PROJECT A4 DISASTER LANDSCAPE ATTRIBUTION, ACTIVE FIRE DETECTION AND HAZARD MAPPING

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- Dr. Andreas Eckhardt, DLR
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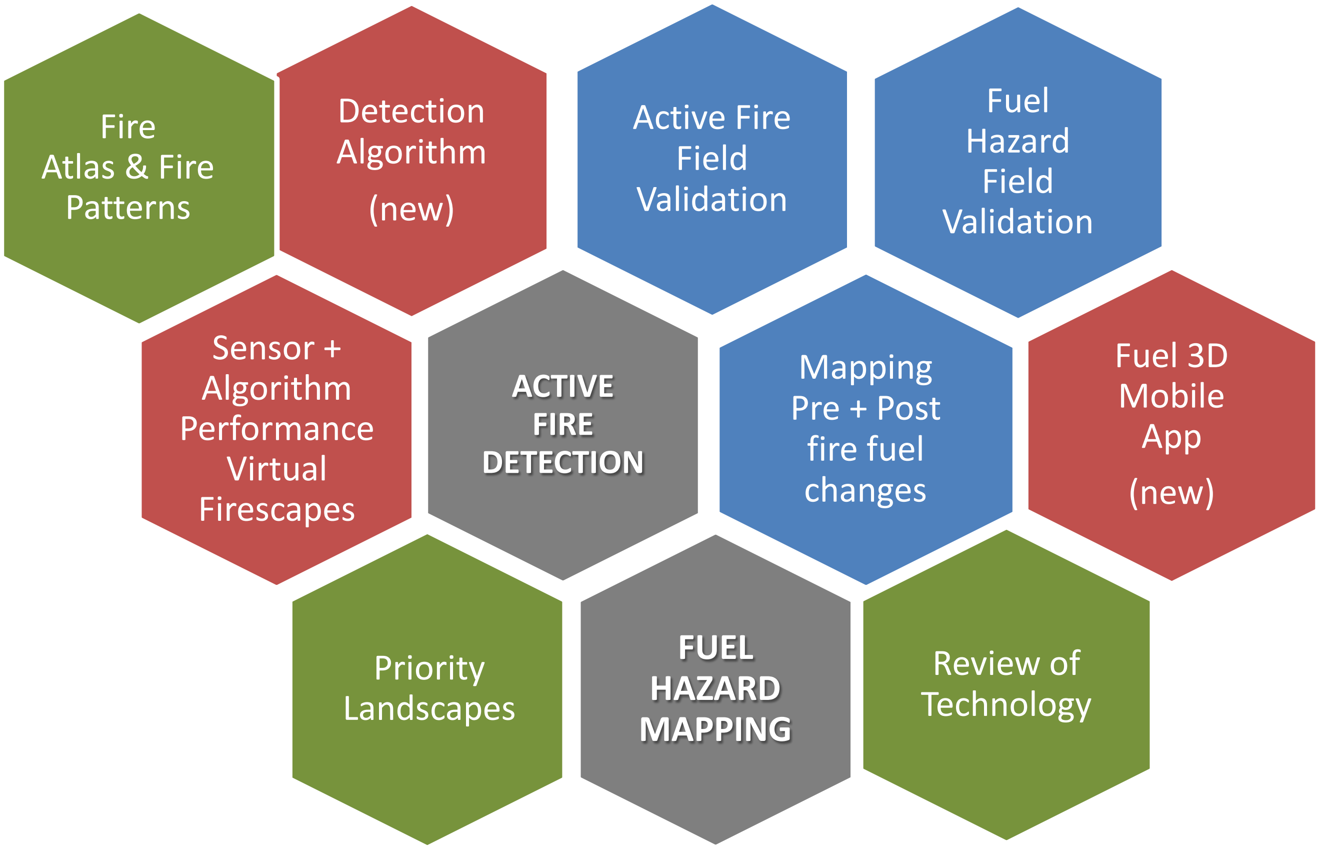
** BNH CRC associated student

PROJECT A4 OVERVIEW



Completion 2015

Completion 2016

Completion 2017

FIRE ATLAS: SPATIO-TEMPORAL FIRE PATTERNS

Objectives

- To create a spatial database of fire in southern Australia to:
  - statistically determine whether fire is increasing/decreasing in the landscape
  - characterise the spatial and temporal patterns of wildfire
  - to inform when and where to task satellite sensor analysis and experiment types; priority landscapes

Approach

- Approval from state agencies
- Compilation and normalisation of the fire atlas database
- Spatio-temporal + statistical analysis of wildfire and prescribed fires

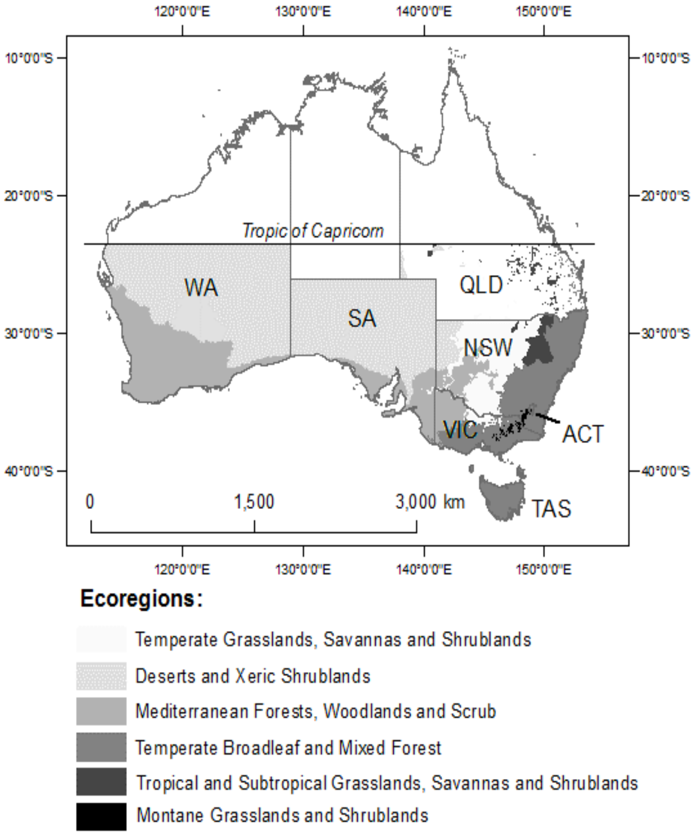
Findings + Outputs

- Oliveira. S., Soto-Berelov, M., Reinke, K. and Jones, J. (2015) *Spatial and temporal patterns of fires across state jurisdictions in southern Australia, from 1990 – 2014*. Manuscript in preparation.
- Soto-Berelov, M., Oliveira. S., Reinke, K. and Jones, J. (2015) *Spatial and temporal patterns of wildfires across ecoregions in southern Australia*. Manuscript in preparation.

