bushfire&natural HAZARDSCRC

FIRE SPREAD ACROSS FUEL TYPES

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Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

OUTLINE

- PROGRESS REPORT
- UTILISATION
- FUTURE RESEARCH DIRECTIONS
- BENEFITS OF OUR RESEARCH

PEOPLE INVOLVED

Core members:

- Khalid Moinuddin
- Duncan Sutherland
- Nazmul Khan
- Mahmood Rashid
- Andrew Ooi
- Jimmy Philip

Collaborators:

- James Hilton (DATA61)
- Jason Sharples (UNSW Canberra)
- Gilbert Acarry (Lebanese University)
- Dominque Morvan (Aix Marseille)
- Sofiane Meradji (University of Toulon)

PROGRESS REPORT

Recent research and achievements

- Physics-based simulation of heat load on structures for improving construction standards for bushfire prone areas – published on Frontiers journal (Khan, Duncan, Moinuddin; 2019)

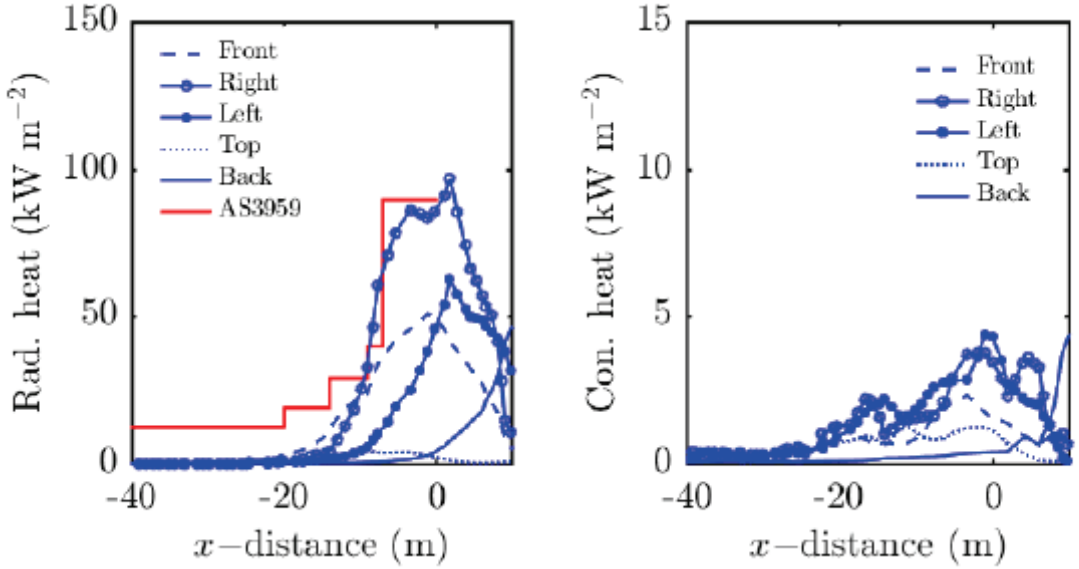


Figure: Assessment of AS3959 BAL quantification by physics based simulation.

PROGRESS REPORT

Recent research and achievements

- The effect of ignition protocol on grassfire development – published on wildland fire (Sutherland, Sharples and Moinuddin, 2019)

