bushfire&natural HAZARDSCRC

MAPPING BUSHFIRE HAZARD AND IMPACT

Developing spatial information on fire hazard for planners, land managers and emergency services

Marta Yebra, Albert Van Dijk and Geoff Cary

Fenner School of Environment and Society, ANU College of Medicine, Biology and Environment, ACT.

An Australian Government Initiative

CRC AUSTRALIA

Australian National University

PROJECT END-USERS

Australian National University

In the room today?

- **John Bally**, Bureau of Meteorology (Lead-end-user)
- Jeff Kingwell, Geoscience Australia, ACT.
- Adam Leavesley and Neil Cooper, ACT Parks and Conservation.
- **Belinda Kenny**, Office of Environment & Heritage, NSW.
- **Robert Preston**, Public Safety Business Agency (QLD).
- **Andrew Sturgess and Bruno Greimel**, QLD Fire and Emergency
- Mike Wouters and **Simeon Telfer**, Department of Environment, Water and Natural Resources. SA
- Laurance McCoy and **Stuart Matthews** . NSW Rural Fire Service
- Andrew Grace, Attorney-General's Dept, ACT
- Richard Wald, SA Country Fire Service
- David Taylor, Tasmania Parks and Wildlife Service.

PROJECT EXTERNAL COLLABORATORS

Australian National University

- Emilio Chuvieco (University of Alcala, Spain)
- Alex Held, Arancha Cabello and Michael Schaefer (CSIRO / TERN-AUSCOVER)
- Jim Gould and Tom Jovanovic (CSIRO)
- Philip Zylstra (UOW)
- Samsung Lim (UNSW)
- Darius Culvenor (Sensing Systems)

PROJECT STUDENTS

Australian National University

PhD students on "Mapping forest fuel load and structure from LiDAR".

- Narshima Garlapati (ANU-APA)
- **Yang Chen** (University of Monash - BNHCRC top-up scholarship under application)

Academic study visitors (February-April)

- Susanne Marselis (Graduated Msc Earth Sciences, University of Amsterdam)- LiDAR and fuel structure.
- Facundo Oddi. Postdoctoral Fellow at the University of Buenos Aires: Academic study visit to the ANU. "Estimating live fuel moisture content from remote sensing"

GOAL

Australian National University

- **Activity 1:** Produce reliable and operationally useful **spatial information on critical aspects of bushfire hazard** (fuel structure, load and flammability);

- **Activity 2:** Determine the **impact of unplanned and prescribed burning** on fuel accumulation as well as landscape values (habitat, water resources and carbon storage) over time, in support of fire management.

PROJECT ROAD MAPS

Australian National University

Activity 1

- 2014: Case study: using LiDAR for fuel structure mapping
- 2015: Trials: spatial satellite monitoring of fuel structure and moisture
- 2016: Development plan: data products chosen for development into operations
- 2017: Algorithm validation and documentation
- 2018: Data processing chain development and testing
- 2019: Transition to agency as pre-operational product
- 2020: Products released in beta

Activity 2

- 2014: Analysis of spatial data and models for fire impact prediction
- 2015: Model-data assimilation method demonstrated
- 2016: Case study documented, roll-out planned
- 2017: Method trialled for two other case studies
- 2018: Prediction software coded and tested
- 2019: Prediction method and software documented
- 2020: Prediction software released in beta

