Fuels3D and the assessment of bark hazard

Luke Wallace*, Karin Reinke, Samuel Hillman, Bryan Hally, Simon Jones

RMIT UNIVERSITY

bushfire&natural HAZARDS CRC

Overview

- Fuels3D project – aims, proof-of-concept and ongoing work
- Bark fuel and its role in wildfire
- Method
- Results thus far
- Outcomes and outlook

Fuels 3D Project

- Challenge: Data collection technologies and methods for **repeatable** and **quantitative** measurement of fuel hazard

- Opportunity: Investigate emerging terrestrial and aerial **remote sensing technologies**

- Solutions: (i) **Sampling techniques and technologies** for repeatable and low-cost capture of the fuel environment (ii) **Point cloud data analytics** to derive fuel layers and quantitative hazard metrics

Fuels 3D Solution Overview

DATA CAPTURE AND POINT CLOUD CREATION

Other 3D Point Cloud Data Sources

Fuels3D

- In-field image collection method
- Image matching and scale
- Creation of 3D point clouds

Data Inputs

DATA PROCESSING, ANALYSIS AND FUEL METRIC CREATION

Fuels3D+

- Data management
- Point cloud processing into data products describing fuel layers and metrics

Data Outputs

Determining Precision and Repeatability

sensors

MDPI

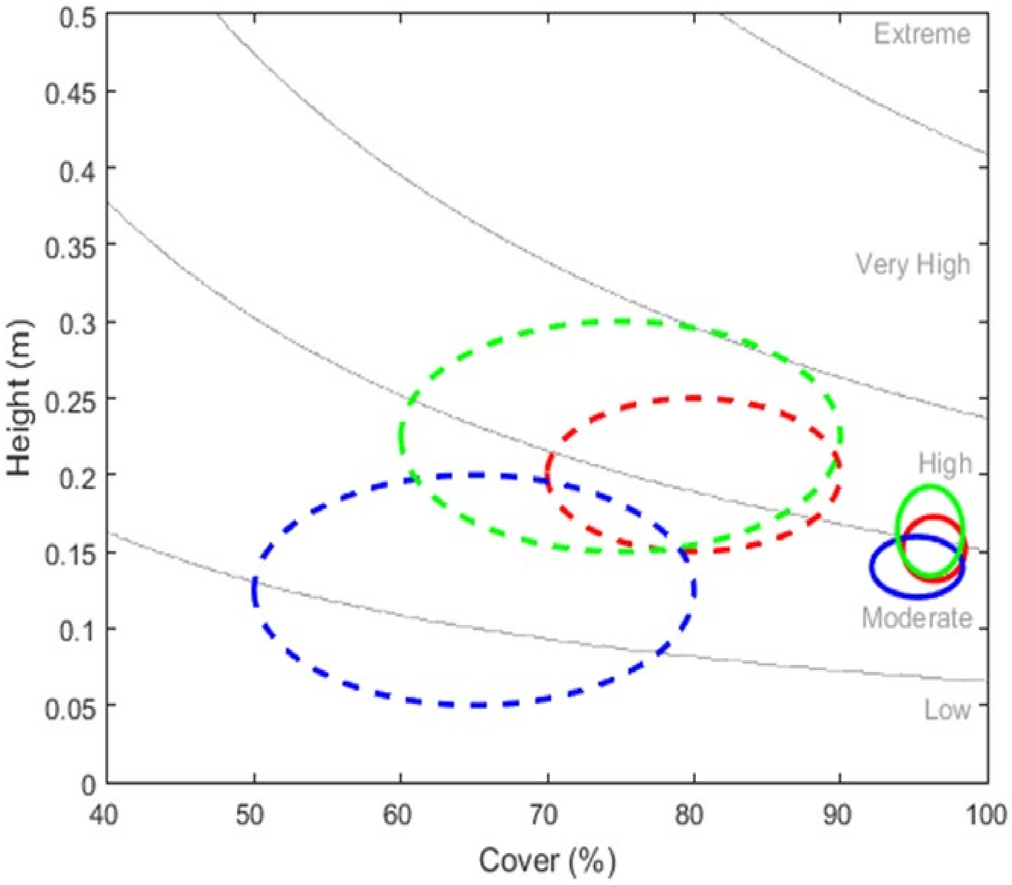
Article

Investigating Surface and Near-Surface Bushfire Fuel Attributes: A Comparison between Visual Assessments and Image-Based Point Clouds

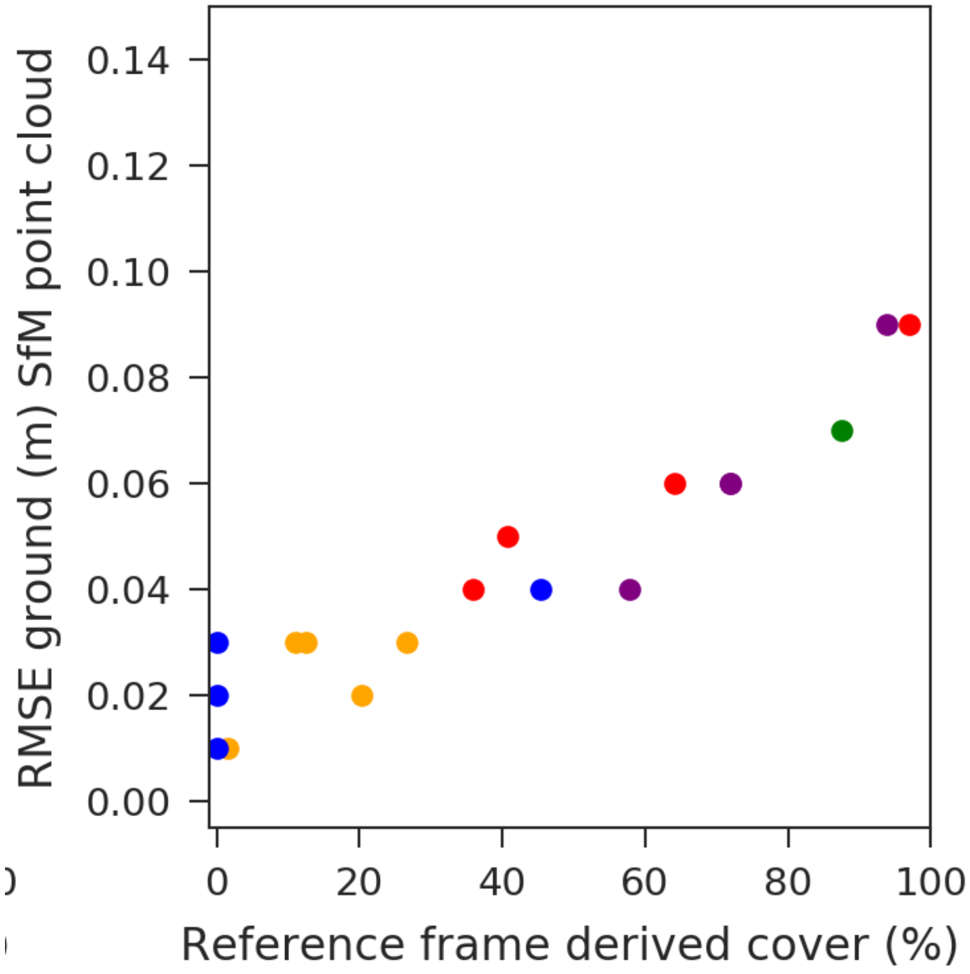
Christine Spits [1,*], Luke Wallace [1,2] and Karin Reinke [1,2]

