Mapping and validating forest stand height from airborne LiDAR data

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THE AVAILABILITY OF SPATIALLY EXPLICIT QUANTITATIVE FOREST INFORMATION IS CRITICAL FOR FIRE MANAGEMENT. TRADITIONAL AND CONVENTIONAL DIRECT MEASUREMENT METHODS FOR DEVELOPING FOREST INVENTORIES ARE LABOUR INTENSIVE, TIME-CONSUMING AND EXPENSIVE. LIGHT DETECTION AND RANGING (LIDAR) IS A PROMISING TECHNOLOGY FOR MEASURING TERRAIN AND VEGETATION CHARACTERISTICS OVER LARGE SPATIAL SCALES.

Introduction: LiDAR technology is extensively applied in the field of forestry because of its robustness and added advantages in assessment of tree heights over complex forests and in typical terrain. Tree/canopy height measurement is a key aspect in environmental and forestry applications for the critical assessment of forest structures, biomass, fuel stocks, and yield [1], allowing researchers to develop and use inputs for forest fire behaviour modelling.

Objective: To test the relationship between canopy heights extracted from multiple LiDAR point densities and correlate with field measurements

Method: A pilot study was conducted in the Black Mountain Natural Reserve in the Australian Capital Territory. The entire study site has a medium to high canopy closure of dry eucalypt forest cover over a complex terrain. Existing field surveyed plot data for 23 random sites were used in this analysis (Figure1). These surveys were concurrently conducted with the 2013 LiDAR acquisition which had a pulse density of 5 points/m^2. In 2016 the ACT government released LiDAR data with a better pulse density of 8 points/m^2 for the urban Canberra region (Figure 2).

The LiDAR point clouds were processed by using the filters and algorithms available in FUSION/LDV software tools [2]. The first step was to apply ground filters and extract the ground (bare-earth) surface models on a tile by tile basis, and then to derive the Canopy Height Models (CHMs).

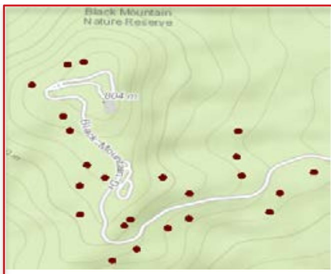

Figure 1: Black Mountain Natural Reserve and field sampling locations

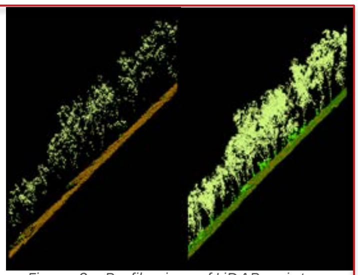

Figure 2 : Profile view of LiDAR point clouds 5 & 8 points / m^2

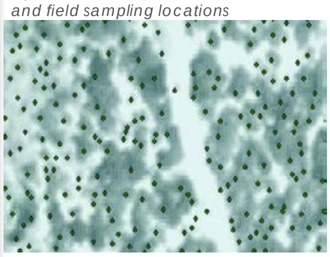

Figure 3: CHM representing the individual trees derived from 5 points/m^2 (2013)

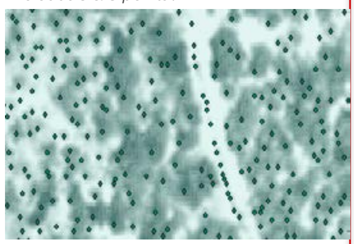

Figure 4: CHM representing the individual trees from 8 points/m^2(2016)

For individual tree detection and metrics the local maxima algorithm was applied to the canopy models. The resulting tree inventory is a spatially explicit point database and has been visually assessed by overlaying onto the CHMs (Figures 3&4).This point data has been masked to the extent of 15m circular plots and the mean canopy heights were computed for each site.

The Pearson correlation coefficient was applied to determine the correlation between the LiDAR derived tree heights and field measurements.

Results: The mean canopy height comparisons from the Pearson correlation test are in Figure 5. It is observed that there is a strong positive correlation in the 5 & 8 point LiDAR sampling datasets (Figure-5(c)) and a slightly weaker relation with the field measurements (Figure5:(a)&(b)). These results also suggest that densification of point densities may not influence the distribution and canopy height measurements.

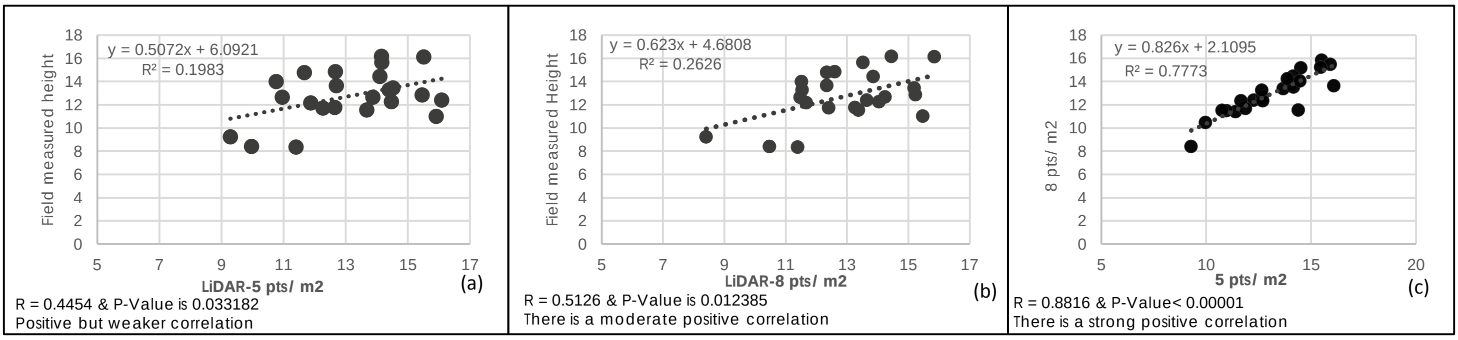

Figure 5: Correlations between the field measurements and LiDAR derived canopy measurements of multiple densities

Conclusion: This study provides a simple and robust demonstration of how we can apply LiDAR to detect tree heights and compare at plot level. It also suggests that tree height variables from plot-level data may not essentially equate to LiDAR data even with the higher densities.

References:
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2.McGaughey, R.J., 2009. FUSION/LDV: Software for LIDAR data analysis and visualization. *US Department of Agriculture, Forest Service, PWRS: Seattle, WA, USA*, *123*(2)

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