Summary of remote sensing projects at Scion

Michael Watt, Research Leader, Scion

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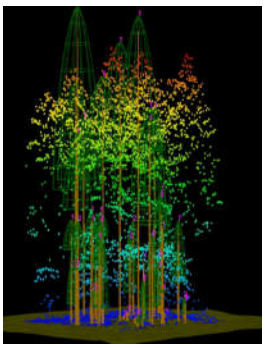
Provide remote sensing research that adds value to the forest sector and to New Zealand



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Over the last two years remotely sensed data has been used to….

- Detect wilding conifers
- Model stream locations within a watershed
- Develop a set of metrics that take LiDAR to the next level for inventory
- Identify needle mortality, symptomatic of a disease, using a UAV
- Prove the use of satellite data as an inexpensive alternative to LiDAR for inventory

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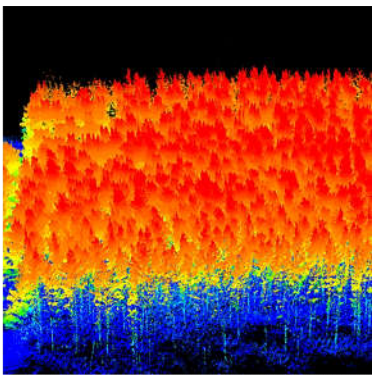
Detecting wilding conifers





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Detecting wildings using remote sensing

- 1.7 M ha covered
- Increasing by 6 % per year
- Ecological / economic implications
- Control efforts need accurate detection methods.

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Vegetation survey

We measured and recorded the position of all wildings in the plots.

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High resolution aerial imagery

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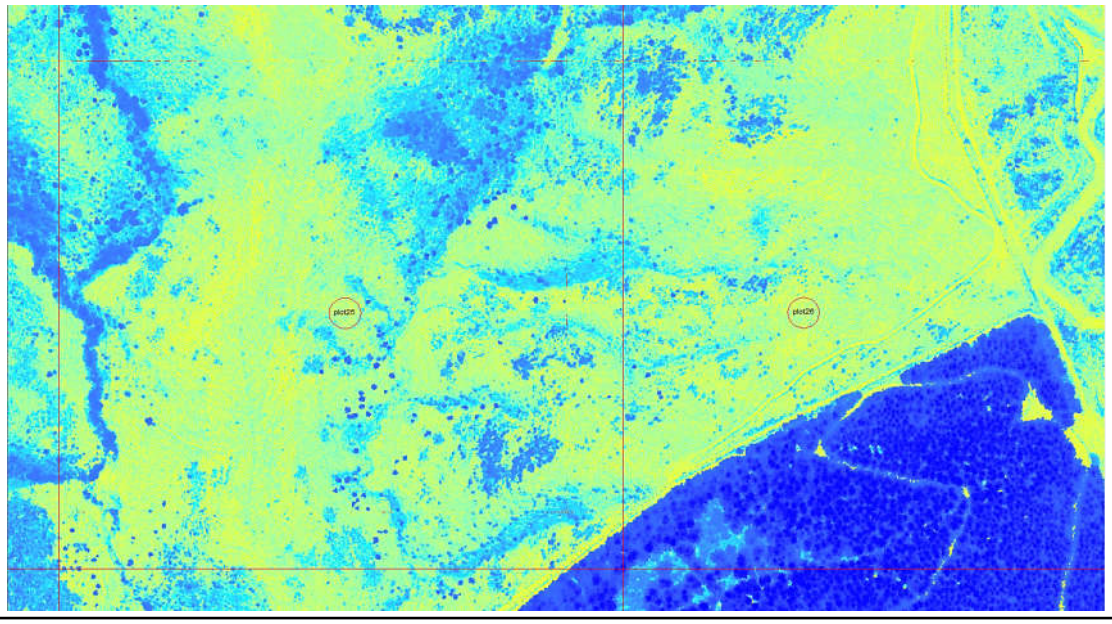
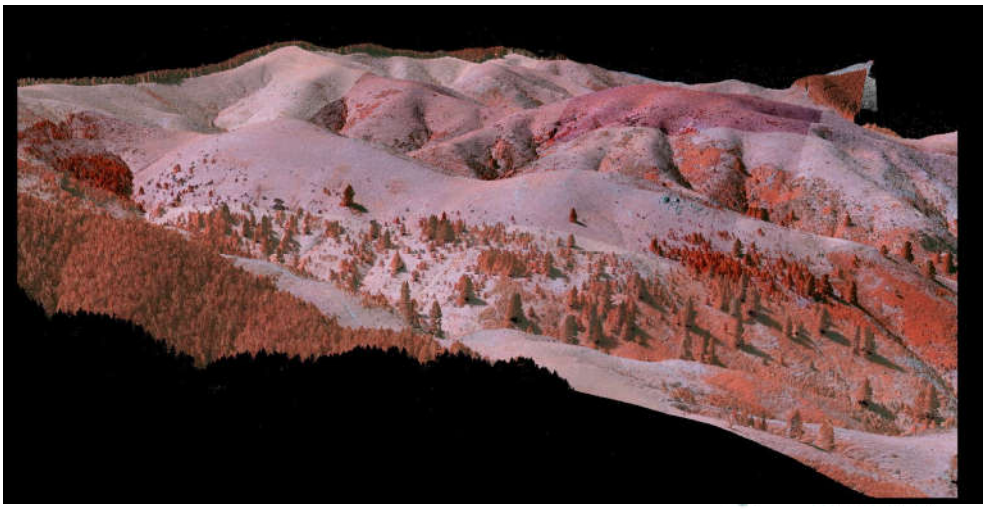
Canopy Height Model (CHM) from LiDAR



