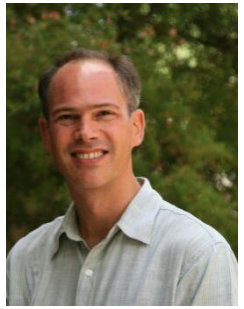
Mapping bushfire hazard and impacts

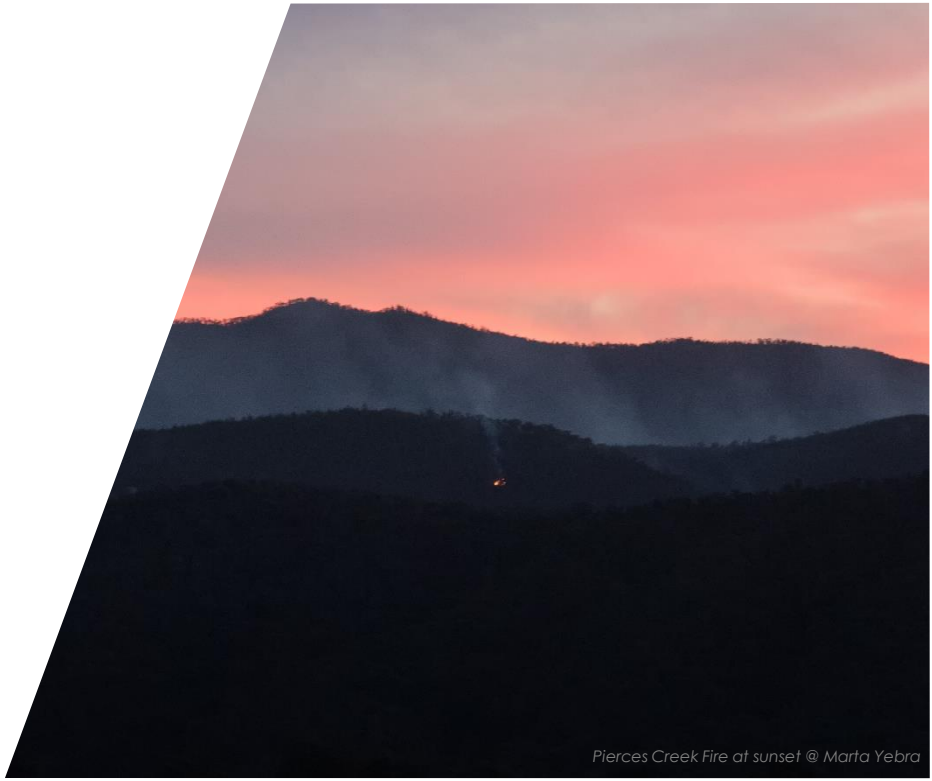
Research advisory forum / **2018**

Dr Marta Yebra, Prof Albert van Dijk, A/Prof Geoff Cary and Li Zao
Fenner School of Environment & Society, Australian National University






@bnhcrc @bnhcrc


Pierces Creek Fire at sunset @ Marta Yebra

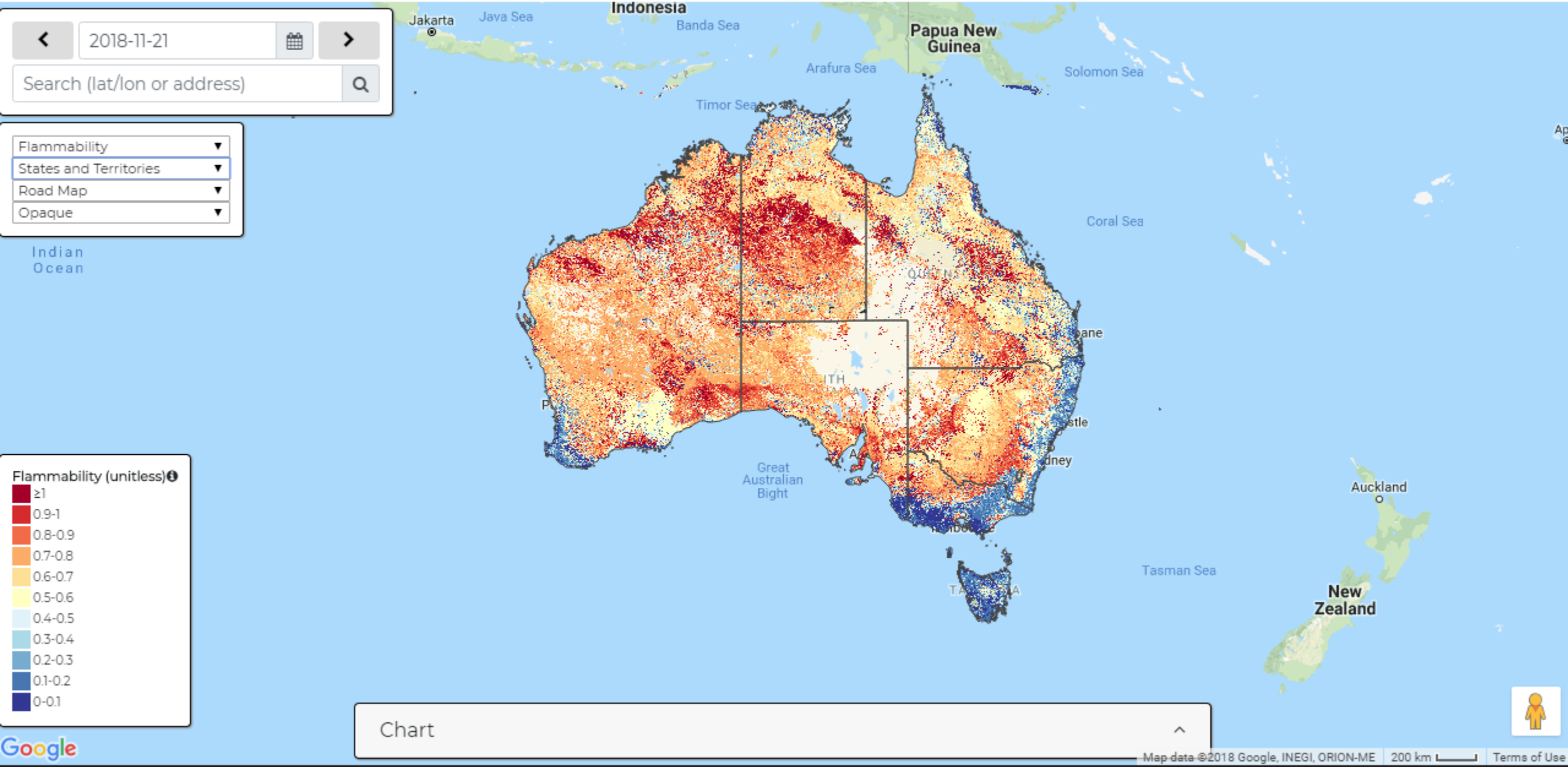
bushfire&natural HAZARDSCRC

Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

Australian Flammability Monitoring System

bushfire&natural HAZARDSCRC

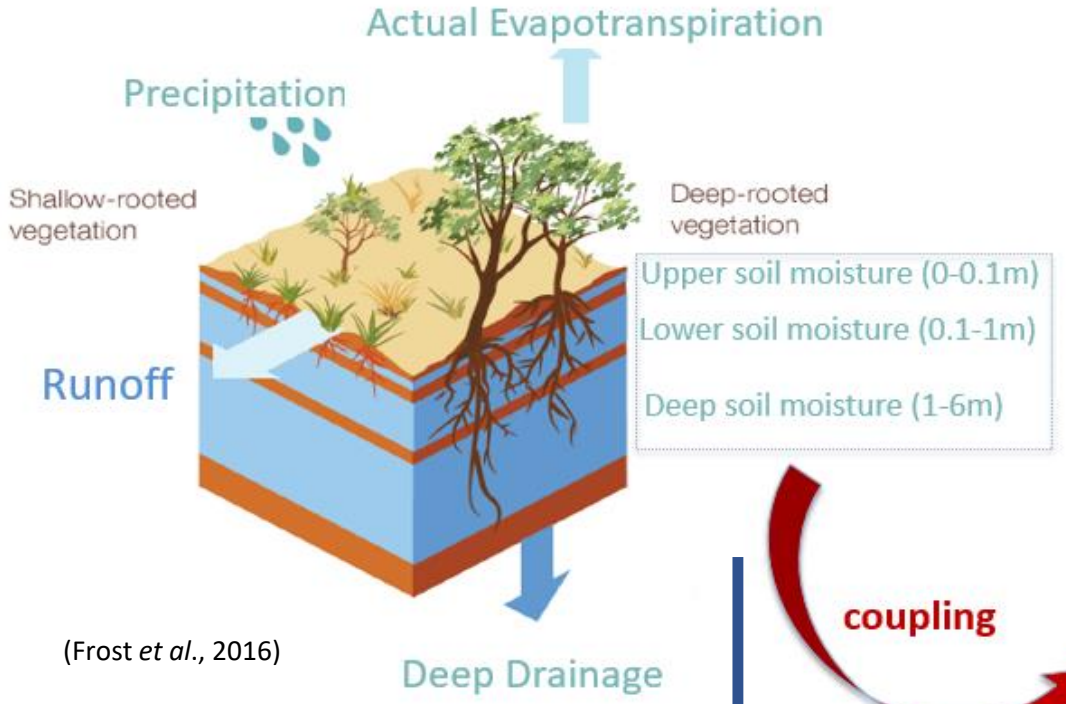


The Australian Flammability Monitoring System (AFMS)

Layer	Method	Resolution		Latency	Reference
		Spatial	Temporal		
Live FMC (%)	Inversion of **physical models** using MODIS reflectance data (water inside the fuels absorbs solar energy in the short wavelength water bands)	500 m	4 days	2/4 days	Yebra *et al.* 2018. RSE
Uncertainty (%)	**Standard deviation** of 40 best FMC estimates				
Flammability Index (0-1, unitless)	**Logistic regression** models between fire occurrence from the MODIS burned area product (binary dependent variable) and predictor variables derived from FMC estimates (independent variable)			**8 days* forecast**	
Soil moisture at 0-10 and 10-35 cm	BoM's **JASMIN** modelling system	5km	Daily	7 days	Dharssi *et al.* 2017

