Assessing degraded forest structures using UAV and SAR remote sensing data

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Forest degradation accounts for 68.9% of overall forest carbon losses and changes forest structure. Due to the diversity (nature, intensity and frequency) of anthropogenic disturbances, multiple forest structures can be observed within the forest landscape mosaic. Remote sensing offers a unique opportunity to identify and characterize these structures. Very High Spatial Resolution (VHRS) optical imagery has the capacity to model forest canopy. SAR VHSR data which are independent of visibility conditions are capable to retrieve forest biomass, depending on the radar frequency and forest density. However, optical and SAR images have rarely been combined to study degraded forest structure. The aim of this study is i) to characterize the structure of a wide range of degraded forests types using optical UAV imagery and ii) to evaluate the potential of VHSR SAR imagery for scaling up.The investigated area is located in the human-dominated landscape of Paragominas municipality (Para state, Brazil). 52 UAV images of 25 ha (10 cm resolution) were acquired in September 2017 along the whole forest degradation gradient (from "undisturbed" to logged and/or burned forests) and to derive Digital Elevation Models. Four TerraSAR-X images were acquired in October 2017 (1.5m resolution) with different incident angles and polarizations. Three textural indexes based on the spatial variation in pixel radiance were derived from VHSR images (Fourier Transform Textural Ordination spectrum, the lacunarity and the skewness indexes) within different window sizes (from 50 to 200m). Generalized Linear Models were established between the UAV and SAR derived indexes and the forest canopy heights. Model ï¬ts and robustness were assessed by calculating the coefficient of determination (R-squared), the Akaike information criterion (AIC) and the root mean square error (RMSE). The combination of the three textural indexes from UAV images were able to capture the full gradient of canopy crown size distribution and canopy gaps and show a positive relation with the opening and lowering of the canopy. TerraSar X derived indexes showed most accurate results with the 26° incidence angle and HH-HV polarization. This quantification is highly informative for forested land use planning and policy makers to better understand and characterize degraded forests status from local to regional scale.