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MULTI-TEMPORAL AND -SPATIAL REMOTE SENSING IMAGERY TO MONITOR FLAMMABILITY IN AUSTRALIA

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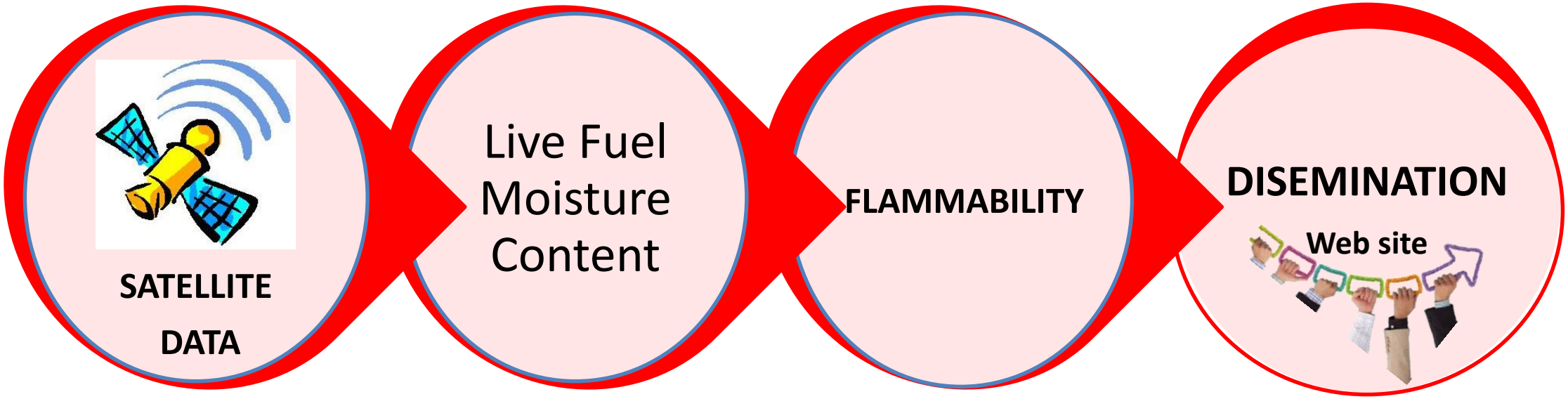
Australian Government
Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme

ANU WATER & LANDSCAPE DYNAMICS

Australian National University

THE AUSTRALIAN FLAMMABILITY MONITORING SYSTEM (AFMS)

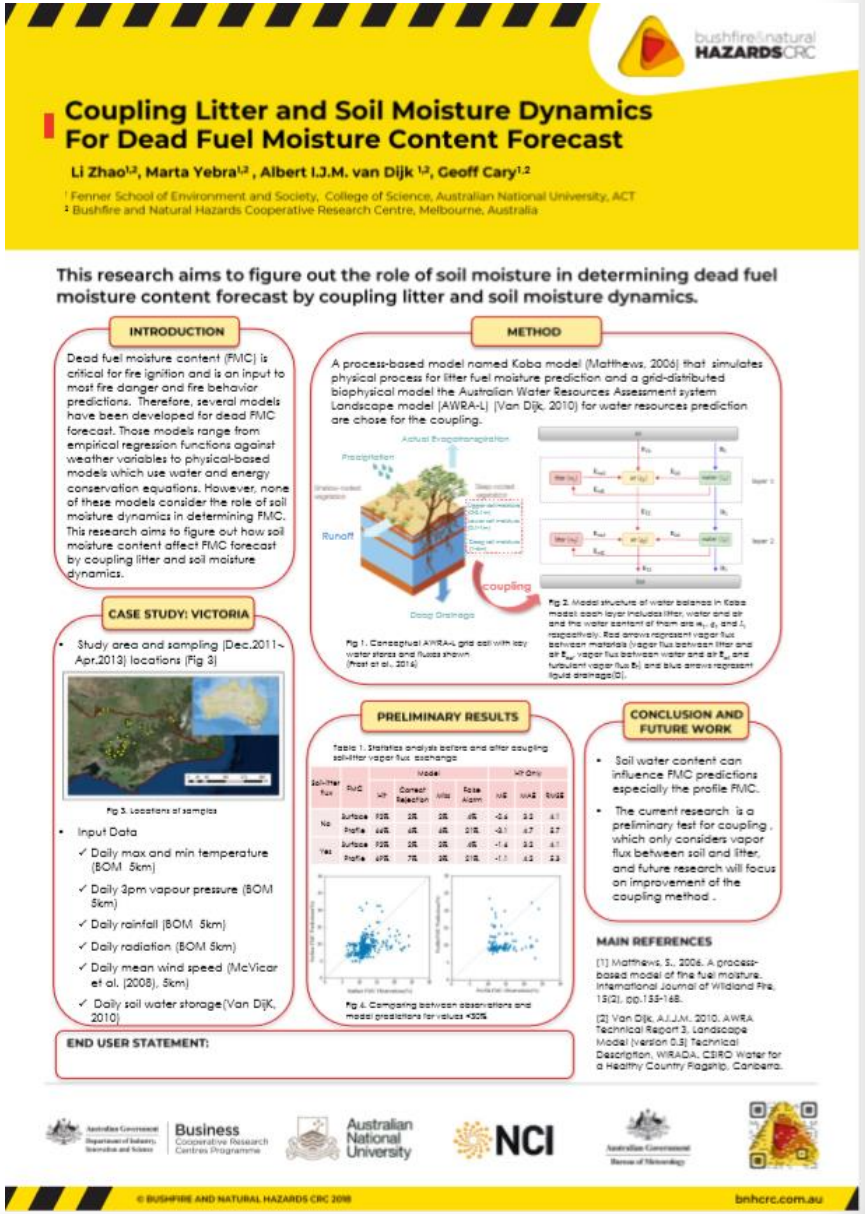
First **continental-scale** web site providing spatial information on landscape-scale **live fuel moisture content and flammability** derived from **satellite observations (currently MODIS)**



LIVE VERSUS DEAD FUEL MOISTURE

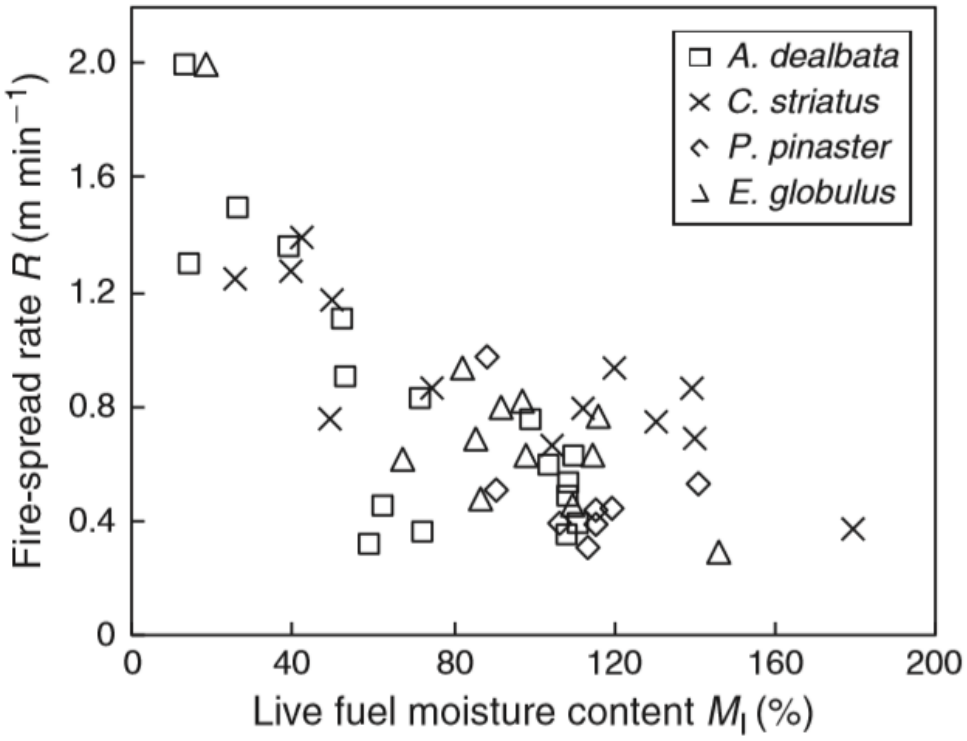
- **LIVE fuel moisture:**
  - FMC of Living plants (grass, shrub, forest)
  - Typically ranges 30-300%
  - Varies over space, species and seasons

