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Quantifying Local-scale Forest Degradation Intensity from Charcoal Production Using a Fusion of GEDI and Landsat Data

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Deforestation and degradation are two major threats to the global forest that jeopardize their functions to store carbon and mitigate climate change. Forest degradation undermines the health and functions of the forest to perform ecosystem services and is a stepping stone to deforestation. However, forest degradation has not been sufficiently monitored and quantified due to the varying intensity of disturbance and usually inconsistent spectral signals reflected in optical remote sensing. Drivers of forest degradation can be natural and/or human-related, and charcoal production is a key driver of forest degradation in sub-Saharan Africa due to the high demands for charcoal for energy consumption and the increasing rate of population growth and urbanization. In this study, we focus on charcoal production-driven forest degradation that occurred at the Mabalane district in Southern Mozambique from 2008 to 2018. We intend to demonstrate the potential of combining Global Ecosystem Dynamics Investigation (GEDI) data and Landsat time stacks for inspecting the changes in forest structure and aboveground biomass (AGB). To do so, we categorize the degraded forest by the year of disturbance based on a disturbance map produced for the study area for 2008-2018 by Sedano et al. (2019) and analyze the first year of publicly-released GEDI data to characterize forest structure and AGB at different disturbance classes. We also compare the GEDI L4A biomass with three other global and continental AGB products to understand the pre-disturbance biomass storage and the degradation patterns. Lastly, we build an empirical model between GEDI biomass and Landsat spectral bands and vegetation indices to quantify the biomass removal and regrowth from 10-year charcoal production. Uncertainties from the GEDI-Landsat models are estimated using Monte Carlo Simulations to propagate errors. The study improves the current understanding of forest degradation and carbon dynamics associated with it in tropical dry forests of sub-Saharan Africa. It also demonstrates the potential of combining spaceborne lidar missions and Landsat archives to facilitate accurate mapping of forest structural and AGB change in the degraded forest at a local scale.