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Changes of the green house gas production potential of inundated peatlands in the perspective of temporal vegetation shifts

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Artificially drained minerotrophic peatlands, commonly called fens, are being rewetted on a large scale in many European countries, including Germany. The objectives behind rewetting include the reduction of greenhouse gas (GHG) emissions, in particular of carbon dioxide (CO_2) via oxidative degradation processes in the aerated peat soil, as well as the recovering of the nutrient sink and ecological habitat functions of pristine fens. As a result of long-term organic soil losses, subsidence and the associated lowering of the land surface, rewetting of these areas often results in shallow lake formation. These developing ecosystems differ considerably from pristine fens. Peat formation cannot occur in the open waterbody; instead the highly degraded submerged peat surface becomes covered by organic sediments which form readily due to the subaqueous decomposition of dying grassland vegetation that is intolerant to permanent flooding and the decomposition of shoot biomass from wetland plants. With regard to lake ontogeny, these sites can be compared to lakes in the process of terrestrialization, where peat formation can follow as infill proceeds to surface levels. These newly formed shallow lakes with a highly degraded peat substrate are characteristically eutrophic and show high mobilisations of nutrients and dissolved organic carbon. Furthermore, extremely high methane (CH4) emissions from rewetted fens have been observed. The GHG emissions in the initial stage after rewetting have even been shown to lead to a net climate impact that exceeds that of drained fens.

Another distinct difference of rewetted fens from natural fens in Central Europe is the rapid secondary plant succession. In the initial phase of rewetting, Phalaris arundinacea has been observed to be the dominating plant species; more adapted to wet-dry conditions, this species routinely dies off within the first year of inundation. Helophytes like Typha latifolia in marginal areas and Ceratophyllum demersum in the open waterbody have been observed to colonize the area within one or two years of rewetting. With increasing rewetting time, the peat forming plants Phragmites australis and various Carex species, such as Carex riparia, can become re-established. The influence of these predictable vegetation shifts on CO_2 and CH4 emissions has not been studied yet.

In this paper, the CO_2 and CH4 production due to the subaqueous decomposition of these five most abundant plant species, which are considered to be representative of different rewetting stages, will be presented. Beside continuous gas flux measurements, bulk chemical analysis of plant tissue, including C, N, P, and plant polymer dynamics, were performed in order to gain further insights into changing litter characteristics. With respect to temporal vegetation shifts in rewetted fens, the results provide new insights into the mid-term climate effect of these ecosystems.