- **DEAD fuel moisture**
  - FMC of Dead plants, forest litter, slash, etc.
  - Typically <30% in absence of surface free water
  - Can change quickly over time and space



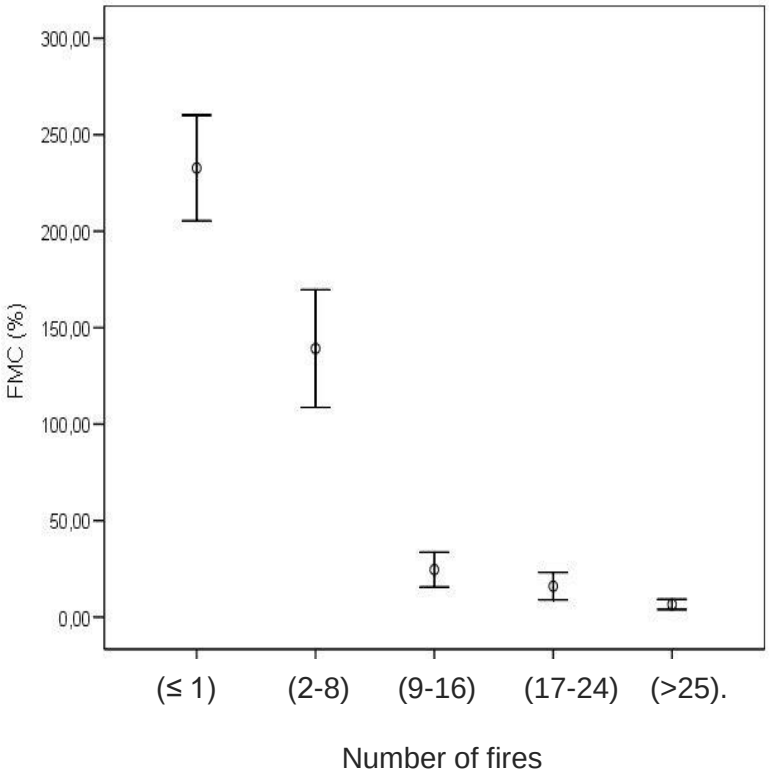
WHY MONITORING LIVE FUEL MOISTURE CONTENT?

Forest

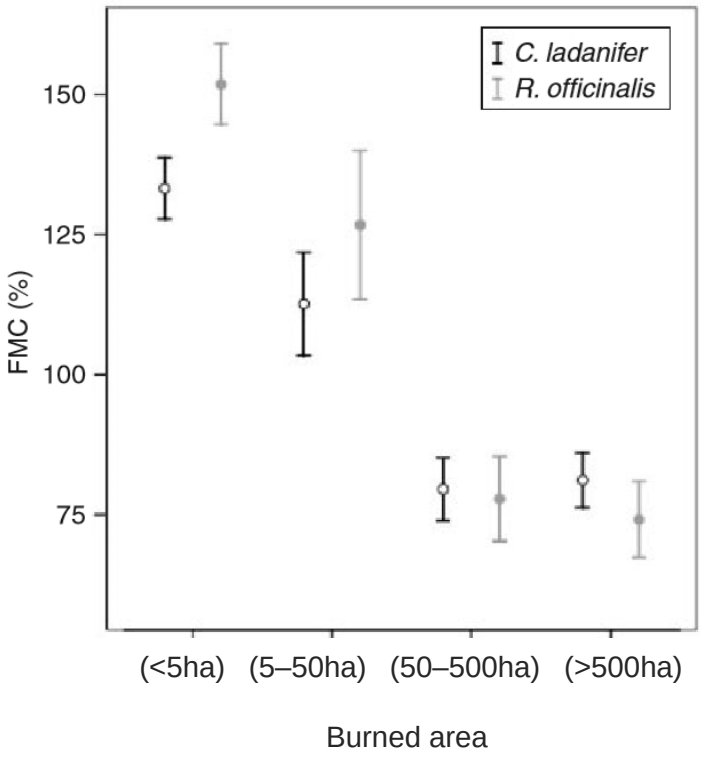


Rossa *et al.*, 2016, IJWF

Grass



Mediterranean Shrub

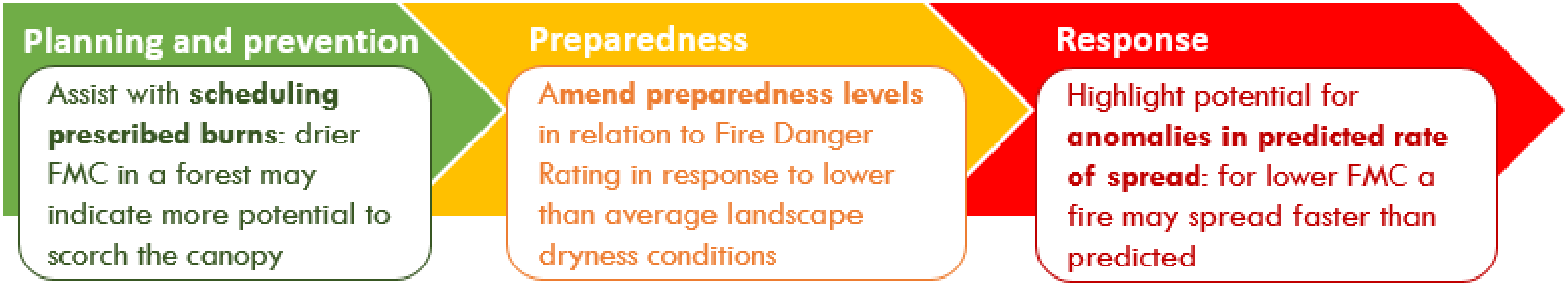


Chuvieco *et al.* 2009, IJWF

WHY CREATE A WEB SITE?

To make spatially- and temporally- explicit information on live FMC and flammability **easier and faster to access**