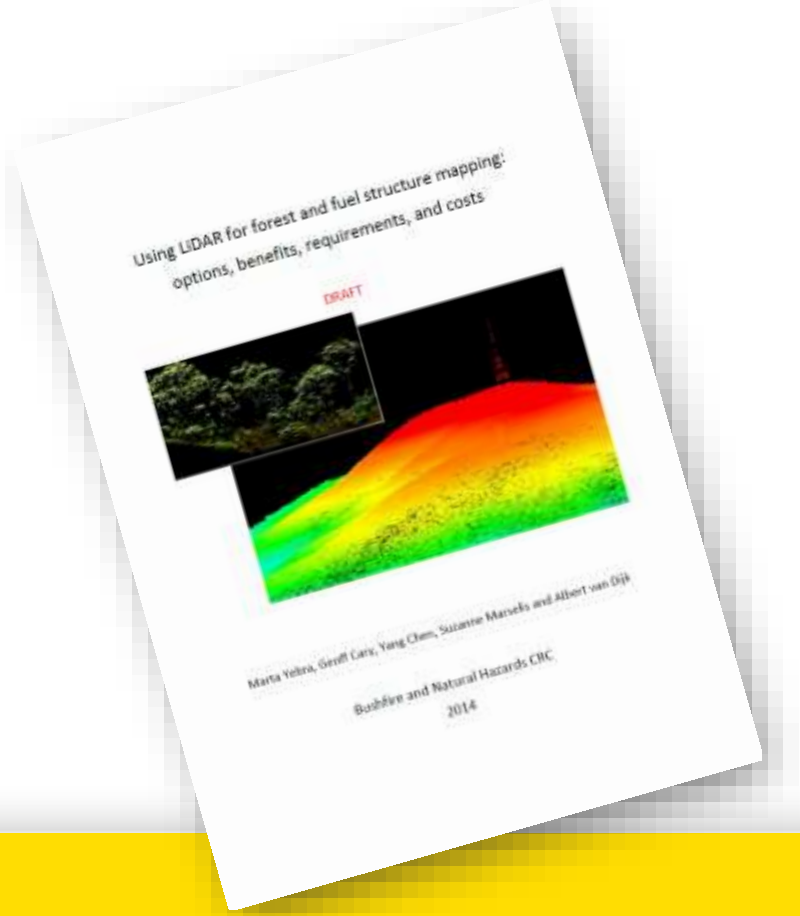
PROGRESS ON MILESTONES

Australian National University

- Activity 1. Fire hazard mapping and monitoring
  - Analysis of the information content and accuracy of **airborne LiDAR** and opportunities to reduce the costs of data processing and information extraction (10/2014)
  - Analysis of the suitability of operational coarse resolution near-surface soil moisture data to improve the **MacArthur FFD index** (6/2015)
- Activity 2. Fire impacts on landscape values
  - Case study for ACT forests analysing usefulness and reliability of LiDAR, Landsat and SRTM derived information for **spatial estimation of fire impacts** on landscape values (2/2015)

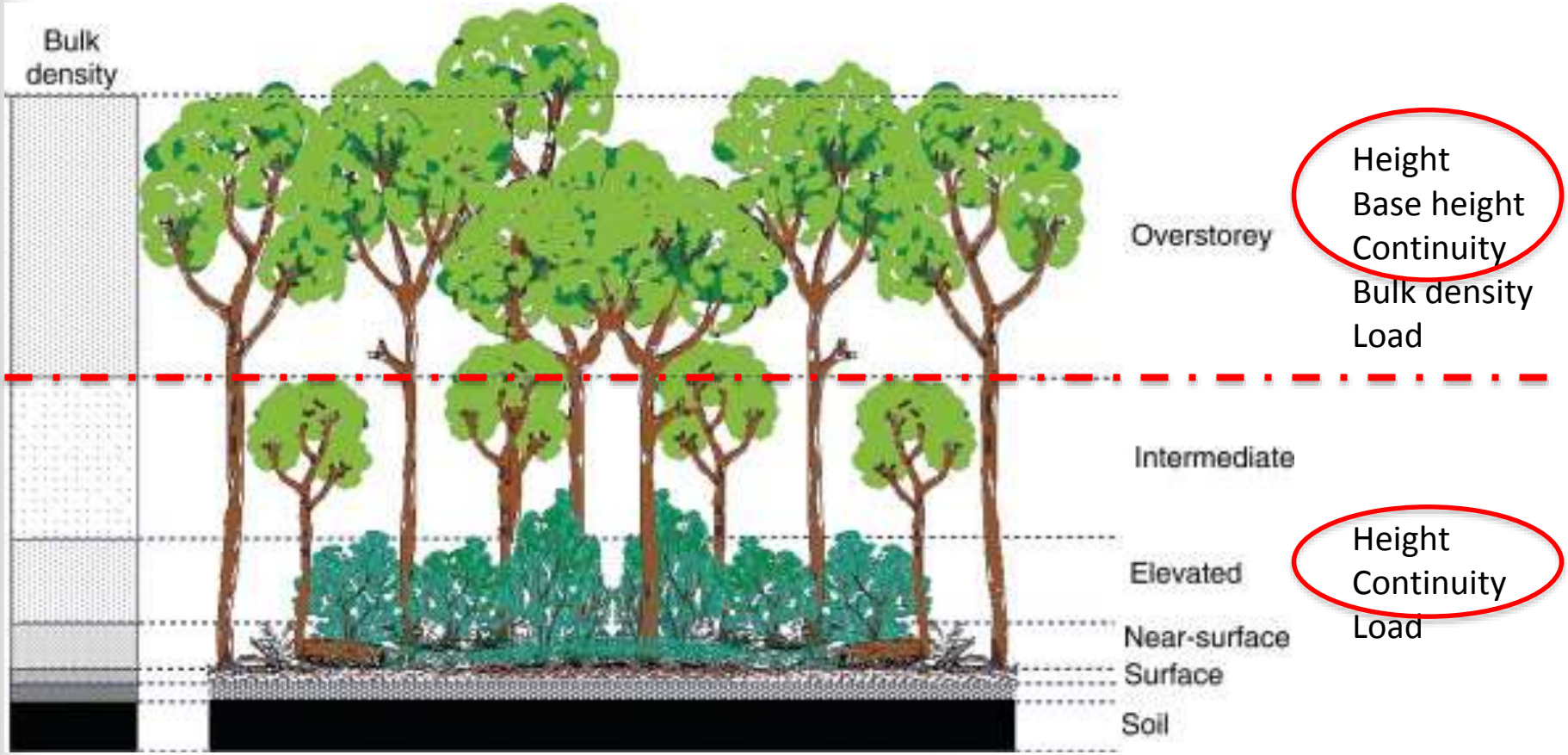
Activity 1. Fire hazard mapping and monitoring

- Analysis of the information content and accuracy of **airborne LiDAR** and opportunities to reduce the costs of data processing and information extraction (10/2014)



