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Utilizing LiDAR to Quantify Aboveground Tree Biomass within an Urban University

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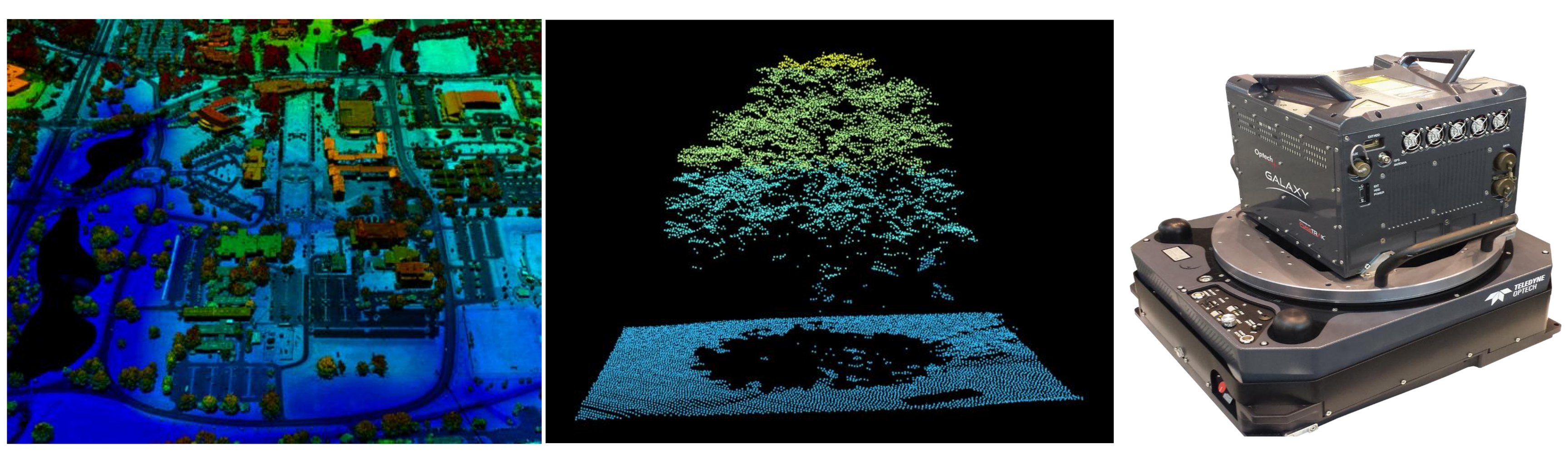
Abstract

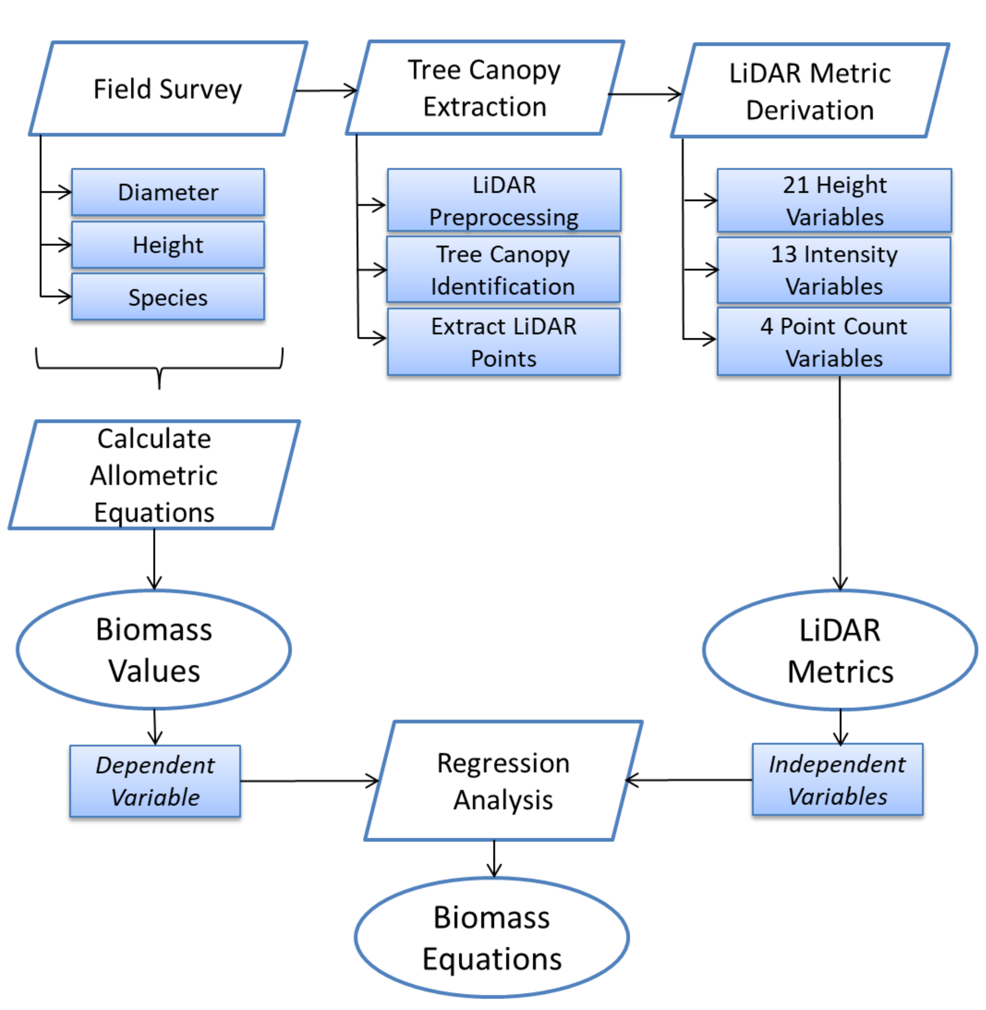
Urban tree cover is not only useful in shading and cooling of buildings, but also in carbon sequestration from emissions due to industry and other anthropogenic impacts. **By estimating biomass in trees, researchers can spatially identify which areas are lacking these carbon sinks.** As there is currently a void of urban biomass research in the southeast, The UAH campus was chosen as the focus point of this research in which **methods for estimating biomass were performed**. Light Detection and Ranging (LiDAR) height measurements have been proven as a proxy for biomass—therefore, **38 variables related to LiDAR height, intensity, and point count were joined with observed biomass values derived from a field survey in a regression analysis to yield species-specific biomass equations**. The resulting R^2 and RMSE values show positive results for most tree species and confirms **LiDAR as an adequate source for biomass estimation research.**