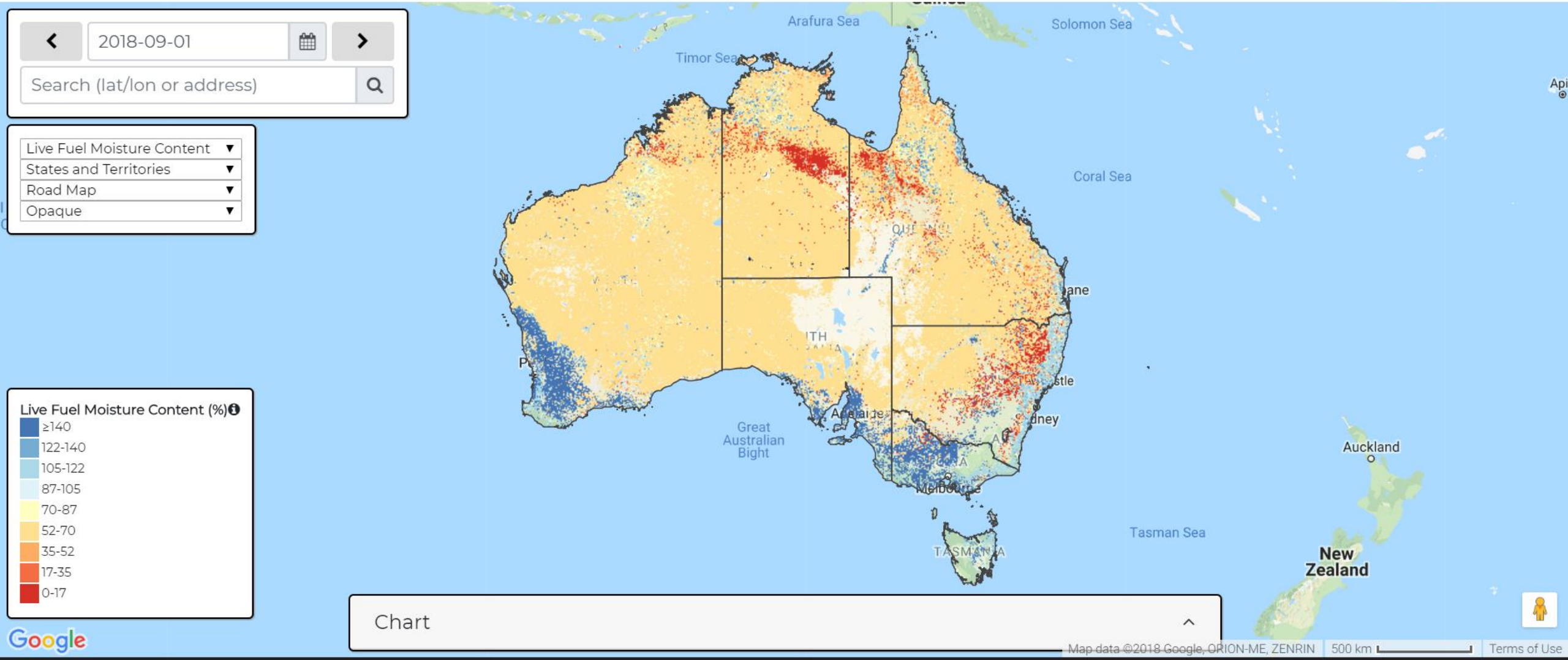
Automated, Systematic, Real time, Nation-wide



DATA CURRENTLY DISPLAYED

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	Daily	2 days	Yebra *et al.* 2018
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	7 days	7 days	Dharssi *et al.* 2017

Australian Flammability Monitoring System



ABOUT THIS SITE SEND FEEDBACK SITE TOUR

http://wenfo.org/afms/

bnhcrc.com.au

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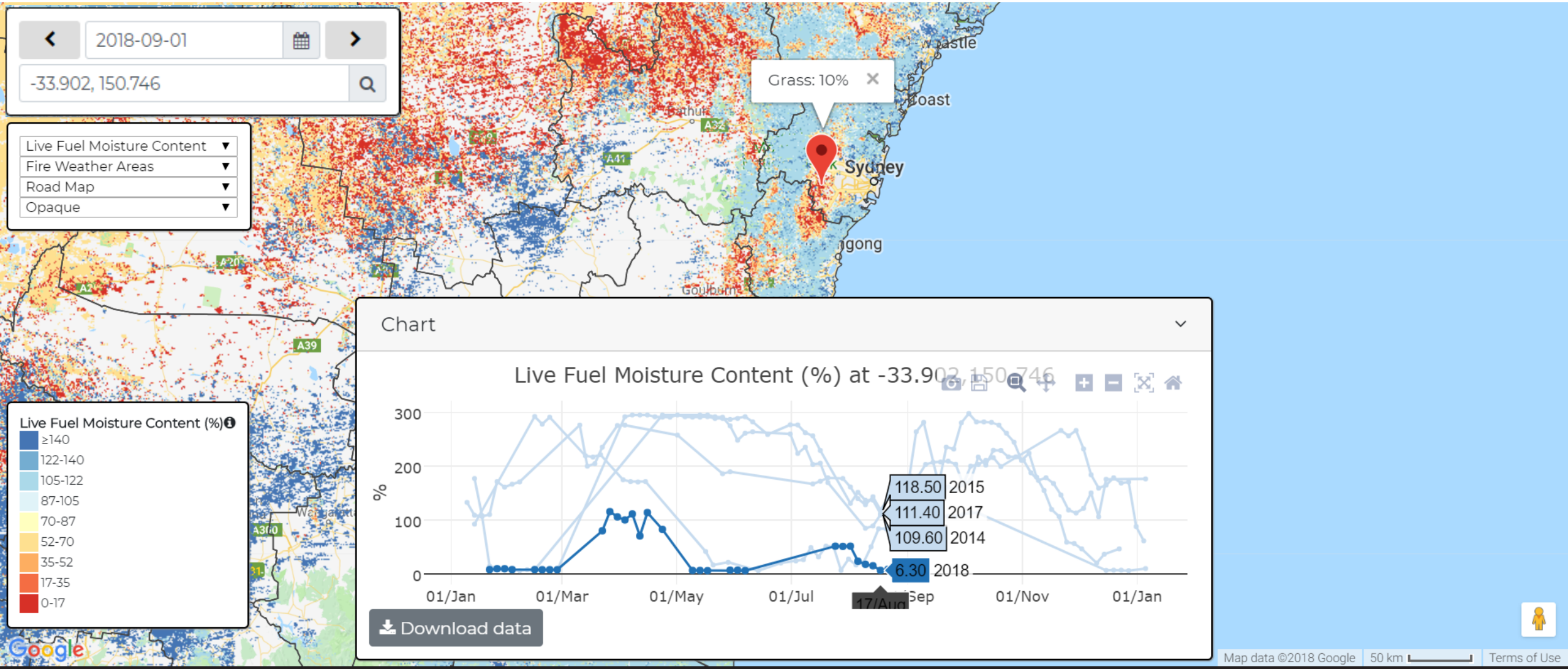

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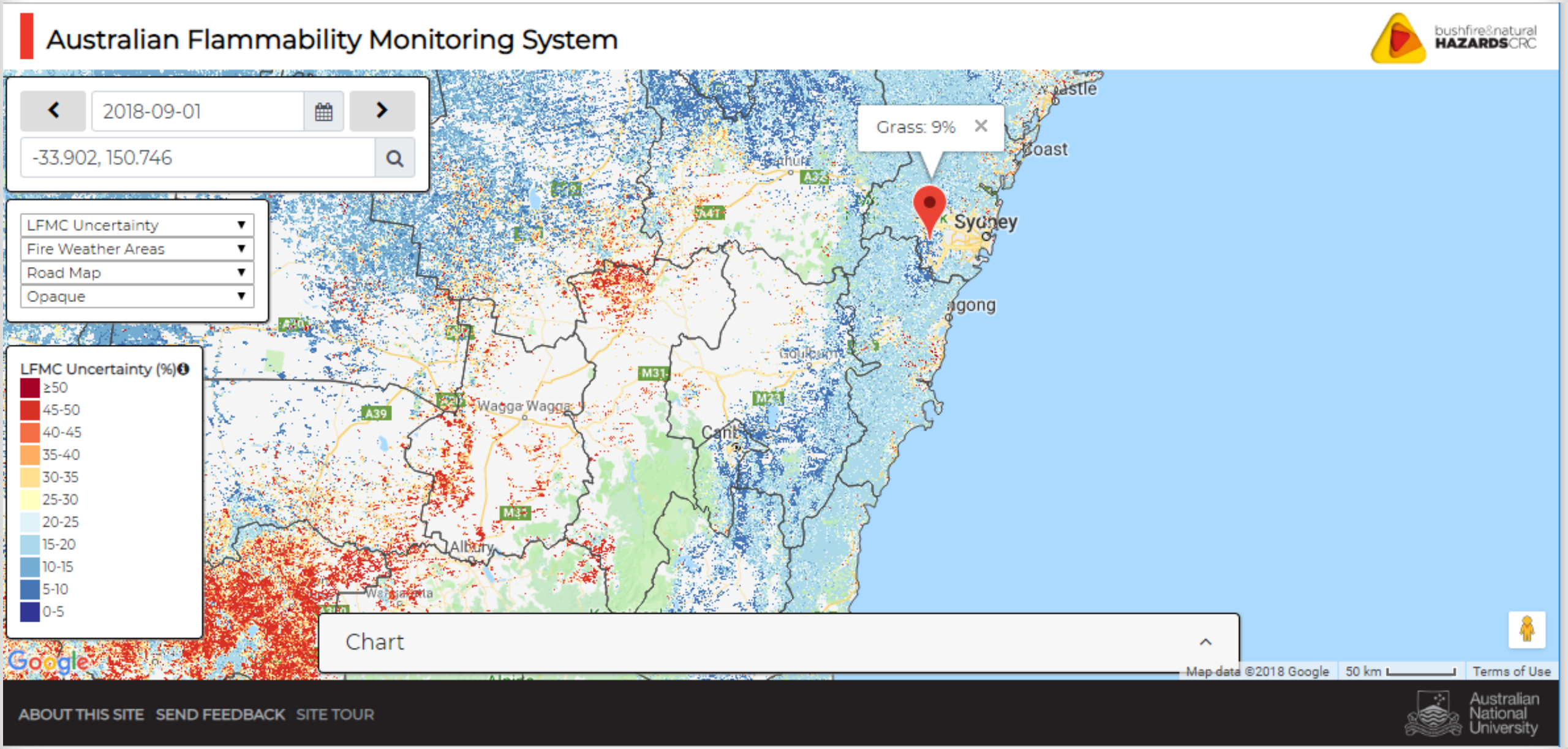

