# Quantifying Fuel Consumption for the Las Conchas Fire using Airborne LiDAR

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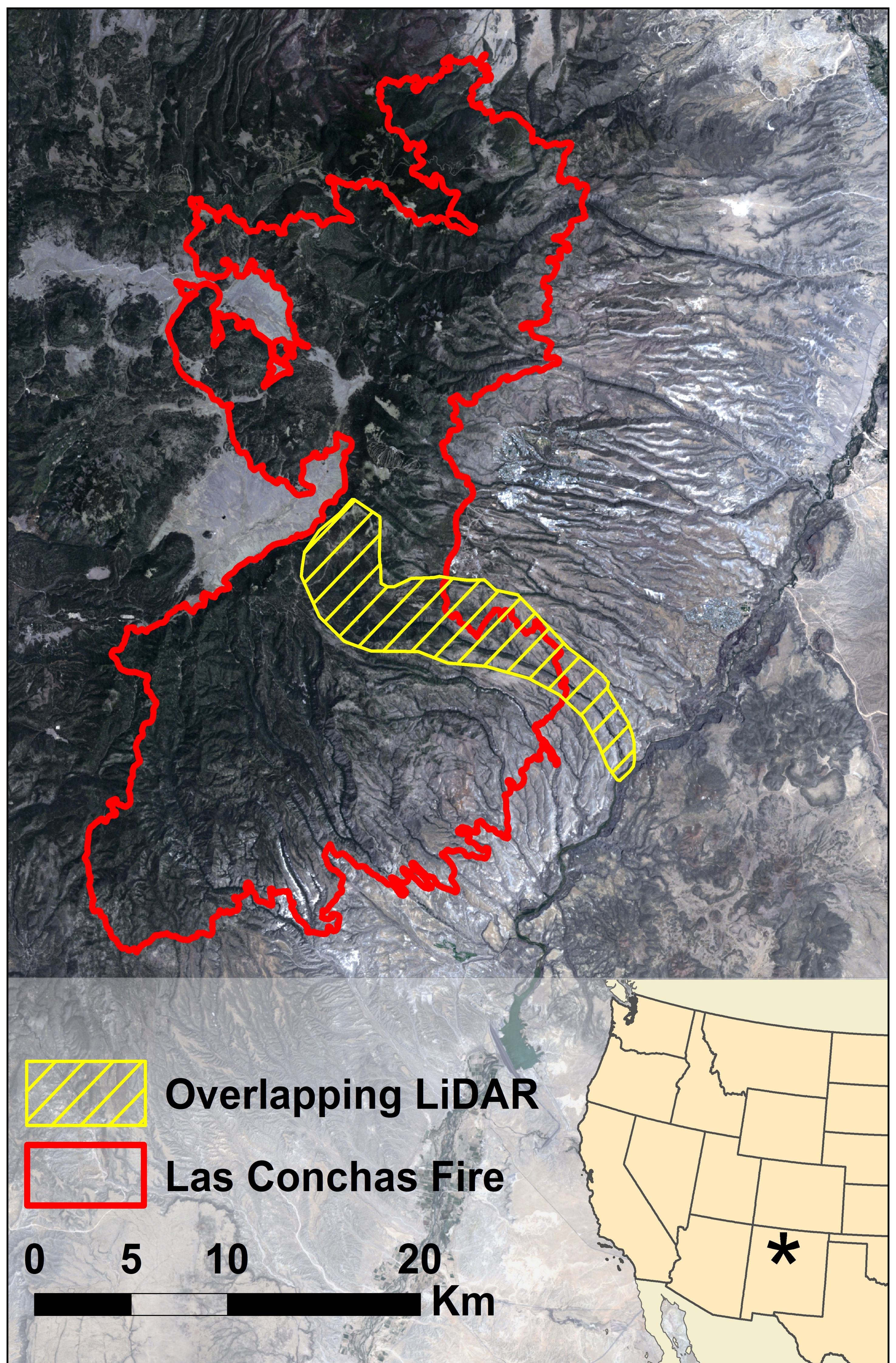
## Introduction

Quantifying fine-scale fuel consumption is important for estimating pattern and amount of carbon lost during a wildfire [1,2]. This study utilized pre- and post- fire LiDAR and field data for the 2011 Las Conchas fire in northern New Mexico in order to quantify changes in standing biomass, surface biomass, and canopy bulk density.



