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Effect of disturbances on greenhouse gas emissions of Indonesian and Malaysian peat soils

（インドネシアおよびマレーシア泥炭土壌における森林火災，人為的排水，および土地利用変化がもたらす温室効果ガス排出への影響）

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1. Introduction

Disturbance of tropical peat forest (e.g. drainage, peat fire, and land use change) contributes largely to global C cycles as a “hotspot” of CO_2 emission. Peat disturbances may also alter peat chemistry, particularly declined on peat substrates quality, which demonstrated by high recalcitrant content in the soil. Changes in peat chemistry and substrate quality may simulate CH_4 depletion by suppressing the electron transfer to CO_2, the methanogenesis substrate. For better understanding how changes on chemical properties affects CH_4 emission, related to peat disturbances in tropical peatlands, an anaerobic incubation study is performed. The objectives of this study are: 1) to clarify the effect of disturbance on peat chemistry, and 2) to clarify the effect of peat chemistry on GHGs emissions in Indonesia and Malaysia.

2. Materials and Methods

Samples were taken from Indonesia (Palangka Raya) and Malaysia (Sarawak), which following the disturbance intensities, were defined as: undrained forest (UFI and UFM), drained forest (DFI and DFM), oil palm (DOM), burnt forest (BFI), and cropland (CL). Samples were submerged and incubated with N_2 gas in the headspace (25^0C, 10 weeks). Headspace gas was taken every week to measure CO_2, N_2O, and CH_4 concentrations. Acid insoluble component (AIC) as the representative of recalcitrant component in the soil, was analyzed by TAPPI method. Soil properties such as pH, EC, CEC, and Eh were measures, as well as anion and cation concentrations.

3. Result and Discussion

Highest CO_2 and CH_4 emissions were found from undrained forests, while N_2O emission was from CL site derived from fertilizer application. Soil substrates of NO_3^-, Mn (IV), Fe (III), SO_4^{2-} and CO_2, role as electron acceptor in anoxic system. This study found higher initial concentration of R-Fe (easily reducible iron), NO_3^- and SO_4^{2-} in CL, DOM, and BFI compare to undrained forests, indicating that disturbance simulates accumulation of soil substrates by altering the microbial activity. The time series of redox reactions showed that CH_4 produced after the previous substrates were exhausted. Undrained forests with lower substrate availability was found to have higher anaerobic decomposition rates, indicated by higher CEC and AIC, and acceleration of at least NO_3^- and SO_4^{2-}e reduction (Mn (IV) and Fe (III) were neglected since they were assumed to have minor importance in the system). Higher reduction rates of NO_3^- and SO_4^{2-} resulting in higher CH_4 emission in undrained forests because methanogenesis was started faster than other sites. CO_2:CH_4 ratio was found higher in DOM, CL, and BFI sites, indicating that higher disturbance intensity may increase SOM oxidation capacity, resulting in excess production of CO_2 over CH_4.

4. Conclusion

Higher initial concentration of R-Fe, NO_3^-, and SO_4^{2-} as substrate in DOM, BFI, and CL resulting in CH_4 suppression by competing with CO_2 as electron acceptor, demonstrated by delaying in the methanogenesis starting time.