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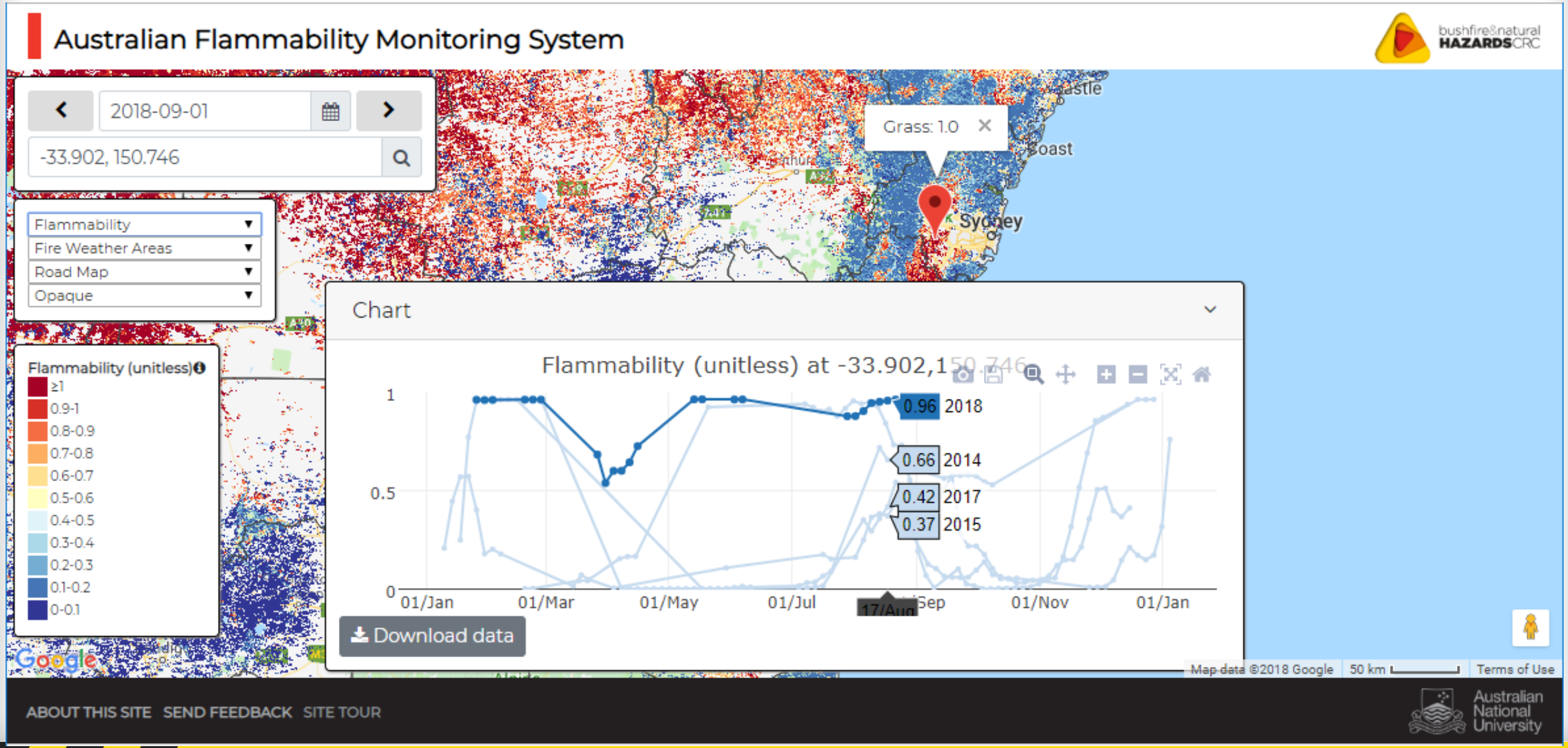

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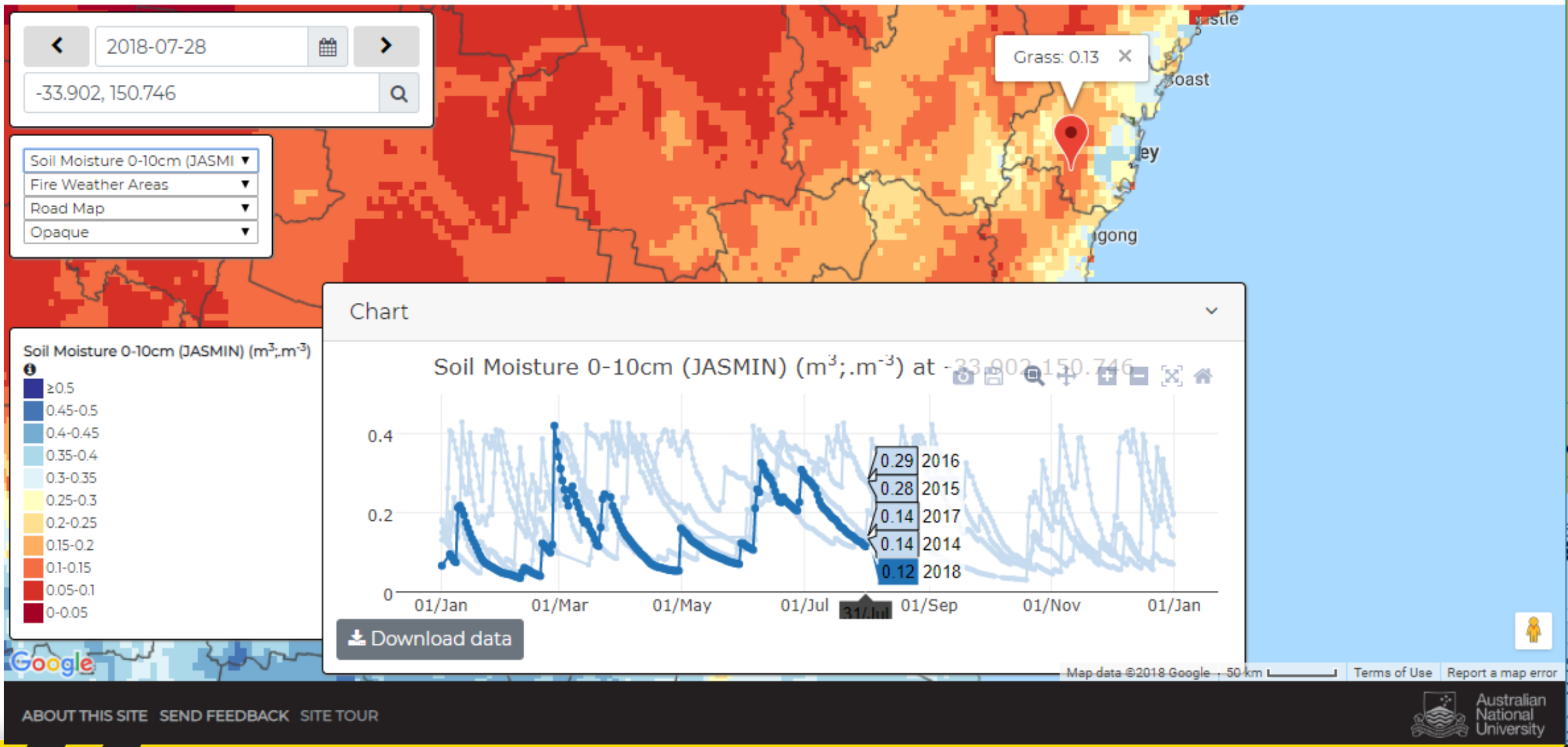
Australian Flammability Monitoring System