[Left] LiDAR image of the UAH campus [*Center*] LiDAR point cloud example of a Red Oak on campus [*Right*] Optech Galaxy PRIME LiDAR sensor used in aerial data collection

Methodology

Aerial LiDAR data were collected in June 2018. From that, LiDAR metrics such as mean, min, max, etc. height and intensity values were used as variables in a linear regression with field derived biomass values. The field survey consisted of recording the diameter, height and species of 1,985 trees and using that information to calculate observed biomass.

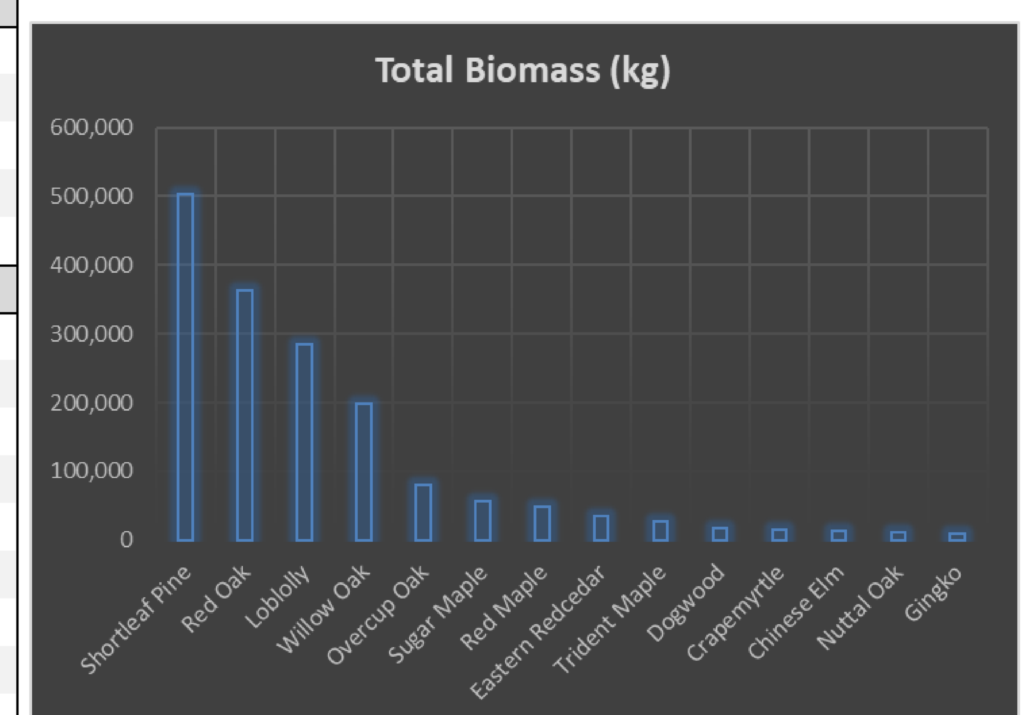


[*Above*] Workflow of research.