WHAT CAN AIRBORNE LIDAR TELL US ABOUT THE FOREST FUEL ATTRIBUTES

Australian National University



Height
Base height
Continuity
Bulk density
Load

Height
Continuity
Load

BARK
Type of bark

Figure from Gould et al 2011

FUEL MAPS DERIVED FROM AIRBORNE LIDAR

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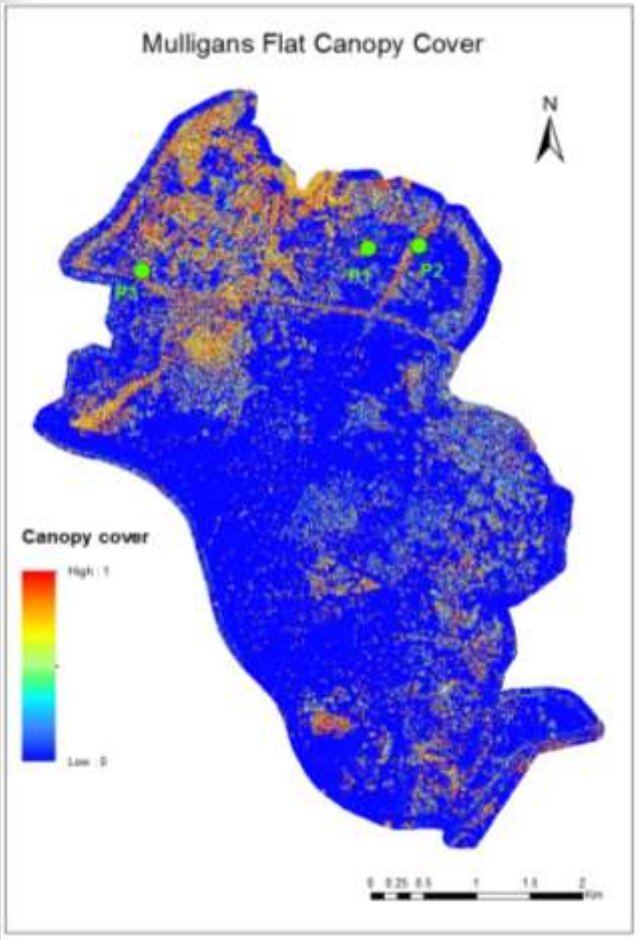

