A Comparison of Methods to Estimate Forest Canopy Structure in Cedarville, Ohio

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METHODS COMPARISON FOR ESTIMATING FOREST CANOPY OPENNESS

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INTRODUCTION

Plant canopy architecture results from the relationships of species composition, historical land use, succession, and species competition. Each ecosystem's unique architecture influences those who live in it and the abiotic environment in different ways. For example, differences in light caused by plant architecture create habitats for various species that are specialized for survival in that niche. Knowing more about the plant architecture of the area may prove vital to ongoing projects and research in a particular area. Key variables used to quantify the canopy architecture are leaf area index (LAI, m2 leaf m-2 ground) and canopy openness.

In the past ecosystems have been assessed by below canopy ground-based measurements. Remotely sensed data have also been used, though at a much coarser spatial scale. Technology on mobile devices has also advanced, and several mobile apps claim to be able to calculate leaf area index and other canopy statistics from a cell phone. If such claims are valid, researchers could easily find canopy statistics for their area of interest, saving valuable time and labor.

OBJECTIVE

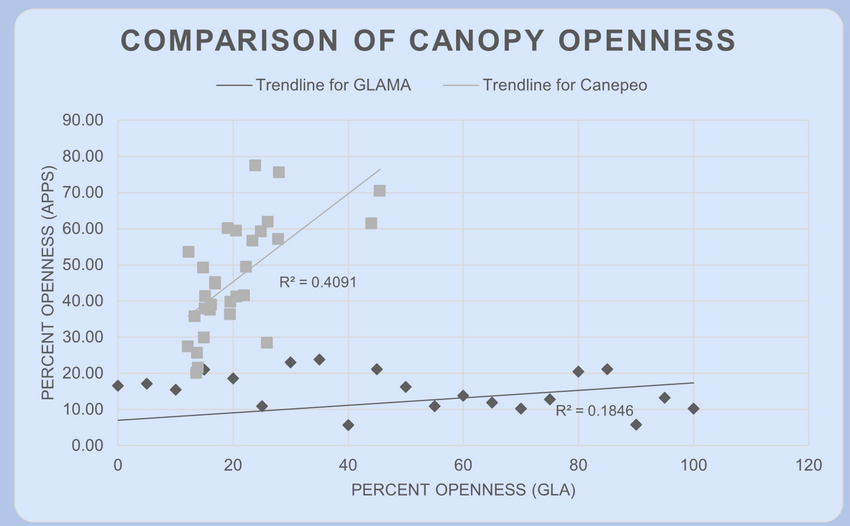
The objective of our study was to analyze the accuracy of several mobile phone applications in interpreting the varying light environments of a second-growth forest in Ohio as compared to the standard technique using hemispherical photography.

STUDY SITE

Research conducted within a forest property of Cedarville University; 39*45'58"N 83*48'22"W. We measured 30 randomly selected points throughout a 15 acre forest stand in Greene County, Ohio. The wooded area is surrounded by farm fields.

METHODS

We used the standard technique of hemispherical photography with an 8mm fisheye lens and a Nikon 5100 camera. These images were processed using Gap Light Analyzer (GLA, v.2.0, Simon Fraser University, British Columbia, CANADA, Institute of Ecosystem Studies, New York, USA). GLA provided estimates of canopy openness (%) and leaf area index (LAI). We compared this method against two mobile phone applications: Gap Light Analysis Mobile App (GLAMA, v.3.0, Masaryk University Brno, Czech Republic) using an Android Alcatel TCL A1 phone, and Canopeo (version 2.0, Oklahoma State University, Stillwater, Oklahoma) using an iPhone XR phone. GLAMA calculated values of Canopy Openness (%). Canopeo provided values of canopy cover; in comparison, the inverse of canopy cover was used.



RESULTS

Mean canopy openness (minimum - maximum) for the site was 14.7 (5.7 - 23.8) and 46.1 (20.0 - 77.4) for GLAMA and Canopeo, respectively. Additionally, we processed digital hemispherical photographs using Gap Light Analyzer (GLA v 2.0) and calculated a mean % openness of 20.6 (12.2 - 45.5) and mean (minimum - maximum) LAI of 2.1 (1.0 -3.1). When compared to the standard method of hemispherical photographs Canopeo and GLAMA described 41 and 19% of the total variability in forest canopy openness as measured by GLA.

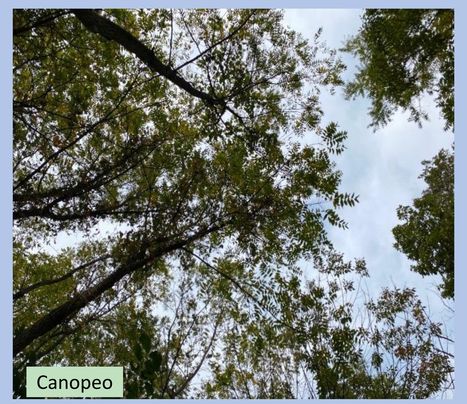
Study Site 'A' is marked on the map of Ohio.

CONCLUSIONS

Our data show that GLAMA consistently over estimated while Canopeo underestimated openness. The data from this study reveals how each application used image processing methods to calculate canopy openness. The various applications showed inadequacies regarding the typical methods used to calculate canopy openness; none of the applications proved to be more accurate at calculating canopy openness than the others. In the future, a third method of comparison using drone imagery would be helpful to investigate correlations between greeness and openness of the canopy.


Hemispherical Image(GLA)


GLAMA Image


Canopeo