bushfire&natural HAZARDSCRC

MAPPING BUSHFIRE HAZARD AND IMPACT

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

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An Australian Government Initiative

CRC AUSTRALIA

Australian National University

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9. Simeon Telfer, Department of Environment, Water and Natural Resources, SA
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12. Frank Crisci and Ali Walsh, SA Power Networks
13. David Hudson and Maggie Tran, Geoscience Australia.

PROJECT EXTERNAL COLLABORATORS

- **Philip Frost (CSIR-South Africa)**
- David Riano (UC-Davis, USA)- Visiting research fellow Sept 2016 (funds from the ANUCES and UC-Davis professional development award.
- Emilio Chuvieco (University of Alcala, Spain)
- Alex Held (CSIRO / TERN-AUSCOVER)
- Philip Zylstra (UOW)
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PROJECT STUDENTS

PhD students:

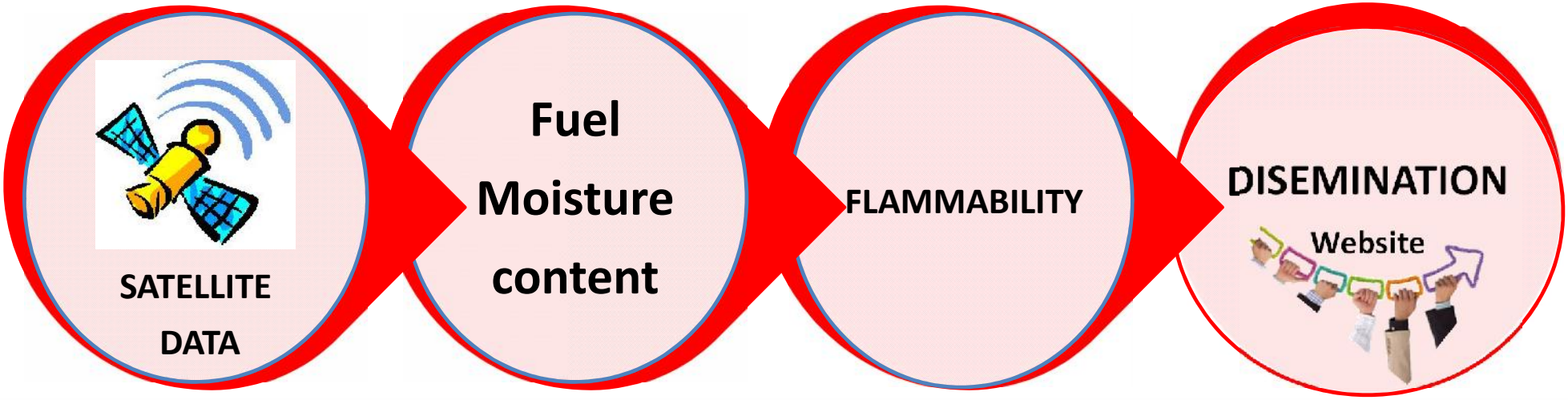
- **Yang Chen** (University of Monash-APA + BNHCRC top-up). "Mapping forest fuel load and structure from LiDAR". GRADUATED!
- **Andrea Massetti** (University of Monash-APA + BNHCRC Associate student). "Enhancement of fire spread modelling using high-resolution remotely sensed data".
- **Li Zhao** (Chinese enviromental institution+BNHCRC). "Spatial forecasting coupled litter and root zone moisture dynamics for bushfire management"

