MAPPING BUSHFIRE HAZARD AND IMPACT

Developing spatial information on fire hazard for planners, land managers and emergency services

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PROJECT END-USERS

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3. John Bally, Bureau of Meteorology
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9. Simeon Telfer, Department of Environment, Water and Natural Resources, SA
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11. David Taylor, Tasmania Parks and Wildlife Service
12. Frank Crisci and Ali Walsh, SA Power Networks
13. David Hudson and Maggie Tran, Geoscience Australia.
PROJECT EXTERNAL COLLABORATORS

• Philip Frost (CSIR-South Africa)
• David Riano (UC-Davis, USA)- Visiting research fellow Sept 2016 (funds from the ANUCES and UC-Davis professional development award.
• Emilio Chuvieco (University of Alcala, Spain)
• Alex Held (CSIRO / TERN-AUSCOVER)
• Philip Zylstra (UOW)
• Samsung Lim (UNSW)
• Darius Culvenor (Sensing Systems)
• Xingwen Quan (UT China)
• Pablo Rozas (NCI)
• Glenn Newman, Ross Bradstock, Mathias Boer, Rachael Nolan
PROJECT STUDENTS

PhD students:

• **Yang Chen** (University of Monash-APA + BNHCRC top-up). “Mapping forest fuel load and structure from LiDAR”. GRADUATED!

• **Andrea Massetti** (University of Monash-APA + BNHCRC Associate student). "Enhancement of fire spread modelling using high-resolution remotely sensed data".

• **Li Zhao** (Chinese enviromental institution+BNHCRC). “Spatial forecasting coupled litter and root zone moisture dynamics for bushfire management”

Master students

• **Honghao Zeng** (ANU). “Using weather data ad satellite-derived FMC to estimate flammability for Australia"
THE AUSTRALIAN FLAMMABILITY MONITORING SYSTEM (AFMS) WEBSITE

First continental-scale prototype website providing spatial information on fuel moisture content and landscape-scale fuel flammability derived from satellite observations.
New mapping system set to predict severity of bushfire season from space

ABC RADIO CANBERRA – HANNAH WALMSLEY
TUE 12 SEP 2017, 9:00 AM AEST

PHOTO: A warm and dry winter is the major contributor to summer bushfire risk.

Can you predict bushfires from space? ANU scientist Dr Marta Yebra is researching new uses for satellites in space
AFMS WEBSITE

Data currently displayed (2001-August 2017*, 500 m, 4 days*)
- Fuel Moisture Content (FMC) physical model based on the inversion of Radiative Transfer Models.
- Uncertainty in the FMC estimates
- Flammability index ($FI$, 0-1) by comparison of satellite-based FMC with mapping of actual fire events (MODIS).
- Fuel class mask (grassland, shrubland, forest)

Basic input data
- MODIS reflectance (4 days*)
- MODIS land cover type (yearly)
1. Layers
   1. Live FMC
   2. Uncertainty
   3. Flammability
   4. Fuel Class
2. Vectors
   1. States Territories
   2. Local Government Areas
   3. Fire Weather Areas
   4. Defence Training areas
   5. National Parks
   6. NRM Regions
3. Road Map/Satellite
4. Opaque/Transparent

AFMS WEB SITE: VISUALIZATION OPTIONS

http://wenfo.org/afms/
AFMS WEB SITE: FEATURES

Allows users to **visualise and interpret national-scale** information on FMC and flammability as **maps**

(Bushfire outlook ≈ timing of the drying of the fuel)

**Example: Overview of FMC in 2015**

1) Temperate zones of Australia
   a) Low FMC values in January.
   b) FMC reach their maximum at the end of winter or beginning of spring (August/September).
   c) FMC started to decrease until the end of the summer when values reach their minimums.
2) Tropical regions in the north of the country, the tendency was the opposite.
3) Desert zones FMC values constantly low
AFMS WEB SITE: FEATURES

Allows users to visualise and interpret national-scale information on FMC and flammability as graphs.

http://wenfo.org/afms/
AFMS WEBSITE: YOUR FEEDBACK IS ESSENTIAL FOR FUTURE DEVELOPMENTS!!

