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Vegetation plays a role on the net GHG budget of Dutch peatlands

Tanya Lippmann (1), Ko van Huissteden (1), and Monique Heijmans (2)
(1) Vrije Universiteit Amsterdam, the Netherlands (t.j.r.lippmann@vu.nl), (2) Wageningen University & Research, the Netherlands

This study provides insight into the role vegetation plays in regulating the carbon balance in peatlands. This study hypothesizes that subsequent to the rewetting of drained peatlands, those with restoration of natural vegetation emit fewer greenhouse gases (GHG) compared to those without peat-forming vegetation.

A peatland is a water-saturated environment where the anoxic conditions lead to an accumulation of partially decomposed organic matter. In their natural state, peatlands typically act as a carbon sink. However, drainage leads to decomposition, bacterial oxidation and the net loss of total organic carbon. Over the last one thousand years, peat drainage in the Netherlands has led to substantial land subsidence and a significant dent in the soil carbon pool.

Renewed sequestration of soil carbon through peatland restoration/rewetting is considered as an option to mitigate these problems. However, re-wetted peatlands become effective releasers of methane (CH4) due to reduced anaerobic CH4 oxidation and increased CH4 production. This leads to restored peatlands becoming a net GHG source rather than a GHG sink, contributing to anthropogenic climate change instead of functioning as an abatement.

Previous research has consistently focused on surface water level as the primary determining factor of the GHG fluxes in peatlands. Therefore, the influence of vegetation types on GHG fluxes is not well understood. To quantify the relationship between vegetation composition and long-term GHG emissions, model simulations are necessary. To date, existing peatland models either a) lack adequate representation of belowground biogeochemistry necessary to reliably simulate methane fluxes or b) neglect to represent the aboveground vegetation functioning, which may influence GHG exchange between the soil and atmosphere.

This study presents a new model, PVN, built upon improving and reconfiguring an existing belowground biogeochemistry model (Peatland-VU) and a peat bog ecosystem model (NUCOM-bog). The new model uses Plant Functional Types (PFT) to represent vegetation types as is a common practice in ecosystem models. Year-round CO_2 and CH4 fluxes observations measured using automated chambers at two restored peatland sites located in the Netherlands are used to validate simulated GHG fluxes.

Four land-use scenarios are presented. Three of these scenarios present proposed paludiculture crops, namely, Sphagnum, Typha latifoli and Vaccinium oxycoccos (Cranberry). Paludiculture is the use of peatlands for economically competitive, productive agriculture under wet conditions. The final scenario represents a nature restoration scenario composed of mixed vegetation.

The seasonal fluxes and net annual GHG budget of all land-use scenarios is assessed using both 20- and 100-year global warming potentials. Results show that T. latifoli is the largest net GHG source, V. oxycoccos second, the mixed-restoration scenario third. Complete Sphagnum coverage was the only scenario resulting in the peatland becoming a net GHG sink.

These results show that the vegetation composition of restored peatlands plays a substantial role in determining the greenhouse gas budget.