restoration sites. These were intensively monitored between January 2013 and December 2015. The monitoring included continual hydrological measurements and regular sampling for dissolved organic and inorganic carbon (DOC and DIC), particulate organic carbon (POC) and dissolved carbon dioxide, methane and nitrous oxide. These data were used to calculate the amount of water flowing out of each site and the total aquatic carbon loss. In addition, the hydrological data were used to provide contextual data to explain carbon flux variations between sites and help explain and model variations in gaseous carbon fluxes.

The hydrology of all these lowland peat sites is typically complex with most having been drained, which when combined with their relatively flat gradients results in most having no clear single outlet. In addition the drainage networks are often used to not only drain water during periods of excess rainfall but also to maintain raised water tables during summer months when rainfall totals are low. As a result, aquatic losses were determined using a mixture of water mass balance approaches (e.g. using flux tower evapotranspiration data) and groundwater flow monitoring.

The hydrology of the 11 sites was found to vary considerably, even between co-located sites, however as might be expected given the west-east rainfall gradient observed in the UK, discharge was typically highest at the Anglesey Fens sites (western Wales) and lowest at the East Anglian Fens sites (eastern England). One influence on the observed differences in discharge was the impact of vegetation type on evapotranspiration rates, with sites with high ET having some of the lowest discharge.

Compared to gaseous fluxes, aquatic carbon fluxes made a smaller but significant contribution to overall rates of carbon loss, with the 'reactive' aquatic C flux accounting for 2-26% of NEE. Dissolved organic carbon (DOC) made the largest contribution. Concentrations of DOC were generally high, with all sites having mean concentrations greater than 20 mg L-1. DOC fluxes ranged from just 4 g C m-2 yr-1 up to 67 g C m-2 yr-1 being more variable than concentrations due to the wide variation in discharge from the different sites. Fluxes were highest from the raised bog sites and lowest from the fen sites.