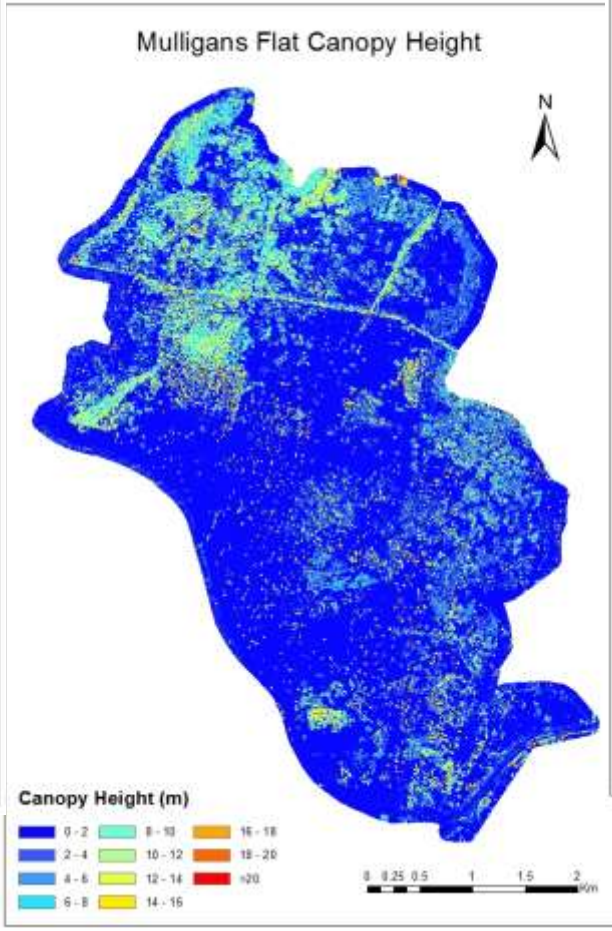

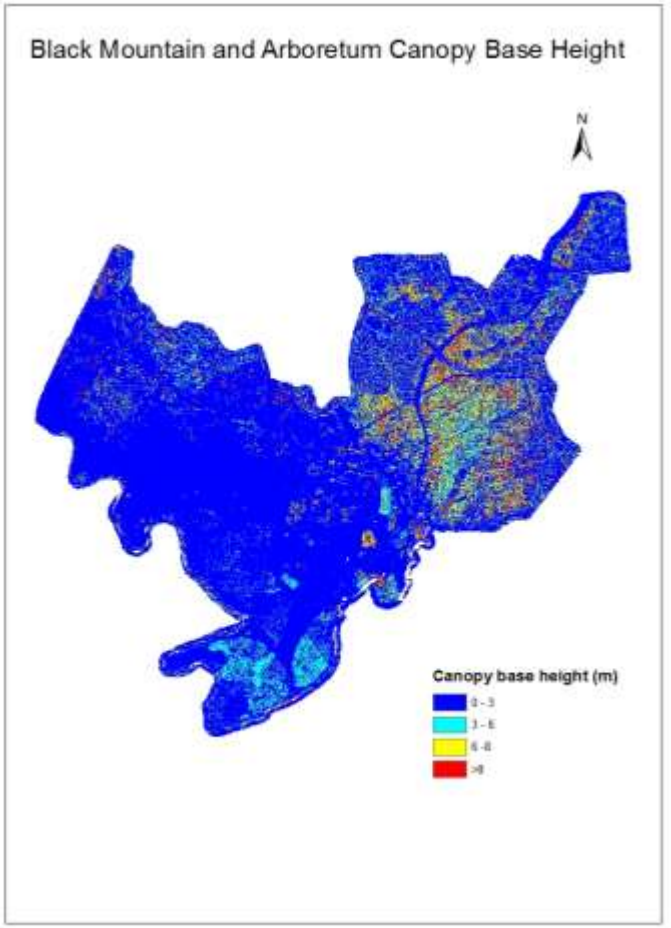

AIRBORNE LIDAR DATA COLLECTION

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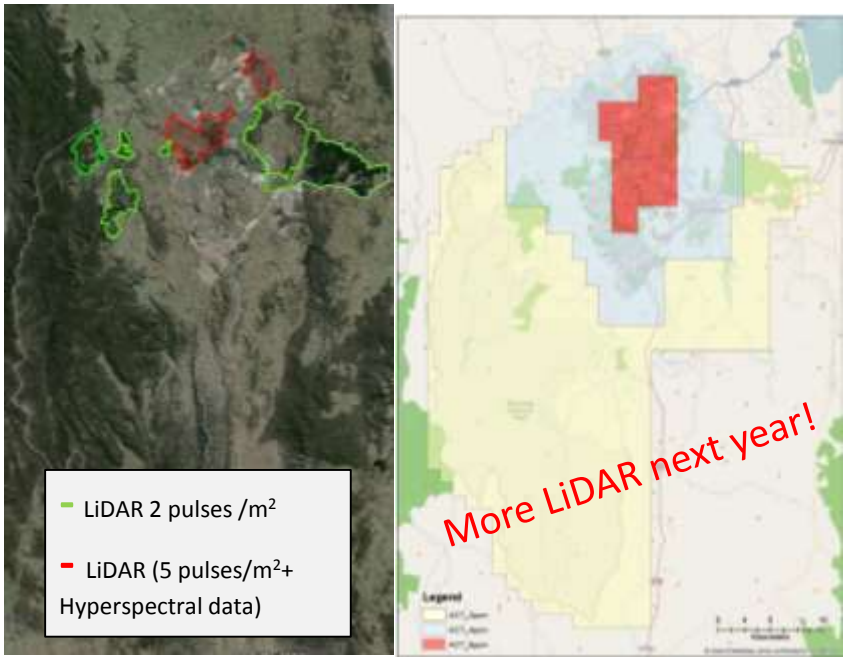
Airborne LiDAR was successfully collected across several parts of the ACT.



Funding from **ACT Parks and Conservation**, The Terrestrial Ecosystem Research Network (**TERN**), the **CSIRO** Earth Observation Informatics Transformational Capability Platform, and a CSIRO Payne-Scott Award

Ground Truthing: Fuel structure was measured at 40 plots.

In collaboration with Philip Zylstra and colleagues (**University of Wollongong**) and volunteer students from the ANU

CSIRO TERN

GROUND BASED LIDAR

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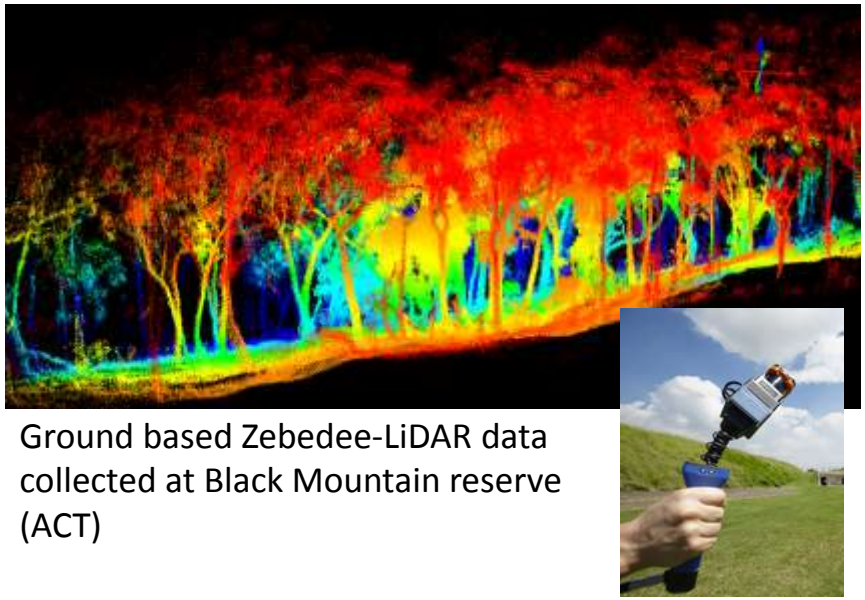
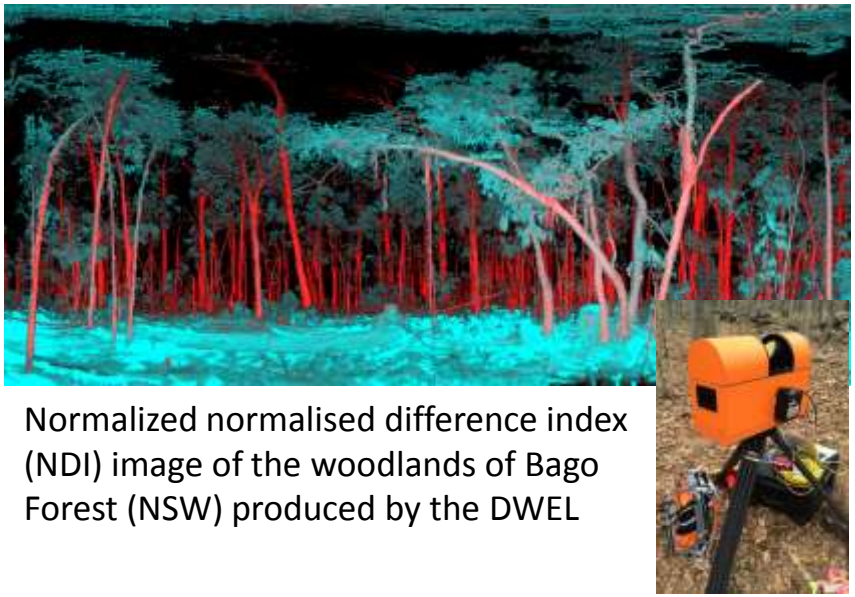
Provides **high resolution, reliable understory information** useful to validate and/or complement airborne data

