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CO_2 exchange in restored milled peatlands in Estonia — importance of vegetation, water table and weather conditions

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Peat excavation has altered carbon balance on vast areas in Northern Hemisphere, so turning pristine mires from CO_2 sinks to sources. Peatland restoration aims at mitigating the situation, by supporting the CO_2 uptake in these areas through raising the water table, which creates suitable conditions for vegetation development. There is over 9 000 ha of abandoned milled peatlands in Estonia, while peat extraction is ongoing on about 20 000 ha. Over the past few years, restoration activities have been carried out on several peatlands in Estonia. The objective is to restore at least 2 000 ha of abandoned milled peatlands by 2023 (co-funded by the European Union). So convenient methods are needed for estimating CO_2 fluxes on recovering peatlands, and we would like to discuss the possibilities for using drones with multispectral cameras to monitor vegetation recovery and from that estimate CO_2 fluxes on restored milled peatlands.

The main aim of the study is to relate vegetation recovery and CO_2 fluxes on three recovering milled peatlands in N-Estonia, which have been rewetted, or restored using moss-transfer technique (Rochefort et al., 2003) from 2005 to 2012. From May to September in 2015 and 2016 the CO_2 balance measurements were made with transparent measurements. The two years the coverage of plant species was analysed, whereas plant biomass was found in 2016. In September 2017, Normalized Difference Vegetation Index (NDVI) quantifying the photosynthetic capacity of the land cover was measured with Sensefly eBee fixed winged mapping drone with multispectral camera.

In 2015, precipitation during the growing season was only 80% of the long-time average, and mean temperature was about 2°C higher than long-time average. On 2016, the growing season was somewhat wetter. On drier year, all sites were CO_2 sources (1-77 g CO_2 m^{-2}), while on the wetter year, two sites were CO_2 sinks (–13 up to –210 g CO_2 m^{-2}). The driest site, with lowest water table was CO_2 source during the two growing seasons, but had significantly smaller CO_2 emission values, compared with unrestored abandoned milled peatlands. This clearly demonstrates the need for multi-annual CO_2 flux measurements, as one year measurements could be influenced by extreme weather conditions like droughts.

CO_2 uptake increased with higher plant coverage and LAI, *Eriophorum vaginatum* cover and biomass and Sphagnum cover, while plots with bare peat remained to be CO_2 sources in both years. Respiration was higher with higher coverage of dwarf-shrubs (mainly *Calluna vulgaris*). NDVI explained about 25% of the variation in Net Ecosystem Exchange, CO_2 uptake was higher on plots with higher NDVI values (which indicates higher amount of photosynthetically active biomass). To increase CO_2 uptake in abandoned milled peatlands, raising the water level is essential to reduce peat oxidation and create conditions for development of vegetation similar to untouched mires. Spatial distribution of NDVI values obtained with drone equipped with multispectral camera may give us valuable information about vegetation, weather and water table condition temporal changes in photosynthetic capacity on recovering peatlands.