1) Additional **data** that could be displayed;

   a) BoM’s JASMIN Soil Moisture Content estimates
   b) Fuels3D data? (RMIT group)

   c) Information on past fires (occurrence, intensity and burn extent from MODIS)
   d) Fire weather, Grassland curing
   e) Near surface fuel moisture content (Matthews et al. 2006)

2) Additional **web features** that could be added

   a) e.g. Regional summaries?
      • States Territories
      • Local Government Areas …
RESEARCH PLAN FOR 2017-2020

SPECIFIC OBJECTIVES

1. To collect field observations of FMC and spectra from a variety of relevant fuel types and further calibrate and verify the FMC retrieval method, and to quantify its uncertainty and reliability in the context of fire risk assessment.

2. To integrate other factors such as fire weather, dead FMC and total biomass into AFMS for a comprehensive characterization of flammability.

3. To investigate the use of reflectance data from alternative satellite instruments in AFMS to achieve long-term continuity as well as improved temporal and spatial quality.

4. To further evaluate alternative low-cost in-field methods to develop innovative ways to monitor key fuel properties determining fire hazard (e.g. FMC, fuel structure and fuel load).
## COMPREHENSIVE CHARACTERIZATION OF FLAMMABILITY

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Fuel class</th>
<th>Equation</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (T) and relative humidity (RH)</td>
<td>grassland</td>
<td>$0.2007 - 0.0062 \times T_{\text{max}_{t-1}}$</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>shrubland</td>
<td>$-0.0017 - 0.00097 \times V_{\text{ph15}<em>{t-1}} + 0.00266 \times V</em>{\text{ph15}_{t-2}}$</td>
<td>0.499</td>
</tr>
<tr>
<td>T+RH+FMC</td>
<td>grassland</td>
<td>$2.94 - 0.06 \times LFMC_{t-1} + 0.08 \times LFMC_{\text{Difference}<em>t} + 1.21 \times LFMC</em>{\text{Anomaly}<em>{t-1}} + 0.0057 \times T</em>{\text{max}_{t-1}}$</td>
<td>0.93</td>
</tr>
<tr>
<td></td>
<td>shrubland</td>
<td>$4.64 - 0.078 \times LFMC_{t-1} - 0.021 \times LFMC_{\text{Difference}<em>t} + 0.075 \times LFMC</em>{\text{Anomaly}<em>{t-1}} + 0.0013 \times V</em>{\text{ph15}<em>{t-1}} + 0.0021 \times V</em>{\text{ph15}_{t-2}}$</td>
<td>0.8</td>
</tr>
<tr>
<td>FMC</td>
<td>grassland</td>
<td>$0.18 - 0.01 \times LFMC_{t-1} + 0.02 \times LFMC_{\text{Difference}<em>t} - 0.02 \times LFMC</em>{\text{Anomaly}_{t}}$</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>shrubland</td>
<td>$5.66 - 0.09 \times LFMC_{t-1} + 0.005 \times LFMC_{\text{Difference}<em>t} - 0.28 \times LFMC</em>{\text{Anomaly}_{t}}$</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>forest</td>
<td>$1.51 - 0.03 \times LFMC_{t-1} + 0.02 \times LFMC_{\text{Difference}<em>t} - 0.02 \times LFMC</em>{\text{Anomaly}_{t}}$</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Zeng, 2017
THANK YOU!!

Acknowledgments

Web developers; Zac Hatfield Dodds, Joel Rahman (Flow Matters), Chris Tapper
Project collaborators: Xingwen Quan, Glenn Newman, Gabrielle Caccamo, Ross Bradstock, Mathias Boer, Rachael Nolan, Pablo Rozas

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Journal papers published

LIVE OR DEAD FUEL MOISTURE CONTENT?

[Image of a graph showing Fuel Moisture Content (%) over time from 2013 to 2016.]
FUEL MOISTURE CONTENT OF WHICH STRATA?

Pixel (500 x500 m)
Holgate et al. (2017)

- Evaluated the replacement of KBDI and DF in FFDI with alternative soil moisture (SM) estimates
- KBDI had a wet & slow bias; appears to be representative of a deep SM profile.
- Direct replacement of KBDI or DF with a alternative SM causes different behaviour of FFDI.
- DF dynamics agree better with (shallow) SM – if at all, consider replacing entire DF with SM.

Frequency of FDR categories at Yanco (Vic) replacing KBDI with alternative soil moisture estimates.