The Year Ahead

- Completed

RESULTS



Ecoregion	Fire type	Number of fires	Burned area (ha)	Peak month	Length of fire season
Temperate grasslands	WF	643	158,722	Dec	5 months (Oct - Feb)
	PB	351	28,486	Apr	6 months (Mar-May & Sep - Nov)
Deserts	WF	1,746	13,343,090	Jan	6 months (Sep-Feb)
	PB	614	1,437,917	Apr/May/Oct	5 months (Mar-Apr & Oct-Dec)
Mediterranean forests	WF	40,429	9,761,569	Jan	3 months (Sep & Dec-Jan)
	PB	65,824	3,788,796	Sep	3 months (Apr-May & Sep)
Temperate forests	WF	45,481	9,010,767	Oct	6 months (Aug-Jan)
	PB	57,632	2,361,257	Apr	3 months (Mar-May)
Tropical savannas	WF	5,431	2,924,484	Nov	5 months (Sep-Jan)
	PB	8,963	1,643,012	Aug	5 months (Apr-May & Jul-Sep)
Montane grasslands	WF	298	1,043,188	Feb	3 months (Dec-Feb)
	PB	712	48,697	Apr	2 months (Mar-Apr)

RESULTS

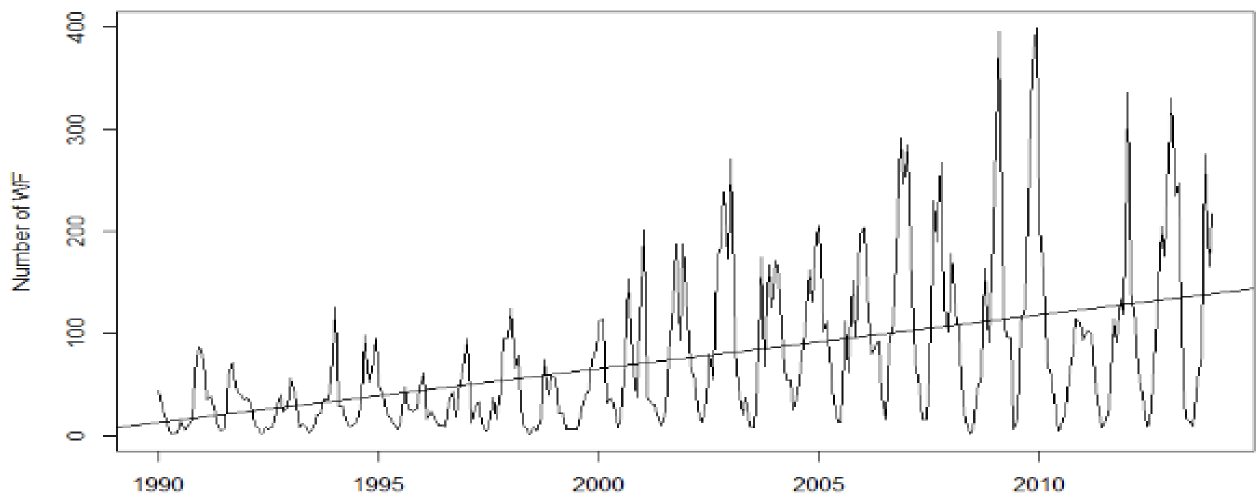
Statistical analysis of wildfire incidence:

-1990 - 2014
-Increasing in number
-Increasing in size
-Rate of change

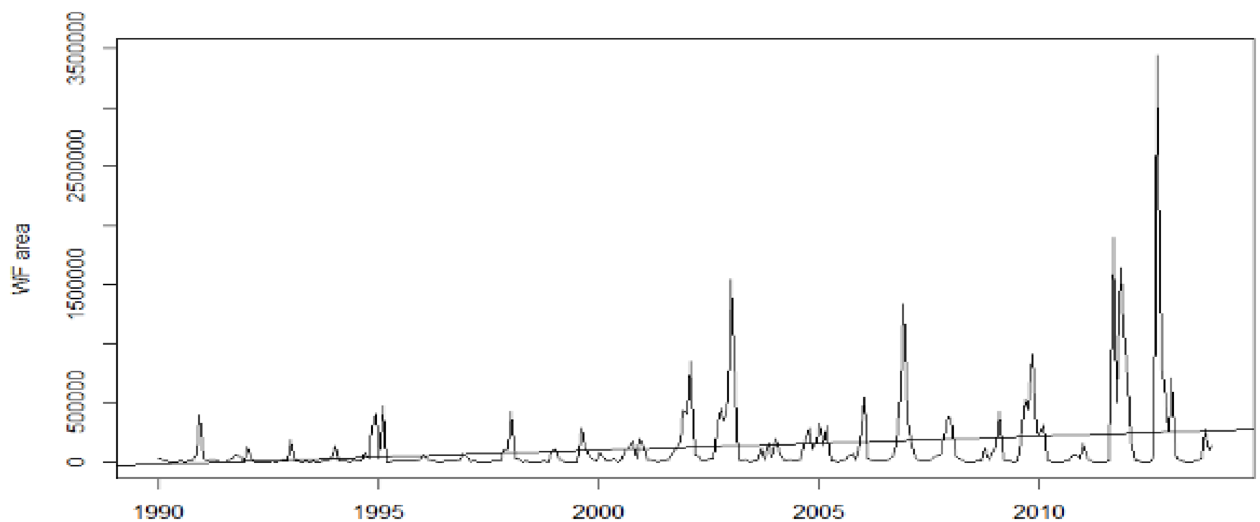
Repeated for stratification to states and ecoregions

Repeated for prescribed burns

Number of wildfires



Area of wildfires



FIELD VALIDATION FOR ACTIVE FIRE DETECTION

Objectives

- To validate satellite sensor performance and product accuracy of TET-1 and Himawari8 for fire detection in the field under different fire conditions
- Explore the effects of scale

Approach

- Experimental set up and survey design for moving fires (prescribed burns) and fixed fires (experimental fires)
- Multi-scale and multi-sensor data collection
- Spatial integration of fire temperature to energy equivalent for sensor bands and FOV
- Accuracy assessment and reporting