We merged spectral values (red, green, NIR bands) from aerial imagery with LiDAR data and coloured each individual point.



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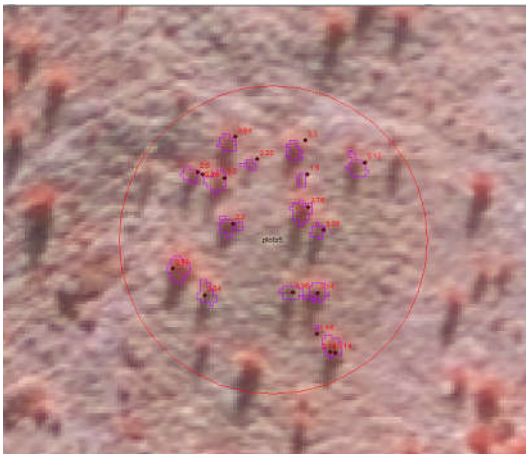
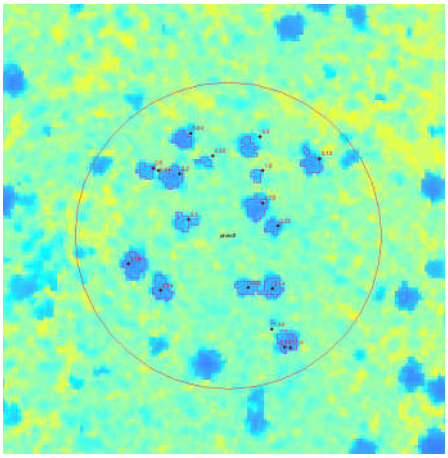
Wilding conifer detection

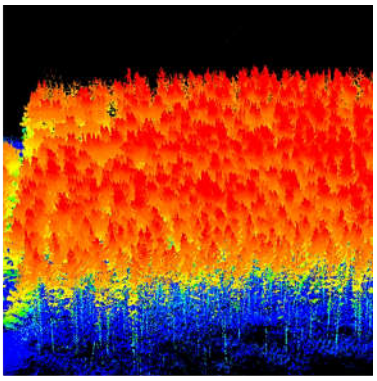
Demonstrated successful detection using aerial imagery and LiDAR data.





