# Mapping bushfire hazard and impacts

Research advisory forum / **2019**

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

@myebra12

@anu_wald

@Li_Zhao

*Pierces Creek Fire at sunset @ Marta Yebra*

bushfire&natural HAZARDSCRC

Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Programme

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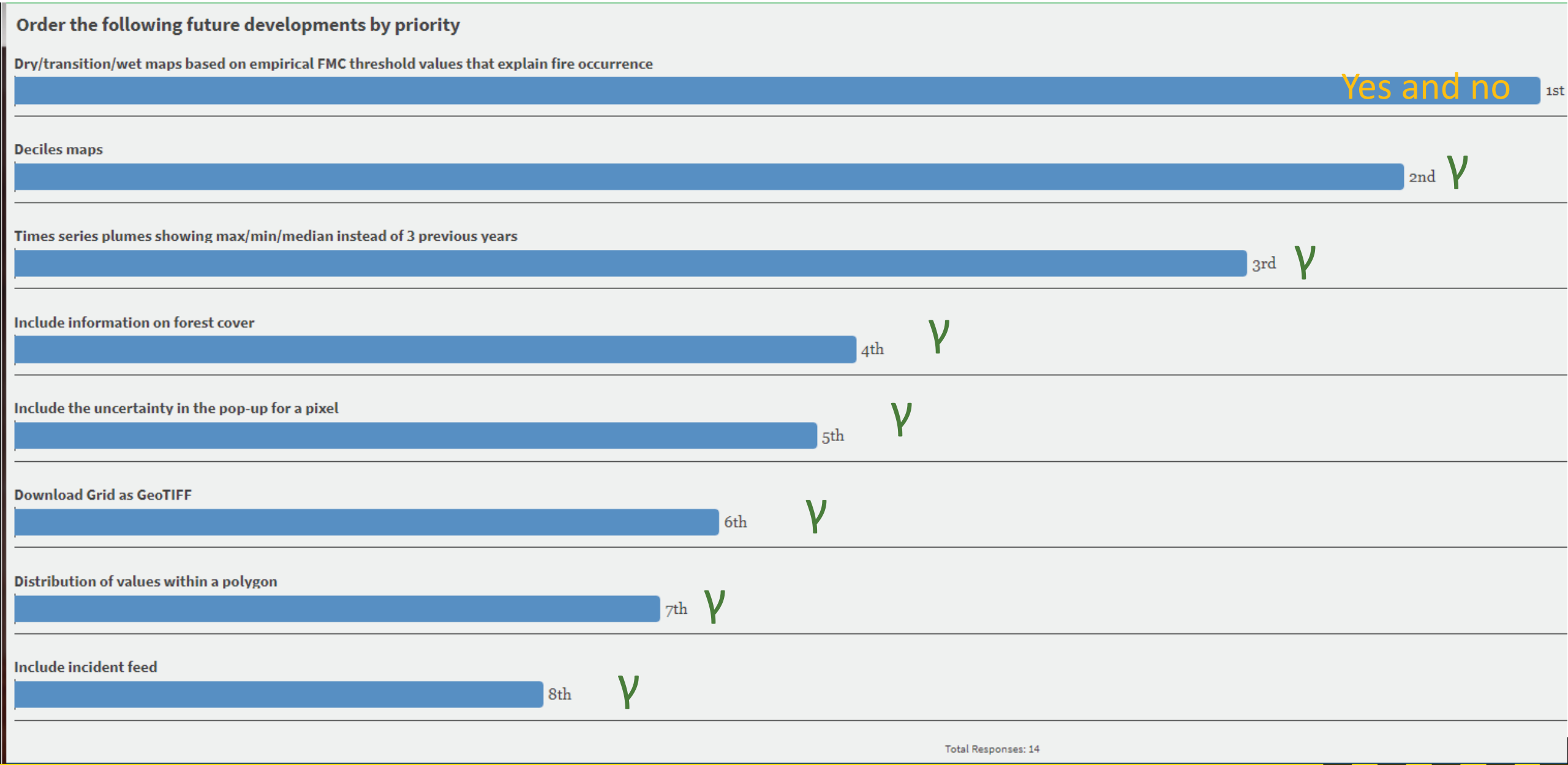
# AFMS: Agreed developments priorities



# Australian Flammability Monitoring System

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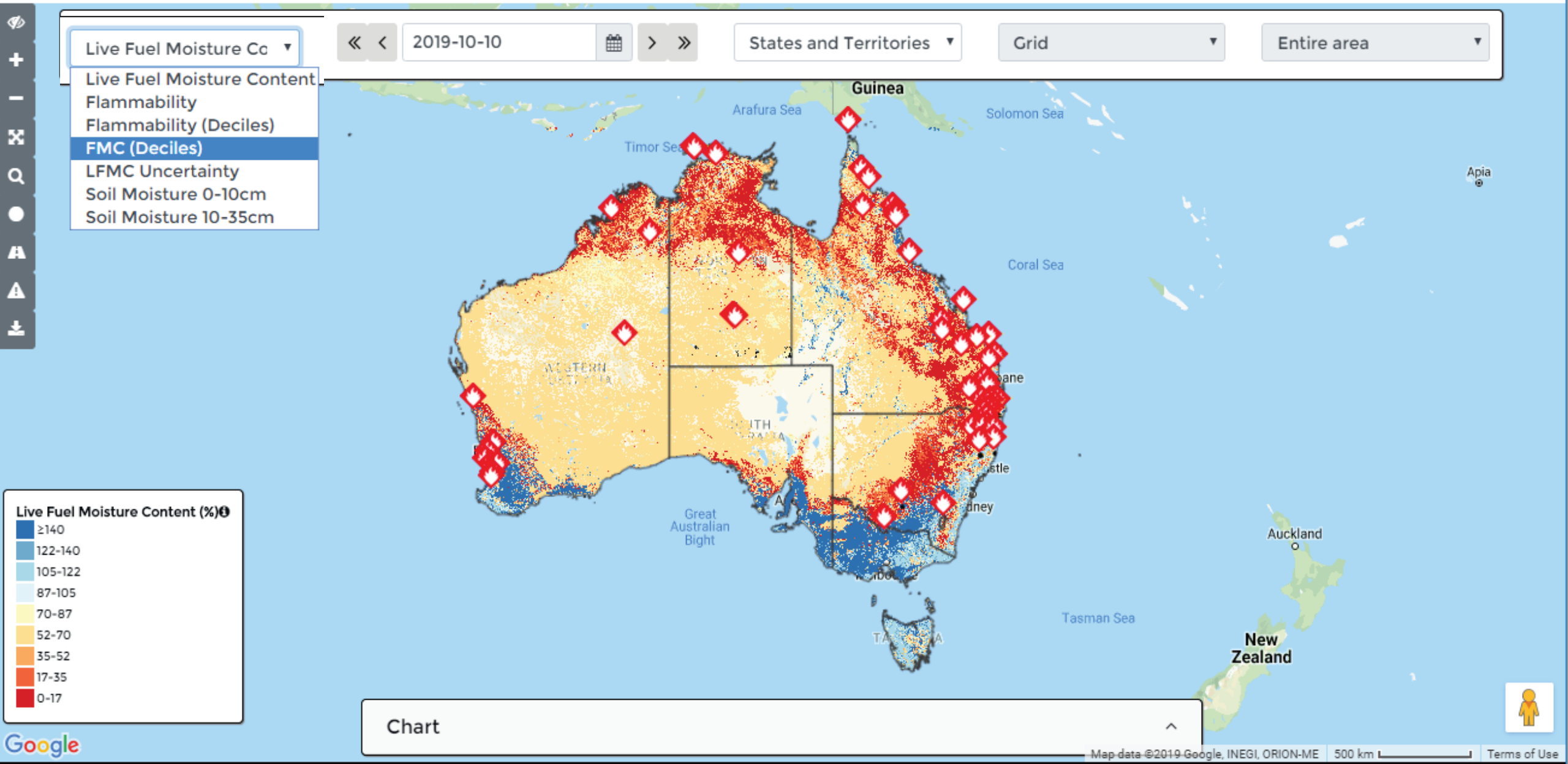


