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Evaluation of soil burn severity using very high spatial resolution products from Unmanned Aerial Vehicles (UAV)

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Abstract

The evaluation of soil burn severity at fine scale is one of the main challenges in fire ecology. The innovative technology of unmanned aerial vehicles (UAV) provides highly detailed spatial information that could be used to characterize accurately different attributes of burned areas. The main purpose of this study was to assess the ability of very high spatial resolution spectral indices derived from RGB and multispectral imagery collected by UAVs to discriminate soil burn severity after a wildfire. We evaluated soil burn severity one month after a wildfire occurred in the León province (NW Spain) in August 2019, which burnt 83 ha in a heterogeneous forest area. We fixed 80 square plots of 50 cm × 50 cm where an adaptation of Composite Burn Index (CBI) was applied to estimate soil burn severity levels. Simultaneously, we operated an UAV to obtain RGB and multispectral postfire images, which allowed us to calculate six widely used spectral indices: Excess Green Index (EGI), Green Chromatic Coordinate Index (GCC) and Char Index (CI) from RGB camera, and Normalized Difference Vegetation Index (NDVI), Normalized Difference Vegetation Red Edge Index (NDVIRE) and Normalized Difference Water Index (NDWI) from Parrot Sequoia multispectral camera. We explored the relationship between spectral indices and field soil burn severity metrics by means of univariate proportional odds (PO) regression models. These models were used to establish threshold values for each soil burn severity category (low, moderate and high). These classifications were validated through confusion matrices. Results indicated that multispectral indices were more strongly related to the soil burn severity than RGB indices. NDWI featured the best performance in univariate PO models (R^2cv = 0.6893) and soil burn severity category predictions (overall accuracy (OA) and Kappa of 83% and 0.74, respectively). High NDWI values showed high probabilities to distinguish accurately severely burned areas. Regarding RGB indices, CI was the best predictor of soil burn severity (R^2cv = 0.44; OA = 58% and Kappa = 0.34). Our results showed the ability of

UAV multispectral and RGB images with a very high spatial resolution to assess soil burn severity in landscapes affected by mixed-severity wildfires. UAV remote sensing technology might be a valuable tool for the identification of priority areas where restoration actions need to be applied to reduce the ecological impacts of wildfires.

Keywords: soil burn severity; Unmanned Aerial Vehicle; UAV; spectral indices; Parrot SEQUOIA

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