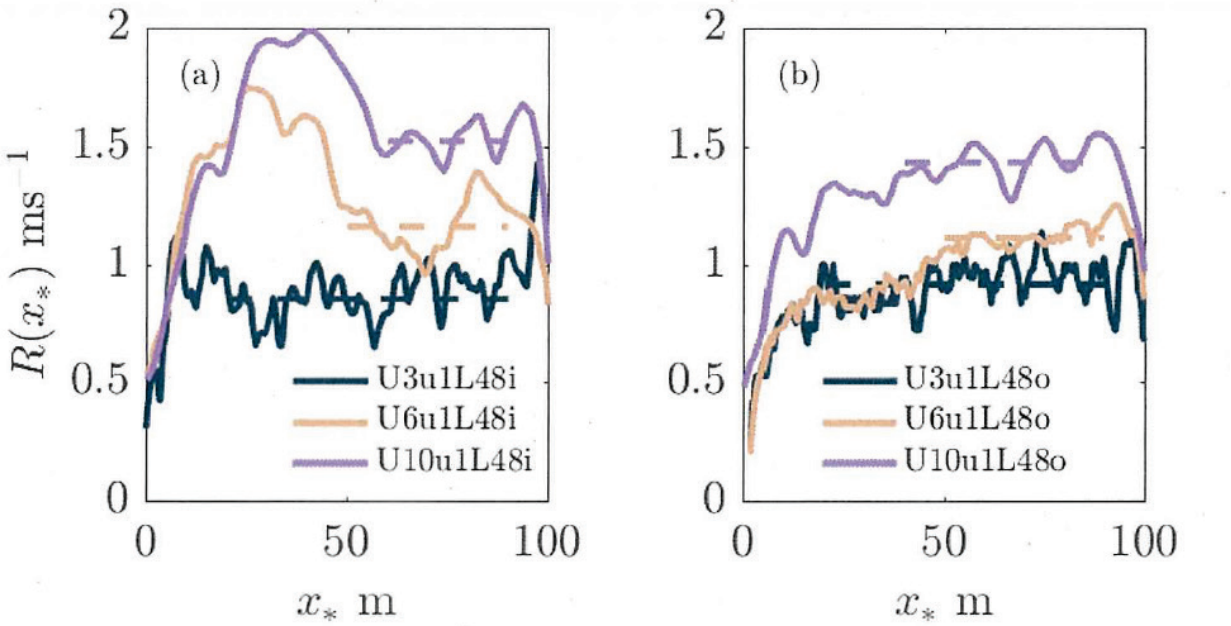


Figure: The ROS at inward ignition (a) and outward ignition (b)

PROGRESS REPORT

Recent research and achievements

- **Physics-based simulations of grassfire propagation on sloped terrain –submitted in IAFSS, Canada (Innocent, Duncan, Nazmul and Moinuddin, 2019)**