1 School of Science, RMIT University, Melbourne 3001, Australia; luke.wallace2@rmit.edu.au (L.W.); karin.reinke@rmit.edu.au (K.R.)
2 Bushfire and Natural Hazards Cooperative Research Centre, East Melbourne 3002, Australia
* Correspondence: christine.spits@gmail.com; Tel.: +61-422-234-688

Academic Editor: Jason K. Levy
Received: 30 January 2017; Accepted: 17 April 2017; Published: 20 April 2017

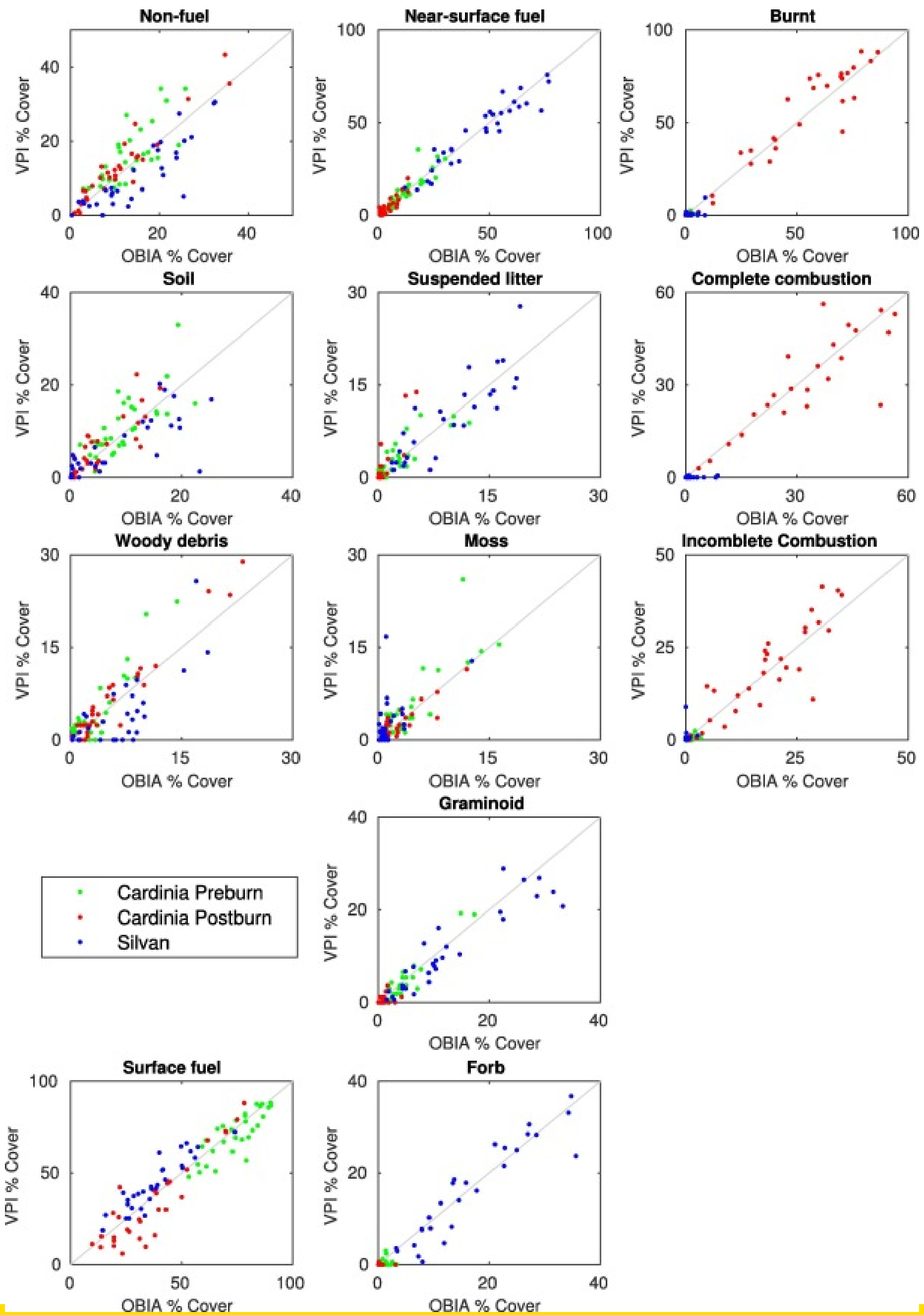


Determining Accuracy in a Point Cloud



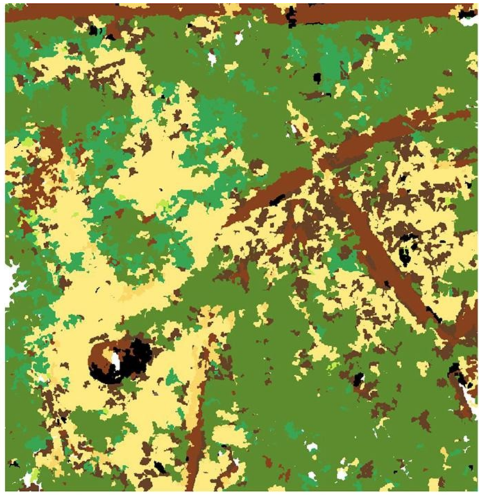
Determining Fuel Hazard Metric Accuracy

What aspects of the fuel structure and complex are accurately captured?