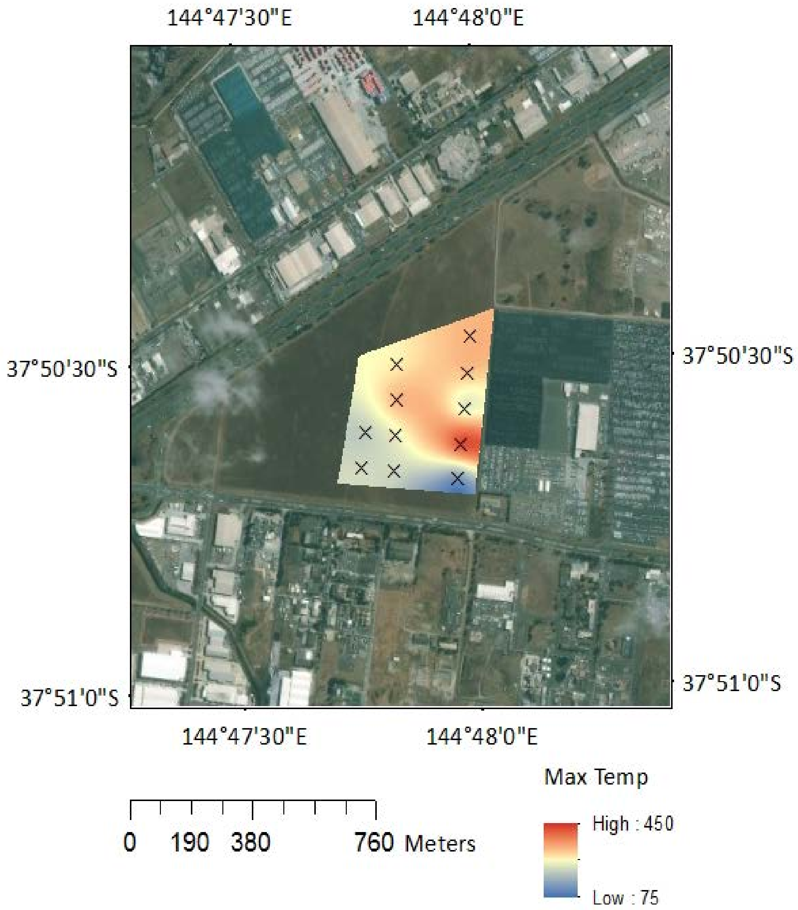
Findings + Outputs

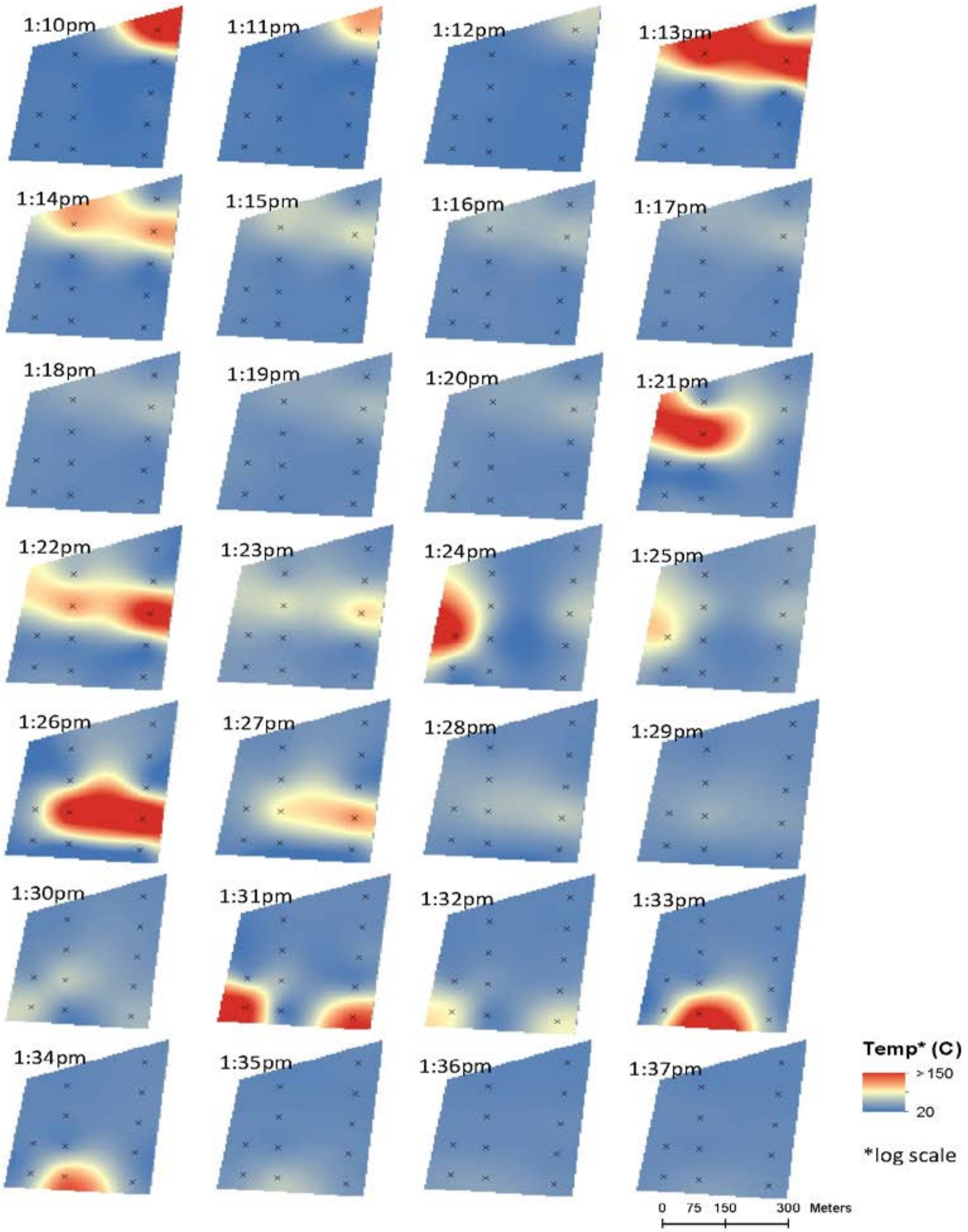
- Two Victorian experiments completed: Laverton grasslands prescribed burn and Kangaroo Ground experimental fire (draft reports in preparation)
- In-situ instruments and set up trialled (manual pyrometers unsuitable), sensor fusion complete
- Method for spatial integration of in-situ electronic fire loggers finalised

The Year Ahead

- Finalise satellite sensor performance and product/algorithm analysis for past experiments
- Repeat experiments to include aerial observations of fire (mast mounted and UAV mounted) using sensor fusion instruments, to be conducted Autumn 2016
- Findings added to the experiments completed in 2015
- Final report distributed

RESULTS


144°47'30"E
144°48'0"E
37°50'30"S
37°50'30"S
37°51'0"S
37°51'0"S
144°47'30"E
144°48'0"E
0 190 380 760 Meters
Max Temp
High : 450
Low : 75


1:10pm
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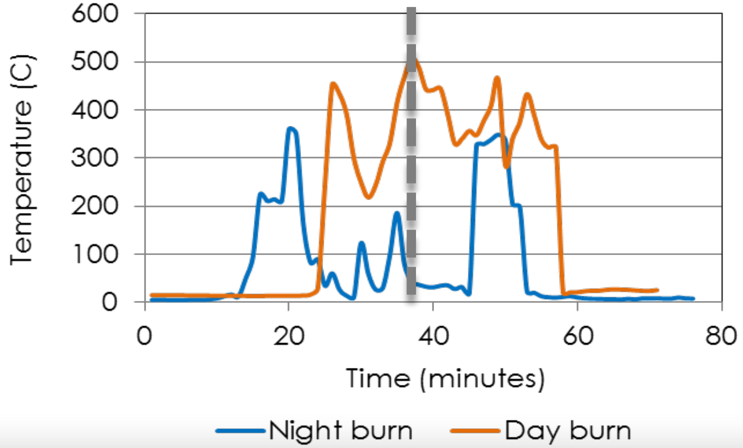
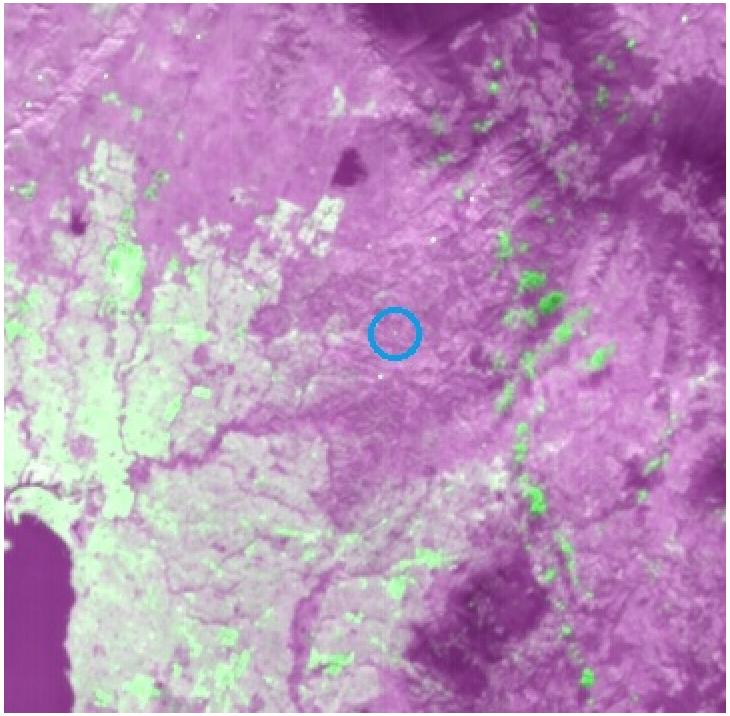
20
*log scale
0 75 150 300 Meters