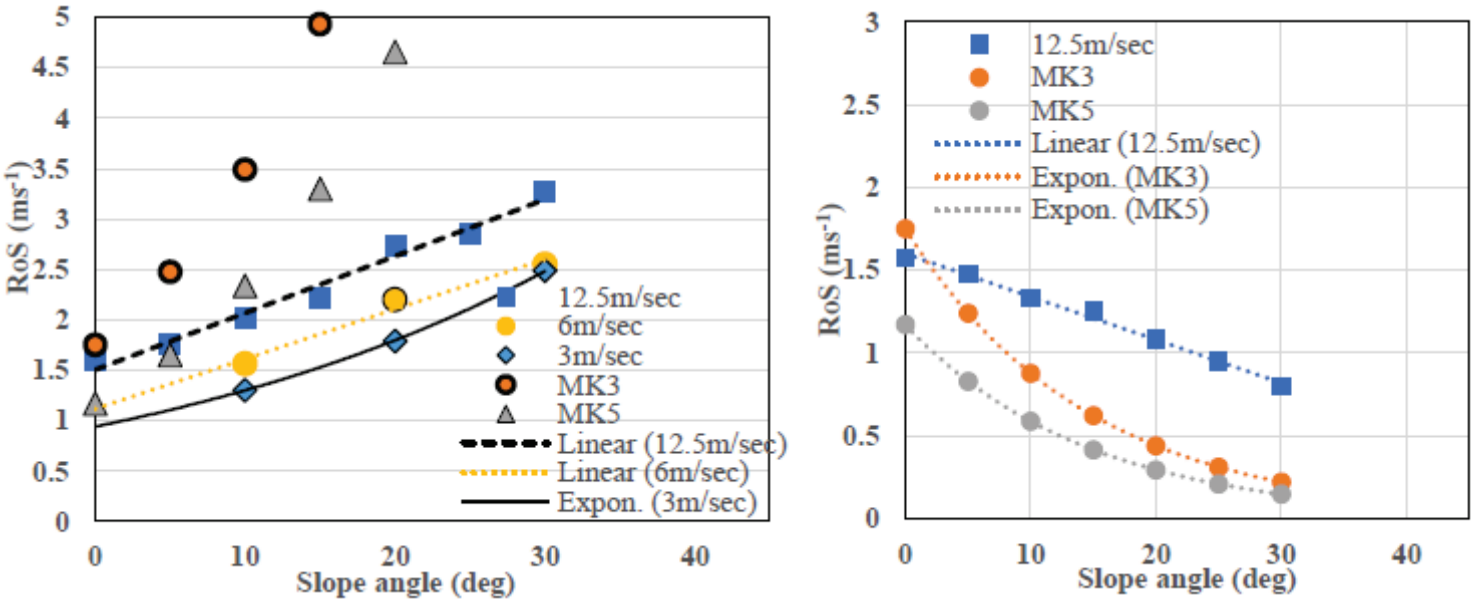


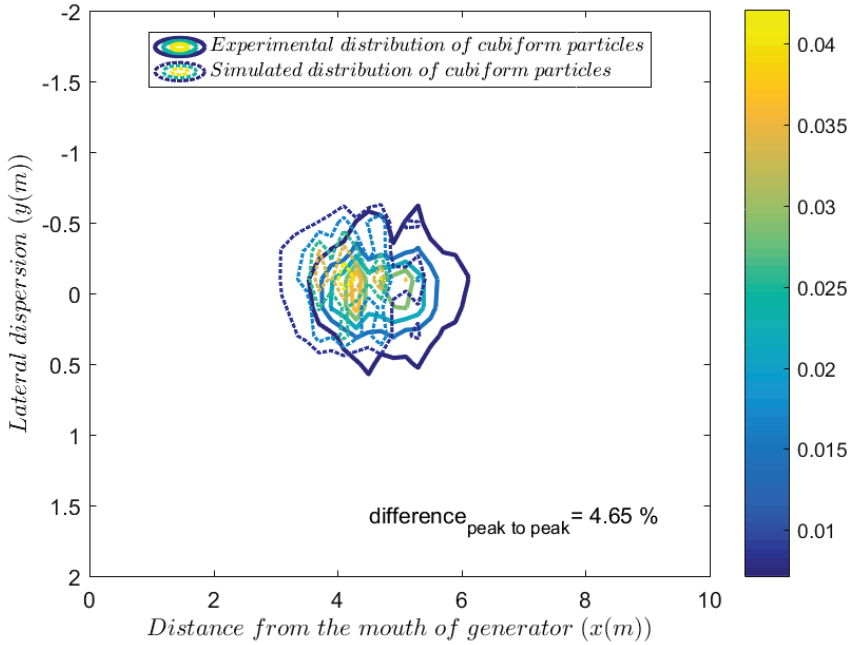
Figure: The effect of coupled wind-slope on ROS, left(upslope) and right downslope cases.

Uphill, $RoS_{corr} = RoS\, e^{(0.069\gamma_s)}$

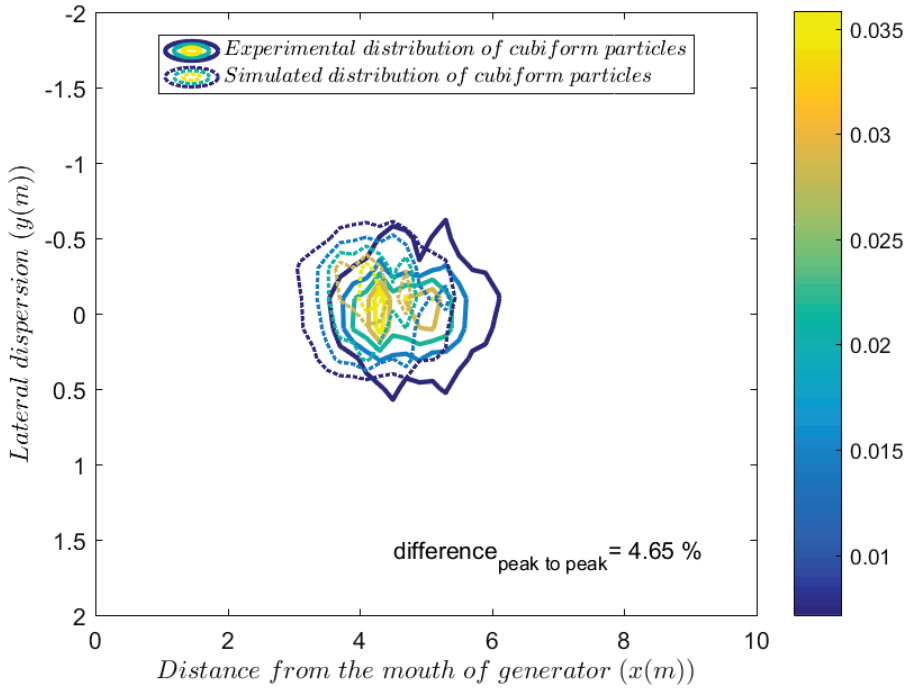
Downhill, $RoS_{corr} = RoS\, e^{(-0.069\,\gamma_s)}$