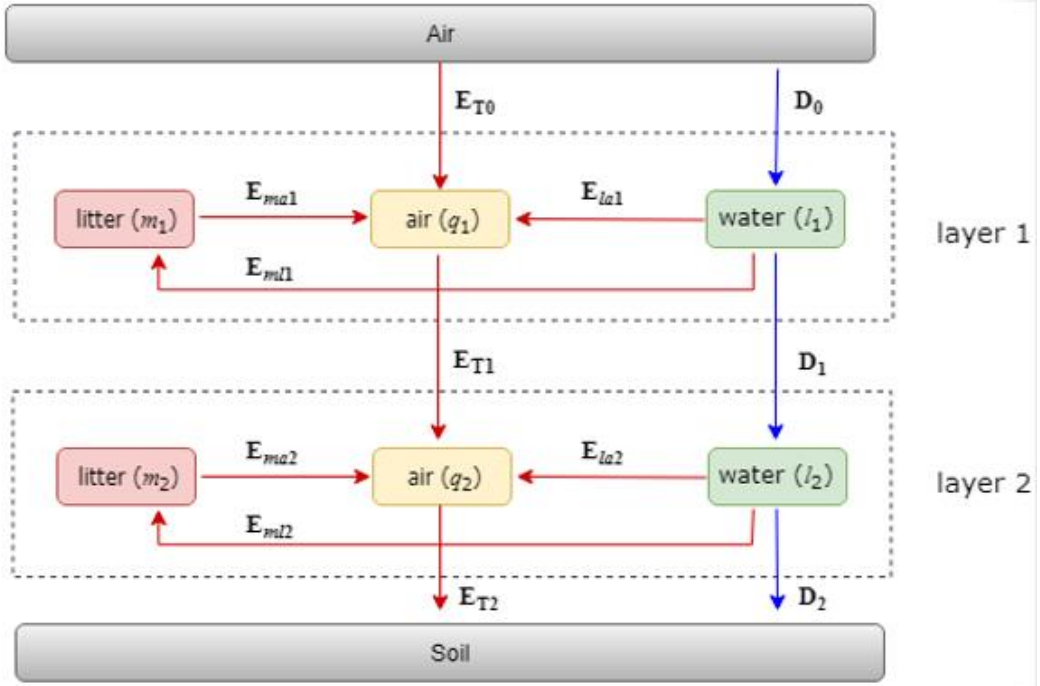
Coupling Litter and soil moisture dynamics for dead fuel moisture content

AWRA-L model (Van Dijk, 2010)



(Frost *et al.*, 2016)

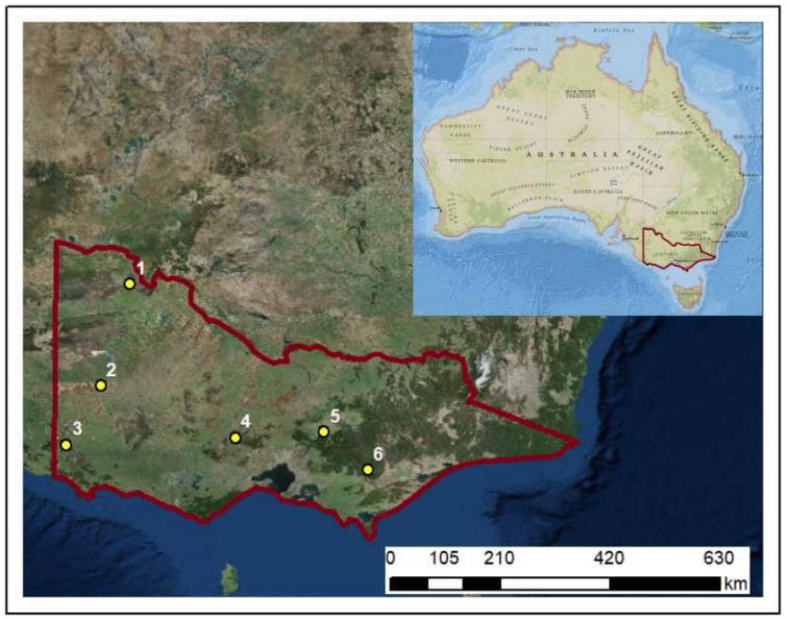
Koba model (Matthews, 2006)

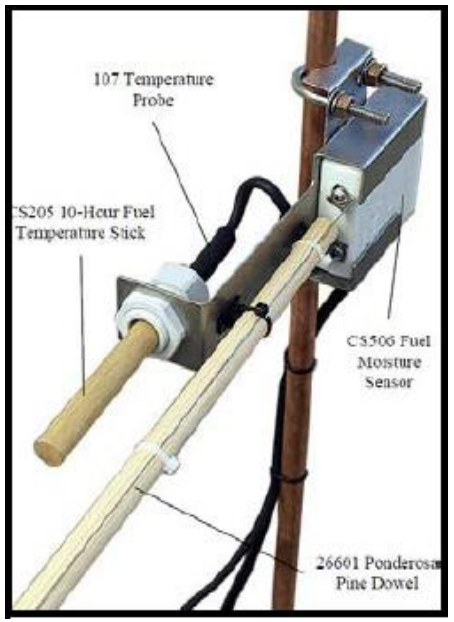


coupling

soil water storage $S\,(mm)$ → α → $E_g = \frac{\rho}{R_a}[\,\alpha q_{sat}(T_s) - q_a\,]$

Coupling Litter and soil moisture dynamics for dead fuel moisture content





Sites	Surface litter	
	No Coupling	With Coupling
1	0.68	0.74
2	0.73	0.78
3	0.7	0.74
4	0.68	0.75
5	0.7	0.75
6	0.44	0.44

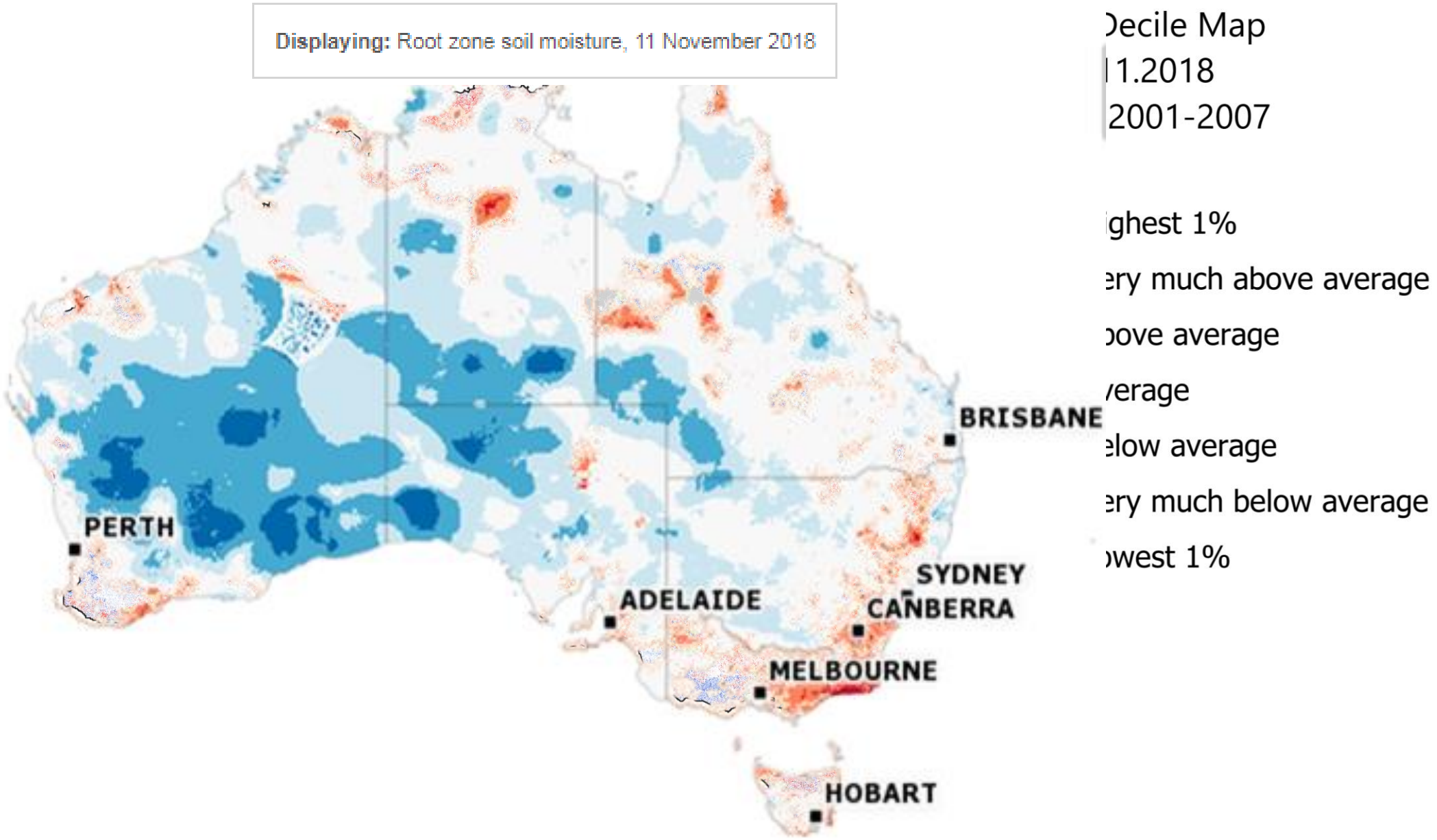
Sites	Bottom litter	
	No Coupling	With Coupling
1	0.75	0.80
2	0.69	0.7
3	0.73	0.77
4	0.74	0.76
5	0.67	0.74
6	-0.16	0.06

The AFMS: Priorities of future development

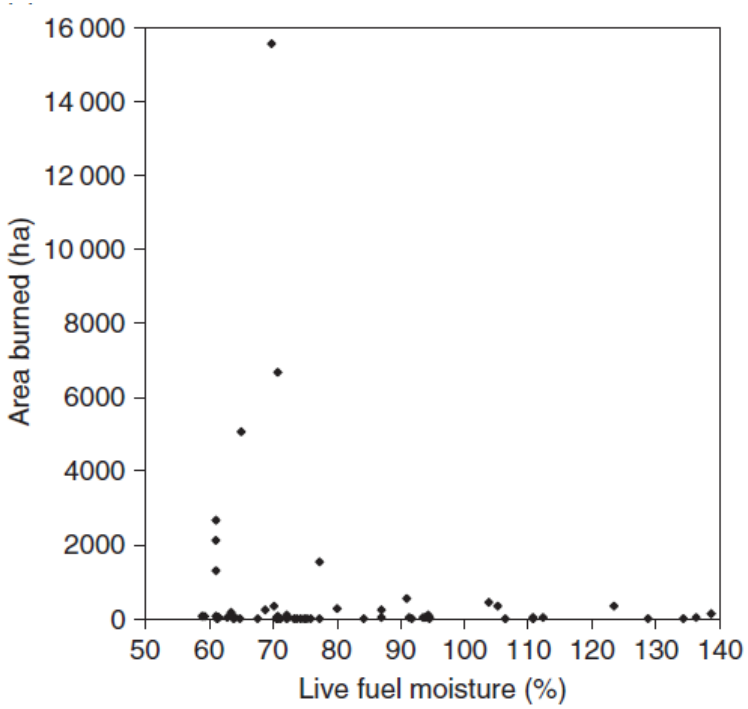
THEME	FEEDBACK	SOLUTION	STATUS
Web Service Enhancement	Pixels are not square	Change in the projection	Done
	The system needs to better represent the interaction between vegetation types with vastly different FMC dynamics and the scale of the coloured classification	Map the different fuels (grass, shrub and forest) separately Display decile maps in addition to absolute values	TBD
	It is confusing to know what the FMC and FI products inform in a multilayer forest in relation to what the satellite senses	Make it easy to identify from what layer the FMC is being calculated by adding additional contextual data layers that are already available online.	TBD
	Data needs to be integrated into the users' GIS systems	Allowing direct data downloads for a region of interest as GeoTIFF	In progress
	More regular updates of data displayed are needed	Automate this process	Done
Understanding and usability	Users want to make more use of the information displayed on the AFMS	Invest more time working with the end users and develop specific, operational applications and integrate the information displayed in the AFMS into current decision processes and tool.	In progress
	Users want to learn more about integrating AFMS products into their current systems	Develop use examples or instruction videos for new website users that explain the strengths and limitations of the data (based on our conversation with end users)	
	Users would like to use FMC in the current grass fire spread model	Relate grass moisture content to curing	TBD
Algorithm development	Explore other satellite data sources to allow finer spatial and temporal resolution.	Suitability study of different satellite data sources	Done