Master students

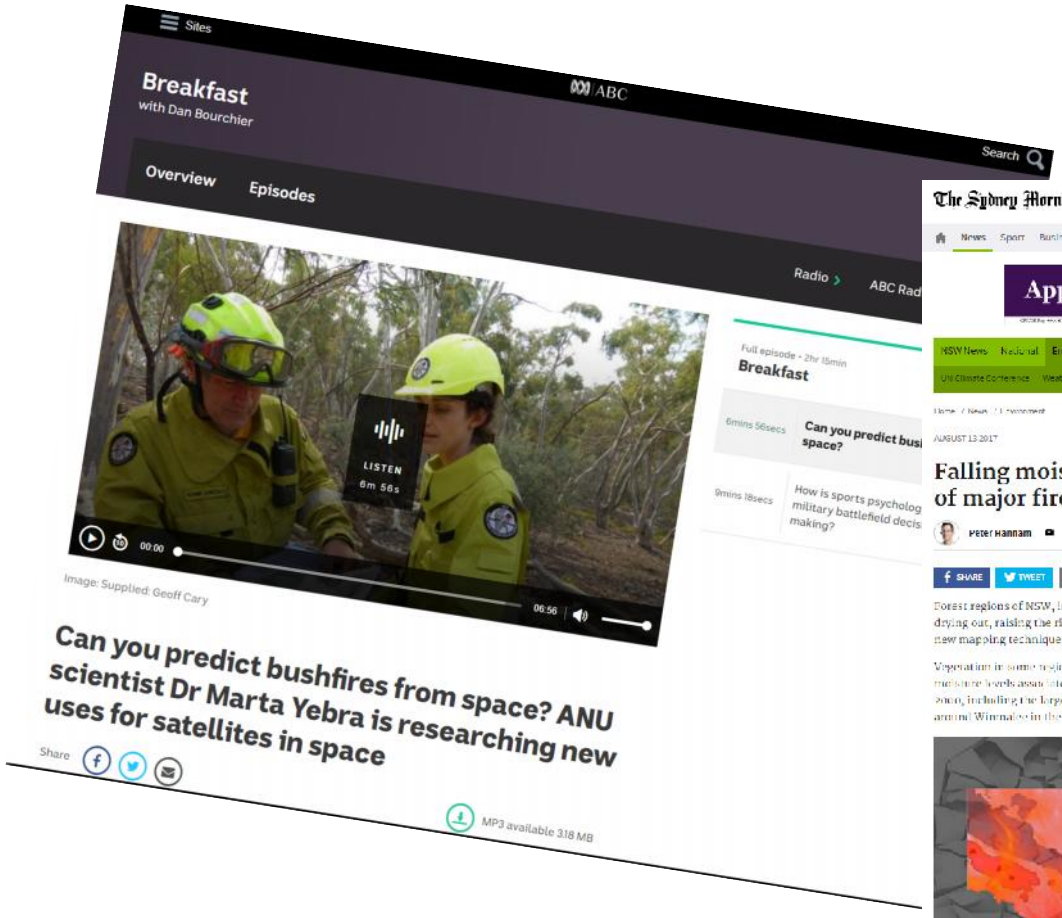
- **Honghao Zeng** (ANU). "Using weather data ad satellite-derived FMC to estimate flammability for Australia"

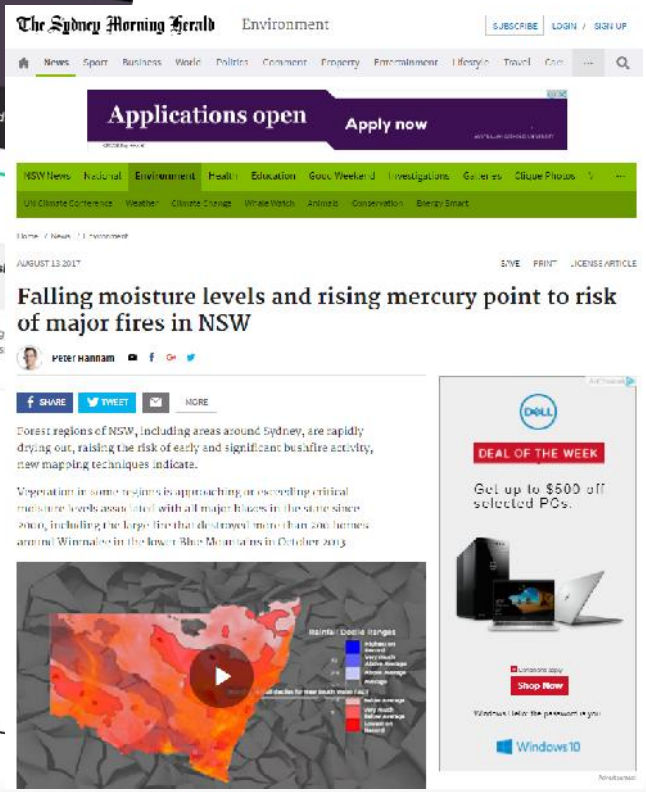
THE AUSTRALIAN FLAMMABILITY MONITORING SYSTEM (AFMS) WEBSITE

First **continental-scale** prototype website providing spatial information on **fuel moisture content** and landscape-scale **fuel flammability** derived from **satellite observations**