- **Zebedee** (CSIRO)



Ground based Zebedee-LiDAR data collected at Black Mountain reserve (ACT)

- **DWEL** (CSIRO-Boston uni)



Normalized normalised difference index (NDI) image of the woodlands of Bago Forest (NSW) produced by the DWEL

(Yebra et al, 2014, http://www.bnhcrc.com.au/resources/poster/1233)

Photos courtesy of Michael Schaefer

AIRBORNE AND GROUND-BASED LIDAR DATASET COMPLEMENT EACH OTHER

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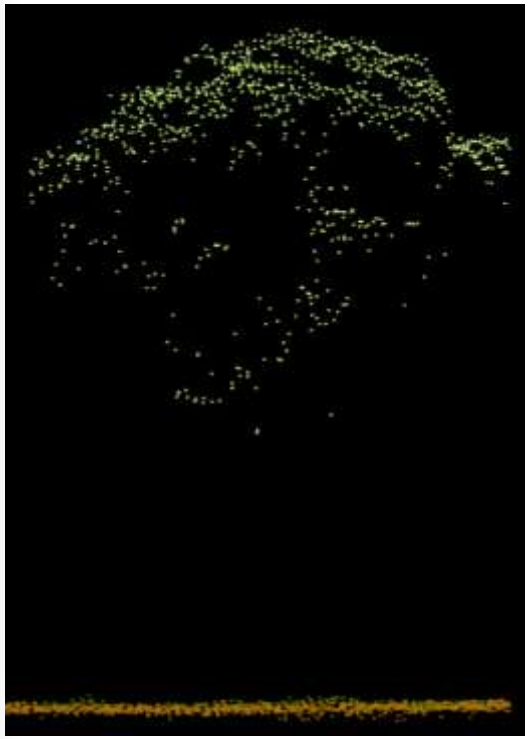
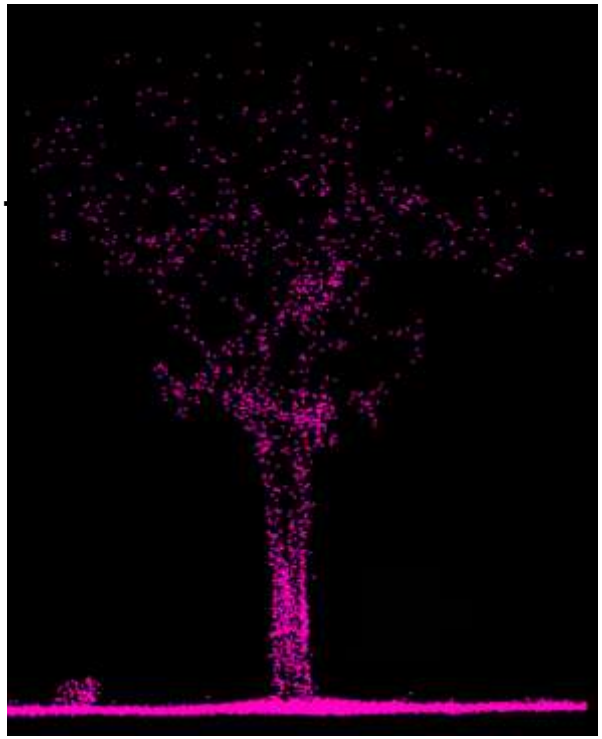
a) Airborne



b) Zebedee

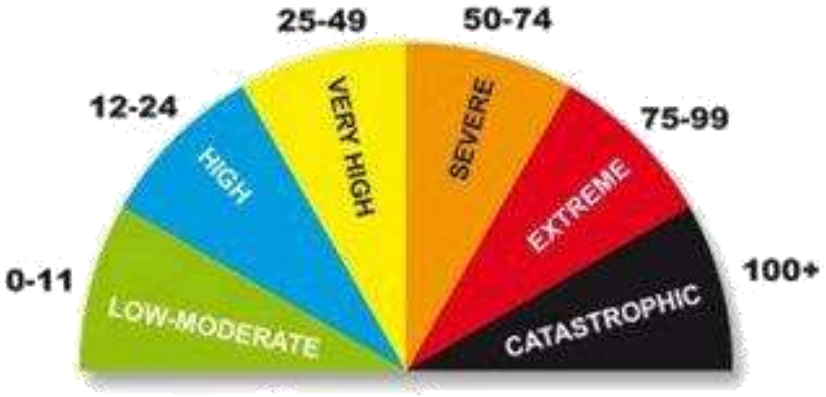


c) Airborne+Zebedee

(*Yebra et al*, 2014, http://www.bnhcrc.com.au/resources/poster/1233)