RESULTS





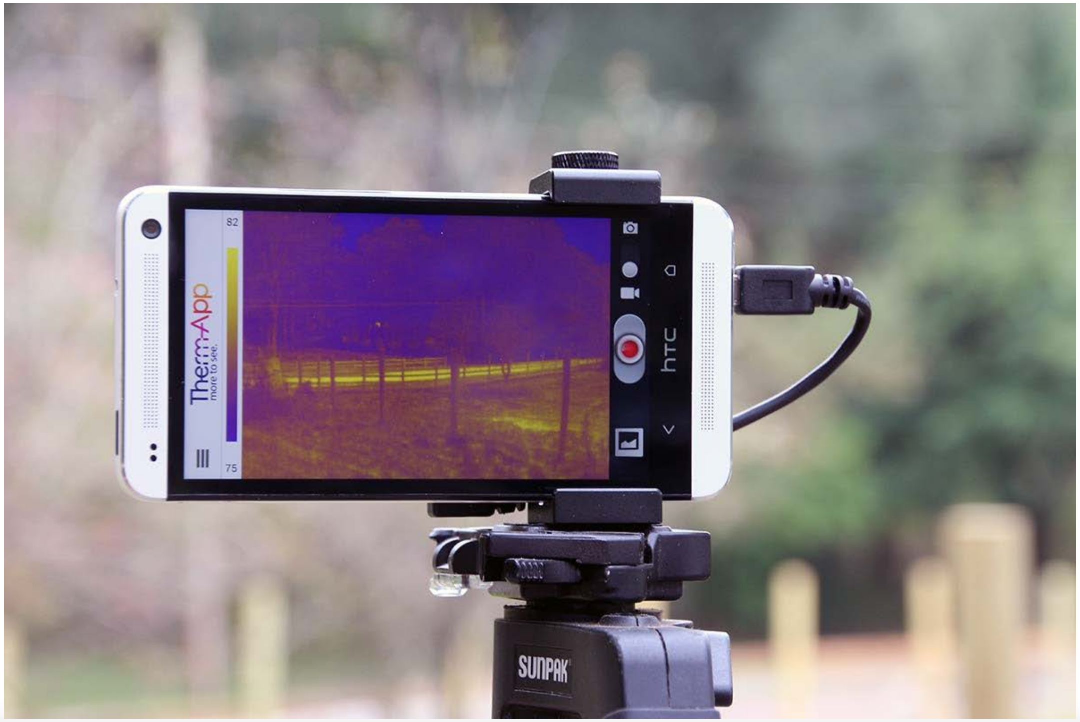
False color composite TET-1, daytime fire

RESULTS

In-situ + aerial (below/above canopy) + space borne observations

Novel sensor fusion to allow periodic observation of fire temperature during a burn
Therm-app thermal imager + android based raspberry pi logging pc + custom software

- fixed mast deployment
- UAV deployment



VIRTUAL FIRESCAPES: SENSOR + ALGORITHM PERFORMANCE

Objectives

- To develop a simulated fire landscape modelling approach to statistically assess the performance of TET-1 and Himawari 8:
  - model parameterisation
  - identification of TET-1 and Himawari 8 minimum fire mapping capabilities

Approach

- Creation of fire landscapes representative of different fire types (Justice et. al. 2008)
- Spatial integration of fire temperature to energy equivalent for sensor bands and FOV
- Algorithm implementation*
- Atmospheric effects, landscape complexity and obscuration effects
- Accuracy assessment and reporting

Findings + Outputs

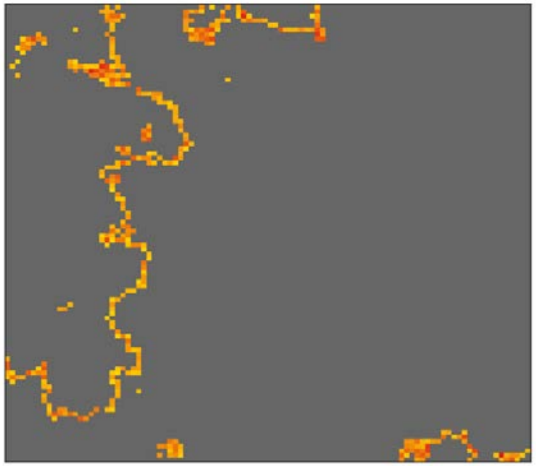
- Virtual fire landscapes automated in Python
- Mitchell, S., Jones, S., Reinke, K., Lorenz, E. and Reulke, R. (2015) *Assessing the utility of the TET-1 hotspot detection and characterization algorithm for determining wildfire size and temperature*. Manuscript in review.

The Year Ahead

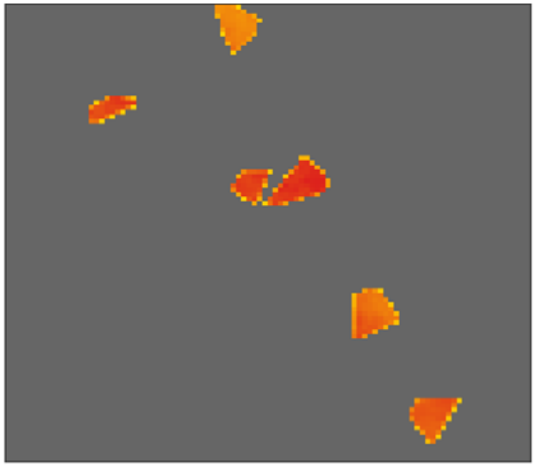
- Atmospheric effects built into model (6S)
- Spatial integration of fire temperature for Himawari 8 specifications
- Algorithm implementation and testing of Himawari 8 for presentation at ISPRS 2016 and publication*
- PhD student Bryan Hally to spend 3 months at Uni of Twente working with Prof. Andrew Skidmore

