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Mitigation of greenhouse gas emission on abandoned peatlands by growing reed canary grass

J. Järveoja, J. Laht, K. Soosaar, M. Maddison, I. Ostonen, and Ü. Mander
Uni Tartu, Institute of Ecology & Earth Sciences, Estonia (ulo.mander@ut.ee)

We used combined closed-chamber and plant biomass techniques to study the impact of reed canary grass (RCG, Phalaris arundinacea) cultivation on greenhouse gas (GHG) fluxes and carbon balance of an abandoned peat extraction area in Lavassaare, Estonia (N58°34'20"; E24°23'15"). Three core study sites were chosen within the abandoned peat extraction area: (I) bare peat soil (abandoned and not planted site), (II) non-fertilized Phalaris site, (III) and fertilized Phalaris site (all on drained Fibric Histosols). In addition, (IV) the natural raised bog (Fibric Histosol) and (V) the cultivated fen meadow (drained Sapric Histosol) served as reference sites.
The CO_2, CH4 and N2O fluxes were determined using the closed-chamber method once a month from May 2010 to December 2011. White 60 L chambers made of PVC and sealed with a water-filled ring on the soil surface were installed in 5 replicates on each site. The gas was sampled 3 times per hour in 100 mL pre-evacuated glass bottles, and in the lab the gas concentrations were measured using the Shimadzu GC-2014 (ECD, FID) gas–chromatographic system combined with a Loftfield autosampler. Measurements of groundwater level and soil temperature (10, 20, 30, and 40 cm depths) were performed simultaneously. Biomass assessments of RCG were carried out just after maximal growth of macrophytes, in early September 2010, in April 2011 just after snow melt (time of minimum aboveground biomass), and again in September 2011. Aboveground biomass samples were collected from 1×1m plots. Belowground biomass samples were collected at a depth of 25 cm in 3 replicates adjacent to each chamber using a 10×10 cm auger. Samples were analyzed for N, P and C.
Our results showed high nitrous oxide emissions (up to 541 μg N2O-N m-2 h-1) from the fen meadow and high methane emissions from the natural raised bog (up to 12915 μg CH4-C m-2 h-1). The low CH4 emission from the Phalaris plots and bare soil was due to the deeper water table (up to 85 cm below ground) and high sulfur concentration in peat (up to 23 g kg-1), which probably inhibited methanogenesis. The high CO_2 emission on fertilized and non-fertilized Phalaris plots in comparison to the bare peat site was probably caused by: (1) the higher plant biomass: more dissolved C coming from roots and greater amount of fine root turnover, (2) the influence of fresh plant litter on the peat mineralization on Phalaris plots, and (3) inhibited mineralization by recalcitrant C of bare peat. Our results demonstrated that as a total, the Phalaris sites acted as net carbon sinks, sequestering C in the amount of 6929.5 and 6083.5 kg CO_2-C ha-1 yr-1 on the fertilized and non-fertilized plots, respectively, whereas the bare peat site acted as a carbon source (emitting 687.5 kg CO_2-C ha-1 yr-1).