ORTHOIMAGE

VEGETATION HEIGHT



CLASSIFICATION

Fuels3D Current Work and Approaches

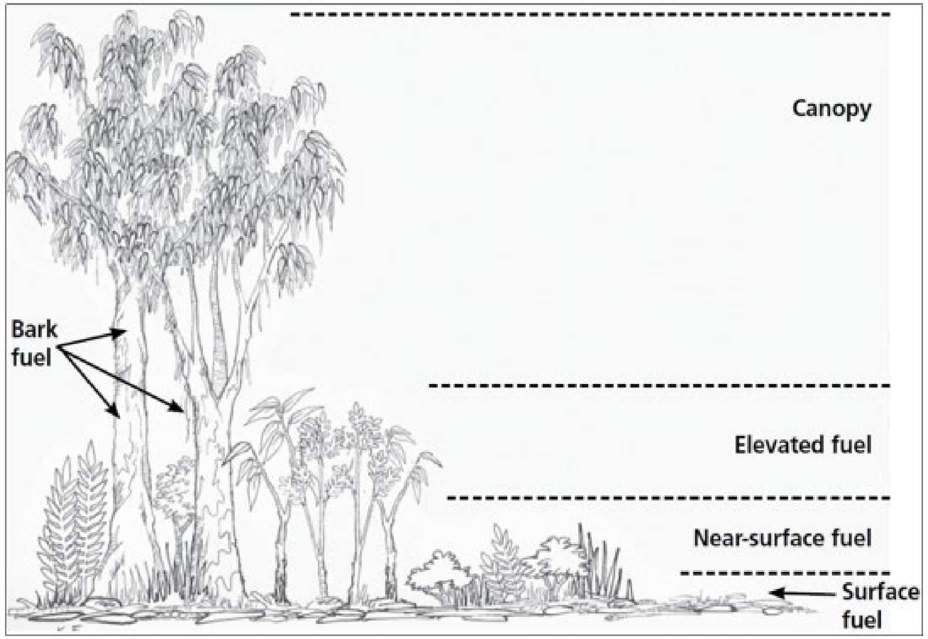
How do we sample a fuel environment effectively with different technologies?

How to best extract different fuel layers from a 3D point cloud?

Which point cloud technologies best describe certain fuel features? And in which environments?

What other elements beyond surface and near-surface fuels can be captured using the Fuels3D approach?

- Exploring bark hazard



Bark Fuel Hazard

- Key attribute of fuel hazard assessment
- Major contributor of firebrands
- Different type of barks in Eucalypt forests
- Current visual method of assessment:
    - Selection of type of tree
    - Quantity of combustible bark on trunk
    - How bark is attached (Stringybarks)

Study Area

- Silvan Reservoir, Victoria.
- Mixed species forest (predominantly Stringybarks)
- 33 Trees of varying species were surveyed
- DBH and bark hazard assessed at each tree

Low Cost Camera-Based Assessment

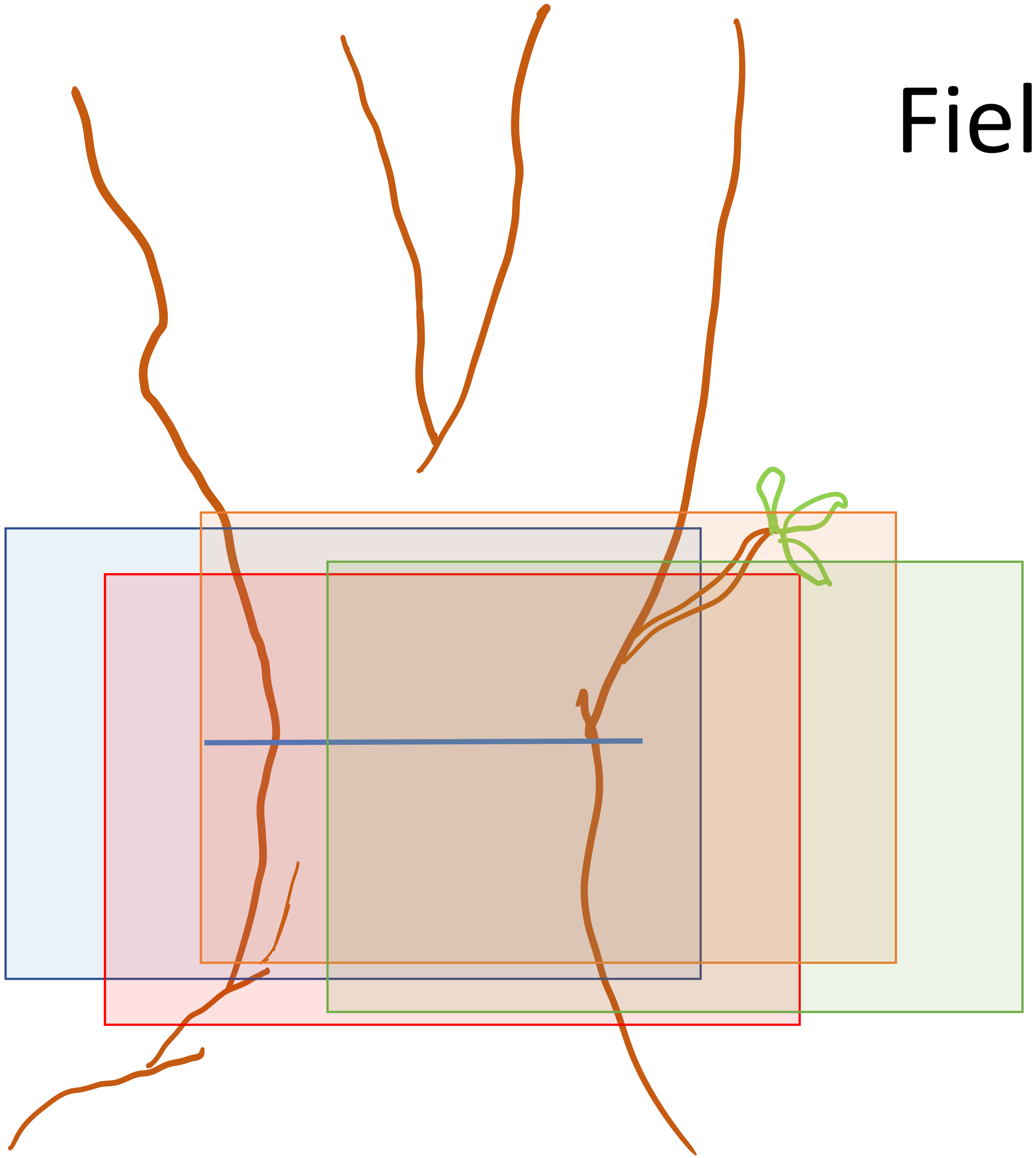
Passive remote sensing

Structure from Motion (SfM) workflow

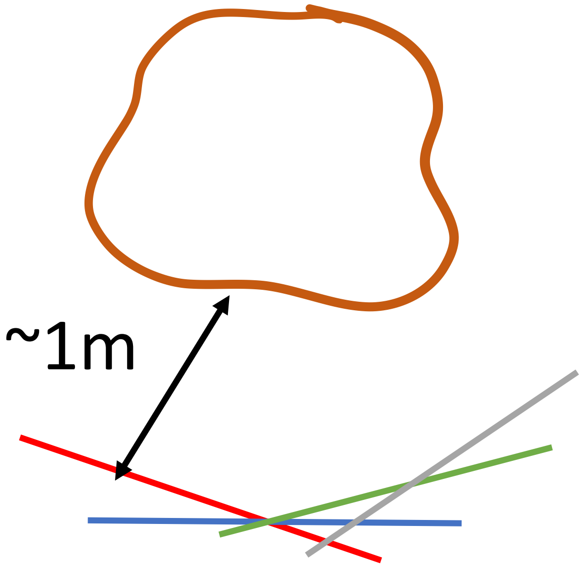
Same features observed in multiple images from different viewpoints to build 3D point cloud