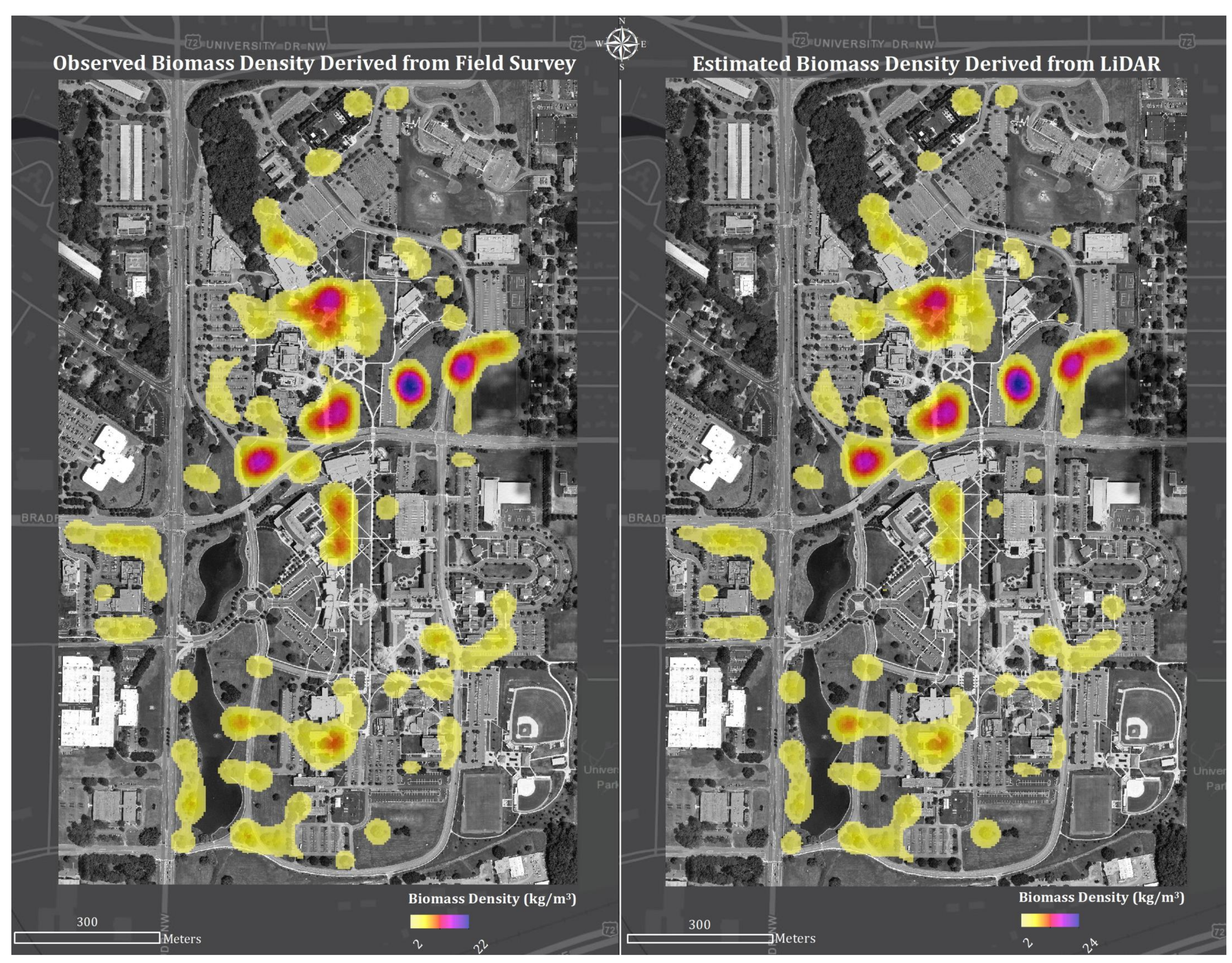
Results

Species	n	R^2	RMSE (kg)
Coniferous			
Eastern Redcedar	41	0.98	438
Loblolly Pine	214	0.43	651
Shortleaf Pine	221	0.39	1071
All Conifers	1006	0.41	921
Deciduous			
Chinese Elm	54	0.95	134
Crapemyrtle	224	0.26	111
Dogwood	60	0.87	243
Ginkgo	45	0.97	105
Nuttal Oak	110	0.8	36
Overcup Oak	81	0.91	432
Red Maple	67	0.82	552
Red Oak	127	0.63	1527
Sugar Maple	181	0.73	337
Trident Maple	54	0.91	241
Willow Oak	89	0.92	1154
All Deciduous	1047	0.62	978

[*Above*] Regression results for all trees with greater than 40 samples.



[*Above*] Total biomass by species derived from LiDAR analysis



[*Above*] Biomass values were calculated for individual trees based on the field survey as well as from LiDAR. The results of the biomass density for the UAH campus is shown above.

Conclusions

- The most common species on campus **(Crapemyrtle, Shortleaf Pine, and Loblolly Pine) yielded low R^2 values**. This is most likely **due to the tree extraction method** used on the LiDAR data, as it **does not account for trees with overlapping canopies** which these species often have.
- Standalone trees yielded the highest R^2 which shows a **high correlation of observed biomass and LiDAR metrics**.
- The **Shortleaf Pine, Red Oak, and Loblolly Pine** species contribute most to the overall biomass on campus
- The resulting **biomass equations can be used to estimate biomass throughout the Southeastern U.S.** as a proxy for health of the surrounding urban forest ecosystem.

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