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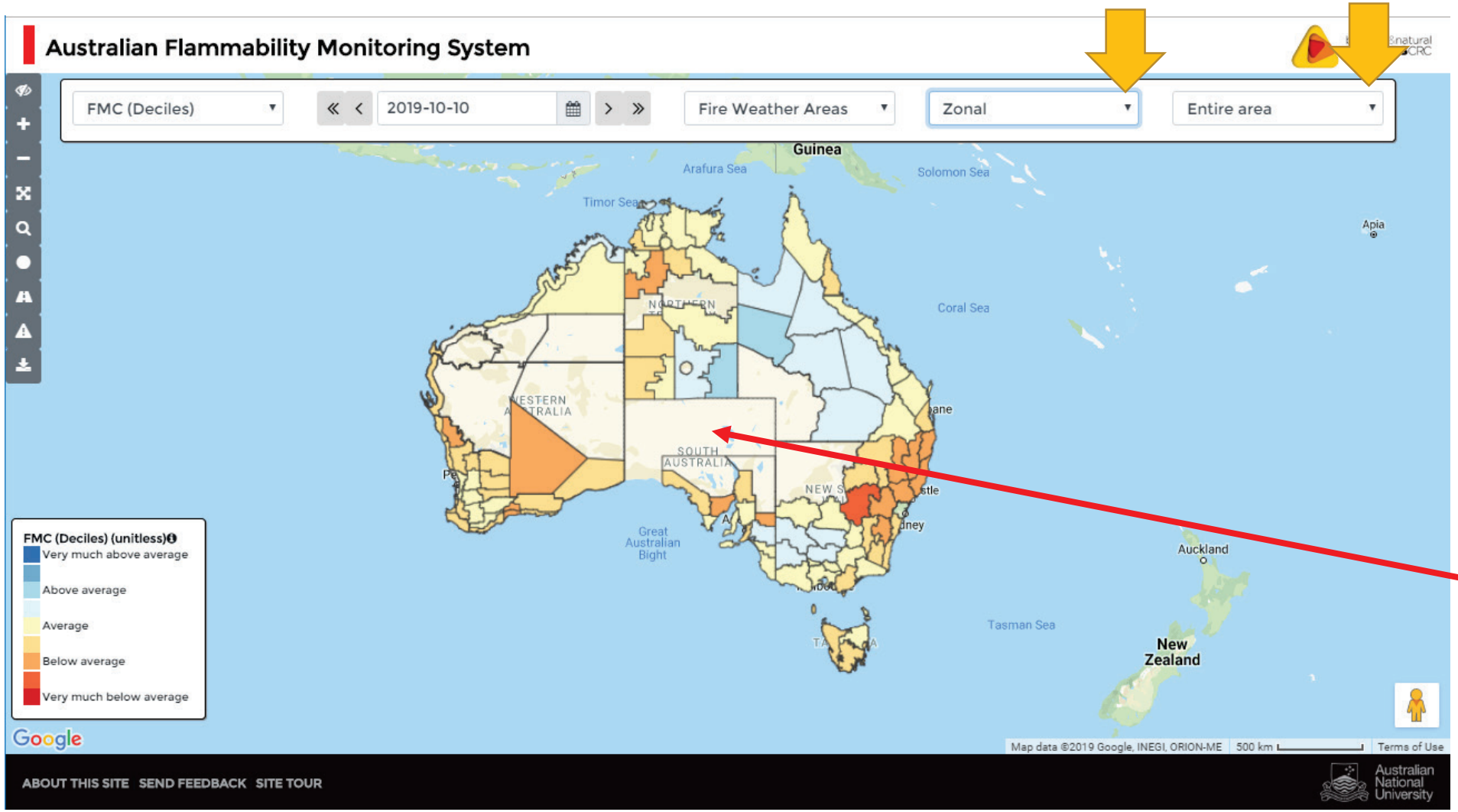
http://anuwald.science/afms

Australian National University

# Deciles maps: will tell you whether FMC or FI is above average, average or below average **in comparison to the observations for a given month in the previous years** (2001-year before current) and for a given pixel ("Grid" view) or region ("Zonal" view, e.g. fire weather areas)



