

Factsheet # 13

Deriving Site Growth Indices From Multi-Temporal Small-Footprint Aerial LiDAR

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Understanding multiscale dynamics of landscape change through the application of remote sensing & GIS

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What is Site Index?

Site index (SI) is a measure of a given area's potential to grow trees of a certain species. SI strongly indicates the combined effects of environmental variables such as topography, soil conditions, and climate. In even-aged stands, SI expresses the relationship between the height and overall productivity of unsuppressed, dominant trees at 50 years of age.

What are the traditional methods for deriving site index?

The age-height data used to calculate regionally specific SI regression curves are traditionally derived from measuring sample trees in designated plots and/or through increment bore analysis. These methods are labor intensive, costly, and require extrapolation to derive landscape indices.

What are the new methods of deriving site index?

Canopy height models (CHM) derived from small-footprint aerial LiDAR (light detecting and ranging) provide a novel dataset for analyzing changes in the canopy height over time. Since average tree height growth slows when plotted over time it is important to classify the landscape by age in order to compare height growth in relative age stands. The age of a forest stand can be determined by classifying and segmenting the current state of the CHM into several meaningful tree height categories. Site indices relative to each height class can then be determined by subtracting the initial state of the CHM from its' current state. The Definians eCognition software was used to segment the CHM into manageable units (~10 acres). Zonal statistics, such as mean absolute change, can be computed for each separate height class polygon showing average tree height growth. Figure 4 shows the average change in canopy height by height class and can be used to compare tree productivity by similar height classes. Areas that have experienced a thinning of trees will have less relevant canopy height change values when compared to areas that are homogenous in both datasets.

What are the traditional applications of site index?

- Mapping site productivity
- Planning harvest schedules

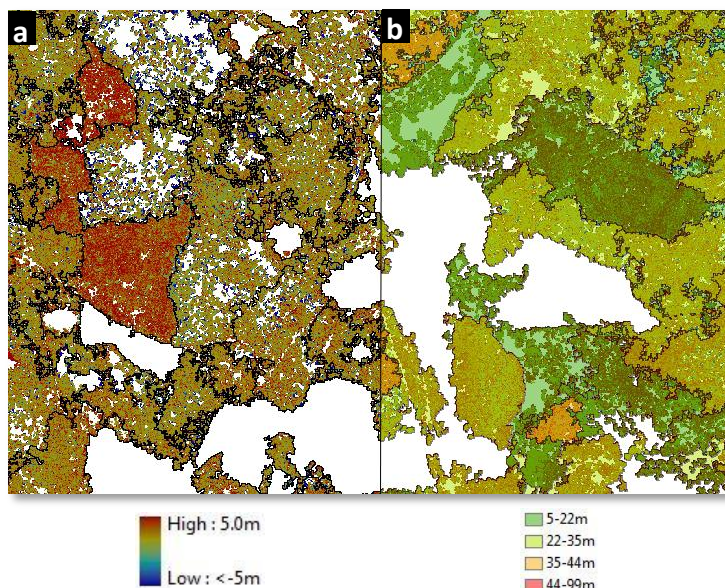


Figure 4. Change analysis layers for each height class: (a) Absolute differences across all height classes, (b) height classes as a shaded overlay. Red areas indicate a positive change in canopy height while blue areas indicate a negative change.

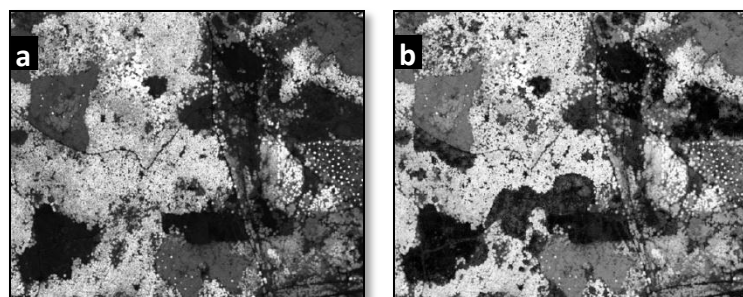


Figure 1. Multi-temporal canopy height models derived from small-footprint aerial LiDAR data with 2.5m pixel resolution: (a) 2005 (b) 2010. Lighter areas indicate taller canopies.

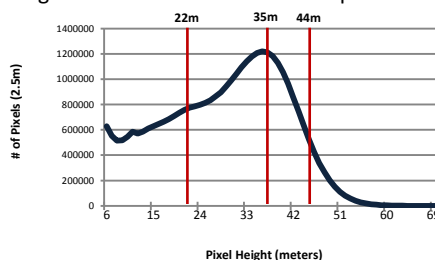


Figure 2. 2010 CHM histogram of mean height values and the separation into 4 height classes (2.5m pixel resolution)

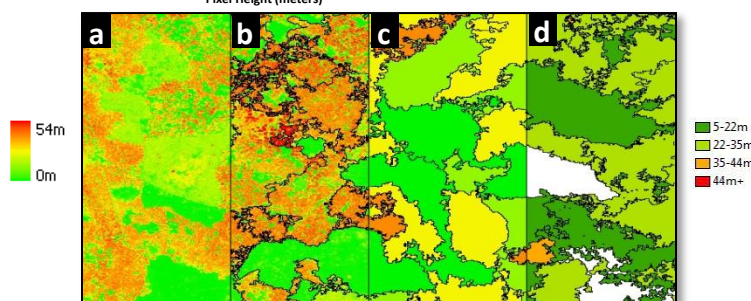


Figure 3. Image segmentation process: (a) 2010 CHM 2.5m (b) 2010 CHM eCognition segmentation (c) classified image (d) height class segmentation polygons.

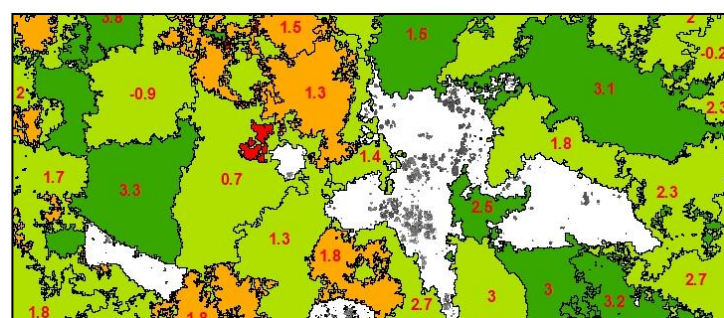


Figure 5. Results of averaging within polygon pixel values from each height class change layer. The average change value is very sensitive to polygon size and within polygon height variability. (values in meters)

Opportunities

- Sub-Stand growth analysis
- Pathogen monitoring
- Notice early signs of forest health change

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THE KEY QUESTION:

Can multitemporal LiDAR detect forest change and can we apply it to derive forest site index?

THE ISSUE: As climate changes in the Pacific Northwest, forest growth may slow or even recede. Our ability to monitor this change will insure decision support tools for sustainable forest management. Remote sensing, such as small-footprint LiDAR, is a promising tool to acquire this information. LiDAR costs 25% more than traditional aerial photography but requires much less technician-driven post-processing and orthorectification. Yet, similar tools used for imagery analysis, such as segmentation and classification can also be applied to LiDAR data.