TBD= To be decided

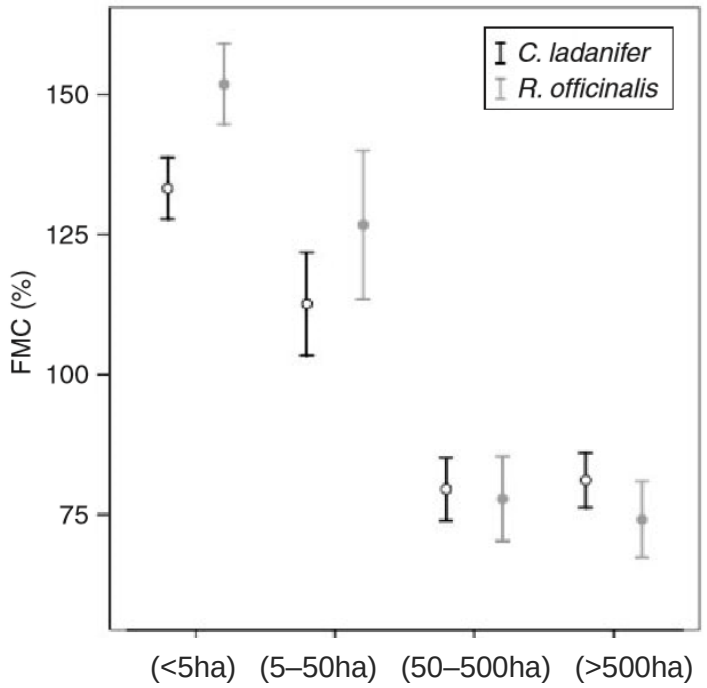
Web service enhancement



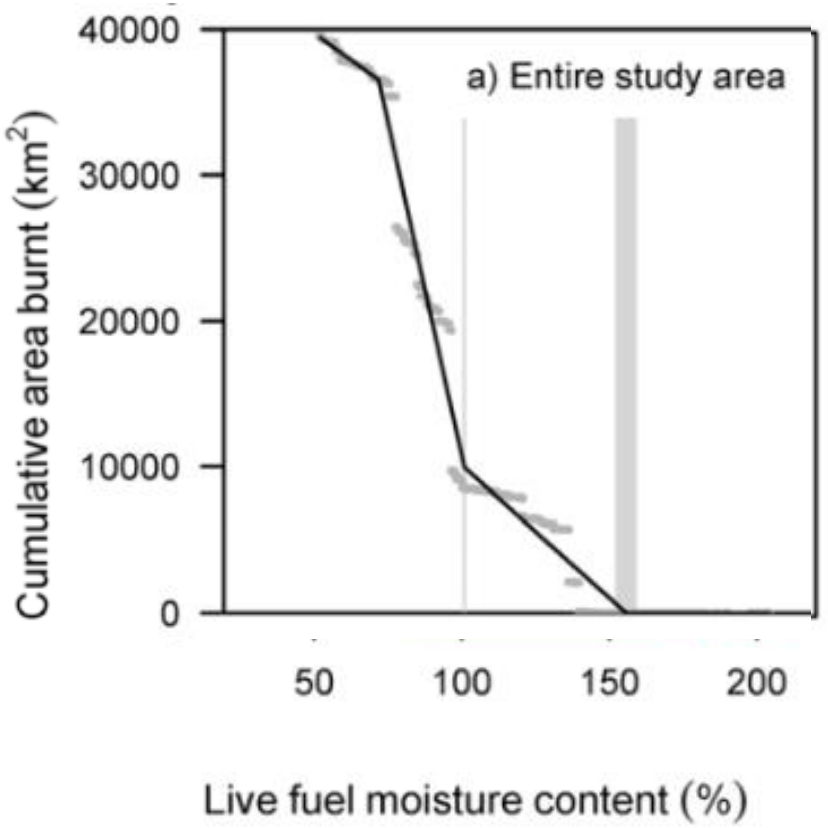
Live Fuel Moisture Content and fire occurrence



Dennison *et al.* 2008, IJWF



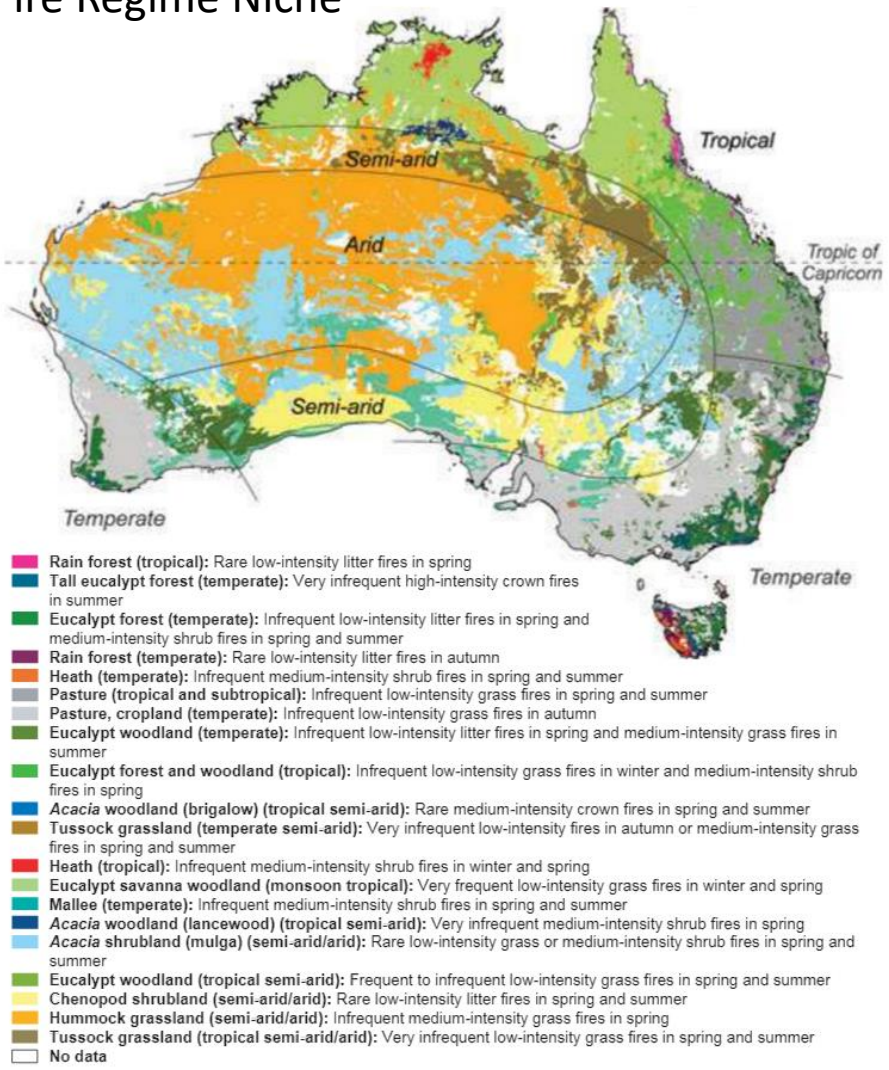
Chuvieco *et al.* 2009, IJWF



Nolan et al. 2016

Web service enhancement

Fire Regime Niche



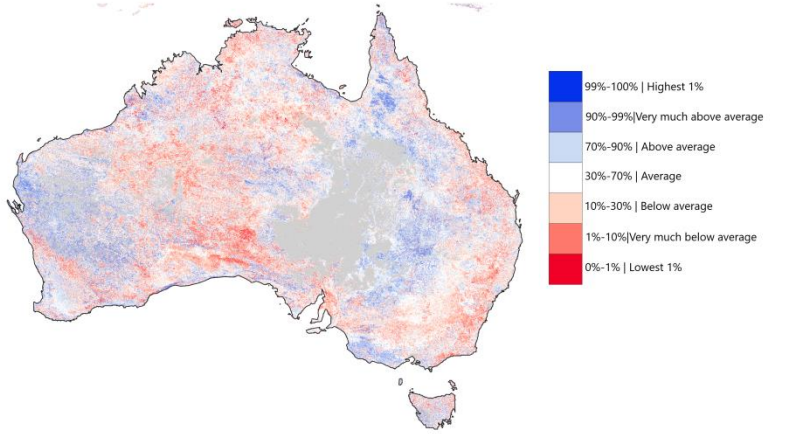
Murphy et al (2013)

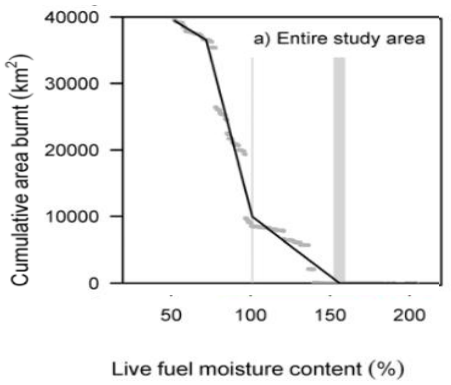
Table 1: Approximate LFMC threshold values indicating marked increases in burnt area, and the proportion of each studied niche burnt during the studied time period (2002-2014).