PROGRESS REPORT

- **BURNING FIREBRAND DISTRIBUTION MODELLING (Rahul Wadhwani, PhD student –thesis is passed with minor amendment)**



With default drag Model

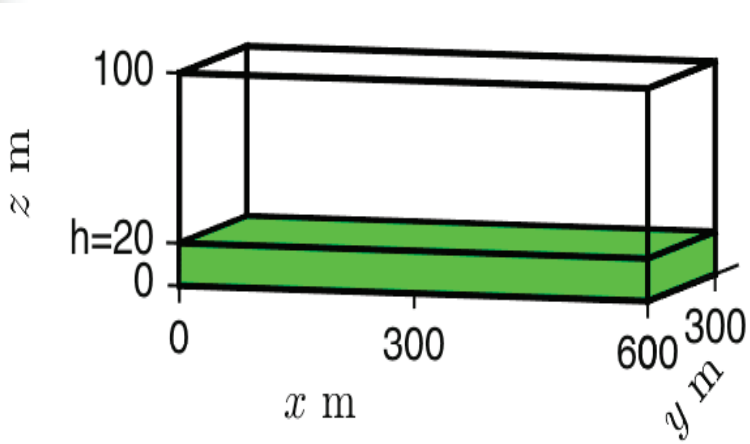


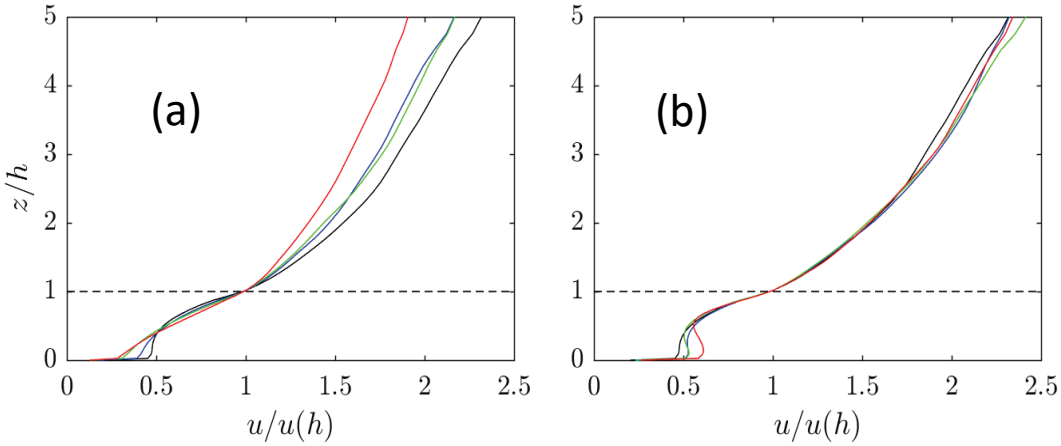
With Haider model

Cuboid particles - Reynolds No ~10^5

PROGRESS REPORT

WIND FLOW THROUGH VERTICALLY HETEROGENEOUS CANOPIES (DUNCAN, MOINUDDIN)





