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Methane and CO_2 fluxes from peat soil, palm stems and field drains in two oil palm plantations in Sarawak, Borneo, on different tropical peat soil types.

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Oil palm plantations have been expanding rapidly on tropical peat soils in the last 20 years, with $\sim$ 50 % of SE Asian peatlands now managed as industrial or small-holder plantations, up from 11% in 1990. Tropical peat soils are an important carbon (C) store, containing an estimated 17 % of total peatland C. There are large uncertainties as to the soil C dynamics in oil palm plantations on peat due to a shortage of available data. It is therefore essential to understand the soil C cycle in order to promote effective management strategies that optimise yields, whilst maintaining the high C storage capacity of the soil.

Here we present CO_2 and CH4 fluxes from two oil palm plantations in Sarawak, Malaysia on peat soils. Data were collected from different surface microforms within each plantation that experienced different surface management practices. These included the area next to the palm, in bare soil harvest paths, beneath frond piles, underneath cover crops, from the surface of drains, and from palm stems. Data were collected continuously over one year and analysed with different environmental variables, including soil temperature, WTD, O_2, soil moisture and weather data in order to best determine the constraints on the dataset.

Total soil respiration (Rtot) varied between 0.09 and 1.59 g C m-2 hr-1. The largest fluxes (0.59 – 1.59 g C m-2 hr-1) were measured next to the palms. Larger CO_2 fluxes were observed beneath the cover crops than in the bare soil. This trend was attributed to priming effects from the input of fresh plant litter and exudates. Peat soil type was shown to have significantly different fluxes. The different plantations also had different environmental drivers best explaining the variation in Rtot – with soil moisture being the most significant variable on Sabaju series soil and soil temperature being the most significant environmental variable in the plantation with the Teraja series soil.

Rtot was shown to reduce significantly with increasing distance from the palm. The relationship between Rtot and root biomass, which also decreased significantly with increasing distance from the palm, allowed for the partitioning of Rtot into peat oxidation and Ra. Here rates of peat oxidation were estimated to be 0.11 g C m-2 hr-1 following partitioning, and 0.16 g C m-2 hr-1 without partitioning.

Methane fluxes varied between 0 and 1.95 g C m-2 hr-1. The largest methane fluxes were emitted from collection drains. Methane oxidation was occasionally observed in field drains, when the water table dropped below the depth of the drain. Soil methane fluxes were lower than those from collection drains. The highest methane fluxes were observed next to palms (0.02 mg C m-2 hr-1) and the lowest under frond piles (0.08 mg C m-2 hr-1). Methane emissions were measured from the palm stems. Preliminary data gives a range between 0.005 and 0.27 μg C m-2 hr-1.

These results show wide ranges in both CO_2 and CH4 emissions from different sources within the plantations, with the collection drains being the largest source of C fluxes.