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PROJECT 2.07 | WOODY VEGETATION LANDSCAPE FEATURE GENERATION

An Australian Government Initiative

CRC AUSTRALIA

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Objectives To derive spatial layers of relevant descriptors of Australian woody vegetation from remote sensing data
To use those descriptor layers to create landscape features characterising large area woody vegetation systems

Outcomes The project team will deliver a set of tools ready to be applied by Australian state agencies to create landscape features describing woody vegetation.
The tools will be developed using open source language and adapted to be applied at a large area scale.

Derivation of canopy complexity from LiDAR at the landscape scale

A metric of canopy complexity, such as a count of significant canopy layers, has been identified by land managers and forest research scientists as a key data primitive for the attribution and management of native forests at the landscape scale [1].

Presented below is preliminary research where the forest canopy is attributed for complexity across structurally diverse native forest (Figure 1)

Data collection

Airborne LiDAR (Figure 2) was captured in April 2012, LiDAR point density was ~7 pts m^2 with up to 6 returns recorded per pulse. 27 field inventory plots were concurrently installed where structural and biophysical parameters were measured.

Counting canopy layers

To compute number of layers, P_{gap} is estimated where each return is weighted by the "number of returns" (NoR) value [2, 3]. P_{gap} is then smoothed using a cubic spline to remove intra-canopy gaps [4] and log transformed [2] to account for occlusion. The exact derivative of P_{gap} is the canopy height profile [2], the zero-crossings of P_{gap} second derivative are used to estimate position and number of layers as an metric of canopy complexity (Figure 3).

To derive a robust estimate of canopy complexity, the initial estimate of the canopy profile is used to create a Bayesian model of height and NoR probability. This is then run in a bootstrap (n = 99) and mean number of layers is reported.

Results and discussion

Figure 4 suggests that canopy height explains a large proportion of variance in number of layers at the landscape scale. However in very tall closed canopy forest examples there appears to be canopy structure diversity not explained by canopy height alone. Also in low open woodland complexity seems independent of canopy height.

Conclusion

LiDAR can characterise complexity across a range of native forest types. This is of particular importance to land managers for forest typing, determining succession and habitat suitability. These results can also be used as inputs into canopy/atmosphere modelling.

