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Vulnerability of drained and rewetted organic soils to climate change impacts and associated adaptation options

Florence Renou-Wilson (1), Christoph Müller (2), and David Wilson (3)

(1) University College Dublin, School of Biology and Environmental Science, Dublin 4, Ireland, (2) Justus-Liebig University Giessen, Heinrich-Buff-Ring 26, 35392 Giessen, Germany, (3) Glenvar, Letterkenny, Co. Donegal, F92HX03, Ireland

With 20% of the land covered with peat soils, Ireland needs to develop a deeper understanding among stakeholders of the potential vulnerability of peatlands and organic soils to climate change (both gradual and extreme events) in the context of current land use changes.

The fate of carbon in organic soils is critical for predicting future greenhouse gas (GHG) concentrations in the atmosphere. While keeping carbon stock in organic soils (for example by rewetting drained sites) can be an effective mitigation measures to reduce CO_2 emissions, adaptation options are also required to ensure their 'resilience'.

Rewetting of drained organic soils has been initiated at several sites across the country with the aim to (i) reduce net GHG emissions at the source and/or (ii) create suitable conditions for carbon sequestration in active peatland habitats. We present here two sites: an industrial cutaway peatland and an extensive grassland over organic soil, where long-term (> 4 years) environmental and GHG flux (chamber) datasets in both drained and rewetted areas have provided information on the impact of annual weather variability on net ecosystem exchange (NEE). Statistical response functions estimated for gross primary production (GPP) and ecosystem respiration (Reco) were used to reconstruct annual CO_2 balances using site-specific models driven by soil temperature, solar radiation, soil water table levels and leaf area index. The modification of some of the model parameters to fit predicted future climate scenarios for the region allowed potential changes in modelled NEE to be assessed.

Both sites were, on average, an annual source of CO_2 when drained (138 – 232 g C m^{-2} yr^{-1}) and a sink when rewetted (ranging from -40 g C m^{-2} yr^{-1} in the ungrazed rewetted grassland to a maximum of -260 g C m^{-2} yr^{-1} in the rewetted cutaway). At both sites, soil temperatures and water table levels varied significantly between all years. Average NEE at each site displayed a very large standard deviation over the years suggesting a strong influence of external factors (weather variability) and vegetation change in some cases. Such wide variation in annual NEE values is not encountered in their natural counterparts within the same region.

Under simulated moderate scenarios of (i) increased soil temperature (1°C) and (ii) deeper WT (-10cm) (both seasonal and/or annual), the rewetted areas always displayed a larger change (increase) in annual NEE compared to the drained areas. Furthermore, all rewetted sites became CO_2 sources when both parameters were altered simultaneously over 4 years. Although positive feedbacks from vegetation may occur following such environmental changes, it is expected that the rewetted peatland areas will remain at risk under even moderate levels of climate change and may therefore require further intervention.