Extended abstract No. 34

REDUCING GREENHOUSE GAS EMISSIONS BY SPHAGNUM FARMING?

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SUMMARY

By measuring greenhouse gas (GHG) emissions from a *Sphagnum* farming field in Lower Saxony, Germany we attempt to confirm that *Sphagnum* farming peatlands may act as a GHG sink. Furthermore we conducted laboratory experiments regarding the decomposition of transplanted sphagna. Field results show a high future potential for reducing GHG emission compared to extensively used peatlands. Laboratory experiments with regard to GHG emissions of the two transplanted *Sphagnum* species *S. palustre* and *S. papillosum* will provide more detailed information about GHG production and consumption by this species.

KEYWORDS: greenhouse gas balance, methane, carbon dioxide, renewable resources

INTRODUCTION

Pristine peatlands represent a considerable long-term carbon sink. However, peat extraction and drainage of peatlands leads to a release of carbon in form of greenhouse gases (GHG) into the atmosphere. Peat sources are decreasing and living undisturbed bogs are being destroyed. Recultivation of degraded wetlands for *Sphagnum* farming may help to prevent further destruction or degradation of pristine peatlands. *Sphagnum* farming can provide a sustainable strategy for the production of alternative horticultural substrates. The sustainable cultivation of *Sphagnum* mosses is CO_2 neutral following harvesting. However, the question arises whether *Sphagnum* farming on peatlands leads to continuing CO_2 loss from peat, counteracting the notion of GHG mitigation by *Sphagnum* farming.

We measure GHG emissions (CH_4, CO_2 and N_2O) bi-weekly by means of static closed chambers in a *Sphagnum* farming field in Lower Saxony, Germany. The measurements of GHG and the *Sphagnum* farming field experiment started at the same time, allowing us to evaluate the GHG reduction potential of farmed *Sphagnum* species. We investigate the GHG emission potential of different *Sphagnum* taxa in comparison to GHG emissions from bare peat and extensively used peatlands. Additionally, we conduct laboratory experiments regarding the decomposition of both *Sphagnum* species growing at the research field (*S. papillosum* Lindb. and *S. palustre* L.) by the use of incubation methods. Results from five months of field measurements and from the laboratory experiments are presented here.

We hypothesise (1) a reduction of GHG emission over time via *Sphagnum* farming, (2) a marginal influence of GHG emission by freezing-thaw occurrence.

MATERIAL AND METHODS

Gas flux measurements have been carried out biweekly since September, 7th 2011 for the estimation of methane, nitrous oxide and ecosystem respiration fluxes by applying static closed chambers and floating chambers on the ditches in a *Sphagnum* farming field at Ovelgönne in Lower Saxony, Germany (53°15´ N, 8°16´ E) following the method by Livingston and Hutchinson, 1995; Martikainen *et al*., 1993.

Boardwalks were installed at all sites and spots to minimize soil disturbance and hence ebullition effects. In our investigation we compare the two farmed *Sphagnum* species (*S. palustre* and *S. papillosum*) to bare peat and to data from the Ahlen-Falkenberger Moor (Beetz *et al*.,. unpublished, same evaluation technique as in this study) in Lower Saxony (53°41' N, 8°49' E) as an example of extensively used peatland. In order to detect the GHG concentration change in the chamber headspace gas samples were taken every twenty minutes over a 60 minute incubation period at the *Sphagnum* lawn (Volume: 0.3255 l) and every five minutes for a 20 minute period of time at the ditches (Volume: 0.0073 l), and stored in evacuated 60 ml glass vials. Gas samples are analyzed with a Perkin-Elmer Auto System gas chromatograph equipped with a flame ionization detector (FID) and electron capture detector (ECD). The concentration values were converted to flux estimates using the package "flux" (Version 0.1-6) of the statistical software R (R Development Core Team 2010) Fluxes with no significant linear increase or decrease in headspace GHG concentration are estimated to be zero fluxes.

Laboratory tests were conducted in 125 ml glasses with air tight caps. Sphagna were thoroughly washed, separated in green and brown parts, dried at 4 °C over night and each 5 g fresh mass was incubated in the dark (method slightly modified after Raghoebarsing et al. 2005; Larmola et al. 2010).We analyzed methane production in oxic conditions by measuring for seven days and taking four samples (0, 5, 30 and 60 minutes) every day. Furthermore we conducted freezing-thaw experiments with all four variants by taking samples every 10 minutes with five minutes incubation time for 80 minutes while thawing.