Activity 1. Fire hazard mapping and monitoring

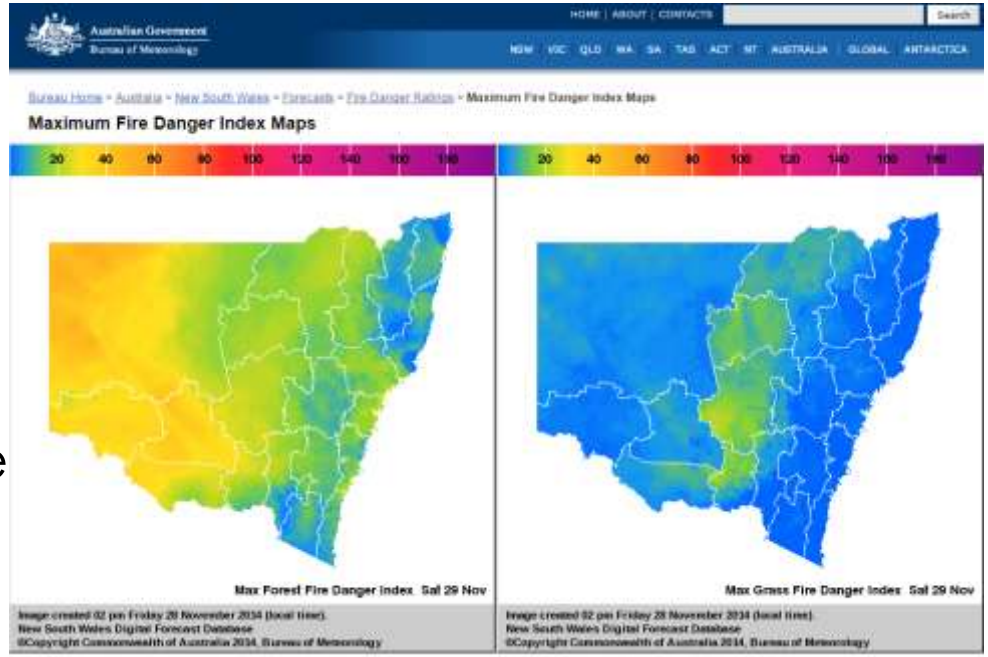
- Analysis of the suitability of operational coarse resolution near-surface soil moisture data to improve the **MacArthur FFD index** (6/2015)



IMPROVING FIRE DANGER INFORMATION

Sources of uncertainty:

1. Drought Factor estimates
2. Local variations in elevation, slope, and aspect
3. Fuel load and moisture content



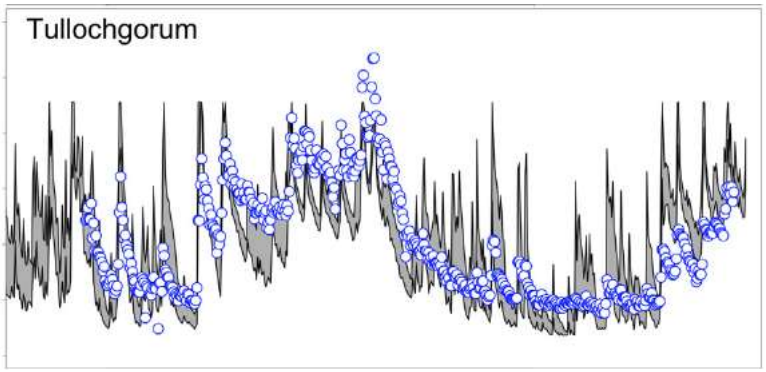
IMPROVING FIRE DANGER INFORMATION

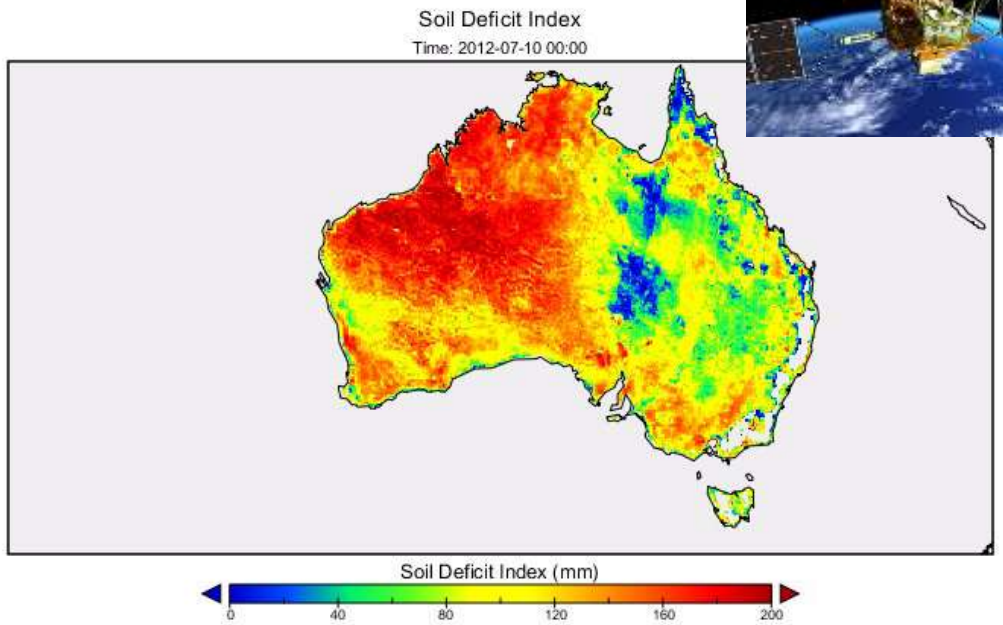
1. Drought Factor estimates

- BoM has better surface moisture model at its disposal (AWRA)
- Can be combined with remotely sensed surface moisture

Challenge:

To fit in with current FFDI uses: how does soil moisture relate to DF?





