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Analysing land developments on peatlands using spectral-temporal metrics to calculate land cover-based GHG emissions and emissions pathways in North Kalimantan, Indonesia

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GHG emissions from drained peatlands in Southeast Asia contribute about 68% of the total regional emissions. Monitoring of land use dynamics on peatlands is necessary to quantify resulting climate impact. Optical satellite-based spatial land cover (LC) analyses are challenging in tropical regions due to high cloud covers. To overcome the limitation, we used the annual medians of spectral bands of Landsat 7/8 and Sentinel-2 which included all available observations per pixel and year for assessing LC in the Peatland Hydrological Units (PHUs) in North Kalimantan, Indonesia, for 2013, 2016 and 2019. Peatlands cover 290,000 ha of the 350,000 ha PHU area. In 2019, half of them still appeared to be covered by primary peat swamp forest (PSF). Drainage-based land use in the PHUs had expanded from 2013 to 2019, from 14 percent to nearly 30 percent of the total peatland area, with oil palm plantations covering more than half of the area under land use. Despite remaining data scarcity in some parts of the study area, which led to misclassifications, f1 scores classification accuracies range between 0.76 and 0.83.

In combination with a derived peatland map, greenhouse gas (GHG) emissions from land use on peatlands were calculated for the study years and a set of future GHG emission scenarios developed based on IPCC emission factors.

Peatland conversion between 2013 and 2019 led to a doubling of GHG emissions from land use reaching 3.24 Mt CO_2-eq yr^{-1} in 2019. As only 8% of the peatland area in the North Kalimantan PHUs falls under the moratorium, whereas 69% is designated as plantation concessions, we expect PSF conversion to continue and the area of degraded peatland to increase. In the "business-as-usual" (BAU) scenario with conversion rates as between 2013 and 2019, GHG emissions would reach about 10 Mt CO_2-eq per year by 2050. In the "stop new drainage" scenario, conversion would stop in 2020 and GHG emissions would remain at 3.24 Mt CO_2-eq yr^{-1}. The cumulative avoidance potential until 2050 of the latter scenario is 48 %, compared to the BAU scenario. Complete rewetting of all drained peatlands by 2025 and halting any new drainage would until 2050 avoid 190.5 Mt CO_2-eq, i.e. 89%, compared to the BAU scenario. These avoidances will, however, only be achieved when the average annual water table depth after rewetting reaches or exceeds the peat surface. Otherwise, Indonesia's NDC assumption of a zero peat decomposition in restored

peatlands will not be achieved.

To reduce expansion of drainage-based land use and associated GHG emissions, all peatland outside existing concessions in North Kalimantan would need to be covered by the Indonesian Moratorium. In parallel, existing concessions for drainage-based land use should be cancelled or replaced by concessions for wet peatland use, such as paludiculture.