Dash, J. P., Pearse, G. D., Watt, M. S., & Paul, T. (2017). Combining Airborne Laser Scanning and Aerial Imagery Enhances Echo Classification for Invasive Conifer Detection. *Remote Sensing*, *9*(2), 156.

Hydrological modelling using LiDAR



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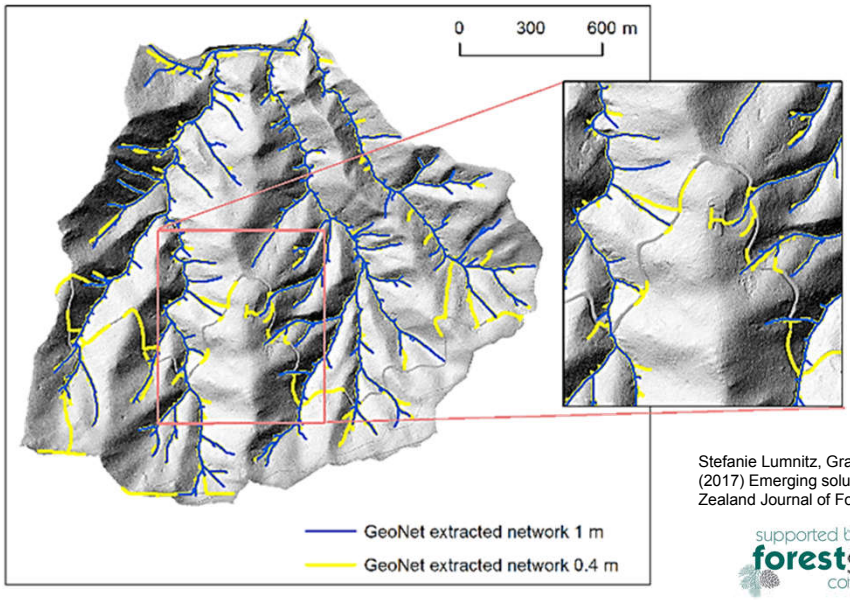
Hydrological modelling using LiDAR



Stefanie Lumnitz, Grant D. Pearse, Jonathan P. Dash, Michael S. Watt. (2017) Emerging solutions for hydrological modelling from LiDAR. New Zealand Journal of Forestry.

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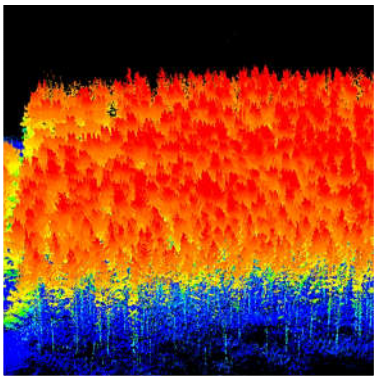
Using voxelised metrics – taking LiDAR to the next level



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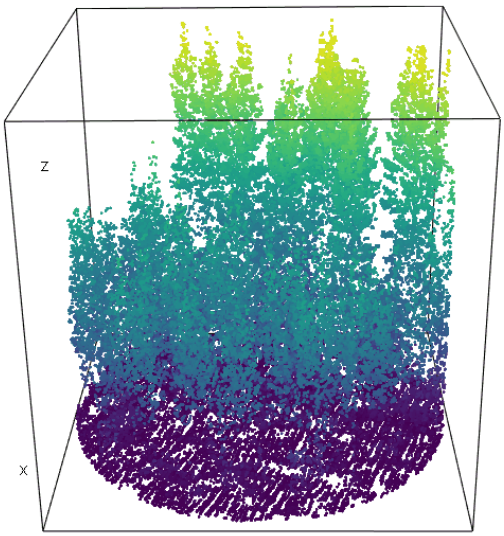
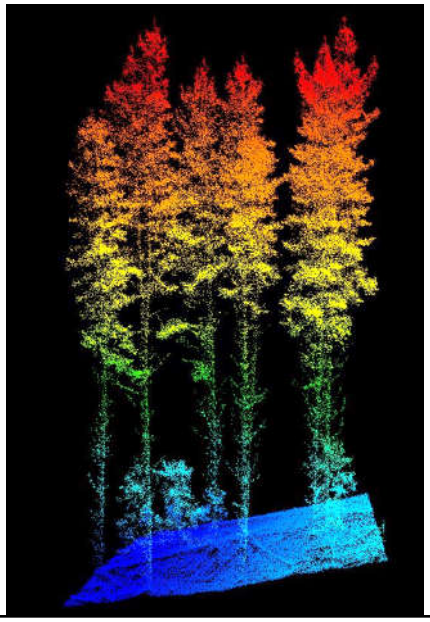
High density LiDAR project – voxel vs. std metrics