RESULTS

In situ CH_4 emissions were between 0,00 mg/m^2 and 2,06 mg/m^2. The highest CH_4 emissions occur in extensively used peatlands, followed by the ditches of the *Sphagnum* farming field, *S. papillosum*, bare peat and *S. palustre* (Fig. 1).

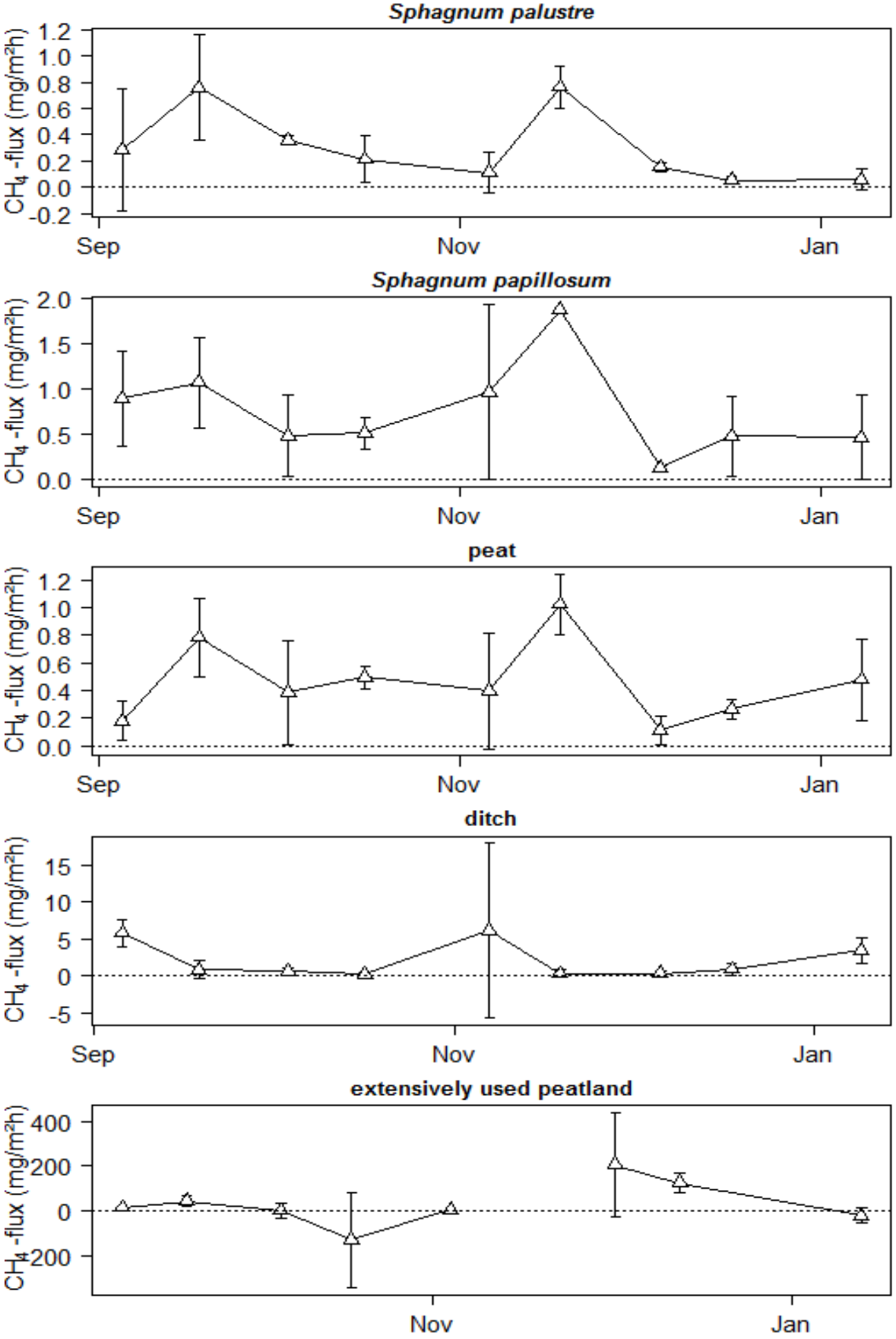

Fig. 1. Methane-Flux comparison of the two farmed *Sphagnum* species, the ditches in between, bare peat within the field and extensively used peatlands. Please note the different scales. Median n = 3.