Used in a number of environmental applications

Field Data / Image Capture



- 3 images (photographs) captured per tree
- Field of view centred on the centre or mid-point of the stem at breast height

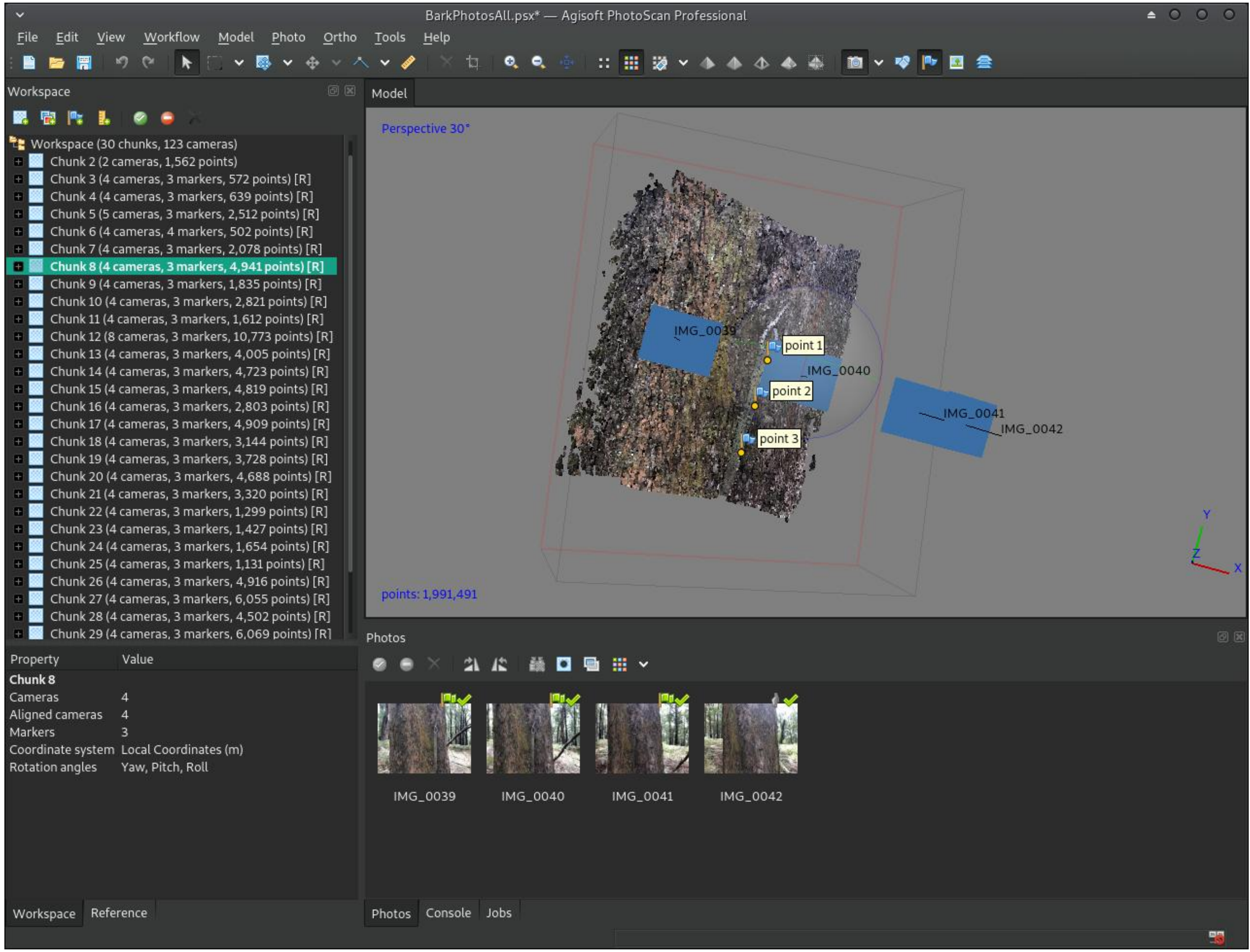


Images to Point Cloud

Images were processed in Agisoft photoscan using high quality settings

Scale was add by automatically detecting a control target

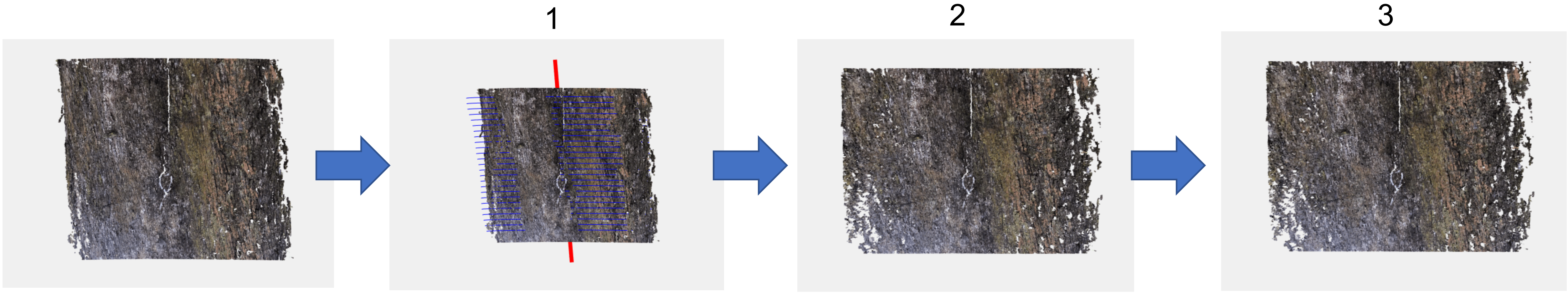
Processing took 20 seconds per image set



Point Cloud Normalisation

To estimate bark properties the point cloud was normalised to the trees stem. This was achieved by:

1. Firstly a simplified stem model (DBH and stem axis) was created by fitting circles to small slices of the point cloud
2. A new cooridinate system was then defined as x: distance around the stem, y: height above ground and z: distance from stem axis effectively rolling out the bark
3. Finally a local minima filter is applied and the bark is flattened