Fire Regime Niche	Threshold LMFC (%)	% Area Burnt
Temperate Eucalypt forest	160, 135	1.6
Tall Temperate Eucalypt Forest	160, 130	6.5
Temperate heath	55, 20	6.4
Tropical and subtropical pasture	20	10.7
Cropland pasture	65, 20	14.49
Temperate Eucalypt woodland	130, 45	2.5
Tropical Eucalypt forest and woodland	45, 15	26.9
Tropical Heath	95, 50, 20	158.2
Eucalypt savanna woodland	90, 55, 20	19.7
Temperate mallee	45	3.1
Acacia shrubland (mulga)	45	9.2
Hummock grassland	45, 20	43.5

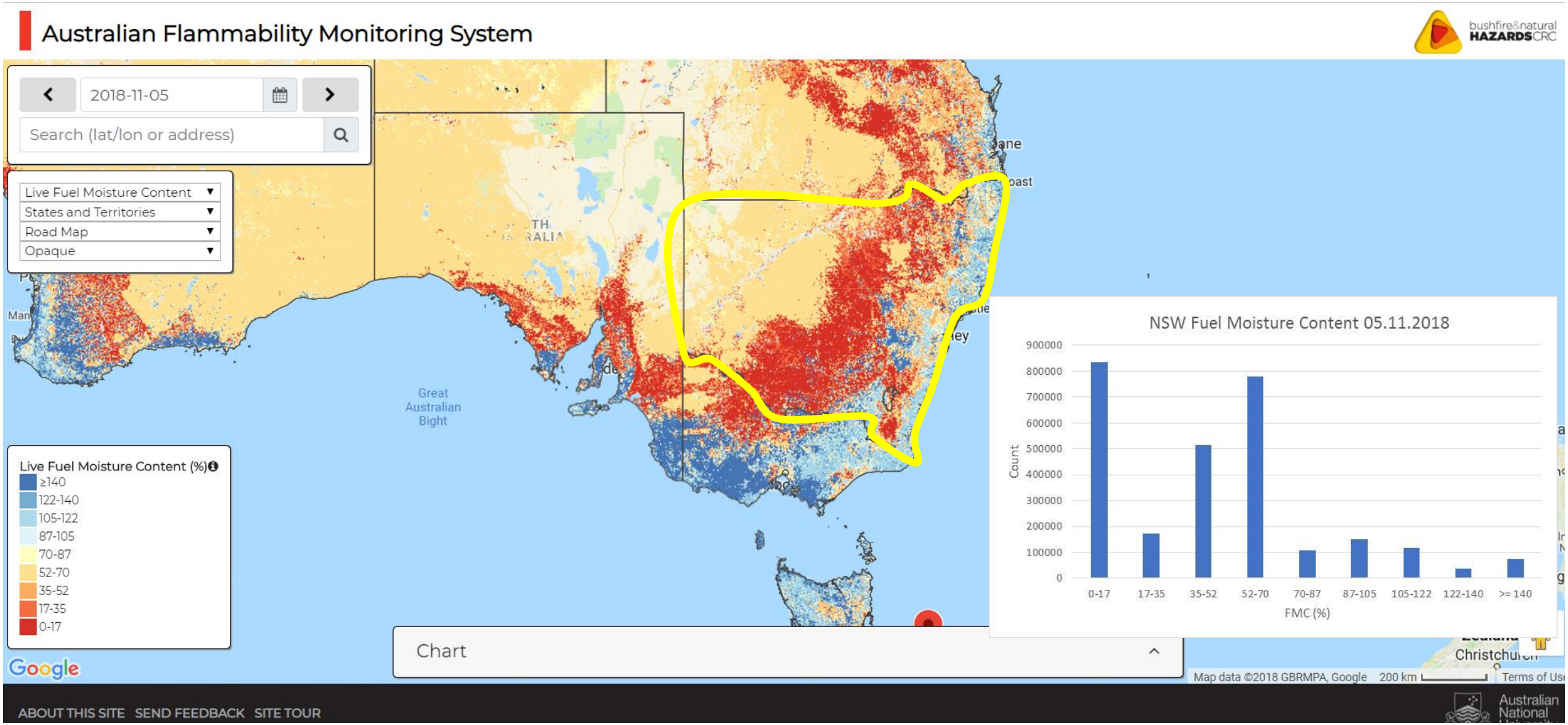
Gale et al. (2016)

Web service enhancement



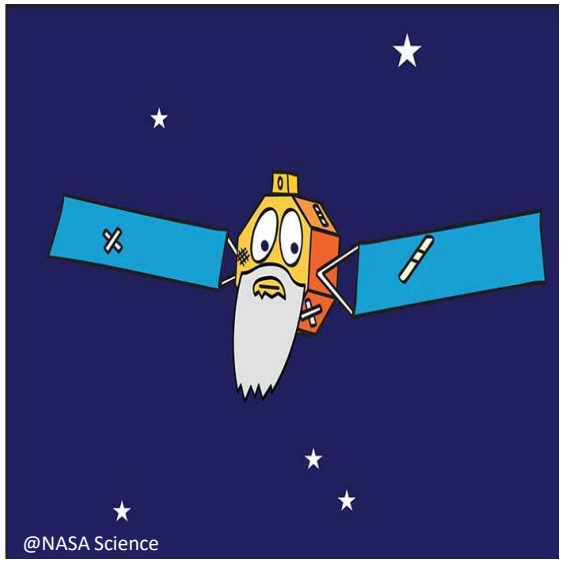


Web service enhancement



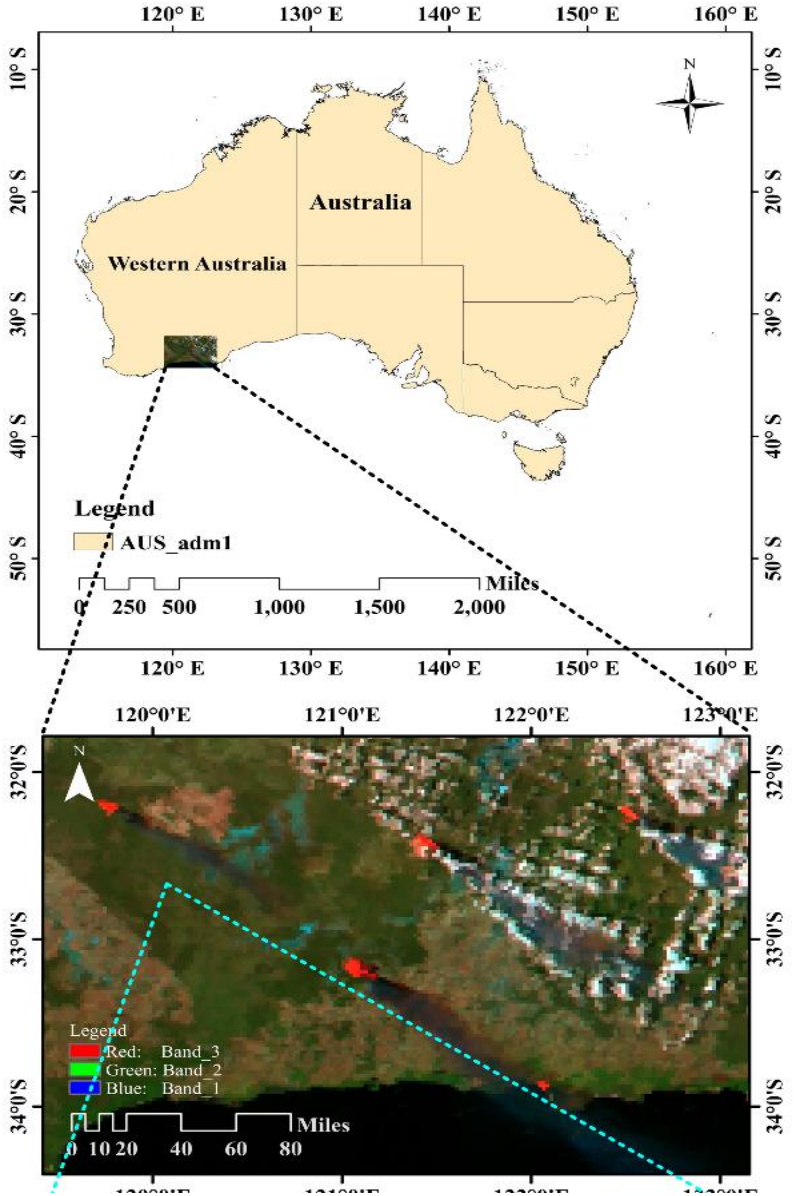
The AFMS planning for continuity

Satellite Sensor	Spatial resolution (m)	Temporal resolution	Spectral resolution		Year Launch	Designed Life (Years)
			Spectral range (μm)	Multi-spectral Bands		
MODIS	500	1-2 days	458-2155	7	2000	5
Landsat-8 OLI	30	16 days	433-1390	8	2013	6
VIIRS	750	Daily	4412-2250	10	2011	7
Himawari-8	2000	10 minutes	470-2256	6	2014	15
Sentinel-2A/2B MSI	20	5 day	442-2202	13	2017	12