MEDIA COVERAGE





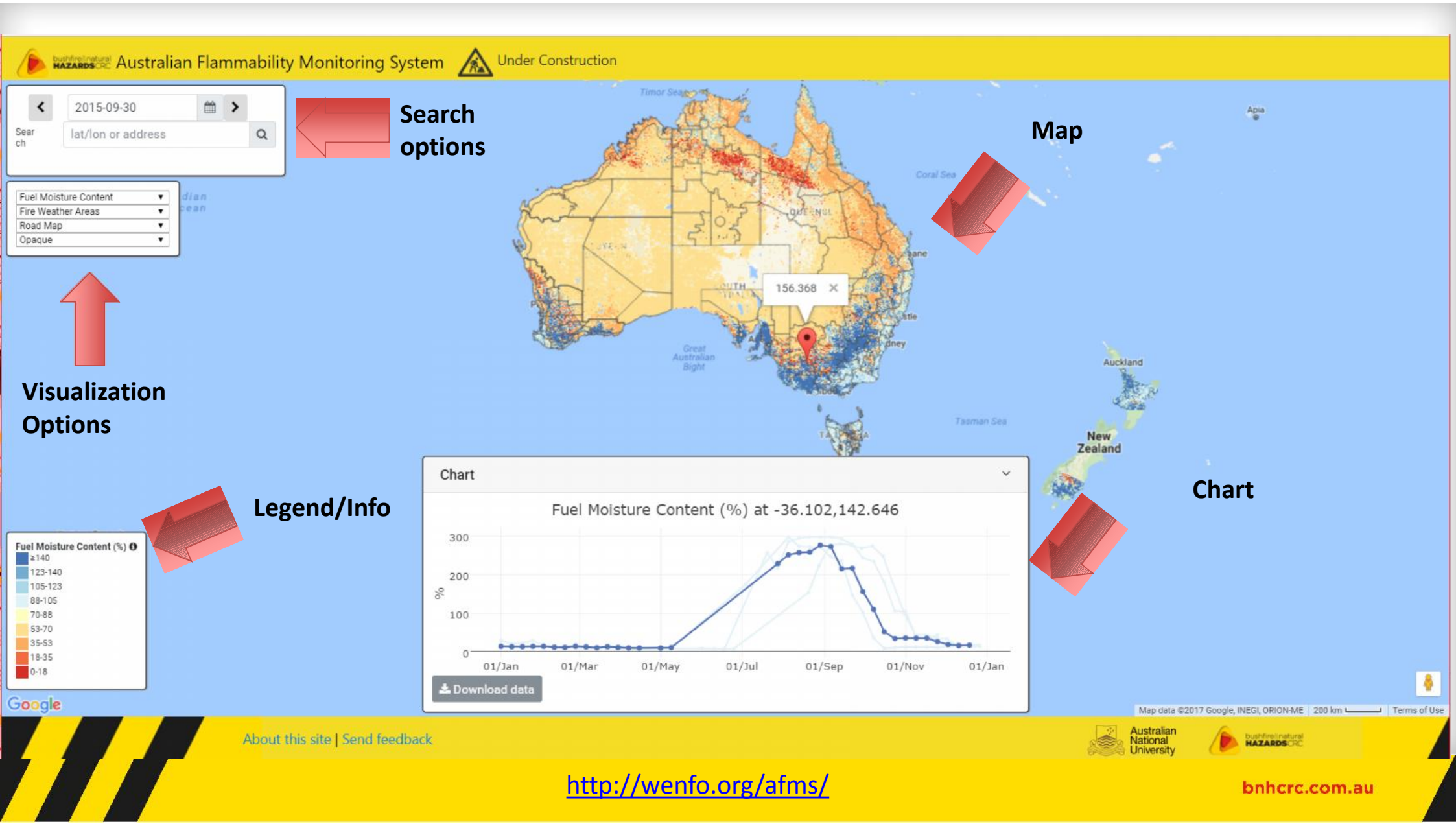
AFMS WEBSITE

Data currently displayed (2001-August 2017*, 500 m, 4 days*)

- Fuel Moisture Content (FMC) physical model based on the inversion of Radiative Transfer Models.
- Uncertainty in the FMC estimates
- *Flammability index (FI, 0-1) by comparison of satellite-based FMC with mapping of actual fire events (MODIS).*
- Fuel class mask (grassland, shrubland, forest)

Basic input data

- MODIS reflectance (4 days*)
- MODIS land cover type (yearly)