RESULTS

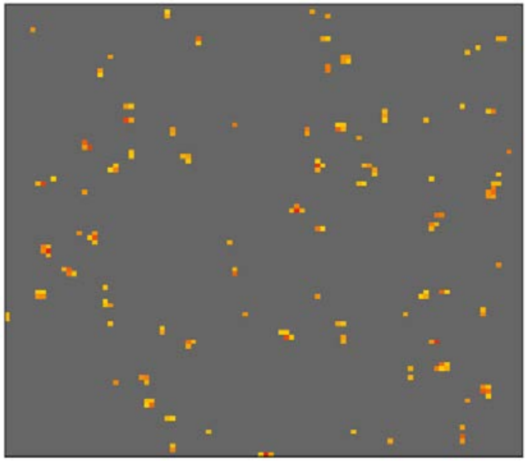
Simulated fire front landscape

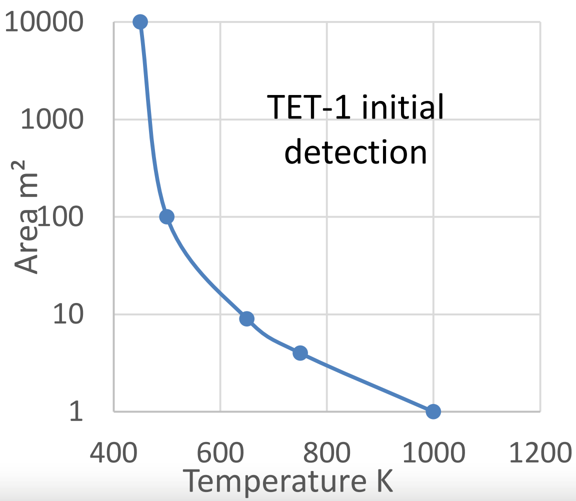


Simulated fire blocks landscape

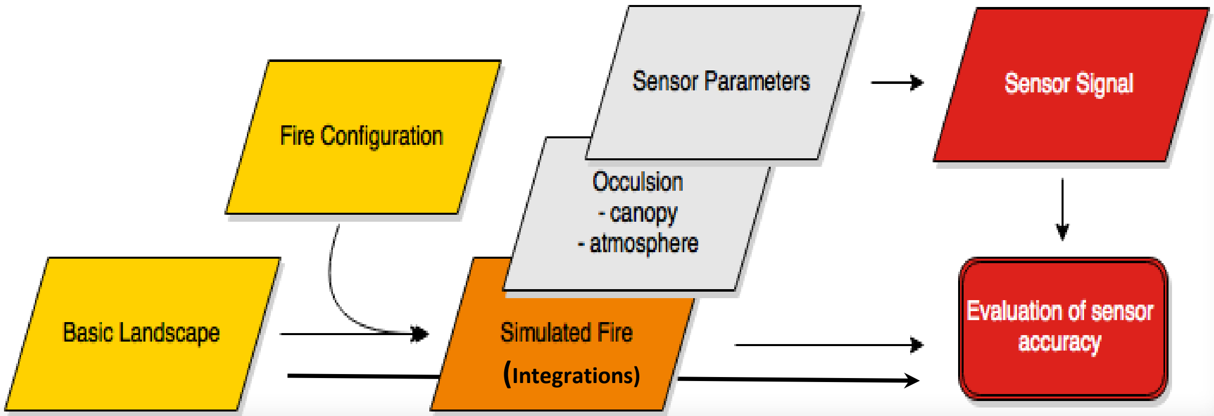


Simulated fire spotting landscape





Model overview



REVIEW OF TECHNOLOGIES FOR FUEL MAPPING

Objectives

- To identify emerging technologies for rapid assessment of fuel hazards and biomass of grassland and forest understorey environments
- To assess the accuracy of measurements

Approach

- Three landscapes were assessed: grasslands, open woodland and closed riparian forest
- Surface and Near-surface layers only
- Rising plate meter, Structured light (Tango Tablet), Structure from Motion (SfM) and Terrestrial LiDAR (TLS) compared to destructive wet and dry weight samples

Findings + Outputs

- Unpublished report. *Potential emerging technologies for assessing fuel and change in the 3D structure of a vegetated landscape induced by a fire event.*
- Hillman, S., Wallace, L., Reinke, K. and Hally, B. (2015) *Evaluating new terrestrial techniques for estimating volume of surface and near-surface biomass,* Manuscript in review.
- SfM selected as approach to develop (rapid, repeatable and accurate)

The Year Ahead

- Completed

RESULTS

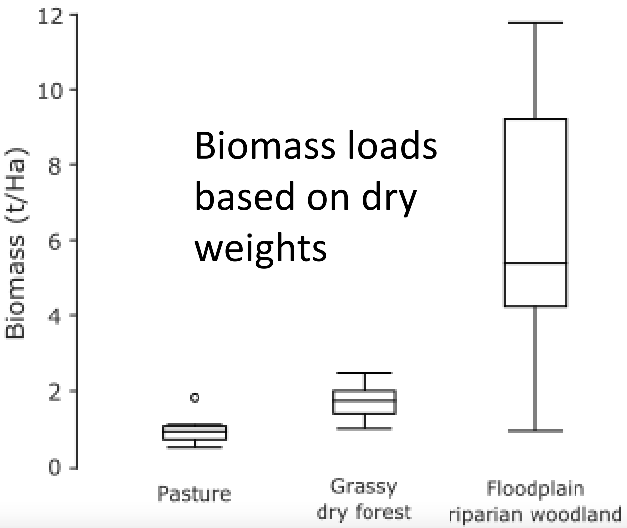
Pasture / Grasslands

Grass dry forest

Floodplain riparian woodland

Site	TLS capture and processing time per plot	SfM capture and processing time per plot
Pasture	120 minutes	45 minutes
Grassy dry forest	120 minutes	45 minutes
Floodplain riparian woodland	120 minutes	45 minutes