$$a(z) = A\exp(-(z-\mu)^2/\sigma^2) + B$$

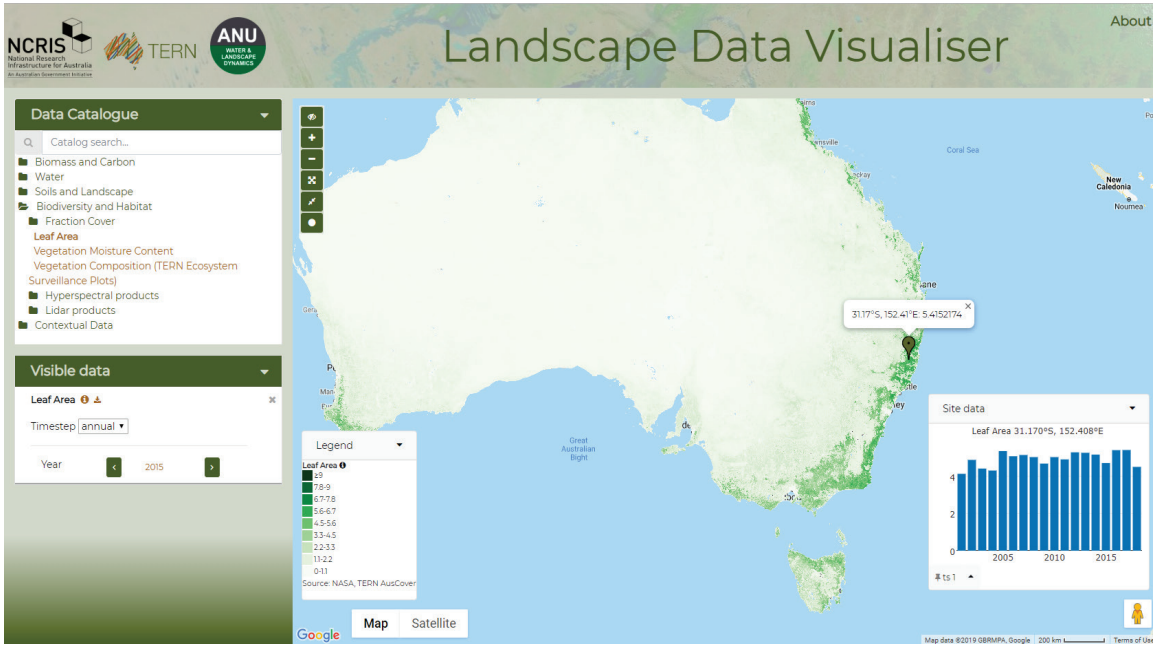
$$LAI = \int_0^h a(z)dz$$

Mean u-velocity profiles normalised by the canopy top value. In (a) σ^2=0.325 is held constant and μ= 0.00 (red), 0.233 (green), 0.467 (blue), and 0.700 (black). In (b) μ=0.70 is constant and σ^2=0.325 (black – the same curve as in (a)), 0.233 (blue), 0.142 (green), and 0.050 (red).

UTILISATION

WRF MODEL DEVELOPMENT IN SPARK (Rashid, Hilton, Sutherland, Khan, Moinuddin)

- Create a raster map of WRF using the Leaf Area data obtained from Landscape Data Visualiser.

