



Science-based technological innovations can reduce socio-economic impacts and enhance the sustainability of tropical peatlands

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Unprecedented drainage and burning of tropical peatlands in Southeast Asia for commercial agro-industrial plantations lead to nearly 12% global CO₂ emissions. Hydrological restoration of drained peatlands by rewetting them is being planned on a large scale, as a strategy to reduce fire incidences as well as mitigate CO₂ emissions. However, the immediate consequences of saturating dry peat on greenhouse gas emissions that result from carbon decomposition are not well understood. We conducted this study to unravel the consequences of drying and wetting on peat carbon decomposition. We show from both controlled microcosms and field studies that anoxic decomposition from water-saturated peat is the major source of CO₂ production, and accounts for 70-80% of emissions. Controlled wetting of dry peat increased CO₂ production by 25% within a few hours. Also, corroborating field data showed that rainfall inundations do not reduce peat decomposition rates and loss of carbon continues during wet periods. The mechanistic basis of the continued peat decomposition even in the wet period, which results in high anoxia, was linked with increased nutrient availability (of both carbon and nitrogen) due to 'priming' effect. The solubilization of nutrients due to priming resulted in extensive changes in >360 different organic molecules from carbon and nitrogen metabolism in a coupled manner. This coupled carbon-nitrogen metabolism is also explained from high N₂O and CO₂ emissions that emerged from anoxic zones in the field. We also suggest some science-based technological solutions that not only improve the sustainability of agriculture in tropical peatlands but also reduce peat-loss resulting from microbial oxidation. By adopting these technological solutions, we aim to perform socio-economic analysis in future that can reveal the benefits for the livelihood of people affected by the land-use change in the region.