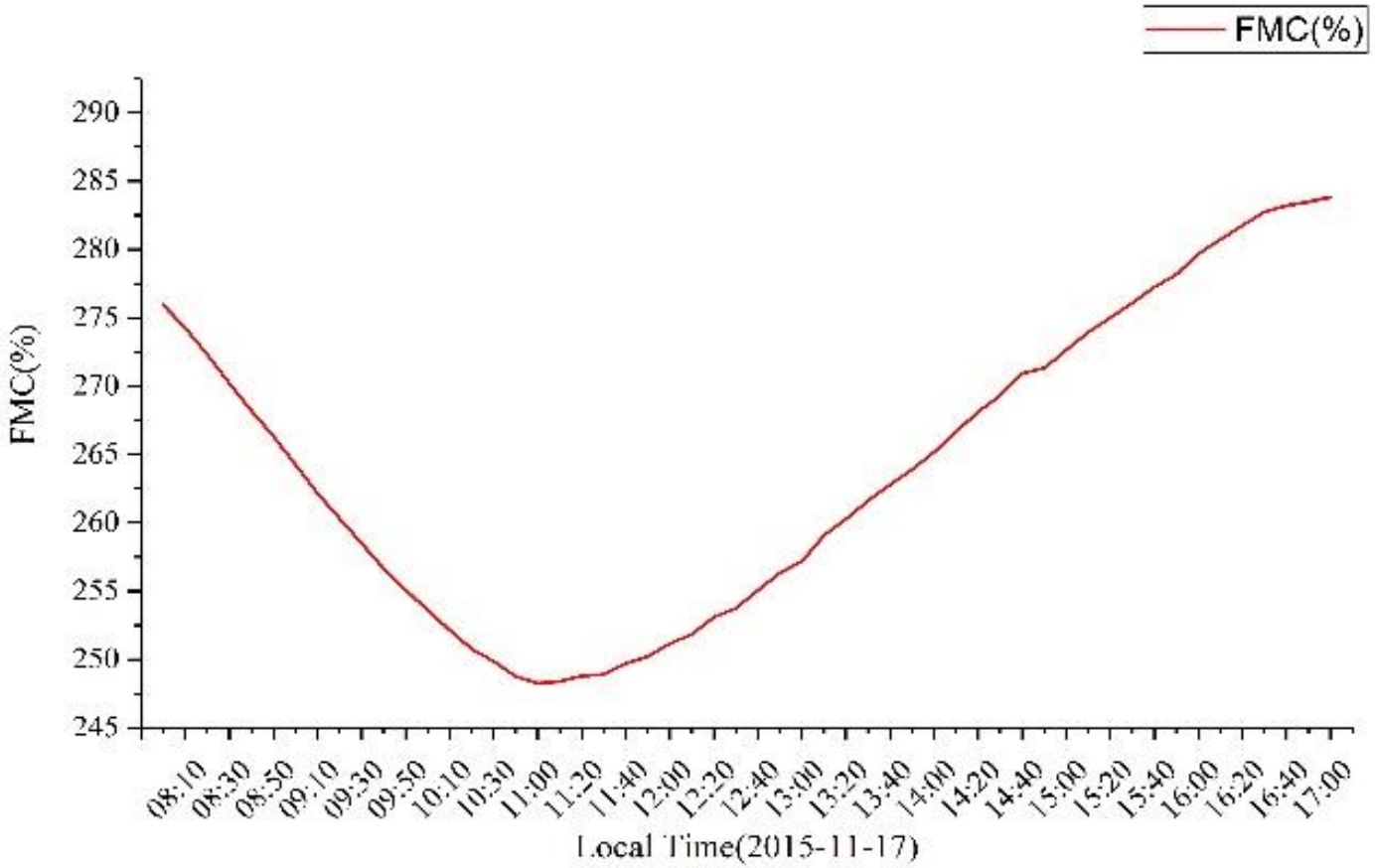
Sensor	Slope	intercept	R^2	RMSE	RMSEs	RMSEu	n
Landsat-8 OLI	1.2	-21	0.8	24	7	23	6178
Sentinel-2A/2B MSI	1.2	-22	0.8	23	7	21	6178
VIIRS	1.2	-18	0.8	19	6	18	6178
Himawari-8	1.2	-19	0.7	26	6	25	6178
MODIS	1.14	-16	0.7	24	5	24	6178

The AFMS planning for continuity



Himawari-8: geostationary Japanese satellite

- Temporal resolution: **10 minutes**
- Spatial resolution: **2km**



Quan *et al.* 2018, IGARSS

Potential uses of the AFMS

Spatially-explicit knowledge of FMC and flammability must be a key aim for fire managers

Planning

Assist with **scheduling and plan prescribed burns:**

- drier FMC in a forest may indicate more potential to score the canopy
- fuel moisture differential can act as soft control lines
- long term fuel conditions for the PB-DST
- emissions assessment and smoke dispersion

Preparedness

Amend preparedness levels in relation to Fire Danger Rating in response to lower/higher than average landscape dryness conditions or exceed set FMC or **FI** thresholds

Response

Assist in firefighting and resources allocation

- FMC as an **input in Spinifex grass** fire behaviour
- Highlight potential for **anomalies in predicted rate of spread:** for lower FMC a fire may spread faster than predicted
- soft control lines based on fuel moisture differential

What's next

- Utilization milestones - AFMS
  - Writing up use examples or instructions for new website users that explain strengths and limitations of data (base on tour) → February 2019
  - Feedback on trial utilization of the AFMS → March 2019
  - AFMS v.1.1. → April 2019