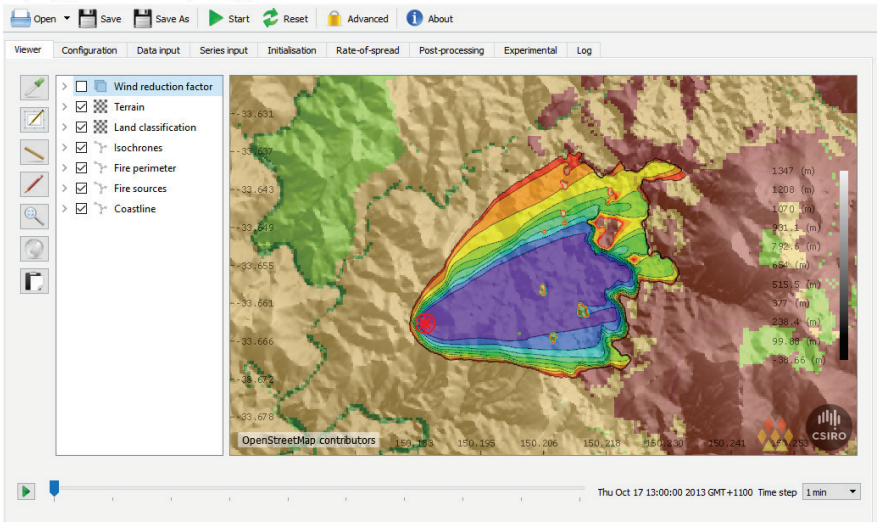


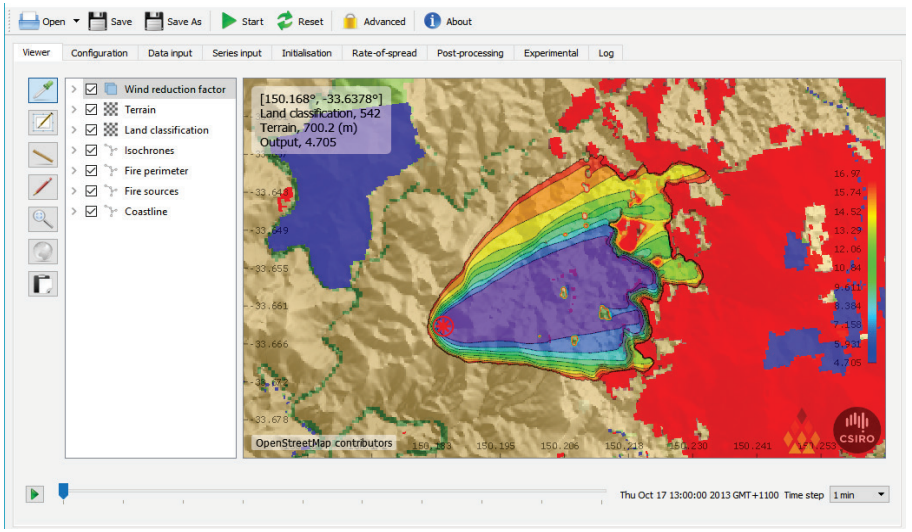
https://maps.tern.org.au/#/

- We acknowledge Dr Marta Yebra and Professor Albert Van Dijk for providing LAI data for our WRF model.

UTILISATION

- WRF as a layer in spark
- Simulation Time: Few Seconds ? YES !!





Harman and Finnnigan Model: Not a physics based model

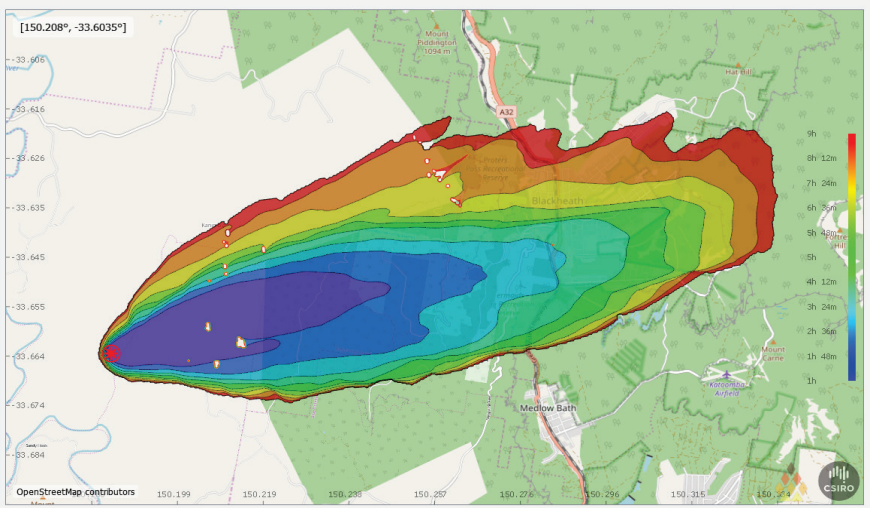
The three layers in the model are:

$$wrf = \frac{u_o(z)}{u(z)}$$

- Sub-canopy layer
- Shear layer across the top of the canopy and immediately above the canopy, and
- Above the canopy layer