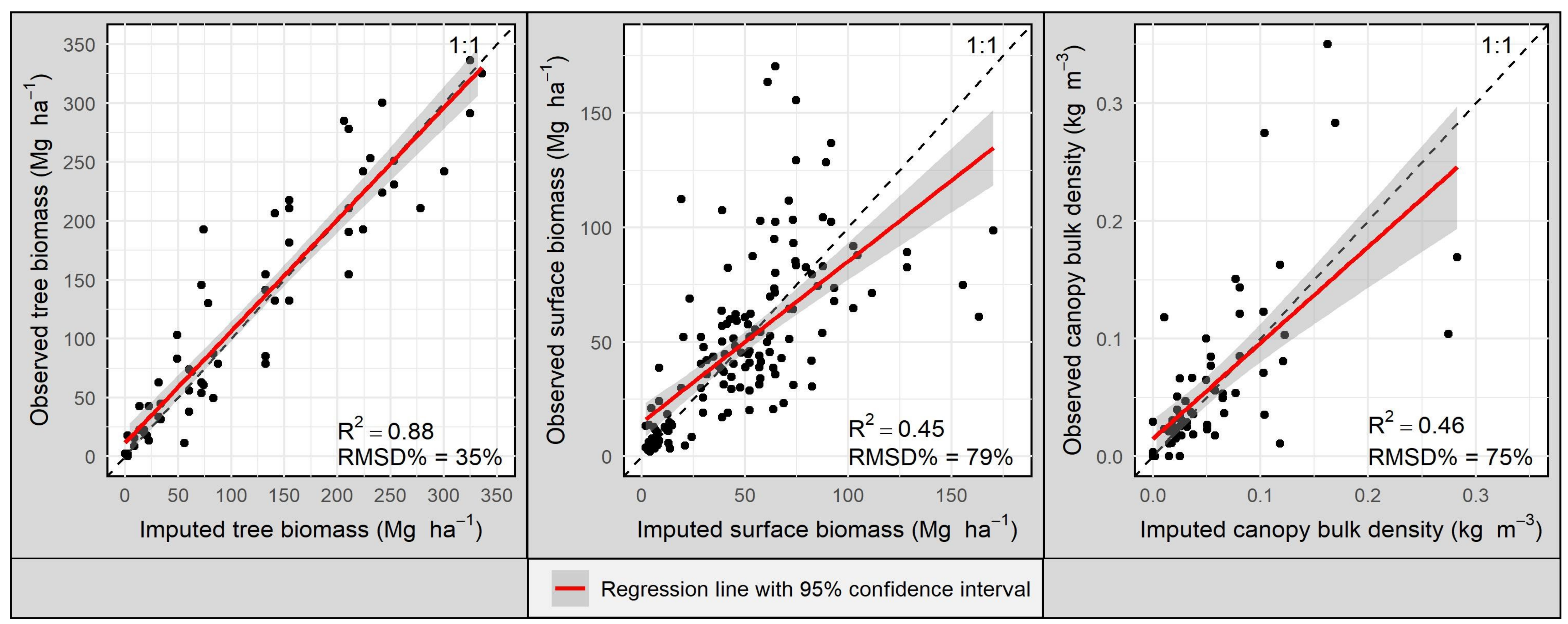

## Methods

Pre-fire LiDAR data were acquired between June 28th and July 3rd, 2010, while post-fire LiDAR data were acquired between September 24th and September 28th 2013. Both collections had a resolution of at least 8 points per square meter. Field data were collected between 2002 and 2016 by Bandelier National Monument. A total of 68 plots were used to estimate tree biomass and canopy bulk density, while 147 plots were used to estimate surface biomass.

Height-normalized pre-fire LiDAR data were clipped to plots measured prior to the fire, while post-fire LiDAR data were clipped to plots measured after the fire. Height and density metrics were computed from the point cloud for each plot and across the entire LiDAR dataset. Pre- and post-fire measurements were combined to create a single model, a temporal transferability approach found to be effective in other studies [4]. Models for tree biomass, surface biomass, and canopy bulk density were developed using random forest imputation, then iteratively refined to eliminate predictor variables that were highly correlated or relatively unimportant (see table). The final models were applied to generate pre- and post-fire images of the response variables, then differenced to create the final outputs.