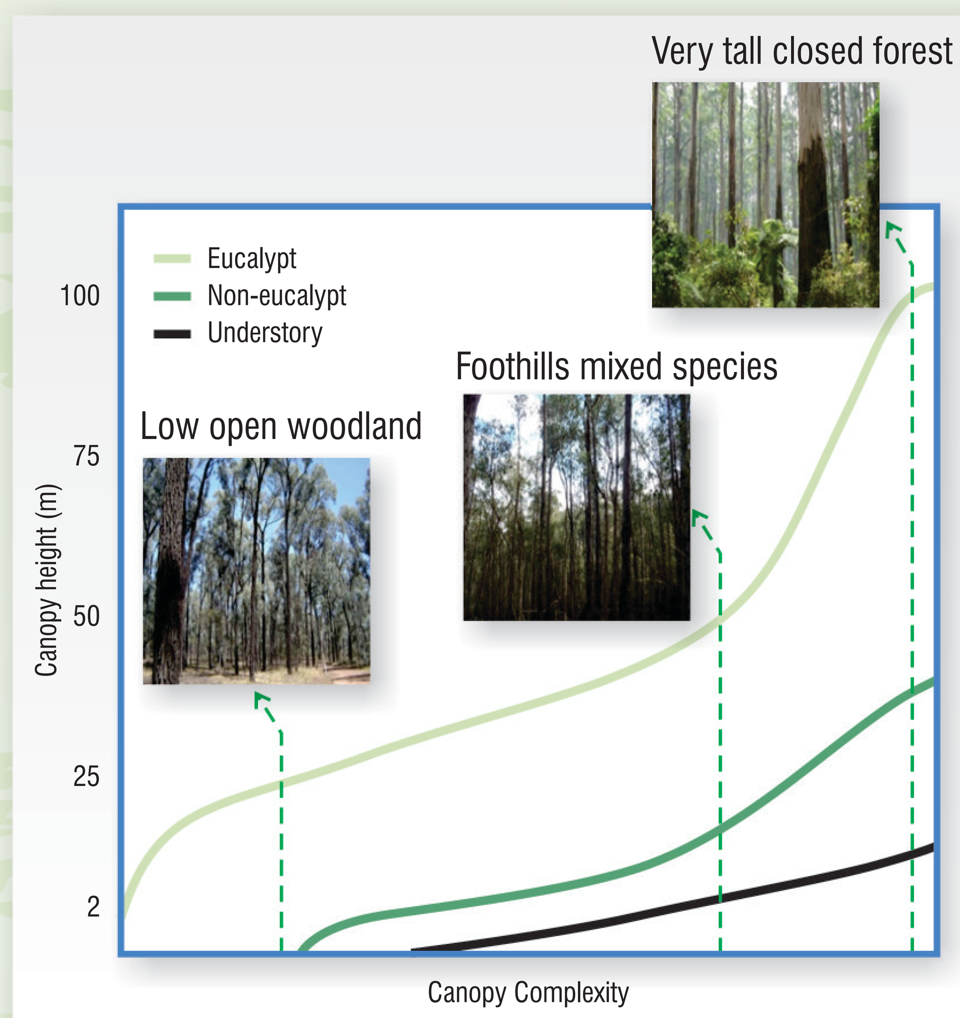

Figure 1. Location of the three study sites within a canopy complexity continuum