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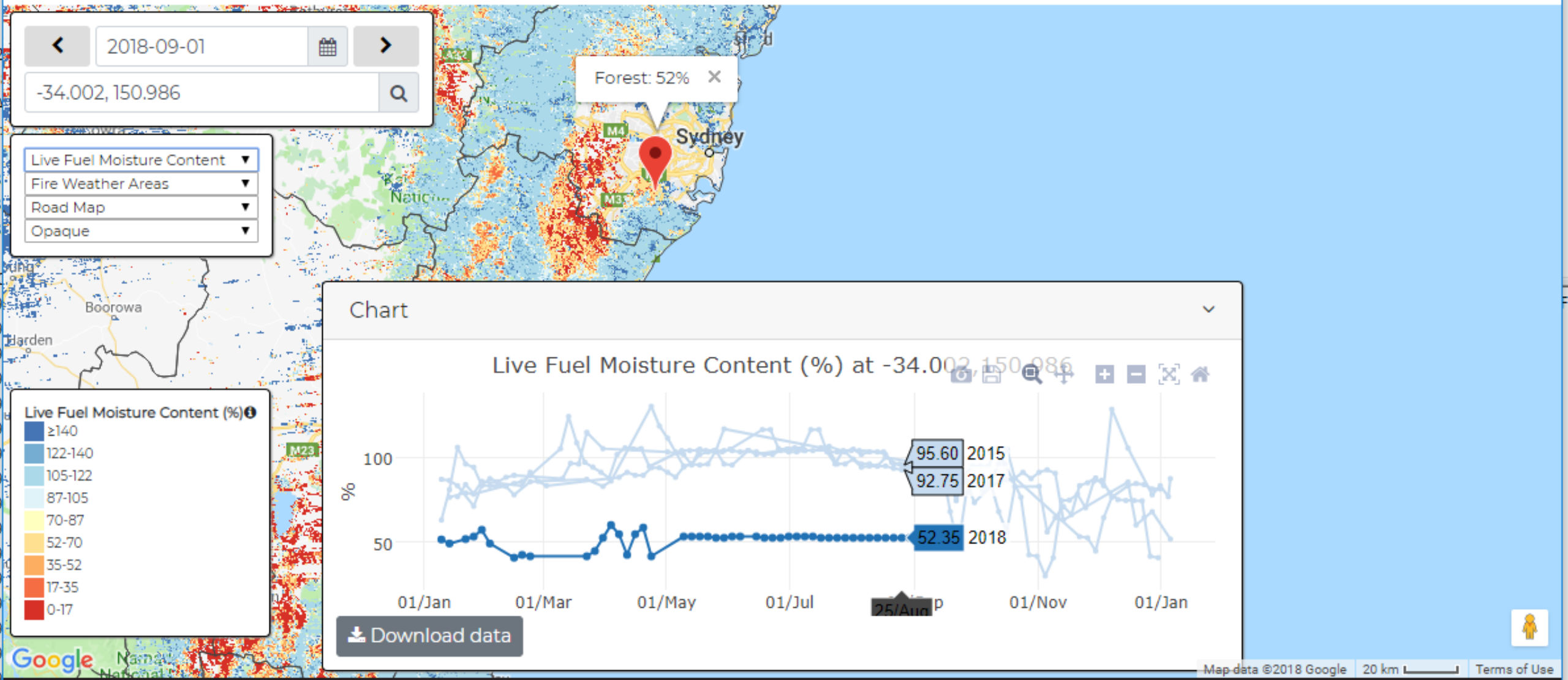

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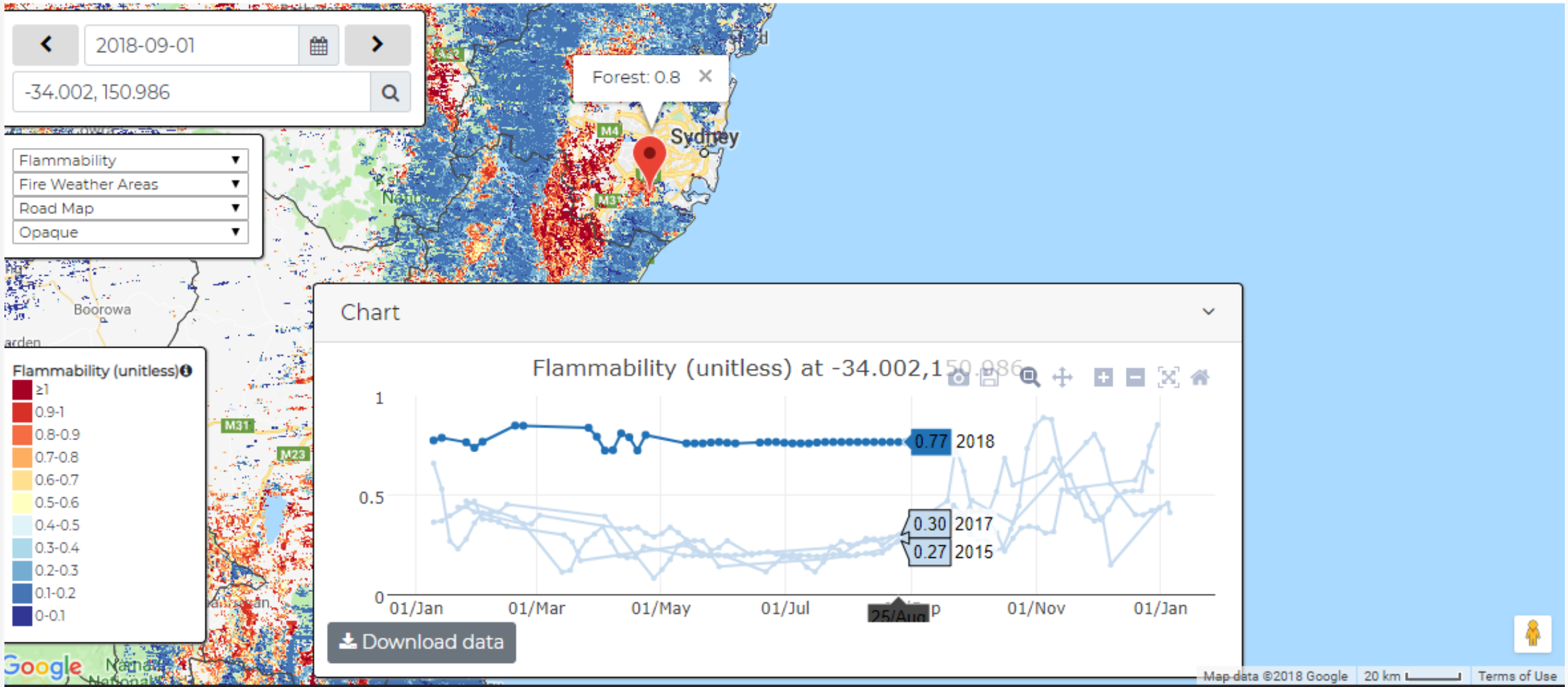