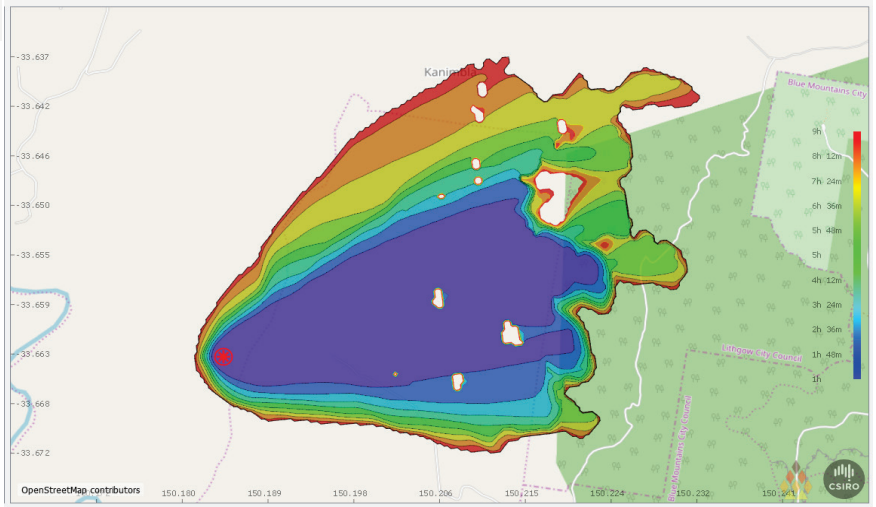
UTILISATION

PRELIMINARY RESULT OF USING WRF IN SPARK



Without WRF

With WRF



UTILISATION

FUTURE DIRECTIONS FOR WRF MODEL

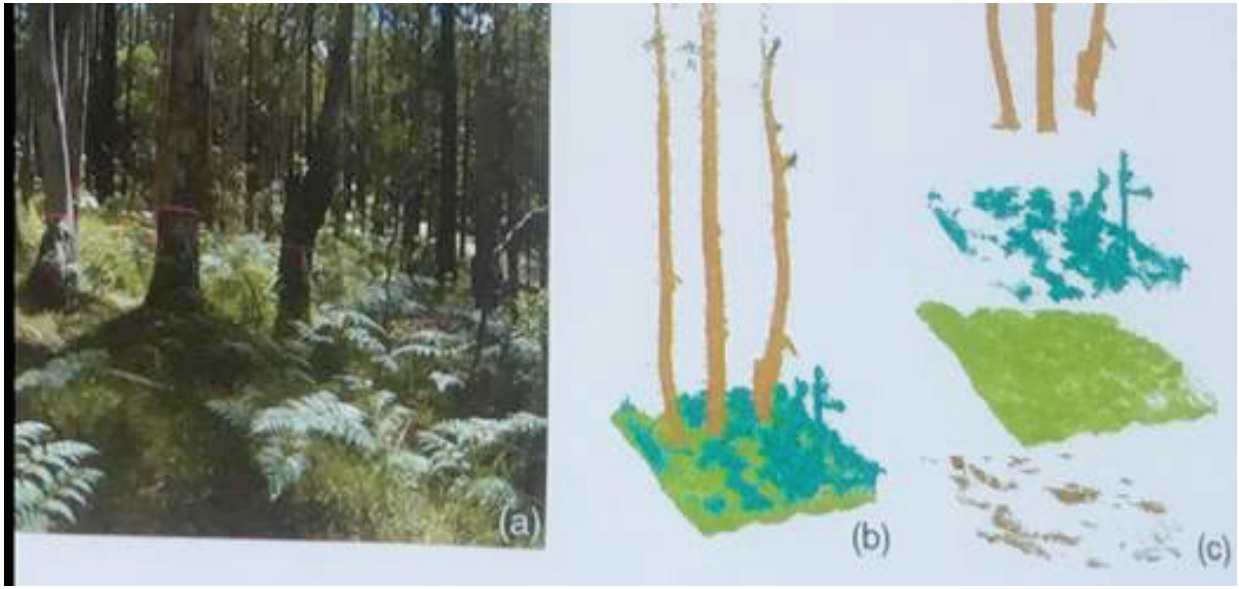


FIGURE: RECONSTRUCTION OF FUEL STRUCTURE AND QUANTIFICATION USING LIDAR (COURTESY: DR MARTHA YEBRA, AUSTRALIAN NATIONAL UNIVERSITY).

(A) ACTUAL FOREST, (B) COMBINED RECONSTRUCTION AND (C) SEPARATION OF EACH KIND OF FUEL STRATA. LAD CAN BE DERIVED FROM (B).

FUTURE RESEARCH DIRECTIONS

- **Forest canopy modelling**
  - Development of WRF model in Spark
  - Atmospheric stability analysis in a forest canopy flow
  - The effect of recirculation zones in a canopy covered hill.
- **Rate of spread (ROS) on grassfire**
  - Coupled slope and wind effect on ROS
  - The flow through non-uniform terrains and ROS
  - The effect of weather and fuel conditions in grass fire ROS.
- **Firebrands modelling**
  - Heat flux received by structure during a fire event (grass fire and forest fire) for assessment of AS3959
  - Firebrands mapping and quantification for identification of fire hazard (in the context of AS3959).

BENEFITS OF OUR RESEARCH

- Physics based fire dynamic simulation implements real mechanisms of wind flow, chemical reactions and characteristics of fire.

- Better understanding about:
  - ROS,
  - dynamic behaviour of fire on different terrain,
  - characteristics of different mode of fire spread and
  - quantification of fire hazard (AS3959).

- Benefits of WRF model in Spark:
  - Calculate dynamic WRF based on vegetation's LAI/ LAD value.
  - ROS prediction will be more accurate
  - Help operational people to track fire spread accurately.
  - Better management and resource allocation for fire management and control.

THANKS FOR YOUR ATTENTION !