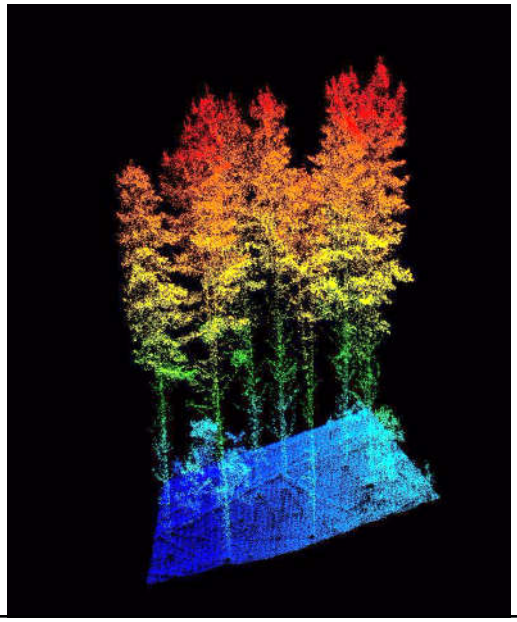
High density aerial point clouds collected from 74 plots in a radiata pine forest using VUX-1 scanner attached to a helicopter

Objective: Compare predictive precision of models created using voxel-based metrics (Voxel) with that of standard metrics (Base)



VUX1 Data: Sub-plot





Results – method comparison

- Increasing pulse density had little effect on model precision
- Relatively constant gains in precision for BA, stocking and volume from use of voxel-based metrics across pulse density gradient
- Major improvements in R^2 :
  - BA – 0.22 (0.44 to 0.66)
  - Stocking – 0.24 (0.34 to 0.58)
  - Volume – 0.23 (0.53 to 0.76)

Pearse, G. D., Caccamo, G., Watt, M. S. (submitted). Comparison of models describing forest inventory metrics using standard and voxel-based LiDAR predictors thinned to a range of pulse densities. *Remote Sensing*.

