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| **Modelling and mapping multi-layer fine fuel loads in Australian Eucalypt forests using airborne Lidar** |
| Fine fuels are pivotal in the spread and behaviour of wildfires, particularly in highly flammable ecosystems such as Eucalypt forests in Australia. Despite this significance, the spatially explicit mapping of fine fuels in Australian Eucalypt forests using lidar remote sensing remains scarce. Vertical complexity in Eucalypt forests creates a non-uniform distribution of fine fuels across different heights. Previous studies focusing on quantifying fine fuel loads from airborne lidar (ALS) data often concentrated on upper canopy layers and achieved low accuracies for understorey layers. Addressing these gaps, this study employs fine-scale forest structural information derived from stratified ALS data to model and map multi-layer fine fuel loads in Eucalypt forests in East Gippsland, southeastern Australia.  We initially stratified ALS point clouds into distinct vertical forest strata and computed a large set of metrics from both stratified and unstratified ALS data. These metrics were then utilised to predict forest inventory-based fine fuel variables (canopy, elevated, near-surface, surface, and total loads) using Random Forest models. The model for canopy fine fuel load demonstrated the highest accuracy, with an R2 value of 0.83, followed by total fine fuel load with an R2 of 0.74. Elevated and near-surface fine fuel loads were moderately well predicted, with R2 values of 0.57 and 0.58 respectively, while the model for surface fine fuel load yielded an R2 of 0.68. Our findings also suggest that the integration of ALS predictors from different vertical strata led to optimal model performance for all fuel variables. Although predictors from upper canopy layers exerted the most influence, metrics describing shrub and herb structures also significantly contributed by interacting with other predictors, thereby impacting prediction results. These findings elucidate the complex interplay within vertical strata, highlighting how attributes across multiple forest layers explain the variation in fine fuel loads.  We finally applied the developed models for wall-to-wall mapping of pre- and post-fire (2019-2020 season) fine fuel loads across a re-surveyed ALS area. Fine fuel consumptions were then analysed in relation to burnt severities using the derived prediction maps. Comprehensive research methods and results from this study are important to support fire management and fire behaviour modelling activities. |

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