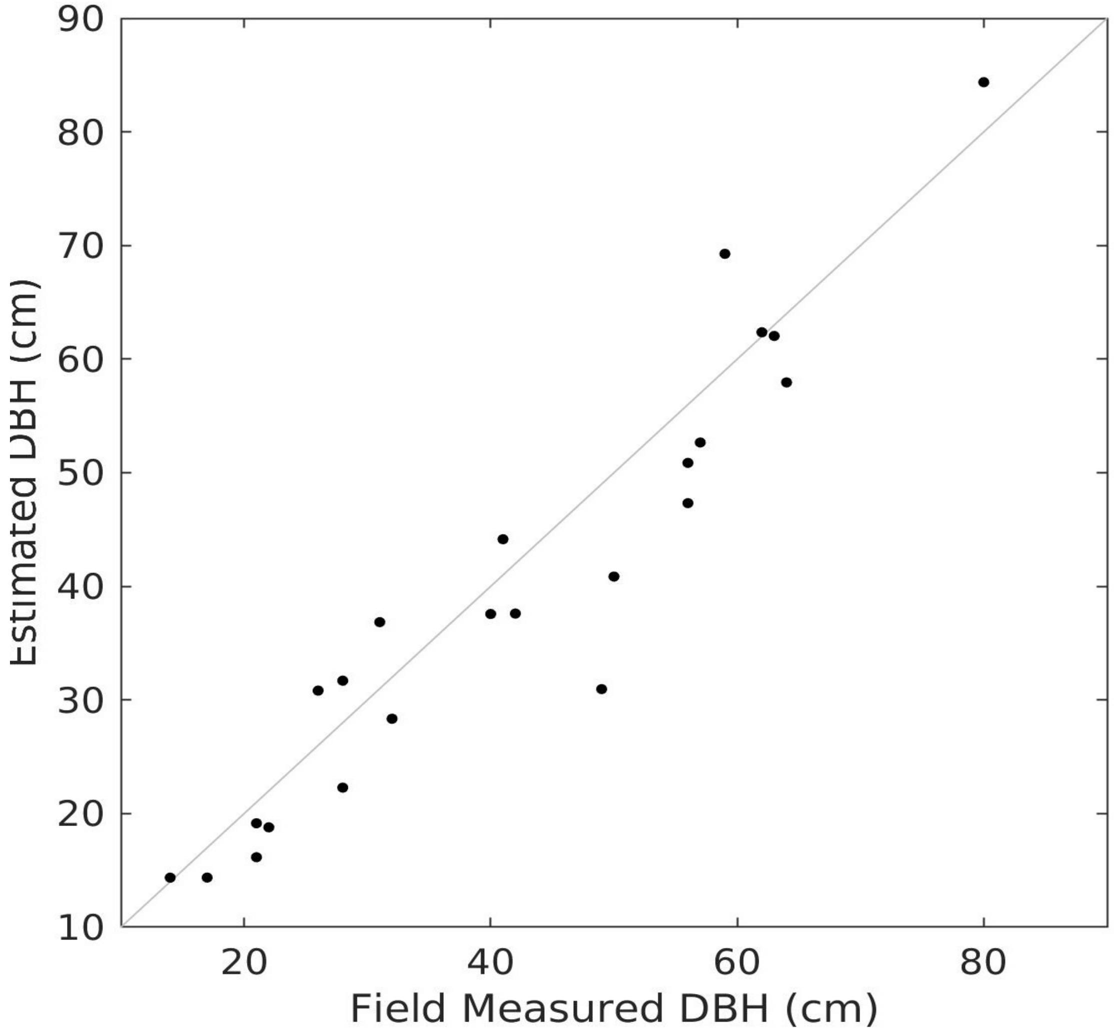


Stem Fitting Accuracy

Difference in field and estimated DBH used as a measure of accuracy of stem fit

$R2 = 0.9$ and $RMSE = 6.1$ cm

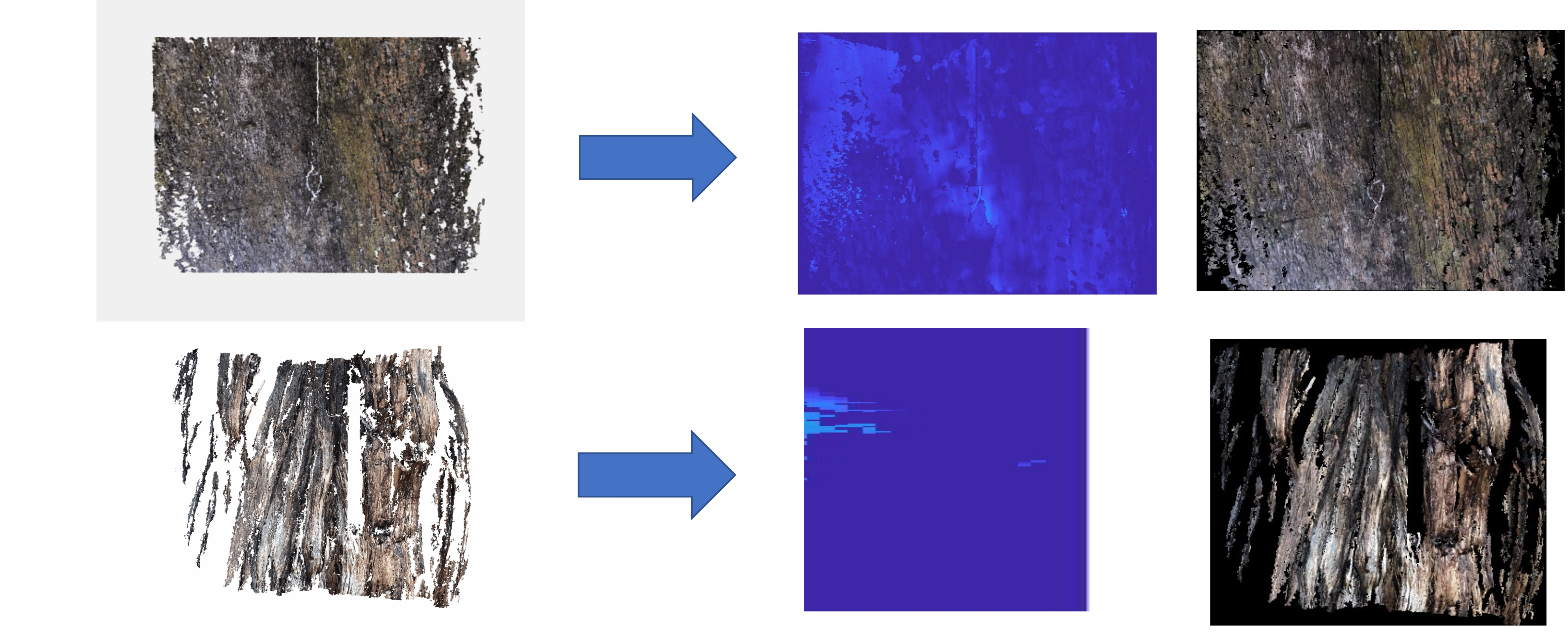
Measures of bark width will be added as further source of validation



Point Cloud to Raster

A 2mm resolution raster image was then created with the following bands:

- Red, Green, Blue
- 95th Percentile Bark Height



Bark Description

Descriptors were calculated from the flattened bark representations (both point cloud and raster)

Texture was calculated both along bark and across bark at 3 scales (1 cm SD, 5 cm SDand 9cm SD)