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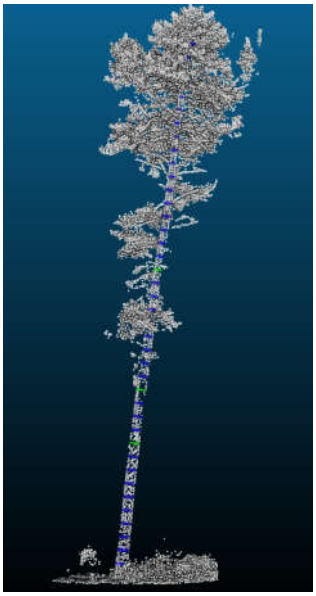
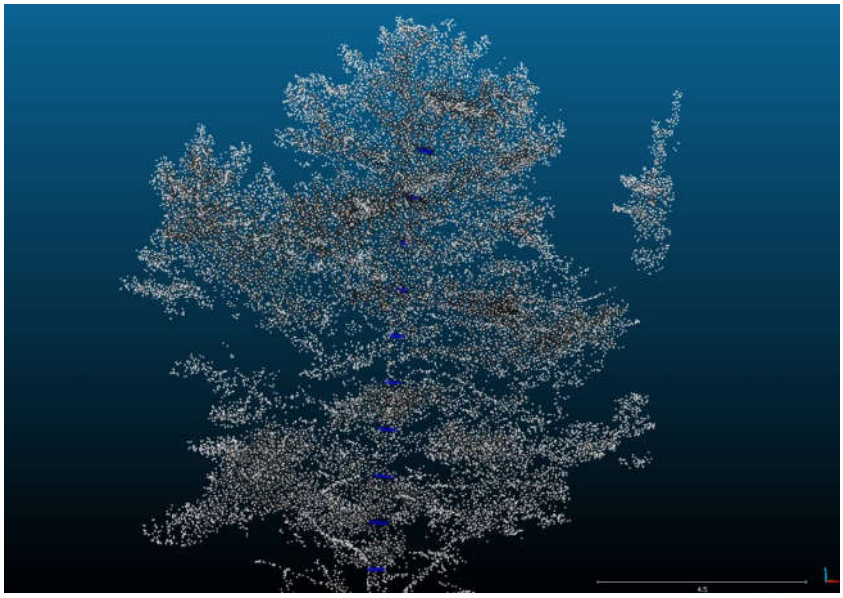
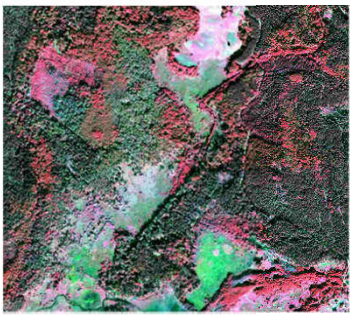
Cloud2stem software – direct estimation of diameter





Scion UAV programme



Where do UAV fit in to plantation forest management?

We need effective procedures for data acquisition …

and for extraction of meaningful metrics and analytics.

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UAV

- Altus Delta LRX
  - 11 kg payload, 25-35 mins flight
- Sensors include :
  - Video
  - Multispectral
  - LiDAR
  - Thermal

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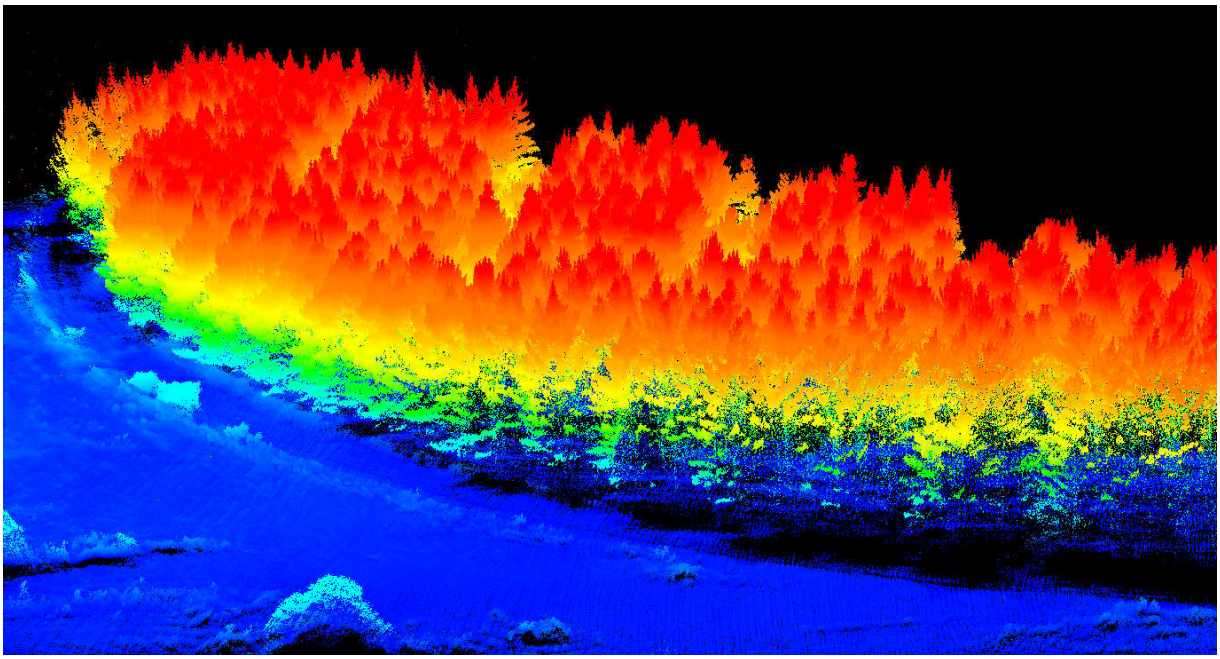

