Estimating biomass in the Panther Creek Watershed using LiDAR

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Presentation Overview

- Background
- Research question
- Study area
- Data
- Methods
- Results
- Discussion

Panther Creek study area vegetation plot
Background

Biomass is key to understanding carbon sequestration (Houghton, 2005).

Estimating biomass involves costly field work and destructive sampling (Brown, 2002).

Increasingly, researchers are looking to estimate biomass with remotely sensed data.

Research question

How accurately can LiDAR-derived data predict biomass in the Panther Creek watershed?

What is the biomass above ground within the study area?
Data

Vegetation sample plot data:
• 78 circular plots of 100 ft. diameter, 2009
• Diameter at breast height (DBH)
• Tree height

LiDAR data:
• Discrete return data collected in leaf-off conditions, 2010
• Pulse density of ~ 8 pulses/m²

GIS data:
• ESRI grids of bare earth LiDAR returns
• Study area
Workflow and Software Used

- Estimate LiDAR-derived biomass (ArcGIS)
- Derive LiDAR surface of selected variable (Fusion)
- Variable selection, OLS regression (R)
- Calculate LiDAR feature height statistics by plot (Fusion)
- Calculate biomass for each plot (R)

Calculating biomass

- Allometric equations for each tree by species.
- Variables: DBH, Height, wood density
- Species distribution:
78 vegetation sample plots

Biomass

Bole biomass + Bark biomass + Branch biomass = Tree biomass
Calculating plot biomass in R

Biomass by plot

Above-ground biomass (kilograms)
- < 5000
- 25,001 - 50,000
- 5000 - 25,000
- > 50,000
LiDAR data processing

DEM -> ASCII

Convert LAS elevation values to height values

Compute metrics for LiDAR data for each plot

DEM to ASCII
LAS elevation to height values

Compute metrics

- Cloudmetrics
- Run through DOS Command Prompt
Statistical variables for each plot

Regression analysis

Best predictor = 70th percentile, LiDAR feature height
- Highly correlated with biomass \((r = 0.8824)\)
- Straightforward interpretation

Ordinary least square regression
- Estimate slope \((\alpha)\) and intercept \((\beta)\): \(Y = \alpha + \beta X + \epsilon\)
- Goodness-of-fit: \(R^2, \text{RMSE}\)
Regression equation

\[ y = 33.519 + 4.984x + \varepsilon \]

Predicting plot biomass from LiDAR

R-squared = 0.853
RMSE = 7984
Derive surface from LiDAR returns

- Raster to ASCII
- ASCII to PLANS DTM
- LAS Values to height values
- Mosaic ASCII files
- CSV to ASCII
- Calculate Metrics (CSV files)

Estimating biomass across study area

- LIDAR surface
- Raster Calculator
- Biomass (30 meter)
- Aggregate
- Biomass (Hectare)
Land Ownership in the Study Area

Discussion

Max height is not the best predictor. We found that the 70-90th percentile is better.

Very good correlation for plots with 70th percentile < 25 meters. Rsq=0.85 below, 0.51 above.

The accuracy of this method is contingent on the accuracy of the derived surface and elevation models as well as allometric equations for biomass.
Conclusion

Remotely-sensed data can be used to model biomass.

Forest biomass ranges from 5.6 Mg/h for deforested areas to 740.3 Mg/h on forested stands. Avg = 135.7 Mg/h throughout study area.

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References