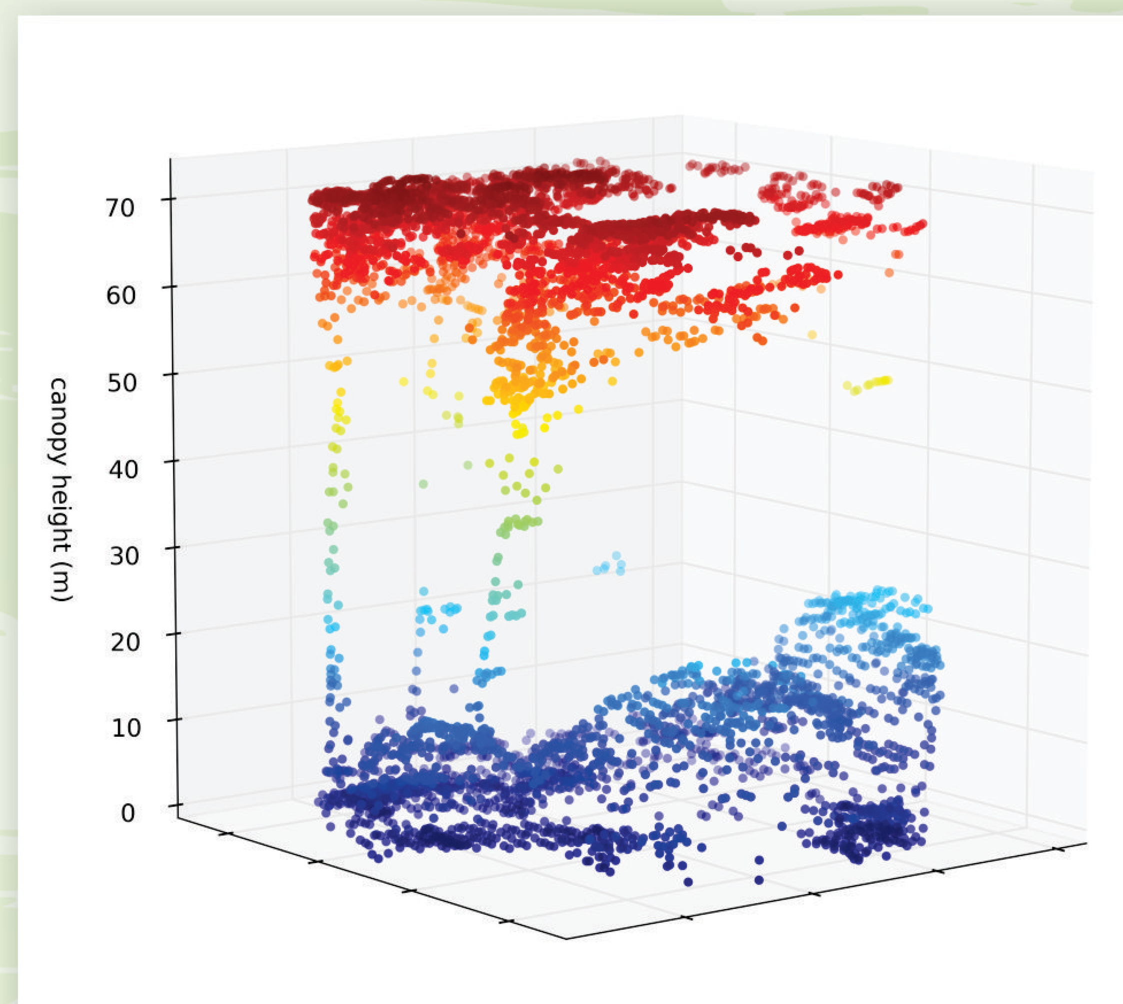

Figure 2. Point cloud (coloured by return height) captured over very tall closed canopy forest.

