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"Fire impacts in the Cerrado: Integrating LiDAR and field data to monitor vegetation structure and post-fire recovery."

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Fire is a natural disturbance capable of altering plant distributions and community assemblages, influencing species evolution through the selection of traits and strategies, and affecting biogeochemical cycles. This powerful tool of landscape transformation can negatively impact even a fire-dependent ecosystem when natural fire regimes are altered. In recent times, interactions between human activities in the Cerrado (e.g., deforestation and intentional fires used to clear land), and a hotter and drier climate (due to climate change), have altered natural fire regimes causing more frequent and intense fire events, negatively impacting biodiversity, human health, and the regional climate. These fire-disturbed areas are widespread and highly vulnerable to future degradation from compounding disturbances, but they still harbour valuable biodiversity and carbon stocks that deserve protection and restoration. Monitoring the impacts of fire disturbance on vegetation structure and the potential pathways of recovery is critical to understand and protect resilient ecosystems under a rapidly changing climate. Robust monitoring requires the integration of modelled and field-based data tools and techniques. Field inventories alone are insufficient to capture the spatiotemporal variability of impacts of fire on native vegetation and should be coupled with remotely sensed data, among which, LiDAR (light detection and ranging) is unparalleled in characterising 3-D vegetation structure. Thus, the combination of LiDAR and forest inventory data is ideally suited for scaling the impacts of fire on forest vegetation and associated carbon stocks. In this study, we are assessing key metrics of vegetation structure derived from a combination of LiDAR and field data collected at the Experimental Station Serra das Araras, Mato Grosso state, Brazil. This field site comprises Cerrado vegetation that has been subject to three experimental fire treatments: every year, every two years, and every three years beginning in 2017, as well as fire suppression for over three decades. We are investigating whether key vegetation structural metrics can capture different fire treatments and identify spatial patterns of disturbance. We are also assessing if these patterns are different when comparing

LiDAR data collected with a handheld scanner versus an airborne drone. This study aims to refine our methods and improve our understanding of vegetation structure responses across a gradient of fire disturbance regimes and potential post-fire recovery trajectories, which are key not only for ecological studies but also for emerging carbon markets – one of several mechanisms aimed at achieving climate change mitigation, conservation, and sustainable development outcomes. We hope to improve the process of carbon stock mapping in disturbed ecosystems and use the outputs to drive scenarios modelling at larger scales, providing a more comprehensive assessment of what future Cerrado carbon dynamics might look like under a range of possible disturbance/recovery dynamics.