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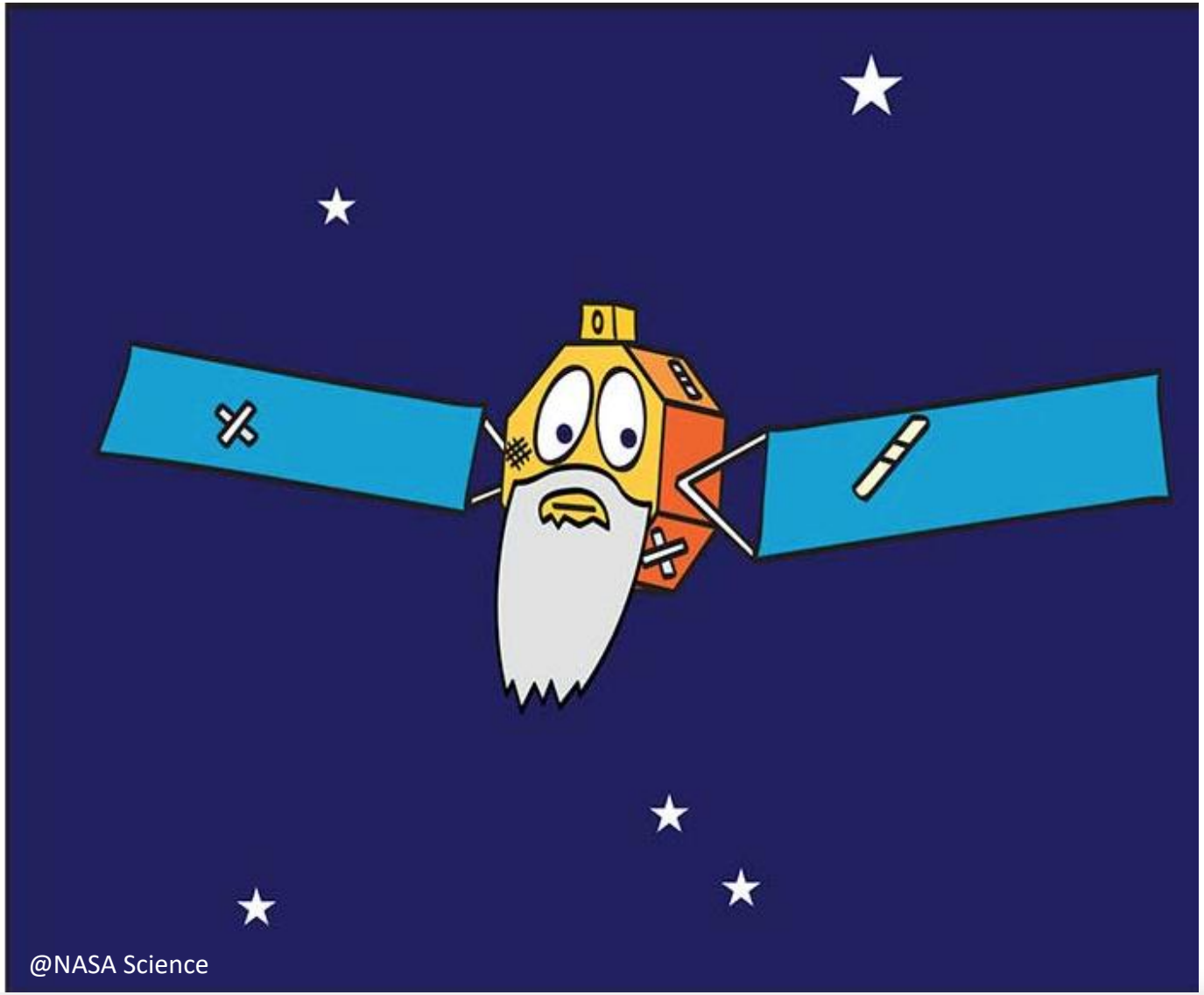
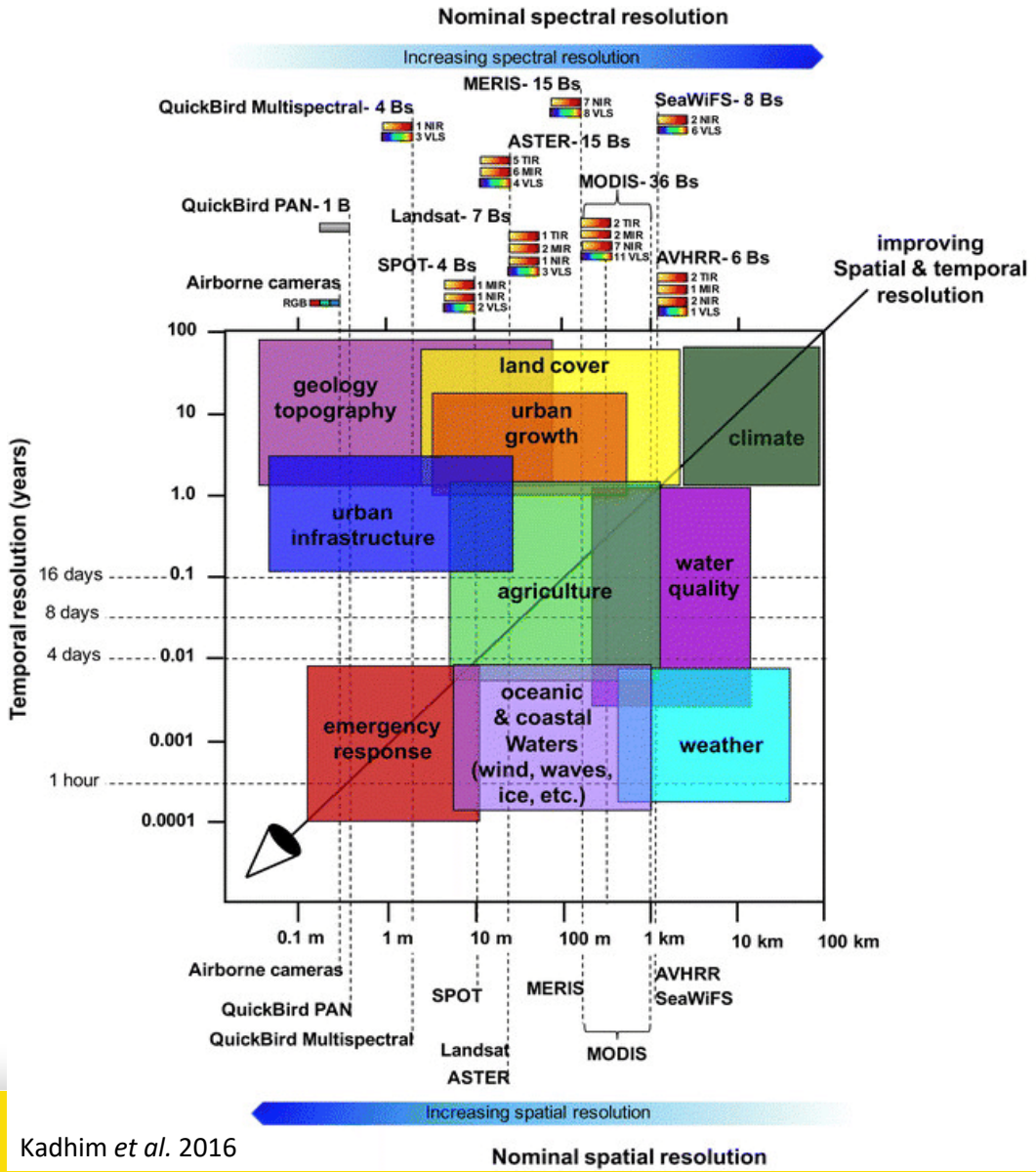
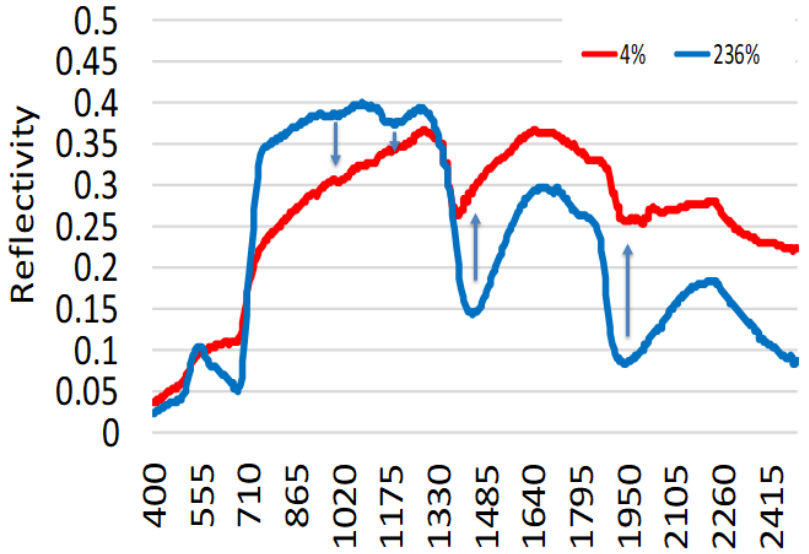
EVENTUALLY ALL SATELLITES GROW OLD, WEAR OUT, AND DIE