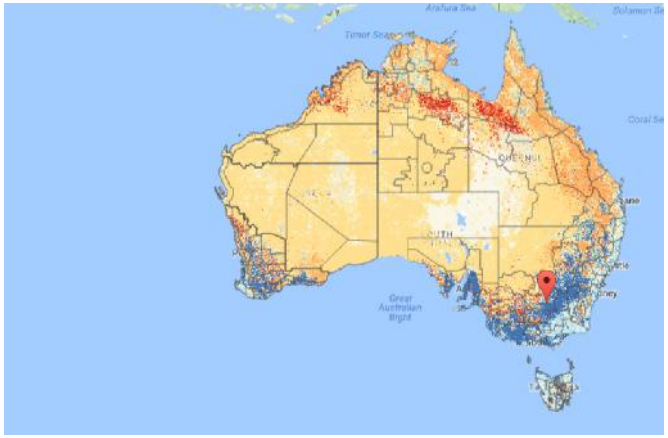


http://wenfo.org/afms/

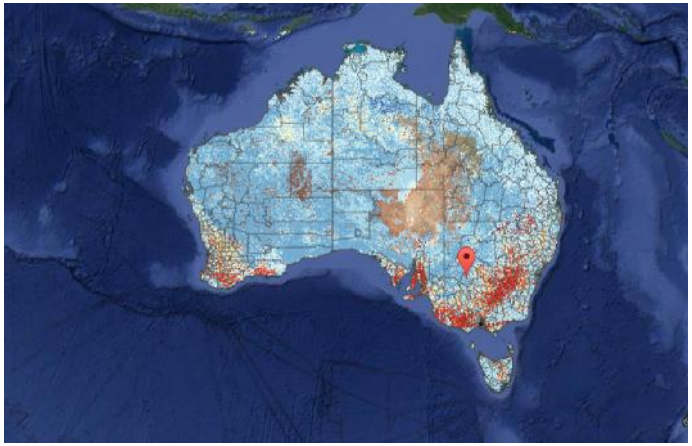
AFMS WEB SITE: VISUALIZATION OPTIONS

1. Layers
    1. Live FMC
    2. Uncertainty
    3. Flammability
    4. Fuel Class
2. Vectors
    1. States Territories
    2. Local Government Areas
    3. Fire Weather Areas
    4. Defence Training areas
    5. National Parks
    6. NRM Regions
3. Road Map/Satellite
4. Opaque/Transparent

