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A rapid assessment of microclimate and meteorological conditions in the tropical lowlands of Jambi province (Sumatra, Indonesia): Land-use intensity gradients and spatial small-scale climate variability across 120 plot locations

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Indonesia is one of the hotspots of land transformation from forest ecosystems toward oil palm and other cash-crop monocultures. Land-cover changes directly impact below-canopy microclimate, which are critical drivers for many ecological functions, such as greenhouse gas exchange and soil microbial activity. However, microclimatic variability below canopies, even within the same land-use type can be quite large due to structural heterogeneity, vegetation age or vitality, and differences in management practices.

In this study, we focused on the assessment of microclimatic differences within the most common land-use types in tropical lowland Jambi province (Sumatra, Indonesia), using mini-meteorological stations. We used a rapid assessment approach in which we monitored below-canopy key meteorological parameters at a total of 120 different locations from June to November 2021, covering lowland tropical rainforest, oil palm monoculture, rubber monoculture and agroforestry systems, and fallow shrublands. We clustered the study region into 16 micro-regions, each with a radius of four kilometres. In each micro-region, an open-land area served as a reference meteorological location. Based on the gradients of meteorological parameters between below-canopy and open-land conditions we derived the site-specific impact of the respective land-use type on below-canopy microclimate. To further explore microclimatic characteristics of the different land-use types, we used airborne laserscanning (ALS) data available at a subset of 90 plots as well as information on age, management intensities and ownerships of plantations, distance between plantations and forests, and overall land cover distribution.

Preliminary results show that forests and fallow shrublands are generally cooler, wetter and receive lower below-canopy radiation compared to agricultural systems and open land. Forests show a strong capacity to buffer high levels of open-land air temperature and atmospheric vapour pressure deficit (VPD) variability by, on average, 1.7°C and 6.4 hPa, respectively, while oil palm showed very little buffering capacities (0.2°C and 2.2 hPa). At a regional scale, mixed land-use

systems tend to be slightly warmer (+0.36±0.18°C) and drier (+1.47±0.52 hPa VPD) compared to forest-dominated land-use systems. Within the mixed land-use systems, forests tend to be drier (+1.05±0.41 hPa VPD) while below-canopy temperature remains similar (+0.38±0.34°C) compared to forests in the forest-dominated land-use systems. Interception is an important component in the hydrology of the studied forest locations, with approx. 66% of precipitation being intercepted, while at fallow shrubland, rubber and oil palm locations, only 24, 25 and 17%, respectively, of precipitation was intercepted. Overall, our preliminary results show that there is high variability in meteorological conditions, even within the same micro-region or land-use type.