Forest health

- We simulated a disease outbreak by invoking changes in foliar colour and needle retention.
- Experimental treatments- Trees poisoned in different sized clusters (0, 1, 2, 4, 8, 16) with 5 replicates
- Regular monitoring from the ground (conventional tree health scoring) and from a UAV

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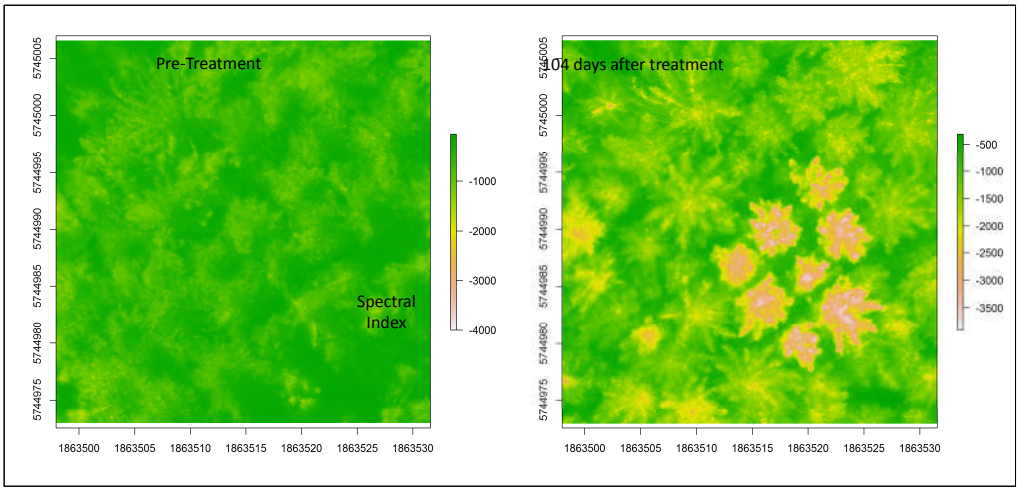
Herbicide treatment was evident in the spectral indices



Dash, J. P., Pearse, D., Watt, M.S. (2017) UAV Based Detection of Physiological Stress in Trees is Affected by Image Resolution and Choice of Spectral Index. ISPRS Journal of Photogrammetry and Remote Sensing.

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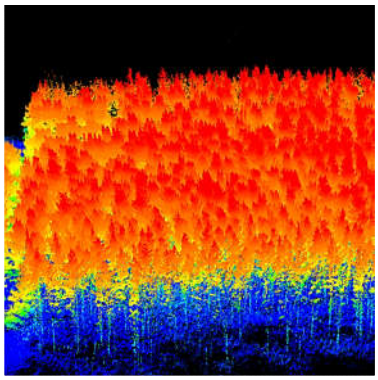
Predicting forest dimensions from LiDAR and satellite



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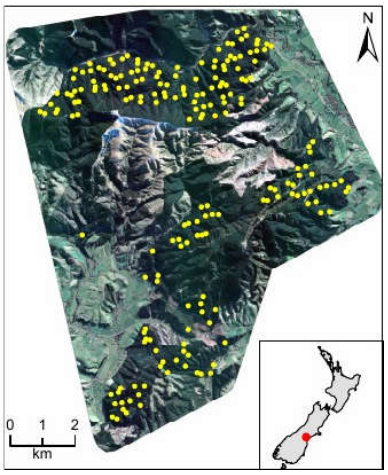
Forest inventory comparison study