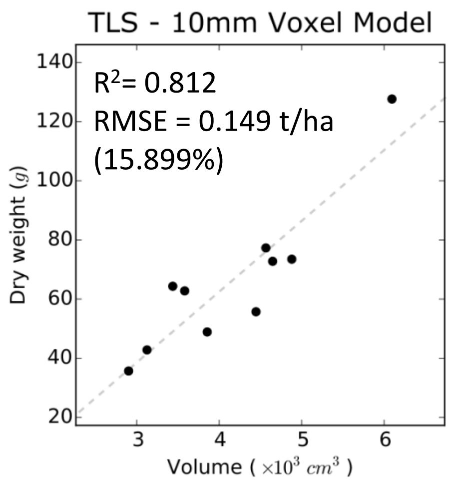
Time comparisons between TLS and SfM

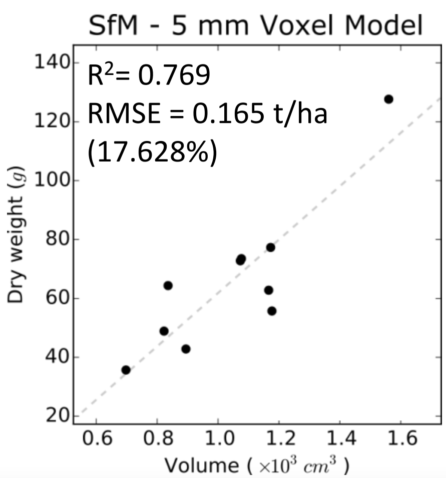


Biomass loads based on dry weights

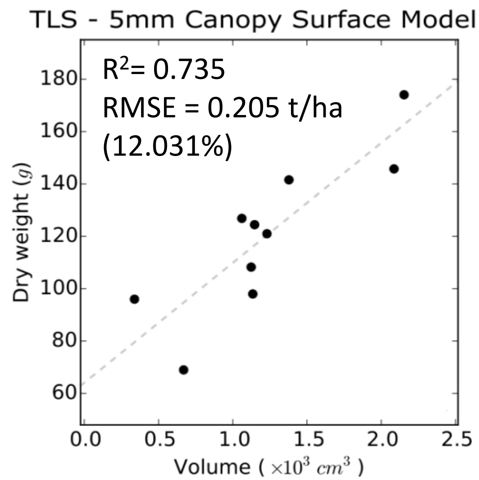
RESULTS

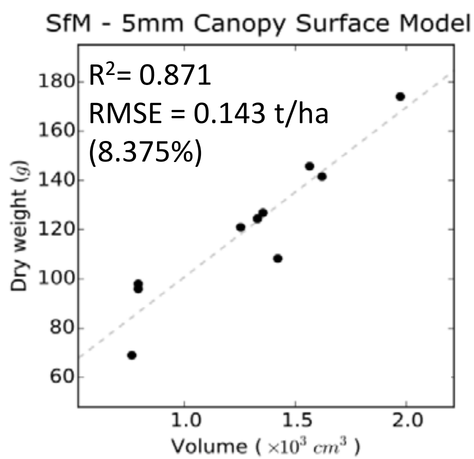
Pasture



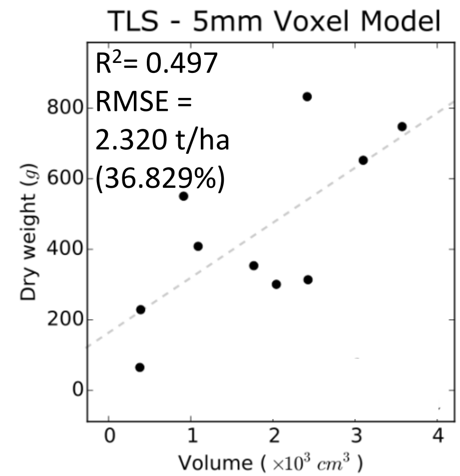


Dry Grassy Forest





Floodplain Riparian Woodland



SfM-No Data

DEVELOPMENT OF A FUEL HAZARD MOBILE APP

Objectives

- To create a mobile App for rapid and repeatable information to support quantitative fuel hazard assessments
- To develop an imaging sampling protocol to support the mobile App

Approach

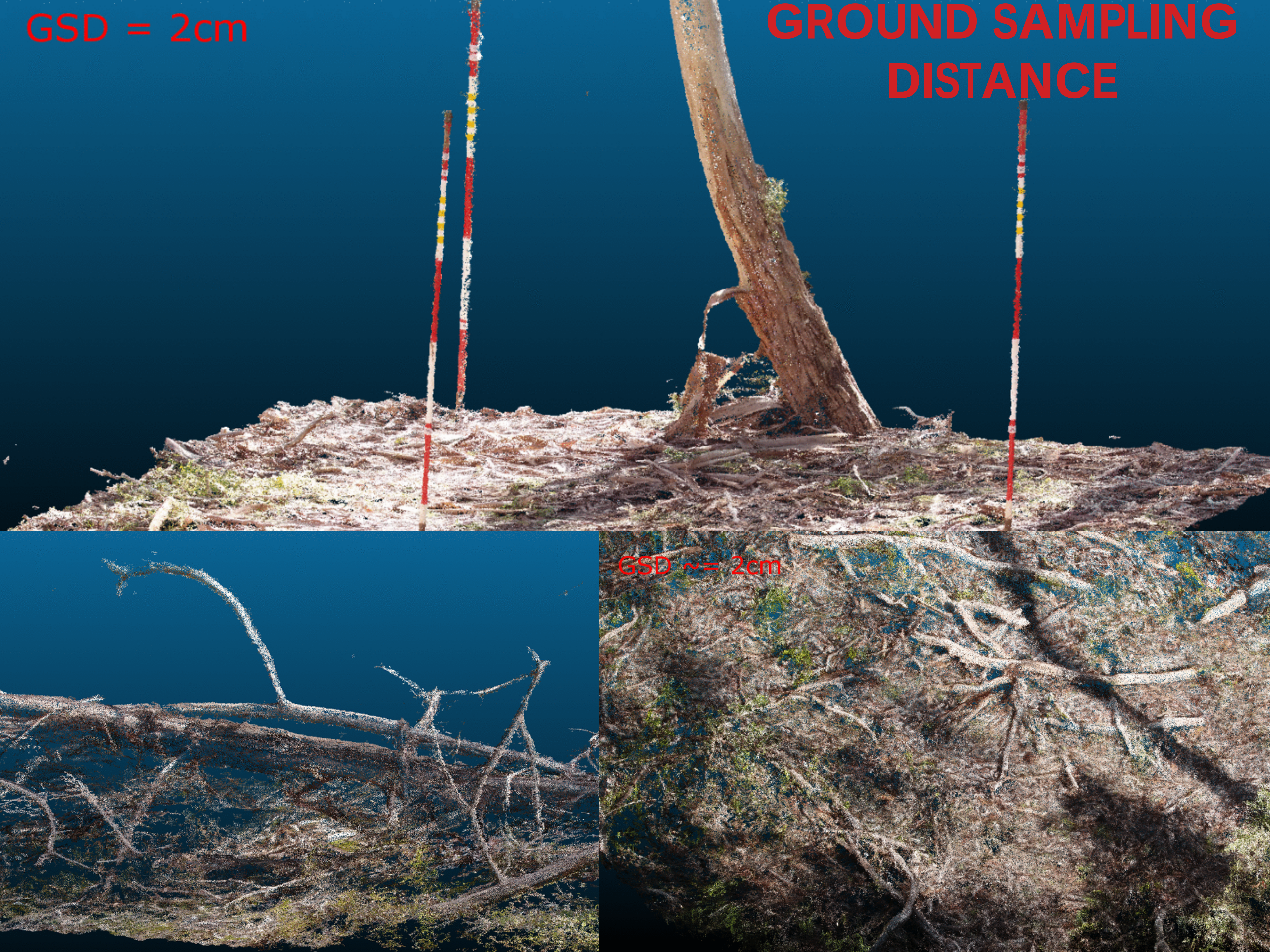
- Outcomes from review and testing of technologies
- Development of App on Androids, workflow for data transfer between the field ←→office
- Determine sampling and imaging protocol for different priority landscapes and scales
- Use of Agisoft and custom programming to derive estimates and maps of fuel hazards
- Field validation, accuracy assessments and ground-truthing

Findings + Outputs

- Fuels 3D trial version testing by DEWLP
- Abstract Submitted to 5th International Fire Behavior and Fuels Conference (Melbourne, April 11-15) entitled *Leveraging smart phone technology for assessing fuel hazard in fire prone landscapes*.