FMC/Fire weather areas/Road Map/Opaque

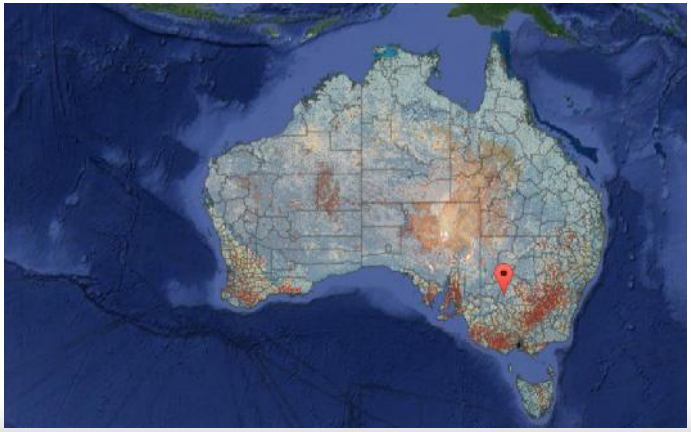


Uncertainty/Local Government areas/Satellite/Opaque



FMC/Fire weather areas/Road map/Transparent

Uncertainty/Local Government/Satellite/Transparent



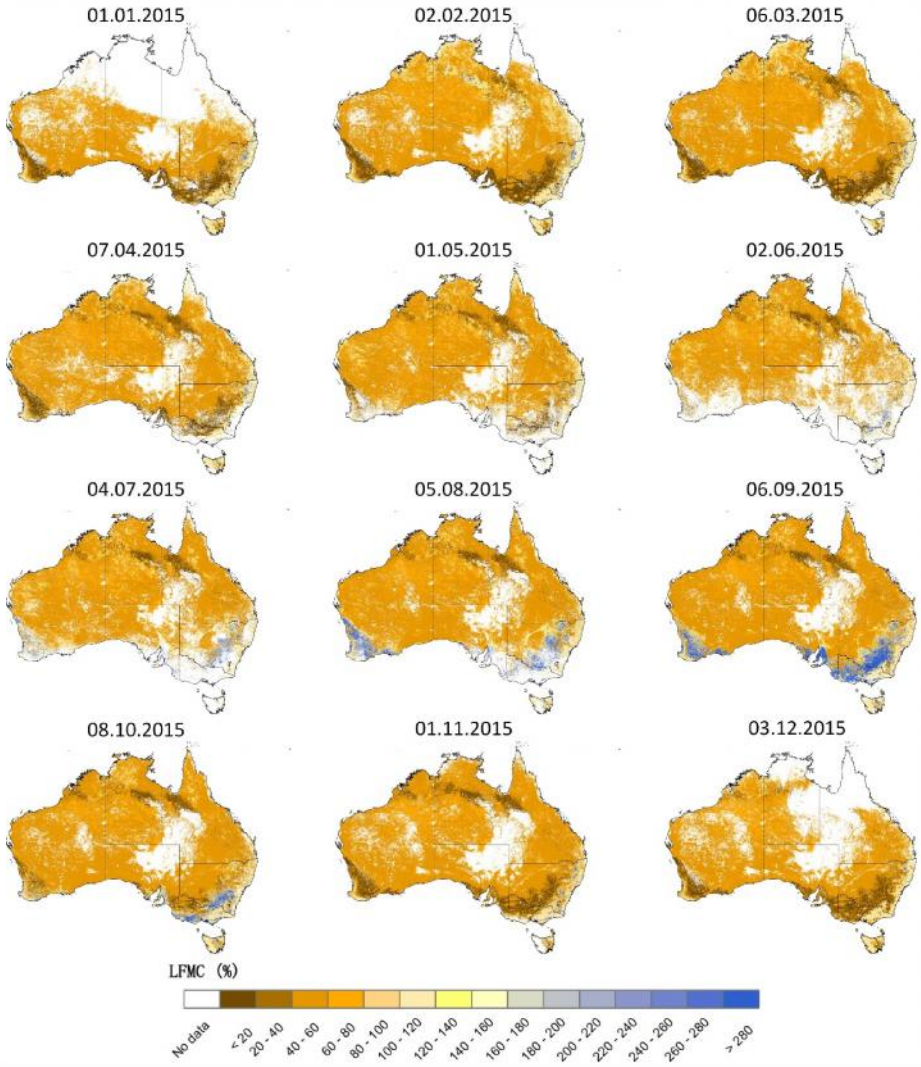
AFMS WEB SITE: FEATURES

Allows users to **visualise and interpret national-scale** information on FMC and flammability as **maps**

(Bushfire outlook ≈ timing of the drying of the fuel)

