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A black alder plantation improves the greenhouse gas balance of a degraded moist peat grassland

Sarah Bereswill (1,2), Mathias Hoffmann (3), Vytas Huth (2,4), Yulia Popova (2,5), Dominik Zak (6,7), and Jürgen Augustin (2)

(1) Department of Life Sciences and Engineering, University of Applied Sciences Bingen, Bingen, Germany, (2) Institute of Landscape Biogeochemistry, Leibniz Centre for Agricultural Landscape Research, Müncheberg, Germany, (3) Institute of Soil Landscape Research, Leibniz Centre for Agricultural Landscape Research, Müncheberg, Germany, (4) Department of Landscape Ecology, University of Rostock, Rostock, Germany, (5) Institute for Chemistry and Biology, Immanuel Kant Baltic Federal University, Kaliningrad, Russian Federation, (6) Department of Chemical Analytics and Biogeochemistry, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany, (7) Department of Bioscience, Aarhus University, Silkeborg, Denmark

Drained peatlands are among the strongest terrestrial sources of the greenhouse gases (GHG) CO_2 and N_2O. Therefore, activities of peatland revitalisation through rewetting, often combined with the implementation of peat forming vegetation, aim to restore the GHG sink function that is characteristic for pristine peatlands. Black alder (*Alnus glutinosa*) naturally occurs in temperate marshes and minerotrophic peatlands (= fens) and is also suitable for paludiculture, the cultivation of biomass on wet or rewetted peatlands. However, only little information exists, if a black alder plantation can reduce the climate impact of restored peatlands.

Therefore, we investigated the effect of a newly established black alder plantation on the net GHG balance of a degraded fen in north-eastern Germany during a two-year study (August 2010 – August 2012). We compared the alder plantation (A_{wet}) with an extensively used meadow (M_{wet}) both characterized by very moist soil conditions and a drier reference meadow (M_{dry}) characterized by moderately moist soil conditions. CO_2, CH_4 and N_2O fluxes were measured monthly to bi-monthly with the manual closed chamber method. Fluxes were calculated using a modular R script and gap filled to obtain continuous daily fluxes.

A_{wet} was a net GHG sink of -4.8 t CO_2-eq ha^{-1} yr^{-1}, M_{wet} was climate neutral (-0.03 t CO_2-eq ha^{-1} yr^{-1}), and M_{dry} was a net GHG source of 15.7 t CO_2-eq ha^{-1} yr^{-1}. This was mainly caused by CO_2 uptake at the two very moist sites and a high CO_2 release at the drier reference site. In addition, A_{wet} was a larger CO_2 sink than M_{wet}, likely caused by an additional CO_2 uptake of the alder stand. All sites were significant CH_4 sources. Due to inundation following extraordinarily heavy precipitation in summer 2011 remarkable CH_4emission peaks were found on all sites which accounted for up to 70 % of the cumulated two-year CH_4emissions. However, overall A_{wet} emitted significantly lesser CH_4(4.9 g C m^{-2} yr^{-1}). We assume that the black alders decreased the CH_4emissions due to their effective O_2 transport mechanism. N_2O emissions were negligible at all three sites.

Our results indicate that rewetting and planting black alders significantly improve the GHG balances of formerly drained fens already in the first two years after plantation. Furthermore, only one wet summer significantly increased the CH_4 emissions of our study site, despite two-year average groundwater levels (GWL) of -0.2 to -0.35 m. This highlights the importance of acknowledging extreme precipitation events and groundwater fluctuations for the derivation of reliable GHG emission factors.