- Comprehensive flammability index → June 2019

End user statement

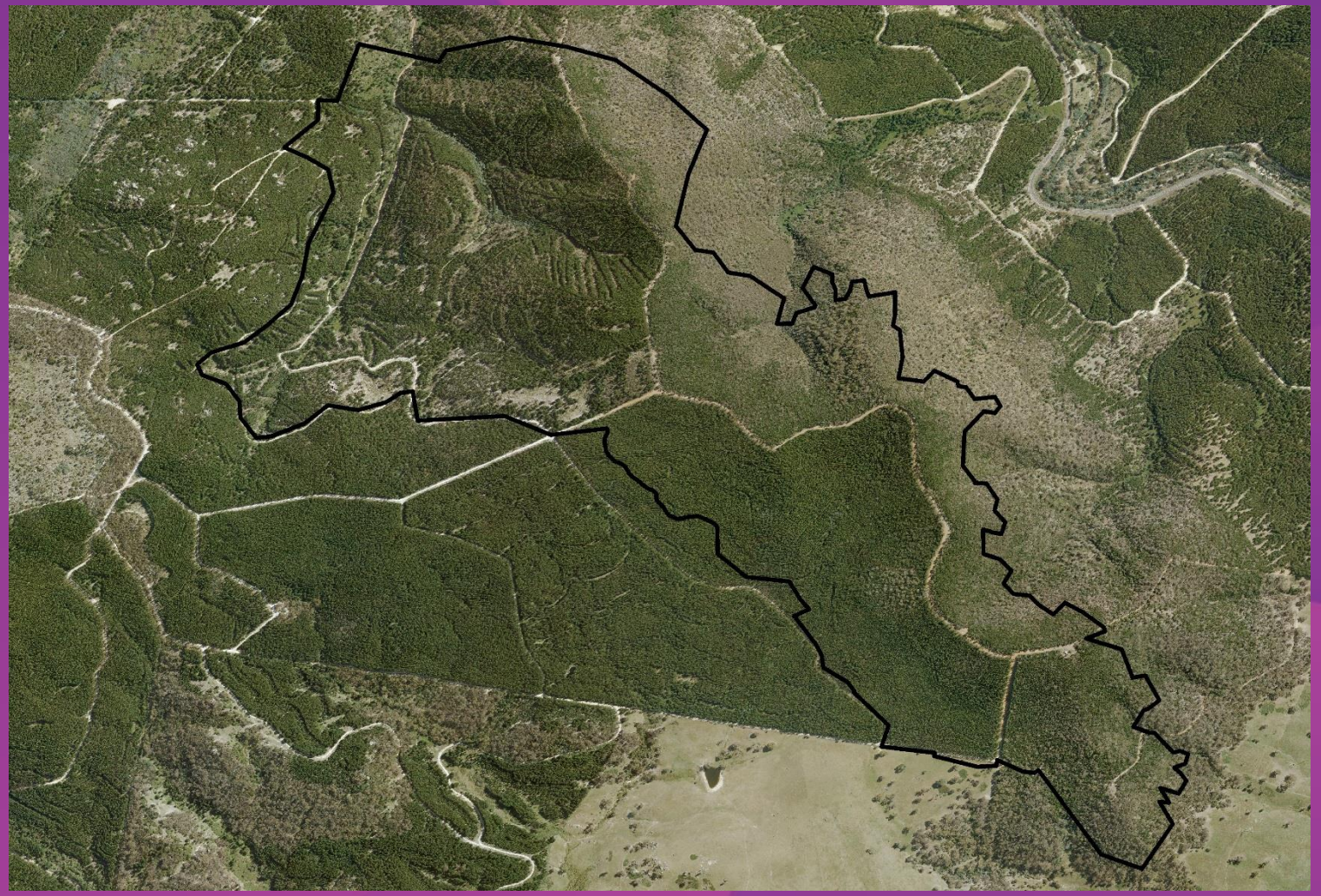
Dr Adam Leavesley

ACT Parks and Conservation Service

ACT Government

Operational sequence

Aerial image of fire ground

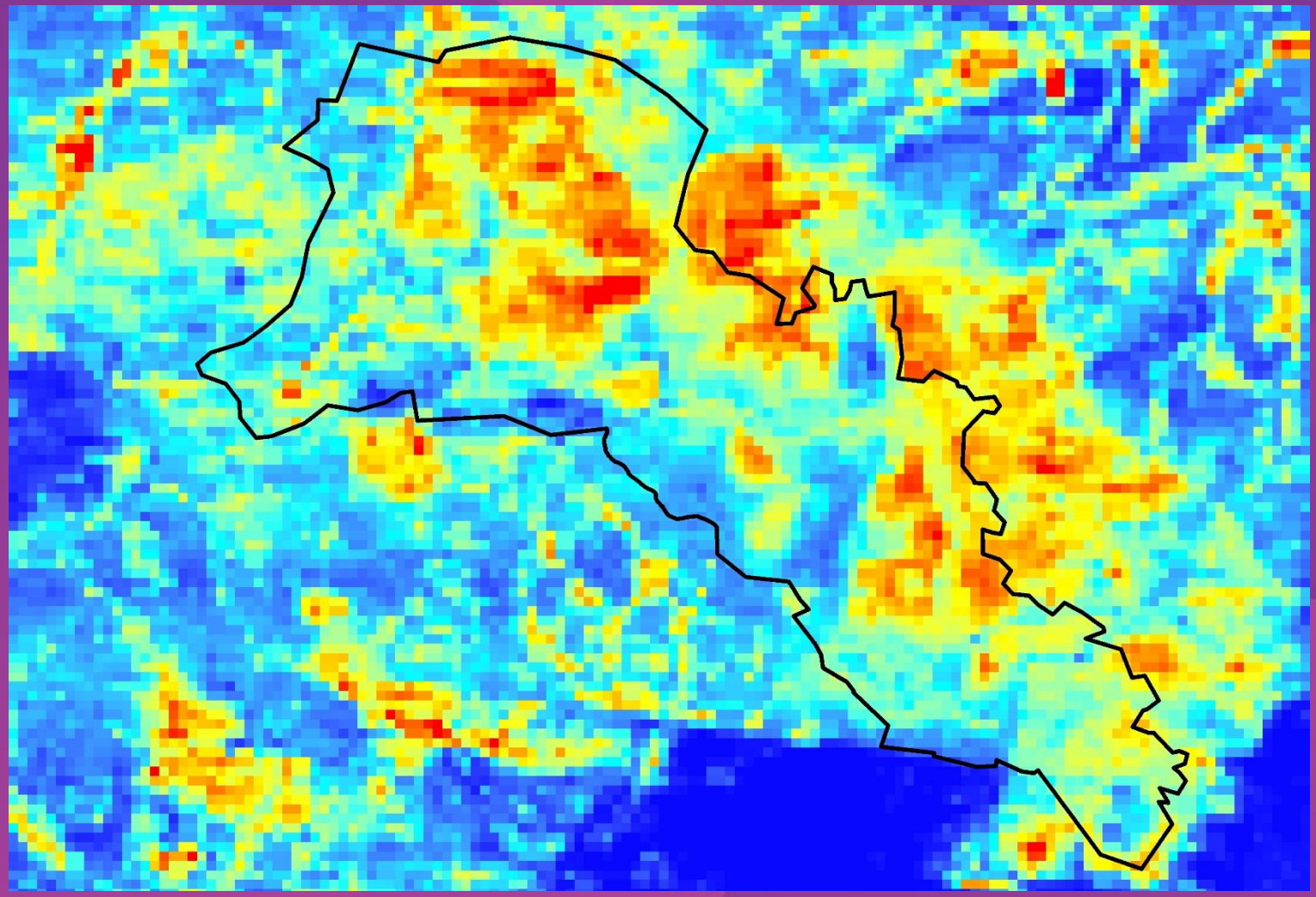


Pierce’s Creek Fire, ignited 1 November 2018

ACT Government

Operational sequence

Elevated fuel
derived from LiDAR

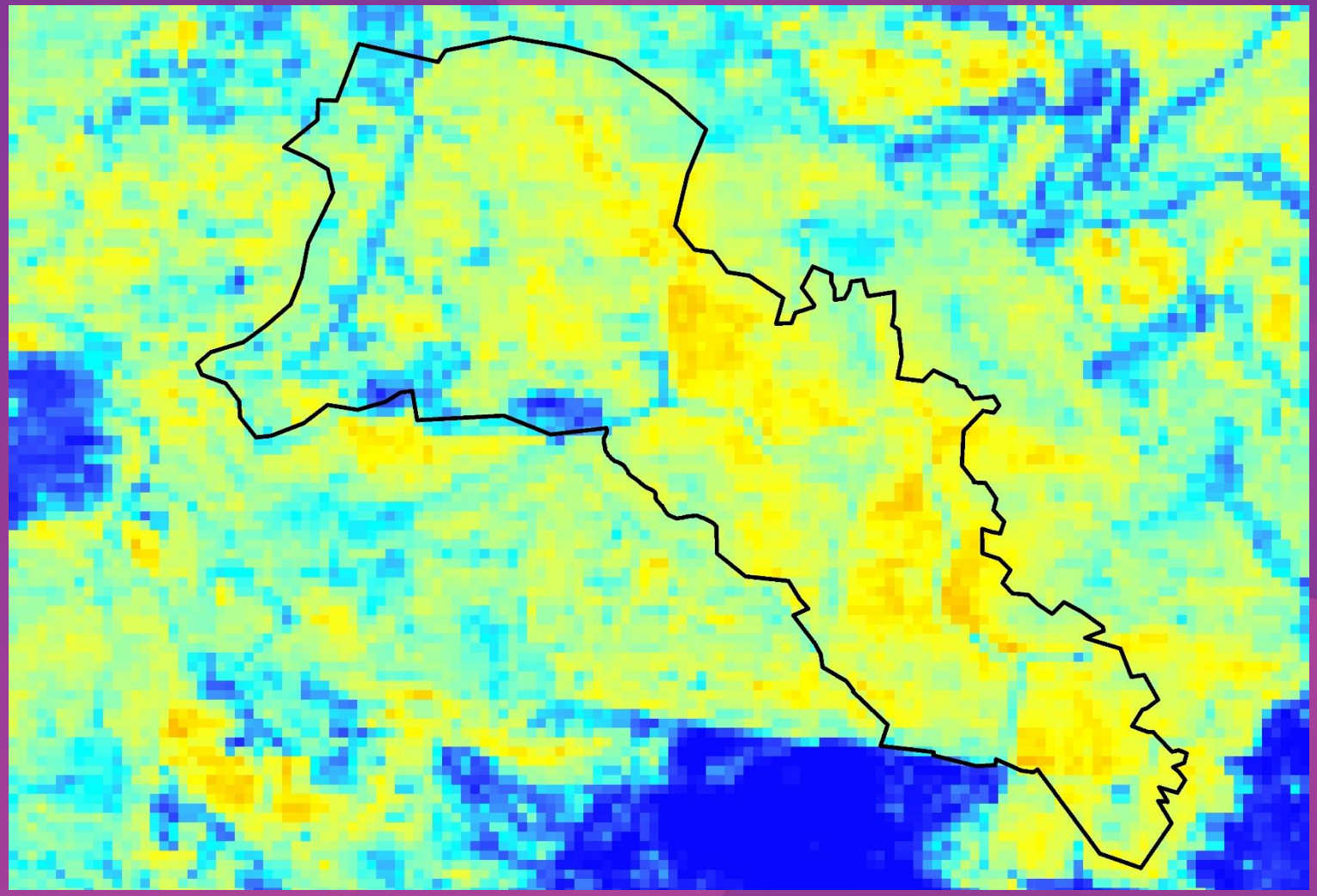


Pierce's Creek Fire, ignited 1 November 2018

ACT Government

Operational sequence

Near-surface fuel
Derived from LiDAR

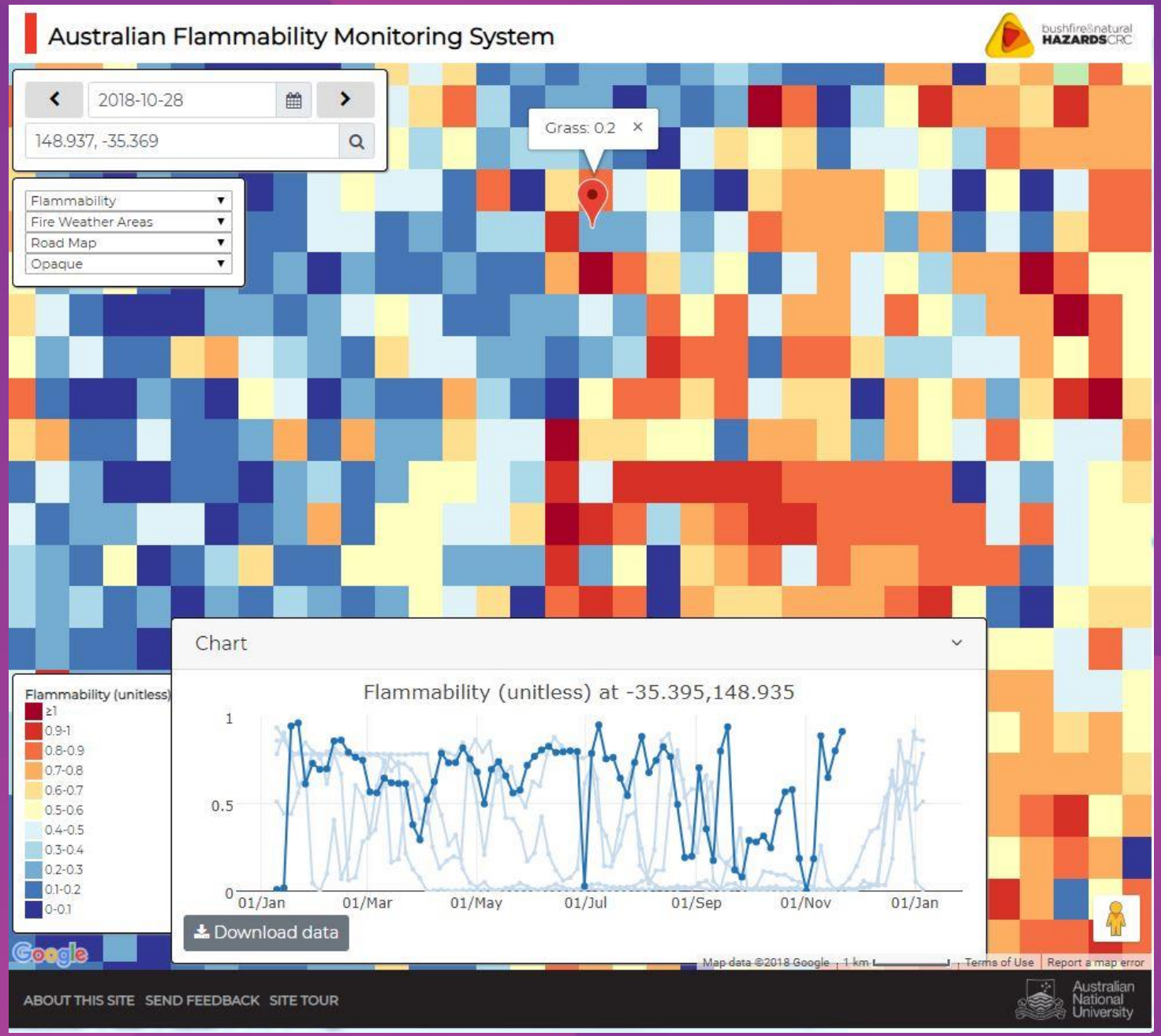


Pierce's Creek Fire, ignited 1 November 2018

ACT Government

Operational sequence