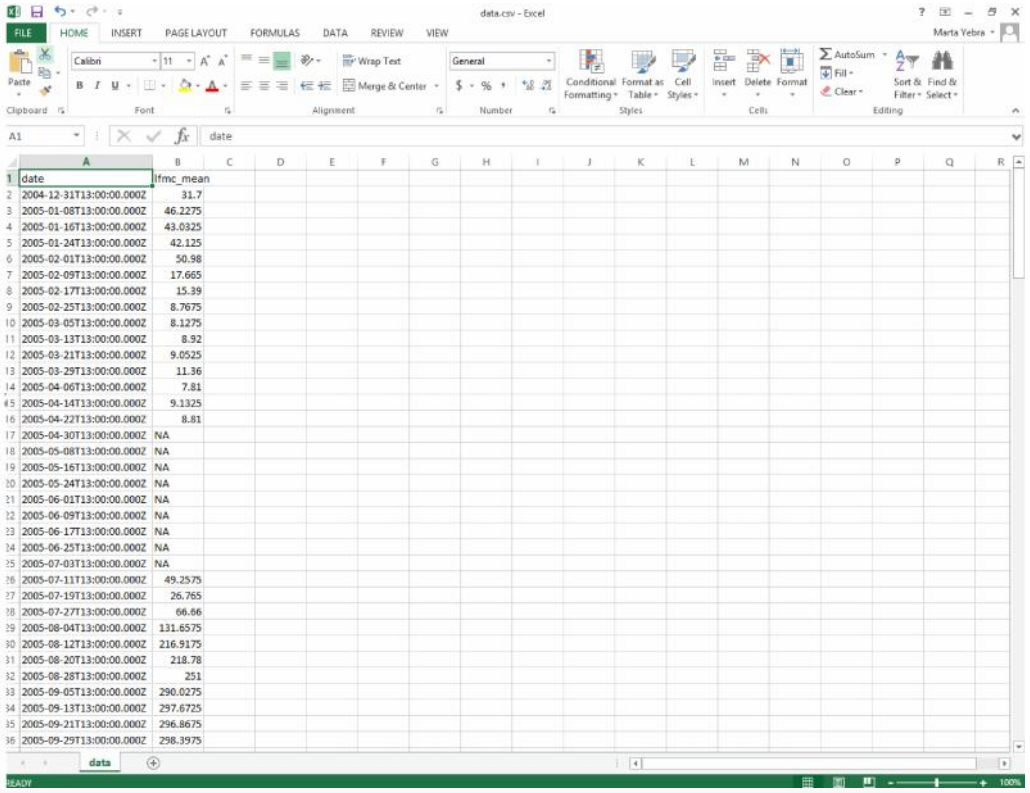
Example: Overview of FMC in 2015

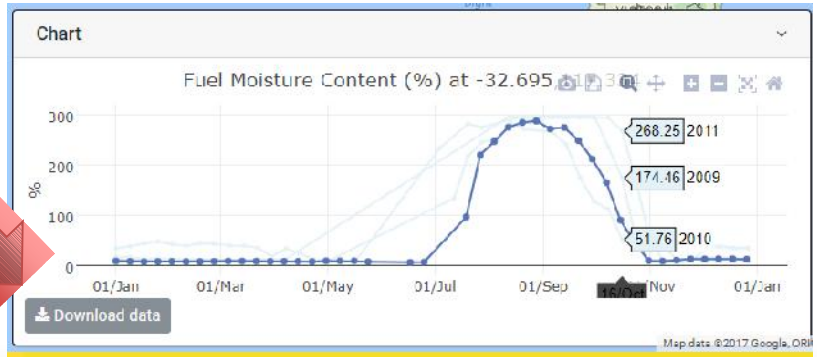
1) Temperate zones of Australia
   a) Low FMC values in January.
   b) FMC reach their maximum at the end of winter or beginning of spring (August/September).
   c) FMC started to decrease until the end of the summer when values reach their minimums.
2) Tropical regions in the north of the country, the tendency was the opposite.
3) Desert zones FMC values constantly low



AFMS WEB SITE: FEATURES

Allows users to visualise and interpret national-scale information on FMC and flammability as **graphs**.





AFMS WEBSITE: YOUR FEEDBACK IS ESSENTIAL FOR FUTURE DEVELOPMENTS!!

1) Addional **data** that could be displayed;

   a) BoM's JASMIN Soil Moisture Content estimates
   b) Fuels3D data? (RMIT group)

   c) Information on past fires (occurrence, intensity and burn extent from MODIS)
   d) Fire weather, Grassland curing
   e) Near surface fuel moisture content (Matthews et al. 2006)

2) Additional **web features** that could be added

   a) e.g. Regional summaries?
      - States Territories
      - Local Government Areas …

Automated, Systematic, Near-real time, Nation-wide

RESEARCH PLAN FOR 2017-2020

SPECIFIC OBJECTIVES

1. To collect field observations of FMC and spectra from a variety of relevant fuel types and **further calibrate and verify the FMC retrieval method**, and to quantify its uncertainty and reliability in the context of fire risk assessment.

2. To integrate other factors such as fire weather, dead FMC and total biomass into AFMS for a **comprehensive characterization of flammability**

3. To investigate the use of reflectance data from alternative satellite instruments in AFMS to **achieve long-term continuity** as well as improved **temporal and spatial** quality.

4. To further **evaluate alternative low-cost in-field methods** to develop innovative ways to monitor key fuel properties determining fire hazard (e.g. FMC, fuel structure and fuel load)

COMPREHENSIVE CHARACTERIZATION OF FLAMMABILITY

Independent variable	Fuel class	Equation	AUC
Temperature (T) and relative humidity (RH)	grassland	$0.2007-0.0062*Tmax_{t-1}$	**0.51**
	shrubland	$-0.0017-0.00097*Vph15_{t-1}+0.00266*Vph15_{t-2}$	**0.499**
T+RH+FMC	grassland	$2.94-0.06*LFMC_{t-1}+0.08*LFMC_{Difference}-1.21*LFMC_{Anomaly}+0.0057*Tmax_{t-1}$	**0.93**
	shrubland	$4.64-0.078*LFMC_{t-1}-0.021*LFMC_{Difference}-0.075*LFMC_{Anomaly}+0.0013*Vph15_{t-1}+0.0021*Vph15_{t-2}$	**0.8**
FMC	grassland	$0.18-0.01*LFMC_{t-1}+0.02*LFMC_{Difference}-0.02*LFMC_{Anomaly}$	**0.7**
	shrubland	$5.66-0.09*LFMC_{t-1}+0.005*LFMC_{Difference}-0.28*LFMC_{Anomaly}$	**0.78**
	forest	$1.51-0.03*LFMC_{t-1}+0.02*LFMC_{Difference}-0.02*LFMC_{Anomaly}$	**0.71**

Zeng, 2017

THANK YOU!!