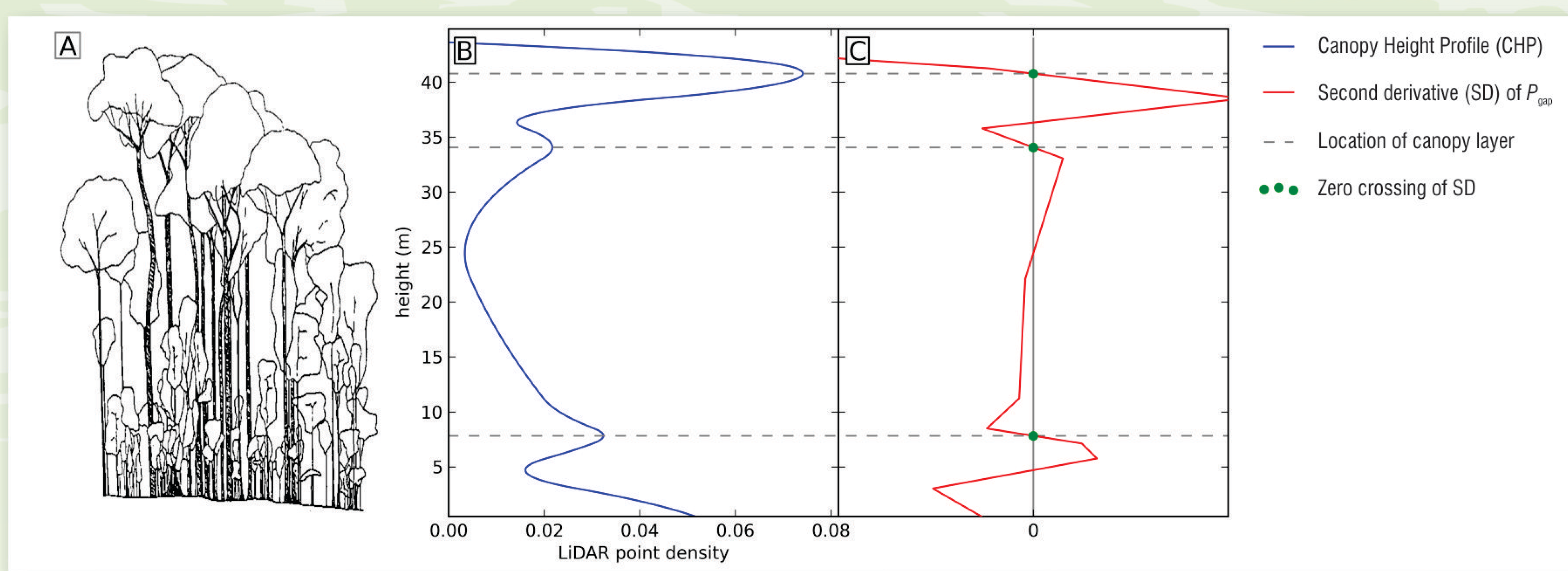

Figure 3. Generation of a Canopy Height Profile (CHP) and number and location of canopy layers using airborne LiDAR captured over a forest plot. (A) Diagram of structurally complex very tall closed canopy forest plot; (B) LiDAR derived CHP is used to characterise the distribution of vegetation along the vertical axis; (C) the number and location of canopy layers is estimated from the first derivative of CHP.

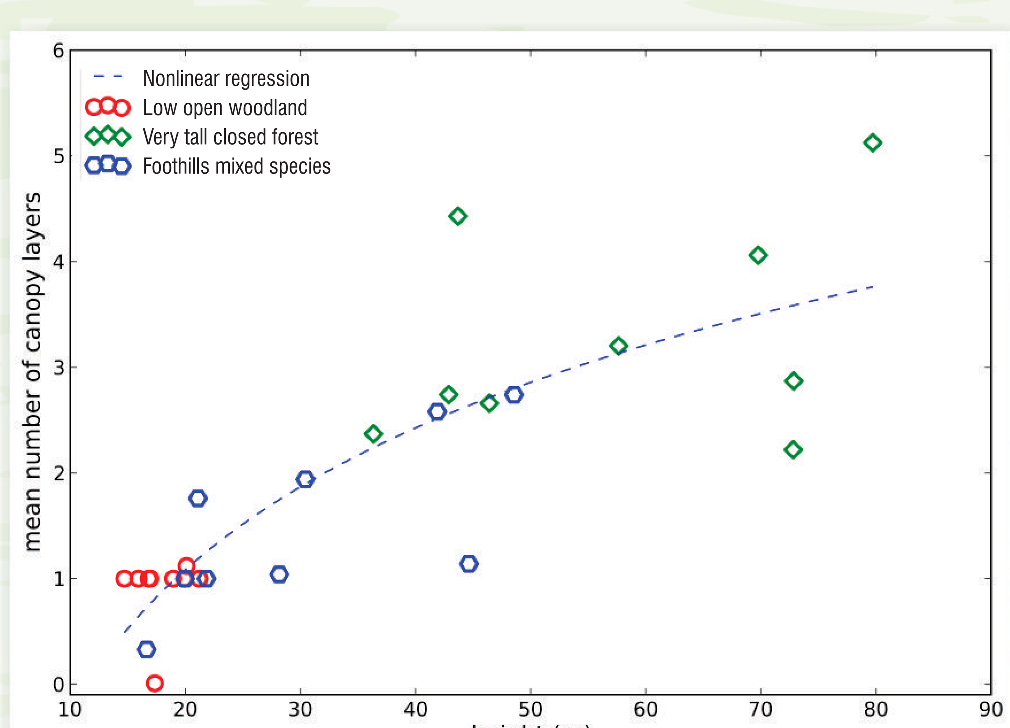

Figure 4. Relationship between LiDAR derived canopy height and mean number of layers. Mean number of canopy layers is generated using a bootstrap where simulated point clouds are derived from a Bayesian model of height and NoR.

References

[1] Axelsson, C et al. (2012). Key attributes for monitoring and assessment of Australian forests: a land management perspective. GSR_2, RMIT University, Melbourne, 10-12th December.

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[3] Armston, J. et al. (2013). Direct retrieval of canopy gap probability using airborne waveform LiDAR. Remote Sensing of Environment, 134, pp.24–38

[4] Coops, NC, et al. (2007). Estimating canopy structure of Douglas-fir forest stands from discrete-return LiDAR. Trees, 21(3): 295–310.