## Selected predictor variables

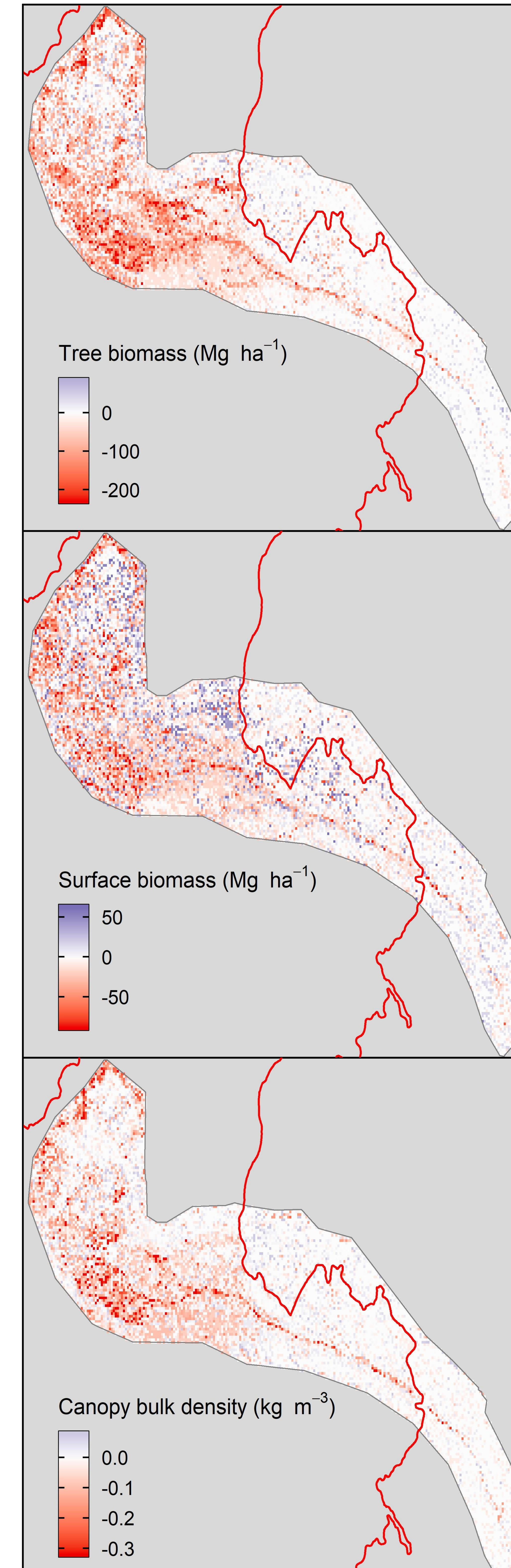
| Tree biomass and canopy bulk density | Surface biomass |
|---|---|
| Percent of first returns > 2.0m | Percent of all returns > 2.0m |
| Percent returns 1-2m | Percent returns 1-2m |
| Percent returns 2-4m | Percent returns 2-4m |
| Percent returns 4-8m | Percent returns 4-8m |
| Percent returns 16-32m | Skewness of returns > 2.0m |
| 10th percentile of returns > 2.0m | 25th percentile of returns > 2.0m |
| Standard deviation of returns >2.0m | 99th percentile of returns > 2.0m |




## Results and Discussion

The model for tree biomass had the best fit overall with a high $R^2$ and low root mean squared difference (RMSD; see above). These results are consistent with other attempts to estimate biomass using LiDAR and field data [1,2,3,4]. Both surface biomass and canopy bulk density were particularly difficult to predict at high levels. Comparatively poor ability to predict surface fuels and canopy bulk density is also consistent with other studies [4]. All three models were applied to pre- and post-fire LiDAR data and differenced in order to generate and map change (see right).

There is significant potential for future work using these data, as well as data from other fires. One possible pursuit is the comparison of LiDAR-derived fuel consumption with fire radiative energy. At smaller scales fire radiative energy has been linked to fuel consumption [5, 6]; however, large LiDAR datasets such as this provide an opportunity to compare landscape-scale fuel consumption and fire radiative power measured by the MODIS satellite. Another area of interest is the prospect of a more universal biomass model, which would promote standardized biomass change mapping as fires occur.




## References

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