IMPROVING FIRE DANGER INFORMATION

2. Local variations in elevation, slope, and aspect

- Detailed and consistent data are already available
- Can be used to improve DF estimation as well as local wind speed

Example: Prescott Index for Hobart and surrounds

Challenge:

- Predicting local wind speed from forecasts and topography

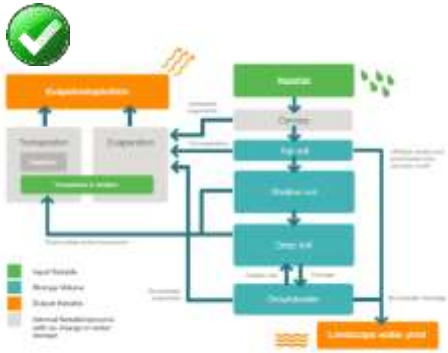
Source: http://www.clw.csiro.au/aclep/soilandlandscapegrid/

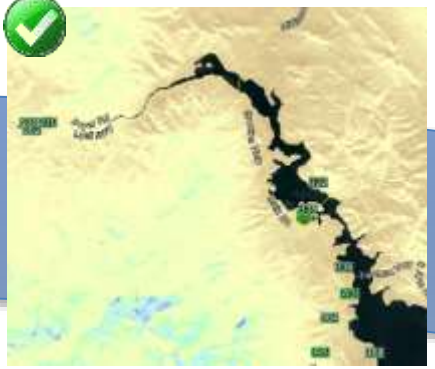
IMPROVING FIRE DANGER INFORMATION

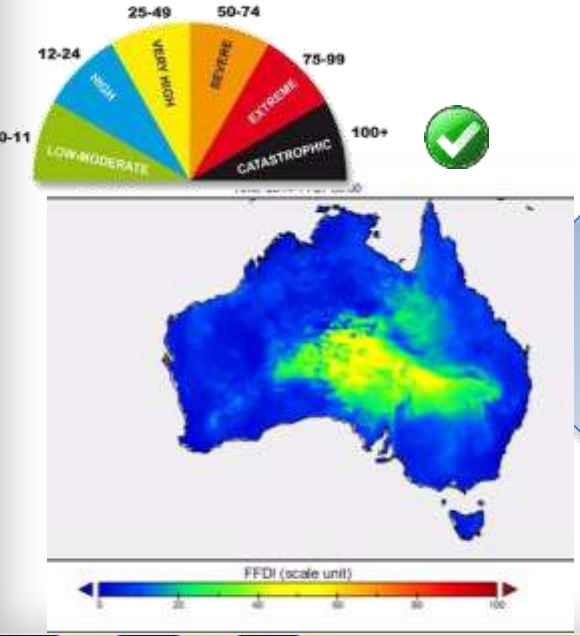
AWRA model

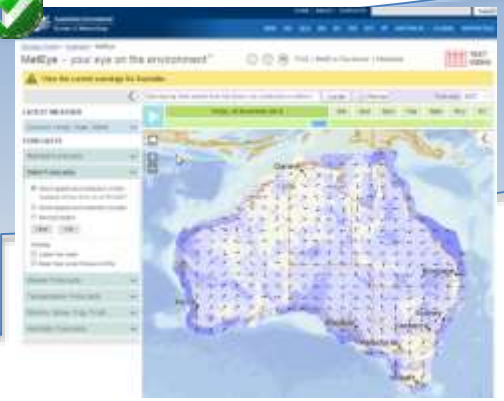
topography

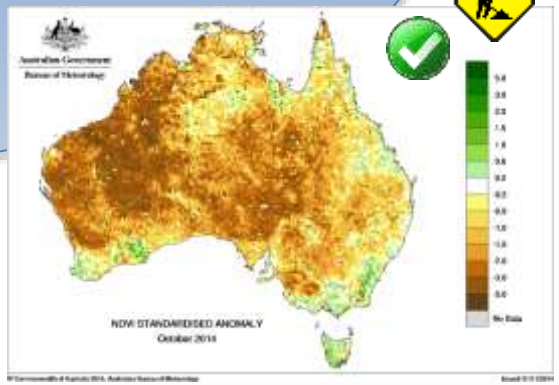
satellite soil moisture











Danger Index

ACCESS forecasts

satellite fuel load & moisture

GROUND OBSERVATIONS OF GRASSLAND CURING AND FMC

Trial with in-situ sensors for monitoring grass curing and FMC

- Detailed and consistent observations
- Useful for models evaluation

Activity 2. Fire impacts on landscape values

- Case study for ACT forests analysing usefulness and reliability of LiDAR, Landsat and SRTM derived information for **spatial estimation of fire impacts** on landscape values (2/2015)

SPATIAL ESTIMATION OF FIRE IMPACTS

Questions:

- What is the impact of planned or unplanned burning on water, carbon, habitat?
- How does it vary in space over 10-100 m scale?
- Can that knowledge help management, e.g. prescribed burning?