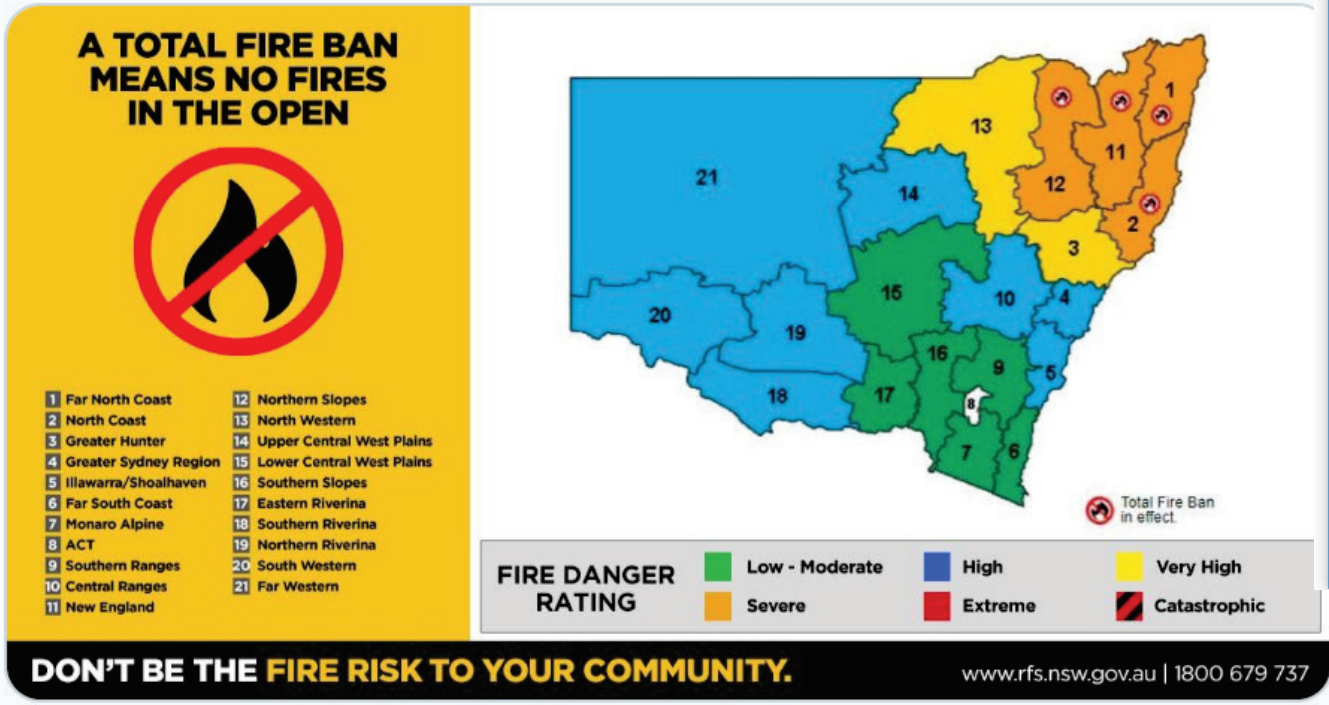

Gaps ~ 85% of valid pixels in the polygon

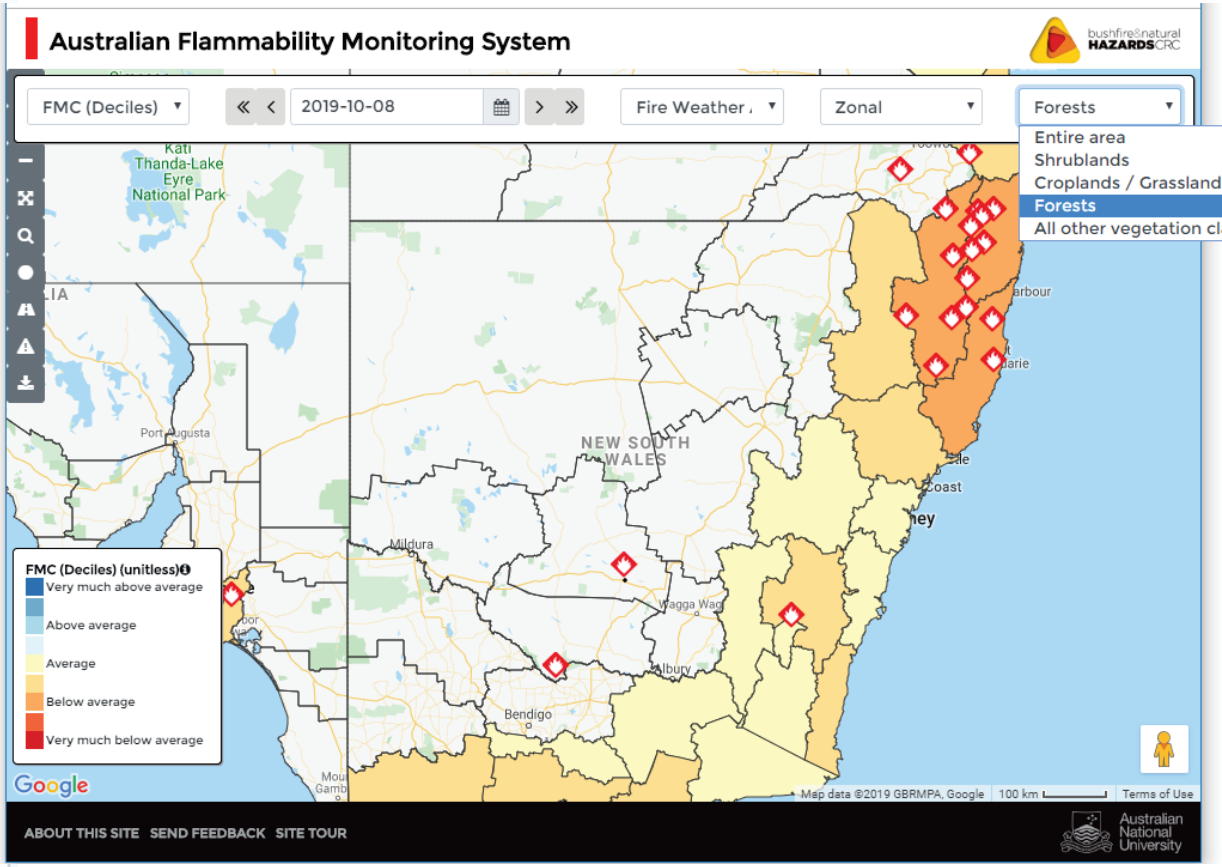
?

