A global study on the natural dynamics and land-use impacts on tropical peat soil properties and greenhouse gas effluxes

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Abstract

Tropical peatlands are one of the most effective long-term natural carbon stores on Earth. The drainage, conversion, and degradation of natural tropical peatlands for agricultural development shifts the magnitude and direction of their carbon balance, from net carbon sinks to sources. Yet, there are limited studies that globally synthesize information to constrain our general understanding of the characteristics and linkages between peat soil physicochemical properties and greenhouse gas (GHG) effluxes in tropical peatlands, as well as how their dynamics may be altered by land-use and land-cover change (LULCC). Here, we systematically reviewed more than 100 published field-based papers on soil physicochemical properties such as peat thickness, ages, bulk density, carbon and nitrogen contents, carbon to nitrogen ratio, water table, and CO2 and CH4 effluxes across three main tropical peatland regions, i.e., Latin America, Central Africa, and Southeast Asia. We report that Southeast Asian peatlands have the thickest layer with 537±230 cm compared to Latin America (150±104 cm) and Central Africa (250±160 cm). We also observed a strong natural variation of soil physicochemical properties within the region, which may imply variability of produced GHGs. Most managed peatlands have a higher bulk density compared to undisturbed ones (0.12±0.05 and 0.20±0.18 g cm-3) despite a slightly similar carbon content (44±9 and 47±10 %), which may suggest substantial peat subsidence and losses. Similarly, LULCC generates more than double increase in CO_2 effluxes despite lowering CH_4 effluxes compared to undisturbed peatlands. The global database constructed through this literature review will be valuable for future modelling improvement of peatland carbon estimates in the tropics, a significant carbon-rich system but often overlooked in the terrestrial climate model. Further, our synthesis and dataset will help provide science-based guidelines to set and monitor emissions reduction targets as part of the forestry and land-use sector.

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