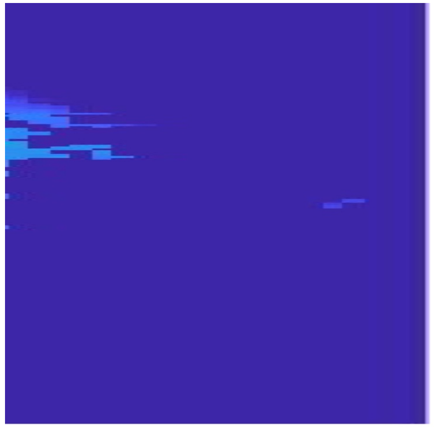
Point Cloud Space

Bark Volume Per Unit Area
Points per square cm
Number of intercepts

Raster Space

HSV Colour Based

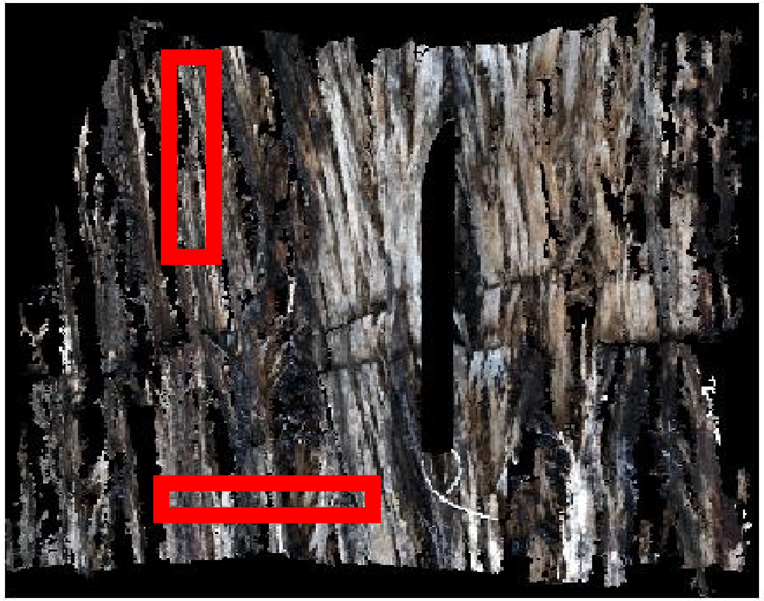
Mean and Std Value
Across bark texture (mean and std)
Along bark texture (mean and std)
Texture difference abs(along – across)



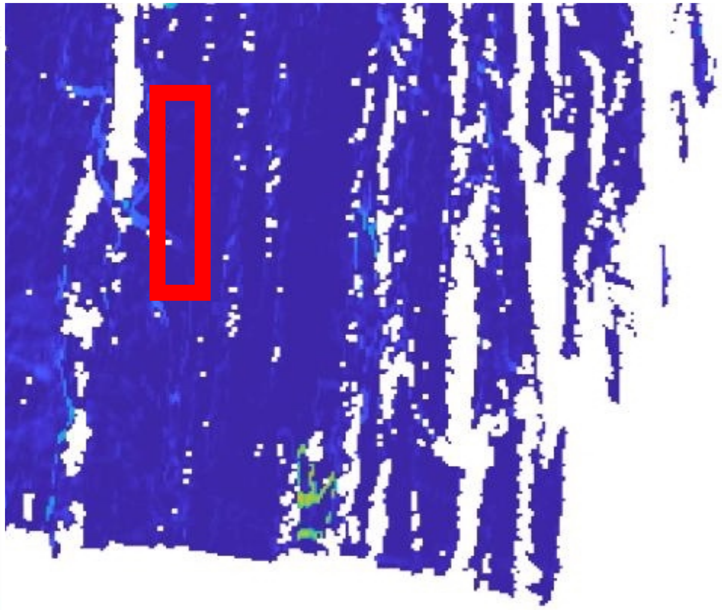
Bark Width Based

Mean Width
Std Width
Across bark texture (mean and std)
Along bark texture (mean and std)
Texture difference abs(along – across)