# How can deciles maps be used?

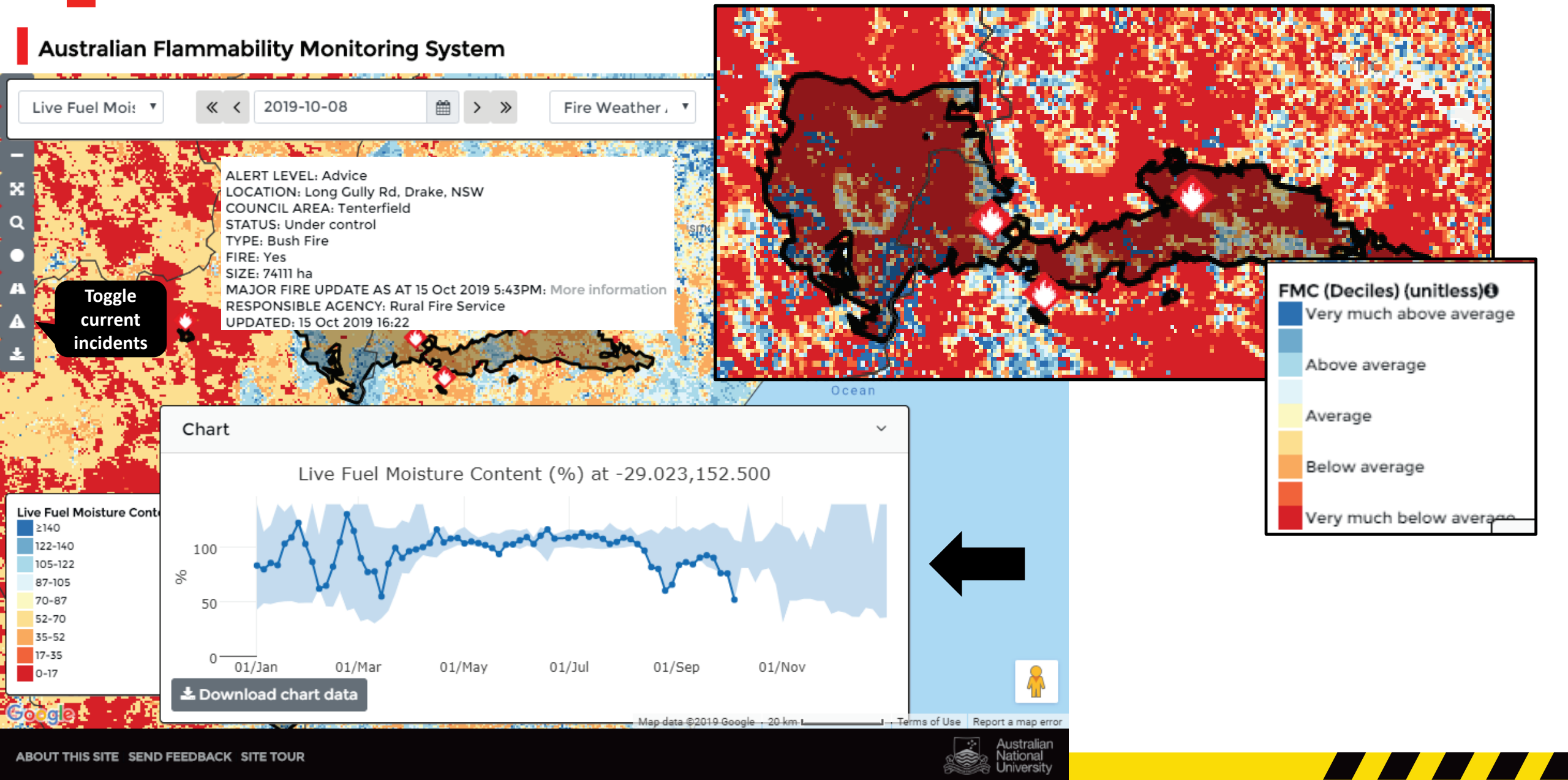
**NSW RFS** @NSWRFS · Oct 8

Hot and dry weather will continue across northern NSW today (Tues 8/10/19), with total fire bans declared for the Far North Coast, North Coast, New England and Northern Slopes. If you're travelling, know the fire danger for your area by checking rfs.nsw.gov.au/fdr #nswrfs



# Other new features



# Australian Flammability Monitoring System

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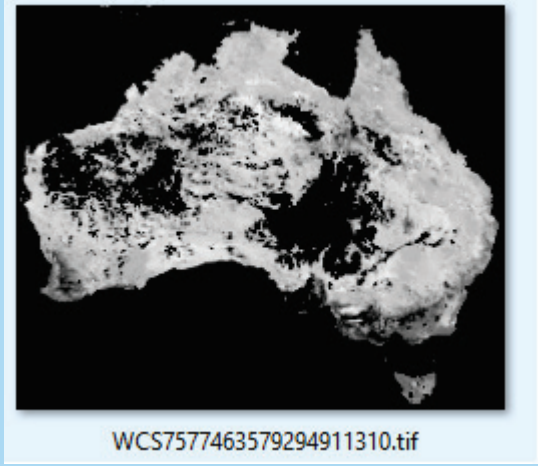
Flammability | « ‹ | 2019-10-16 | › » | States and Territories | | Entire area



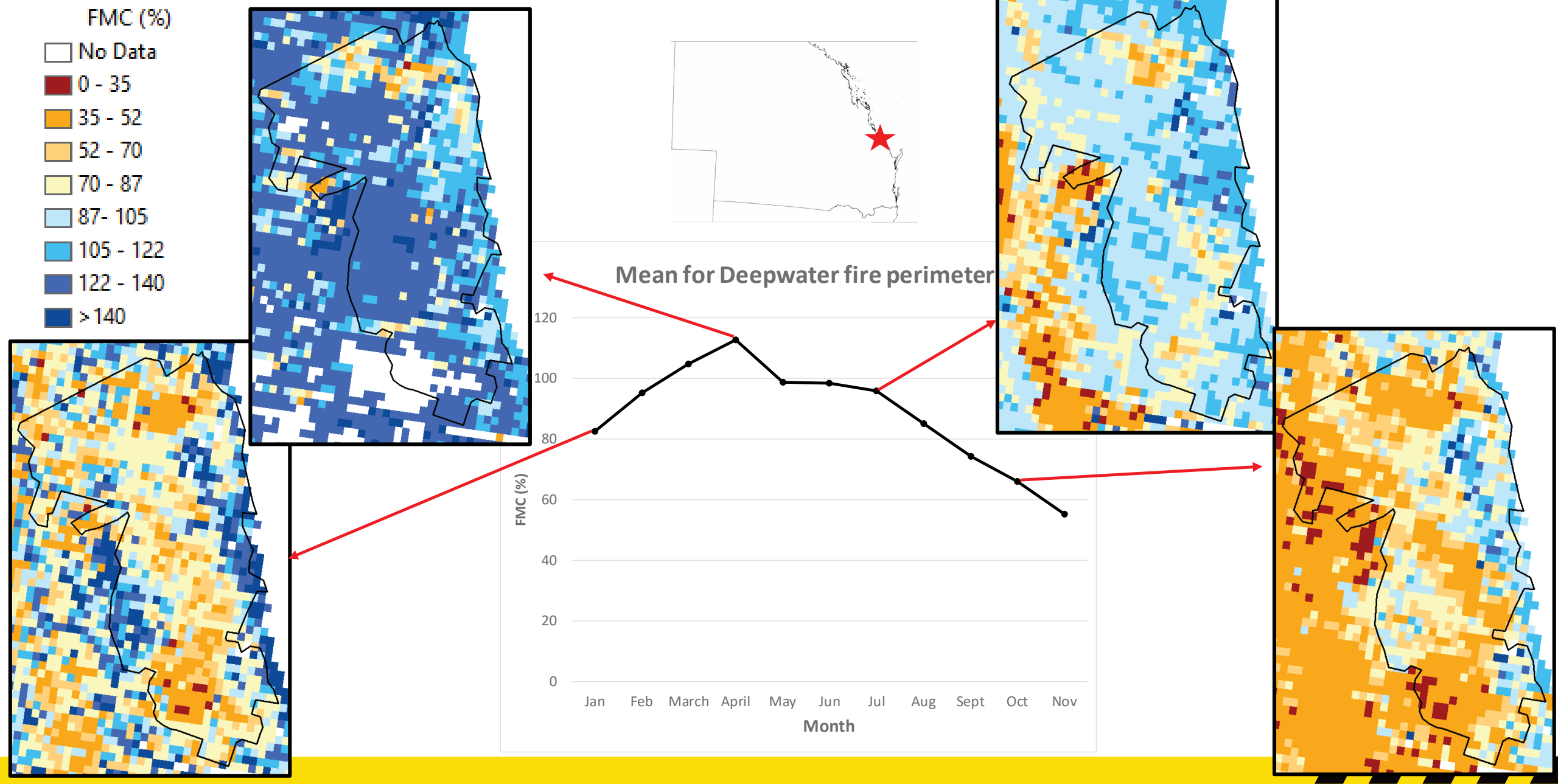
WCS7577463579294911310.tif

Flammability (unitless)
- ≥1
- 0.9-1
- 0.8-0.9
- 0.7-0.8
- 0.6-0.7
- 0.5-0.6
- 0.4-0.5
- 0.3-0.4
- 0.2-0.3
- 0.1-0.2
- 0-0.1

