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The effect of *Sphagnum* farming on the greenhouse gas balance of donor and propagation areas, irrigation polders and commercial cultivation sites

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Background and Objectives

- Drainage of peatlands turned these ecosystems into hotspots of greenhouse gas (GHG) emissions.
- Sphagnum farming on former peat extraction sites could combine economical and ecological goals by restoring the function as a sink for atmospheric carbon dioxide (CO_2) and providing both an habitat for rare species and high-quality substrate for horticulture.
- Sphagnum farming has yet to be tried on strongly decomposed "black peat".
- GHG data from the temperate zone is still scarce (Beyer and Höper, 2014) and limited to the actual cultivation site.
- This project aims to quantify the GHG balance of the whole peat-based Sphagnum production chain:
  - → How does Sphagnum removal impact a near-natural donor site?
  - → Is the GHG balance of Sphagnum farming sites comparable to a near-natural reference site?
  - → Which irrigation technique is optimal in terms of *Sphagnum* growth and GHG emissions?
  - → How strong are effects of potential climate warming conditions?
  - → What is the fate of the newly sequestered CO_2 in soil, biomass, water and respiration?

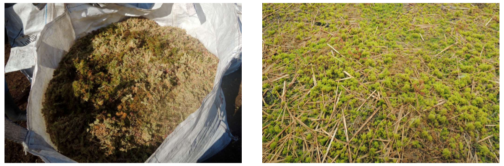

Figure 1: Harvested *Sphagnum* for spreading (left) and *Sphagnum* in the propagation area after less than one year (right)

Field sites in North-Western Germany

Donor area

- Near-natural bog.
- Manual harvest of *Sphagnum* hummock species (upper 5 cm) on 1 ha.

Figure 2: Inoculation of a former peat extraction site

Propagation area

- Former peat extraction site rewetted 15 years ago.
- Optimization of hydrological conditions by irrigation from surrounding rewetted polders (Fig. 3).
- Successful inoculation of 5 ha: *Sphagnum papillosum* Lindb., *Sphagnum palustre* L. or mixture of hummock species (Fig. 2).

Commercial cultivation site

- Former peat extraction site.
- No previous agricultural use.
- Irrigation by surface drains and ditches.
- Protection of young Sphagnum by straw cover (superior) or fibre mats.
- 5 ha with the same species as the propagation area.

Fluxes of methane (CH_4) and nitrous oxide (N_2O)

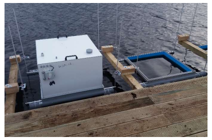

Figure 3: Static opaque chamber (0.75 m x 0.75 m x 0.5 m) on a buoyant frame in an irrigation polder with dynamic water level.

- 5 samples within 1h analyzed by gas chromatography.
- Calculation of annual balances by interpolation and/or functional relationships.

Exchange of carbon dioxide (CO_2)

- Transparent (NEE) and opaque (R_{eco}) manual chambers connected to an infrared gas analyser.
- Intensive campaigns to cover diurnal ranges of photosynthetic active radiation (PAR) and temperature:
  - → Calculation of annual balances using functional relationships between NEE and PAR (Menten and Michaelis, 1913) and of R_{eco} and soil temperature (Lloyd and Taylor, 1994), respectively.

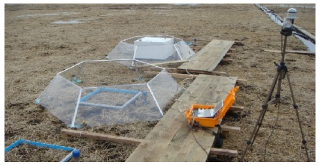

Figure 4: Infrared gas analyser

Open-Top Chambers (OTC)

Figure 5: Selected plots were equipped with Open-Top Chambers (Molau and Mølgaard, 1996): UV resistant polycarbonate (3 mm): 2.08 m lower diameter, 1.50 m upper diameter, 0.6 m height.

- Simulation of potential climate change conditions by increasing the temperature:
  - → Increased biomass production?
  - → Increased ecosystem respiration?
    - → Increased, decreased or unchanged carbon balance?
  - → Increased methane emissions?
- Measurement of soil and air temperature, humidity, soil moisture and leaf wetness (yet to be finalized).
- Resilience of near-natural and differently irrigated sites to climate warming conditions.

Separation of CO_2 sinks and sources at the commercial cultivation site

- Radiocarbon (^{14}C) dating of carbon pools and fluxes
  - → Age determination of the old peat layer.
  - → Quantification of the turnover of the peat layer.
- Pulse-Labelling (^{13}C) experiment
  - → Where is the newly sequestered Carbon going?
  - → What is the ratio of old and new Carbon in respiration?
  - → Quantification of fluxes in soil dissolved organic matter (DOM), biomass and respiration.

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