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Net ecosystem exchange of CO2 and ecosystem respiration in two bogs in Estonia along disturbance gradient

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Northern peatlands are important terrestrial carbon (C) stores, but their ability to sequestrate C is at delicate balance affected by management and also by climate change. The climate change causes less snow pack and warmer winters with faster water table drop in spring and drier summers in most boreal areas. Due to those changes natural peatlands may become C source instead of sink.

This study presents ecosystem respiration (ER) over five-year period and the annual estimates of net ecosystem exchange (NEE) of CO_2 in Umbusi and Laukasoo in Estonia along disturbance gradient from drained to natural ombrotrophic bog. Both study sites locate next to the active cutaway peatlands. There were four CO_2 flux measurements plots with three measurements points at different distance from the drainage ditch (10, 50, 100 and 200 m in Umbusi; 3, 40, 50, 125 m in Laukasoo) to form a water table depth and soil moisture gradient on both study sites. ER was measured using opaque static chamber throughout of the year in period 2012-2016. A vented and thermostated transparent plastic chamber with removable opaque cover was used for CO_2 exchange measurements. NEE measurements occurred biweekly from April to December in 2015, totally were done 648 measurements. NEE was derived from modelling of ER and gross primary production with temperature, photosynthetically active radiation, water level and days of year (as phenological phase) as driving variables.

Annual mean NEE at four different distance from the ditch toward undisturbed area in Umbusi and Laukasoo were 0.37, 0.28, 0.15, 0.08 and 0.44, 0.34, 0.04, 0.21 kg C m^{-2} y^{-1}, respectively. Although mean NEE was positive for all plots on both sites, there were also negative annual NEE values in some points in undisturbed plots (100 and 200 m from the ditch in Umbusi and 50 and 125 m in Laukasoo).

Average water level at four different distance from the ditch toward undisturbed area in Umbusi and Laukasoo during growing period (from the beginning of May to the end of October) in 2015 were -94, -45, -22, -22 and -124, -33, -21, -22 cm, respectively. Monthly mean air temperature and sum of precipitation were not different from the long-term measurements in studied growing period in 2015 while winter was significantly warmer.

Modelled ER remained high for cold period because of higher air temperature in 2015. Due to higher respiration rate from non-frozen peat layer in cold season, more CO_2 was released back to

atmosphere and annually less C was accumulated. Monthly mean air temperature for cold period was 3.5 ºC warmer than the long-term average.