

Surface Fuel Load Estimation in the China-Mongolia Border Forests Based on Multi-Source Remote Sensing Satellite Data

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Abstract: Management approach may influence biomass production as well as carbon contents in plant component. Frequent wildfires occur in the China-Mongolia border region, with fires spreading into China, potentially causing severe forest fires. Surface fire spread is the primary mode of fire expansion in forest fire areas. Therefore, accurately estimating surface fuel load is of great significance for predicting fire occurrence probability and fire behavior. This study used three machine learning algorithms (RF, XGBoost, MLR) combined with three satellite remote sensing data sets (optical data from Landsat 8 Operational Land Imager (OLI), Synthetic Aperture Radar (SAR) data from Sentinel-1, and L-band Synthetic Aperture Radar (PALSAR) data from the Advanced Land Observing Satellite (ALOS)) along with 300 ground-truth sample points to estimate surface fuel load. The study first explored the correlation between fuel load and optical/SAR data and developed corresponding estimation models. The differences in estimation performance between various remote sensing data combinations were analyzed and evaluated. Using K-fold cross-validation, the RMSE of the remote sensing-based model was compared with the RMSE between the forest-type-based average and the field-measured fuel load to understand the differences between remote sensing-based estimates and field-measured average fuel load. The results show that combining optical and SAR data significantly improved the estimation of surface dead fuel load ($R^2 = 0.61$, RMSE = 1.75, MAE = 1.24), emphasizing the importance of data selection and combination in fuel load estimation.