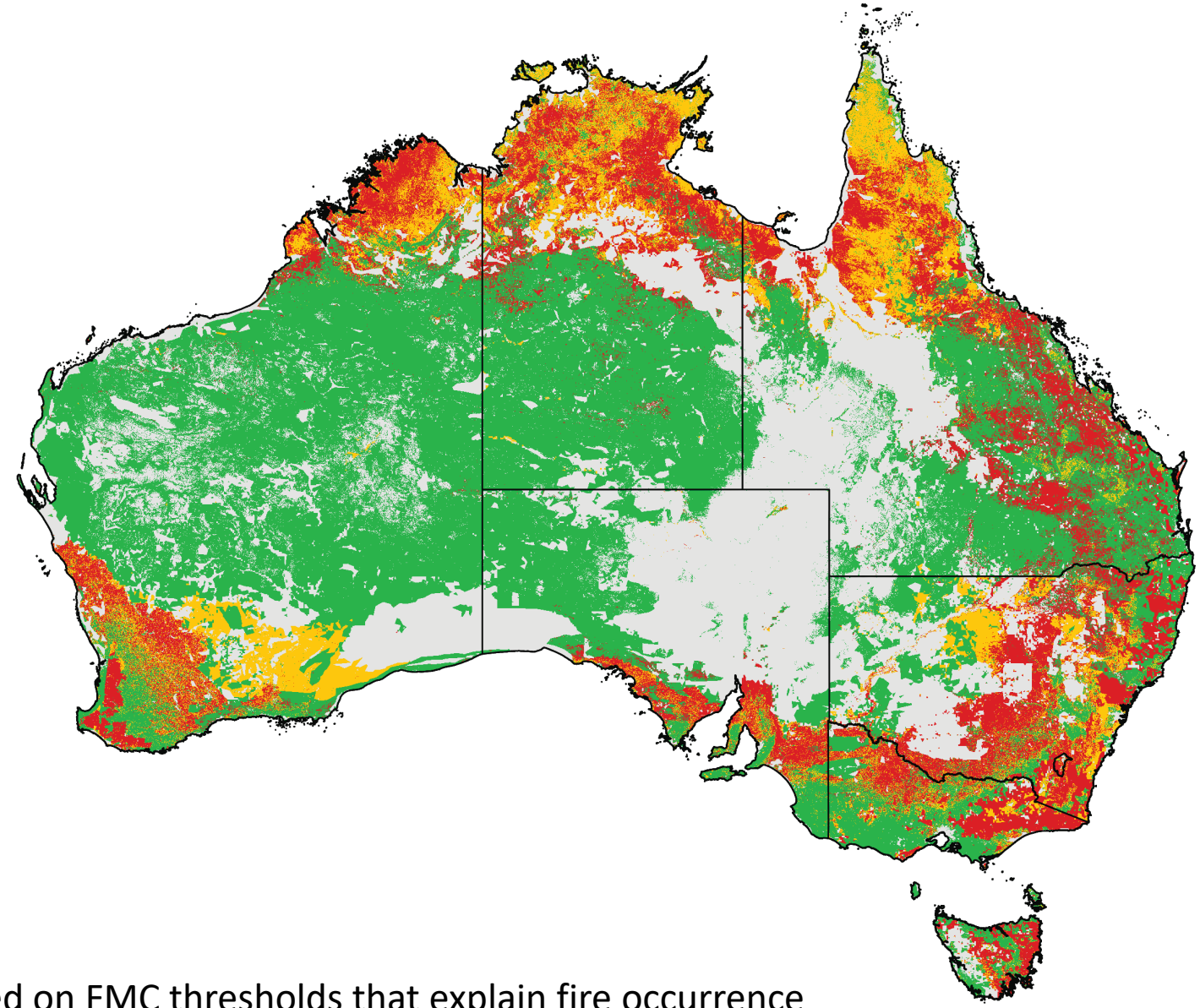
Chart

Google Map data ©2019 Google, INEGI, SK telecom 200 km Terms of Use

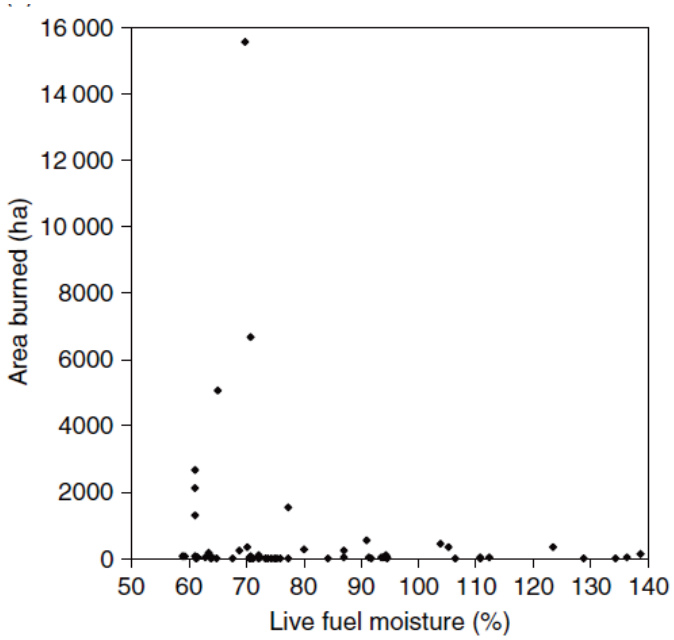
# Temporal FMC dynamics: Deepwater fire 2018



# FMC map for Australia



Wet
Transitional
Dry

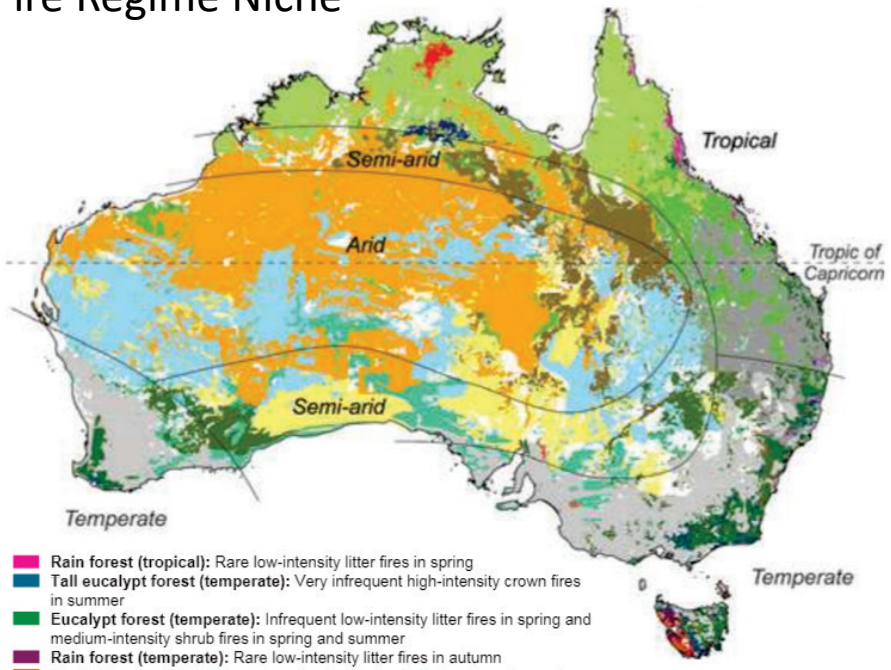



Dennison *et al.* 2008, IJWF

Based on FMC thresholds that explain fire occurrence

# FMC empirical thresholds

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., 2017

# Some examples of current use

David Taylor (Tasmania) " tools for out Fire Duty Officer → Bushfire Operational Hazard Model(BOHM) "… if you were to drop a match how hot a fire would get, **we use that in prepositioning fire crews and patrols**"

