USING SATELLITE DATA TO IDENTIFY FUEL MOISTURE CONDITIONS PRIOR TO MAJOR FIRES IN SOUTH-EAST AUSTRALIA

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2009 BLACK SATURDAY AND OTHER LARGE FIRE EVENTS – MOISTURE CONDITIONS PROJECT

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BACKGROUND

- Fuel moisture (FM) is a primary driver of the ignition and spread of wildfires. Monitoring FM is thus critically important for predicting forest fire risk.
- FM models are commonly parameterised from weather observations, which can be spatially coarse, generating model uncertainty. In contrast, satellite observations offer a spatially explicit means of modelling FM.

RESEARCH QUESTIONS

1. What is the association between live fuel moisture, estimated from MODIS data, and major fire events in south-eastern Australia?
2. Can dead fuel moisture be estimated from MODIS data?

METHODS AND RESULTS

1. *Live fuel moisture prior to major fires*

- Live FM is estimated from the Normalized Difference Infrared Index (NDIIb6), based on 8-day composite spectral reflectance data.
- NDIIb6 = Band 2 – Band 6 / Band 2 + Band 6
- Anomalies in monthly NDIIb6 ('z-scores') are compared to an historical average of monthly NDIIb6 (calculated from 13 years of data).
- $Z_{kxy} = (SI_{kzy} - \alpha_{kx}) / \sigma_{kx}$; where Z_{kxy} and SI_{kzy} are the z-score and spectral index (NDIIb6) of pixel *k* for month *x* in year *y*; and α_{kx} and σ_{kx} are the mean and standard deviation over *n* years.
- Z-scores classified into fuel dryness classes[1] (Fig. 1).
- An analysis of multiple fire seasons in Victoria (SE Aus), found increased patches of dry or severely dry FM to be associated with an increase in the area burnt by wildfire (Fig. 2).

[1]Caccamo, G., Chisholm, L. A., Bradstock, R. A., Puotinen, M. L. 2012. Using remotely-sensed fuel connectivity patterns as a tool for fire danger monitoring. *Geophysical Research Letters* 39. L01302.

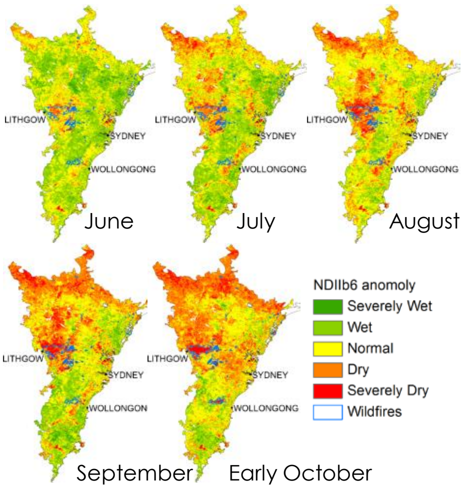

Figure 1: *Development of live fuel moisture prior to major fires in the Sydney Basin (an area of ~39 000 km²), in mid-October 2013. Note the dry patches east of Lithgow, where fire burnt 55 000 ha.*

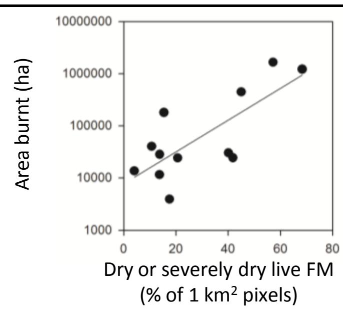

Figure 2: *Annual area of Victoria burnt by wildfire, as a function of the area classified as 'dry', or 'severely dry' for a given fire season,* r^2*=0.57.*

2. *Live fuel moisture prior to major fires*

- FM was collected across south-eastern Australia in eucalypt forest and woodland (Fig. 3).
- Dead fuel moisture collected included 1-hour and 10-hour suspended fuels and profile fuel.
- FM was also continuously monitored with Campbell 10-hour fuel moisture sensors.
- A range of MODIS derived variables were regressed against observed dead FM.

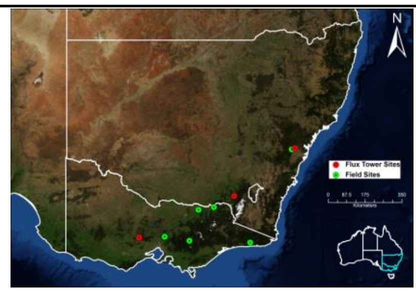

Figure 3: *Location of fuel moisture field sites*

- Vapour pressure deficit, calculated from MODIS land surface temperature, was well correlated with dead FM, particularly when the relationship was independently modelled on days with and without recent rain (Fig. 4).

CONCLUSIONS

1. The proportion of live fuel moisture across a landscape that is classified as 'dry', is a good indicator of forest fire hazard condition.
2. Dead fuel moisture can be estimated from remotely sensed vapour pressure deficit on days without rain.

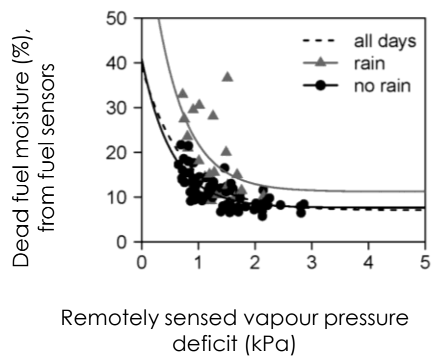

Figure 4: *Relationship between dead fuel moisture and vapour pressure deficit, estimated from MODIS land surface temperature*

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