The Year Ahead

- Workshop on sampling protocol and image acquisition using Fuels3D mobile App on Dec 3rd 2015
- Large scale validation and testing of Fuels3D App with end-users DEWNR, DEWLP & CFA
- Manual and protocol developed for using Fuels 3D mobile app (grasslands and one other priority landscape)


GSD = 2cm
GROUND SAMPLING DISTANCE
GSD ~= 2cm

RESULTS

MAPPING CHANGES IN FUEL PRE/POST FIRE

Objectives

- To collect multi-temporal data surrounding a burn event to develop a method that:
  - estimates change in fuel hazards for different time epochs
  - maps horizontal connectivity of fuel hazards
  - is accurate rapid, repeatable and easy to implement

Approach

- Monitoring of sites pre-burn, immediately after a burn and >1 years after the burn
- Compare different metrics and technologies for suitability for estimating and mapping change
- Field validation, accuracy assessment and ground-truthing

Findings + Outputs

- Gupta, V., Reinke, K.J., Jones, S.D., Wallace, L. and Holden, L. (2015) *Assessing Metrics for Estimating Fire Induced Change in the Forest Understorey Structure Using Terrestrial Laser Scanning* in Remote Sensing, vol. 7, pp. 8180 – 8201.
- Jones, S., Reinke, K., Wallace, L., Oliveira, S., Soto-Berelov, M., Gupta, V., Held, A. and Grant, I. (2015) *Understanding wildfire spatial and temporal patterns in Australia and associated hazard mapping,* Presented at the 10th EARSeL Forest Fire Special Interest Group Workshop, Limassol, Cyprus. Paper to be submitted to special issue of Remote Sensing.

The Year Ahead

- Repeat experiment using Fuels 3D
- Collaboration request by Professor David Roy co-chair USGS Landsat science program for field validation using Fuels3D during the prescribed burn Autumn 2016 season, and co-authored publication

RESULTS

- TLS data captured at three stages:
  - Pre-fire – < 2 weeks prior to burn
  - Post-fire – 2 Weeks following burn
  - Recovery – 2 Years following burn

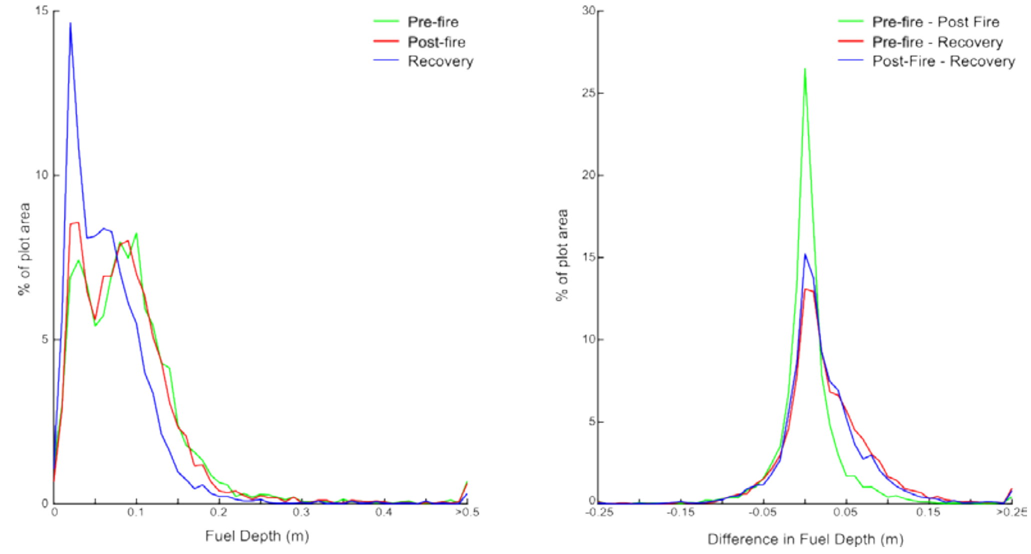
- Metrics calculated – fuel depth and connectivity

- The distribution of fuel height hasn't greatly changed at all three measurement points in the control plot.

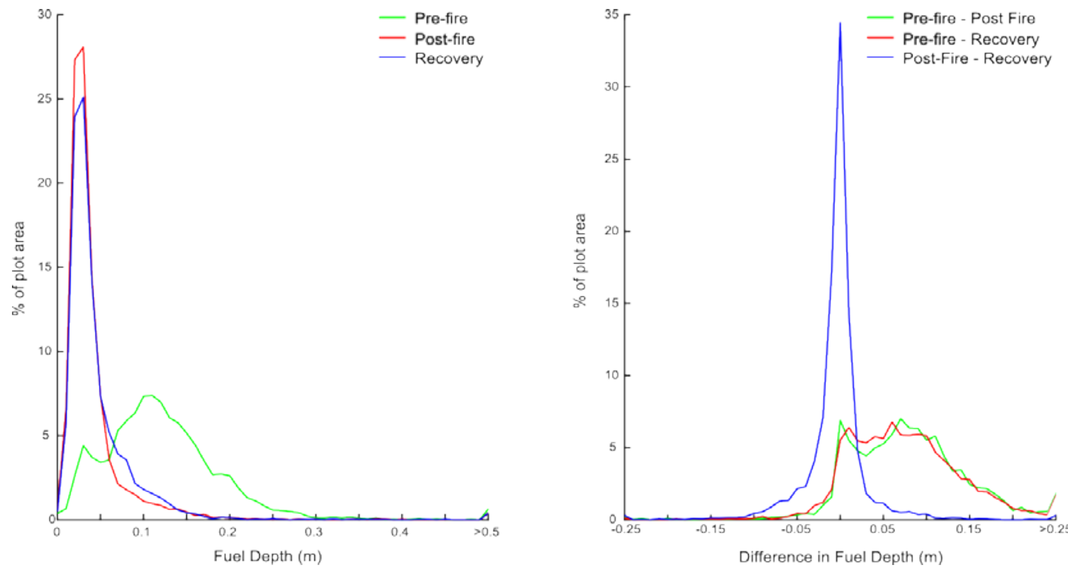
- Dramatic change is evident due to fire event in fire altered plot

- No significant differences can be observed between the 2 post fire datasets

Control (no fire)