Table 1. Carbon dioxide (only respiration data) and methane fluxes from September 2011 to January at the *Sphagnum* farming field in Ovelgönne. Budgets calculated by the integrals of the means (n=3) of the time variation curves

Vegetation	CO_2 [mg/m^2]	CH_4 [mg/m^2]
Sphagnum palustre	276687	907
Sphagnum papillosum	158465	2275
peat	148614	1412
ditch	259886	5338

The different spots show varying emissions. The lowest emission rates occur at spots with transplanted *S. palustre*. The ditches release most of CH_4, but compared to the extensively used peatland the output is smaller.

Preliminary oxic incubation experiments resulted in median elevated CH_4 concentration in the incubation flasks. Methane production rates decreased over time but we noted differences in methane fluxes in green and brown parts of the moss and *Sphagnum* taxa. Further tests and analyses will be necessary in order to identify the reasons for this. Interestingly, all four variants of thawing experiments show a large increase of methane production from 2300 ppb up to 4000 ppb between the fifth and tenth minute of thawing. Afterwards the methane concentration decreases. This indicates CH_4 release in an oxic environment during thaw-up of the moss. More comprehensive tests will follow to determine the exact impact of this occurrence.

CONCLUSION/DISCUSSION

We hypothesized (1) a reduction of GHG emissions over time via *Sphagnum* farming: the first results lead to the assumption that *Sphagnum* farming has the potential to reduce GHG production. The overall amount of N_2O emissions is negligible. Byrne *et al*. (2004) states the following emission factors of peatlands in Europe: Close to nature peat bog (710 CO_2 –C (kg C ha $^{-1}$ a $^{-1}$), 174 CH_4 –C (kg C ha $^{-1}$ a $^{-1}$), extensively used peatland (2350 CO_2 –C (kg C ha $^{-1}$ a $^{-1}$), 2 CH_4 –C (kg C ha $^{-1}$ a $^{-1}$). Compared to these annual GHG emissions rates, the balance of the *Sphagnum* farming field is at the upper range of the recorded values, but it is necessary to imply the fact that the a summer is missing so far and sphagna where freshly transplanted just before the start of the field measurements.

So far, our experiments suggest considerable, but transient CH_4 production from thawing moss, so the second hypothesis cannot yet be answered conclusively.

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REFERENCES

Byrne, K.A; Chojnicki, B.; Christensen, T.R; Drösler, M. and Freibauer A. (2004): *EU peatlands: Current carbon stocks and trace gas fluxes. CarboEurope-GHG Concerted Action – Synthesis of the European Green-house Gas Budget. Specific Study* (Report 4/2004), October 2004.

Jurasinski, G.; Koebsch, F. (2011): Estimate gas flux rates using dynamic closed chamber data. R package.

Larmola, T.; Tuittila, E. S.; Tiirola, M.; Nykänen, H.; Martikainen, P. J.; and Yrjälä, K. (2010): The role of *Sphagnum* mosses in the methane cycling of a boreal mire. In: *Ecology* 91 (8), S. 2356–2365.

Livingston, G. P.; and Hutchinson, G. L. (1995): Enclosure-based measurement of trace gas exchange: applications and sources of error. In: P. A. Matson und R. C. Harriss (Hg.): Biogenic trace gases. *Measuring emissions from soil and water.* Oxford [England], Cambridge, Mass., USA: Blackwell Science, S. 14–51.

Martikainen, P. J.; Nykänen, H.; Crill, P.; Silvola, J. (1993): Effect of a lowered water table on nitrous oxide fluxes from northern peatlands. In: *Nature* 366, S. 51–53.

R Development Core Team (2010): R. *A language and environment for statistical computing.* Vienna, Austria. Online verfügbar unter http://www.R-project.org.

Raghoebarsing, A. A.; Smolders, A. J. P.; Schmid, M. C.; Rijpstra, W. I. C.; Wolters-Arts, M.; and Derksen, J. (2005): Methanotrophic symbionts provide carbon for photosynthesis in peat bogs. In: *Nature* 436 (7054), S. 1153–1156.