PLANNING FOR CONTINUITY



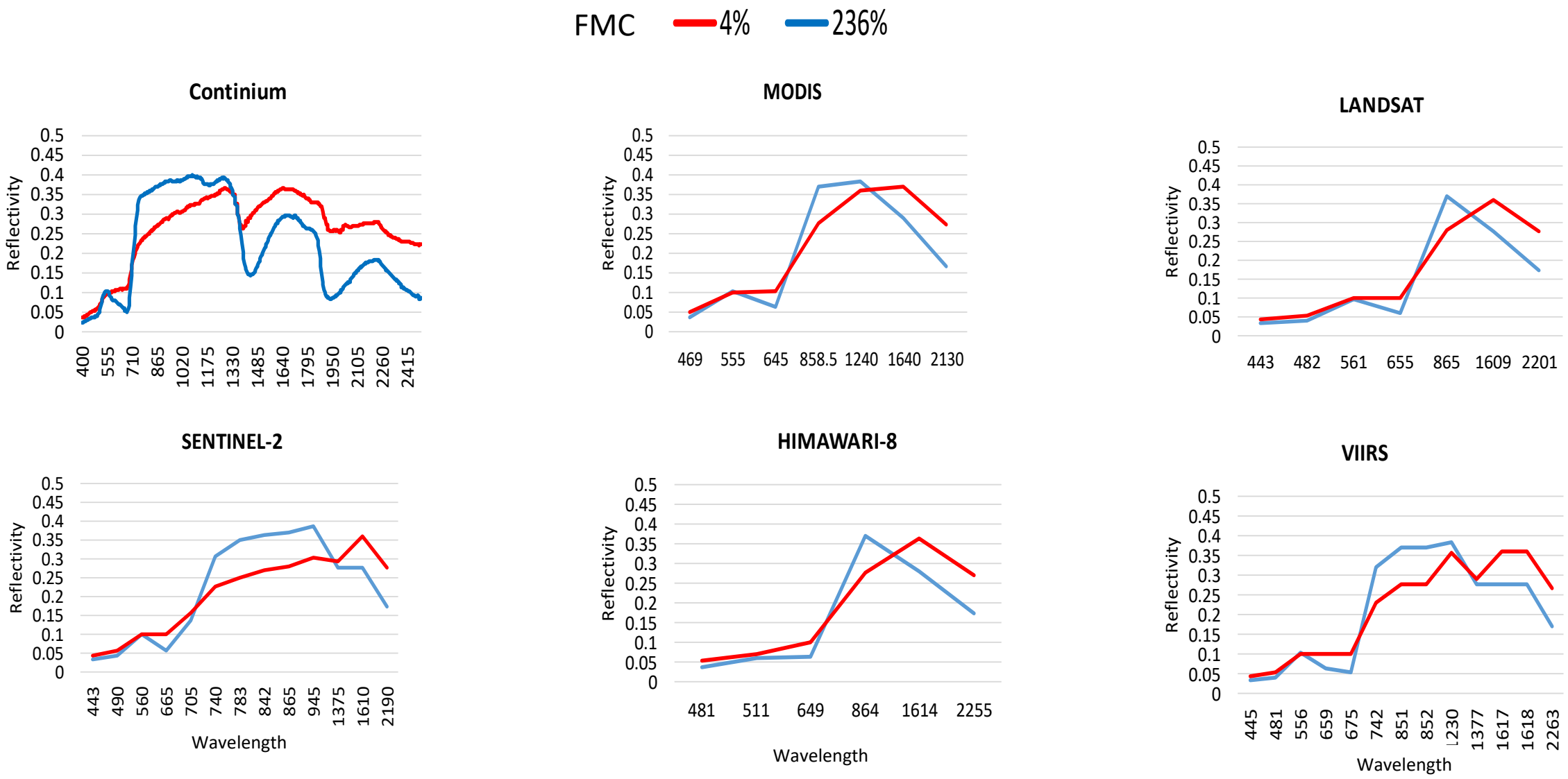
Kadhim *et al.* 2016



CANDIDATE SENSORS

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

SPECTRAL RESOLUTION OF CANDIDATE SENSORS



PERFORMANCE OF CANDIDATE SENSORS TO RETRIEVE FMC

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

PATH FORWARD

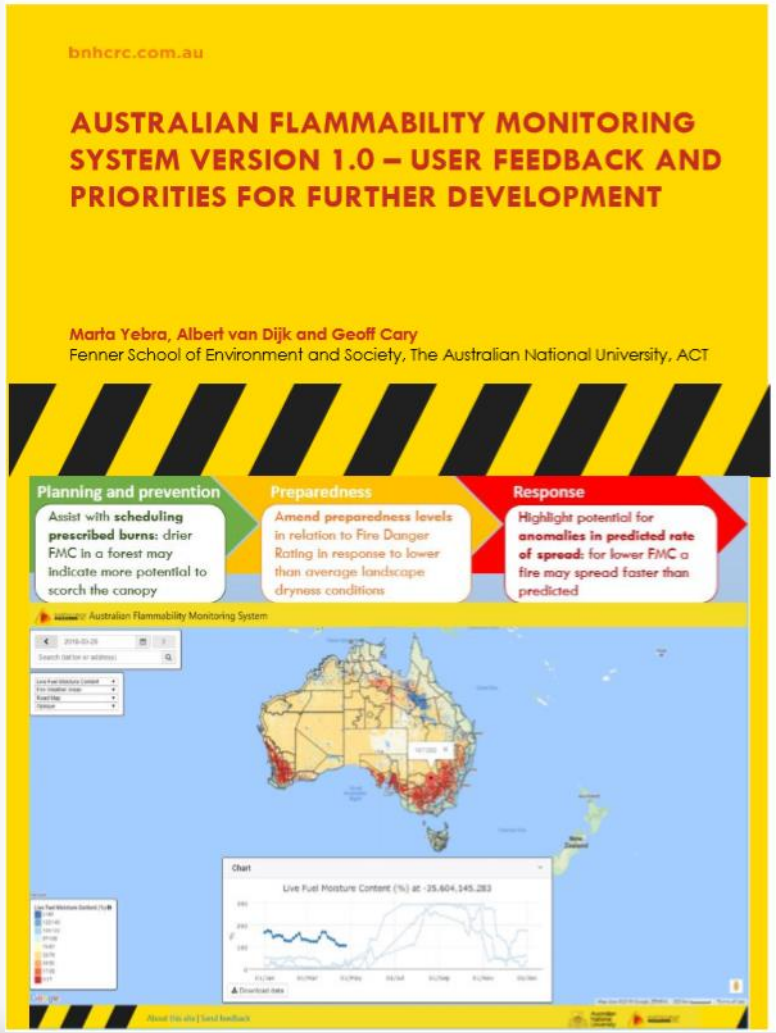


TABLE 1. SUMMARIZES THE USER FEEDBACK AND PRIORITIES FOR FURTHER DEVELOPMENT

THEME	FEEDBACK	SOLUTION
Web Service Enhancement	Pixels are not square	Change in the projection
	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
	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 or fire danger factor data layers that are already available online.
	Data needs to be integrated into the users' GIS systems	Allowing direct data downloads for a region of interest as GeoTIFF
	More regular updates of data displayed are needed	Automate this process
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.
	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
Algorithm development	Explore other satellite data sources to allow finer spatial and temporal resolution.	Suitability study of different satellite data sources

(Yebra et al., 2018, BNHCRC Report. http://www.bnhcrc.com.au/publications*)*

AFMS; TAKE HOME MESSAGE

- **First Australia-wide** system providing **near-real time** estimates of live FMC and flammability **predictions** one week ahead at 500m based on MODIS.