Australian Flammability Monitoring System

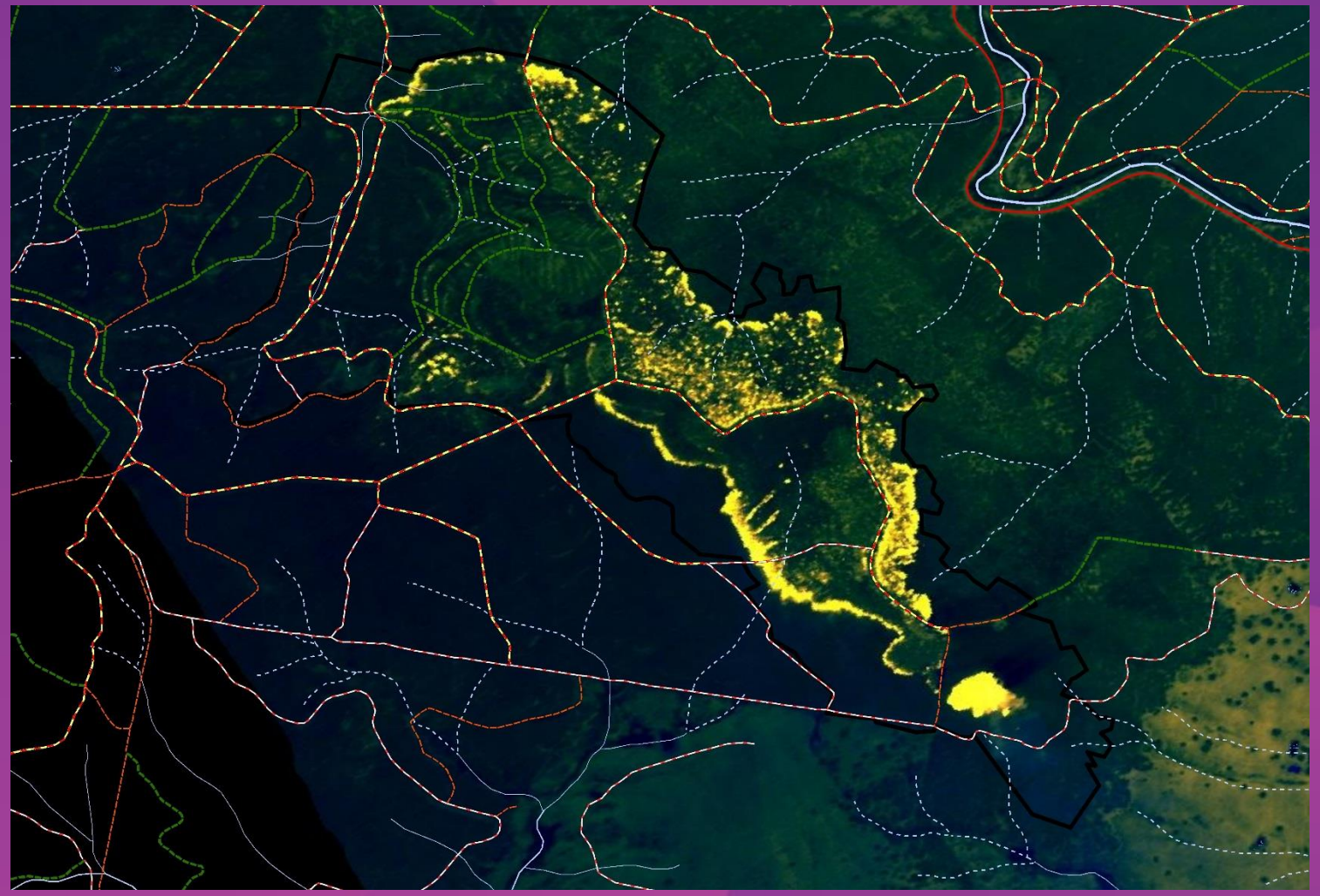


Pierce's Creek Fire, ignited 1 November 2018

ACT Government

Operational sequence

Linescan
2 November 2018, 12:39



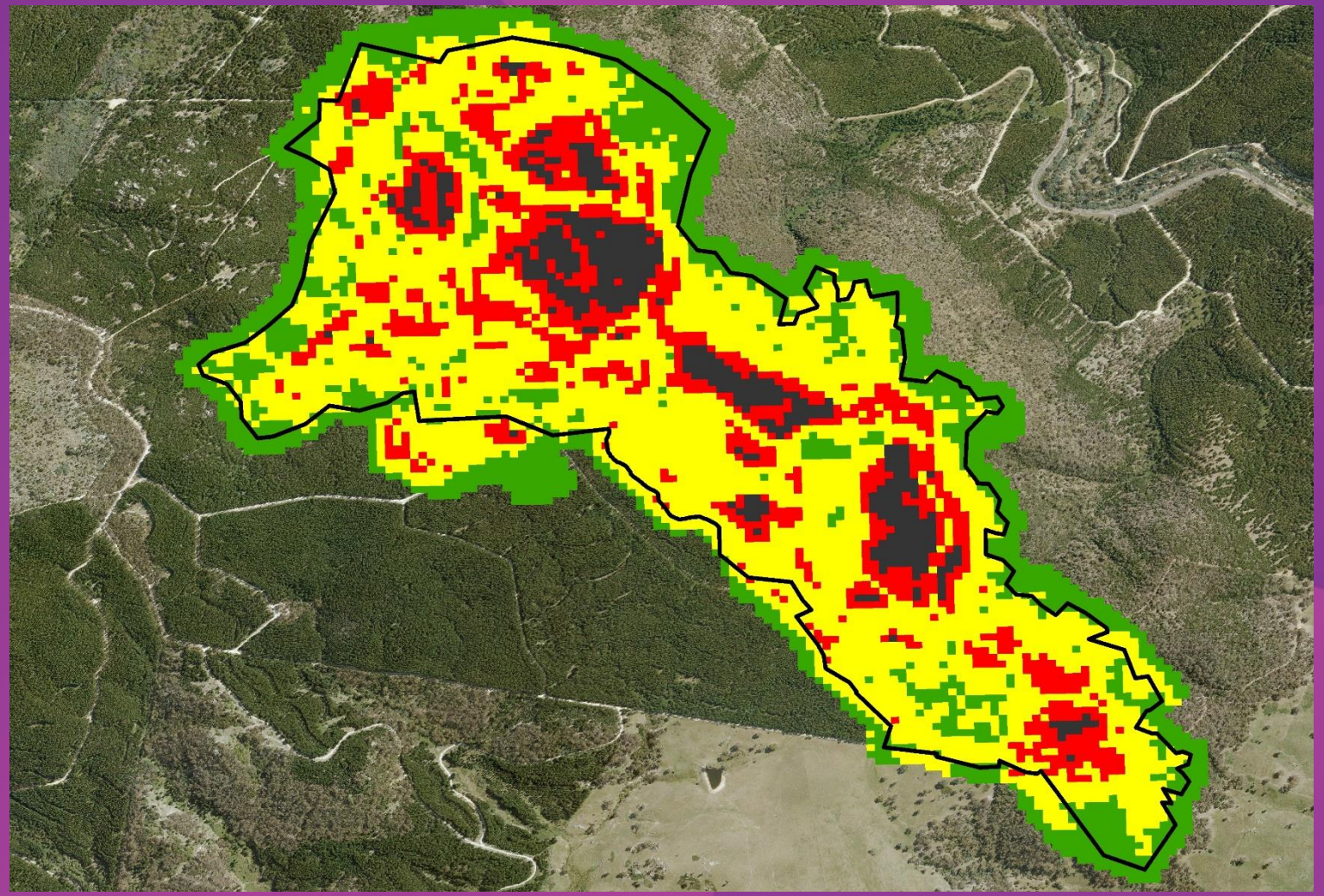
Pierce’s Creek Fire, ignited 1 November 2018

ACT Government

Operational sequence

dNBR – Sentinel 2

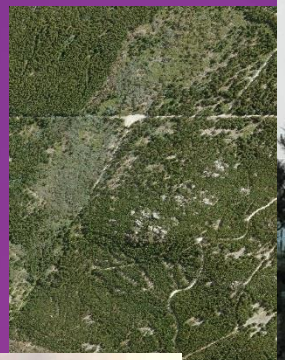
Green = Unburnt
Yellow = Low/Moderate
Red = High
Black = Very high



Pierce's Creek Fire, ignited 1 November 2018

ACT Government

Operational sequence

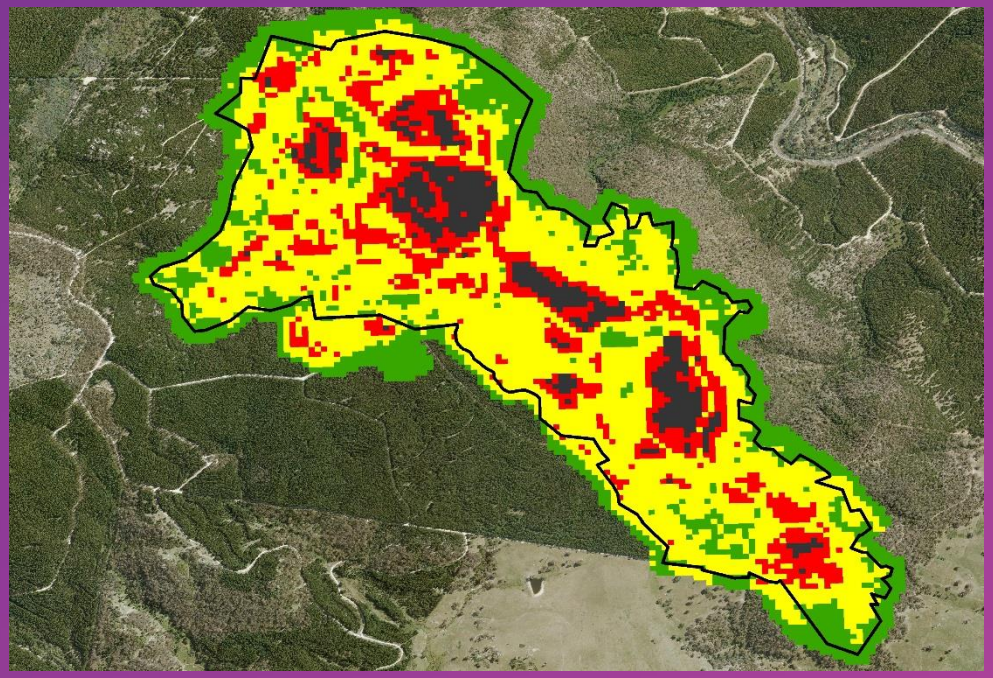


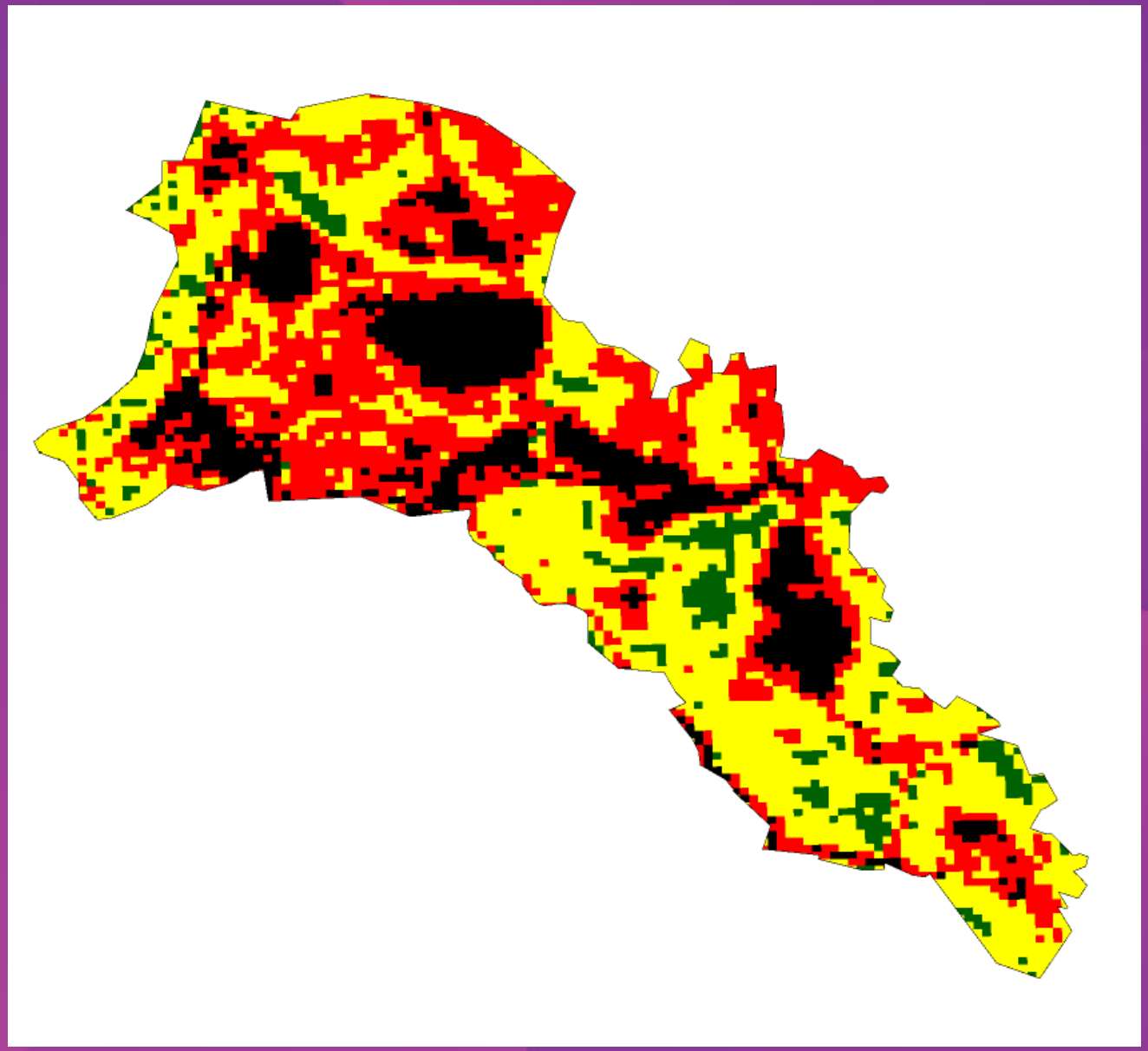
Pierce’s Creek Fire, ignited 1 Novem ber 2018

