Mapping bushfire hazard and impacts

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## AFMS: Agreed developments priorities

Order the following future developments by priority:

<table>
<thead>
<tr>
<th>Development</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry/transition/wet maps based on empirical FMC threshold values that explain fire occurrence</td>
<td>1st</td>
</tr>
<tr>
<td>Deciles maps</td>
<td>2nd</td>
</tr>
<tr>
<td>Times series plumes showing max/min/median instead of 3 previous years</td>
<td>3rd</td>
</tr>
<tr>
<td>Include information on forest cover</td>
<td>4th</td>
</tr>
<tr>
<td>Include the uncertainty in the pop-up for a pixel</td>
<td>5th</td>
</tr>
<tr>
<td>Download Grid as GeoTIFF</td>
<td>6th</td>
</tr>
<tr>
<td>Distribution of values within a polygon</td>
<td>7th</td>
</tr>
<tr>
<td>Include incident feed</td>
<td>8th</td>
</tr>
</tbody>
</table>

Yes and no:

- Yes: ✓
- No: ☐

Total Responses: 14
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?

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](http://rfs.nsw.gov.au/fdr) #nswrf
Other new features

Australian Flammability Monitoring System

- Toggle current incidents
- Live Fuel Moisture Content (%) at -29.023,152.500

Chart

- Download chart data

Alert level: Advice
Location: Long Gully Rd, Drake, NSW
Council area: Tenterfield
Status: Under control
Type: Bush Fire
Fire: Yes
Size: 74111 ha
Major fire update as at 15 Oct 2019 5:43PM
More information
Responsible agency: Rural Fire Service
Updated: 15 Oct 2019 16:22

FMC (Deciles) (unitless)
- Very much above average
- Above average
- Average
- Below average
- Very much below average
Temporal FMC dynamics: Deepwater fire 2018

Mean for Deepwater fire perimeter
FMC map for Australia

Based on FMC thresholds that explain fire occurrence

Dennison et al. 2008, IJWF
### 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).

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

Gale et al., 2017

Murphy et al (2013)
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 ($w_0$, 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 ($T_{max}$, °C)
  - Daily mean wind speed ($U_{avg}$, m/s)
- Calculated from $T_{max}$ 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

Herbert and Lower Burdekin (QLD) – grassland (N=293)

Factor fire danger

Predicted and observed fire frequency
Future work: Bayesian Learning Networks

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

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

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

\[
\text{Joint } pd = p(wD) \cdot p(\text{Tmax}) \cdot p(\text{Uavg}) \cdot p(wS|wD) \cdot p(\text{VPD}|\text{Tmax}) \cdot p(\text{FMC}|wS,\text{VPD}) \\
p(w0|wS,\text{Uavg}) \cdot p(\text{RH}|w0, \text{Uavg}, \text{VPD}) \cdot p(\text{Fire}|\text{FMC,RH})
\]

**Joint distribution**

![Diagram of Bayesian Learning Network](image)
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 GA

Include our new FDI

Fire Danger forecast (using BoM ACCESS weather forecast)
Thanks

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Pierces Creek Fire at sunset @ Marta Yebra

NCI