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A review of greenhouse gas emissions from restored agricultural peatlands

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I 2022 er reviewmanuskriptet blevet opdateret med et afsnit og tilhørende tabel om emissionerne fra drænede kulstofrige jorde inden omlægning, sådan at både emissionerne før og efter vådlægning indgår. Dermed giver reviewet et overblik over emissionerne før og efter restaurering og dermed hvilke klimaeffekter man kan forvente.
Manuskriptet er også blevet skærpet så fokus udelukkende er på kulstofrige jorde, og konklusionen er påbegyndt.

Abstract

Over the past 100 years, many temperate peatlands have been drained for agricultural purposes. These ecosystems are in their natural state characterized by high amounts of organic carbon (C) in the soil due to a slow build-up over thousands of years. But when drained, the organic C is rapidly respired as CO_2 by decomposing microorganisms, and thus these drained wetlands release large amounts of this potent greenhouse gas to the atmosphere. Therefore, there is a growing interest to restore wetlands to prevent further C loss and release of CO_2, but the effects of wetland restoration on greenhouse gas emissions are uncertain due to a scarcity of studies and syntheses. This review aims to provide an overview of current knowledge within the field, identify knowledge gaps, and give directions for future studies.

Drained peat soils are net emitters of CO2, and the emissions are dependent of the depth of drainage (e.g., 237 g CO_2eq m^{-2} y^{-1} in shallow drained areas, and 2260 g CO_2eq m^{-2} y^{-1} in fully drained areas). Restored temperate wetlands can be both greenhouse gas sinks and sources and the emissions are in the range of -800 to 675 g CO_2eq m^{-2} y^{-1}. The majority of available studies show that the restored temperate peatlands generally have a small emission or a small to large uptake of greenhouse gasses (mainly as CO_2). In contrast, restored peatlands in warmer climate zones show a tendency to larger emissions with the range of -395 – 3500 g CO_2eq m^{-2} y^{-1}. In case of large emissions, these are driven by large fluxes of methane (CH_4).

There is not a consensus in literature about the effect of time after restoration on greenhouse gas budgets from restored peatlands. Some studies show high initial emissions and a gradual transition towards lower emissions or a net uptake, while other studies show sustained high emissions over longer time periods. Therefore, there is a need for more research on this topic to tease out the different effects of time, previous land use, climate conditions and ecosystem type.

Reference	Climate region	Site name	Soil type	Hydroregime	Time since drainage initiation (years)	NEE (g CO_2-C m^{-2} y^{-1})	Reco (g CO_2-C m^{-2} y^{-1})	CH_4 (g CH_4-C m^{-2} y^{-1})	N_2O (mg N_2O-N m^{-2} y^{-1})	Decrease in peat thickness (cm y^{-1})	GHG budget (g CO_2 eq m^{-2} y^{-1})
Maljanen et al. 2010	Nordic lands		Peat – grass and crops	Drained	100 years time horizon	488		0.16	1134		2260
Renou-Wilson et al, 2016	NW Ireland		Peat – grass with grazing	Shallow drained, water table depth: -24.9 cm	>60	77	1336	1.19			237
Kluge et al. 2008	NE Germany		Peat – intensively managed grassland		90					0.7	687.5 (past 40 years)
Schrier-Uijl et al. 2014	Holland		Peat – intensively managed grassland	Drained, -0.55 cm		109		12.8	1336		1400
D'Angelo et al. 2021	France		Sphagnum peat – drained by a road.	Drained, -5 - -8 cm	>85	220					