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Project collaborators: : Xingwen Quan, Glenn Newman, Gabrielle Caccamo, Ross Bradstock, Mathias Boer, Rachael Nolan, Pablo Rozas

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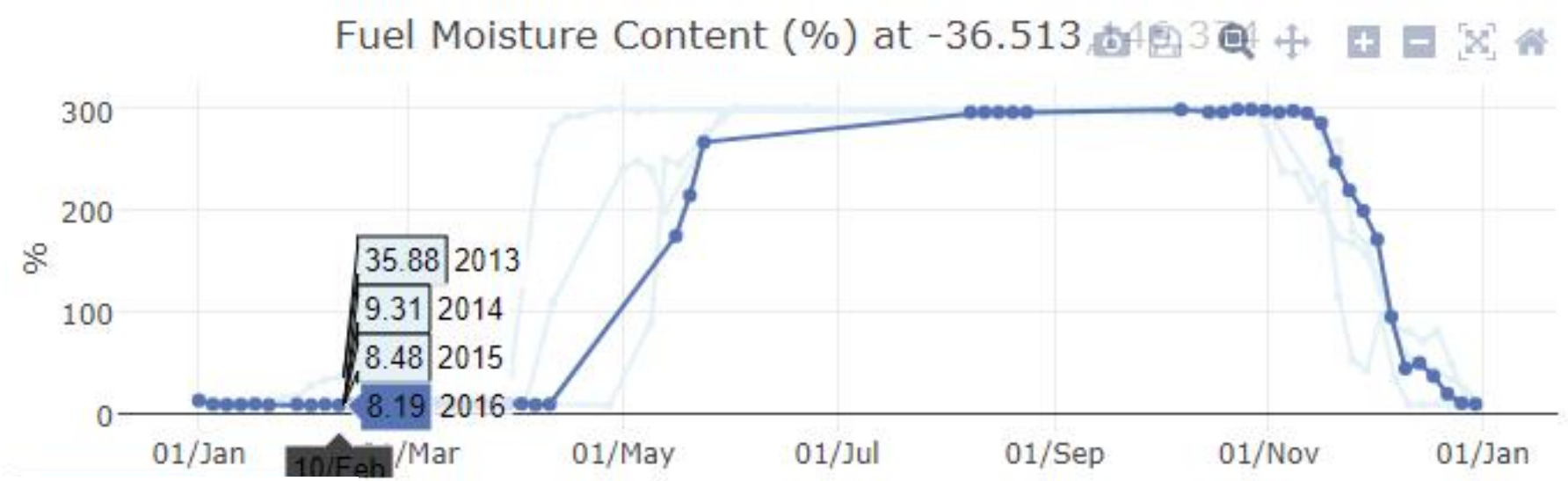
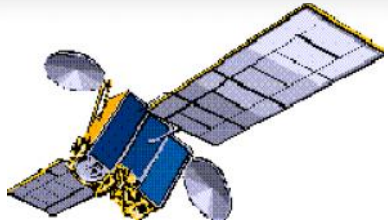
Journal papers published