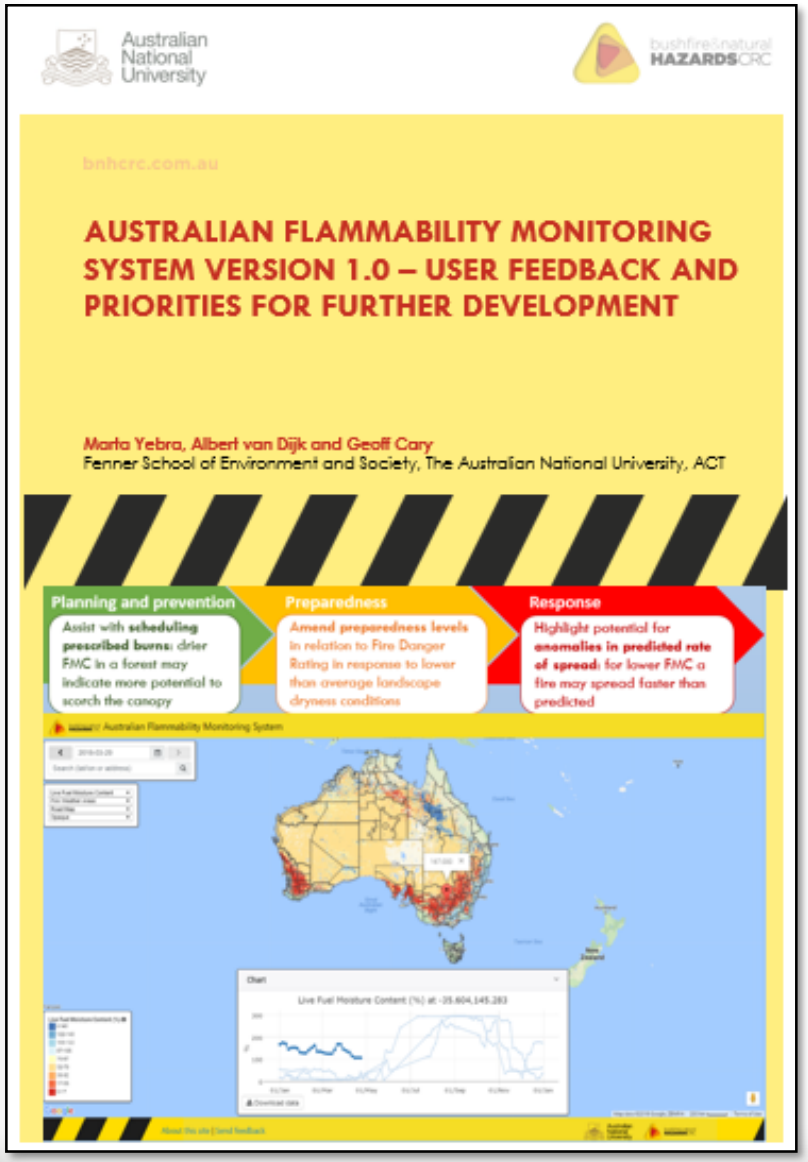
- Offers flexibility to incorporate other relevant spatial information that might be currently available (e.g. soil moisture)

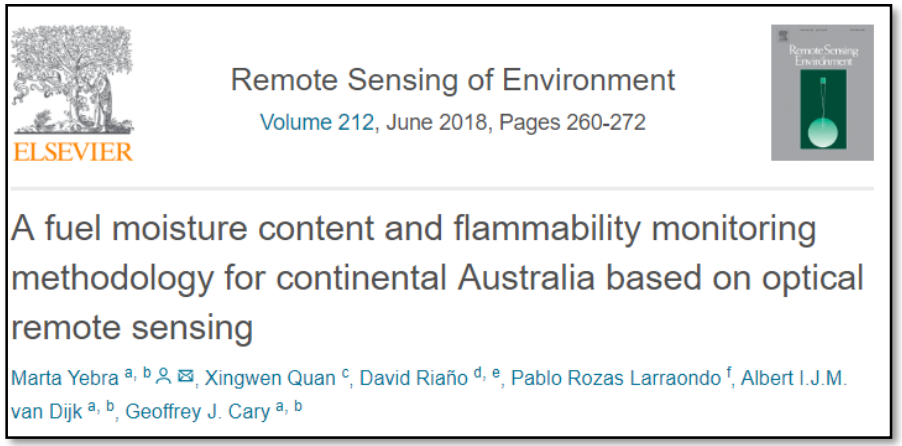
- **VIIRS** (750m, daily), **Sentinel-2** (20m, 5 days) and **Himawari-8** (2km,10 min) will ensure **continuity** at the same time than provide **finer spatial and temporal resolutions**.

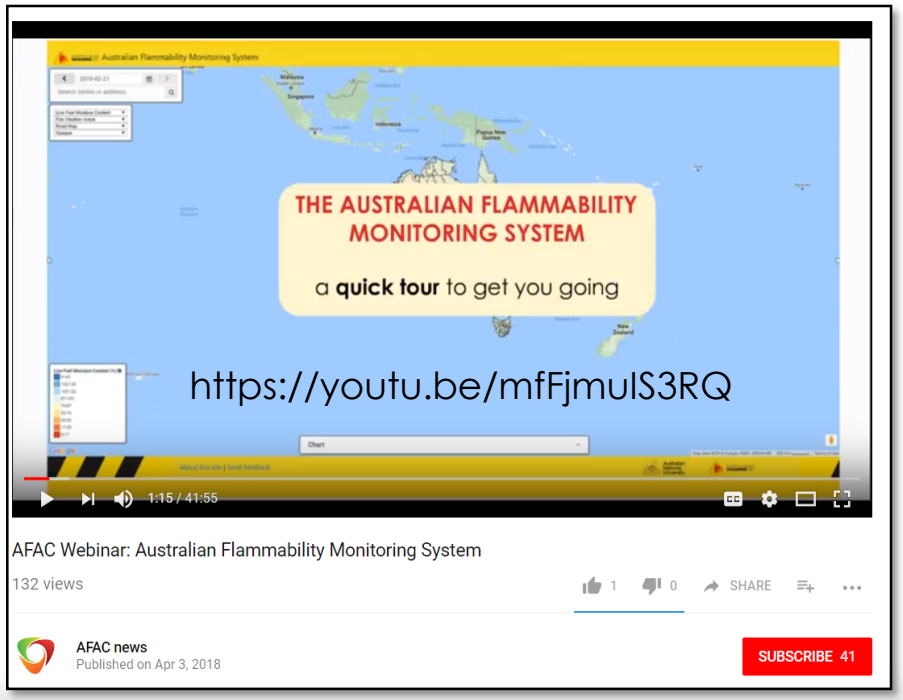
- AFMS can **help fire managers** in their prescribe burning efforts, improved awareness of fire hazards and pre-positioning of firefighting resources

- **Seeking your inputs to improve data usability!!**

MORE INFO







Link to data:
http://dapds00.nci.org.au/thredds/catalog/ub8/au/FMC/catalog.html

ACKNOWLEDGMENTS

Project end-users!!
Web developers; Pablo Rozas, Zac Hatfield Dodds, Joel Rahman, Chris Tapper

THANKS!

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