Mapping forest fuel load and structure from airborne LiDAR data

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Research Cluster: Monitoring and prediction, Project: Mapping bushfire hazard and impacts

AUSTRALIA IS A DRY CONTINENT, WITH HIGH CLIMATE VARIABILITY, AND IS CONTINUALLY VULNERABLE TO NATURAL HAZARDS LIKE BUSHFIRES. TO BETTER EVALUATE AND REDUCE THE RISK OF BUSHFIRES, FIRE MANAGEMENT AGENCIES AND LAND MANAGERS NEED TIMELY, ACCURATE AND SPATIALLY EXPLICIT UNDERSTOREY FUEL METRICS ALONG WITH CLIMATIC AND OTHER SPATIAL TOPOGRAPHICAL INFORMATION. THE LIGHT DETECTION AND RANGING (LIDAR) DATA AND TECHNOLOGY IS A PROVEN ALTERNATIVE TO TRADITIONALLY TIME CONSUMING AND LABOUR INTENSIVE FUEL ASSESSMENT METHODS.

INTRODUCTION

- LiDAR technology and full-waveform form data has wide potential in forestry fuel mapping. This is because of increased capabilities in capturing the understorey and near surface fuel loads and other structural information with highest precision in a reasonable time.
- Now Bushfire research must overcome many challenges (time & spatial accuracies) with the utilisation of the advanced ALS-FWL technologies to develop more accurate fuel databases which are crucial for fire risk assessments.

Figure 1: Field survey plots (Photo credit: Phil Zylstra, UoW)

- **EARLIER fire management** was making reliable estimates about the fuels with the combination of extensive ground survey data along with other remote sensing data *(Figure 1).*
- Even after the evolution of LiDAR, the remote identification and assessment of the elevated and near surface fuel (NSF) under denser canopies was challenging (Palace *et al.*, 2015). This is because discrete pulses cannot detect the understorey fuel/other structures due to weakening of pulses which were unable to reflect back to the sensor from the ground *(Figure2).*

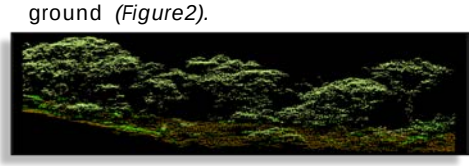

Figure 2 : Black Mountain discrete LiDAR vegetation profile

Did you know?

Today airborne LiDAR systems (ALS) and technology with full-waveform LiDAR data (FWL) capability, has become a very accurate and affordable solution for forestry mapping covering larger areas in shorter timeframes ?(Wagner *et al.*, 2008)

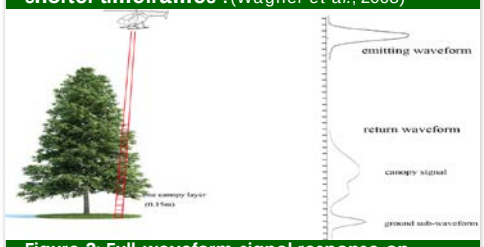

Figure 3: Full-waveform signal response on vegetation (Ma et al., 2015)

WHY FULL-WAVE LIDAR?

FW Laser pulses can penetrate through the dense canopies and are able to detect the understorey fuels over large areas with high spatial and volumetric accuracies. *(Figure 3)*

HOW MIGHT IT WORK?

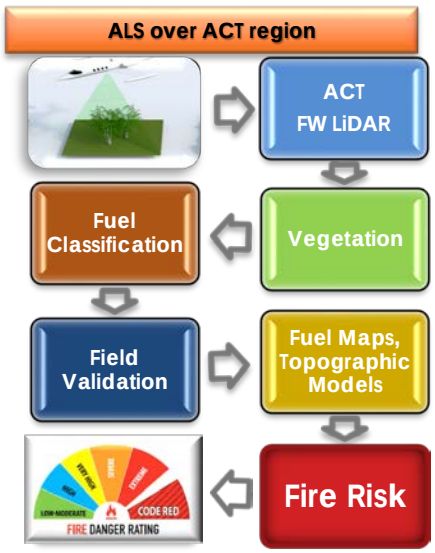

Figure 4 : Proposed research methodology

THIS PhD RESEARCH

- Investigates and utilises cutting-edge active remote sensing technologies like LiDAR to advance Australian bushfire research and utilise the next generation spatial information.
- Assesses the competence of full-waveform LiDAR to map the understorey forest fuels and structures for the whole of the ACT.
- Identify and develop high resolution spatial products which are of particular interest to bushfire and emergency management.
- Will develop an accurate fire risk index and add value to existing spatial data, to make informed decisions in critical times.

RESEARCH QUESTIONS

- Is FW LiDAR any better than the discrete form?
- How and to what extent the can FW-LiDAR data can be used in mapping bushfire hazards and impacts?
- Is the available LiDAR data complying with the American Society of Photogrammetry and Remote Sensing (ASPRS) LiDAR data standards and project specifications?
- Can we establish an objective way to define the national fuel classification system and the fuel hazard assessments based on the LiDAR derived fuel metrics?

1. Ma, H., Song, J. and Wang, J., 2015. Forest Canopy LAI and Vertical FAVD Profile Inversion from Airborne Full-Waveform LiDAR Data Based on a Radiative Transfer Model, Remote Sensing, 7(2): 1897-1914.
2. Wagner, W., et al. (2008). "3D vegetation mapping using small-footprint full-waveform airborne laser scanners."
3. Palace, M. W., et al. (2015). "Estimating forest structure in a tropical forest using field measurements, a synthetic model and discrete return lidar data.
4. Photos from mdpi, carbon map , black mountain field work

ACKNOWLEDGEMENTS

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2. BNHCRC for top-up scholarship and project support.
3. CSIRO for the provision of discrete LiDAR and TERN for co-funding the FW acquisitions.

END-USER STATEMENT

This PhD research is well aligned with the BNHCRCs priorities and also with the stakeholders strategic objectives.
Andreia Siqueira, Geoscience Australia