- LiDAR is a proven technology for predicting stand dimensions
- Point clouds are also available from satellite at a far reduced cost
- Undertook a study in Geraldine Forest to compare the precision of the two approaches
- A total of 195 plots were installed within radiata pine stands aged 15 – 30 years

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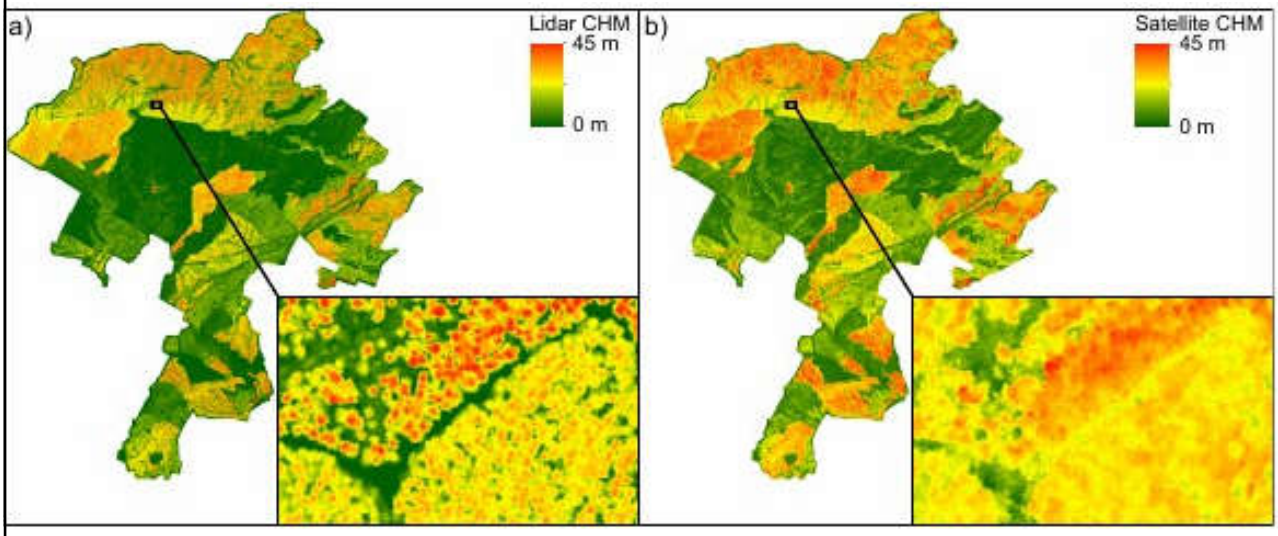
Forest inventory comparison study



Forest inventory comparison study

Dimension	LiDAR	Satellite
MTH (m)	1.6	2.0
BA (m^2/ha)	11.2	11.3
Stocking (s/ha)	107.9	110.1
TRV (m^3/ha)	90.4	90.5
TSV (m^3/ha)	105.2	105.4

- Predictions of a very similar precision
- Approach used the DTM from the LiDAR
- These results suggest that satellite based imagery can be used as a substitute for LiDAR, following an initial LiDAR acquisition

Pearse, G. D., Dash, J.P., Persson, H., Watt, M. S. (submitted). Comparison of high density LiDAR and satellite photogrammetry for forest inventory. *Remote Sensing*.

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Additional projects

- Regional scale prediction of the effects of genetics on tree productivity
- Large scale estimation of leaf area index

Pearse, G., Watt, M.S, Morgenroth, J., Dash J. (in press) Large scale lidar estimation of leaf area index using nearest neighbour classifiers. Remote Sensing of Environment.

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Conclusion

- Wildings can be identified using a combination of LiDAR and spectral data
- Stream locations can be delineated using LiDAR although validation is required
- Voxel-based metrics can be used to more accurately predict inventory than standard LiDAR metrics
- Simulated disease can be detected from spectral data obtained from a UAV
- Leaf area index can be modelled at broad spatial scale with reasonable precision
- Satellite point clouds can predict inventory metrics with similar precision as LiDAR

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The Geomatics Team


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David Pont, Scientist (Remote Sensing)


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