ACT Government

Vegetation Structure Perpendicular Index

(Massetti et al. 2017)

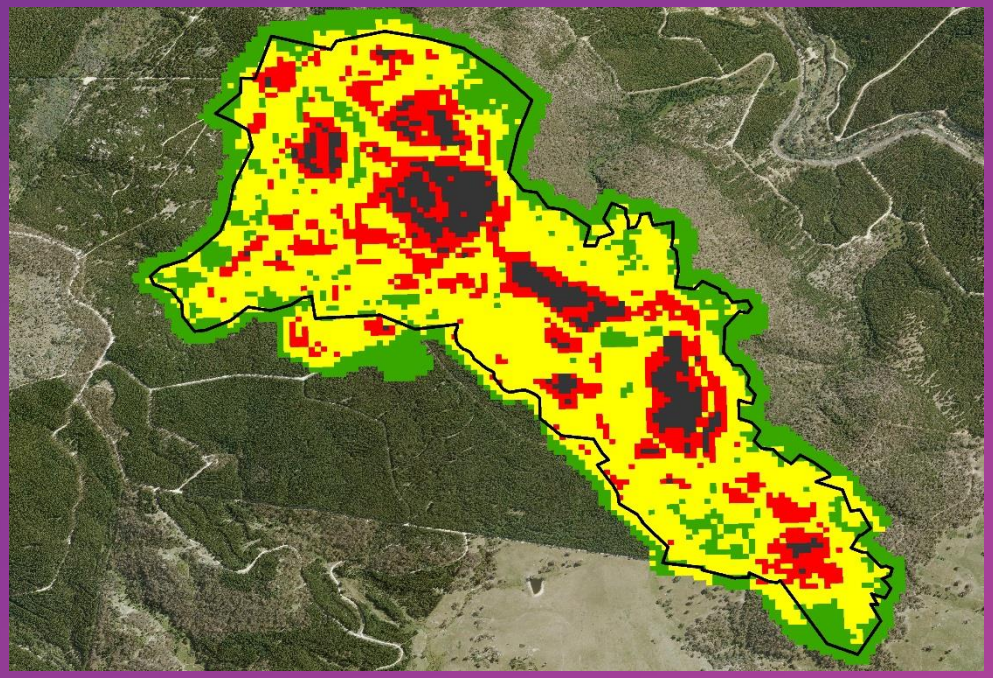


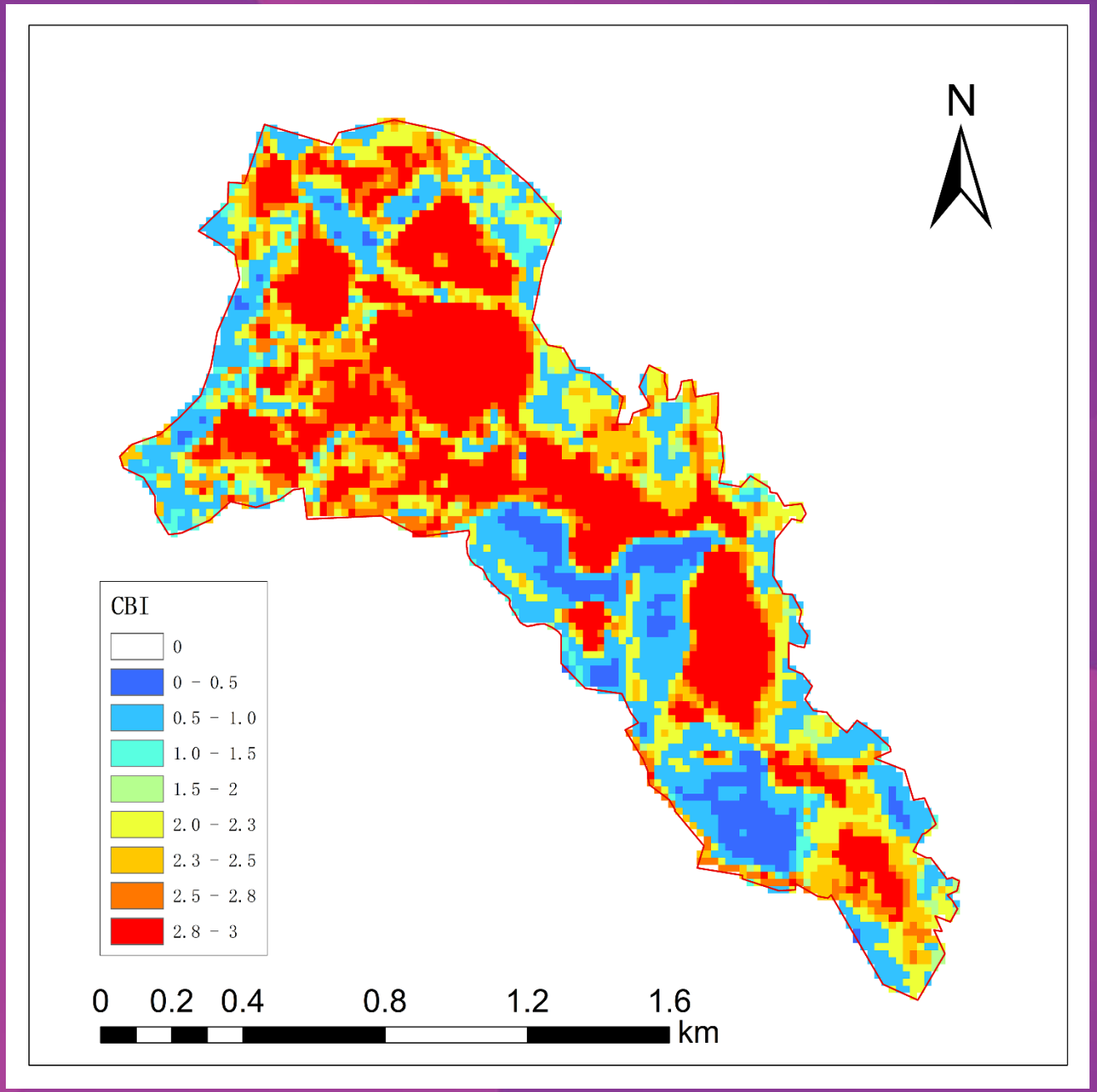


ACT Government

Radiative Transfer Model

(Changming Yin)



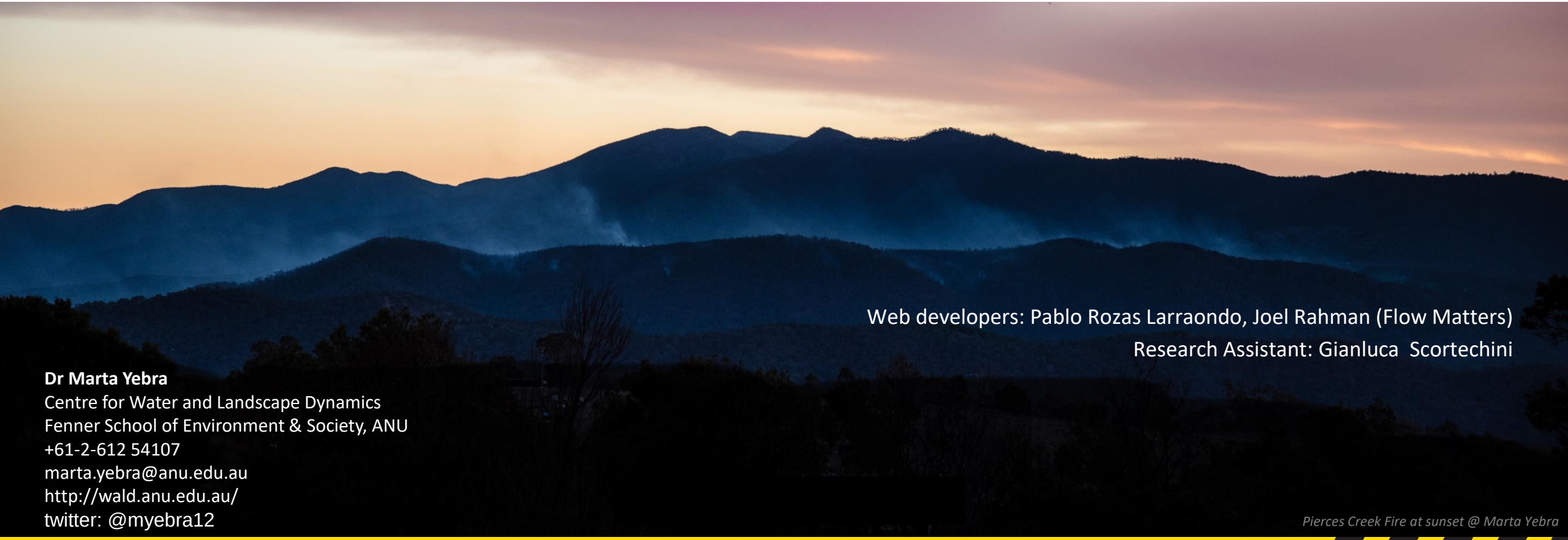


Thanks

See you at
15:30am-16:15 pm
Room Z306

Web developers: Pablo Rozas Larraondo, Joel Rahman (Flow Matters)
Research Assistant: Gianluca Scortechini

Dr Marta Yebra
Centre for Water and Landscape Dynamics
Fenner School of Environment & Society, ANU
+61-2-612 54107
marta.yebra@anu.edu.au
http://wald.anu.edu.au/
twitter: @myebra12



Pierces Creek Fire at sunset @ Marta Yebra