Simeon Telfer (WA) "we are using it in the western part of South Australia for **planning our burning** this spring, as some areas are well below average rainfall and are experiencing more dramatic fire behaviour, while other areas are more like average."

Stuart Matthews (NSW) "this (new realise AFMS) is a huge advance in making the data useful for operations!
A couple of things that stand out for me:
-Area averaged moisture deciles (which capture current incidents in NSW very well)
-Being able to see the seasonal state of grasses compared to their usual and range of values."

# Towards a comprehensive Fire Danger Index

**Dependent variable**: Fire ignitions (date+intensity)
**Drivers:**
Fuel condition
- MODIS-derived ***LFMC*** (%) – 500m (Yebra *et al.* 2018)

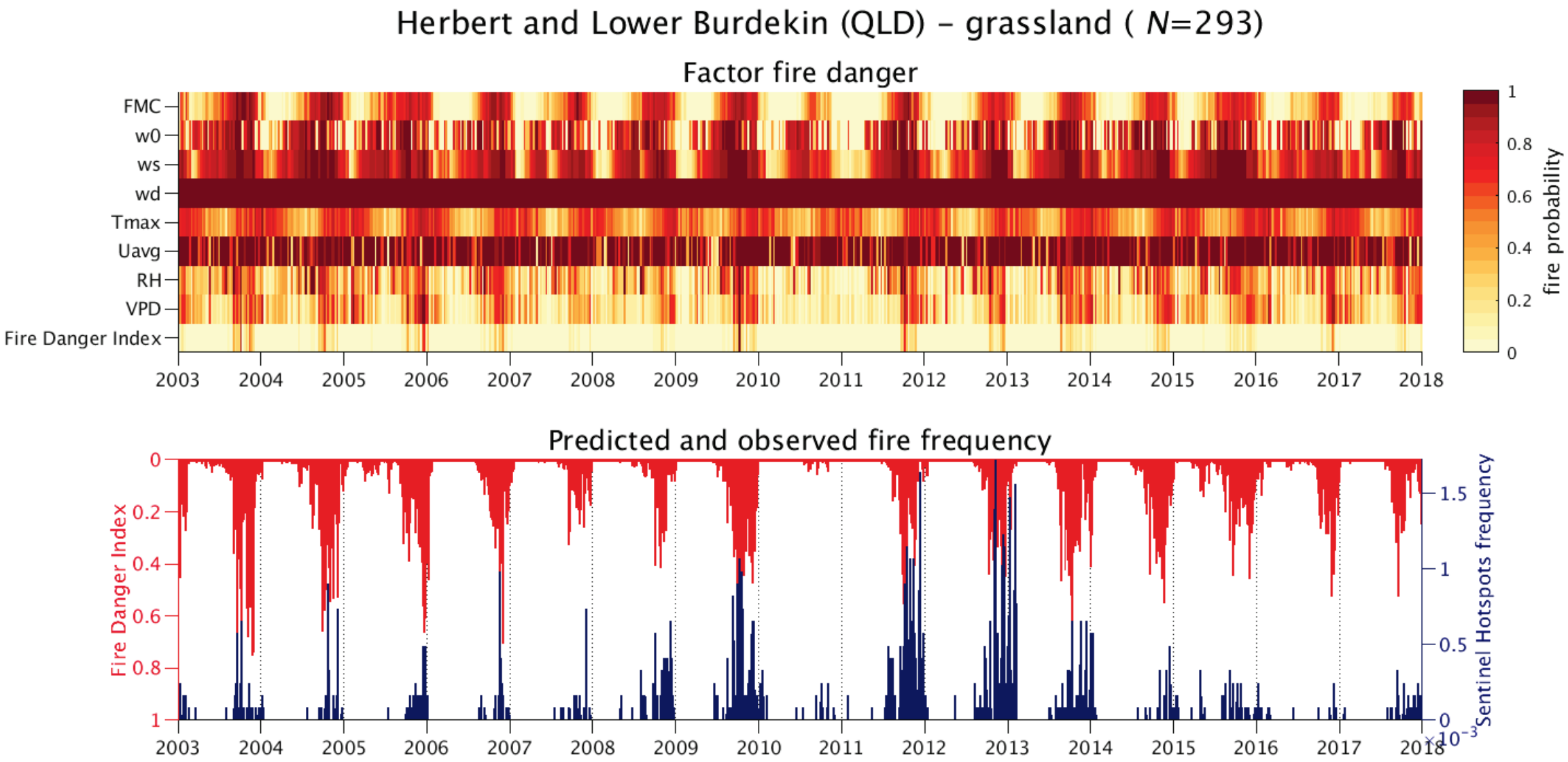
Bureau of Meteorology Landscape water balance model predictions (~5km) (van Dijk, 2010)
- Top soil moisture (***w0***, fraction of plant available water capacity)
- Shallow soil moisture (***ws***)
- Deep soil moisture (***wd***)

Fire weather
Bureau of Meteorology daily gridded climate data (~5km):
- Maximum temperature (***Tmax***, °C)
- Daily mean wind speed (***Uavg***, m/s)

Calculated from *Tmax* and Vapour pressure at 3pm
- Relative Humidity (***RH***, %)
- Vapour pressure deficit (***VPD***, Pa)

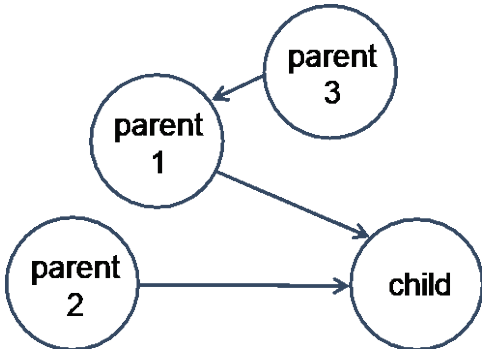
All data available for 2003-2017 and resampled (from 500-m to 5-km) to 2.5 km and daily time step.

