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Effects of post-fire vegetation structure on CH4 emissions from a degraded tropical peatland in Brunei

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Tropical peatlands are one of the most carbon (C) dense ecosystems in the world storing 3% of global soil C on 0.25% of the total land area. However, over the past few decades peatlands in Southeast Asia have been heavily deforested for multiple landuses, mainly by employing drainage and fire. This has resulted in converting them to a net source of C. These disturbances not only result in loss of vegetation structure but also enhances peat oxidative decomposition thereby resulting in subsidence and frequent flooding which leads to formation of cryptic wetland. Flood-tolerant vascular plants like ferns and sedges form the post-fire vegetation structure in degraded tropical peatlands. The role of different species of sedges and individual processes involved in production, oxidation, and transportation of CH4 have been well-studied in northern peatlands where community composition significantly affects these rates.

In this study, we adopt a systems level approach integrating in-situ gas measurements with metabolomics and genomics to assess the role of microbial community composition, its dynamics, and plant associated feedback mechanisms to unravel the mechanistic aspects of CH4 production and oxidation from a heavily fire-degraded peatland in Brunei.

The vegetation at our site is composed of two species of ferns (Nephrolepis biserrata, Blechnum indicum) and one species of sedge (Scleria sumatrensis). Here, we show for the first time that sedges in tropical peatlands can also be a significant source of C transporting >80% of CH4 directly into the atmosphere [Total CH4 flux: 3.7 + 0.5 mg CH4 m-2 hr-1; Sedge flux: 3.1 + 0.4 mg CH4 m-2 hr-1 (n=56)]. We hypothesize that the microbial niche in the rhizosphere of these plant species could actively contribute to CH4 production and transportation. Further, secondary metabolites and signalling molecules from the root exudate could be providing a feedback mechanism to control and regulate the ecosystem-scale CH4 fluxes in tropical peatlands.

Key words: Tropical peatlands, Fire, CH4, Sedges, Root exudate, Microbes