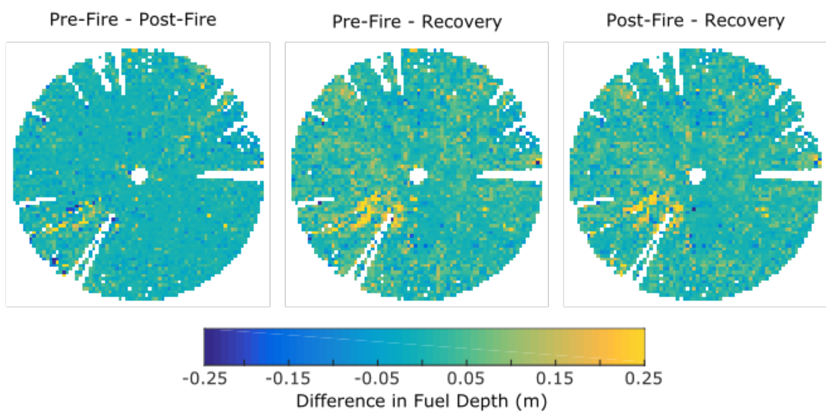


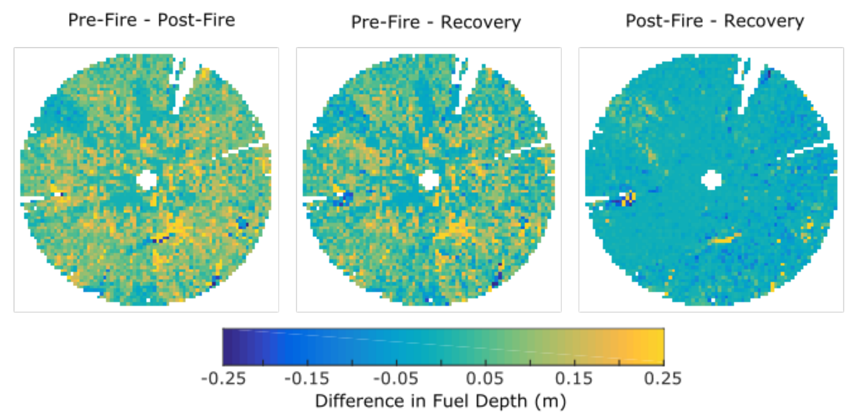
Fire treatment



RESULTS

Multi-temporal fire altered landscape monitoring – Fuel Accumulation



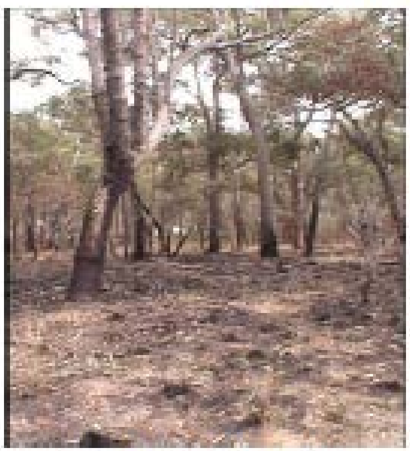


Control

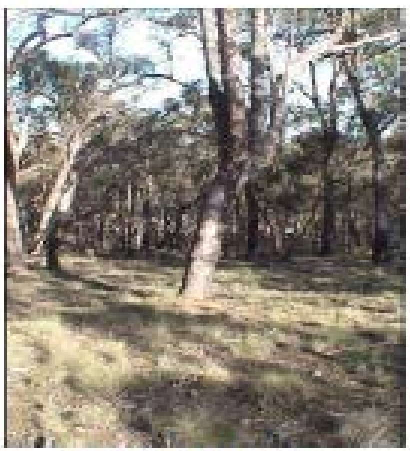
Post-burn 2 weeks

Post-burn 2 years

Fire-altered Plot 3



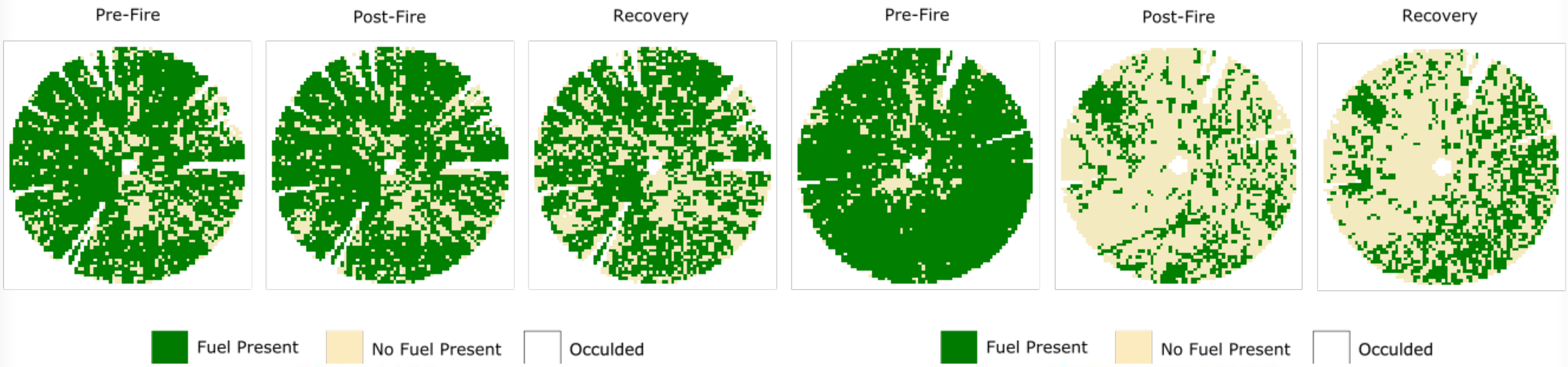
Post-burn 2 weeks



Post-burn 2 years

RESULTS

Multi-temporal fire altered landscape monitoring – Horizontal Connectivity

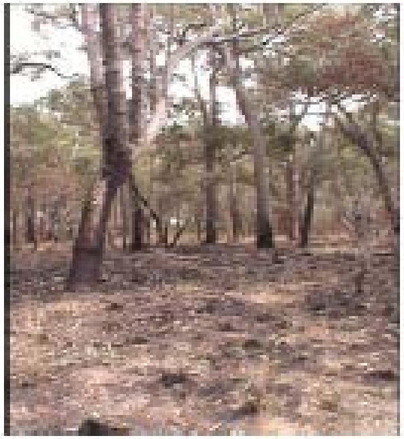


Control

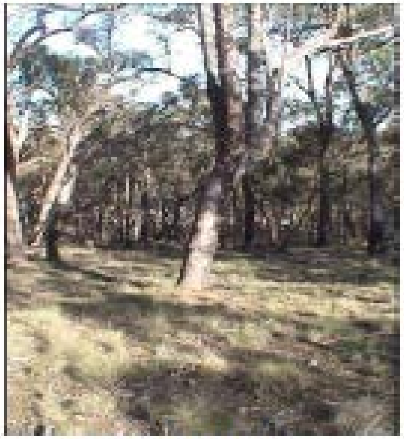
Post-burn 2 weeks

Post-burn 2 years

Fire-altered Plot 3



Post-burn 2 weeks



Post-burn 2 years

END-USER ACKNOWLEDGEMENTS FOR 2015

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Danni Martin, Country Fire Authority, Victoria

Andrew Sturgess, Queensland Fire and Emergency Services

Adam Damen, Department of Environment, Land, Water and Planning, Victoria
Naomi Withers, Department of Environment, Land, Water and Planning, Victoria
Anthony Griffiths, Department of Environment, Land, Water and Planning, Victoria

Rowena Richardson, Office of the Inspector-General Emergency Management, Queensland

Andrew Grace, Attorney-General's Department

David Hudson, Geoscience Australia

END-USER REPRESENTATIVE

Simeon Telfer – DEWNR(South Australia)

QUESTIONS

Thank you