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Heterotrophic respiration in drained tropical peat temperatures influenced by shading gradient

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Lowland peatlands in Southeast Asia constitute a highly concentrated carbon (C) pool of global significance. These peatlands have formed over periods of several millennia by forest vegetation tolerant to flooding and poor substrates. Uncontrollable drainage and reoccurring wild fires in lack of management after removal of forest cover has impaired the C-storing functions in large reclaimed areas. Intergovernmental Panel on Climate Change (IPCC) reporting sees drained tropical organic soils as one of the largest greenhouse gas emissions releasing terrestrial systems. Vast areas of deforested tropical peatlands do not receive noteworthy shading by vegetation, which increases the amount of solar radiation reaching the peat surface. We studied heterotrophic carbon dioxide (CO_2), nitrous oxide (N2O) and methane (CH4) fluxes in tropical peat in conditions, where; (i) peat temperatures were modified by artificial shading (no shade, 28%, 51% and 90% from the full sun exposure), (ii) root respiration was minimized, (iii) nutrient availability for peat decomposer community was changed (NPK fertilization of 0 and 313 kg ha-1). The experiment was repeated at two over 20 years ago drained fallow agricultural- and degraded sites in Central Kalimantan, Indonesia.

Enhanced shading created a lasting decrease in peat temperatures, and decreased diurnal temperature fluctuations, in comparison to less shaded plots. The largest peat temperature difference was between the unshaded and 90% shaded peat surface, where the average temperatures within the topmost 50-cm peat profile differed 3 ºC, and diurnal temperatures at 5 cm depth varied up to 4.2 ºC in the unshaded and 0.4 ºC in the 90% shaded conditions.

Highest impacts on the heterotrophic CO_2 fluxes caused by the treatments were on agricultural land, where 90% shading from the full exposure resulted in a 33% lower CO_2 emission average on the unfertilised plots and a 66% lower emission average on the fertilised plots. Correlation between peat temperature and CO_2 flux suggested an approximately 8% (unfertilised) and 25% (fertilised) emissions change for each 1 ºC temperature change at 5 cm depth on the agricultural land. CO_2 flux responses to the treatments remained low or were inconsistent over the peat temperature range.. Fertilised conditions negatively correlated with N2O efflux with increases in temperature, suggesting a 12–36% lower efflux for each 1 ºC increase in peat temperature (at 5 cm depth) at the sites. Despite the apparently similar landscapes of fallow agricultural land and degraded peatland sites, the differences in greenhouse gas dynamics are expected to be an outcome of the long-term management differences. Based on the results it is possible to seek management practices that prolong timespan for using drained tropical peat for cultivation, simultaneously reduce negative climate impacts created from peat substrate carbon loss, and also improve greenhouse gas monitoring techniques at field.