# Evaluation example



# Future work: Bayesian Learning Networks

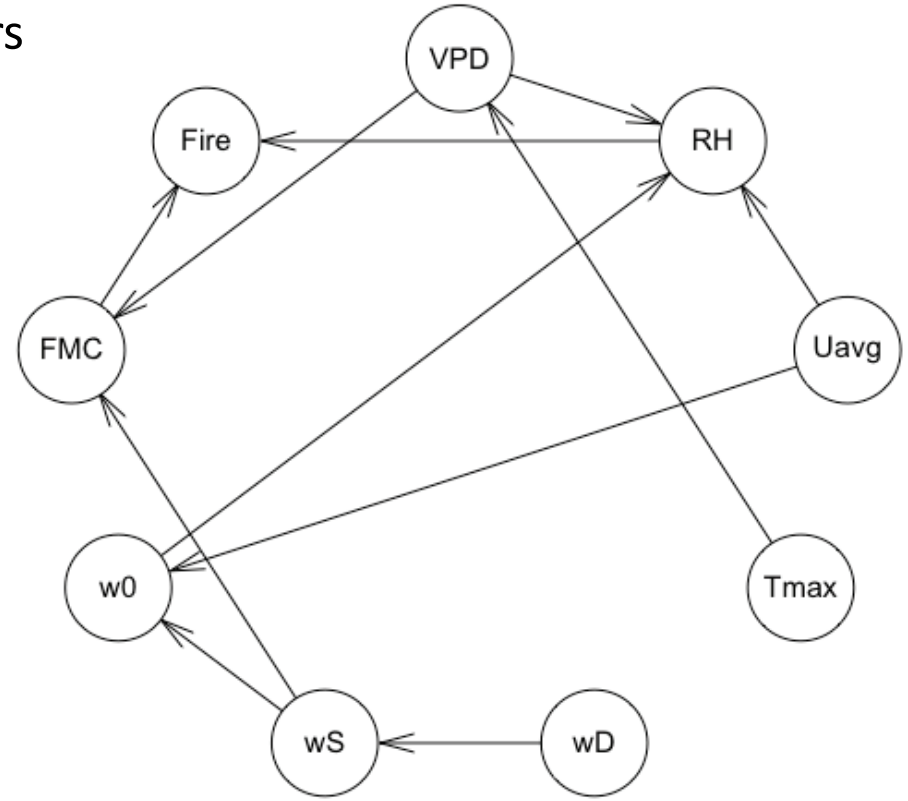
- **Data driven** approach to avoid subjective combining of fire drivers
- Derive **causal relationship** between variables




**Joint distribution**

$$p(\text{child}|\text{par. } 1, \text{par. } 2)p(\text{par. } 1|\text{par. } 3)$$

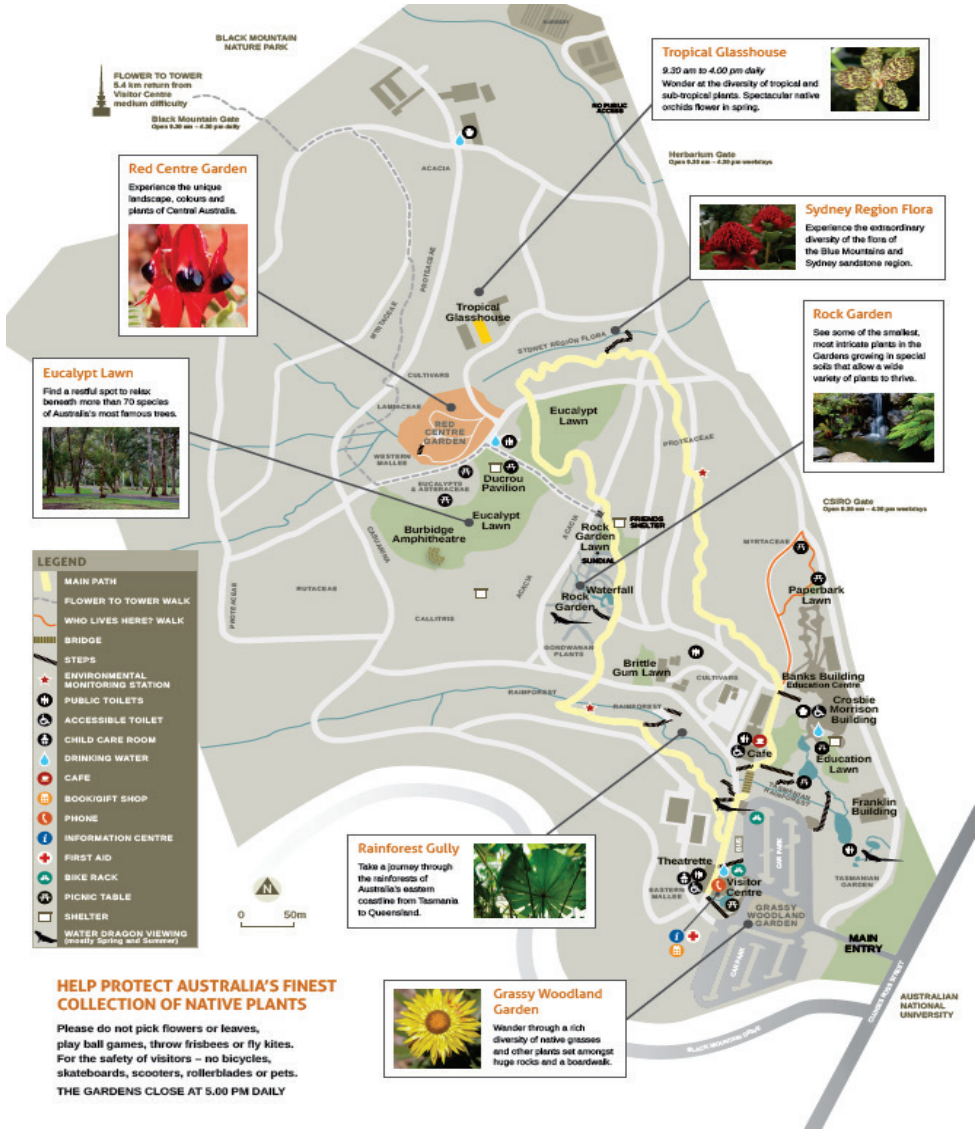
- Provides **joint probability distribution** as inferred from the data