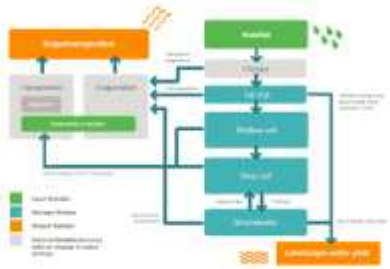
Case studies:

- Bago SF, NSW (Tumbarumba)
- Corin Dam catchment, ACT
- Arboretum-Black Mountain-Mulligans Flat, ACT

SPATIAL ESTIMATION OF FIRE IMPACTS

Model

Spatial forest growth, water use and carbon uptake model based on the BoM AWRA model.



Basic data

- 30m Data Cube Landsat data (vegetation)
- 1km TERN e-Mast climate data
- 30m relief and landscape morphology (TERN, GA)

Data for **validation** and investigation of **added value**:

- airborne LiDAR (forest structure)
- airborne hyperspectral data (canopy density, moisture)
- field measurements (vegetation and fuel attributes)
- TERN OzFlux site data @ Tumbarumba (water and carbon fluxes, vegetation structure)
- CosmOz cosmic ray sensor @ Corin Dam (large area soil moisture, micro-climate)

SPATIAL ESTIMATION OF FIRE IMPACTS

- **The importance of local variation:** relative drying rate in October (south of Coring Dam, ACT)

- This type of information can be generated everywhere.
- **What mapping products would you like to see?**

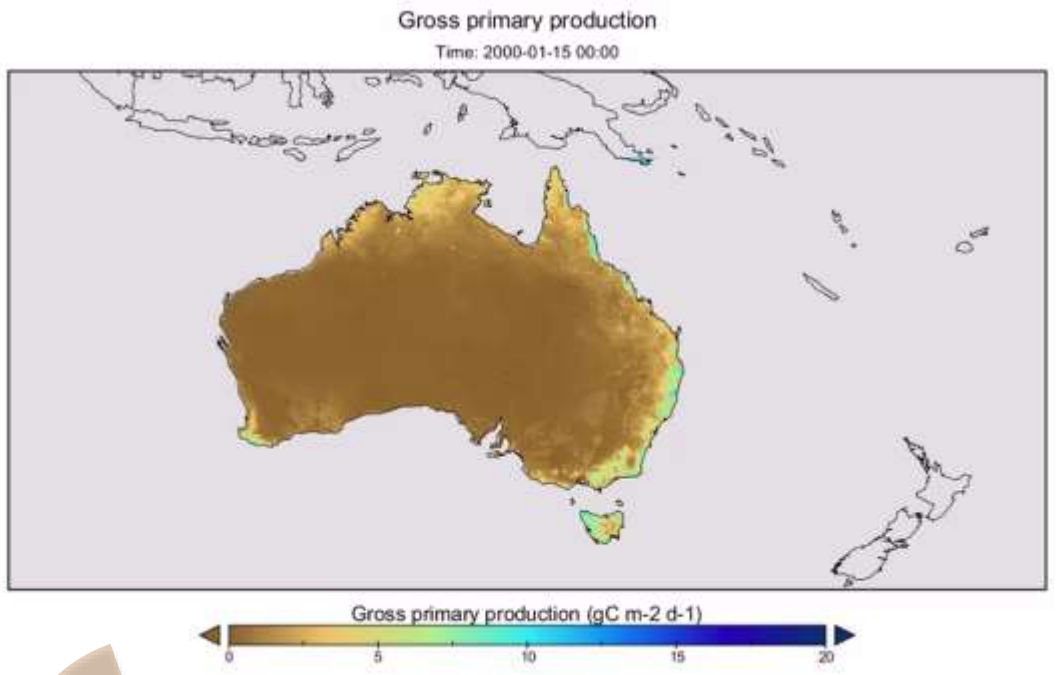
SPATIAL ESTIMATION OF FIRE IMPACTS

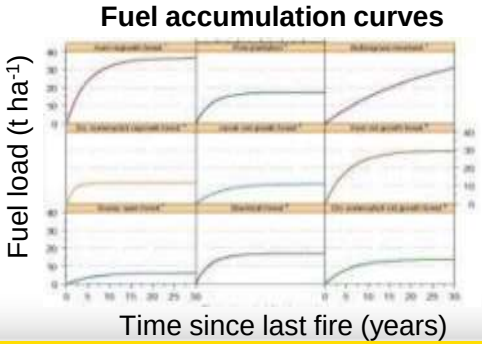
Progress to date

- algorithms to use satellite data for water use (ET) and carbon uptake (GPP) estimation already developed (Yebra et al., 2013 & submitted)
- evaluated for Tumbarumba forest
- Implemented in AWRA
- further validation for additional Australian sites underway

R&D needed

- Implement using Landsat data cube
- Predict fuel accumulation from GPP





END USER STATEMENT

This research is valuable because it is bringing the industry closer to an ***operational broad-scale, spatially explicit fuel data collection system akin to Vesta or OFHA*** *that can be used in existing fire behaviour models. The work will also help us to understand what information is easily and reliably collected from remote systems as a precursor to developing a new fire behaviour model based on the remote data.*

Adam Leavesley, ACT Parks and Conservation Service