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Using Airborne Laser Scanning to characterize different land uses in a tropical landscape based on their structural complexity

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Accurate characterization of land use and land cover (LULC) is important in a rapidly changing environment such as the Indonesian tropics. Over the past 30 years, native tropical forests have been cleared and replaced by fast-growing cash-crops, such as oil palm and rubber plantations. This change in land use dramatically alters the vegetation structure of the entire region. Vegetation structural complexity is highly variable in tropical forests, and provides habitat to a large number of native species. In addition, vegetation structure has an impact on micro-climate and the exchange of greenhouse gases (GHG), water and energy. Measuring vegetation structure in the field can be costly and time consuming, particularly in remote, inaccessible areas of tropical forest. In contrast, Airborne Laser Scanning (ALS) can provide very detailed three-dimensional information on forest structure without the need to reach remote areas in the field. Here, we aim to study the potential of ALS-derived measures of structural complexity as ecological indicators to highlight differences in forest structure across a gradient of LULC in Sumatra, Indonesia. We analysed the structural complexity of four main LULC types relevant to the region: tropical secondary forests, rubber agroforests, oil palm plantations and shrublands. Several structural metrics have been extracted from ALS data over 136 circular 0.1 ha plots (34 plots per LULC type): top height, height percentiles, rumple index, leaf area index (LAI), effective number of layers (ENL), vegetation cover, number of gaps. Results from a Principal Component Analysis (PCA) indicated number of gaps to be a major driver associated with the occurrence of oil palm plantations, while higher values of key structural metrics, such as top height, LAI and ENL were strongly linked with the presence of secondary tropical forest plots. Furthermore, a clear separation in metrics behaviour between forest and oil palm plots was evident from the pairwise comparison of these metrics, with rubber and shrubland plots behaving similarly to either forests or oil palm plantings according to different metrics. Our results show clear distinctions in several structural attributes among different LULC, which indicate the need for careful considerations regarding the impact of

land-use change on ecosystem functioning, biodiversity and climate.