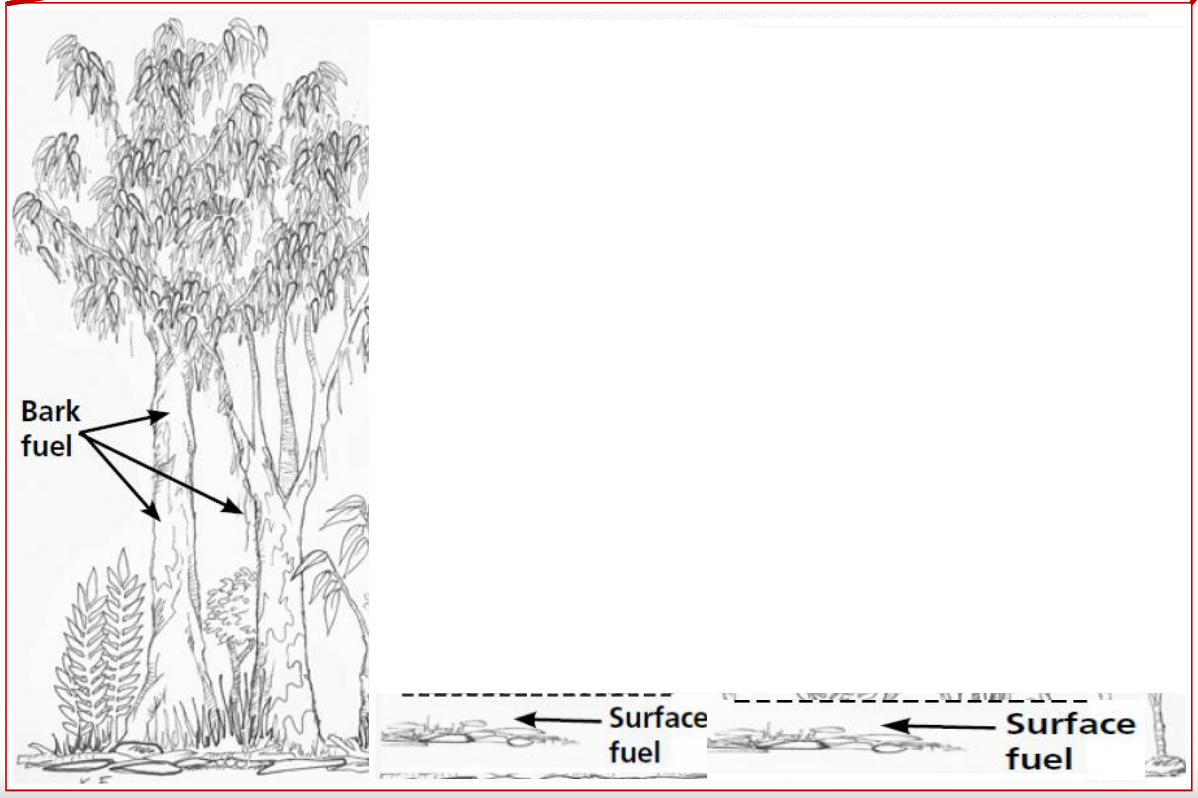
1. Holgate, C.M., van Dijk, A.I.J.M, Cary, G.J., Yebra, M., 2017. Influence of using alternative soil moisture estimates in the McArthur Forest Fire Danger Index. Accepted for publication at International Journal of Wildland Fire. WF16217
2. Chen, Y., Zhu, X., Yebra, M., Harris, S., Tapper, N. 2017. Development of a Predictive Model for Estimating Forest Surface Fuel Load in Australian Eucalypt forests with LiDAR Data. Environmental Modelling and Software. 97, 61-71, 2017.
3. Quan., X, Hea, B., Yebra, M. Yina, C., Liaoa, .and Xing L. 2017. Retrieval of forest fuel moisture content using a coupled radiative transfer model. Environmental Modelling & Software. 95, 290-302.
4. Quan, X., He, B., Yebra, M., Yin, C., Liao, Z., Xueting, Z. 2017. Estimating Grassland Aboveground Biomass Using Radiative Transfer Model. IEEE International Journal of Applied Earth Observation and Geoinformation. 54, 159-168.
5. Chen, X., Liu, Y.Y., Evans, J.P., Parinussa, R.M., van Dijk, A., Yebra, M. Estimating fire severity and carbon emissions over Australian tropical savannas based on satellite observations. Accepted for publication at the International journal of remote sensing

LIVE OR DEAD FUEL MOISTURE CONTENT?



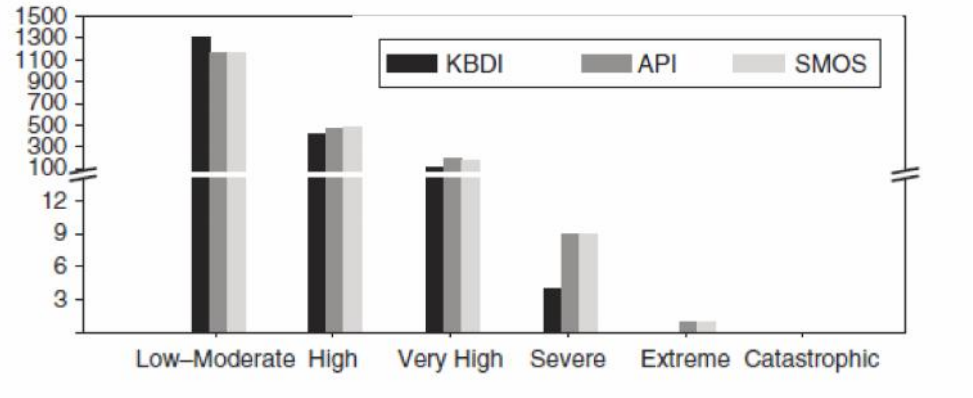
FUEL MOISTURE CONTENT OF WHICH STRATA?





Pixel
(500 x500 m)

ALTERNATIVE SOIL MOISTURE ESTIMATES IN THE MCARTHUR FFDI



Frequency of FDR categories at Yanco (Vic) replacing KBDI with alternative soil moisture estimates.

- Evaluated the replacement of KBDI and DF in FFDI with alternative soil moisture (SM) estimates
- KBDI had a wet & slow bias; appears to be representative of a deep SM profile.
- Direct replacement of KBDI or DF with a alternative SM causes different behaviour of FFDI.
- DF dynamics agree better with (shallow) SM – if at all, consider replacing entire DF with SM.

Holgate et al. (2017)