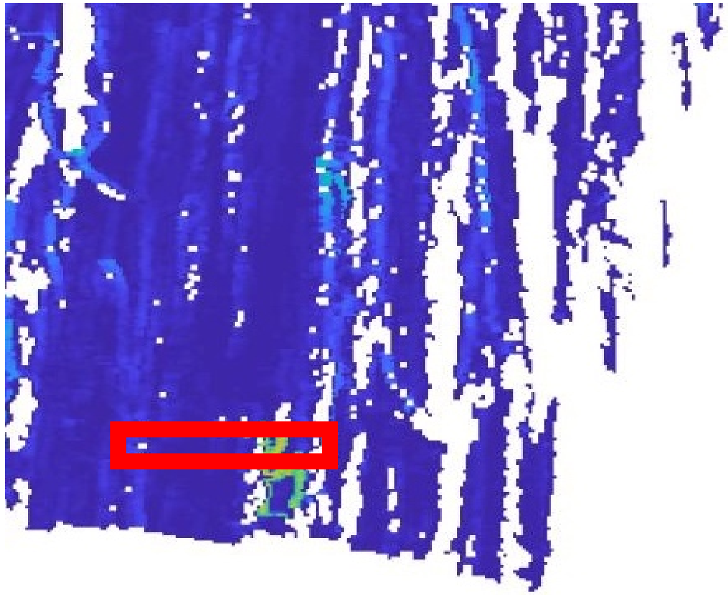
Bark Texture Method



ALONG STEM



ACROSS STEM

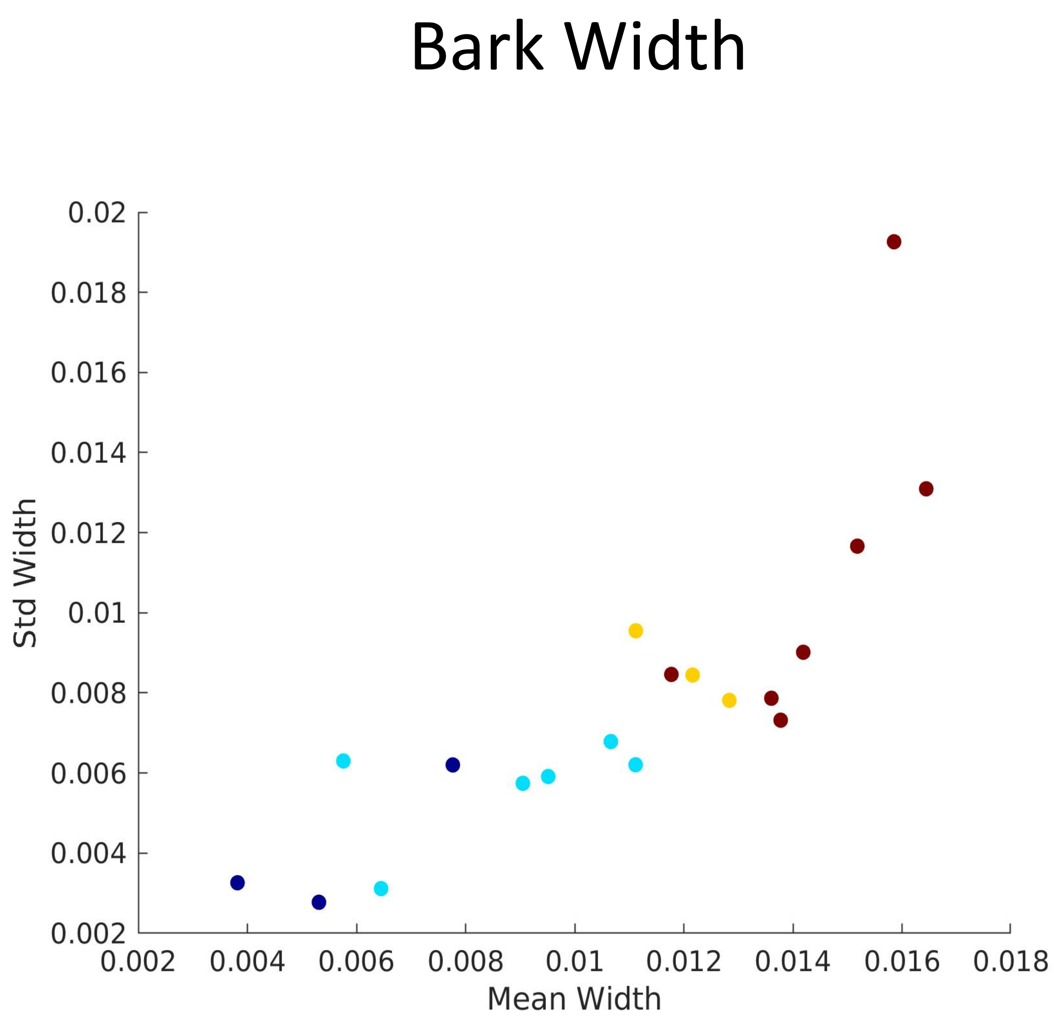


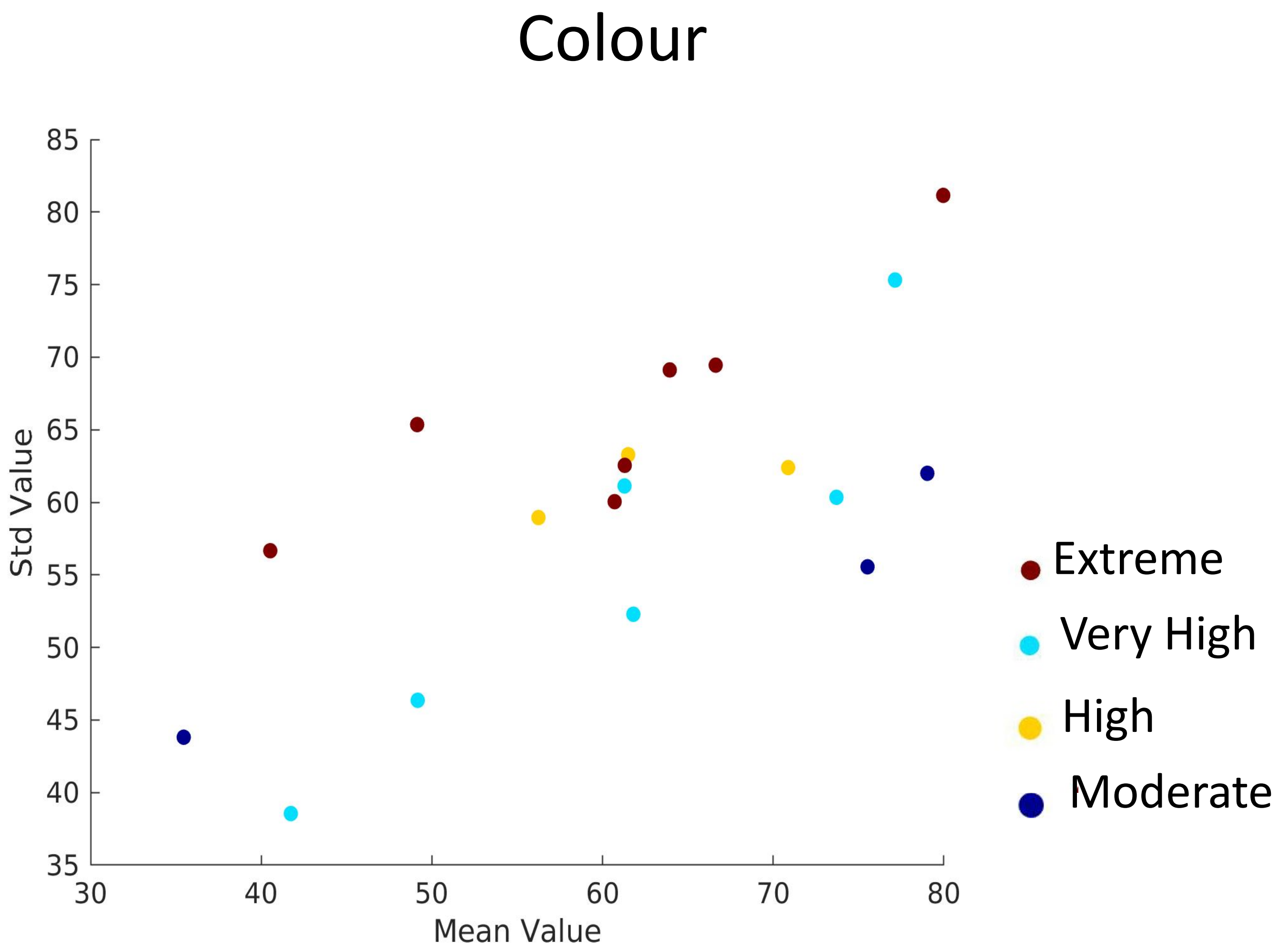
Stringybark Hazard

Moderate High Very High Extreme

Hazard Rating

Stringybark Hazard

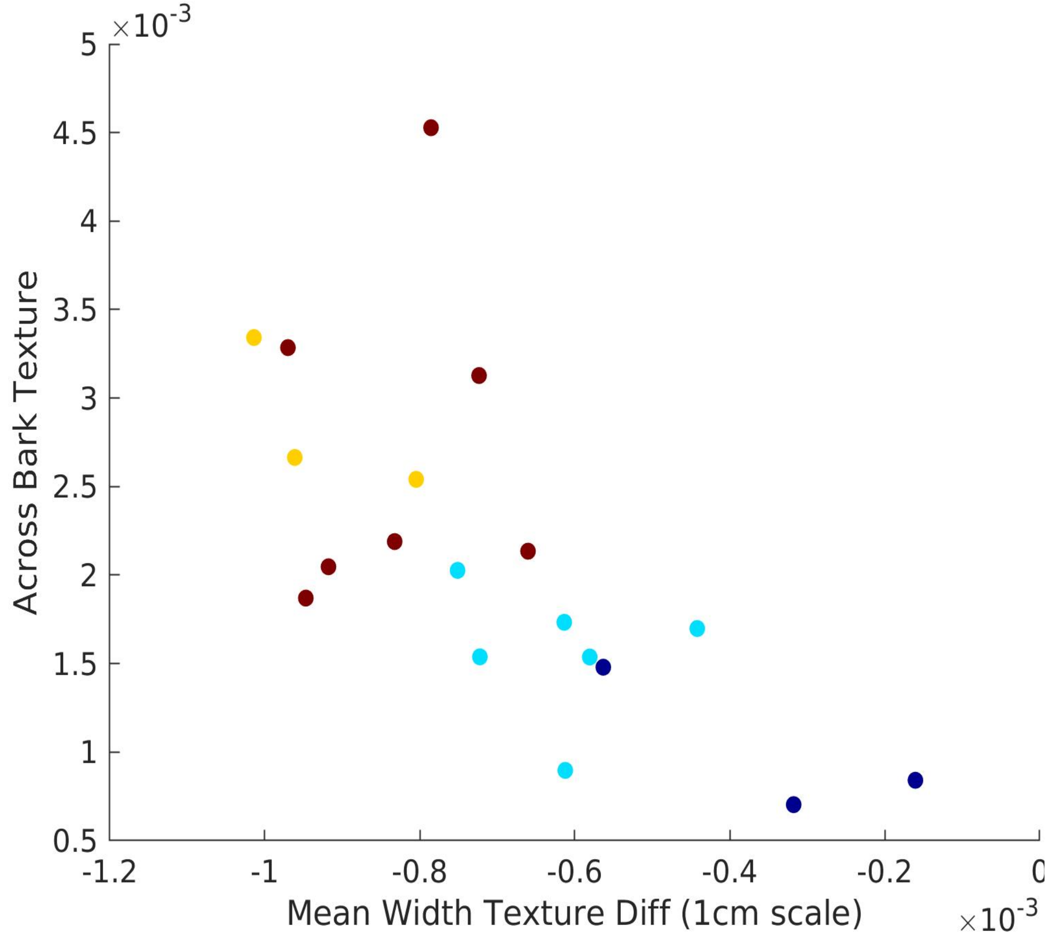




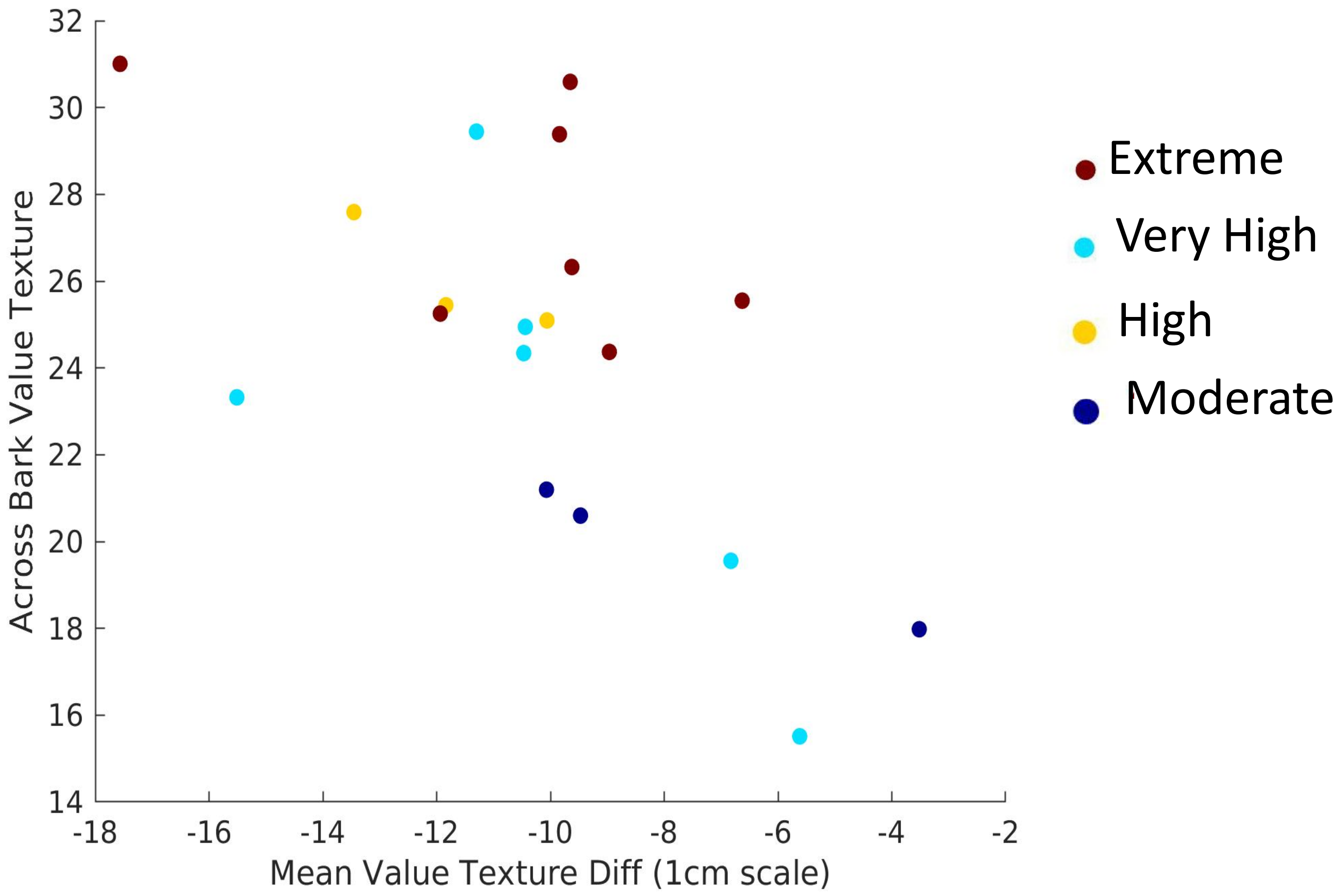
x: Mean Value y: Std Deviation Value

Stringybark Hazard

Bark Width Texture



Colour Texture



Conclusions - Towards quantified bark hazard

New rapid approach to assess bark hazard that is non-destructive and provides quantified metrics

Metrics were developed here to classify bark into species and hazard however further opportunities exist.

Continuous metrics that could allow more quantifiable information of bark hazard to be captured in-field.

To achieve this further validation data is required and input from fire behaviour modelers on variables to focus on.

Thank You

Contact info:

Luke: luke.wallace2@rmit.edu.au

@ProfCoffeeRMIT

@lukeowallace