Using LiDAR to Estimate Aboveground Carbon Storage in Indiana State Forests

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Introduction: Forest plays an important role in carbon sequestration and climate change mitigation. Research reviews nearly 45% of terrestrial carbon is stored in forests (Bonan, 2008). Traditional estimation of forest carbon storage requires field-measured tree diameter or height, but the process of collecting field data is often time-consuming and labor-intensive. The advent of remote sensing technologies, such as Light Detection and Ranging System (LiDAR), makes it possible to collect large-scale tree information within a timely manner. By shooting laser beams to objects, LiDAR collect laser returns to create point clouds for target objects. Numerous studies have used LiDAR point clouds to analyze forest structure and estimate aboveground carbon storage (Zolkos et al., 2012).

Objectives:

- Use 3DEP LiDAR to estimate aboveground carbon at Morgan-Monroe & Yellowwood State Forests (MMYSF).
- Compare carbon storage among different silvicultural treatments at MMYSF.

Method: The USGS 3D Elevation Program (3DEP) LiDAR data were downloaded to extract input variables that can describe horizontal/ vertical forest canopy structure or topographic information. Then, random feature elimination was used in a machine learning algorithm to filter out variables that can significantly reduce model error. The improved model was used to generate a carbon map for the study area (Fig.1). Lastly, statistical testing was performed to compare carbon among 6 different silvicultural treatments (Fig. 2).

Results:

- Predicted values of carbon density explained 85% data variation with an average error at 14 Mg/ha (17%).
- Patch Cut and Clearcut have only 40% carbon density of any other treatment.
- Carbon density values under treatments of single-tree selection, shelterwood, and prescribed burning are not significantly different from control sites.

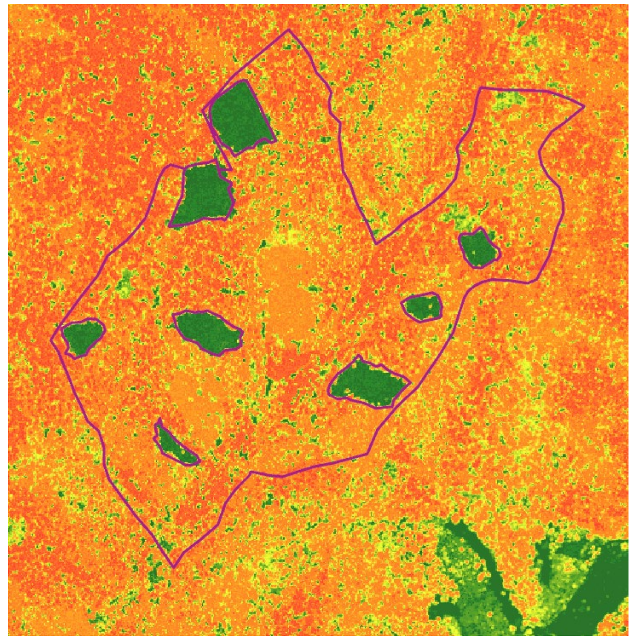

Figure 1. Aboveground carbon map of a management site at Yellowwood State Forest in 2017.

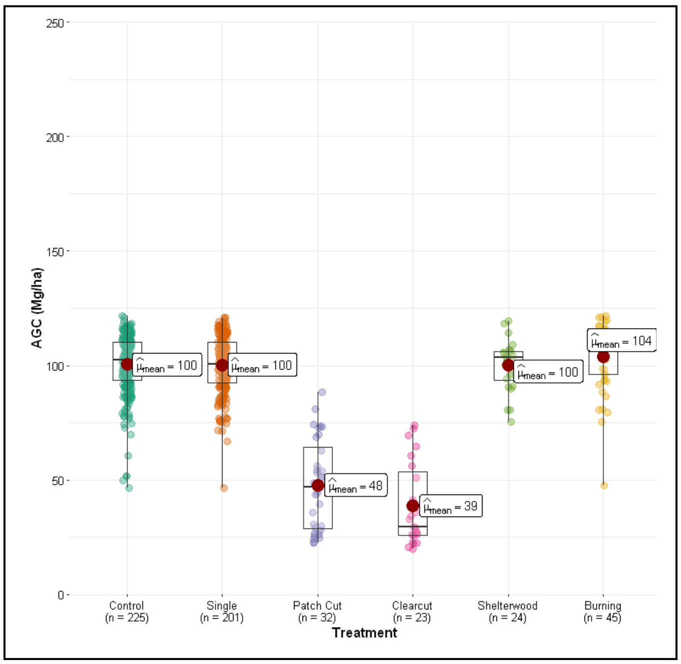

Figure 2. Aboveground carbon storage (Mg/ha) among 6 silvicultural treatments at MMYSF in 2017 (left to right): control, single-tree selection, patch cut, clearcut, shelterwood, and prescribed burning.

FOR FURTHER READING:

Bonan, G. B. (2008). Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests. *Science (American Association for the Advancement of Science), 320(5882), 1444–1449.* https://doi.org/10.1126/science.1155121

Zolkos, S. G., Goetz, S. J., & Dubayah, R. (2013). A meta-analysis of terrestrial aboveground biomass estimation using lidar remote sensing. *Remote Sensing of Environment*, *128*, 289–298.