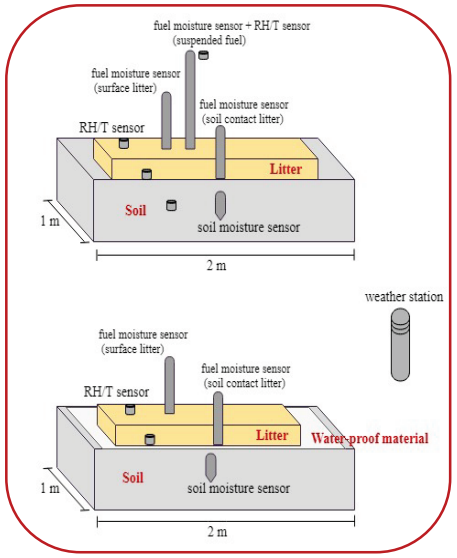


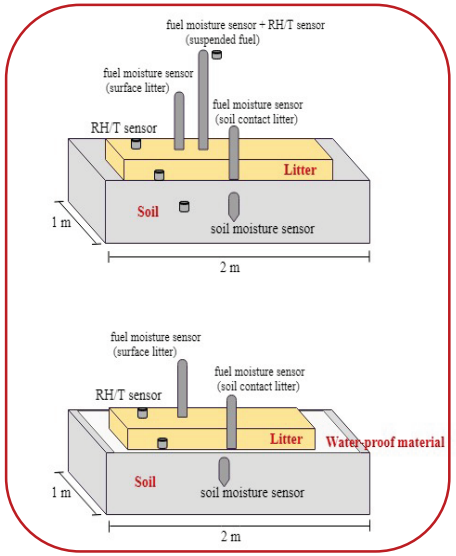

e.g. Region 42

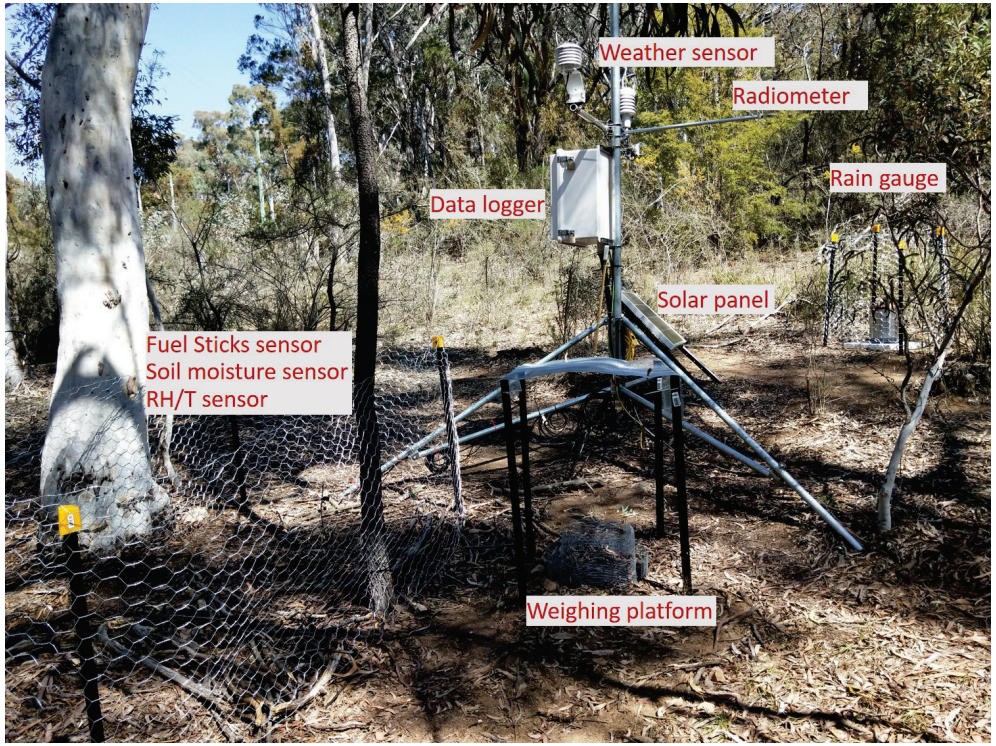
*Joint pd* = *p*(wD) *p*(Tmax) *p*(Uavg) *p*(wS|wD) *p*(VPD|Tmax) *p*(FMC|wS,VPD)
*p*(w0|wS,Uavg) *p*(RH|w0, Uavg, VPD) *p*(Fire|FMC,RH)

# Coupling Litter and soil moisture dynamics for dead FMC





# AFMS: Future developments:

**High-resolution AFMS (<30m)** Using satellite imagery from the Geoscience Australia Digital Earth Australia (GA-DEA) database →pilot areas in the ACT and the Sydney Basin Region.

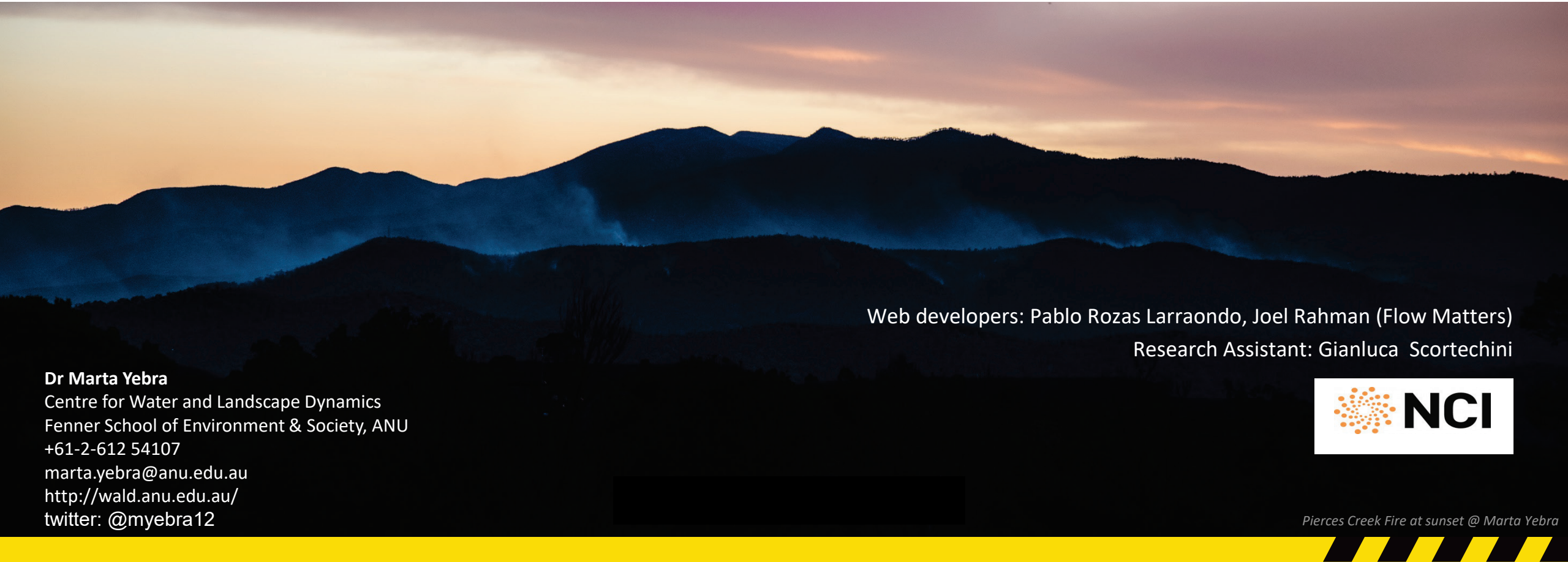
- Open more opportunities for use (e.g. schedule and plan prescribed burns in topographic terrain)

- Facilitate the sustainability of the AFMS in the longer term, as we transition the current service to GAInclude

**Include our new FDI**

**Fire Danger forecast** (using BoM ACCESS weather forecast)

# Thanks



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*